11. According to Stoke's theorem which of the following is currect:

(a) $\oint_C \vec{E}.d\vec{l} = \iint_{surface} curl\,\vec{E}.\hat{n}dS$

(b) $\oint_C \vec{E}.d\vec{l} = \iiint_{volume} div\