Solved Paper 2016

PHYSICS

1. A man who weighs 670 N runs the first 7.0 m in 1.6 s, starting from rest and accelerating uniformly. What is the average power does the man generate during the 1.6 s time interval?

(a) 3.2 kW　　　　(b) 1.6 kW

(c) 0.9 kW　　　　(d) None of these

2. The kinetic energy of a particle of mass m kg is half of that of another particle of mass $m/2$ kg. If the speed of heavier particle is increased by $3\,m\,s^{-1}$, its kinetic energy becomes equal to the original kinetic energy of the lighter particle. The original speeds of the heavier and lighter particles are

(a) $3\,m\,s^{-1}$, $6\,m\,s^{-1}$　　(b) $2\,m\,s^{-1}$, $4\,m\,s^{-1}$

(c) $2\,m\,s^{-1}$, $6\,m\,s^{-1}$　　(d) $4\,m\,s^{-1}$, $8\,m\,s^{-1}$

3. Starting from origin, a body moves along x-axis. Its velocity at any time is given by $v = 4t^3 - 2t\,m\,s^{-1}$.

Acceleration of the particle when it is 2 m away from the origin is

(a) $28\,m\,s^{-2}$　　　　(b) $12\,m\,s^{-2}$

(c) $22\,m\,s^{-2}$　　　　(d) $14\,m\,s^{-2}$

4. Two cars are in a race. The white car passed the finishing point with a velocity $v\,m\,s^{-1}$ more and took time t s less than the red car. If both the cars start from rest and travel with constant accelerations a_w and a_r respectively, $\dfrac{v}{t}$ is given

(a) $a_w a_r$　(b) $\sqrt{\dfrac{a_w}{a_r}}$　(c) $\sqrt{a_w a_r}$　(d) $\sqrt{\dfrac{a_r}{a_w}}$

5. Three particles P, Q and R are at rest at the vertices of an equilateral triangle of side s. Each of the particles starts moving with constant speed $v\,m\,s^{-1}$. P is moving along PQ, Q along QR and R along RP. The particles will meet each other at time t given by
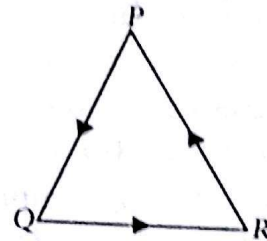
(a) $\dfrac{s}{v}$　(b) $\dfrac{3s}{v}$　(c) $\dfrac{3s}{2v}$　(d) $\dfrac{2s}{3v}$

6. A drunkard walking in a narrow lane takes 5 steps forward and 3 steps backward, followed again by 5 steps forward and 3 steps backward and so on. Each step is 1 m long and requires 1 s. Determine how long the drunkard takes to fall in a pit 13 m away from the starting point.

(a) 37 s　(b) 13 s　(c) 49 s　(d) 18 s

7. The displacement x of a body varies with time as

$$x = -\frac{1}{3}t^2 + 16t + 3$$

where x is in metres and t is in seconds. The time taken by the body to come to rest is

(a) 12 s　(b) 24 s　(c) 30 s　(d) 36 s

8. The expression of the trajectory of a projectile is given as

$$y = px - qx^2,$$

where y and x are respectively the vertical and horizontal displacements, and p and q are constants. The time of flight of the projectile is

(a) $\dfrac{p^2}{4q}$　(b) $\dfrac{p^2}{2q}$　(c) $\sqrt{\dfrac{2p}{qg}}$　(d) $p\sqrt{\dfrac{2}{qg}}$

9. A particle moving with an initial velocity $u\,m\,s^{-1}$ is retarded by a force at the rate of $a = -k\sqrt{v}$, where k is a positive constant and

v is the instantaneous velocity. The particle comes to rest in a time given by

(a) $\dfrac{2\sqrt{u}}{k}$ (b) $k\sqrt{u}$ (c) $\dfrac{\sqrt{2u}}{k}$ (d) $\dfrac{\sqrt{u}}{2k}$

10. The velocity of a transverse wave in a string is directly proportional to $\sqrt{T}$ and inversely proportional to $\sqrt{\mu}$. In a measurement, the mass applied at the end of string is 3.0 gm, length of string is 1 m and mass of string is 5 gm. If possible error in measuring mass is 0.1 gm and that of length is 1 mm, the percentage error in measurement of velocity is

(a) 4.5%   (b) 2.7%   (c) 2.1%   (d) 3.7%

11. A gas at pressure P_0 is contained in a vessel. If the masses of all the molecules are halved and their speeds doubled, the resulting pressure would be

(a) $4P_0$ (b) $2P_0$ (c) P_0 (d) $\dfrac{P_0}{2}$

12. A gas under constant pressure of 4.5×10^5 Pa when subjected to 800 kJ of heat, changes the volume from 0.5 m³ to 2.0 m³. The change in internal energy of the gas is

(a) 6.75×10^5 J   (b) 5.25×10^5 J
(c) 3.25×10^5 J   (d) 1.25×10^5 J

13. Work done in increasing the size of a soap bubble from a radius of 3 cm to 5 cm is nearly (surface tension of soap solution = 0.03 N m⁻¹)

(a) 4π mJ   (b) 0.4π mJ
(c) 0.2π mJ   (d) 2π mJ

14. A cylinder of radius R made of a material of thermal conductivity, k_1 is surrounded by a cylindrical shell of inner radius R and outer radius $2R$ and made of a material of thermal conductivity, k_2. The two ends of the combined system are maintained at two different temperatures. There is no loss of heat across the cylindrical surface and the system is in steady state. The effective thermal conductivity of the system is

(a) $\dfrac{3k_1 + k_2}{4}$ (b) $\dfrac{k_1 + 3k_2}{4}$

(c) $k_1 + k_2$ (d) $\dfrac{k_1 k_2}{k_1 + k_2}$

15. The density of air in atmosphere decreases with height and can be expressed by the relation $\rho = \rho_0 e^{-\alpha h}$, where ρ_0 is the density at sea level, α is a constant and h is the height. The atmospheric pressure at the sea level is

(a) $\dfrac{\rho_0 g}{\alpha}$ (b) $\dfrac{\rho_0 \alpha h}{g}$ (c) $\dfrac{\alpha h}{\rho_0 g}$ (d) $\dfrac{h}{\rho_0 g}$

16. Two wires of equal cross section but one made of steel and the other of copper, are joined end to end. When the combination is kept under tension, the elongations in the two wires are found to be equal. (Y for steel $= 2 \times 10^{11}$ N/m² and Y for copper $= 1.1 \times 10^{11}$ N/m²). The ratio of the lengths of the two wires is

(a) 20 : 11   (b) 2 : 1   (c) 1 : 2   (d) 1 : 1

17. An asteroid of mass $2 \times 10^{-4} M_e$, where M_e is the mass of the earth, revolves in a circular orbit around the sun at a distance that is twice earth's distance from the sun. Find the ratio of the kinetic energy of the asteroid to that of earth.

(a) 0.9×10^{-6} (b) 1.6×10^{-5}
(c) 3.6×10^{-5} (d) 1.0×10^{-4}

18. The density of a newly discovered planet is twice that of earth. The acceleration due to gravity at the surface of the planet is equal to that at the surface of the earth. If the radius of the earth is R, the radius of the planet would be

(a) $4R$ (b) $2R$ (c) $R/2$ (d) $R/4$

19. Find the x and y coordinates of the centre of mass of the three particle system (as shown).

(a) 1.0 m, 1.0 m
(b) 1.3 m, 0.9 m
(c) 1.1 m, 1.3 m
(d) 1.3 m, 1.1 m
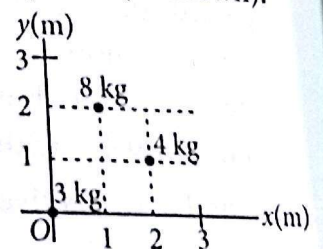
20. The torque acting on a body about a given point is given by $\vec{\tau} = \vec{A} \times \vec{L}$, where $\vec{A}$ is a constant vector and $\vec{L}$ is the angular momentum of the body about that point. It follows that

(a) the magnitude of $\vec{L}$ does not change with time.

(b) the component of $\vec{L}$ in the direction of $\vec{A}$ does not change with time.

(c) $\dfrac{d\vec{L}}{dt}$ is perpendicular to $\vec{L}$ at all instants of time.

(d) all the above choices are correct.

21. A disc of mass M and radius R is rolling with angular speed ω on a horizontal surface as shown in figure. The magnitude of angular momentum of the disc about the origin O is (here v is the linear velocity of the disc)

(a) $\dfrac{3}{2}MR^2\omega^2$ (b) $MR^2\omega$

(c) MRv (d) $\dfrac{3}{2}MRv$
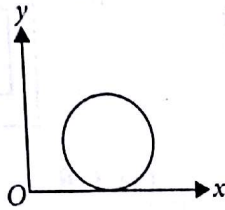
22. If the moment of inertia of a disc about an axis tangential and parallel to its surface be I, then the moment of inertia about an axis tangential but perpendicular to the surface will be

(a) $\dfrac{6}{5}I$ (b) $\dfrac{3}{4}I$ (c) $\dfrac{3}{2}I$ (d) $\dfrac{5}{4}I$

23. A long straight wire of radius R carries a steady current I. The current is uniformly distributed across its cross-section. The ratio of magnetic field at $R/2$ and $2R$ is

(a) $\dfrac{1}{2}$ (b) 2 (c) $\dfrac{1}{4}$ (d) 1

24. An ion with a charge of $+3.2\times10^{-19}$ C is in a region where a uniform electric field of 5×10^4 V/m is perpendicular to a uniform magnetic field of 0.8 T. If its acceleration is zero, then its speed must be

(a) 0 (b) 1.6×10^4 m/s
(c) 4.0×10^4 m/s (d) 6.3×10^4 m/s

25. Two particles X and Y having equal charges, after being accelerated through the same potential difference, enter a region of uniform magnetic field and describe circular paths of radii R_1 and R_2 respectively. The ratio of masses of X and Y is

(a) $\left(\dfrac{R_1}{R_2}\right)^{1/2}$ (b) $\left(\dfrac{R_2}{R_1}\right)$

(c) $\left(\dfrac{R_1}{R_2}\right)^{2}$ (d) $\left(\dfrac{R_1}{R_2}\right)$

26. A wire is being drawn to make it thinner such that the length of the wire l increases and radius r decreases. Its resistance R will finally be proportional to

(a) $\dfrac{1}{r}$ (b) $\dfrac{1}{r^2}$ (c) $\dfrac{1}{r^3}$ (d) $\dfrac{1}{r^4}$

27. Three batteries of emf 1 V and internal resistance 1 Ω each are connected as shown. Effective emf of the combination between the points P and Q is
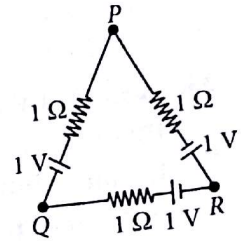
(a) zero (b) 1 V (c) 2 V (d) $\dfrac{2}{3}$ V

28. Two bulbs consume the same power when operated at 200 V and 300 V respectively. When these bulbs are connected in series across a D.C. source of 500 V then the ratio of potential difference across them is

(a) $\dfrac{2}{3}$ (b) $\dfrac{4}{9}$ (c) $\dfrac{6}{27}$ (d) $\dfrac{8}{24}$

29. Three resistances P, Q and R, each of 2 Ω and an unknown resistance S form the four arms of a Wheatstone bridge circuit. When a resistance of 6 Ω is connected in parallel to S, the bridge gets balanced. The value of S is

(a) 3 Ω (b) 6 Ω (c) 1 Ω (d) 2 Ω

30. A point charge $+Q$ is placed at a distance $d/2$ directly above the centre of a square of side d. The magnitude of electric flux through the square is

(a) $\dfrac{Q}{6d}$ (b) $\dfrac{Q}{6\varepsilon_0}$ (c) $\dfrac{Qd}{6\varepsilon_0}$ (d) $\dfrac{Q\varepsilon_0}{6d}$

31. Three plates A, B and C each of area 50 cm^2 have separation 3 mm between A and B and 6 mm between B and C. The energy stored when the plates are fully charged by a 12 volt battery is
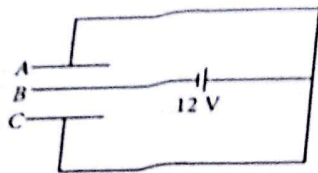
(a) 2 μJ   (b) 1.6 nJ   (c) 5 μJ   (d) 3.2 nJ

32. A photographic flash unit consists of a xenon filled tube. It gives a flash of average power 2000 W for 0.04 sec. The flash is due to discharge of a fully charged capacitor of 40 μF. The voltage to which it is charged before a flash is given by the unit is

(a) 1500 V   (b) 2000 V
(c) 2500 V   (d) 3000 V

33. A quantity of a substance in a closed system is made to undergo a reversible process from an initial volume of 3 m³ and initial pressure 10^5 N/m² to a final volume of 5 m³. If the pressure is proportional to the square of the volume (*i.e.* $P = AV^2$), the work done by the substance will be

(a) 3.6×10^2 J   (b) 7.4×10^3 J
(c) 2.2×10^4 J   (d) 3.6×10^5 J

34. An ideal gas at pressure P is adiabatically compressed so that its density becomes n times the initial value. If $\gamma = C_p/C_v$, the final pressure of the gas will be

(a) $n^{(1-\gamma)}P$ (b) $n^{(r-\gamma)}P$
(c) $n^{(-\gamma)}P$ (d) $n^{(\gamma)}P$

35. The red shift observed for stars due to the natural expanding of universe is given by the expression

(a) $(\lambda' - \lambda) = \left(\dfrac{c+v}{c}\right)\lambda$

(b) $(\lambda' - \lambda) = \left(\dfrac{c-v}{c}\right)\lambda$

(c) $(\lambda' - \lambda) = \left(\dfrac{v\lambda}{c}\right)$ (d) $(\lambda' - \lambda) = \left(\dfrac{c\lambda}{v}\right)$

36. If the modulation index of an AM wave is changed from 0 to 1, the transmitted power is
(a) unchanged   (b) doubled
(c) increased by 50%   (d) zero

37. In an *N-P-N* transistor circuit, the collector current is 10 mA. If 90% of the electrons emitted reach the collector

(a) the emitter current will be nearly 9 mA
(b) the emitter current will be nearly 11.1 mA
(c) the base current will be nearly 0.9 mA
(d) the base current will be nearly 0.3 mA

38. The diagram given below is equivalent to logic function of
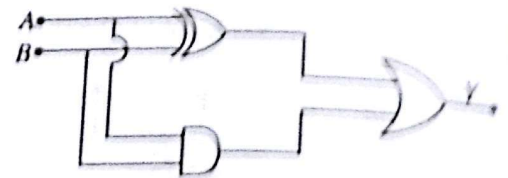
(a) OR   (b) AND
(c) NAND   (d) XOR

39. The half life of radioactive nucleus is 100 years. The time interval between 20% and 80% decay of the parent nucleus is

(a) 100 years   (b) 200 years
(c) 300 years   (d) 400 years

40. Lines of Balmer series are emitted by the hydrogen atom when the electron jumps from the

(a) first ($n = 1$) orbit to any higher orbit
(b) second orbit ($n = 2$) to any higher orbit
(c) higher orbits to the first orbit
(d) higher orbits to the second orbit

41. A proton (p) and an α-particle are accelerated through the same potential difference V volt. The de-Broglie wavelengths associated with the proton and the α-particle, λ_p and λ_α respectively are in the ratio

(a) $2:1$ (b) $2\sqrt{2}:1$
(c) $4:1$ (d) $\sqrt{2}:1$

42. The spherical aberration is minimized in a reflecting telescope using
(a) a concave mirror as objective
(b) a convex mirror as objective
(c) a parabolic mirror as objective
(d) an elliptical mirror as objective

855

43. Consider an optical system consisting of a concave mirror M_1 and convex mirror M_2 of radii of curvatures 60 cm and 20 cm respectively. Two mirror are separated by a distance of 40 cm. An object O is placed at a distance 80 cm from P. The final image is formed at a distance.
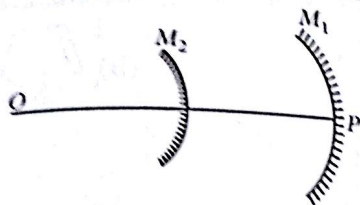
(a) 40 cm on the right of M_2
(b) 40 cm on the left of M_2
(c) 48 cm on the right of M_1
(d) 40 cm on the left of M_2

44. A vessel of depth d is half filled with a liquid of refractive index n_1 and the upper half is occupied by immiscible liquid of refractive index n_2. Viewing it from an eye in the upper liquid, the apparent depth of the lower liquid is

(a) $\dfrac{d}{2n_2}$

(b) $\dfrac{dn_1}{2n_2}$

(c) $\dfrac{dn_2}{2n_1}$

(d) $\dfrac{d}{2}\left(\dfrac{n_1+n_2}{n_1 n_2}\right)$

45. Two lenses have 10 D power each and they are separated by a distance. Beyond which distance does the power of combination changes from positive to negative?

(a) 5 cm (b) 10 cm (c) 20 cm (d) 50 cm

46. Electromagnetic waves travel in a medium with a speed of 2×10^8 m/s. If the relative permeability of the medium is 1, the relative permittivity will be

(a) 1.5 (b) 2.25 (c) 3.37 (d) 1.0

47. In a series L-C-R circuit the voltages across resistance, capacitance and inductance are 20 V each. If the capacitance is short-circuited, the voltage across the inductance will be

(a) $\dfrac{20}{\sqrt{2}}$ V (b) 20 V (c) $20\sqrt{2}$ V (d) 40 V

48. A flat rectangular coil is placed in a uniform magnetic field and rotated about an axis passing through its centre, parallel to its shorter edges and perpendicular to the field. The maximum flux linked and maximum induced emf are ϕ and E respectively. If the axis is shifted to coincide with one of the shorter edges, then

(a) Maximum flux and induced emf are $\phi/2$ and $E/2$

(b) Maximum flux and induced emf are $\phi/3$ and $E/3$

(c) Maximum flux and induced emf are $\phi/4$ and $E/4$

(d) Maximum flux and induced emf remain ϕ and E

49. A solenoid of inductance 50 mH and resistance 10 Ω is connected to a battery of 6 V. The time elapsed before the current acquires half of its steady state value is

(a) 2 ms (b) 3.5 ms (c) 5 ms (d) 5.5 ms

50. Two circular coils 1 and 2 are made from the same wire but the radius of the first coil is twice that of the second coil. What potential difference ratio should be applied across them so that the magnetic field at their centres is the same?

(a) 2 (b) 3 (c) 4 (d) 6

CHEMISTRY

51. For complexes $[NiCl_4]^{2-}$ and $Ni(CO)_4$ which one of the following statements is true ?

(a) $[NiCl_4]^{2-}$ is diamagnetic while $[Ni(CO)_4]$ is paramagnetic and both the complexes have square planar geometry.

(b) $[NiCl_4]^{2-}$ is paramagnetic while $[Ni(CO)_4]$ is diamagnetic and both the complexes have tetrahedral geometry.

(c) $[NiCl_4]^{2-}$ is paramagnetic while $[Ni(CO)_4]$ is diamagnetic and both the complexes have square planar geometry.

(d) $[NiCl_4]^{2-}$ is diamagnetic while $[Ni(CO)_4]$ is paramagnetic and both the complexes have tetrahedral geometry.

AMU Updates

52. Which of the following complexes can also represent facial (*fac*) and meridional (*mer*) isomers ?
   (a) $[Co(NH_3)_3NO_2Cl]$
   (b) $[Co(NH_3)_2(NO_2)_2Cl_2]$
   (c) $[Co(NH_3)_2(NO_2)_3Cl]$
   (d) $[Co(NH_3)_3(NO_2)_3]$

53. Select the correct ground state electronic configuration.

	Cr	Eu	Ti^{2+}
(a)	$[Ar]3d^5 4s^1$	$[Xe]4f^7 5d^0 6s^2$	$[Ar]3d^2 4s^2$
(b)	$[Ar]3d^4 4s^2$	$[Xe]4f^7 5d^0 6s^2$	$[Ar]3d^2 4s^2$
(c)	$[Ar]3d^4 4s^2$	$[Xe]4f^6 5d^1 6s^2$	$[Ar]4s^2 3d^0$
(d)	$[Ar]3d^5 4s^1$	$[Xe]4f^6 5d^2 6s^1$	$[Ar]4s^1 3d^1$

54. Which of the followings is invert sugar?
   (a) Sucrose   (b) Cellulose
   (c) Glucose   (d) Fructose

55. The carbocation formed in S_N1 reaction of alkyl halide in the slow step is
   (a) sp^3-hybridised   (b) sp^2-hybridised
   (c) sp-hybridised   (d) sp^3d-hybridised.

56. DDT is
   (a) 2,2-di(*p*-chlorophenyl)-1,1,1-trichloroethane
   (b) 2,2-di(*m*-chlorophenyl)-1,1,1-trichloroethane
   (c) 2,2-di(*o*-chlorophenyl)-1,1,1-trichloroethane
   (d) 2,2-di(*p*-chlorophenyl)-1,1,1-trichloroethane.

57. Nucleotides are joined together by _?_ between 5' and 3' carbon atoms of pentose sugar.
   (a) glycosidic linkage
   (b) peptide linkage
   (c) ether linkage
   (d) phosphodiester linkage

58. Mention the catalyst and reaction conditions in the given reaction :

$$R-CH_2-COOH \xrightarrow{\quad ? \quad} R-\underset{\underset{X}{|}}{CH}-COOH$$
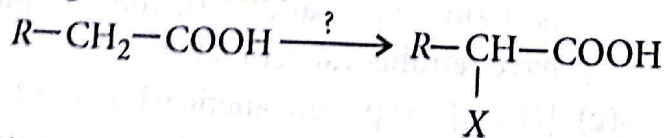
   (where X = Cl, Br)
   (a) X_2/grey phosphorus, H_2O
   (b) X_2/red phosphorus, H_2O
   (c) X_2/white phosphorus, H_2O
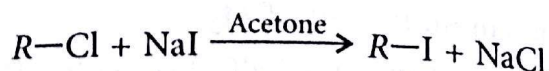   (d) X_2/blue phosphorus, H_2O

59. Nylon-6 is obtained by the condensation of
   (a) terephthalic acid and ethylene glycol
   (b) adipic acid and styrene
   (c) caprolactum with water at high temp
   (d) phenol and formaldehyde.

60. Which of the following is aromatic compound ?

(a)   (b)
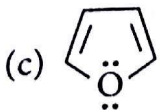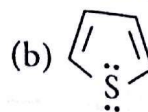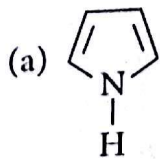
(c)   (d) All of these

61. The following reaction

$$R-Cl + NaI \xrightarrow{\text{Acetone}} R-I + NaCl$$

   is known as
   (a) Frankland reaction
   (b) Swarts reaction
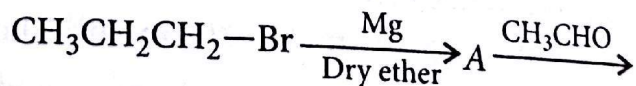   (c) Etard reaction
   (d) Finkelstein reaction.

62. Which one of the following compounds can exist in Zwitter ionic form?
   (a) Amino acid   (b) Fat
   (c) Carbohydrate   (d) Alcohol

63. *p*-Hydroxyazobenzene is
   (a) an orange dye   (b) a yellow dye
   (c) a red dye   (d) an orange-red dye.

64. In the reaction sequence

$$CH_3CH_2CH_2-Br \xrightarrow[\text{Dry ether}]{Mg} A \xrightarrow{CH_3CHO} B \xrightarrow{H_3O^+} C$$
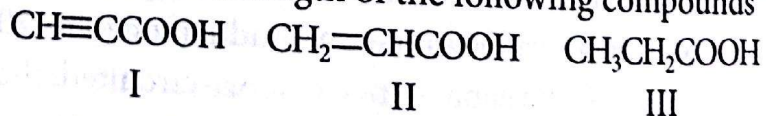
   the product 'C' is
   (a) 1-propanol   (b) 2-butanal
   (c) 2-butanol   (d) 2-pentanol.

65. The acid strength of the following compounds
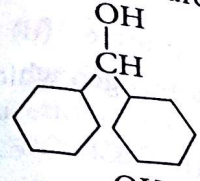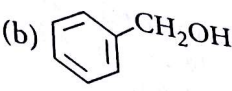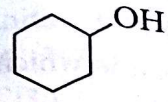
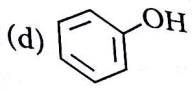| $CH\equiv CCOOH$	$CH_2=CHCOOH$	CH_3CH_2COOH
I	II	III

   is in the order :
   (a) II > I > III   (b) III > II > I
   (c) I > III > II   (d) I > II > III

The most stable carbocation is

(a) ▷⁺

(c) $CH_3\overset{+}{C}HCH_3$

(b) $CH_2=CH-\overset{+}{C}H_2$

(d) $CH_3\overset{+}{C}H=CH_2$

67. Which of the following compounds has the most acidic nature?

(a) [cyclohexyl-CH(OH)-cyclohexyl structure]

(b) [benzene-CH₂OH structure]

(c) [cyclohexane-OH structure]

(d) [phenol-OH structure]

68. Classify the following reaction.

[cyclohexanone] + $H-C\equiv N \rightarrow$ [cyclohexane with OH and C≡N]
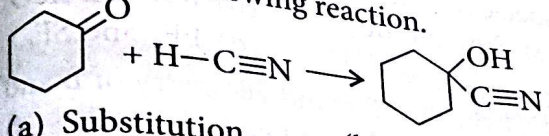
(a) Substitution

(b) Addtion

(c) Elimination

(d) Rearrangement

69. Pick out the electrophiles from the following : BF_3, NH_3, Me_3C^+, HCl

(a) BF_3 and NH_3

(b) Me_3C^+ and HCl

(c) BF_3 and Me_3C^+

(d) NH_3 and HCl

70. The antibiotic that contains arsenic is

(a) prontosil

(b) ofloxacin

(c) bithionol

(d) salvarsan.

71. For the cell $Ag_{(s)}|Ag^+_{(aq)}||Cu^{2+}_{(aq)}|Cu_{(s)}$, the reduction potentials of the left and right hand electrodes are 0.337 and 0.799 volts, the cell e.m.f. is

(a) –1.136 volt

(b) 1.136 volt

(c) –0.462 volt

(d) 0.462 volt

72. 50% of a first order reaction is complete in 23 minutes. Caculate the time required to complete 90% of the reaction.

(a) 70.4 minutes

(b) 76.4 minutes

(c) 38.7 minutes

(d) 35.2 minutes

73. The first order gaseous decomposition of N_2O_4 into NO_2 has a k value of 4.5×10^3 s⁻¹ at 1°C and an energy of activation of 58 kJ mole⁻¹. At what temperature would k be 1.00×10^4 s⁻¹?

(a) 274 K

(b) 283 K

(c) 273 K

(d) 293 K

74. 30.4 kJ is required to melt one mole of NaCl. The entropy change during melting is 28.4 J mol⁻¹ K⁻¹. What is the melting point of sodium chloride?

(a) 1070.4 K

(b) 535.2 K

(c) 273.1 K

(d) 1007.4 K

75. What weight of HCl is present in 155 mL of a 0.54 M solution?

(a) 3.06 g (b) 6.12 g (c) 1.53 g (d) 0.30 g

76. When PCl_5 is heated it gasifies and dissociates into PCl_3 and Cl_2. The density of the gas mixture at 200°C is 70.2. What is the degree of dissociation of PCl_5 at 200°C ?

(a) 0.485 (b) 0.242 (c) 0.845 (d) 0.542

77. What is the value of K_{sp} for Bismuth sulphide (Bi_2S_3), which has a solubility of 1.0×10^{-15} mol/L at 25°C?

(a) 1.08×10^{-73}

(b) 1.08×10^{-74}

(c) 1.08×10^{-72}

(d) 1.08×10^{-75}

78. At 20°C the solubility of N_2 gas in water is 0.015 g/L when the partial pressure of N_2 is 580 torr. What is the solubility of N_2 in H_2O at 20°C when its partial pressure is 800 torr?

(a) 0.207 g/L

(b) 0.0207 g/L

(c) 0.414 g/L

(d) 0.0414 g/L

79. Which of the following is incorrect?

(a) Chemisorption is caused by bond formation.

(b) Chemisorption is reversible process.

(c) Chemisorption is specific in nature.

(d) Chemisorption increases with increase in temperature.

80. In a suspension the diameter of the dispersed particles is of the order

(a) 10 Å

(b) 100 Å

(c) 1000 Å

(d) 2000 Å

81. The correct order of bond angles (smallest first) in H_2S, NH_3, BF_3 and SiH_4 is

(a) $H_2S < SiH_4 < NH_3 < BF_3$

(b) $NH_3 < H_2S < SiH_4 < BF_3$

(c) $H_2S < NH_3 < SiH_4 < BF_3$

(d) $H_2S < NH_3 < BF_3 < SiH_4$

82. Which of the following statements is false for alkali metals?
   (a) Lithium is the strongest reducing agent.
   (b) Na is amphoteric in nature.
   (c) Li^+ is exceptionally small.
   (d) All alkali metals give blue solution in liq. ammonia.

83. Among $LiCl$, $RbCl$, $BeCl_2$, $MgCl_2$ the compounds with greatest and least ionic character respectively are
   (a) $LiCl$ and $RbCl$
   (b) $RbCl$ and $BeCl_2$
   (c) $RbCl$ and $MgCl_2$
   (d) $MgCl_2$ and $BeCl_2$

84. Chemical formula for 'inorganic benzene' is
   (a) $B_3N_3H_3Cl_3$
   (b) $(BN)_x$
   (c) $B_3N_3H_6$
   (d) $B_3P_3H_6$

85. Which of the following statements is wrong about the oxides of nitrogen?
   (a) N_2O_5 is an anhydride of HNO_3.
   (b) NO is an acidic oxide.
   (c) N_2O_3 is an anhydride of HNO_2.
   (d) NO is not anhydride of an acid.

86. The molecule which is linear is
   (a) N_2O
   (b) NO_2
   (c) SO_2
   (d) H_2O

87. Which of the following complexes does not show geometrical isomerism ?
   (a) $[Pt(NH_3)_2Cl_2]$
   (b) $[Co(NH_3)_4Cl_2]$
   (c) $[CoCl_2(en)_2]$
   (d) $[Ni(CO)_4]$

88. Which of the following complexes would give white precipitate with excess of $AgNO_3$ sol.
   (a) $[Co(NH_3)_2Cl_2]NO_3$
   (b) $[Co(NH_3)_5SO_4]Cl$
   (c) $[Co(NH_3)_4Cl_2]$
   (d) $[Co(NH_3)_5NO_3]NO_3$

89. The spin only magnetic moment (μ_s) of a complex $[MnBr_4]^{2-}$ is 5.9 BM. The geometry of the complex will be
   (a) tetrahedral
   (b) square planar
   (c) square pyramidal
   (d) tetragonal.

90. The purple colour of $KMnO_4$ can be attributed to
   (a) d-d transitions
   (b) charge transfer transition
   (c) n-π^* transitions
   (d) none of these.

91. The number of P—O—P bonds in cyclic metaphosphoric acid is
   (a) zero   (b) two   (c) three   (d) four.

92. Among the trihalides of nitrogen which one is the least basic ?
   (a) NF_3
   (b) NCl_3
   (d) NBr_3
   (d) NI_3

93. Among the following the pair in which the two species are not isostructural is
   (a) SiF_4 and SF_4
   (b) IO_3^- and XeO_3
   (c) BH_4^- and NH_4^+
   (d) PF_6^- and SF_6

94. The hybridization and geometry of B and N is $[H_3B \leftarrow NH_3]$ are, respectively
   (a) sp^3, tetrahedral and sp^3, pyramidal
   (b) sp^3, pyramidal and sp^3, tetrahedral
   (c) sp^3, pyramidal and sp^3, pyramidal
   (d) sp^3, tetrahedral and sp^3, tetrahedral

95. Permanganate ions are
   (a) tetrahedral and paramagnetic
   (b) tetrahedral and diamagnetic
   (c) octahedral and paramagnetic
   (d) octahedral and diamagnetic.

96. The root mean square velocity of hydrogen at STP is 1.83×10^5 cm sec^{-1} and its mean free path is 1.78×10^{-5} cm. What will be the collision number at STP?
   (a) 9.476×10^9 sec^{-1}
   (b) 9.746×10^{-9} sec^{-1}
   (c) 9.746×10^9 sec^{-1}
   (d) 9.647×10^9 sec^{-1}

97. There are certain properties related to adsorption :
   I.   revesible
   II. formation of unimolecular layer
   III. low heat of adsorption
   IV. occurs at low temperature and decreases with increasing temperature

   Which of the above properties are for physical adsorption?
   (a) I, II, III
   (b) I, III, IV
   (c) II, III, IV
   (d) I, III

Which of the following fcc structures contains cations in the alternate tetrahedral voids ?
(a) Na_2O (b) ZnS (c) CaF_2 (d) CaO

One litre of water (molecular weight 18.06) weighs 0.9970 kg. The degree of ionisation of water is _____ , if $K_w = 1.10 \times 10^{-14}$ at 25°C.
(a) 1.05×10^{-7}
(b) 1.9×10^{-9}
(c) 1.01×10^{-11}
(d) 4.52×10^{-7}

100. The specific conductance of 0.01 M solution of acetic acid was found to be 0.0163 S m⁻¹ at 25°C. Molar conductance of acetic acid at infinite dilution is 390.7×10^{-4} S m² mol⁻¹ at 25°C. What will be the degree of dissociation of CH_3COOH?
(a) 0.4072 (b) 0.7402 (c) 0.2720 (d) 0.0472

MATHEMATICS

101. A certain item is manufactured by machine M_1 and M_2. It is known that machine M_1 turns out twice as many items as machine M_2. It is also known that 4% of the items produced by machine M_1 and 3% of the items produced by machine M_2 are defective. All the items produced are put into one stock pile and then one item is selected at random. The probability that the selected item is defective is equal to
(a) 10/300
(b) 11/300
(c) 10/200
(d) 11/200

102. Out of $(2n + 1)$ consecutively numbered tickets, three tickets are drawn at random. The probability that the numbers on them are in arithmetic progression is
(a) $\dfrac{n}{4n^2 - 1}$
(b) $\dfrac{n^2}{4n^2 - 1}$
(c) $\dfrac{3n}{4n^2 - 1}$
(d) $\dfrac{3n^2}{4n^2 - 1}$

103. The determinant $\begin{vmatrix} xp+y & x & y \\ yp+z & y & z \\ 0 & xp+y & yp+z \end{vmatrix} = 0$ if
(a) x, y, z are in A.P.
(b) x, y, z are in G.P.
(c) x, y, z are in H.P.
(d) xy, yz, zx are in A.P.

104. The only integral root of the equation
$\begin{vmatrix} 2-y & 2 & 3 \\ 2 & 5-y & 6 \\ 3 & 4 & 10-y \end{vmatrix} = 0$ is
(a) $y = 3$
(b) $y = 2$
(c) $y = 1$
(d) none of these

105. If A and B are two square matrices such that $AB = A$ and $BA = B$, then
(a) A and B are idempotent
(b) only A is idempotent
(c) only B is idempotent
(d) none of these

106. If $\begin{bmatrix} \alpha & \beta \\ \gamma & -\alpha \end{bmatrix}$ is to be square root of the two rowed unit matrix, then α, β and γ should satisfy the relation
(a) $1 + \alpha^2 + \beta\gamma = 0$
(b) $1 - \alpha^2 - \beta\gamma = 0$
(c) $1 - \alpha^2 + \beta\gamma = 0$
(d) $1 + \alpha^2 - \beta\gamma = 0$

107. Consider the following propositions:
p : I take medicine.
q : I can sleep.
Then the compound statement $\sim p \rightarrow \sim q$ means
(a) If I do not take medicine, then I can not sleep.
(b) I take medicine if I can sleep.
(c) If I do not take medicine, then I can sleep.
(d) I take medicine iff can sleep.

108. The function $f(x) = \cos^2 x$ is strictly decreasing on
(a) $\left[0, \dfrac{\pi}{2}\right]$
(b) $\left[0, \dfrac{\pi}{2}\right)$
(c) $\left(0, \dfrac{\pi}{2}\right)$
(d) $\left(0, \dfrac{\pi}{2}\right]$

109. The maximum value of $\dfrac{\log x}{x}$ is
(a) 1
(b) 2/e
(c) e
(d) 1/e

110. The sum of two numbers is 10. Their product will be maximum when they are
(a) 3, 7
(b) 4, 6
(c) 5, 5
(d) 8, 2

111. The integral $\int \sqrt{16-9x^2}\, dx$ equals

(a) $\dfrac{x}{2}\sqrt{16-9x^2} + \dfrac{8}{3}\sin^{-1}\left(\dfrac{3x}{4}\right) + C$

(b) $\dfrac{3x}{2}\sqrt{16-9x^2} + 16\sin^{-1}\left(\dfrac{3x}{4}\right) + C$

(c) $\dfrac{x}{2}\sin^{-1}\left(\dfrac{3x}{4}\right) + \dfrac{9x}{2} + C$

(d) none of these

112. The value of the integral $\displaystyle\int_{-2}^{0} \dfrac{dx}{\sqrt{12-x^2-4x}}$ is

(a) $\pi/2$ (b) $\pi/6$ (c) $\pi/3$ (d) $-\pi/6$

113. $\displaystyle\int \dfrac{x^3 dx}{1+x^4}$ equals

(a) $\log(x^4 + 1) + C$

(b) $\dfrac{1}{4}\log(x^4 + 1) + C$

(c) $\dfrac{1}{2}\log(x^4 + 1) + C$

(d) none of the above

114. The value of the integral $\displaystyle\int_{0}^{1} \dfrac{e^{5\log_e x} - e^{4\log_e x}}{e^{\log_e x^3} - e^{\log_e x^2}}\, dx$ is

(a) $1/3$ (b) 1 (c) $-1/3$ (d) -1

115. The area bounded by the circle $x^2 + y^2 = 4$ and the line $x = y\sqrt{3}$ in the first quadrant (in sq. units) is

(a) π (b) $\pi/2$

(c) $\pi/3$ (d) none of these

116. If $49^n + 16n + \lambda$ is divisible by 64 for all $n \in N$, then the least negative integral value of λ is

(a) -1 (b) -2 (c) -3 (d) -4

117. Given the LPP

Minimize $f = 2x_1 - x_2$

$x_1 \geq 0,\ x_2 \geq 0$

$x_1 + x_2 \geq 5$

$-x_1 + x_2 \leq 1$

$5x_1 + 4x_2 \leq 40$

The solution is

(a) 1 (b) -1 (c) 2 (d) -2

118. An n-tuple $(x_1, x_2, ..., x_n)$ which satisfies all the constraints of a linear programming problem and for which the objective function is maximum (compared to all n-tuples which satisfy all the constraints) is called

(a) a solution

(b) a feasible solution

(c) an optimal solution

(d) an actual solution

119. If $f(x) = x^\alpha \log x$ and $f(0) = 0$ then the value of α for which Rolle's theorem can be applied in $[0, 1]$ is

(a) -1 (b) $1/2$ (c) $-1/2$ (d) 0

120. If $y = \sec(\tan^{-1}x)$, then $\dfrac{dy}{dx}$ at $x = 1$ is

(a) $\dfrac{1}{2}$ (b) $\dfrac{1}{\sqrt{2}}$ (c) $\sqrt{2}$ (d) 1

121. If $y = \tan^{-1}(\sqrt{1+x^2} - x)$, then $\dfrac{dy}{dx}$ equals

(a) $\dfrac{1}{2(1+x^2)}$

(b) $\dfrac{-1}{(1+x^2)}$

(c) $\dfrac{-1}{2(1+x^2)}$

(d) $\dfrac{2}{(1+x^2)}$

122. If $f(x) = \dfrac{x}{2} - 1$, then on the interval $[0, \pi]$

(a) $\tan[f(x)]$ and $\dfrac{1}{f(x)}$ are both continuous

(b) $\tan[f(x)]$ and $\dfrac{1}{f(x)}$ are both discontinuous

(c) $\tan[f(x)]$ is continuous but $\dfrac{1}{f(x)}$ is not continuous

(d) $\tan[f(x)]$ is not continuous but $\dfrac{1}{f(x)}$ is continuous

123. If $\displaystyle\lim_{x \to 0} \dfrac{\log(3+x) - \log(3-x)}{x} = K$, then K is equal to

(a) $2/5$ (b) $2/3$ (c) $1/2$ (d) $5/2$

124. If $x^2 + y^2 = t - \frac{1}{t}$ and $x^4 + y^4 = t^2 + \frac{1}{t^2}$ then $x^3 y \frac{dy}{dx}$ equals

(a) 0
(b) 1
(c) −1
(d) none of these

125. If $x^y = e^{x-y}$ then $\frac{dy}{dx}$ is equal to

(a) $\dfrac{1}{1 + \log x}$

(b) $\dfrac{1}{(1 + \log x)^2}$

(c) $\dfrac{\log x}{1 + \log x}$

(d) $\dfrac{\log x}{(1 + \log x)^2}$

126. The sum of n terms of the series
$1^2 + (1^2 + 2^2) + (1^2 + 2^2 + 3^2) + \dots$ is

(a) $\dfrac{n(n+1)(n+2)}{12}$

(b) $\dfrac{n(n+1)(n+2)^2}{12}$

(c) $\dfrac{n^2(n+1)(n+2)}{12}$

(d) $\dfrac{n(n+1)^2(n+2)}{12}$

127. The minimum value of $9^x + 9^{1-x}, x \in R$ is

(a) 2   (b) 3   (c) 6   (d) 9

128. Given that the points $P(3, 2, -4)$, $Q(5, 4, -6)$ and $R(9, 8, -10)$ are collinear, the ratio in which Q divides PR externally is

(a) 1 : 2   (b) 2 : 1   (c) 1 : 1   (d) 2 : 2

129. The angle between the lines with direction ratios 4, −3, 5 and 3, 4, 5 is

(a) π/3   (b) π/4   (c) π/6   (d) π/2

130. If origin is the centroid of a triangle PQR with vertices $P(2a, 2, 6)$, $Q(-4, 3b, -10)$ and $R(8, 14, 2c)$, the value of a, b and c are respectively

(a) −2, 2, 2
(b) −2, 2, −16/3
(c) −2, −16/3, 2
(d) −16/3, −2, 2

131. A line perpendicular to the line segment joining the points $(1, 0)$ and $(2, 3)$ divides it in the ratio $1 : n$. The equation of the line is

(a) $3y + x = \dfrac{n+11}{n+1}$

(b) $3y - x = \dfrac{n+11}{n+1}$

(c) $3y + x = \dfrac{n-11}{n+1}$

(d) $3y - x = \dfrac{n+11}{n-1}$

132. The directrix of the parabola $4y^2 + 12x - 12y + 39 = 0$ is

(a) $x = \dfrac{3}{4}$

(b) $x = \dfrac{-7}{4}$

(c) $x = \dfrac{-5}{2}$

(d) $x = \dfrac{3}{2}$

133. The two lines $ty = x + t^2$ and $y + tx = 2t + t^3$ intersect at the point lies on the curve whose equation is

(a) $y^2 = 4x$
(b) $y^2 = -4x$
(c) $x^2 = 4y$
(d) $x^2 = -4y$

134. The equation $x^2 + y^2 + 4x + 6y + 13 = 0$ represents

(a) a pair of coincident lines
(b) a pair of concurrent straight lines
(c) a parabola
(d) a point circle

135. If p and q are the order and degree of the differential equation $y\dfrac{dy}{dx} + x^3 \left(\dfrac{d^2 y}{dx^2}\right)^3 + xy = \cos x$, then

(a) $p < q$
(b) $p = q$
(c) $p > q$
(d) none of these

136. The differential equation of all parabolas whose axis of symmetry is parallel to x-axis is of order

(a) 2   (b) 3   (c) 1   (d) 4

137. The value of λ so that the vectors $\vec{a} = 2\hat{i} - \hat{j} + \hat{k}$, $\vec{b} = \hat{i} + 2\hat{j} - 3\hat{k}$ and $\vec{c} = 3\hat{i} + \lambda\hat{j} + 5\hat{k}$ are coplanar is

(a) −1   (b) −2   (c) −3   (d) −4

138. If A and B are independent events associated to some experiment E such that $P(A^c \cap B) = 2/15$ and $P(A \cap B^c) = 1/6$, then $P(B)$ is equal to

(a) $\dfrac{1}{6}, \dfrac{1}{5}$

(b) $\dfrac{1}{6}, \dfrac{4}{5}$

(c) $\dfrac{4}{5}, \dfrac{1}{5}$

(d) $\dfrac{4}{5}, \dfrac{5}{6}$

139. If A and B are independent events such that

$P(B) = \dfrac{2}{7}$, $P(A \cup B) = 0.8$, then $P(A) =$

(a) 0.4   (b) 0.3   (c) 0.2   (d) 0.1

140. Let R be a reflexive relation on a finite set A having n elements and let there be m ordered pairs in R then

(a) $m \geq n$ (b) $m \leq n$

(c) $m = n$ (d) none of these

141. A root of the equation,

$$17x^2 + 17x \tan\left(2\tan^{-1}\dfrac{1}{5} - \dfrac{\pi}{4}\right) - 10 = 0 \text{ is}$$

(a) $\dfrac{10}{17}$ (b) -1 (c) $\dfrac{-7}{17}$ (d) 1

142. The solution set of the equation $\sin^{-1}x = 2\tan^{-1}x$ is

(a) $\{1, 2\}$ (b) $\{-1, 2\}$

(c) $\{-1, 1, 0\}$ (d) $\{1, 1/2, 0\}$

143. The value of the expression

$$1 - \dfrac{\sin^2 y}{1 + \cos y} + \dfrac{1 + \cos y}{\sin y} - \dfrac{\sin y}{1 - \cos y} \text{ is equal to}$$

(a) $\sin y$ (b) $\cos y$

(c) 0   (d) 1

144. The value of $\dfrac{\sin^2 3\theta}{\sin^2 \theta} - \dfrac{\cos^2 3\theta}{\cos^2 \theta}$ is equal to

(a) $8\cos 2\theta$ (b) $3\sin 2\theta$

(c) $\dfrac{1}{8}\cos 2\theta$ (d) none of these

145. If $X = \{4^n - 3n - 1 \mid n \in N\}$ and $Y = \{9(n-1) \mid n \in N\}$ then

(a) $X \subset Y$ (b) $Y \subset X$

(c) $X = Y$ (d) none of these

146. An electrician can be paid under two schemes as follows:

I : ₹ 600 and ₹ 50 per hour

II : ₹ 170 per hour

If the job take n hours, for which values of n does the scheme I give the electrician better wages

(a) $n > 5$ (b) $n > 4$

(c) $n < 5$ (d) $n < 4$

147. The value of $\displaystyle\sum_{n=1}^{13} (i^n + i^{n+1})$ where $i = \sqrt{-1}$ equals

(a) 0   (b) i (c) $-i$ (d) $i - 1$

148. The value of $\left(\dfrac{1+i}{1-i}\right)^{100}$ is equal to

(a) 1   (b) -1 (c) i (d) $-i$

149. The greatest value of the term independent of x, as α varies over R, in the expansion of $\left(x\cos\alpha + \dfrac{\sin\alpha}{x}\right)^{10}$ is

(a) $^{10}C_5$

(b) $\left(\dfrac{1}{2}\right)^5 {}^{10}C_5$

(c) $\left(\dfrac{1}{2}\right)^4 {}^{10}C_5$

(d) $\left(\dfrac{1}{2}\right)^3 {}^{10}C_5$

150. A polygon has 44 diagonals. The number of its sides are

(a) 9   (b) 8   (c) 11   (d) 7

Answers 2016 Paper

1 (b)	21 (d)	41 (b)	61 (d)	81 (c)	101 (b)
2 (*)	22 (a)	42 (c)	62 (a)	82 (b)	102 (c)
3 (c)	23 (d)	43 (a)	63 (a)	83 (b)	103 (b)
4 (c)	24 (d)	44 (c)	64 (d)	84 (c)	104 (c)
5 (d)	25 (c)	45 (c)	65 (d)	85 (b)	105 (a)
6 (a)	26 (d)	46 (b)	66 (a)	86 (a)	106 (b)
7 (b)	27 (a)	47 (a)	67 (d)	87 (d)	107 (a)
8 (d)	28 (b)	48 (d)	68 (b)	88 (b)	108 (c)
9 (a)	29 (a)	49 (b)	69 (c)	89 (a)	109 (d)
10 (b)	30 (b)	50 (c)	70 (d)	90 (b)	110 (c)
11 (b)	31 (b)	51 (b)	71 (d)	91 (c)	111 (a)
12 (d)	32 (b)	52 (d)	72 (b)	92 (a)	112 (b)
13 (b)	33 (a)	53 (a)	73 (b)	93 (a)	113 (b)
14 (b)	34 (d)	54 (a)	74 (a)	94 (d)	114 (a)
15 (a)	35 (c)	55 (b)	75 (a)	95 (b)	115 (c)
16 (a)	36 (c)	56 (a)	76 (a)	96 (a)	116 (a)
17 (a)	37 (b)	57 (d)	77 (a)	97 (b)	117 (a)
18 (c)	38 (a)	58 (b)	78 (b)	98 (b)	118 (c)
19 (c)	39 (b)	59 (d)	79 (b)	99 (None)	119 (b)
20 (d)	40 (d)	60 (d)	80 (d)	100 (d)	120 (b)

121 (c)	128 (a)	135 (a)	142 (c)	148 (a)
122 (c)	129 (a)	136 (b)	143 (b)	149 (b)
123 (b)	130 (c)	137 (d)	144 (a)	150 (c)
124 (b)	131 (a)	138 (b)	145 (a)	
125 (d)	132 (b)	139 (b)	145 (a)	
126 (d)	133 (a)	140 (a)	146 (c)	
127 (c)	134 (d)	141 (d)	147 (d)	

A.M.U. (ENGINEERING)
## Solved Paper 2015
PHYSICS

1. An oil drop of n excess electrons is held stationary under a constant electric field E in Millikan's oil drop experiment. The density of oil is ρ. The radius of the drop is

   (a) $\left[\dfrac{3neE}{2\pi\rho g}\right]^{1/2}$

   (b) $\left[\dfrac{3n\rho g}{2\pi eE}\right]^{1/2}$

   (c) $\left[\dfrac{3nEe}{4\pi\rho g}\right]^{1/3}$

   (d) $\left[\dfrac{3n\rho g}{4\pi eE}\right]^{1/3}$

2. The potential at a point x (measured in μm) due to some charges situated on the x-axis is given by
   $V(x) = 20/(x^2 - 4)$ volt
   The electric field E at $x = 4\ \mu m$ is given by
   (a) $(10/9)$ volt/μm and in the +ve x direction
   (b) $(5/3)$ volt/μm and in the −ve x direction
   (c) $(5/3)$ volt/μm and in the +ve x direction
   (d) $(20/9)$ volt/μm and in the −ve x direction

3. In the following circuit, if potential difference between A and B is $V_{AB} = 4$ V, then the value of X will be
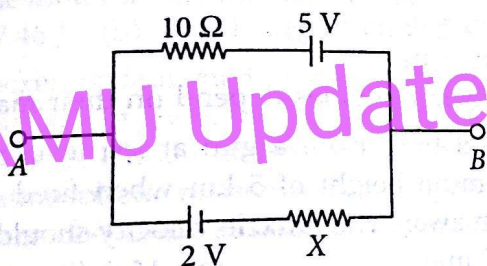
   (a) $5\ \Omega$ (b) $10\ \Omega$ (c) $15\ \Omega$ (d) $20\ \Omega$

4. A wire when connected to 220 V mains supply has power dissipation P_1. Now the wire is cut into two equal pieces which are connected in parallel to the same supply. Power dissipation in this case is P_2. Then $P_2 : P_1$ is
   (a) 1 (b) 4 (c) 2 (d) 3

5. The resistance of the series combination of two resistors is S. When they are joined in parallel the total resistance is P. If $S = nP$, then the minimum possible value of n is
   (a) 4 (b) 3 (c) 2 (d) 1

6. A triangular loop of side l carries a current i. It is placed in a magnetic field B such that the plane of the loop is in the direction of B. The torque on the loop is
   (a) iBl
   (b) i^2Bl
   (c) $\dfrac{\sqrt{3}}{4}Bil^2$
   (d) infinity

7. A long wire carries a steady current. It is bent into a circle of one turn and the magnetic field at the centre of the coil is B. It is then bent into a circular loop of n turns. The magnetic field at the centre of the coil will be
   (a) nB (b) n^2B (c) $2nB$ (d) $2n^2B$

8. A magnetic needle lying parallel to a magnetic field requires W units of work to turn it through $60°$. The torque needed to maintain the needle in this position will be
   (a) $\sqrt{3}W$ (b) W (c) $\left(\dfrac{\sqrt{3}}{2}\right)W$ (d) $2W$

9. The self inductance of the motor of an electric fan is 10 H. In order to impart maximum power at 50 Hz, it should be connected to a capacitance of
   (a) $1\ \mu F$ (b) $2\ \mu F$ (c) $4\ \mu F$ (d) $8\ \mu F$

10. An alternating current is given by
    $i = i_1 \cos\omega t + i_2 \sin\omega t$.
    The rms current is given by
    (a) $\dfrac{i_1 + i_2}{2}$

    (b) $\dfrac{|i_1 + i_2|}{2}$

    (c) $\dfrac{\sqrt{i_1^2 + i_2^2}}{2}$

    (d) $\dfrac{\sqrt{i_1^2 + i_2^2}}{\sqrt{2}}$

11. If the wavelengths of light used in an optical instrument are $\lambda_1 = 4000$ Å and $\lambda_2 = 5000$ Å, then ratio of their respective resolving powers (corresponding to λ_1 and λ_2) is
    (a) $16 : 25$ (b) $9 : 1$ (c) $4 : 5$ (d) $5 : 4$

12. Refractive index of glass is 1.520 for red light and 1.525 for blue light. Let D_1 and D_2 be angles of minimum deviation for red and blue light respectively in a prism of this glass. Then

(a) $D_1 > D_2$
(b) $D_1 < D_2$
(c) $D_1 = D_2$
(d) D_1 can be less than or greater than depending upon angle of prism

13. The maximum number of possible interference maxima for slit separation equal to twice the wavelength in Young's double slit experiment is
(a) infinite
(b) five
(c) three
(d) zero

14. The work function of a substance is 4.0 eV. The longest wavelength of light that can cause photoelectron emission from this substance is approximately
(a) 540 nm
(b) 400 nm
(c) 310 nm
(d) 220 nm

15. A proton when accelerated through a potential difference of V volts has a wavelength λ associated with it. An α particle in order to have the same wavelength λ, must be accelerated through a potential difference (in volts)
(a) $2V$
(b) V
(c) $\dfrac{V}{4}$
(d) $\dfrac{V}{8}$

16. Frequency of the series limit of Balmer series of hydrogen atom in terms of Rydberg constant R and speed of light c is
(a) Rc
(b) $4Rc$
(c) $\dfrac{4}{Rc}$
(d) $\dfrac{Rc}{4}$

17. In the following nuclear reaction, how many α and β particles are emitted?
$$_{92}U^{238} \rightarrow {}_{82}Pb^{206}$$
(a) $8\alpha, 6\beta$
(b) $6\alpha, 10\beta$
(c) $8\alpha, 8\beta$
(d) $12\alpha, 6\beta$
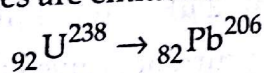
18. The circuit shown in figure contains two diodes, each with a forward resistance of 50 Ω and with infinite reverse resistance. If the battery voltage is 6 V, the current through 100 Ω resistance is
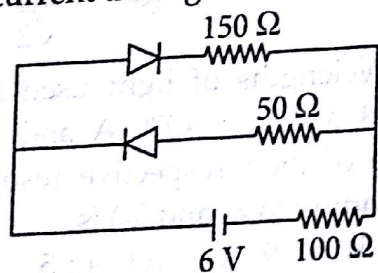
(a) zero
(b) 0.02 A
(c) 0.03 A
(d) 0.036 A

19. Which of the following statements is not true for zener diode?

(a) It is used as a voltage regulator.
(b) It is fabricated by heavily doping both p and n sides of the junctions.
(c) It depletion region is very thin.
(d) The electric field of the junction is very low.

20. For an amplitude modulated wave the maximum amplitude is found to be 10 V while the minimum amplitude is found to be 2 V, the modulation index is
(a) 5
(b) 0.2
(c) $\dfrac{2}{3}$
(d) $\dfrac{3}{2}$

21. The dimension of magnetic field in M, L, T and C (coulomb) is given as
(a) $MLT^{-1}C^{-1}$
(b) $MT^{-2}C^{-1}$
(c) MT^2C^{-2}
(d) $MT^{-1}C^{-1}$

22. A particle located at $x=0$ at time $t=0$, starts moving along the positive x-direction with a velocity v that varies as $v = \alpha\sqrt{x}$ where α is dimensionless constant. The displacement of the particle varies with time as
(a) t^3
(b) t^2
(c) t
(d) $t^{1/2}$

23. From a building two balls A and B are thrown such that A is thrown upwards and B downwards with the same speed (both vertically). If v_A and v_B are their respective velocities on reaching the ground then,
(a) $v_B > v_A$
(b) $v_A = v_B$
(c) $v_A > v_B$
(d) their velocities depend on their masses

24. A shell fired from a gun at sea level rises to a maximum height of 5 km when fired at a ship 20 km away. The muzzle velocity should be
(a) 7 m/s
(b) 14 m/s
(c) 28 m/s
(d) 56 m/s

25. Two racing cars of masses m_1 and m_2 are moving in circles of radii r_1 and r_2 respectively. Their speeds are such that each makes a complete circle in the same time t. The ratio of the angular speeds of the first to the second car is
(a) $r_1 : r_2$
(b) $m_1 : m_2$
(c) $1 : 1$
(d) $m_1m_2 : r_1r_2$

26. A block of mass M is pulled along a horizontal frictionless surface by a rope of mass m. If a force P is applied at the free end of the rope, the force exerted by the rope on the block is

(a) $\dfrac{Pm}{(M + m)}$
(b) $\dfrac{Pm}{(M - m)}$

(c) P
(d) $\dfrac{PM}{(M + m)}$

27. A man fires a bullet of mass 200 g at a speed of 5 m/s. The gun is of one kg mass. By what velocity the gun rebounds backward?

(a) 1 m/s
(b) 0.01 m/s
(c) 0.1 m/s
(d) 10 m/s

28. A man weighs 80 kg. He stands on a weighing scale in a lift which is moving upwards with a uniform acceleration of 5 m/s². What would be the reading on the scale? ($g = 10$ m/s²)

(a) zero
(b) 400 N
(c) 800 N
(d) 1200 N

29. A wire of length 100 cm is connected to a cell of emf 2 V and negligible internal resistance. The resistance of the wire is 3Ω, the additional resistance required to produce a potential difference of 1 mV/cm on the wire is

(a) 297 Ω
(b) 60 Ω
(c) 57 Ω
(d) 35 Ω

30. The only force acting on a 2.0 kg body as it moves along a positive x-axis has an x-component $F_x = -6x$ with x in meters. The velocity at $x = 3.0$ m is 8.0 m/s. The velocity of the body at $x = 4.0$ m is

(a) 6.6 m/s
(b) 46.6 m/s
(c) 60 m/s
(d) 96.6 m/s

31. A quarter horse power motor runs at a speed of 600 rpm. Assuming 40% efficiency, the work done by the motor in one rotation will be

(a) 7.46 J
(b) 74.6 J
(c) 7400 J
(d) 7.46 erg

32. A rocket is launched vertically upward from the surface of the earth with an initial velocity of 10 km/s. If the radius of the earth is 6400 km and atmospheric resistance is negligible, find the distance above the surface of the earth that the rocket will go.

(a) 2.5×10^4 km
(b) 3.0×10^4 km
(c) 4.0×10^3 km
(d) 3.0×10^3 km

33. Consider a two particle system with particles having masses m_1 and m_2. If the first particle is pushed towards the centre of mass through a distance d, by what distance should the second particle be moved, so as to keep the centre of mass at the same position.

(a) d
(b) $\dfrac{m_2}{m_1} d$
(c) $\dfrac{m_1}{m_1 + m_2} d$
(d) $\dfrac{m_1}{m_2} d$

34. A body of mass M while falling vertically downwards under gravity breaks into two parts; a body B of mass $\frac{1}{3}M$ and body C of mass $\frac{2}{3}M$. The centre of mass of bodies B and C taken together shifts compared to that of body A towards

(a) body C
(b) body B
(c) does not shift
(d) depends on height of breaking

35. A metre stick is balanced on a knife edge at its centre. When two coins, each of mass 5 g are put one on top of the other at the 12.0 cm mark, the stick is found to be balanced at 45.0 cm. The mass of the metre stick is

(a) 13 g
(b) 33 g
(c) 66 g
(d) 77 g

36. A particle performing uniform circular motion has angular momentum L. If its angular frequency is doubled and its kinetic energy halved, then new angular momentum is

(a) $\dfrac{L}{4}$
(b) 2L
(c) 4L
(d) $\dfrac{L}{2}$

37. Suppose the gravitational force varies inversely as the nth power of distance. Then the time period of a planet in circular orbit of radius R around the sun will be proportional to

(a) $R^{\left(\frac{n+1}{2}\right)}$
(b) $R^{\left(\frac{n-1}{2}\right)}$
(c) R^n
(d) $R^{\left(\frac{n-2}{2}\right)}$

38. A geo-stationary satellite is in an orbit of radius 36000 km. Approximately what would be the time period of a spy satellite orbiting a few hundred kilometers above the surface of the earth? (Earth radius = 6400 km)

(a) One hour
(b) Two hour
(c) Four hour
(d) Eight hour

39. If S is the stress and Y is the Young's modulus of material of a wire, the energy stored in the wire per unit volume is

(a) $\dfrac{2Y}{S}$
(b) $\dfrac{S}{2Y}$
(c) $2S^2Y$
(d) $\dfrac{S^2}{2Y}$

40. Two identical cylindrical vessels with their bases at the same level, each contains a liquid of density 1.3×10^3 kg/m³. The area of each base is 4.00 cm², but in one vessel, the liquid height is 0.854 m and in the other it is 1.560 m. Find the work done by the gravitational force in equalizing the levels when the two vessels are connected.

AMU Updates

(a) 0.0635 J (b) 0.635 J
(c) 6.35 J (d) 63.5 J

41. A wire extends by 1 mm when a force is applied. Double the force is applied to another wire of the same material and length but half the radius of cross-section. The elongation of the wire in mm will be
(a) 8 (b) 4 (c) 2 (d) 1

42. The energy density $\frac{u}{V}$ of an ideal gas is related to its pressure P as
(a) $\frac{u}{V} = 3P$ (b) $\frac{u}{V} = \frac{3}{2}P$
(c) $\frac{u}{V} = \frac{1}{3}P$ (d) $\frac{u}{V} = \frac{2}{3}P$

43. One kg of a diatomic gas is at a pressure of 8×10^4 N/m². The density of the gas is 4 kg/m³. What is the energy of the gas due to its thermal motion?
(a) 3×10^4 J (b) 5×10^4 J
(c) 6×10^4 J (d) 7×10^4 J

44. A refrigerator is to maintain eatables at 9°C. If room temperature is 36°C, then the coefficient of performance is
(a) 8.6 (b) 10.4 (c) 11.2 (d) 12.5

45. According to Newton's law of cooling, the rate of cooling of a body is proportional to $(\Delta\theta)^n$, where $\Delta\theta$ is the difference of the temperature of the body and surroundings, and n is equal to
(a) four (b) three (c) two (d) one

46. Two spheres of the same material have radii 1 m and 4 m and temperatures 4000 K and 2000 K respectively. The ratio of energy radiated per second by the first sphere to the second is
(a) 1 : 1 (b) 16 : 1 (c) 4 : 1 (d) 1 : 9

47. A whistle producing sound waves of frequency 9500 Hz and above is approaching a stationary person with speed v m/s. The velocity of sound in air is 300 m/s. If the person can hear frequencies upto a maximum of 10000 Hz, the maximum value of v upto which he can hear the whistle is
(a) 30 m/s (b) $15\sqrt{2}$ m/s
(c) $\frac{15}{\sqrt{2}}$ m/s (d) 15 m/s

The displacement of an object attached to a spring and executing simple harmonic motion is given by $x = 2 \times 10^{-2} \cos \pi t$ metre. The time at which the maximum speed first occurs is

(a) 0.25 s (b) 0.50 s
(c) 0.75 s (d) 0.125 s

49. Two concentric spherical shells of radii r_1 and r_2 have similar charges and equal surface charge densities (σ). What is the potential at the common centre?
(a) $\frac{\sigma}{\epsilon_0}(r_1 + r_2)$ (b) $\frac{\sigma}{\epsilon_0}(r_1 - r_2)$
(c) $\frac{\sigma r_1^2}{\epsilon_0 r_2}$ (d) $\frac{\sigma r_2^2}{\epsilon_0 r_1}$

50. The electric field in a region is given by $\bar{E} = \left(\frac{A}{x^3}\right)\hat{i}$. An expression for the potential in the region, assuming the potential at infinity to be zero, is
(a) $\frac{A}{2x^3}$ (b) $\frac{2x^2}{A}$ (c) $\frac{A^2}{2x}$ (d) $\frac{A}{2x^2}$

CHEMISTRY

51. What is the minimum volume of water required to dissolve 1 g of calcium sulphate at 298 K? K_{sp} for $CaSO_4$ is 9.0×10^{-6}.
(Molar mass of $CaSO_4$ = 136 g mol^{-1})
(a) 2.45 L (b) 4.08 L (c) 4.90 L (d) 3.00 L

52. What will be the value of $[OH^-]^2$ in the 0.1 M solution of ammonium hydroxide having $K_b = 1.8 \times 10^{-5}$?
(a) 1.8×10^{-7} (b) 1.8×10^{-6}
(c) 1.8×10^{-4} (d) 1.8×10^{-3}

53. One mole of $N_2O_{4(g)}$ at 300 K is kept in a closed vessel at 1 atm pressure. It is heated to 600 K when 20% by mass of $N_2O_{4(g)}$ decomposes to $NO_{2(g)}$. The resultant pressure is
(a) 1.2 atm (b) 2.4 atm
(c) 2.0 atm (d) 1.0 atm

54. A boy after swimming comes out from a pool covered with a film of water weighing 80 g. How much heat must be supplied to evaporate this water? ($\Delta H°_v = 40.79$ kJ mol^{-1})
(a) 1.61×10^2 kJ (b) 1.71×10^2 kJ
(c) 1.81×10^2 kJ (d) 1.91×10^2 kJ

55. Which of the following is planar?
(a) XeO_4 (b) XeO_3
(c) XeO_2F_2 (d) XeF_4

56. Schrödinger wave equation for a particle in a one-dimension box is
(a) $\frac{\delta^2 \psi}{\delta x^2} + \frac{2m}{h}(E - \infty)\psi = 0$

(b) $\dfrac{\delta^2\psi}{\delta x^2} + \dfrac{8\pi^2 m}{h^2}(E-V) = 0$

(c) $\dfrac{\delta^2\psi}{\delta x^2} + \dfrac{2m}{h}(E-V)\psi = 0$

(d) $\dfrac{\delta^2\psi}{\delta x^2} + \dfrac{8\pi^2 m}{h^2}(E-\infty) = 0$

The number of Cl^- ions in 100 mL of 0.001 M HCl solution is

(a) 6.022×10^{23}
(b) 6.022×10^{20}
(c) 6.022×10^{19}
(d) 6.022×10^{24}

The energy associated with first orbital of hydrogen atom is

(a) -8.72×10^{-18} J
(b) -8.80×10^{-18} J
(c) -87.0×10^{-18} J
(d) -8.82×10^{-19} J

The energy of one mole of photons of radiation whose frequency is 5×10^{14} Hz is

(a) 192.51 kJ mol^{-1}
(b) 199.51 kJ mol^{-1}
(c) 195.45 kJ mol^{-1}
(d) 170 kJ mol^{-1}

The number of unshared valence electron pairs in XeF_2 is

(a) 2
(b) 4
(c) 3
(d) 1

Mustard gas is

(a) $COCl_2$
(b) CCl_3NO_3
(c) $CHCl_2NO_2$
(d) $ClCH_2CH_2SCH_2CH_2Cl$

Amorphous solids are characterised by property as

(a) isotropic
(b) anisotropic
(c) sharp melting point
(d) true solids.

The species having no S—S bond is

(a) $S_2O_4^{2-}$
(b) $S_2O_3^{2-}$
(c) $S_2O_7^{2-}$
(d) $S_2O_5^{2-}$

Television picture tubes are

(a) cathode-ray tubes
(b) α-particle tubes
(c) γ-ray tubes
(d) X-ray tubes.

Density of 3 M NaCl solution is 1.25 g/cc. The molality of the solution is

(a) 2.79 molal
(b) 0.279 molal
(c) 1.279 molal
(d) 3.85 molal

Molecular structures of XeO_3 and $XeOF_4$ respectively are

(a) trigonal planar and octahedral
(b) pyramidal and square pyramidal
(c) pyramidal and trigonal bipyramidal
(d) both have imperfect tetrahedral shape.

67. Which of the following defects are present in AgBr and ZnS crystal systems?

(a) Frenkel and Schottky
(b) Schottky and Frenkel
(c) Frenkel and Frenkel
(d) Schottky and Schottky

68. The hybridisation of atomic orbitals of nitrogen in NO_2^+, NO_3^- and NH_4^+ are

(a) sp, sp^2, sp^3
(b) sp^2, sp^3, sp
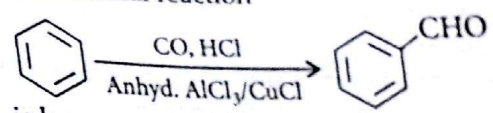(c) sp^2, sp, sp^3
(d) sp^2d, sp^3, sp

69. The correct order of increasing polarising power of the cations in the following $AlCl_3$, $MgCl_2$, NaCl is

(a) $AlCl_3 < MgCl_2 < NaCl$
(b) $MgCl_2 < NaCl < AlCl_3$
(c) $NaCl < MgCl_2 < AlCl_3$
(d) $NaCl < AlCl_3 < MgCl_2$

70. Which of the following oxides of nitrogen is not an air pollutant?
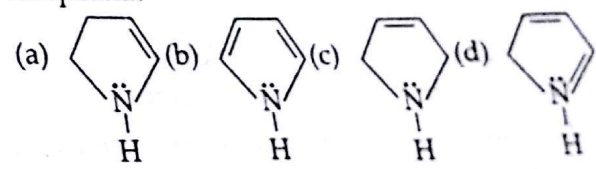
(a) NO_2
(b) N_2O
(c) N_2O_5
(d) NO

71. The chemical reaction

is known as

(a) Gatterman reaction
(b) Tischenko reaction
(c) Gatterman–Koch reaction
(d) Frankland reaction.

72. Which one of the following is an aromatic compound?

73. The number of possible alcohol isomers for $C_4H_{10}O$ is

(a) 4
(b) 3
(c) 2
(d) 5

74. Intra-molecular hydrogen bonding is found in

(a) o-nitrophenol
(b) m-nitrophenol
(c) p-nitrophenol
(d) phenol.

75. The heat produced on combustion of methane is approximately

(a) 890 kJ per g
(b) 74.2 kJ per g
(c) 55.6 kJ per g
(d) 49.5 kJ per g

76. Maximum number of σ-bonds that may be present in an isomer of C_4H_8 are

(a) 10
(b) 11
(c) 12
(d) 13

77. Tick the statement which is not true.
   (a) Boiling point of ethanol is greater than ethoxyethane due to H-bonding.
   (b) Ethoxyethane is soluble in water due to H-bonding.
   (c) Ethanol is soluble in water due to H-bonding.
   (d) Ethoxyethane has nearly same boiling point as that of propane.

78. Which one of the following statements is not true about vitamins?
   (a) They were known as vitamine in their early discovery.
   (b) Vitamin C and D are water soluble.
   (c) Deficiency of vitamin B_6 is responsible for convulsions.
   (d) Thiamine is one from the class vitamin B.

79. Tick the statement which is not true about carboxylic acids.
   (a) Higher carboxylic acids are odourless.
   (b) Benzoic acid is insoluble in water.
   (c) Acetic acid exists as dimer in vapour phase.
   (d) Carboxylic acids show higher boiling points than alcohols of comparable molecular masses.

80. Which one of the following alcohols is known as wood's spirit?
   (a) Methanal   (b) Ethanol
   (c) Propanol   (d) Butanol

81. Which one of the following is an essential amino acid?
   (a) Valine   (b) Serine
   (c) Cystein   (d) Proline

82. Polymer with low degree of polymerisation is known as
   (a) higher polymer (b) oligomer
   (c) macromolecule   (d) copolymer.
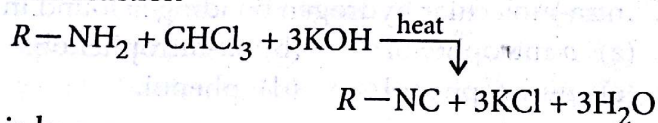
83. The reaction
   $$R-NH_2 + CHCl_3 + 3KOH \xrightarrow{heat}$$
   $$R-NC + 3KCl + 3H_2O$$
   is known as
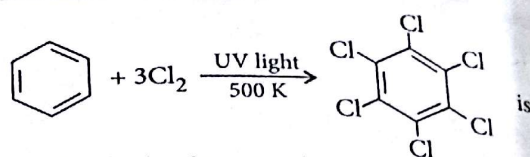   (a) Gabriel phthalimide synthesis
   (b) Hoffmann reaction
   (c) Carbylamine reaction
   (d) Leibermann nitroso reaction.

84. Schiff's base is formed by the reaction of aldehyde with

(a) amine   (b) alcohol
(c) phenol   (d) carboxylic acid.

85. The chemical reaction,

is
   (a) a substitution reaction
   (b) an addition reaction
   (c) an elimination reaction
   (d) rearrangement reaction.

86. $:CCl_2$ is
   (a) an electrophile   (b) a free radical
   (c) a nucleophile   (d) none of these.

87. DIBAL-H is
   (a) $AlH(i\text{-}Bu)_2$ (b) $Al(OC_2H_5)_3$
   (c) $Al[(CH_3)_2CHO]_3$ (d) $AlCl_3$

88. Which of the following is not correct?
   (a) Chemical adsorption is reversible in nature.
   (b) Physical adsorption is reversible in nature.
   (c) ΔH is small in physical adsorption.
   (d) ΔH is large in chemical adsorption.

89. What is the mole fraction of the solute in 2.5 molal aqueous solution?
   (a) 0.043   (b) 0.053   (c) 0.063   (d) 0.073

90. A solution containing 2.44 g of a solute dissolved in 75 g of water boiled at 100.413°C. What will be the molar mass of the solute?
   (K_b for water = 0.52 K kg mol^{-1})
   (a) 40.96 g mol^{-1} (b) 20.48 g mol^{-1}
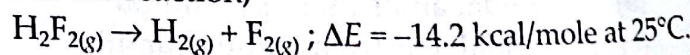   (c) 81.92 g mol^{-1} (d) None of these

91. In the lead-acid battery during charging, the cathode reaction is
   (a) formation of PbO_2
   (b) formation of $PbSO_4$
   (c) reduction of Pb^{2+} to Pb
   (d) decomposition of Pb at the anode.

92. Which concentration plot is linear for a first order reaction?
   (a) $[A]$ versus time
   (b) $\ln[A]$ versus time
   (c) $\log[A]$ versus 1/time
   (d) square root of $[A]$ versus time

93. For the reaction,
   $$H_2F_{2(g)} \rightarrow H_{2(g)} + F_{2(g)} ; \Delta E = -14.2 \text{ kcal/mole at } 25°C.$$
   The change in enthalpy of the reaction is

(a) -1.36 kJ/mole (b) -13.6 kJ/mole
(c) 1.36 kJ/mole (d) 13.6 kJ/mole

94. In the reversible reaction, $2NO_2 \underset{k_2}{\overset{k_1}{\rightleftharpoons}} N_2O_4$, the rate of disappearance of NO_2 is equal to

(a) $\dfrac{2k_1[NO_2]^2}{k_2}$

(b) $2k_1[NO_2] - 2k_2[N_2O_4]$

(c) $2k_1[NO_2]^2 - 2k_2[N_2O_4]$

(d) $(2k_1 - k_2)[NO_2]$

95. A metal oxide has the empirical formula $M_{0.96}O_{1.00}$. What will be the percentage of M^{2+} ions in the crystal?

(a) 90.67 (b) 91.67 (c) 8.33 (d) 9.33

96. 2 g of benzoic acid (C_6H_5COOH) is dissolved in 25 g of benzene. The observed molar mass of benzoic acid is found to be 241.98. What is the percentage association of acid if it forms dimer in solution?

(a) 85.2% (b) 89.2% (c) 95.2% (d) 99.2%

97. 0.6 mL of acetic acid is dissolved in 1 litre of water. The value of van't Hoff factor is 1.04. What will be the degree of dissociation of the acetic acid?

(a) 0.01 (b) 0.02 (c) 0.03 (d) 0.04

98. What pressure of H_2 would be required to make emf of the hydrogen electrode zero in pure water at 25°C?

(a) 10^{-7} atm (b) 10^{-14} atm
(c) 1 atm (d) 0.5 atm

99. The root mean square velocity of an ideal gas at constant pressure varies with density (d) as

(a) d^2 (b) d (c) $\sqrt{d}$ (d) $\dfrac{1}{\sqrt{d}}$

100. How many grams of potassium dichromate are required to oxidise 20.0 g of Fe^{2+} in $FeSO_4$ to Fe^{3+} if the reaction is carried out in an acidic medium? Molar masses of $K_2Cr_2O_7$ and $FeSO_4$ are 294 and 152 respectively.

(a) 6.45 g (b) 7.45 g (c) 8.45 g (d) 9.45 g

MATHEMATICS

101. Let $A = [a_{ij}]_{m \times n}$ be a matrix such that $a_{ij} = 1$ for all i, j. Then

(a) Rank (A) > 1 (b) Rank (A) = 1
(c) Rank (A) = m (d) Rank (A) = n

102. The equation

$$\sqrt{(x-2)^2 + y^2} + \sqrt{(x+2)^2 + y^2} = 4 \text{ represents}$$

(a) a circle (b) a parabola
(c) a pair of lines (d) an ellipse

825

103. $\lim\limits_{n \to \infty} \dfrac{(n!)^{1/n}}{n}$ equals

(a) e (b) e^{-1}
(c) 1 (d) None of these

104. Given that $\displaystyle\int_0^\infty \dfrac{x^2}{(x^2+a^2)(x^2+b^2)(x^2+c^2)}dx$
$= \dfrac{\pi}{2(a+b)(b+c)(c+a)}$, then $\displaystyle\int_0^\infty \dfrac{dx}{(x^2+4)(x^2+9)}$ is

(a) $\dfrac{\pi}{60}$ (b) $\dfrac{\pi}{20}$ (c) $\dfrac{\pi}{40}$ (d) $\dfrac{\pi}{80}$

105. For all real x, $4^{\sin^2 x} + 4^{\cos^2 x}$ is

(a) ≥ 4 (b) > 4
(c) < 4 (d) None of these

106. The length of the perpendicular drawn from $(1, 2, 3)$ to the line $\dfrac{x-6}{3} = \dfrac{y-7}{2} = \dfrac{z-7}{-2}$ is

(a) 4 (b) 5 (c) 6 (d) 7

107. The number of equivalence relations on the set $\{1, 2, 3\}$ containing $(1, 2)$ and $(2, 1)$ is

(a) 3 (b) 1
(c) 2 (d) None of these

108. Let $A = \left\{x \in R : x \geq \dfrac{1}{2}\right\}$ and $B = \left\{x \in R : x \geq \dfrac{3}{4}\right\}$
If $f : A \to B$ is defined as $f(x) = x^2 - x + 1$, then the solution set of the equation $f(x) = f^{-1}(x)$ is

(a) $\{1\}$ (b) $\{2\}$
(c) $\left\{\dfrac{1}{2}\right\}$ (d) None of these

109. The complex number $z = x + iy$ which satisfy the equation $\left|\dfrac{z-5i}{z+5i}\right| = 1$ lie on

(a) the x-axis
(b) the straight line $y = 5$
(c) a circle passing through origin
(d) None of these

110. The equation of the curve satisfying the differential equation $y(x + y^3)dx = x(y^3 - x)dy$ and passing through the point $(1, 1)$ is

(a) $y^3 - 2x + 3x^2y = 0$
(b) $y^3 + 2x + 3x^2y = 0$
(c) $y^3 + 2x - 3x^2y = 0$
(d) None of these

111. If $\lim\limits_{x\to a}\dfrac{a^x-x^a}{x^x-a^a}=-1$, then a is equal to
   (a) 0
   (b) e
   (c) 2
   (d) None of these

112. Let $f(x)=\sin x$, $g(x)=x^2$ and $h(x)=\log_e x$.
   If $G(x)=h\circ g\circ f(x)$, then $G''(x)$ is equal to
   (a) $2\,\text{cosec}^2 x\,\cot x$
   (b) $-2\,\text{cosec}^2 x\,\cot x$
   (c) $2\,\text{cosec}^2 x$
   (d) $-2\,\text{cosec}^2 x$

113. For any integer n, the integral
   $$\int_0^\pi e^{\cos^2 x}\cos^3(2n+1)x\,dx \text{ has the value}$$
   (a) 1
   (b) π
   (c) 2π
   (d) None of these

114. The area defined by $1\le |x-2|+|y+1|\le 2$ is
   (a) 2
   (b) 4
   (c) 6
   (d) None of these

115. $C_0, C_1, C_2, \dots, C_{15}$ are the binomial coefficients in the expansion of $(1+x)^{15}$, then
   $$\dfrac{C_1}{C_0}+\dfrac{2C_2}{C_1}+\dfrac{3C_3}{C_2}+\dots+\dfrac{15C_{15}}{C_{14}} \text{ is}$$
   (a) 32
   (b) 64
   (c) 128
   (d) None of these

116. Let the function, f, g, h are defined from R to R such that $f(x)=x^2-1$, $g(x)=\sqrt{x^2+1}$ and $h(x)=\begin{cases}0 \text{ if } x<0\\ x \text{ if } x\ge 0\end{cases}$, then $(ho(fog))(x)$ is
   (a) x
   (b) x^2
   (c) 0
   (d) None of these

117. AB is a diameter of a circle and C is any point on the circumference of the circle. Then
   (a) the perimeter of $\triangle ABC$ is maximum when it is isosceles
   (b) the area of $\triangle ABC$ is minimum when it is isosceles
   (c) the area of $\triangle ABC$ is maximum when it is isosceles
   (d) None of these

118. If $\begin{vmatrix} a & a^2 & 1+a^3 \\ b & b^2 & 1+b^3 \\ c & c^2 & 1+c^3 \end{vmatrix}=0$ and vectors $(1, a, a^2)$, $(1, b, b^2)$ and $(1, c, c^2)$ are non coplanar, then the product abc equals
   (a) 2
   (b) –1
   (c) 1
   (d) 0

119. If $\vec{a}=4\hat{i}+6\hat{j}$ and $\vec{b}=3\hat{j}+4\hat{k}$ then the vector form of component of $\vec{a}$ along $\vec{b}$ is
   (a) $\dfrac{18}{10\sqrt{3}}(3\hat{j}+4\hat{k})$
   (b) $\dfrac{18}{25}(3\hat{j}+4\hat{k})$
   (c) $\dfrac{18}{\sqrt{3}}(3\hat{j}+4\hat{k})$
   (d) $\dfrac{18}{25}(4\hat{i}+6\hat{j})$

120. Let $f(x)=\sin x-\tan x$, $x\in(0,\pi/2)$, then tangent drawn to the curve $y=f(x)$ at any point will
   (a) lie above the curve
   (b) lie below the curve
   (c) nothing can be said
   (d) be parallel to a fixed line

121. If $[x]$ denotes the greatest integer $\le x$, then the value of $\lim\limits_{x\to 0}|x|^{[\cos x]}$ is
   (a) 0
   (b) 1
   (c) –1
   (d) does not exists

122. The differential equation of all conics whose centre lies at origin is of order
   (a) 2
   (b) 3
   (c) 4
   (d) None of these

123. Let $\vec{a}, \vec{b}, \vec{c}$ be three vectors such that $\vec{a}\times\vec{b}=\vec{c}$ and $\vec{c}\times\vec{a}=\vec{b}$, then
   (a) $\vec{a}\cdot\vec{b}=|\vec{c}|^2$
   (b) $\vec{c}\cdot\vec{a}=|\vec{b}|^2$
   (c) $\vec{b}\cdot\vec{c}=|\vec{a}|^2$
   (d) $\vec{a}||(\vec{b}\times\vec{c})$

124. If $\cos^{-1}x>\sin^{-1}x$, then x belongs to the interval
   (a) $(-\infty, 0)$
   (b) $(-1, 0)$
   (c) $\left[0, \dfrac{1}{\sqrt{2}}\right)$
   (d) $\left[-1, \dfrac{1}{\sqrt{2}}\right)$

125. The number of non-zero diagonal matrices of order 4 satisfying $A^2=A$ is
   (a) 2
   (b) 4
   (c) 16
   (d) 15

126. Find the number of ways in which 52 cards can be divided into 4 sets, three of them having 17 cards each and the fourth one having just one card.
   (a) $\dfrac{\underline{|52}}{\left(\underline{|17}\right)^3}$
   (b) $\dfrac{\underline{|52}}{\left(\underline{|17}\right)^3\underline{|3}}$
   (c) $\dfrac{\underline{|51}}{\left(\underline{|17}\right)^3}$
   (d) $\dfrac{\underline{|51}}{\left(\underline{|17}\right)^3\underline{|3}}$

127. If R is a relation on a finite set having n elements, then the number of relations on A is
   (a) 2^n
   (b) 2^{n^2}
   (c) n^2
   (d) n^n

128. The area bounded by the curve $y=f(x)$, x-axis and the ordinates $x=l$ and $x=b$ is $(b-1)\sin(3b+4)$. Then $f(x)$ is

(a) $(x-1)\cos(3x+4)$

(b) $\sin(3x+4)$

(c) $\sin(3x+4)+3(x-1)\cos(3x+4)$

(d) None of these

129. If the angles of a triangle are in the ratio $4:1:1$, then the ratio of the longest side and perimeter is

(a) $\sqrt{3}:(2+\sqrt{3})$ (b) $1:6$

(c) $1:(2+\sqrt{3})$ (d) $2:6$

130. If $|z-1|+|z+3|=8$, then the range of values of $|z-4|$ is

(a) $(0,8)$ (b) $[0,8]$ (c) $[1,9]$ (d) $[5,9]$

131. If a,b,c are the roots of equation $x^3-px^2+qx-r=0$, then the value of $\dfrac{1}{a^2}+\dfrac{1}{b^2}+\dfrac{1}{c^2}$ is

(a) $\dfrac{p^2-2qr}{r^2}$ (b) $\dfrac{q^2-2pr}{r^2}$

(c) $\dfrac{r^2-2pq}{q^2}$ (d) $\dfrac{r^2-2pq}{p^2}$

132. If $\int f(x)dx=F(x)$, then $\int x^3 f(x^2)dx$ is equal to

(a) $\dfrac{1}{2}\{x^2 F(x^2)-\int F(x^2)dx^2\}$

(b) $\dfrac{1}{2}\{x^2 F(x^2)-\int F(x^2)dx\}$

(c) $\dfrac{1}{2}\left(x^2 F(x)-\dfrac{1}{2}\int F(x^2)dx\right)$

(d) None of these

133. In three dimensional space $x^2-5x+6=0$ represents

(a) two points

(b) two parallel planes

(c) two parallel lines

(d) a pair of non parallel lines

134. If $f(x)=\log_x(\log_x)$, then $\dfrac{d}{dx}(f(x))$ is

(a) $\dfrac{1}{e}$ (b) e

(c) $e+1$ (d) None of these

135. Let $f(x)=\begin{cases}\dfrac{x^3+x^2-16x+20}{(x-2)^2}, & \text{if } x\neq 2.\\ b, & \text{if } x=2\end{cases}$

If $f(x)$ is continuous for all x, then b is equal to

(a) 7 (b) 3 (c) 2 (d) 5

136. The locus of the middle points of the chords of the circle $x^2+y^2=a^2$ which subtend a right angle at the centre is

(a) $x^2+y^2=\dfrac{a^2}{2}$ (b) $x^2+y^2=2a^2$

(c) $x^2+y^2=\dfrac{a^2}{4}$ (d) None of these

137. An integrating factor of the differential equation $y\log y\dfrac{dx}{dy}+x-\log y=0$ is

(a) $\log(\log y)$ (b) $\log y$

(c) $\dfrac{1}{\log y}$ (d) $\dfrac{1}{\log(\log y)}$

138. A fair die is rolled. Consider the events $A=\{1,3,5\}$, $B=\{2,3\}$ and $C=\{2,3,4,5\}$. Then the conditional probability $P((A\cup B)\mid C)$ is

(a) $\dfrac{1}{4}$ (b) $\dfrac{5}{4}$ (c) $\dfrac{1}{2}$ (d) $\dfrac{3}{4}$

139. India play two matches each with West Indies and Australia. In any match, the probabilities of India getting 0, 1 and 2 points are 0.45, 0.05 and 0.50 respectively. Assuming that the outcomes are independent, the probability of India getting at least 7 points is

(a) 0.0875 (b) $\dfrac{1}{16}$

(c) 0.1125 (d) None of these

140. The region represented by the inequation system $x,y\geq 0,\ y\leq 6,\ x+y\leq 3$ is

(a) unbounded in first quadrant

(b) unbounded in first and second quadrant

(c) bounded in first quadrant

(d) None of these

141. If x^2+px+1 is a factor of ax^3+bx+c, then

(a) $a^2+c^2=ab$ (b) $a^2+c^2=-ab$

(c) $a^2-c^2=ab$ (d) None of these

142. The set of values of x for which $\dfrac{\tan 3x-\tan 2x}{1+\tan 3x\cdot\tan 2x}=1$ is

(a) ϕ (b) $\left\{\dfrac{\pi}{4}\right\}$

(c) $\left\{n\pi+\dfrac{\pi}{4}, n=1,2,3,\dots\right\}$

(d) $\left\{2n\pi+\dfrac{\pi}{4}, n=1,2,3,\dots\right\}$

143. If $y = a \log x + bx^2 + x$ has its extremum values at $x = -1$ and $x = 2$, then

(a) $a = 2, b = -1$

(b) $a = 2, b = \dfrac{1}{2}$

(c) $a = -2, b = \dfrac{1}{2}$

(d) $a = 2, b = -\dfrac{1}{2}$

144. The angle through which the axes must be rotated, without translation, in anti-clockwise sense so that the expression $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$ does not contain the mixed product xy, is given by

(a) $\tan^{-1}\left(\dfrac{2h}{a-b}\right)$

(b) $\dfrac{1}{2}\tan^{-1}\left(\dfrac{2h}{b-a}\right)$

(c) $\dfrac{1}{2}\tan^{-1}\left(\dfrac{2h}{a-b}\right)$

(d) $\dfrac{1}{2}\tan^{-1}\left(\dfrac{h}{a-b}\right)$

145. If $\cos A + \cos C = 4\sin^2\dfrac{B}{2}$, then the sides a, b, c of the triangle are in

(a) A.P.

(b) G.P.

(c) H.P.

(d) None of these

146. The two consecutive terms in the expansion of $(3 + 2x)^{74}$ whose coefficients are equal are

(a) 30th and 31st terms

(b) 31st and 32nd terms

(c) 29th and 30th terms

(d) None of these

147. If $g(f(x)) = |\sin x|$, $f(g(x)) = (\sin\sqrt{x})^2$, then

(a) $f(x) = \sin x, g(x) = |x|$

(b) $f(x) = x^2, g(x) = \sin\sqrt{x}$

(c) f and g can not be determined

(d) $f(x) = \sin^2 x, g(x) = \sqrt{x}$

148. Let $*$ be a binary operation on the set $Q^{\cdot}$ of all +ve rational numbers defined by $a * b = \dfrac{ab}{100}$ for all $a, b \in Q^{\cdot}$. The inverse of 0.1 under opeation $*$ is

(a) 10^5

(b) 10^6

(c) 10^4

(d) None of these

149. If a, b, c, d and p are distinct real numbers such that $(a^2 + b^2 + c^2)p^2 - 2(ab + bc + cd)p + (b^2 + c^2 + d^2) \le 0$, then a, b, c, d are in

(a) A.P

(b) H.P

(c) $ab = cd$

(d) G.P

150. If the position vectors of three points are $\vec{a} - 2\vec{b} + 3\vec{c}$, $2\vec{a} + 3\vec{b} - 4\vec{c}$ and $-7\vec{a} + 10\vec{c}$, then the three points are

(a) collinear

(b) non-collinear

(c) coplanar

(d) None of these

2015 Paper Answer

No.	Ans	No.	Ans	No.	Ans	No.	Ans	No.	Ans
1	(c)	31	(a)	61	(d)	91	(c)	121	(b)
2	(d)	32	(a)	62	(a)	92	(b)	122	(b)
3	(d)	33	(d)	63	(c)	93	(None)	123	(d)
4	(b)	34	(c)	64	(a)	94	(c)	124	(a)
5	(a)	35	(c)	65	(a)	95	(b)	125	(d)
6	(c)	36	(a)	66	(b)	96	(d)	126	(b)
7	(b)	37	(a)	67	(b&c)	97	(d)	127	(b)
8	(a)	38	(b)	68	(a)	98	(c)	128	(c)
9	(a)	39	(d)	69	(c)	99	(d)	129	(a)
10	(d)	40	(b)	70	(c)	100	(a)	130	(c)
11	(d)	41	(a)	71	(c)	101	(b)	131	(b)
12	(b)	42	(b)	72	(b)	102	(c)	132	(a)
13	(b)	43	(b)	73	(d)	103	(b)	133	(b)
14	(c)	44	(b)	74	(a)	104	(a)	134	Not correct
15	(d)	45	(d)	75	(c)	105	(a)	135	(a)
16	(d)	46	(a)	76	(c)	106	(d)	136	(a)
17	(a)	47	(d)	77	(d)	107	(c)	137	(b)
18	(b)	48	(b)	78	(b)	108	(a)	138	(d)
19	(d)	49	(a)	79	(b)	109	(a)	139	(a)
20	(c)	50	(d)	80	(None)	110	(e)	140	(c)
21	(d)	51	(a)	81	(a)	111	(d)	141	(c)
22	(b)	52	(b)	82	(b)	112	(d)	142	(a)
23	(b)	53	(b)	83	(c)	113	(d)	143	(d)
24	( )	54	(c)	84	(a)	114	(c)	144	(c)
25	(c)	55	(d)	85	(a)	115	(d)	145	(a)
26	(d)	56	(None)	86	(a)	116	(b)	146	(a)
27	(a)	57	(c)	87	(a)	117	(c)	147	(d)
28	(d)	58	(None)	88	(a)	118	(b)	148	(a)
29	(c)	59	(b)	89	(a)	119	(b)	149	(a)
30	(a)	60	(c)	90	(a)	120	(a)	150	(a,c)

1. A parallel-plate capacitor with circular plates of radius R is being charged with a current i. Find the value of $\oint \bar{B}.d\bar{s}$ between the plates at a radius $r = \dfrac{R}{5}$ from their centre.

   (a) $\dfrac{\mu_0 i}{5}$

   (b) $\dfrac{\mu_0 i}{25}$

   (c) $\mu_0 i$

   (d) $5\mu_0 i$

2. A series RLC circuit, driven with $E_{rms} = 120$ V at frequency 50 Hz, contains an inductance with $X_L = 100 \ \Omega$, a capacitance with $X_C = 110 \ \Omega$, and an unknown resistance R. For what value of R, the power factor is 0.9 ?

   (a) $20 \ \Omega$

   (b) $42 \ \Omega$

   (c) $59 \ \Omega$

   (d) $110 \ \Omega$

3. What inductance must be connected to a 17 PF capacitor in an oscillator capable of generating 550 nm electromagnetic waves?

   (a) 2.3×10^{-25} H

   (b) 4.2×10^{-23} H

   (c) 2.6×10^{-22} H

   (d) 5.0×10^{-21} H

4. In the figure, a ray of light is perpendicular to the face AB of a glass prism ($\mu = 1.52$). Find the value of θ so that the ray is totally reflected at face AC, if the prism is immersed in water.
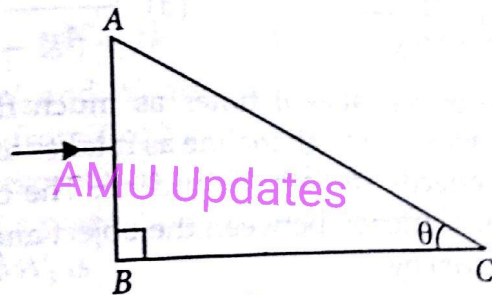
   (a) $45°$

   (b) $30°$

   (c) $15°$

   (d) None of these

5. Figure shows an object AB placed in front of two thin coaxial lenses 1 and 2 with focal lengths 24 cm and 9.0 cm, respectively. The object is 6.0 cm from the lens 1 and the lens separation is $L = 10$ cm. Where does the system of two lenses produce an image of the object AB ?
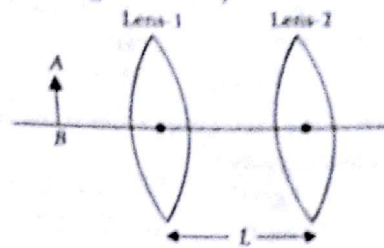
   (a) $+18$ cm

   (b) -18 cm

   (c) $+24$ cm

   (d) -24 cm

6. A concave mirror has a radius of curvature of 35 cm. It is positioned so that the (upright) image of an object is 2.5 times the size of the object. How far is the mirror from the object?

   (a) 10.5 cm

   (b) 9.2 cm

   (c) 8.7 cm

   (d) 6.7 cm

7. White light, with a uniform intensity, is perpendicularly incident on a water film of refractive index 1.33 and thickness 320 nm, that is suspended in air. At what wavelength is the light reflected by the film brightest to an observer?

   (a) 459 nm

   (b) 567 nm

   (c) 623 nm

   (d) 690 nm

8. Rank the following radiations according to their associated energies, greatest first.

   (1) Yellow light from a sodium lamp

   (2) Gamma ray emitted by a radioactive nucleus

   (3) Radio wave emitted by the antenna

   (4) Microwave beam emitted by radar

   (a) (2), (1), (4), (3)

   (b) (1), (2), (3), (4)

   (c) (3), (4), (1), (2)

   (d) (1), (2), (4), (3)

9. Find the maximum wavelength of the light that will excite an electron in the valence band of diamond to the conduction band. The energy gap is 5.5 eV.

   (a) 225 nm

   (b) 315 nm

   (c) 352 nm

   (d) 412 nm

10. In Rutherford experiment, a 5.3 MeV alpha particle moves towards the gold nucleus $(Z = 79)$. How close does the alpha particle get to the centre of the nucleus, before it comes to rest momentarily and reverses its motion? $(\varepsilon_0 = 8.8 \times 10^{-12}$ F/m)

    (a) 3.4×10^{-15} m   (b) 8.6×10^{-14} m
    (c) 4.3×10^{-14} m   (d) 1.6×10^{-14} m

11. Which of the following fusion reactions will not result in the net release of energy

    (1) $^6Li + {}^6Li$ (2) $^4He + {}^4He$
    (3) $^{12}C + {}^{12}C$ (4) $^{35}Cl + {}^{35}Cl$

    (a) (1)   (b) (2)   (c) (3)   (d) (4)

12. Which of the following values is the correct order of nuclear density?

    (a) 5×10^5 kg/m³   (b) 9×10^{10} kg/m³
    (c) 3×10^{21} kg/m³   (d) 2×10^{17} kg/m³

13. A man running at a speed 5 m/s is viewed in the side view mirror of radius of curvature $R = 2$ m of a stationary car. Calculate the speed of image when the man is at a distance of 9 m from the mirror.

    (a) 0.3 m/s   (b) 0.2 m/s
    (c) 0.1 m/s   (d) 0.05 m/s

14. The image of an object in concave lens is formed at $\dfrac{f}{2}$, where f is the focal length of the lens. Find the distance of the object from the lens

    (a) f (b) $2f$ (c) $\dfrac{f}{2}$ (d) infinity

15. The height of a man is measured by a metre scale having graduations in centimeter only and the height turns out to be 170 cm. The scientific method for reporting the measurement is

    (a) 170×10^0 cm   (b) 1.700 m
    (c) 170 cm   (d) 1.70×10^2 cm

6. In an experiment the values of two resistance are $R_1 = (5.0 \pm 0.2)\ \Omega$ and $R_2 = (10.0 \pm 0.1)\ \Omega$. The total resistance when they are connected in parallel is

    (a) $3.3 \pm 7\%$ (b) $3.3 \pm 5\%$
    (c) $3.3 \pm 0.3\%$ (d) $2.5 \pm 7\%$

'. What are the dimensions of $\dfrac{A}{B}$ in the relation $F = A\sqrt{x} + Bt^2$, where F is the force, x is distance and t is time?

(a) ML^2T^{-2}
(c) $L^{-1/2}T^{-1}$
(b) $L^{-1/2}T^2$
(d) LT^{-2}

18. Figure shows the position-time graph of an object. Find the ratio of the velocities at 5th and 27th seconds.
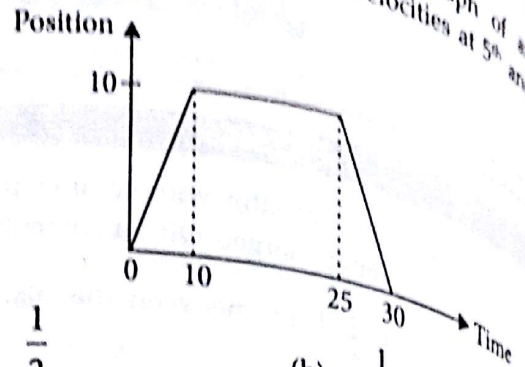
    (a) $\dfrac{1}{2}$ (b) $-\dfrac{1}{2}$
    (c) 1   (d) -1

19. Two vectors $\vec{A}$ and $\vec{B}$ are such that $\vec{A} + \vec{B} = \vec{C}$ and $|\vec{A}| + |\vec{B}| = |\vec{C}|$. Then the vectors $\vec{A}$ and $\vec{B}$ are

    (a) parallel   (b) perpendicular
    (c) anti-parallel   (d) null vectors

20. A particle P falling vertically from a height hits a plane inclined to the horizontal at an angle θ with speed v and rebounds elastically, as shown. The distance along the plane where it hits the second time is
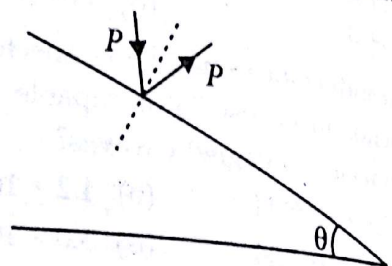
    (a) $\dfrac{4v^2 \sin^2\theta}{g}$ (b) $\dfrac{v^2 \sin\theta}{2g}$
    (c) $\dfrac{4v^2 \sin\theta}{g}$ (d) $\dfrac{v^2 \sin\theta}{4g}$

21. An object takes n times as much time to slide down a 45° rough incline as it takes to slide down a perfectly smooth 45° incline. The coefficient of kinetic friction between the object and the incline is given by

    (a) $\dfrac{1}{1 - n^2}$ (b) $1 - \dfrac{1}{n^2}$
    (c) $\sqrt{1 - \dfrac{1}{n^2}}$ (d) $\sqrt{\dfrac{1}{1 - n^2}}$

22. A particle of mass 2 mg moves with constant speed and is found to pass two points 5.0 m apart in a time interval of 5 ms. Find the kinetic energy of the particle

(a) 1.0 J

(b) 2.0 J

(c) 3.0 J

(d) 4.0 J

23. In the figure shown, a ball of mass 1.0 kg is rolled with a kinetic energy of 330 J. It reaches R through the path PQR. Find the speed of the ball at R, if its potential energy at P is zero

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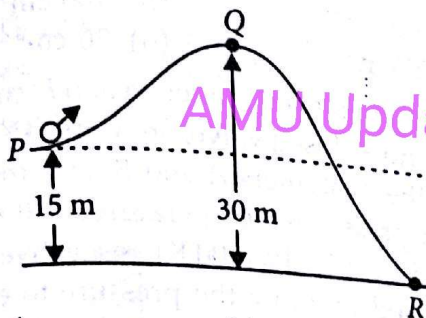
(a) 52 m/s

(b) 45 m/s

(c) 40 m/s

(d) 31 m/s

24. A force $\vec{F} = -(y\hat{i} + x\hat{j})$ acts on a particle moving in the X-Y plane. Starting from the origin, the particle is taken along the positive X-axis to the point $(2a, 0)$ and then parallel to the Y-axis to the point $(2a, 2a)$. The total work done on the particle is

(a) $-4a^2$ (b) $-2a^2$ (c) $4a^2$ (d) $2a^2$

25. Two masses of 6 and 2 units are at positions $(6\hat{i} - 7\hat{j})$ and $(2\hat{i} + 5\hat{j} - 8\hat{k})$ respectively. The co-ordinates of the centre-of-mass (c.m.) are

(a) $(2, -5, 3)$

(b) $(5, -5, -3)$

(c) $(5, -4, -2)$

(d) $(5, -4, -4)$

26. Find the linear velocity of a point on a rigid body rotating with angular velocity $\vec{\omega} = 3\hat{i} - 4\hat{j} + \hat{k}$, the radius vector of the point is $\vec{r} = 5\hat{i} - 6\hat{j} + 6\hat{k}$

(a) $-18\hat{i} - 13\hat{j} + 2\hat{k}$ (b) $18\hat{i} + 3\hat{j} - 2\hat{k}$

(c) $3\hat{i} - 18\hat{j} + 2\hat{k}$ (d) $-3\hat{i} - 18\hat{j} + 2\hat{k}$

27. If W_1, W_2 and W_3 are the work done in moving a particle from A to B along three different paths 1, 2, and 3 respectively (as shown) in the gravitational field of a point mass M, the relation between W_1, W_2 and W_3 is
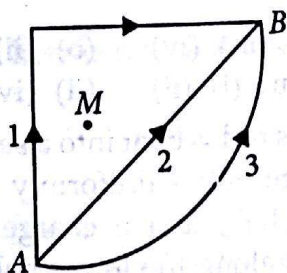
(a) $W_1 > W_2 > W_3$

(b) $W_1 = W_2 = W_3$

(c) $W_1 < W_2 < W_3$

(d) $W_2 > W_1 > W_3$

28. The height of a mountain is H and the density of its rock is 3×10^3 kg/m^3. If the elastic limit of the rock is 3×10^8 N/m^2, find the height of the mountain

(a) 50 km

(b) 30 km

(c) 8 km

(d) 10 km

29. A glass capillary of radius 0.4 mm is inclined at 60° with the vertical in water. Find the length of water in the capillary tube. (Surface tension of water $= 7 \times 10^{-2}$ N/m)

(a) 7.1 cm

(b) 3.6 cm

(c) 1.8 cm

(d) 0.9 cm

30. The densities of a certain material at 10°C and 40°C are 2.5 gm/cm^3 and 2.49 gm/cm^3, respectively. The average value of the coefficient of linear expansion of the material in this temperature range is

(a) 4.0×10^{-7}/°C

(b) 4.0×10^{-6}/°C

(c) 4.0×10^{-5}/°C

(d) 2.0×10^{-3}/°C

31. Stars S_1 and S_2 emit maximum energy at wavelengths 5000 Å and 50 μm, respectively. The surface temperature of S_1 is 6000 K. Find the surface temperature of S_2

(a) 90 K

(b) 80 K

(c) 70 K

(d) 60 K

32. Which of the following statements is true for the specific heat of solids at constant volume (C_V)?

(a) It is independent of temperature

(b) It increases with rise in temperature and its value is different for different solids at high temperatures

(c) It increases with rise in temperature and its value becomes 3R for different solids at large temperatures

(d) Its value becomes zero for different solids at large temperatures

33. A particle of mass m is placed in a potential field $U(x) = U_0 (1 - \cos \alpha x)$, where U_0 and α are positive constants. The time period of small oscillations would be

(a) $\dfrac{2\pi}{\alpha} \sqrt{\dfrac{m}{U_0}}$

(b) $\dfrac{2\pi}{U_0} \sqrt{\dfrac{m}{\alpha}}$

(c) $2\pi \sqrt{\dfrac{m}{\alpha U_0}}$

(d) $2\pi \dfrac{m}{U_0}$

34. The displacement-time graph of a particle executing S.H.M. is shown below
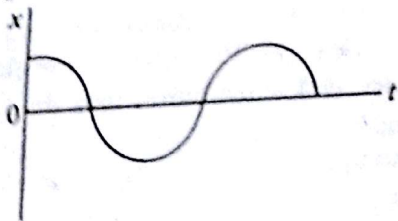
Which of the following statement(s) is (are) true?

(i) The force is zero at $t = 3T/4$
(ii) The acceleration is maximum at $t = T$
(iii) The velocity is maximum at $t = T/4$
(iv) The potential energy is equal to kinetic energy at $t = T/2$

(a) (i) and (ii)
(b) (i), (ii) and (iii)
(c) all of the above
(d) (i) and (iv)

35. Find the order of root mean square (r.m.s.) velocity of molecules of a gas, if the velocity of sound in the same gas is 330 m/s. ($\gamma = 1.41$)

(a) 481 m/s
(b) 293 m/s
(c) 280 m/s
(d) 260 m/s

36. Two progressive waves are represented by the following equations

$$y_1 = 10 \sin 2\pi (10\, t - 0.1\, x)$$
$$y_2 = 20 \sin 2\pi (20\, t - 0.2\, x)$$

Find the ratio of their intensities.

(a) $\dfrac{1}{2}$
(b) $\dfrac{1}{4}$
(c) $\dfrac{1}{8}$
(d) $\dfrac{1}{16}$

37. A resonance tube is resonated with a tuning fork of frequency 380 Hz. Two successive lengths of the resonated air-column are found to be 16 cm and 50 cm. Find the length of the third resonance.

(a) 84 cm
(b) 72 cm
(c) 69 cm
(d) 92 cm

8. Some of the frequencies of tones produced by an organ pipe are :

220, 440, 550, 660, Hz.

Find the effective length of the pipe.

(Take the speed of sound in air 330 m/s)

(a) 1.8 m
(b) 1.7 m
(c) 1.5 m
(d) 1.3 m

As shown in figure, a sound wave of wavelengths 2.28 m enters the tube at S. Find the smallest radius of the circular path to hear minimum sound at D.
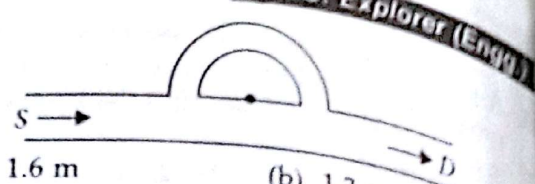
(a) 1.6 m
(b) 1.3 m
(c) 1.1 m
(d) 1.0 m

40. An air bubble of volume 20 cm³ is at the bottom of a pond 40 m deep where the temperature is 4°C. What will be the volume of the bubble if it rises to the surface, which is at a temperature of 20°C?

(a) 200 cm³
(b) 100 cm³
(c) 50 cm³
(d) 20 cm³

41. The volumes of containers A and B, connected by a tube and a closed valve, are V and 4V respectively. Both the containers A and B have the same ideal gas at pressures (temperatures) 5.0×10^5 Pa (300 K) and 1.0×10^5 Pa (400 K), respectively. The valve is opened to allow the pressure to equalize, but the temperature of each container is kept constant at its initial value. Find the common pressure in the containers

(a) 2.5×10^5 Pa
(b) 2.0×10^5 Pa
(c) 3.0×10^5 Pa
(d) 1.5×10^5 Pa

42. Two particles of charges $q_1 = +8q$ and $q_2 = -2q$ are placed, as shown. At what point away from q_2 on the X-axis, can a proton be placed so that it is in equilibrium ?
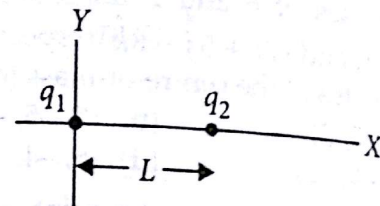
(a) $x = 2\,L$
(b) $x = 2.5\,L$
(c) $x = 3.0\,L$
(d) $x = 3.2\,L$

43. The potential energies associated with four orientations of an electric dipole in an electric field are :

(i) $-5U_0$ (ii) $-7U_0$ (iii) $3U_0$ (iv) $5U_0$

where U_0 is positive. Rank the orientations according to the angle between the electric dipole moment $\vec{p}$ and the electric field $\vec{E}$, greatest first

(a) (i), (ii), (iii), (iv)
(b) (ii), (iii), (i), (iv)
(c) (iv), (iii), (i), (ii)
(d) (iv), (i), (iii), (ii)

44. A thin glass rod is bent into a semi-circle of radius R. A charge +Q is uniformly distributed along the upper half, and a charge -Q is uniformly distributed along the lower half. The magnitude

of the electric field at the centre of the semi-circle is

(a) $\dfrac{2Q}{\pi^2\varepsilon_0 R^2}$

(b) $\dfrac{Q}{\pi^2\varepsilon_0 R^2}$

(c) $\dfrac{Q}{3\pi^2\varepsilon_0 R^2}$

(d) $\dfrac{2Q}{3\pi^2\varepsilon_0 R^2}$

Figure shows the portions of two infinite parallel non-conducting sheets having the magnitude of the surface charge densities $\sigma_{(+)} = 6.8 \ \mu C/m^2$ and $\sigma_{(-)} = 4.3 \ \mu C/m^2$ for the positively and negatively charged sheets, respectively. Find the electric field $\vec{E}$ between the sheets
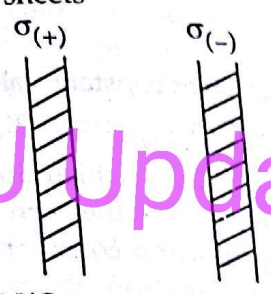
(a) 6.3×10^5 N/C towards right
(b) 6.3×10^5 N/C towards left
(c) 1.41×10^5 N/C towards right
(d) 1.41×10^5 N/C towards left

46. Figure shows two points P and R, separated by a distance d, in a uniform electric field $\vec{E}$. Find the potential difference by moving the positive test charge q_0 from P to R along the path PQR.
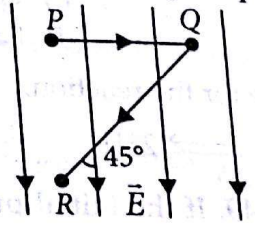
(a) Ed
(b) $-\dfrac{Ed}{\sqrt{2}}$
(c) $\sqrt{2}\ Ed$
(d) $-Ed$

47. Two conductors are made of the same material and have the same length. Conductor A is a solid wire of diameter 1.0 mm, and conductor B is a hollow tube of outside diameter 2.0 mm and inside diameter 1.0 mm. Find the resistance ratio $\dfrac{R_A}{R_B}$ measured between their ends

(a) 3
(b) 2
(c) 1
(d) 0.5

48. The table shows four sets of values for the circuit elements, when the fully charged capacitor is discharged. Rank the sets according to the time required for the current to decreases to half its initial value, greatest first

	1	2	3	4
E(V)	12	12	10	10
R(Ω)	2	3	10	5
C(μF)	3	2	0.5	2

(a) 1, 2, 3, 4
(b) 3, 2 = 4, 1
(c) 4, 1 = 2, 3
(d) 1, 2 = 3, 4

49. A cyclotron is operated at an oscillator frequency of 24 MHz and has a dee radius of 60 cm. Find the magnitude of the magnetic field needed for deuterons to be accelerated in the cyclotron

(a) 6.4 T
(b) 3.2 T
(c) 1.6 T
(d) 0.9 T

50. A long solenoid with 10 turns/cm and a radius of 7.0 cm carries a current of 20.0 mA. A current of 6.0 A exists in a straight conductor located along the central axis of the solenoid. At what radial distance from the axis will the direction of the magnetic field be at 45° to the axial direction?

(a) 4.8 cm
(b) 8.1 cm
(c) 9.9 cm
(d) 10.6 cm

CHEMISTRY

51. On complete combustion, 0.246 g of an organic compound gave 0.198 g of CO_2 and 0.1014 g of H_2O. The ratio of carbon and hydrogen atoms in the compound is

(a) 1 : 3
(b) 1 : 2
(c) 2 : 5
(d) 2 : 7

52. The correct order of basic strength in aqueous solution is

(a) $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N$
(b) $(CH_3)_3N > (CH_3)_2NH > CH_3NH_2$
(c) $CH_3NH_2 > (CH_3)_3N > (CH_3)_2NH$
(d) $(CH_3)_3N > CH_3NH_2 > (CH_3)_2NH$

53. $n\text{-}C_7H_{16} \xrightarrow[\text{10-20 atm}]{V_2O_5,\ 500°C} A \xrightarrow{Cl_2\ /\ h\nu} B$

What is B in the above reaction?

(a) Benzyl chloride
(b) Benzal chloride
(c) Hexachlorobenzene
(d) Benzene hexachloride

54. What will be the product/s if benzal chloride is heated with a concentrated aqueous KOH solution?
    (a) Benzaldehyde
    (b) Benzoic acid
    (c) Benzyl alcohol and sodium benzoate
    (d) An aldol

55. What will be the end product (B) in the following sequence of reactions?

$$\xrightarrow[\text{(ii) } H_2O/H^+]{\text{(i) } KMnO_4 / OH^-} A \xrightarrow[\text{heat}]{CaO + 4NaOH} B$$
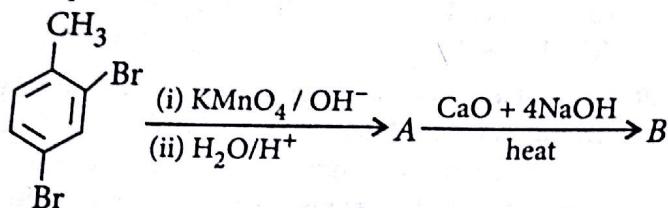
    (a) 1, 2-Dibromobenzene
    (b) 1, 2-Dibromobenzaldehyde
    (c) 1, 3-Dibromobenzene
    (d) 1, 4-Dibromobenzene

56. The monosaccharide constituents of lactose are
    (a) α-D-Glucose and β-D-fructôse
    (b) α-D-Glucose only
    (c) β-D-Glucose only
    (d) β-D-Glucose and β-D-galactose.

57. Identify the reagents in the following transformations :
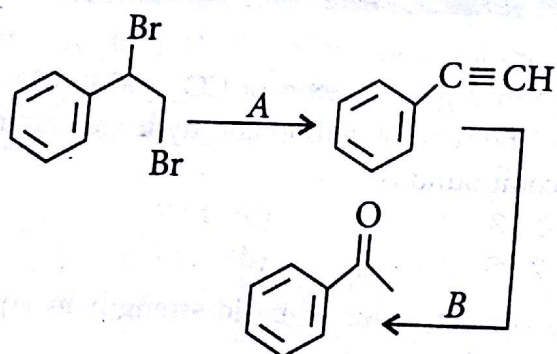
    (a) Alc. KOH and H_2O, $HgSO_4$, H_2SO_4
    (b) Alc. KOH and $KMnO_4/H^+$
    (c) $NaNH_2$ and H_2O, $HgSO_4$, H_2SO_4
    (d) $NaNH_2$ and $KMnO_4/H^+$

58.
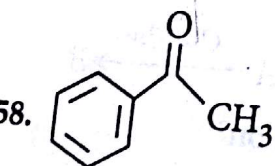
The above ketone will not be formed by
    (a) reaction of benzene and acetyl chloride in the presence of $AlCl_3$

    (b) reaction of acetonitrile with phenyl magnesium bromide in ether followed by hydrolysis
    (c) treatment of acetyl chloride with dibenzyl cadmium
    (d) addition of water to phenylacetylene in the presence of mercuric sulphate and dilute sulphuric acid.

59. What shall be the pH of a solution formed by mixing 10 mL of 0.1 M H_2SO_4 and 10 mL of $\dfrac{N}{10}$ KOH?
    (a) 11.40
    (b) 8.64
    (c) 3.00
    (d) 7.00

60. In the reaction at constant volume,
    $$C_{(s)} + CO_{2(g)} \rightleftharpoons 2CO_{(g)}$$
    argon gas is added which does not take part in the reaction; choose the correct statement.
    (a) The equilibrium constant is unchanged.
    (b) The equilibrium shifts in the forward direction.
    (c) The equilibrium shifts in the backward direction.
    (d) The direction of equilibrium depends on the amount of argon added.
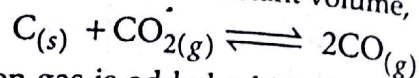
61. The Balmer series in atomic hydrogen is observed in the following spectral region
    (a) Infrared
    (b) Ultraviolet
    (c) Visible
    (d) Far IR.

62. The K_p value for the reaction,
    $$H_2 + I_2 \rightleftharpoons 2HI$$
    at 460 °C is 49. If the initial pressure of H_2 and I_2 is 0.5 atm respectively, what will be the partial pressure of H_2 at equilibrium?
    (a) 0.111 atm
    (b) 0.123 atm
    (c) 0.133 atm
    (d) 0.222 atm
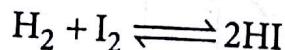
63. In the redox reaction,
    $$MnO_4^- + 8H^+ + 5Br^- \longrightarrow$$
    $$Mn^{2+} + 4H_2O + \frac{5}{2}Br_2$$
    which one is the reducing agent?
    (a) H^+
    (b) MnO_4^-
    (c) Br^-
    (d) Mn^{2+}
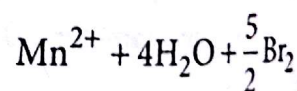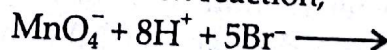
64. The rate constant (k_1) of one of the reaction is found to be double that of the rate constant (k_2)

of another reaction. The relationship between the corresponding activation energies of the two reactions E_{a_1} and E_{a_2} will be

(a) $E_{a_1} < E_{a_2}$
(b) $E_{a_1} > E_{a_2}$
(c) $E_{a_1} = E_{a_2}$
(d) $E_{a_1} = 2E_{a_2}$

. The energy required to remove an electron from metal X is $E = 3.31 \times 10^{-20}$ J. Calculate the maximum wavelength of light that can photo eject an electron from metal X.

(a) 6.01×10^{-6} m
(b) 3.01×10^{-3} m
(c) 5.01×10^{-6} m
(d) None of the above.

. A 5.82 g silver coin is dissolved in nitric acid. When sodium chloride is added to the solution, all the silver is precipitated as AgCl. The AgCl precipitate weighs 7.20 g. The percentage of silver in the coin is

(a) 60.3%
(b) 80%
(c) 93.1%
(d) 70%

. For a reaction taking place in three steps, the rate constants are k_1, k_2 and k_3 and overall rate constant is $k = \dfrac{k_1 k_3}{k_2}$. If the energies of activation E_1, E_2 and E_3 are 60, 30 and 10 kJ mol^{-1} respectively, then the overall energy of activation is

(a) 30 kJ mol^{-1}
(b) 40 kJ mol^{-1}
(c) 60 kJ mol^{-1}
(d) 100 kJ mol^{-1}

68. At 25°C, for the combustion of 1 mole of liquid benzene, the heat of reaction at constant pressure is given by

$$C_6H_{6(l)} + \frac{7}{2}O_{2(g)} \rightarrow 6CO_{2(g)} + 3H_2O_{(l)};$$

$$\Delta H = 780980 \text{ cal}$$
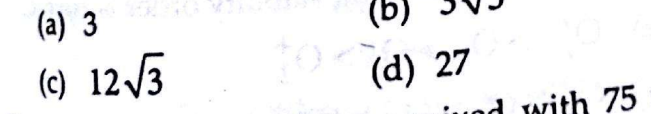
Calculate the heat of reaction at constant volume.

(a) 780.086 kcals
(b) −780.086 kcals
(c) −390.043 kcals
(d) 390.043 kcals

69. What will be solubility product of Ca(OH)$_2$ if its solubility is $\sqrt{3}$?

(a) 3
(b) $3\sqrt{3}$
(c) $12\sqrt{3}$
(d) 27

70. 25 mL of 3.0 M HCl are mixed with 75 mL of 4.0 M HCl. If the volumes are additive, the molarity of the final mixture will be

(a) 4.0 M
(b) 3.75 M
(c) 4.25 M
(d) 3.50 M

71. An exothermic chemical reaction proceeds in two stages :

$$R \xrightarrow{\text{Stage I}} \text{Intermediate} \xrightarrow{\text{Stage II}} P$$
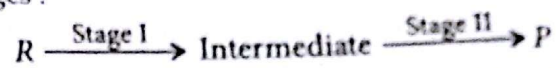
The activation energy of stage 1 is 50 kJ mol^{-1}. The enthalpy change of the reaction is −100 kJ mol^{-1}. Identify the energy level diagram for the reaction.

(a)

(b)

(c)

(d)
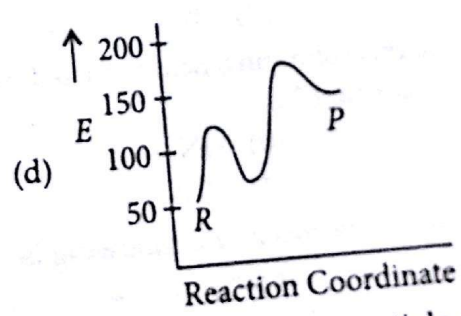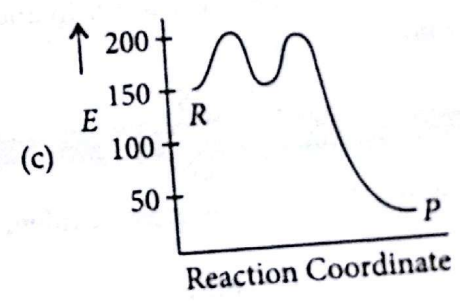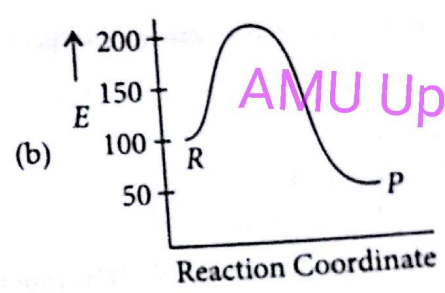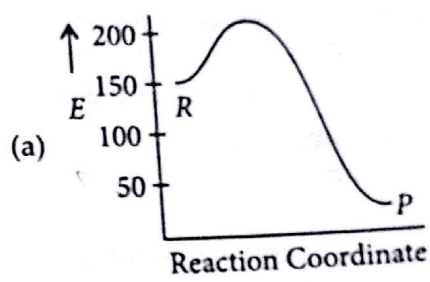
72. Given the reduction potentials of Na$^+$, Mg^{2+}, Al^{3+} and Ag$^+$ as

$$E^o_{Na^+/Na} = -2.71 \text{ V} \qquad E^o_{Mg^{2+}/Mg} = -2.37 \text{ V}$$

$$E^o_{Al^{3+}/Al} = -1.66 \text{ V} \qquad E^o_{Ag^+/Ag} = 0.80 \text{ V}$$

The least stable oxide is

(a) Ag$_2$O
(b) Al$_2$O$_3$
(c) MgO
(d) Na$_2$O

73. The depression in freezing point of water observed for the same amount of acetic acid (I), trichloroacetic acid (II) and trifluoroacetic acid (III) decreases in the order
(a) I > II > III
(b) II > I > III
(c) III > I > II
(d) III > II > I

74. The first ionization potential of Na, Mg and Si are respectively 496, 737 and 786 kJ mol⁻¹. The ionization potential of Al will be closer to
(a) 760 kJ mol⁻¹
(b) 575 kJ mol⁻¹
(c) 801 kJ mol⁻¹
(d) 419 kJ mol⁻¹

75. Television picture tube is basically
(a) cathode ray tube
(b) anode ray tube
(c) hybrid of cathode and anode tube
(d) none of the above.

76. The television picture on the screen results due to the phenomenon called
(a) phosphorescence
(b) fluorescence
(c) chemofluorescence
(d) fluorophosphorescence.

77. The correct symbol of the species with number of electrons, protons and neutrons as 18, 16 and 16 respectively is
(a) $_{16}^{32}S$
(b) $_{18}^{32}S$
(c) $_{16}^{32}S^{2-}$
(d) $_{18}^{32}S^{2-}$

78. Which one of the following is least covalent in nature?
(a) NF_3
(b) BiF_3
(c) PF_3
(d) SbF_3

79. Which one of the following acids is used as an oxidizer in rocket fuel ?
(a) $HClO_4$
(b) HNO_2
(c) H_3PO_4
(d) HNO_3

80. The paramagnetic species in the following is
(a) S_8
(b) S_6
(c) S_2
(d) S_2^{2-}

81. The spin only magnetic moment value (in B.M. unit) of $Cr(CO)_6$ is
(a) Zero
(b) 2.84
(c) 4.90
(d) 5.92

82. Which one of the following oxidation states is not possible in metal carbonyls?
(a) +1
(b) 0
(c) –1
(d) +2

83. The lanthanoid which exhibits +4 oxidation state is
(a) Pm
(b) Sm
(c) Ce
(d) Gd

84. The production of dihydrogen gas via water gas shift reaction :
$$CO_{(g)} + H_2O_{(g)} \xrightarrow[\text{Catalyst}]{\Lambda} CO_{2(g)} + H_{2(g)}$$
The CO_2 gas is removed by scrubbing with solution of
(a) sodium arsenite
(b) calcium oxide
(c) sodium phosphite
(d) aluminium oxide.

85. How many hydrogen-bonded water molecule(s) are associated in $CuSO_4.5H_2O$?
(a) 5
(b) 1
(c) 4
(d) 3

86. The ratio of magnetic moment (spin only value) between $[FeF_6]^{3-}$ and $[Fe(CN)_6]^{3-}$ is approximately
(a) 4
(b) 2
(c) 5
(d) 3

87. Which is not true for describing the catalytic activity of transition metals?
(a) Their ability to adopt multiple oxidation states.
(b) Their ability to form bonds between reactant molecule and atoms of the surface of catalysts.
(c) Increasing the concentration of reactants at the catalyst surface.
(d) Strengthening the bonds in the reacting molecules.

88. The bond order between Ni—C bond in $Ni(CO)_4$ is
(a) one
(b) two
(c) less than two
(d) more than two.

89. The interhalogen having dimeric structure is
(a) ClF_3
(b) BrF_3
(c) IF_3
(d) ICl_3

90. Which one of the following transition element has the lowest value of enthalpy of atomization?
(a) Cr
(b) Cu
(c) Zn
(d) Mn

91. Which of the following stability order is correct?
(a) $O_2^{2-} > O_2^- > O_2 > O_2^+$
(b) $O_2^+ > O_2 > O_2^- > O_2^{2-}$
(c) $O_2^+ > O_2 < O_2^- > O_2^{2-}$
(d) $O_2 > O_2^+ > O_2^{2-} > O_2^-$

The IUPAC name of the following compound is

$$CH_2 - CH - CH_2$$
$$\begin{array}{ccc} | & | & | \\ CN & CN & CN \end{array}$$

(a) 1, 2, 3-tricyanopropane
(b) propane, 1, 2, 3-trinitrile
(c) 3-cyanopentane-1, 5-dinitrile
(d) 1, 3, 5-pentanetrinitrile.

94. Which is the least stable carbocation ?

(I) $CH_3CH_2\overset{+}{C}H_2$ (II) $CH_3\overset{+}{C}HCH_3$

(III) $(CH_3)_3\overset{+}{C}$

(IV) $(CH_3)_3C\overset{+}{C}H_2$

(a) I   (b) II
(c) III   (d) IV

94. The order of compounds in their reactivity towards HCN is

(a) Acetaldehyde < Acetone < Methyl *tert*-butyl ketone < Di-*tert*-butyl ketone
(b) Di-*tert*-butyl ketone < Methyl *tert*-butyl ketone < Acetone < Acetaldehyde
(c) Di-*tert*-butyl ketone < Acetone < Methyl *tert*-butyl ketone < Acetaldehyde
(d) Acetone < Acetaldehyde < Di-*tert*-butyl ketone < Methyl *tert*-butyl ketone.

95. The product/s of following reaction is (are)

$$C_2H_5Br + 2Na + CH_3Br \xrightarrow{\text{dry ether}} ?$$
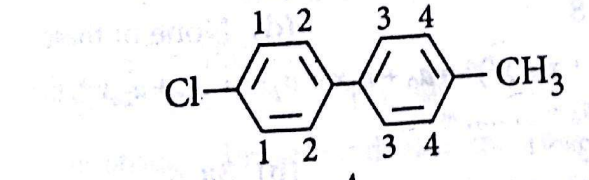
(a) Ethane
(b) Propane
(c) Butane
(d) Ethane, propane and butane.

96. Amongst the following, the most basic compound is

(a) benzylamine   (b) aniline
(c) acetanilide   (d) *p*-nitroaniline.

97. Electrophilic substitution of compound A will be fastest at position _____.

Cl—⟨ 1 2 / 3 4 ⟩—⟨ 1 2 / 3 4 ⟩—CH₃

A
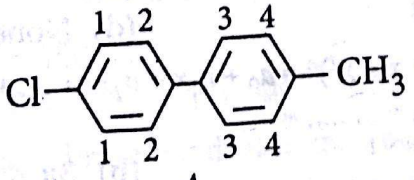
(a) 1   (b) 2
(c) 3   (d) 4

98. Which of the following haloalkanes would undergo S_N2 reaction faster?

I. ⟨ ⟩—CH₂Cl   II. ⟨ ⟩—Cl

III. (structure) I
(a) I
(c) III
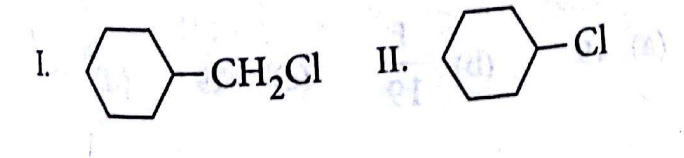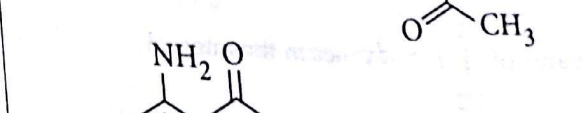
IV. (structure) Cl
(b) II
(d) IV

99. Propene was oxidised by aqueous $KMnO_4$ to give a compound (A). Treatment of compound (A) with thionyl chloride gave

(a) 1, 2-dichloropropane
(b) 1-chloropropanone
(c) 2-chloropropanoic acid
(d) 2-chloropropanal.

100. (benzene ring with NH₂) $\xrightarrow{CH_3COCl, AlCl_3}$?

What product will be obtained?

(a) (structure NHCOCH₃)

(b) (structure NH₂ ... O-CH₃)

(c) (structure NH₂ O, CH₃)   (d) None of these.

MATHEMATICS

101. The distance between the lines $3x + 4y = 9$, $6x + 8y = 15$ is

(a) $\frac{3}{10}$ (b) $\frac{7}{10}$ (c) $\frac{3}{2}$ (d) $\frac{2}{3}$

102. If $-3 + ix^2y$ and $x^2 + y + 4i$ be conjugate complex numbers, then (x, y) is

(a) $(1, -4)$ (b) $(-1, 4)$
(c) $(2, 1)$ (d) $(-2, 1)$

103. Three of the six vertices of a regular hexagon are chosen at random. The probability that the triangle with three vertices is equilateral, equals

(a) $\frac{1}{2}$ (b) $\frac{1}{5}$ (c) $\frac{1}{10}$ (d) $\frac{1}{20}$

104. If $f(x) = \begin{cases} -x - \pi/2, & x \le -\pi/2 \\ -\cos x, & -\pi/2 < x \le 0 \\ x - 1, & 0 < x \le 1 \\ \ln x, & x > 1 \end{cases}$, then

(a) $f(x)$ is continuous at $x = -\pi/2$
(b) $f(x)$ is differentiable at $x = 0$
(c) $f(x)$ is not differentiable at $x = 1$
(d) $f(x)$ is not differentiable at $x = -3/2$

105. Which of the following is correct solution of

$$(1+e^{x/y})dx + e^{x/y}\left[1-\left(\frac{x}{y}\right)\right]dy = 0?$$

(a) $x + y\, e^{x/y} = C$
(b) $y + x\, e^{x/y} = C$
(c) $x + y = C\, e^{-x/y}$
(d) $y = x + C\, e^{x/y}$

106. $^mC_{r+1} + \sum\limits_{k=m}^{n} {}^kC_r =$

(a) $^nC_{r+1}$
(b) $^{n+1}C_{r+1}$
(c) ^nC_r
(d) None of these

107. Let $\left[\dfrac{1}{2}, 1\right] \to R$ (the set of all real numbers) be a

positive, non-constant and differentiable function

such that $f'(x) < 2f(x)$ and $f\left(\dfrac{1}{2}\right) = 1$. Then the

value of $\displaystyle\int\limits_{1/2}^{1} f(x)dx$ lies in the interval

(a) $(2e - 1, 2e)$
(b) $(e - 1, 2e - 1)$
(c) $\left(\dfrac{e-1}{2}, e-1\right)$
(d) $\left(0, \dfrac{e-1}{2}\right)$

108. The existence of the unique solution of the system
of equations $x + y + z = \beta$, $5x - y + \alpha z = 10$ and
$2x + 3y - z = 6$ depends on
(a) α only
(b) β only
(c) α and β both
(d) neither β nor α

109. Let $f : [0, 1] \to R$ (the set of all real numbers)
be a function. Suppose the function f is twice
differentiable, $f(0) = f(1) = 0$ and satisfies
$f''(x) - 2f'(x) + f(x) \geq e^x$, $x \in [0, 1]$. If the function
$e^{-x} f(x)$ assumes its minimum in the interval
$[0, 1]$ at $x = \dfrac{1}{4}$, which of the following is true?

(a) $f'(x) < f(x)$, $\dfrac{1}{4} < x < \dfrac{3}{4}$

(b) $f'(x) < f(x)$, $0 < x < \dfrac{1}{4}$

(c) $f'(x) < f(x)$, $0 < x < \dfrac{1}{4}$

(d) $f'(x) < f(x)$, $\dfrac{3}{4} < x < 1$

110. If $\displaystyle\int\limits_0^{\pi/3} \dfrac{\cos x}{3+4\sin x}\,dx = k \log\left(\dfrac{3+2\sqrt{3}}{3}\right)$,

(a) $\dfrac{1}{2}$
(b) $\dfrac{1}{3}$
(c) $\dfrac{1}{4}$
(d) $\dfrac{1}{8}$

111. $\dfrac{C_1}{C_0} + 2\dfrac{C_2}{C_1} + 3\dfrac{C_3}{C_2} + \dots + n\dfrac{C_n}{C_{n-1}} =$

(a) $\dfrac{n(n-1)}{2}$
(b) $\dfrac{n(n+1)}{2}$
(c) $\dfrac{n(n+1)(n+2)}{2}$
(d) None of these

112. If x, y and z are all different and

$$\begin{vmatrix} x & x^2 & 1+x^3 \\ y & y^2 & 1+y^3 \\ z & z^2 & 1+z^3 \end{vmatrix} = 0, \text{ then}$$

(a) $xyz = -1$
(b) $xyz = 1$
(c) $xyz = -2$
(d) $xyz = 2$

113. Which of the following is a correct solution of

$$x\cos x\left(\dfrac{dy}{dx}\right) + y(x\sin x + \cos x) = 1 ?$$

(a) $y\, x \sec y = C + \tan x$
(b) $y\, x \cos y = C + \tan x$
(c) $y\, x \sec x = C + \tan x$
(d) None of the above

114. Let f be the function on $[-\pi, \pi]$ given by

$f(0) = 9$ and $f(x) = \sin\left(\dfrac{9x}{2}\right)\Big/ \sin\left(\dfrac{x}{2}\right)$ for $x \neq 0$.

The value of $\dfrac{2}{\pi}\displaystyle\int\limits_{-\pi}^{\pi} f(x)dx$ is

(a) 0
(b) 4
(c) 8
(d) None of these

115. If $(1 + x + x^2)^n = a_0 + a_1 x + a_2 x^2 + \dots + a_{2n}x^{2n}$, then $a_0 +$
$a_3 + a_6 + \dots\dots =$
(a) 3^{n+1}
(b) $3n$
(c) $3^n - 1$
(d) None of these

116. If $A = \begin{bmatrix} 2 & 3 \\ 5 & -2 \end{bmatrix}$ be such that $A^{-1} = kA$, then k is

equal to

(a) 19
(b) $\dfrac{1}{19}$
(c) -19
(d) $-\dfrac{1}{19}$

17. Let $f(x)$ be differentiable on the interval $(0, \infty)$ such that $f(1) = 1$, and $\lim\limits_{t \to x} \dfrac{t^2 f(x) - x^2 f(t)}{t - x} = 1$ for each $x > 0$. Then $f(x)$ is

(a) $\dfrac{1}{3x} + \dfrac{2x^2}{3}$

(b) $-\dfrac{1}{3x} + \dfrac{4x^2}{3}$

(c) $-\dfrac{1}{x} + \dfrac{2}{x^2}$

(d) $\dfrac{1}{x}$

18. If α, β are the roots of the equation $ax^2 + bx + c = 0$ and $S_n = \alpha^n + \beta^n$, then $a S_{n+1} + b S_n + c S_{n-1}$ is equal to

(a) 0

(b) abc

(c) $a + b + c$

(d) None of these

19. Let V_r denote the sum of the first r terms of an arithmetic progression (A.P.) whose first term is r and the common difference is $(2r - 1)$. Let $T_r = V_{r+1} - V_r - 2$ and $Q_r = T_{r+1} - T_r$ for $r = 1, 2, \ldots$. The sum $V_1 + V_2 + \ldots + V_n$ is

(a) $\dfrac{1}{12} n(n+1)(3n^2 - n + 1)$

(b) $\dfrac{1}{12} n(n+1)(3n^2 + n + 2)$

(c) $\dfrac{1}{2} n(2n^2 - n + 1)$

(d) $\dfrac{1}{3}(2n^3 - 2n + 1)$

20. If $x^p y^q = (x + y)^{p+q}$, then $\dfrac{dy}{dx}$ is equal to

(a) $\dfrac{y}{x}$

(b) $\dfrac{py}{qx}$

(c) $\dfrac{x}{y}$

(d) $\dfrac{qy}{px}$

21. Let $z = x + iy$ be a complex number where x and y are integers. Then the area of the rectangle whose vertices are the roots of the equation $\bar{z}z^3 + z\bar{z}^3 = 350$ is

(a) 48

(b) 32

(c) 40

(d) 80

22. Let the straight line $x = b$ divide the area enclosed by $y = (1 - x^2)$, $y = 0$ and $x = 0$ into two parts R_1 $(0 \le x \le b)$ and R_2 $(b \le x \le 1)$ such that $R_1 - R_2 = \dfrac{1}{4}$. Then b equals

(a) $\dfrac{3}{4}$

(b) $\dfrac{1}{2}$

(c) $\dfrac{1}{3}$

(d) $\dfrac{1}{4}$

123. If $\omega = \alpha + i\beta$, where $\beta \ne 0$ and $z \ne 1$, satisfies the condition that $\left(\dfrac{\omega - \bar{\omega}z}{1 - z}\right)$ is purely real, then the set of values of z is

(a) $\{z : |z| = 1\}$

(b) $\{z : z = \bar{z}\}$

(c) $\{z : z \ne 1\}$

(d) $\{z : |z| = 1, z \ne 1\}$

124. If the function $f(x) = \dfrac{a \sin x + 2 \cos x}{\sin x + \cos x}$ is increasing for all values of x, then

(a) $a < 1$

(b) $a > 1$

(c) $a < 2$

(d) $a > 2$

125. If A is a square matrix of order $n \times n$, then adj (adj A) is equal to

(a) $|A|^n A$

(b) $|A|^{n-1} A$

(c) $|A|^{n-2} A$

(d) $|A|^{n-3} A$

126. Let $\vec{a} = \hat{i} - \hat{k}, \vec{b} = -\hat{i} + \hat{j}$ and $\vec{c} = \hat{i} + 2\hat{j} + 3\hat{k}$ be three given vectors. If $\vec{r}$ is a vector such that $\vec{r} \times \vec{b} = \vec{c} \times \vec{b}$ and $\vec{r} \cdot \vec{a} = 0$, then the value of $\vec{r} \cdot \vec{b}$ is

(a) 3

(b) 6

(c) 9

(d) 12

127. Let n be a positive integer such that $\sin\dfrac{\pi}{2n} + \cos\dfrac{\pi}{2n} = \dfrac{\sqrt{n}}{2}$, then

(a) $6 \le n \le 8$

(b) $4 < n \le 8$

(c) $4 \le n < 8$

(d) $4 < n < 8$

128. Let $L = \lim\limits_{x \to 0} \dfrac{a - \sqrt{a^2 - x^2} - \dfrac{x^2}{4}}{x^4}, a > 0$. If L is finite, then

(a) $a = 2$

(b) $a = 1$

(c) $a = \dfrac{1}{3}$

(d) None of these

129. If three digit numbers A28, 3B9 and 62C, where A, B and C are integers between 0 and 9, are divisible by a fixed integer k, then the determinant $\begin{vmatrix} A & 3 & 6 \\ 8 & 9 & C \\ 2 & B & 2 \end{vmatrix}$ is

(a) divisible by k

(b) divisible by k^2

(c) divisible by $2k$

(d) none of these

130. The number of points of intersection of the two curves $y = 2 \sin x$ and $y = 5x^2 + 2x + 3$ is

(a) 0

(b) 1

(c) 2

(d) ∞

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131. A straight line $\vec{r} = \vec{a} + \lambda \vec{b}$ meets the plane $\vec{r} \cdot \hat{n} = p$ in the point P whose position vector is

(a) $\vec{a} + \dfrac{\vec{a} \cdot \hat{n}}{\vec{b} \cdot \hat{n}} \vec{b}$

(b) $\vec{a} + \left(\dfrac{p - \vec{a} \cdot \hat{n}}{\vec{b} \cdot \hat{n}} \right) \vec{b}$

(c) $\vec{a} - \left(\dfrac{\vec{a} \cdot \hat{n}}{\vec{b} \cdot \hat{n}} \right) \vec{b}$

(d) none of these

132. The probability that a leap year selected at random contains 53 Sundays is

(a) $\dfrac{7}{366}$

(b) $\dfrac{28}{183}$

(c) $\dfrac{1}{7}$

(d) $\dfrac{2}{7}$

133. The principal value of $\sin^{-1}\left[\sin\left(\dfrac{2\pi}{3} \right) \right]$ is

(a) $\dfrac{-2\pi}{3}$

(b) $\dfrac{2\pi}{3}$

(c) $\dfrac{4\pi}{3}$

(d) none of these

134. Let R be the relation on the set R of all real numbers defined by aRb iff $|a - b| \leq 1$. Then R is
(a) reflexive
(b) transitive
(c) anti-symmetric
(d) none of these

135. Let $\vec{a} = \hat{i} + 2\hat{j} + \hat{k}, \vec{b} = \hat{i} - \hat{j} + \hat{k}$ and $\vec{c} = \hat{i} - \hat{j} - \hat{k}$. A vector in the plane of $\vec{a}$ and $\vec{b}$ whose projection on $\vec{c}$ is $\dfrac{1}{\sqrt{3}}$, is

(a) $4\hat{i} - \hat{j} + 4\hat{k}$

(b) $3\hat{i} + \hat{j} - 3\hat{k}$

(c) $2\hat{i} + \hat{j} - 2\hat{k}$

(d) $4\hat{i} + \hat{j} - 4\hat{k}$

136. If the squares of the tangents from a point P to the circles $x^2 + y^2 = a^2, x^2 + y^2 = b^2$ and $x^2 + y^2 = c^2$ are in A.P., then
(a) a, b, c are in A.P.
(b) a, b, c are in G.P.
(c) a^2, b^2, c^2 are in A.P.
(d) a^2, b^2, c^2 are in G.P.

137. Set A and B have 3 and 6 elements respectively. What can be the minimum number of elements in $A \cup B$?
(a) 18   (b) 9   (c) 6   (d) 3

138. If a function $f : [2, \infty) \to A$ defined by $f(x) = x^2 - 4x + 5$ is a bijection, then A is equal to

(a) R

(c) $[2, \infty)$

(a) $[1, \infty)$

(d) none of these

139. Let A and B be two distinct points on the parabola $y^2 = 4x$. If the axis of the parabola touches a circle of radius 2 having AB as its diameter, then the slope of the line joining A and B can be

(a) $-\dfrac{1}{2}$

(b) $\dfrac{1}{2}$

(c) 1

(d) none of these

140. For any two independent events E_1 and E_2, $P\{(E_1 \cup E_2) \cap (\bar{E}_1) \cap (\bar{E}_2)\}$ is

(a) $< \dfrac{1}{4}$

(b) $> \dfrac{1}{4}$

(c) $\geq \dfrac{1}{2}$

(d) none of these

141. Let $\vec{a}, \vec{b}, \vec{c}$ be unit vectors such that $\vec{a} + \vec{b} + \vec{c} = \vec{0}$. Which one of the following is correct?
(a) $\vec{a} \times \vec{b} = \vec{b} \times \vec{c} = \vec{c} \times \vec{a} = \vec{0}$
(b) $\vec{a} \times \vec{b} = \vec{b} \times \vec{c} = \vec{c} \times \vec{a} \neq \vec{0}$
(c) $\vec{a} \times \vec{b} = \vec{b} \times \vec{c} = \vec{a} \times \vec{c} = \vec{0}$
(d) $\vec{a} \times \vec{b}, \vec{b} \times \vec{c}, \vec{c} \times \vec{a}$ are mutually perpendicular

142. The locus of the orthocentre of the triangle formed by the lines $(1 + a)x - ay + a(1 + a) = 0$, $(1 + b)x - by + b(1 + b) = 0$ and $y = 0$, where $a \neq b$, is a/an
(a) hyperbola
(b) parabola
(c) ellipse
(d) straight line

143. If $\vec{r} \cdot \vec{a} = \vec{r} \cdot \vec{b} = \vec{r} \cdot \vec{c} = 0$ for some non-zero vector $\vec{r}$, then the value of $[\vec{a} \, \vec{b} \, \vec{c}]$ is
(a) 2
(b) 3
(c) 0
(d) none of these

144. Which one of the following is correct solution of $\left(\dfrac{dy}{dx} \right) \tan y = \sin(x + y) + \sin(x - y)$?

(a) $\sec x = C - 2 \sec y$

(b) $\sec y = C + 2 \cos y$

(c) $\sec y = C - 2 \cos x$

(d) $\sec x = C - 2 \cos y$

145. The line $\dfrac{x - 2}{3} = \dfrac{y - 3}{4} = \dfrac{z - 4}{5}$ is parallel to the plane
(a) $3x + 4y + 5z = 7$
(b) $2x + 3y + 4z = 0$
(c) $x + y - z = 2$
(d) $2x + y - 2z = 0$

146. The circle $x^2 + y^2 - 8x = 0$ and hyperbola $\dfrac{x^2}{9} - \dfrac{y^2}{4} = 1$ intersect at the points A and B. Equation of a common tangent with positive slope to the circle as well as to the hyperbola is

(a) $2x - \sqrt{5}y - 20 = 0$ (b) $2x - \sqrt{5}y + 4 = 0$

(c) $3x - 4y + 8 = 0$ (d) $4x - 3y + 4 = 0$

147. Area bounded by the curve $x = 0$ and $x + 2\,|y| = 1$ is

(a) $\dfrac{1}{4}$ (b) $\dfrac{1}{2}$ (c) 1 (d) 2

AMU Updates

148. Which of the following is a correct solution of
$$y^2 + \left(x - \dfrac{1}{y}\right)\dfrac{dy}{dx} = 0 ?$$

(a) $y = ce^{1/x} + \dfrac{1}{y} + 1$ (b) $x = ce^{1/y} + \dfrac{1}{y} + 1$

(c) $x = ce^{1/x} + \dfrac{1}{y} + 1$ (d) $x = ce^{1/y} + \dfrac{1}{x} + 1$

149. For any real number x, let $[x]$ denote the largest integer less than or equal to x. Let f be a real valued function defined on the interval $[-10, 10]$ by

$$f(x) = \begin{cases} x - [x], & \text{if } [x] \text{ is odd} \\ 1 + [x] - x, & \text{if } [x] \text{ is even} \end{cases}$$

Then the value of $\dfrac{\pi^2}{10} \displaystyle\int_{-10}^{10} f(x) \cos \pi x \, dx$ is

(a) 2 (b) 4

(c) 0 (d) none of these

150. Sum of the series $(x + y)(x - y) + \dfrac{1}{2!}(x + y)(x - y)(x^2 + y^2) + \dfrac{1}{3!}(x + y)(x - y)(x^4 + y^4 + x^2y^2) + \ldots \infty$ is

(a) $e^x + e^y$ (b) $e^x - e^y$

(c) $e^{x^2} + e^{y^2}$ (d) $e^{x^2} - e^{y^2}$

A.M.U. (ENGINEERING)
Solved Paper 2013

PHYSICS

1. Light from a source located in a medium (refractive index = μ_0) enters an optical fibre with core refractive index μ_1 and clad refractive index μ_2, as shown in the figure. The maximum value of incident angle θ which would undergo total internal reflection in the fibre is

(a) $\theta = \cos^{-1}\left(\dfrac{\sqrt{\mu_1^2 - \mu_2^2}}{\mu_0}\right)$

(b) $\theta = \tan^{-1}\left[\dfrac{\mu_1 - \mu_2}{\mu_0}\right]$

(c) $\theta = \sin^{-1}\left(\dfrac{\sqrt{\mu_1^2 - \mu_2^2}}{\mu_0}\right)$

(d) none of these

2. A cyclotron is operated at an oscillator frequency of 12 MHz and has a dee radius $R = 50$ cm. What is the magnitude of the magnetic field needed for a proton to be accelerated in the cyclotron?

(a) 0.72 T   (b) 0.65 T

(c) 0.39 T   (d) 0.12 T

3. Which of the following expressions represents the relation between orbital magnetic moment and orbital angular momentum of an electron?

(a) $\vec{\mu}_{orb} = -\dfrac{2m_e}{e}\vec{L}_{orb}$ (b) $\vec{\mu}_{orb} = -2m_e\vec{L}_{orb}$

(c) $\vec{\mu}_{orb} = -\dfrac{e}{2m_e}\vec{L}_{orb}$ (d) $\vec{\mu}_{orb} = \dfrac{e}{2m_e}\vec{L}_{orb}$

4. In the following figure, the variation of electric field magnitude E versus time is shown for four uniform electric fields contained within identical circular regions. Arrange the fields according to the magnitudes of the magnetic fields they induce at the edge of the region, in decreasing order.
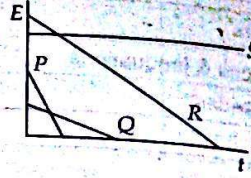
(a) P, R, Q, S   (b) R, P, Q, S

(c) Q, R, P, S   (d) S, P, Q, R

5. In a double slit experiment, the distance between slits is 5.0 mm and the slits are 1.0 m from the screen. Two interference patterns can be seen on the screen : one due to light of wavelength 480 nm and the other due to light of wavelength 600 nm. What is the separation on the screen between the third order bright fringes of the two interference patterns?

(a) 0.20 mm   (b) 0.05 mm

(c) 0.07 mm   (d) 0.09 mm

6. A LED is constructed from a p-n junction based on a certain Ga-As-P semiconducting material whose energy gap is 1.9 eV. Identify the colour of the emitted light.

(a) blue   (b) red

(c) violet   (d) green

7. The binding energy per nucleon in a heavy nucleus is of the order of

(a) 8 MeV   (b) 7 MeV

(c) 5 MeV   (d) 2 MeV

8. In the following nuclear reaction
$^{235}U + n \rightarrow X + Y + 2n$, which of the following pairs cannot represent X and Y?

(i) ^{141}Xe and ^{93}Sr (ii) ^{139}Cs and ^{95}Rb

(iii) ^{156}Nd and ^{79}Ge (iv) ^{141}Ba and ^{92}Kr

(a) (iii) and (iv)   (b) (i) and (ii)

(c) (ii) and (iii)   (d) (i) and (iv)

9. Which of the following fusion reactions will not result in the net release of energy?

(i) $^6Li + ^6Li$ (ii) $^4He + ^4He$

(iii) $^{12}C + ^{12}C$ (iv) $^{35}Cl + ^{35}Cl$

(a) (iv)   (b) (iii)   (c) (i)   (d) (ii)

10. For a damped harmonic oscillator of mass 250 gm, the values of spring constant (k) and damping constant (b) are 85 N/m and 70 gm/s, respectively. What is the period of motion?
(a) 2.5 s (b) 5.0 s (c) 6.25 s (d) 7.2 s

11. A string oscillates according to the equation,
$$y = (0.50\ cm) \sin\left[\frac{\pi x}{3}\right] \cos[40\pi t].$$ Find the distance between nodes.
(a) 1.5 cm (b) 2.5 cm (c) 3.0 cm (d) 3.5 cm

12. Two point sources, which are in phase and separated by distance $D = 1.5\lambda$, emit identical sound waves of wavelength λ. If a circle with a radius much greater than D, centered on the mid-point between the sources, what is the number of points around the circle at which the interference is fully constructive?
(a) 12 (b) 8 (c) 6 (d) 4

13. The figure shows the temperatures at four faces of a composite slab consisting of four materials S_1, S_2, S_3 and S_4 of identical thickness, through which the heat transfer is steady. Arrange the materials according to their thermal conductivities in decreasing order.

25°C	15°C	10°C	−5°C	−10°C
S_1	S_2	S_3	S_4	

(a) S_2, S_4, S_1, S_3
(b) $S_2 = S_4, S_1, S_3$
(c) $S_1 = S_2, S_3, S_4$
(d) S_1, S_2, S_3, S_4

14. The figure shows two identical copper blocks of mass 0.5 kg. When they were not in contact, block L was at temperature 60°C and block R was at temperature 20°C. But, when the blocks bring in contact, they come to the equilibrium temperature 40°C. What is the net entropy change of the two block system during the irreversible process? (Specific heat of copper = 386 J/kg K)

L	R
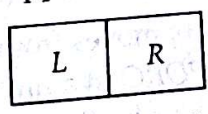
(a) 2.4 J/K (b) 3.6 J/K
(c) 4.2 J/K (d) 5.2 J/K

15. Two parallel large nonconducting sheets with identical (positive) uniform surface charge densities, and a sphere A with a uniform (positive) volume charge density are arranged as shown in figure. Rank the points 1, 2, 3 and 4 according to the magnitudes of the net electric field in increasing order.
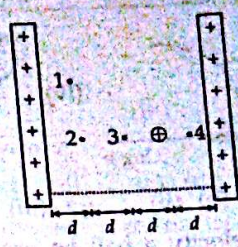
(a) 1, 2, 3, 4
(b) 1, 2, 3 = 4
(c) 1 = 2, 3, 4
(d) 4, 3, 2, 1

16. Choose the electromagnetic radiation relevant to telecommunication
(a) ultraviolet (b) infrared
(c) visible (d) microwave

17. A microscope is focused at a point at the bottom of a beaker containing water. The microscope is then raised through 3 cm. To what height water must be added into the beaker to bring the point again in focus?
(a) 15 cm (b) 12 cm (c) 10 cm (d) 8 cm

18. The electric field in a region is given by
$$\bar{E} = \frac{A}{x^3}\hat{i} + By\,\hat{j} + Cz^2\hat{k}$$
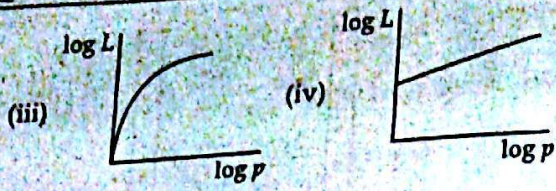The SI units of A, B and C are, respectively
(a) $\frac{N-m^3}{C}, V/m^2, \frac{N}{m^2-C}$
(b) $V-m^2, V/m, \frac{N}{m^2-C}$
(c) $V/m^2, V/m, \frac{N-C}{m^2}$
(d) $V/m, \frac{N-m^3}{C}, \frac{N-C}{m}$

19. Find the component of vector $\bar{A} = 2\hat{i}+3\hat{j}$ along the direction $(\hat{i}-\hat{j})$.
(a) $-\frac{1}{2}(\hat{i}-\hat{j})$
(b) $-\frac{1}{2}(\hat{i}+\hat{j})$
(c) $\frac{1}{2}(\hat{i}-\hat{j})$
(d) $\frac{1}{2}(\hat{i}+\hat{j})$

20. Angular momentum L is given by $L = p.r$. The variation of log L and log p is shown by

(i) log L vs log p
(ii) log L vs log p

(iii) — graph of $\log L$ vs $\log p$
(iv) — graph of $\log L$ vs $\log p$
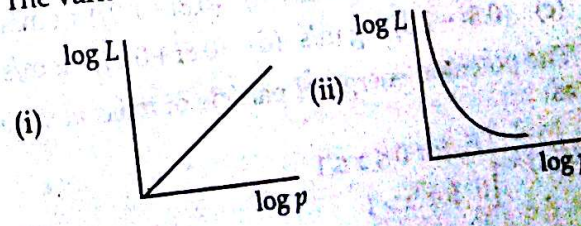
(a) (i) (b) (ii) (c) (iii) (d) (iv)

21. By what velocity a ball be projected vertically upwards so that the distance covered in 5th second is twice of that covered in 6th second?

(a) 19.6 m/s (b) 58.8 m/s
(c) 49 m/s (d) 65 m/s

22. A ball is dropped vertically from a height h above the ground. After touching the ground, it bounces up to a height $h/2$. Neglecting the air resistance, its velocity v varies with the height above the ground as.

(i) — v vs height graph
(ii) — v vs height graph
(iii) — v vs height graph
(iv) — v vs height graph
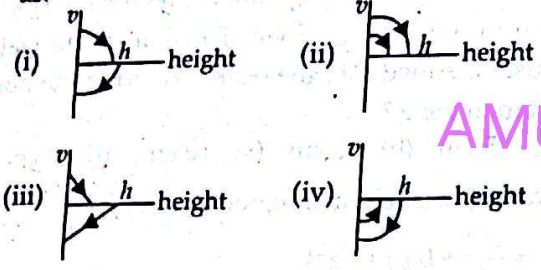
(a) (i) (b) (ii) (c) (iii) (d) (iv)

23. A uniform rope of mass 0.1 kg and length 2.45 m hangs from a ceiling. The time taken by a transverse wave to travel the full length of the rope is

(a) 1.2 s (b) 1.0 s (c) 2.2 s (d) 3.1 s

24. The magnitudes of gravitational field at distances r_1 and r_2 from the centre of a uniform sphere of radius R and mass M are I_1 and I_2, respectively. Find the ratio (I_1/I_2) if $r_1 > R$ and $r_2 < R$.

(a) $\dfrac{R^2}{r_1 r_2}$

(b) $\dfrac{R^3}{r_1 r_2^2}$

(c) $\dfrac{R^3}{r_1^2 r_2}$

(d) $\dfrac{R^4}{r_1^2 r_2^2}$

25. A toy car of mass 2.0 kg is moving towards $-ve$ Y-axis with a velocity of 0.5 m/s. It takes a turn towards X-axis with a velocity of 0.4 m/s. How much is the change in the linear momentum of the car due to the turn?

(a) $(0.6\hat{i} - 1.0\hat{j})$ kg m/s (b) $(0.8\hat{i} + 1.0\hat{j})$ kg m/s
(c) $(0.8\hat{i} - 1.0\hat{j})$ kg m/s (d) $(0.8\hat{i} + 0.6\hat{j})$ kg m/s

26. The potential energy of particle of mass m varies as

$$U(x) = \begin{cases} E_0 & \text{for } 0 \le x \le 1 \\ 0 & \text{for } x > 1 \end{cases}$$

The de Broglie wavelength of the particle in the range $0 \le x \le 1$ is λ_1 and that in the range $x > 1$ is λ_2. If the total energy of the particle is $2E_0$, find λ_1/λ_2.

(a) $\sqrt{2}$ (b) $\sqrt{3}$ (c) $\sqrt{\dfrac{1}{2}}$ (d) $\sqrt{\dfrac{2}{3}}$

27. A car moves around a curved road of radius R_1 at constant speed v without sliding. If we double the car's speed, what is the least radius that would now keep the car from sliding?

(a) $2 R_1$ (b) $4 R_1$ (c) $6 R_1$ (d) R_1

28. The figure shows the potential energy function $U(x)$ for a system in which a particle is in one-dimensional motion. Arrange regions AB, BC, CD and DE according to the magnitude of the force on the particle in decreasing order.
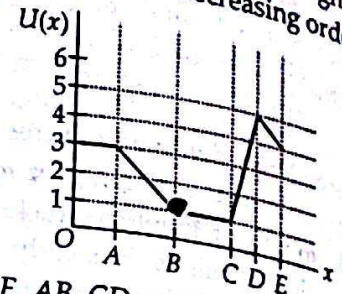

(a) BC, DE, AB, CD (b) BC, AB, CD, DE
(c) AB, CD, BC, DE (d) CD, AB, DE, BC

29. The figure shows four arrangements of three particles of equal masses. Arrange them according to the magnitude of the net gravitational force on the particle labeled m, in decreasing order.

(i)
(ii)
(iii)
(iv)
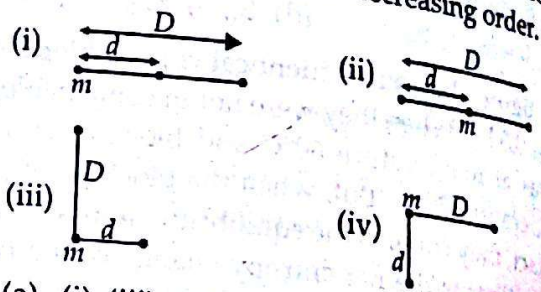
(a) (i), (iii) = (iv), (ii) (b) (i) = (iii), (ii), (iv)
(c) (i), (ii), (iii), (iv) (d) (iv), (iii), (ii), (i)

30. A point charge $+q$ moves from point P to origin O along the path PQRO in a uniform electric field $\vec{E}$. Find the work done by the field.
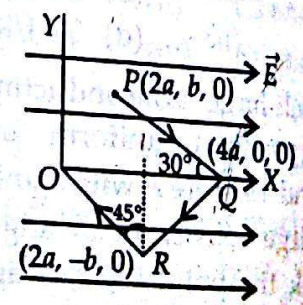

(a) $-2qEa$ (b) $2qEa$
(c) $8qEa$ (d) $-4qEa$

a new system of units called star units, in $1^* = 10$ kg, 1 m* $= 1$ km and 1 s* $= 1$ minute, what will be the value of 1 J in the new system?

(a) 2.4×10^{-5} J*

(b) 3.6×10^{-4} J*

(c) 4.2×10^{-3} J*

(d) 4.2×10^{-2} J*

A wooden box has a 4 m $\times$ 4 m $\times$ 10 cm metallic cover ($K = 1.26$ W/m $-$ °C). At some instant, the temperature outside is 40°C and that inside is 26°C. Neglecting convection, the amount of heat flowing per second into the box through the cover is

(a) 1832 W

(b) 2212 W

(c) 2822 W

(d) 3122 W

33. The following figure shows the Maxwell's speed distribution plots at four different temperatures T_1, T_2, T_3 and T_4
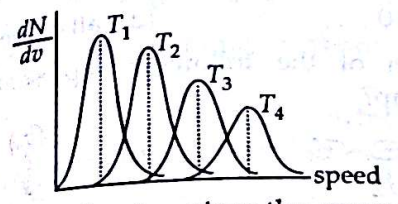
Which of the following gives the correct relation between temperatures?

(a) $T_4 > T_3 > T_2 > T_1$

(b) $T_4 < T_3 < T_2 < T_1$

(c) $T_1 = T_2 = T_3 = T_4$

(d) $T_1 > T_2, T_3 < T_4$

34. A thermodynamic state of a given sample of an ideal gas is completely described, if its

(a) pressure, volume and internal energy are known

(b) pressure, volume, temperature and internal energy are known

(c) pressure, volume and temperatrue are known

(d) pressure and volume are known

35. A cyclic process $ABCA$ on the V-T diagram (shown below) is performed with a constant mass of an ideal gas.
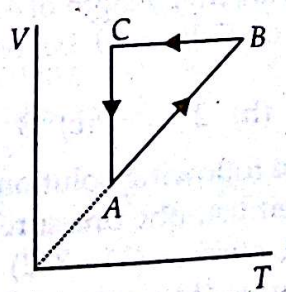
Which of the following figures corresponds to the same process on a P-V diagram?

(i)

(ii)
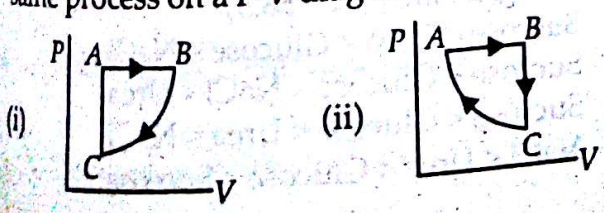
(iii)

(iv)

(a) (i)

(b) (ii)

(c) (iii)

(d) (iv)

36. The ratio of the radii of the nuclei $_{13}Al^{27}$ and $_{52}Te^{125}$ is

(a) $13 : 52$

(b) $27 : 125$

(c) $3 : 5$

(d) $14 : 73$

37. How many NAND gates are needed to obtain OR gate?

(a) 1

(b) 2

(c) 3

(d) 4

38. A capacitor is discharged through a resistance in R-C circuit. The variation of $\log_e i$ with time t is shown by a dotted line in the figure, where i is the discharging current. If the resistance in the circuit be doubled, the variation of $\log_e i$ with time t would be best represented by the line
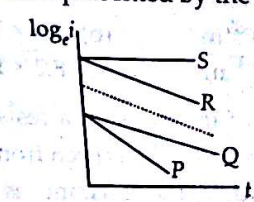
(a) P

(b) Q

(c) R

(d) S

39. A container is filled with water ($\mu = 1.33$) upto a height of 33.25 cm. A concave mirror is held 15 cm above the water level, and the image I of an object O placed at the bottom is formed 25 cm below the water level. The focal length of the mirror is roughly
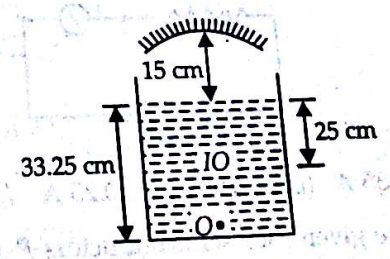
(a) 10 cm

(b) 15 cm

(c) 20 cm

(d) 25 cm

40. A current of 4.0 A is present in a wire of cross-sectional area 2.0 mm^2. Find the number of free electrons in each cubic metre of the wire, if the drift velocity is 2.1×10^{-4} m/s.

(a) 6.0×10^{28} m^{-3}

(b) 3.6×10^{29} m^{-3}

(c) 7.0×10^{30} m^{-3}

(d) 8.2×10^{32} m^{-3}

41. Doubly charged Mg^{24} ions are accelerated to kinetic energy 8 keV and are projected perpendicularly into a magnetic field of magnitude 1.2 T. Find the radius of the circle formed by the ions.

(a) 2.4 cm

(b) 3.2 cm

(c) 4.8 cm

(d) 5.3 cm

42. When two radiations of wavelengths λ_1 and λ_2 fall on a metallic surface, they produce photoelectrons with maximum energies k_1 and k_2 respectively. Which of the following relations is used to estimate the Planck constant?

(a) $h = \dfrac{k_1 - k_2}{c} \dfrac{\lambda_1 \lambda_2}{\lambda_2 - \lambda_1}$

(b) $h = \dfrac{k_1 + k_2}{c} \dfrac{\lambda_1 \lambda_2}{\lambda_2 - \lambda_1}$

(c) $h = \dfrac{k_1 - k_2}{c} \dfrac{\lambda_1 \lambda_2}{\lambda_2 + \lambda_1}$

(d) $h = \dfrac{\sqrt{k_1^2 - k_2^2}}{c} \dfrac{\lambda_1 \lambda_2}{\lambda_2 - \lambda_1}$

43. Which of the following phenomena establishes the wave nature of particles?
   (a) Millikan oil drop experiment
   (b) Davission-Germer experiment
   (c) Stern-Gerlach experiment
   (d) Franck-Hertz experiment

44. Find the de Broglie wavelength for a 100 gm bullet moving at 900 m/s.
   (a) 3.7×10^{-35} m
   (b) 7.4×10^{-36} m
   (c) 7.8×10^{-37} m
   (d) 8.2×10^{-39} m

45. The colours of the rings on a resistor are brown, yellow, green and gold as seen from the left to the right. The value of the resistance is
   (a) (1.4 ± 0.07) MΩ
   (b) (2.4 ± 0.05) MΩ
   (c) (3.4 ± 0.05) MΩ
   (d) (1.4 ± 0.05) MΩ

46. The ammeter, shown below, consists of a 360 Ω coil connected in parallel to a 40 Ω shunt. Find the reading of the ammeter.

AMU Updates

164 Ω A

+ | -
40 V
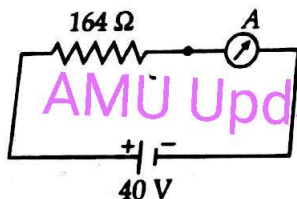
(a) 0.35 A (b) 0.4 A (c) 0.25 A (d) 0.2 A

47. You are given four semiconductors P, Q, R and S with respective band gaps 4 eV, 3 eV, 2 eV and 1 eV for use in a photodetector to detect $\lambda = 1400$ nm. Select the suitable semiconductor.
   (a) P (b) Q (c) R (d) S

When two waves of nearly equal frequencies v_1 and v_2 are produced simultaneously, the time interval between successive maxima is

(a) $\dfrac{1}{v_1 - v_2}$

(b) $\dfrac{1}{v_1} - \dfrac{1}{v_2}$

(c) $\dfrac{1}{v_1} + \dfrac{1}{v_2}$

(d) $\dfrac{1}{v_1 + v_2}$

49. A particular emission line detected in the light from a star, has a wavelength $\lambda_{det} = 1.1 \lambda$, where λ is the proper wavelength of the line. What is the star's distance from us?
   (a) 8.6×10^8 ly
   (b) 1.6×10^9 ly
   (c) 3.2×10^{10} ly
   (d) 9.2×10^{11} ly

50. For sky wave propagation of 10 MHz signal, what should be the minimum electron density in inosphere?
   (a) $\sim 1.2 \times 10^{12}$ m^{-3}
   (b) $\sim 10^6$ m^{-3}
   (c) $\sim 2.3 \times 10^{14}$ m^{-3}
   (d) $\sim 10^{22}$ m^{-3}

CHEMISTRY

51. When a dilute solution of KNO_3 is mixed with a dilute solution of NaBr, the enthalpy change is expected to be
   (a) zero, 0
   (b) > 0
   (c) < 0
   (d) all of the above.

52. Which of the following represents the zero overlap?

(a) p_z s →z

(b) p_x p_x →z

(c) p_x p_x →z

(d) s p_x →z
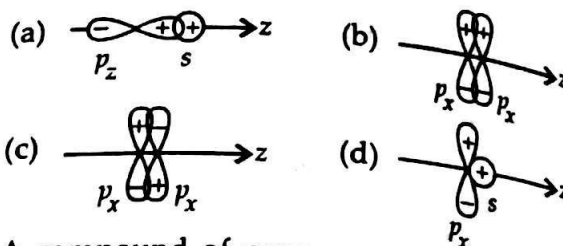
53. A compound of copper and gold crystallises in a cubic lattice in which the copper atoms occupy the centres of each of the cube faces and the gold atoms occupy the lattice point. The formula of compound is
   (a) Au_3Cu
   (b) $AuCu_3$
   (c) Au_2Cu_3
   (d) Au_3Cu_2

54. What volume of oxygen at 18°C and 750 torr, can be obtained from 110 g of $KClO_3$?
   (a) 32.6 L
   (b) 42.7 L
   (c) 3.26 L
   (d) 4.27 L

55. CsBr crystallizes in a body-centred cubic unit lattice with an edge length of 4.287 Å. How many molecules of CsBr will be present in the unit lattice?
   (a) 1   (b) 2   (c) 3   (d) 4

56. Arrange the following solutions in the increasing order of their osmotic pressure.
   (i)   34.2 g/L sucrose ($M = 342$)
   (ii) 60 g/L urea ($M = 60$)
   (iii) 90 g/L glucose ($M = 180$)
   (iv) 58.5 g/L NaCl ($M = 58.5$)
   (a) Sucrose < Urea < Glucose < NaCl
   (b) Sucrose < Glucose < NaCl < Urea
   (c) Sucrose < Glucose < Urea < NaCl
   (d) NaCl < Urea < Glucose < Sucrose

the magnitude of the charge on the electron is 1.6×10^{-10} esu. What is the magnitude of the charge on the proton on the nucleus of helium atom?

(a) 4.8×10^{-10} esu   (b) 9.6×10^{-10} esu

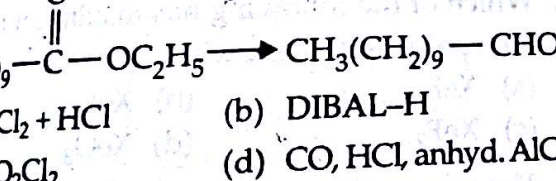(c) 6.4×10^{-10} esu   (d) 14.4×10^{-10} esu

In free radical polymerization, the extent of conversion increases with

(a) increase in temperature

(b) increase in polymerization time

(c) increase in monomer concentration

(d) all of the above.

100 mL of 0.1 M H_2SO_4 is mixed with 100 mL of 0.1 N NaOH. The normality of the solution obtained is

(a) 0.4 N   (b) 0.05 N

(c) 0.04 N   (d) 0.2 N

The thermodynamic equilibrium constant, K_c, for the reaction:

$CuO_{(s)} + H_{2(g)} \rightleftharpoons Cu_{(s)} + H_2O_{(g)}$ is given by

(a) $K_c = \dfrac{[Cu][H_2O]}{[CuO][H_2]}$ (b) $K_c = \dfrac{[Cu][H_2O]}{[H_2]}$

(c) $K_c = \dfrac{[H_2O]}{[CuO][H_2]}$ (d) $K_c = \dfrac{[H_2O]}{[H_2]}$

One mole of compound A, on heating with excess of conc. HI gave two moles of ethyl iodide. Compound A is

(a) ethoxybenzene

(b) 1, 2-dimethoxyethane

(c) methoxyethane   (d) ethoxyethane.

The appropriate reagent(s) for the following transformation is(are)

$$CH_3(CH_2)_9 - \overset{\overset{\displaystyle O}{\|}}{C} - OC_2H_5 \longrightarrow CH_3(CH_2)_9 - CHO$$

(a) $SnCl_2 + HCl$ (b) DIBAL–H

(c) CrO_2Cl_2 (d) CO, HCl, anhyd. $AlCl_3$

Which of the following reactions would provide the best synthesis of butan-2-ol?

(a) $\bigvee MgBr + \overset{\overset{\displaystyle O}{\|}}{\underset{H}{\diagup}}\ \xrightarrow{Ether}\ \xrightarrow{H_3O^+}$

(b) $\diagdown MgBr + \overset{\overset{\displaystyle O}{\|}}{\underset{H}{\diagup}}\ \xrightarrow{Ether}\ \xrightarrow{H_3O^+}$

(c) $\bigvee MgBr + \overset{\bigtriangledown}{O}\ \xrightarrow{Ether}\ \xrightarrow{H_3O^+}$

(d) $\diagdown\diagup MgBr\ \xrightarrow{CO_{2(s)}}\ \xrightarrow{H_3O^+}$

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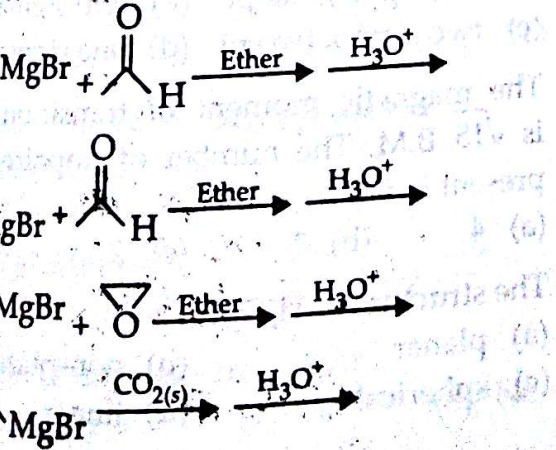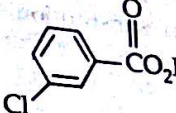
64. Pick out the electrophiles from the following species :

BF_3, NH_3, Me_3C^+, HCl

(a) BF_3 and NH_3

(b) Me_3C^+ and HCl

(c) BF_3 and Me_3C^+

(d) NH_3 and HCl

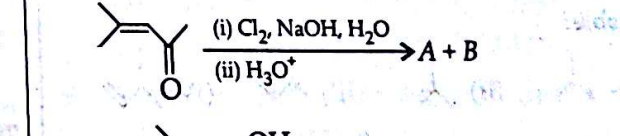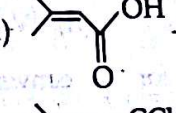**65. What reagent(s) is(are) needed to accomplish the following conversion?**

$$\underset{H}{\overset{Et}{\diagdown}}C=C\underset{H}{\overset{R}{\diagup}} \xrightarrow{?} \underset{H\ OH}{\overset{Et\ \ R}{\triangle}}$$

(a) $O_3, Zn/H^+$

(b) $KMnO_4, \bar{O}H$, cold

(c) (structure: m-chlorobenzoic acid) $Cl\text{-}C_6H_4\text{-}CO_2H$
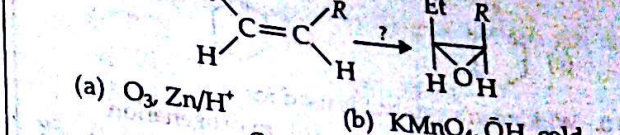
(d) H_3O^+

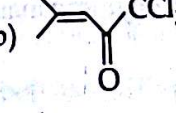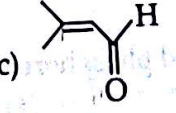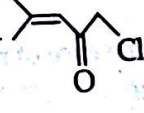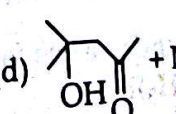**66. Which of the following compounds is strongest acid?**

(I) $\underset{H}{\overset{H}{\diagdown}}C=C\underset{H}{\overset{H}{\diagup}}$

(II) $H-C\equiv C-H$

(III) $\underset{H}{\overset{H}{\diagdown}}C=C=C\underset{H}{\overset{H}{\diagup}}$

(IV) (benzene ring structure)
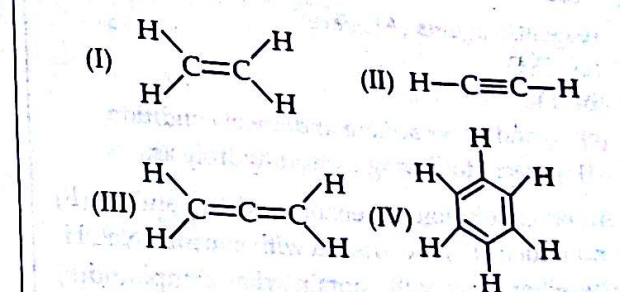
(a) I   (b) II   (c) III   (d) IV

67. Major products, A and B, of the following reactions are

$$\underset{O}{\overset{}{\diagup}}\ \xrightarrow[\text{(ii) }H_3O^+]{\text{(i) }Cl_2,\ NaOH,\ H_2O}\ A + B$$

(a) (structure) $+ CHCl_3$

(b) (structure with CCl_3) $+ NaCl$

(c) (two structures) $+$
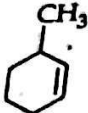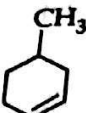
(d) (structure with OH) $+ NaCl$

68. The hydrolysis of which of the following takes the longest time?

(a) CH_3COCl (b) $(CH_3CO)_2O$
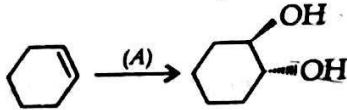
(c) $CH_3COOC_2H_5$ (d) CH_3CONH_2

69. In the given reaction, A may be

$$A \xrightarrow[H_2SO_4]{H_2O} \quad \text{(cyclohexane with } CH_3 \text{ and } OH)$$

(a) (methylcyclohexene) (b) (methylcyclohexene)

(c) (methylenecyclohexane) (d) (ethylidenecyclohexane)
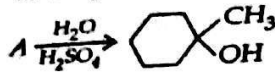
70. Wilkinson's catalyst is used for
(a) epoxidation (b) hydrogenation
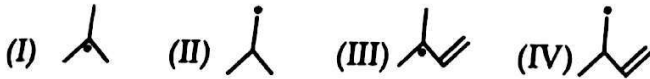(c) polymerization (d) substitution.

71. For the following conversion,

(cyclohexene) $\xrightarrow{(A)}$ (cyclohexane-1,2-diol, cis)

reagent/reagents (A) is/are
(a) OsO_4
(b) O_3

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(c) I_2 and silver acetate under wet condition
(d) peracid following by acid hydrolysis.

72. An ether solution of benzoic acid (A), aniline (B) and toluene (C) is extracted with aqueous NaOH. The ether layer will contain what compound(s) after the extraction?
(a) A (b) A + B (c) B + C (d) A + C

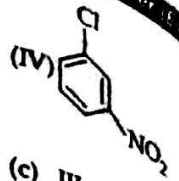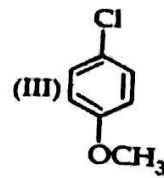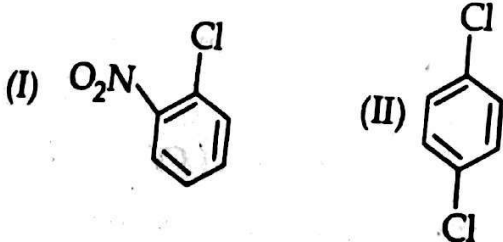**73.** Which of the following free radical is the most stable?

(I) (tert-butyl radical) (II) (isopropyl radical) (III) (allylic tertiary radical) (IV) (allylic radical)

(a) I (b) II (c) III (d) IV

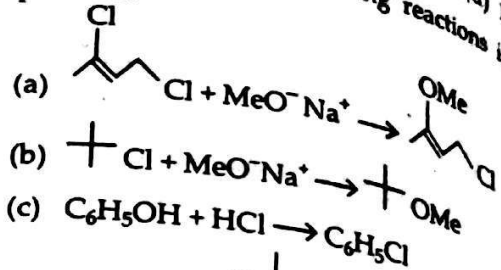**74.** The best reagent for converting 2-phenylpropanamide into 2-phenylpropanamine is
(a) Br_2 in aqueous NaOH
(b) excess of H_2
(c) iodine in the presence of red phosphorus
(d) $LiAlH_4$ in ether.

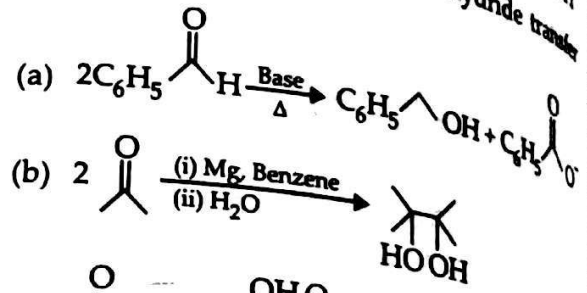**75.** Which of the following compounds reacts faster with sodium methoxide ($NaOCH_3$)?

(I) O_2N (chlorobenzene with ortho O_2N)

(II) (2,4-dichlorobenzene)

(III) (4-chloroanisole, OCH_3)

(IV) (chloro-nitrobenzene, Cl, NO_2)

(a) I (b) II (c) III (d) IV

76. Which one of the following reactions is possible?

(a) (vinyl chloride, Cl) $Cl + MeO^- Na^+ \rightarrow$ (OMe, Cl)

(b) (tert-butyl) $Cl + MeO^- Na^+ \rightarrow$ (OMe)

(c) $C_6H_5OH + HCl \rightarrow C_6H_5Cl$

(d) $C_6H_5MgCl + $ (epoxide, O) $\xrightarrow{Ether} \xrightarrow{H_3O^+} C_6H_5$ (with OH)

77. Which one of the following is hydride transfer reaction?

(a) $2C_6H_5$ (CHO) $\xrightarrow[\Delta]{Base} C_6H_5$ $OH + C_6H_5$ (ester, O)

(b) 2 (acetone, O) $\xrightarrow[(ii) H_2O]{(i) Mg, Benzene}$ (pinacol, HO OH)

(c) (acetone, O) $\xrightarrow{Base}$ (OH O, aldol product)

(d) C_6H_5 (CHO) $\xrightarrow[EtOH]{HCN, NaCN} C_6H_5$ (CH(OH)H)

78. Which of the following has maximum number of lone pairs associated with Xe?
(a) XeF_4 (b) XeF_6
(c) XeF_2 (d) XeO_3

79. The types of bonds between two carbon atoms in calcium carbide is
(a) one sigma, one pi (b) two sigma, one pi
(c) two sigma, two pi (d) one sigma, two pi

80. The magnetic moment of transition metal ion is $\sqrt{15}$ B.M. The number of unpaired electrons present in it are
(a) 4 (b) 1 (c) 2 (d) 3

81. The structure of H_2O_2 is
(a) planar (b) non-planar
(c) spherical (d) linear.

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Which one of the following decides the shapes of orbitals in an energy shell?
(a) Magnetic quantum number
(b) Principal quantum number
(c) Azimuthal quantum number
(d) Spin quantum number

The structure of paramagnetic nickel complex, $[NiCl_4]^{2-}$ is
(a) tetrahedral
(b) square planar
(c) trigonal bipyramidal
(d) distorted octahedral.

The elements Re, Os and Ir belong to
(a) first transition series
(b) second transition series
(c) third transition series
(d) fourth transition series.

Which of the following statements is not true?
(a) Halogens act as strong oxidizing agents.
(b) Fluorine oxidizes water to oxygen and ozone.
(c) Iodine has good solubility in water.
(d) Solubility of iodine in water much increases by adding KI due to formation of I_3^- ions.

Silica is attacked by
(a) conc. HNO_3
(b) conc. H_2SO_4
(c) aqua regia
(d) hydrofluoric acid.

$[Co(NH_3)_5Br]SO_4$ and $[Co(NH_3)_5SO_4]Br$ are the examples of which type of isomerism?
(a) Linkage
(b) Geometrical
(c) Ionization
(d) Optical

Which of the following ions will exhibit colour in aqueous solution?
(a) Lu^{3+} $(Z=71)$
(b) Sc^{3+} $(Z=21)$
(c) La^{3+} $(Z=57)$
(d) Ti^{3+} $(Z=22)$

The correct order of C — O bond length among CO, CO_3^{2-}, CO_2 is
(a) $CO < CO_2 < CO_3^{2-}$
(b) $CO_2 < CO_3^{2-} < CO$
(c) $CO < CO_3^{2-} < CO_2$
(d) $CO_3^{2-} < CO_2 < CO$

In $Fe(CO)_5$, the Fe—C bond possesses
(a) ionic character
(b) σ-character only
(c) π-character only
(d) both σ and π-character.

The anion O^- is isoelectronic with
(a) N^{2-}
(b) F^-
(c) N^{3-}
(d) Ne

92. Which of the following oxides is the most acidic?
(a) BeO
(b) MgO
(c) Al_2O_3
(d) Cl_2O_7

93. Analysis shows that a binary compound of X (atomic mass = 10) and Y (atomic mass = 20) contains 50% X. The formula of the compound is
(a) XY
(b) X_2Y
(c) XY_2
(d) X_2Y_3

94. The volume occupied by 16 g of oxygen gas at S.T.P. is
(a) 22.4 L
(b) 44.8 L
(c) 11.2 L
(d) 5.6 L

95. If K_{sp} of $Ni(OH)_2$ is 2.0×10^{-15} M, the molar solubility of $Ni(OH)_2$ in 0.10 M NaOH is
(a) 2.0×10^{-15} M
(b) 2.0×10^{-13} M
(c) 2.0×10^{-11} M
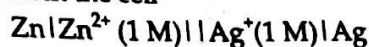(d) 2.0×10^{-9} M

96. Above the Boyle temperature, the compressibility factor of the real gases, Z, is
(a) 1
(b) < 1
(c) > 1
(d) ≤ 1

97. The arsenic content of an agricultural insecticide was reported as 28% As_2O_5. What is the percentage of arsenic in this preparation?
(a) 16%
(b) 18%
(c) 15%
(d) 20%

98. Calculate the maximum work that can be obtained from the cell
$Zn|Zn^{2+}$ (1 M)$||Ag^+$(1 M)$|Ag$
where $E°_{Zn} = -0.76$ V and $E°_{Ag} = 0.80$ V
(a) 301.080 kJ
(b) 201.830 kJ
(c) 112.830 kJ
(d) 212.630 kJ

99. Which metal is protected from corrosion by a layer of its own oxide?
(a) Tl
(b) Ag
(c) Al
(d) Au

100. The ideal gas equation, $PV = nRT$, can be written in terms of density, ρ, as $\rho/P = \dfrac{M}{RT}$ The graph between ρ/P against P is given by

(a) ρ/P

(b) ρ/P

(c) ρ/P

(d) ρ/P
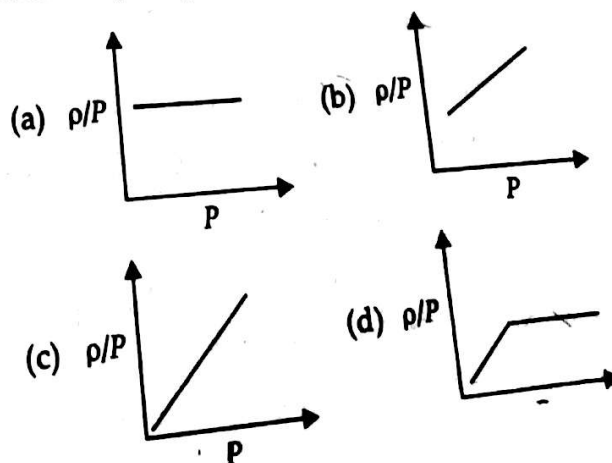
101. Let $z = x + y$, then the maximum of z subject to constraints $y \geq |x| - 1$
$$y \leq 1 - |x|, \text{ is :}$$
$$x \geq 0, y \geq 0$$

(a) 0   (b) 1   (c) 2   (d) −1

102. Let $z = 2x + 3y$, then the maximum of z subject to constraints $y \leq x - 1$
$$y \geq x + 1$$
$$x \geq 0, y \geq 0$$

(a) is 2   (b) is 3
(c) does not exist   (d) is 10

103. For any two events A and B, which of the following result does not hold true in general :

(a) $P(A \cup B) = P(A) + P(B) - P(A \cap B)$
(b) $P(A) = P(A \cap B) + P(A \cap \bar{B})$
(c) $P(B) = P(A \cap B) + P(\bar{A} \cap B)$
(d) $P(A \cup B) = P(A) + P(B)$

104. A fair die is rolled. The probability that the first time 1 occurs at the odd throw is :

(a) $\dfrac{5}{11}$ (b) $\dfrac{6}{11}$ (c) $\dfrac{1}{6}$ (d) $\dfrac{31}{36}$

105. If $A = \begin{bmatrix} \alpha & 0 \\ 1 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 0 \\ 5 & 1 \end{bmatrix}$, then value of α for which $A^2 = B$ is :

(a) $\alpha = 1$ (b) $\alpha = -1$
(c) $\alpha = 4$ (d) no real value of α

106. The number of positive roots of the equation $\begin{vmatrix} x & 3 & 7 \\ 2 & x & 2 \\ 7 & 6 & x \end{vmatrix} = 0$ is :

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(a) 1   (b) 2   (c) 3   (d) 0

107. If $A = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}$, then $A^3 =$

(a) $\begin{bmatrix} -\cos 3\theta & -\sin 3\theta \\ \sin 3\theta & \cos 3\theta \end{bmatrix}$ (b) $\begin{bmatrix} \cos 3\theta & -\sin 3\theta \\ -\sin 3\theta & \cos 3\theta \end{bmatrix}$

(c) $\begin{bmatrix} \cos 3\theta & -\sin 3\theta \\ \sin 3\theta & \cos 3\theta \end{bmatrix}$ (d) $\begin{bmatrix} -\cos 3\theta & \sin 3\theta \\ -\sin 3\theta & -\cos 3\theta \end{bmatrix}$

08. The value of $\begin{vmatrix} \sin\alpha & \cos\alpha & \sin(\alpha+\gamma) \\ \sin\beta & \cos\beta & \sin(\beta+\gamma) \\ \sin\delta & \cos\delta & \sin(\gamma+\delta) \end{vmatrix}$ is :

(a) $\sin\alpha \sin\beta \sin\delta$ (b) $\sin\alpha \cos\beta \cos\delta$
(c) 1   (d) 0

109. The number of real tangents that can be drawn from $(1, 1)$ to the circle $x^2 + y^2 - 6x - 4y + 4 = 0$

(a) 1   (b) 2   (c) 0   (d) 3

110. The line $x = my + c$ is normal to the parabola $x^2 = -4ay$ if $c =$

(a) $-2am - am^3$ (b) $-2am + 2am^3$
(c) $2am - am^3$ (d) $2am + am^3$

111. If $P = (x, y)$, $P_1 = (3, 0)$, $P_2 = (-3, 0)$ and $16x^2 + 25y^2 = 400$, then $PP_1 + PP_2$ equals

(a) 8   (b) 10   (c) 5   (d) 4

112. Let $A = \{(x, y) : y = e^{-x}\}$ and $B = \{(x, y) : y = -x\}$. Then the correct statement is :

(a) $A \cap B = \phi$ (b) $A \subset B$
(c) $B \subset A$ (d) $A \cap B = \{(0, 1)\}$

113. The set of zeros of the function $f(x) = 0$ is not empty, when $f(x)$ equals

(a) $e^{-x} + x$ (b) $|x| + (x - 2)^2$
(c) $x - \ln x$ (d) $x + e^x$

114. If $f(x) = (x + 2)^2 - 2$, $x \geq -2$. Then $f^{-1}(x)$ equals

(a) $-\sqrt{(2+x)} - 2$ (b) $\sqrt{(2+x)} + 2$
(c) $\sqrt{(2+x)} - 2$ (d) $-\sqrt{(2+x)} + 2$

115. Let Z be the set of integers. Then the relation $R = \{(a, b) : 1 + ab > 0\}$ defined on Z is :

(a) reflexive and transitive but not symmetric
(b) symmetric and transitive but not reflexive
(c) reflexive and symmetric but not transitive
(d) an equivalence relation

116. Let L denote the set of all straight lines in a plane. Let a relation R be defined on L by $L_1 R L_2$ if and only if the straight line L_1 is perpendicular to the straight line L_2. Then R is :

(a) symmetric   (b) reflexive
(c) transitive   (d) None of these

117. Which one of the following is not true?

(a) $|\sin x| \leq 1$
(b) $-1 \leq \cos x \leq 1$
(c) $|\sec x| < 1$
(d) $\operatorname{cosec} x \geq 1$ or $\operatorname{cosec} x \leq -1$

118. For $n \in Z$, the general solution of the equation $\sin 3x + \sin x - 3\sin 2x = \cos 3x + \cos x - 3\cos 2x$ is :

(a) $\dfrac{n\pi}{2} + \dfrac{\pi}{8}$ (b) $\dfrac{n\pi}{2} - \dfrac{\pi}{8}$
(c) $n\pi + \dfrac{\pi}{8}$ (d) $n\pi - \dfrac{\pi}{8}$

119. The value of $\tan\left[\cos^{-1}\dfrac{3}{5} + \tan^{-1}\dfrac{2}{3}\right]$ is :

(a) 18   (b) 2
(c) 9   (d) None of these

120. If $\begin{vmatrix} 6i & -3i & 1 \\ 4 & 3i & -1 \\ 20 & 3 & i \end{vmatrix} = x + iy$, then x and y are given by:

(a) $x = 0, y = 1$ (b) $x = 1, y = 0$

(c) $x = 1, y = 1$ (d) $x = 0, y = 0$

121. The smallest positive integer n for which $\left(\dfrac{1+i}{1-i}\right)^n = 1$, is

(a) 4   (b) 2   (c) 8   (d) 0

122. If z_1, z_2 and z_3 are complex numbers such that

$|z_1| = |z_2| = |z_3| = \left|\dfrac{1}{z_1} + \dfrac{1}{z_2} + \dfrac{1}{z_3}\right| = 1$,

then $|z_1 + z_2 + z_3|$ equals :

(a) 3   (b) 1

(c) 2   (d) None of these

123. In a triangle the lengths of the largest and the smallest sides are 10 and 9 respectively. If the angles are in A.P., then the length of the third side is :

(a) $\sqrt{91}$ (b) 8   (c) $\sqrt[3]{3}$ (d) 5

124. Consider an infinite geometric series with first term a and common ration r. If its sum is 4 and the second term is $\dfrac{3}{4}$, then :

(a) $a = 2, r = \dfrac{1}{2}$ (b) $a = 2, r = \dfrac{3}{8}$

(c) $a = 1, r = \dfrac{3}{4}$ (d) None of these

125. If p, q are positive real numbers such that $pq = 1$, then the least value of $(1 + p)(1 + q)$ is :

(a) 4   (b) 1   (c) 2   (d) 3

126. If $49^n + 16n + p$ is divisible by 64 for all $n \in N$, then the least negative integral value of p is:

(a) -2 (b) -3 (c) -4 (d) -1

127. If the 4th term in the expansion of $\left(ax + \dfrac{1}{x}\right)^n$ is $\dfrac{5}{2}$, for all $x \in R$, then the values of a and n are respectively :

(a) $\dfrac{1}{2}, 6$ (b) $\dfrac{1}{2}, 5$ (c) 2, 6   (d) 2, 5

128. Let n be a positive integer. If the coefficients of second, third and fourth terms in the expansion of $(1 + x)^n$ are in A.P., then $n =$

(a) 2   (b) 6

(c) 7   (d) None of these

129. Total number of ways in which five '+' and three '−' signs can be arranged in a line such that no two '−' signs occur together is:

(a) 10   (b) 20

(c) 15   (d) None of these

130. A box contains 2 white balls, 3 black balls and 4 red balls. In how many ways can 3 balls be drawn from the box, if at least one black ball is to be included in the draw?

(a) 64   (b) 24   (c) 3   (d) 12

131. Let $P = (-1, 0)$, $O = (0, 0)$ and $Q = (3, 3\sqrt{3})$ be three points. Then, the equation of the bisector of $\angle POQ$ is:

(a) $y = \sqrt{3}\,x$ (b) $\sqrt{3}\,y = x$

(c) $y = -\sqrt{3}\,x$ (d) $\sqrt{3}\,y = -x$

132. The lines $2x - 3y = 5$ and $3x - 4y = 7$ are the diameters of a circle of area 154 square units. Then the equation of the circle is :

(a) $x^2 + y^2 - 2x + 2y + 47 = 0$

(b) $x^2 + y^2 + 2x - 2y - 47 = 0$

(c) $x^2 + y^2 - 2x + 2y - 47 = 0$

(d) $x^2 + y^2 - 2x - 2y + 47 = 0$

133. The line $2x + y + k = 0$ is a normal to the parabola $y^2 = -8x$, if k equals :

(a) -24 (b) 12   (c) 24   (d) -12

134. If t is a parameter, then $x = a(\sin t - \cos t)$, $y = b(\sin t + \cos t)$ represents :

(a) a circle   (b) a parabola

(c) an ellipse   (d) a hyperbola

135. The eccentricity of the conic :

$9x^2 - 16y^2 + 72x - 32y - 16 = 0$, is

(a) 5/4   (b) 6/5   (c) 4/3   (d) 3/2

136. The value of λ such that $x - 4 = y - 2 = \dfrac{1}{2}(z - \lambda)$ lies in the plane $2x - 4y + z = 7$, is:

(a) 7   (b) -7

(c) 4   (d) None of these

137. The function $f(x) = \dfrac{\ln(1 + ax) - \ln(1 - bx)}{x}$ is not defined at $x = 0$. The value which should be assigned to f at $x = 0$, so that it is continuous at $x = 0$, is:

(a) $a - b$ (b) $a + b$

(c) $b - a$ (d) None of these

138. Let $f : R \to R$ be such that $f(1) = 3$, and $f'(1) = 6$. Then $\lim_{x \to 0} \left[\dfrac{f(1 + x)}{f(1)}\right]^{\frac{1}{x}} =$

(a) 1   (b) $e^{\frac{1}{2}}$ (c) e^2 (d) e^3

139. If $f(x)$ is differentiable and strictly increasing function, then the value of $\lim\limits_{\lambda \to 0} \dfrac{f(x^2) - f(x)}{f(x) - f(0)} =$

(a) -1 (b) 0 (c) 1 (d) 2

140. The angle between the tangents drawn from the point $(1, 4)$ to the parabola $y^2 = 4x$, is :

(a) $\pi/2$ (b) $\pi/6$ (c) $\pi/4$ (d) $\pi/3$

141. The difference between the greatest and the least values of the function $f(x) = \sin 2x - x$ on $\left[-\dfrac{\pi}{2}, \dfrac{\pi}{2}\right]$ is :

(a) π

(b) $\sqrt{3} - \pi/3$

(c) $-\sqrt{3} + \pi/3$

(d) None of these

142. $\displaystyle\int \dfrac{(x^2 - 1)}{x^3\sqrt{2x^4 - 2x^2 + 1}}\,dx =$

(a) $-\dfrac{1}{2}\sqrt{2 - \dfrac{2}{x^2} + \dfrac{1}{x^4}} + c$

(b) $\dfrac{1}{2}\log(2x^4 - 2x^2 + 1) + c$

(c) $\dfrac{1}{2}\sqrt{2 - \dfrac{2}{x^2} + \dfrac{1}{x^4}} + c$

(d) None of these

143. $\displaystyle\int_{-\pi}^{\pi} \sin x[f(\cos x)]\,dx =$

(a) $2f(\pi)$ (b) $2f(2)$

(c) $2f(1)$ (d) None of these

4. The area bounded by the curves $y = x$ and $y = x^3$ is equal to :

(a) 0 (b) $\dfrac{1}{4}$ (c) $\dfrac{1}{2}$ (d) 1

145. The area bounded by the curves $y = e^x$, $y = e^x$, the ordinates $x = 0$ and $x = 1$ is given by :

(a) $e + e^{-1} - 2$ (b) $e - e^{-1}$

(c) $e + e^{-1}$ (d) $e + e^{-2} + 2$

146. The differential equation of all non-vertical lines in a plane is :

(a) $\dfrac{d^2y}{dx^2} = 0$

(b) $\dfrac{dy}{dx} = 0$

(c) $\dfrac{dx}{dy} = 0$

(d) None of these

147. A solution of the differential equation $\left(\dfrac{dy}{dx}\right)^2 - x\dfrac{dy}{dx} + y = 0$ is :

(a) $y = 2x$ (b) $y = -2x$

(c) $y = 2x - 4$ (d) $y = 2x + 4$

148. If $\hat{a}$ and $\hat{b}$ are unit vectors such that $\hat{a} + 3\hat{b}$ is perpendicular to $7\hat{a} - 5\hat{b}$, then the angle between $\hat{a}$ and $\hat{b}$ is :

(a) $\dfrac{\pi}{3}$

(b) $\pi/6$

(c) $2\pi/3$

(d) None of these

149. The unit vector perpendicular to vectors $\hat{i} + \hat{j}$ and $\hat{i} - \hat{j}$ forming a right handed system is :

(a) $\hat{k}$

(b) $2\hat{k}$

(c) $-\hat{k}$

(d) None of these

150. Let $\vec{a} = \hat{i} + \hat{j} + \hat{k}$, $\vec{b} = \hat{i} - \hat{j} + \hat{k}$ and $\vec{c} = \hat{i} - \hat{j} - \hat{k}$ be three vectors. A vector $\vec{v}$ in the plane of $\vec{a}$ and $\vec{b}$, whose projection on $\vec{c}$ is $\dfrac{1}{\sqrt{3}}$, is given by :

(a) $3\hat{i} + \hat{j} - 3\hat{k}$ (b) $3\hat{i} - \hat{j} + 3\hat{k}$

(c) $3\hat{i} + \hat{j} + 3\hat{k}$ (d) $-3\hat{i} + \hat{j} + 3\hat{k}$

AMU Updates

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A.M.U. (ENGINEERING)
Solved Paper 2012

PHYSICS

A heating coil is used to heat water in a container from 15°C to 50°C in 20 minutes. Two such coils are then joined in series to heat the same amount of water for the same temperature difference from the same constant voltage source. The time taken now is

(a) 5 minutes (b) 10 minutes
(c) 20 minutes (d) 40 minutes

Vector $\bar{A}$ has a magnitude of 5 units, lies in the xy-plane and points in a direction 120° from the direction of increasing x. Vector $\bar{B}$ has a magnitude of 9 units and points along the z-axis. The magnitude of cross product $\bar{A} \times \bar{B}$ is

(a) 30   (b) 35   (c) 40   (d) 45

What is approximately the centripetal acceleration (in units of acceleration due to gravity on Earth, $g = 10$ m/s²) of an air-craft flying at a speed of 400 m/s through a circular arc of radius 0.6 km.

(a) 26.7   (b) 16.9   (c) 13.5   (d) 30.2

A parallel plate capacitor is charged to a potential difference of 50 volts. It is then dicharged through a resistance for 2 seconds and its potential drops by 10 volts. Calculate the fraction of energy stored in the capacitance.

(a) 0.14 (b) 0.25
(c) 0.50 (d) 0.64

A particle of mass 200 g is making SHM under the influence of a spring of force constant $k = 90$ N/m and a damping constant $b = 40$ g/s. Calculate the time elapsed for the amplitude to drop to half its initial value.
(Given ln (1/2) = 0.693)

(a) 7 s (b) 9 s
(c) 4 s (d) 11 s

6. A block of mass 15 kg is held by a string on an inclined plane (angle 60°). The tension T in the string is ($g = 10$ m/s²)

M = 15 kg   θ = 60°
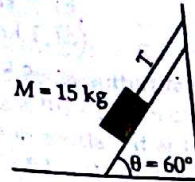
(a) 55 N (b) 60 N
(c) 75 N (d) 90 N

7. A cosmonaut is circling the earth in a satellite at 7 km/s at a height of 630 km above the surface of earth. Calculate the centripetal force acting on the cosmonaut if his mass is 80 kg
(Take $R_E = 6.37 \times 10^6$ m)

(a) zero (b) 560 N
(c) 600 N (d) 650 N

8. Two identical sinusoidal waves each of amplitude 5 mm with a phase difference of $\pi/2$ are traveling in the same direction in a string. The amplitude of the resultant wave (in mm) is

(a) zero (b) $5\sqrt{2}$ (c) $\dfrac{5}{\sqrt{2}}$ (d) 2.5

9. The rotor's velocity of a helicopter engine changes from 330 rev/min to 110 rev/min in 2 minutes. How long does the rotor blades take to stop?

(a) 3 min (b) 4 min (c) 5 min (d) 6 min

10. A force F = 2.0 N acts on a particle P in the xz-plane. The force F is parallel to x-axis. The particle P (as shown in the figure) is at a distance 3 m and the line joining P with the origin makes angle 30° with the x-axis. The magnitude of torque on P with respect to origin O (in N-m) is
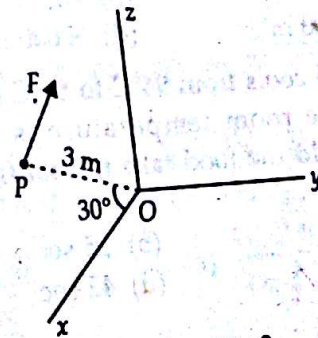
(a) 2 (b) 3
(c) 4 (d) 5

11. An aircraft has a mass 4×10^5 kg with total wing area 500 m² flying at a speed of 720 km/h. The density of air at its height is 1.2 kg/m³. Estimate the fractional increase in air speed on the upper surface of its wings relative to lower surface.
   (a) 0.04   (b) 0.08   (c) 0.17   (d) 0.32

12. A boat goes across a river with a velocity 12 km/h. The magnitude of its resultant speed in flowing water is 13 km/h. The velocity of water flow in the river is
   (a) 5 km/h   (b) 7 km/h
   (c) 9 km/h   (d) 1 km/h

13. A steel rod has a radius R = 9.5 mm and length L = 81 cm. A force $F = 6.2 \times 10^4$ N stretches it along its length. What is the stress in the rod?
   (a) 0.95×10^8 N/m²   (b) 1.1×10^8 N/m²
   (c) 2.2×10^8 N/m²   (d) 3.2×10^8 Nm²

14. Calculate the acceleration due to gravity on the surface of a pulsar of mass $M = 1.98 \times 10^{30}$ kg and radius R = 12 km rotating with time period T = 0.041 seconds. $(G = 6.67 \times 10^{-11}$ MKS)
   (a) 9.2×10^{11} m/s²   (b) 8.15×10^{11} m/s²
   (c) 7.32×10^{11} m/s²   (d) 6.98×10^{11} m/s²

15. A cord is wound over the rim of a flywheel of mass 20 kg and radius 25 cm. A mass 2.5 kg attached to the cord is allowed to fall under gravity. Calculate the angular acceleration of the flywheel.
   (a) 25 rad/s²   (b) 20 rad/s²
   (c) 10 rad/s²   (d) 5 rad/s²

16. A shell of mass 200 g is fired by a gun of mass 100 kg. If the muzzle speed of the shell is 80 m/s, calculate the recoil speed of the gun.
   (a) 16 cm/s   (b) 8 m/s
   (c) 4 cm/s   (d) 16 m/s

17. A body of mass 0.4 kg starting at origin at t = 0 with a speed of 10 m/s in the positive x-axis direction is subjected to a constant force F = 8 N towards negative x-axis. Calculate the position of the particle after 25 seconds.
   (a) –6000 m   (b) –8000 m
   (c) +4000 m   (d) +7000 m

. Hot food cools from 94°C to 86°C in 2 minutes when the room temperature is 20°C. How long would the food take to cool from 71°C to 69°C?
   (a) 12 sec   (b) 25 sec
   (c) 16 sec   (d) 42 sec

19. A police car moving on a highway at 30 km/h fires a bullet on a speeding car of thieves at 150 km/h. If the muzzle speed of bullet is 150 m/s, calculate the speed with which the bullet strikes the car of the thieves.
   (a) 95 m/s   (b) 105 m/s
   (c) 180 m/s   (d) 192 m/s

20. Two trains A and B each of length 400 m are moving on two parallel tracks in the same direction (with A ahead of B) with same speed 72 km/h. The driver of B decides to overtake A and accelerates by 1 m/s². If after 50 s, B just brushes past A, calculate the original distance between A and B.
   (a) 750 m   (b) 1000 m
   (c) 1250 m   (d) 2250 m

21. Given below are four curves describing variation of velocity with time of a particle. Which one of these describe the motion of a particle initially in positive direction with constant negative acceleration?
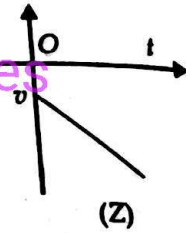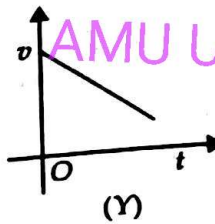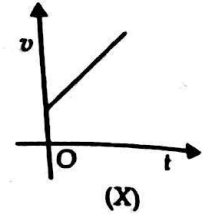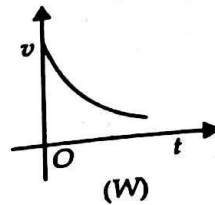
   (a) (W)   (b) (X)
   (c) (Y)   (d) (Z)

22. If mass is measure in units of α kg, length in β m and time in γ s then calorie would be
   (a) $4.2\, \alpha\, \beta^2 \gamma^{-2}$ (b) $4.2\, \alpha^{-1}\beta^2 \gamma^2$
   (c) $4.2\, \alpha^{-1}\beta^{-2} \gamma^2$ (d) $4.2\, \alpha^{-2} \beta^{-1}\gamma^2$

23. The distance traveled 'S' by an accelerated particle of mass M is given by the following relation (in MKS units)
   $$S = 6t + 3t^2$$
   The velocity of the particle after 2 seconds is
   (a) 6   (b) 12
   (c) 18   (d) 24

A new unit of length is so chosen that the speed of light in vacuum is unity. Calculate the distance (in this new unit) between sun and the earth if light takes 8 min and 20 seconds to reach earth from sun.

(a) 300   (b) 400   (c) 500   (d) 600

Calculate the neutron separation energy from the following data

$m\left(^{41}_{20}Ca\right) = 39.962591\ u$; $m\left(^{41}_{20}Ca\right) = 40.962278\ u$;

$m_n = 1.00865$, $1\ u = 931.5\ MeV/C^2$

(a) 7.57 MeV   (b) 8.36 MeV
(c) 9.12 MeV   (d) 9.56 MeV

The following fusion reaction takes place :

$^2_1H + ^2_1H \longrightarrow ^3_2He + n + 3.27\ MeV$

If 2 kg of deuterium is subjected to above reaction, the energy released is used to light a 100 W lamp, how long will the lamp glow?

(a) 2×10^6 years   (b) 3×10^5 years
(c) 5×10^4 years   (d) 7×10^3 years

Calculate the highest frequency of the emitted photon in the Paschen series of spectral lines of the Hydrogen atom.

(a) 3.7×10^{14} Hz   (b) 9.1×10^{15} Hz
(c) 10.23×10^{14} Hz   (d) 29.7×10^{15}

A block of mass 500 g is connected to a spring of spring constant $k = 312.5$ N/m on a frictionless table. The spring is held firmly at the other end. The block is pulled a distance of 5 cm and then released to make SHM. Calculate the time period of its oscillations.

(a) 2.0 s   (b) 1.75 s   (c) 0.5 s   (d) 0.25 s

The image of an electric bulb fixed in a wall is to be obtained on the wall opposite to it at a distance of 3 m. The maximum possible focal length of the convex lens is

(a) 3.25 m   (b) 1.55 m
(c) 0.75 m   (d) 0.28 m

A monochromatic source of light emits photons of frequency 6×10^{14} Hz. The power emitted by the source is 8×10^{-3} W. Calculate the number of photons emitted per second.

(Take $h = 6.63 \times 10^{-34}$ J-s)

(a) 6×10^{14} (b) 4×10^{15}
(c) 2×10^{16} (d) 1×10^{17}

---

31. Two charges +6 µC and −4 µC are placed 15 cm apart as shown. At what distances from A to its right, the electrostatic potential is zero (distances in cm)

A — — — — — — — B
+6 × 10⁻⁶ C   −4 × 10⁻⁶ C
←——— 15 cm ———→
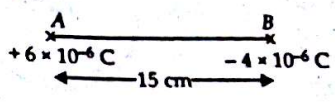
(a) 4, 9, 60   (b) 9, 45, infinity
(c) 20, 45 infinity   (d) 9, 15, 45

32. The position-time graph of a particle of mass 4 kg is shown in the figure. Calculate the impulse (in MKS units) at time $t = 0$ and $t = 6$ seconds respectively

x(m) 5 ....
O   6   t(s)
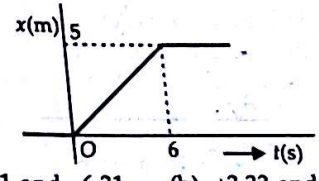
(a) +6.31 and −6.31   (b) +3.33 and −3.33
(c) +5.25 and −5.25   (d) +3.25 and −3.25

33. Pulse rate of a normal person is 75 per minute. The time period of heart is

(a) 0.8 seconds   (b) 0.75 seconds
(c) 1.25 seconds   (d) 1.75 seconds

34. Calculate the linear momentum of a 3 MeV photon.

(a) 0.01 eV–s/m   (b) 0.02 eV–s/m
(c) 0.03 eV–s/m   (d) 0.04 eV–s/m

35. The far point of a myopic person is 80 cm in front of his eyes. The power of the lens required to see very distance objects is
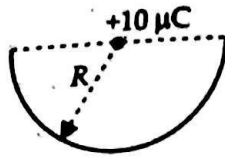
(a) −1.25 diopters   (b) +0.85 diopters
(c) +1.50 diopters   (d) −0.75 diopters

36. A thick metallic spherical shell of inner radius r_1 and outer radius r_2 has a charge +Q. A charge +q is placed at the centre of the shell. The charge per unit area on the outer surface is
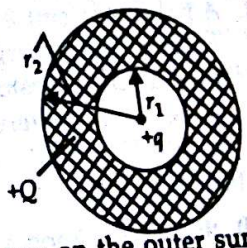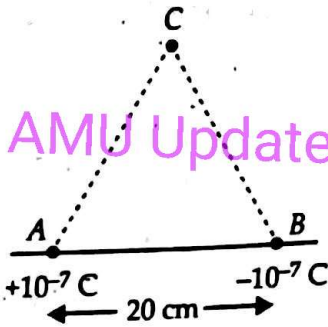
(a) $\dfrac{(Q-q)}{4\pi(r_2^2 - r_1^2)}$ (b) $\dfrac{(Q-q)}{4\pi r_2^2}$

(c) $\dfrac{(Q+q)}{4\pi r_2^2}$ (d) $\dfrac{(Q+q)}{4\pi(r_2^2 + r_1^2)}$

37. A charge 10 µC is placed at the centre of a hemisphere of radius $R = 10$ cm as shown. The electric flux through the hemisphere (in MKS units) is
   (a) 20×10^5
   (b) 10×10^5.
   (c) 6×10^5
   (d) 2×10^5

38. Two point charges $+10^{-7}C$ and $-10^{-7}C$ are placed at A and B, 20 cm apart as shown in the figure. Calculate the electric field at C, 20 cm apart from both A and B.


   (a) 1.5×10^{-5} N/C
   (b) 2.2×10^4 N/C
   (c) 3.5×10^6 N/C
   (d) 3.0×10^5 N/C

39. A particle is thrown vertically up with an initial velocity 9 m/s from the surface of Earth (take $g = 10$ m/s²). The time taken by the particle to reach a height of 4 m from the surface second time (in seconds) is
   (a) 1.3
   (b) 1.2
   (c) 1.1
   (d) 1.0

40. An electric circuit requires a total capacitance of 2 µF across a potential of 1000 V. Large number of 1 µF capacitances are available each of which would breakdown if the potential is more than 350 V. How many capacitances are required to make the circuit?
   (a) 24
   (b) 20
   (c) 18
   (d) 12

41. A battery of emf 8 V with internal resistance 0.5 Ω is being charged by a 120 V d.c. supply using a series resistance of 15.5 Ω. The terminal voltage of the battery is
   (a) 20.5 V
   (b) 15.5 V
   (c) 11.5 V
   (d) 2.5 V

42. In the circuit shown, the galvanometer G of resistance 60 Ω is shunted by a resistance $r = 0.02$ Ω. The current through R is nearly 1 A. The value of resistance R is (in ohms) is nearly

   (a) 1.00 Ω
   (b) 5.00 Ω
   (c) 11.0 Ω
   (d) 60.00 Ω
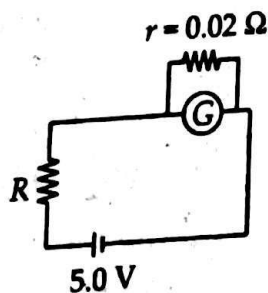
43. A circular coil of radius $R = 10$ cm, 500 turns and total resistance 2 Ω is placed perpendicular to the earth's magnetic 3×10^{-5} T. The coil is rotated about its diameter by an angle 2π in 0.5 second. The induced current in the coil is
   (a) 0.5 mA
   (b) 1.0 mA
   (c) 1.5 mA
   (d) 3.0 mA

44. An electromagnetic wave is propagating the x-axis. At $x = 1$ m and $t = 10$ s, its electric $|\bar{E}| = 6$ V/m then the magnitude of its magnetic vector is
   (a) 2×10^{-8}
   (b) 3×10^{-7}
   (c) 6×10^{-8}
   (d) 5×10^{-7}

45. A charged capacitor $C = 30$ µF is connected an inductor $L = 27$ mH. The angular frequency of their oscillations is
   (a) 9.1×10^3
   (b) 3.0×10^3.
   (c) 1.1×10^3
   (d) 0.3×10^3

46. A 4.5 cm object is placed perpendicular to the axis of a convex mirror of focal length 15 cm at a distance of 12 cm. The size of the image is
   (a) 6.0 cm
   (b) 4.5 cm
   (c) 3.0 cm
   (d) 2.5 cm

47. The energy of a photon of wavelength 390 nm is nearly
   (a) 6.6 eV
   (b) 3.2 eV
   (c) 5.5 eV
   (d) 1.2 eV

48. The angle between the vectors: $\bar{a} = 3\bar{i} - 4\bar{j}$ and $\bar{b} = -2\bar{i} + 3\bar{k}$ is
   (a) $\cos^{-1}\left(-\dfrac{1}{3}\right)$
   (b) $\cos^{-1}\left(-\dfrac{1}{4}\right)$
   (c) $\cos^{-1}\left(-\dfrac{1}{2}\right)$
   (d) $\cos^{-1}\left(-\dfrac{1}{6}\right)$

49. Alpha particles of kinetic energy 7.7 MeV are being scattered by the nucleus of gold which has 79 electrons. The distance of closest approach of the alpha particles is
   (Take $\dfrac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ MKS)
   (a) 4×10^{-14} m
   (b) 30×10^{-15} m
   (c) 10×10^{-15} m
   (d) 7.9×10^{-14} m

50. In a bipolar junction transistor (BJT), the current gain β is defined as

(a) The ratio of the change in collector current to the change in emitter current for a constant collector voltage in the common base configuration.

(b) The ratio of change in emitter current to the change in base current for constant emitter voltage in common emitter configuration.

(c) The ratio of change in collector current to the change in base current for constant collector voltage in CE configuration.

(d) The ratio of change in base current to the change in collector current for constant collector voltage in CE configuration.

CHEMISTRY

1. Which of the following orbitals has zero probability of finding the electron in the xy-plane?

(a) p_x
(b) p_z
(c) d_{yz}
(d) $d_{x^2 - y^2}$

2. 1M solution each of $Cu(NO_3)_2$, $AgNO_3$, $Hg_2(NO_3)_2$ and $Mg(NO_3)_2$ is electrolysed using Pt-electrodes. The values of standard electrode potentials in volts are :

$Ag^+/Ag = +0.80$ V, $Cu^{2+}/Cu = +0.34$ V
$Hg_2^{2+}/Hg = +0.79$ V, $Mg^{2+}/Mg = -2.37$ V

The sequence of deposition of metals on the cathode will be

(a) Mg, Ag, Cu
(b) Mg, Cu, Ag
(c) Ag, Hg, Cu
(d) Cu, Hg, Ag

3. Which of the following acids is stronger than benzoic acid ($K_a = 6.3 \times 10^{-5}$)?

(a) A ($K_a = 1.67 \times 10^{-8}$)
(b) B ($pK_a = 6.0$)
(c) C ($pK_a = 4.0$)
(d) D ($K_a = 1.0 \times 10^{-5}$)

4. The number of moles of $Ca(OH)_2$ that must be dissolved to make 250 mL solution in water of pH = 10.65 is

(a) 5.6×10^{-5}
(b) 6.5×10^{-5}
(c) 4.5×10^{-5}
(d) 5.4×10^{-5}

5. The change of energy on vaporizing 1.00 kg of liquid water at 0°C and 1 atm is

(a) 2367 kJ kg^{-1}
(b) −2367 kJ kg^{-1}
(c) −2367 kJ mol^{-1}
(d) −2367 kJ g^{-1}

6. Cl − O bond order in perchlorate ion is

(a) 1.33
(b) 1.50
(c) 1.75
(d) 1.90

57. The relative basic character of the following is

(a) $ClO^- < ClO_2^- < ClO_3^- < ClO_4^-$
(b) $ClO_4^- < ClO_3^- < ClO_2^- < ClO^-$
(c) $ClO_3^- < ClO_4^- < ClO_2^- < ClO^-$
(d) $ClO_2^- < ClO^- < ClO_3^- < ClO_4^-$

58. The density of a 3 M sodium thiosulphate ($Na_2S_2O_3$) solution is 1.25 g/mL. Calculate the percent by weight of sodium thiosulphate.

(a) 12.64%
(b) 37.92%
(c) 0.87%
(d) 63.21%

59. In $[NiCl_4]^{2-}$, the type of hybridization for Ni is

(a) sp^3d^2
(b) dsp^3
(c) sp^3
(d) dsp^3

60. The hydrogen bonds are encountered in HF, H_2O, NH_3 and HF_2^-. The relative order of energies of hydrogen bonds is

(a) $HF > H_2O > H_3N > HF_2^-$
(b) $H_2O > HF_2^- > HF > NH_3$
(c) $HF > HF_2^- > H_2O > NH_3$
(d) $HF_2^- > HF > H_2O > NH_3$

61. Which of the following is sparingly soluble in water?

(a) 2, 6-dihydrobenzoic acid
(b) p-nitrophenol
(c) o- nitrophenol
(d) Ethanoic acid

62. A solid has a structure in which, atoms of W, O and Na are located respectively at the corners, centre of edges and at the centre of the cubic lattice. The compound is

(a) $NaWO_2$
(b) $NaWO_3$
(c) Na_2WO_3
(d) $NaWO_4$

63. Two solutions of HCl, A and B, have concentrations of 0.5 N and 0.1 M respectively. The volume of solutions A and B required to make 2 litres of 0.2 N HCl are

(a) 0.5 L of A + 1.5 L of B
(b) 1.5 L of A + 0.5 L of B
(c) 1.0 L of A + 1.0 L of B
(d) 0.75 L of A + 1.25 L of B

64. Which of the following is antipyretic and analgesic?

(a) Sulfaguanidine
(b) Paracetamol
(c) Penicilline
(d) Phenol

65. The initial rate, $-\dfrac{d[A]}{dt}$ at $t \approx 0$ was found to be 2.6×10^{-2} mol L^{-1} s^{-1} for the reaction

$$A + 2B \rightarrow \text{Products}$$

The initial rate, $-\dfrac{d[B]}{dt}$, at $t \approx 0$ is
- (a) 0.10 mol L^{-1} s^{-1}
- (b) 2.6×10^{-2} mol L^{-1} s^{-1}
- (c) 5.2×10^{-2} mol L^{-1} s^{-1}
- (d) 6.5×10^{-3} mol L^{-1} s^{-1}

66. For the second order reaction,

$$A + B \rightarrow \text{Products}$$

When a moles of A reacts with b moles of B, the rate equation is given by

$$k_2 t = \frac{1}{(a-b)} \ln \frac{b(a-x)}{a(b-x)}$$

When $a \gg b$, the rate expression becomes that of
- (a) first order
- (b) zero order
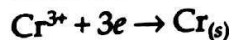- (c) unchanged, second order
- (d) third order

67. Maximum value of paramagnetism is shown by
- (a) $[Fe(CN)_6]^{3-}$
- (b) $[Cr(CN)_6]^{3-}$
- (c) $[Co(CN)_6]^{3-}$
- (d) $[Sc(CN)_6]^{3-}$

68. From the following data at 25°C,

$$Cr^{3+}_{(aq)} + e \rightarrow Cr^{2+}_{(aq)} \quad E° = -0.424 \text{ V}$$
$$Cr^{2+}_{(aq)} + 2e \rightarrow Cr_{(s)} \quad E° = -0.900 \text{ V}$$
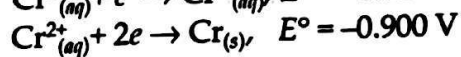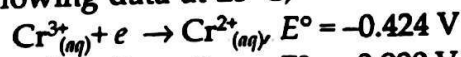
Find $E°$ at 25°C for the reaction,

$$Cr^{3+} + 3e \rightarrow Cr_{(s)}$$

- (a) −0.741 V
- (b) −1.324 V
- (c) −0.476 V
- (d) +0.741 V

69. A sample of liquid in a thermally insulated container is stirred for 1 hr by a mechanical attachment to a motor in the surroundings, which of the following thermodynamic quantity for the system is zero?
- (a) Work (W)
- (b) Change in internal energy (ΔE)
- (c) Change in enthalpy (ΔH)
- (d) None of these

70. The highest osmotic pressure corresponds to the following solution
- (a) $M/10$ urea
- (b) $M/10$ glucose
- (c) $M/10$ HCl
- (d) $M/10$ $BaCl_2$

71. The following is a conjugated diene
- (a) $CH_3 - CH = C = CH - CH_3$
- (b) $CH_2 = CH - CH_2 - CH = CH_2$
- (c) $CH_2 = CH - CH_2 - CH_2 - CH = CH_2$
- (d) $CH_2 = \underset{\underset{CH_3}{|}}{C} - CH = CH_2$

72. For the reaction given below,

$$5Br^-_{(aq)} + BrO_3^-_{(aq)} + 6H^+ \rightarrow 3Br_2 + 3H_2O$$

The rate of formation of Br_2 is related to consumption of Br^- by the following relation
- (a) $\dfrac{d[Br_2]}{dt} = -\dfrac{5}{3}\dfrac{d[Br^-]}{dt}$
- (b) $\dfrac{d[Br_2]}{dt} = \dots$
- (c) $\dfrac{d[Br_2]}{dt} = \dfrac{5}{3}\dfrac{d[Br^-]}{dt}$
- (d) $\dfrac{d[Br_2]}{dt} = \dots$

73. For a diprotic acid, which of the following for 1st and 2nd ionization constant (K_{a_1} and ...)
- (a) $K_{a_1} = K_{a_2}$
- (b) $K_{a_1} > K_{a_2}$
- (c) $K_{a_2} > K_{a_1}$
- (d) $K_{a_2} \geq K_{a_1}$

74. The strongest base of the following is
- (a) NaOH
- (b) KOH
- (c) LiOH
- (d) CsOH

75. If the solubility of $PbBr_2$ is S g-mole per ... its solubility product, considering it to be ... ionized, is
- (a) $2.048\ S^2$
- (b) $20.48\ S^3$
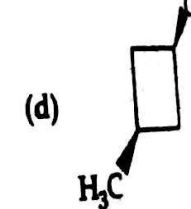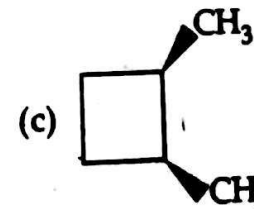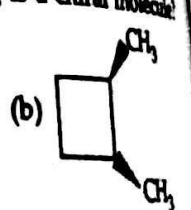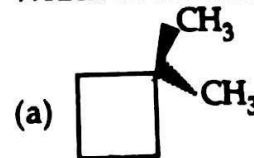- (c) $2.048\ S^3$
- (d) $2.048\ S^4$

76. Solid PCl_5 exists as
- (a) PCl_4^+
- (b) PCl_5
- (c) PCl_4^+ and PCl_6^-
- (d) PCl_4^-

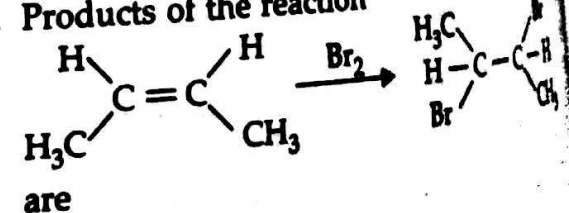77. During charging of lead storage battery, reaction occurring at the cathode is
- (a) $Pb^{2+} + 2e \rightarrow Pb$
- (b) $Pb \rightarrow Pb^{2+} + 2e$
- (c) $PbSO_4 + 2H_2O \rightarrow 2PbO_2 + 4H^+ + SO_4^{2-} + 2e$
- (d) $Pb^{2+} + SO_4^{2-} \rightarrow PbSO_4$

78. Which of the following is a chiral molecule?

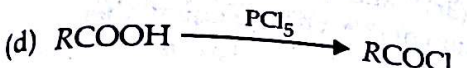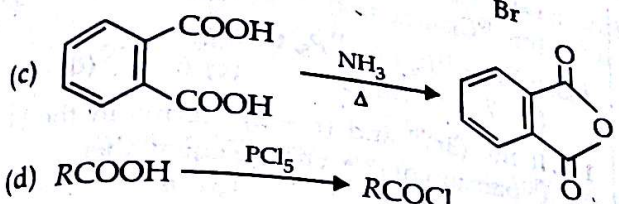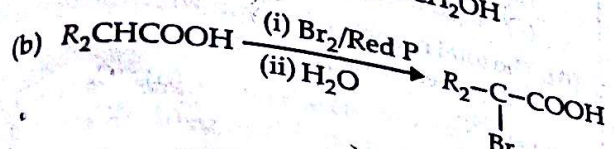

79. Products of the reaction

are

(a) meso-compounds
(b) racemic mixtures
(c) mixtures of racemic and meso-compounds
(d) none of the above

80. Ibuprofen contains
(a) only S-enantiomer
(b) only R-enantiomer
(c) racemic mixture of both R and S enantiomer
(d) both R and S enantiomer are active pain killers.

81. Which one of the following is an example of Hell-Volhard-Zelinsky reaction?

(a) $RCOOH \xrightarrow[\text{(ii) } H_3O^+]{\text{(i) } B_2H_6} RCH_2OH$

(b) $R_2CHCOOH \xrightarrow[\text{(ii) } H_2O]{\text{(i) } Br_2/Red\ P} R_2-\underset{\underset{Br}{|}}{C}-COOH$

(c) [benzene ring with two COOH groups] $\xrightarrow[\Delta]{NH_3}$ [cyclic anhydride structure]

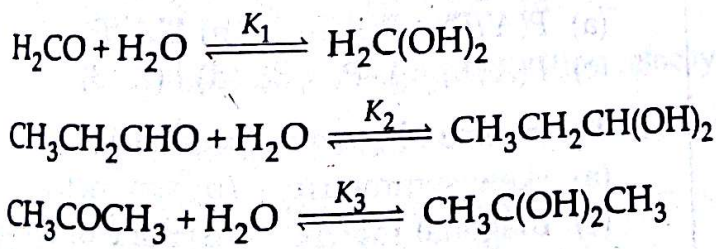(d) $RCOOH \xrightarrow{PCl_5} RCOCl$

82. Zeisel method is used to estimate
(a) alcoholic group   (b) amino group
(c) methoxy group   (d) halo group

83. For an isolated system, $\Delta U = 0$, then
(a) $\Delta S = 0$ (b) $\Delta S < 0$
(c) $\Delta S > 0$
(d) The value of ΔS cannot be predicted

84. Hydrolysis of proteins give
(a) α-amino acids only
(b) β-amino acids only
(c) γ-amino acids only
(d) mixture of all i.e., α, β and γ-amino acids

85. Which one of the following is not a condensation polymer?
(a) Nylon 6, 6   (b) Nylon 6
(c) Dacron   (d) Buna-S

86. The correct order of equilibrium constants for the reactions is

$$H_2CO + H_2O \underset{}{\overset{K_1}{\rightleftharpoons}} H_2C(OH)_2$$

$$CH_3CH_2CHO + H_2O \overset{K_2}{\rightleftharpoons} CH_3CH_2CH(OH)_2$$

$$CH_3COCH_3 + H_2O \overset{K_3}{\rightleftharpoons} CH_3C(OH)_2CH_3$$

(a) $K_1 > K_2 > K_3$ (b) $K_1 < K_2 < K_3$
(c) $K_1 > K_3 > K_2$ (d) $K_1 < K_3 < K_2$

87. The enolic form of acetone contains
(a) 9 sigma bonds, 2 pi bonds and 1 lone pair
(b) 9 sigma bonds, 1 pi bond and 2 lone pairs
(c) 8 sigma bonds, 2 pi bonds and 2 lone pairs
(d) 10 sigma bonds, 1 pi bond and 1 lone pair

88. What happens when aluminum and zinc salts react with an excess of NaOH?
(a) White precipitate is formed.
(b) White precipitate of both Zn and Al first formed re-dissolve in excess of NaOH.
(c) White precipitate of Al redissolves but that of Zn does not.
(d) White precipitate of Zn redissolves and that of Al does not.

89. Four compounds, Toluene (I), o-Dichlorobenzene (II), m-Dichlorobenzene (III) and p-Dichlorobenzene (IV) are arranged in order of increasing dipole moment. The correct order is
(a) IV < I < III < II   (b) I < II < III < IV
(c) II < IV < III < I   (d) IV < III < II < I

90. The correct order of increasing boiling points of the following aqueous solutions 0.0001 M NaCl (I), 0.0001 M Urea (II), 0.001 M MgCl$_2$ (III), 0.01 M NaCl (IV) is
(a) I < II < III < IV   (b) IV < III < II < I
(c) II < I < III < IV   (d) III < II < IV < I

91. The correct order of acidic strength is
(a) $K_2O > CaO > MgO$ (b) $CO_2 > N_2O_5 > SO_3$
(c) $Na_2O > MgO > Al_2O_3$
(d) $Cl_2O_7 > SO_2 > P_4O_{10}$

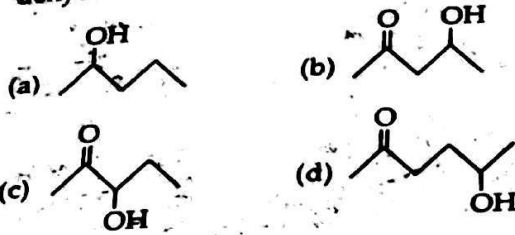92. The reddish brown gas produced by heating KCl with K$_2$Cr$_2$O$_7$ (solid) and conc. H$_2$SO$_4$ is
(a) Cl_2 (b) CrO_2Cl_2
(c) CrO_3 (d) H_2CrO_4

93. The appropriate reagent for the following transformation

[ketone structure with OH] $\rightarrow$ [CH$_2$CH$_3$ structure with OH]
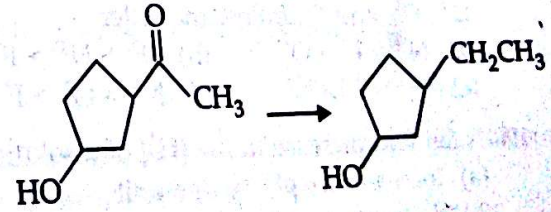
is
(a) NH_2NH_2, OH^- (b) $NaBH_4$
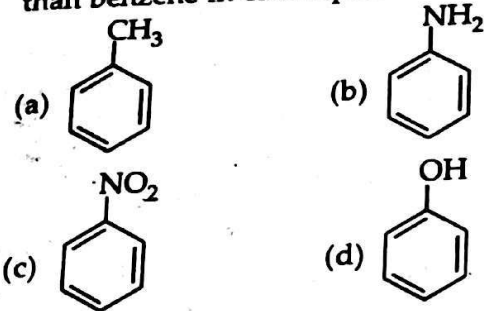(c) H_2 / Ni (d) $AlCl_3$

94. Which one of the following will most readily be dehydrated in acidic solutions?

(a)

(b)

(c)

(d)

95. The reactivity order of alkyl halides towards nucleophiles is
(a) $RF > RBr > RI > RCl$
(b) $RI > RCl > RBr > RF$
(c) $RF > RCl > RBr > RI$
(d) $RI > RBr > RCl > RF$

96. Which of the following compounds reacts slower than benzene in electrophilic substitution?

(a)

(b)

(c)

(d)

97. The IUPAC name of
$CH_3CHOHCH_2CH(CH_3)CHO$ is
(a) 2-hydroxy-4 methyl pentanal
(b) 4-hydroxy-2-methyl pentanal
(c) 2-hydroxy-4-methyl pentanal
(d) 2-methylpent-4-ol-1-al

98. Negatively charged colloidal solution of clay in water will need for precipitation the minimum amount of
(a) aluminium sulphate
(b) potassium sulphate
(c) sodium hydroxide
(d) hydrochloric acid

99. The polarizing power of the following anions, N^{3-}, O^{2-} and F^-, follow the order
(a) $N^{3-} > F^- > O^{2-}$
(b) $O^{2-} > N^{3-} > F^-$
(c) $O^{2-} > F^- > N^{3-}$
(d) $N^{3-} > O^{2-} > F^-$

100. A ten fold increase in the $[H^+]$ of a solution
(a) increases its pH by one unit
(b) decreases its pH by one unit
(c) increases its pH by 10 unit
(d) decreases its pH by 10 unit

MATHEMATICS

101. If $|Z - \bar{Z}| + |Z + \bar{Z}| = 2$, then Z lies on
(a) a circle
(b) a square
(c) an ellipse
(d) a line

102. If the product of the roots of the equation
$x^2 - 2\sqrt{2}\, kx + 2e^{2\log k} - 1 = 0$ is 31, then the roots of the equation are real for $k =$
(a) -4
(b) 1
(c) 4
(d) 0

103. The temperature of a body lies between 10° 85°C. The corresponding temperature in ° lie between
(a) 50 and 180
(b) 50 and 185
(c) 15 and 185
(d) none of these

104. The total number of way in which 30 books distributed among 5 students is
(a) $^{30}C_5$
(b) $^{34}C_5$
(c) $^{30}C_4$
(d) $^{34}C_4$

105. If $^{12}P_r = {}^{11}P_6 + 6 \cdot {}^{11}P_5$, then $r =$
(a) 7
(b) 5
(c) 6
(d) 4

106. If the $(3r)^{th}$ and $(r+2)^{th}$ terms in the binomial expansion of $(1 + x)^{2n}$ are equal, then
(a) $n = r$
(b) $n = r + 1$
(c) $n = 2r$
(d) $n = 2r - 1$

107. The total number of terms in the expansion of $(1 + x)^{2n} - (1 - x)^{2n}$ after simplification is
(a) $n + 1$
(b) $n - 1$
(c) n
(d) $4n$

108. If $\log_{10}2$, $\log_{10}(2^x - 1)$ and $\log_{10}(2^x + 3)$ are in A.P. then $x =$
(a) $\log_2 5$
(b) $\log_2(-1)$
(c) $\log_2(1/5)$
(d) $\log_5 2$

109. If the sum of first n natural numbers is 1/5 times the sum of their squares, then $n =$
(a) 7
(b) 8
(c) 6
(d) 5

110. The equation of the plane through the points (2, 2, 1) and (9, 3, 6) and perpendicular to the plane $2x + 6y + 6z - 1 = 0$ is
(a) $3x + 4y + 5z + 9 = 0$
(b) $3x + 4y - 5z + 9 = 0$
(c) $3x - 4y + 5z - 9 = 0$
(d) $3x + 4y - 5z - 9 = 0$

111. Let A and B be any two events. Which one of the following statements is always true?
(a) $P(A'/B) = P(A/B)$
(b) $P(A'/B) = P(B'/A)$
(c) $P(A'/B) = 1 - P(A/B)$
(d) $P(A'/B) = 1 - P(A/B)$

112. The inverse of a symmetric matrix is
(a) skew symmetric
(b) symmetric
(c) diagonal matrix
(d) none of these

If $f(x) = \begin{vmatrix} x+1 & x & 1 \\ x(x+1) & x(x-1) & 2x \\ x(x+1)(x-1) & x(x-1)(x-2) & 3x(x-1) \end{vmatrix}$,

then $f(1000) =$

(a) 1
(b) 1000
(c) –1000
(d) 0

114. If $\begin{vmatrix} (x+a) & b & c \\ a & (x+b) & c \\ a & b & (x+c) \end{vmatrix} = 0$, then $x =$

(a) $0, -(a+b+c)$
(b) 0
(c) $-(a+b+c)$
(d) $a+b+c$

115. If $f(x) = \log_x\{\ln(x)\}$, then $f'(e) =$
(a) $1/e$
(b) e
(c) $-e$
(d) e^2

116. The fixed point P on the curve $y = x^2 - 4x + 5$ such that the tangent at P is perpendicular to the line $x + 2y = 7$ is given by
(a) $(3, 2)$
(b) $(2, 1)$
(c) $(3, -2)$
(d) $(2, -3)$

117. Which of the following function is decreasing on $(0, \pi/2)$?
(a) $\sin 2x$
(b) $\cos 3x$
(c) $\tan x$
(d) $\cos 2x$

118. The least value of the function $f(x) = ax + b/x$, $a > 0$, $b > 0$, $x > 0$ is
(a) $\sqrt{ab}$
(b) $2\sqrt{\dfrac{a}{b}}$
(c) $2\sqrt{\dfrac{b}{a}}$
(d) $2\sqrt{ab}$

119. $\displaystyle\int \frac{2^x}{\sqrt{1-4^x}}\,dx =$
(a) $(\log 2)\sin^{-1} 2^x + C$
(b) $\dfrac{1}{2}\sin^{-1} 2^x + C$
(c) $\dfrac{1}{\log 2}\sin^{-1} 2^x + C$
(d) $2\log 2\,\sin^{-1} 2^x + C$

120. If $\displaystyle\int_0^x f(t)\,dt = x + \int_x^1 t f(t)\,dt$, then $f(x) =$
(a) $\dfrac{1}{1-x}$
(b) $\dfrac{1}{x-1}$
(c) $\dfrac{1}{1+x}$
(d) $\dfrac{1}{x}$

121. The area of the region lying between the curve $y = x^2$ and the line $y = x + 2$ in the first quadrant is
(a) 10/3
(b) 10/6
(c) 10/2
(d) 9/2

122. A particle moves in a straight line with a velocity given by $\dfrac{dx}{dt} = x + 1$, where x is the distance travelled in time t. The time taken by the particle to travel a distance of 999 metres is

(a) $\log_{1000} e$
(b) $\log_e 100$
(c) $3\log_e 10$
(d) $4\log_e 10$

123. The number of vectors of unit length perpendicular to the vectors $\hat{i} + \hat{j} - \hat{k}$ and $\hat{i} + \hat{j} + \hat{k}$ is
(a) 2
(b) 1
(c) 3
(d) infinite

124. If $\bar{a}, \bar{b}$ and $\bar{c}$ are three non-zero vectors such that $\bar{a} \cdot \bar{b} = \bar{a} \cdot \bar{c}$, then
(a) $\bar{a} \perp \bar{b}$ and $\bar{c}$
(b) either $\bar{a} \perp (\bar{b} - \bar{c})$ or $\bar{b} = \bar{c}$
(c) $\bar{a} \perp (\bar{b} - \bar{c})$
(d) $\bar{b} = \bar{c}$

125. The equation of the plane containing the line $\dfrac{x-x_1}{l} = \dfrac{y-y_1}{m} = \dfrac{z-z_1}{n}$ is $a(x-x_1) + b(y-y_1) + c(z-z_1) = 0$, where
(a) $ax_1 + by_1 + cz_1 = 1$
(b) $a/l = b/m = c/n$
(c) $lx_1 + my_1 + nz_1 = 0$
(d) $al + bm + cn = 0$

126. Which of the following sets are not convex?
(a) $\{(x, y) : 8x^2 + 6y^2 \le 24\}$
(b) $\{(x, y) : 6 \le x^2 + y^2 \le 36\}$
(c) $\{(x, y) : y \ge 3,\ y \le 30\}$
(d) $\{(x, y) : x^2 \le y\}$

127. Consider the linear programming problem
Max $\quad Z = 4x + y$
Subject to $\quad x + y \le 50$
$\quad x + y \ge 100$
$\quad x, y \ge 0$
The max value of Z is
(a) 0
(b) 50
(c) 100
(d) does not exist

128. Suppose A, B and C are three events of a sample space. Which of the following is not true?
(a) $P(A \cap B \cap C) = P(A)\cdot P(B/A)\cdot P(C/(A \cap B))$
(b) $P(A \cap B \cap C) = P(B)\cdot P(A/B)\cdot P(C/(A \cap B))$
(c) $P(A \cap B \cap C) = P(A)\cdot P(B/A)\cdot P((A \cap B)/C)$
(d) $P(A \cap B \cap C) = P(C)\cdot P(B/C)\cdot P(A/(B \cap C))$

129. If $Z_r = \cos\dfrac{\pi}{2^r} + i\sin\dfrac{\pi}{2^r}$, then $Z_0 Z_1 Z_2 \ldots\ldots =$
(a) 1
(b) –1
(c) i
(d) $-i$

130. The area of the circle centred at $(-92, 103)$ and passing through $(-95, 99)$ is
(a) 3π
(b) 4π
(c) 25π
(d) 5π

131. The number of normals that can be drawn from a point inside an ellipse is

(a) 3   (b) 4   (c) 2   , (d) 1

132. If $f(x) = \begin{cases} ax^2 - b, & -1 < x < 1 \\ \dfrac{1}{|x|}, & |x| \geq 1 \end{cases}$ is differentiable at $x = 1$, then

(a) $a = -1/2, b = -3/2$ (b) $a = -1/2, b = 3/2$
(c) $a = 1/2, b = -3/2$ (d) $a = 1/2, b = 3/2$

133. If for a matrix A, $A^2 + I = 0$, where I is the identity matrix of order 2, then $A =$

(a) $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ (b) $\begin{bmatrix} i & 0 \\ 0 & i \end{bmatrix}$

(c) $\begin{bmatrix} i & 0 \\ 0 & 1 \end{bmatrix}$ (d) $\begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$

134. Let $f(x)$ be a function such that $f(x + y) = f(x) + f(y)$ and $f(x) = \sin x \, g(x)$ for $x, y \in R$. If $g(x)$ is a continuous function such that $g(0) = C$, then $f'(x) =$

(a) $C \sin x$ (b) C
(c) $C \cos x$ (d) $\cos x \, g'(x)$

135. The value of α for which the equation $x^3 - 3x - \alpha = 0$ has two distinct roots in $[0, 1)$ is

(a) 1   (b) -1
(c) 2   (d) none of these

136. Let X be a binomial random variable and $X = \{0, 1, 2, \ldots, n\}$. For $r = 0, 1, 2, \ldots n$, which of the following holds?

(a) $P(X = r) = {}^nP_r \, p^r q^{n-r}$ (b) $P(X = r) = {}^nC_r \, p^r q^{n-r}$
(c) $P(X = r) = {}^nC_r \, p^r$ (d) $P(X = r) = {}^nC_r \, p^{n-r}$

137. The degree of the differential equation satisfying $\sqrt{1 - x^2} + \sqrt{1 - y^2} = a(x - y)$ is

(a) 1   (b) 3
(c) 2   (d) none of these

138. The area enclosed by $2|x| + 3|y| \leq 6$ is

(a) 12   (b) 6   (c) 18   (d) 24

139. One of the diameters of the circle $x^2 + y^2 - 12x + 4y + 6 = 0$ is given by

(a) $x - 3y = 0$ (b) $3x + y = 0$
(c) $3x - y = 0$ (d) $x + 3y = 0$

140. The curve represented by $x = a(\sinh\theta + \cosh\theta)$, $y = b(-\sinh\theta + \cosh\theta)$ is

(a) a hyperbola   (b) a parabola
(c) an ellipse   (d) a circle

141. The parametric coordinates of any point on the parabola $y^2 = 4ax$ are given by

(a) $(-at^2, 2at)$ (b) $(a\sin^2 t, -2a\sin t)$
(c) $(-at^2, -2at)$ (d) $(a\sin t, -2a\sin t)$

142. If the two pairs of lines $x^2 - 2mxy - y^2 = 0$ and $x^2 - 2nxy - y^2 = 0$ are such that one of them represents the bisector of the angles between the other, then

(a) $mn = 1$ (b) $m + n = mn$
(c) $mn = -1$ (d) $m - n = mn$

143. Let R be a relation on the set N, defined by $\{(x, y) : 2x - y = 10\}$, then R is

(a) reflexive   (b) symmetric
(c) transitive   (d) none of these

144. If $aN = \{ax : x \in N\}$ and $bN \cap cN = dN$, where b, $c \in N$ are relatively prime, then

(a) $b = cd$ (b) $c = bd$
(c) $d = bc$ (d) none of these

145. If $A = \{4^n - 3n - 1 : n \in N\}$ and $B = \{9(n - 1) : n \in N\}$, then

(a) $B \subset A$ (b) $A \cup B = N$
(c) $A \subset B$ (d) none of these

146. If $f(x) = |\sin x|$ has an inverse, then its domain is

(a) $[-\pi/2, \pi]$ (b) $[0, \pi/2]$
(c) $[0, 2\pi]$ (d) $[-\pi, \pi]$

147. If $c^2 = a^2 + b^2$, $a + b + c = 2s$, then $4s(s - a)(s - b)(s - c)$ equals

(a) a^2b^2 (b) a^2c^2 (c) b^2c^2 (d) s^4

148. If $\tan^{-1}(a/x) + \tan^{-1}(b/x) = \pi/2$, then $x =$

(a) $\sqrt{\dfrac{b}{a}}$ (b) $\sqrt{\dfrac{a}{b}}$ (c) $-\sqrt{ab}$ (d) $\sqrt{ab}$

149. For a natural number n, which one is the correct statement?

(a) $1^3 + 2^3 + \ldots + n^3 = (1 + 2 + \ldots + n)^2$
(b) $1^3 + 2^3 + \ldots + n^3 > (1 + 2 + \ldots + n)^2$
(c) $1^3 + 2^3 + \ldots + n^3 < (1 + 2 + \ldots + n)^2$
(d) $1^3 + 2^3 + \ldots + n^3 \neq (1 + 2 + \ldots + n)^2$

150. $\left(\dfrac{1 + i}{1 - i}\right)^n$ is real

(a) for every real number n
(b) for every odd integer n
(c) for every rational n
(d) for every even positive integer n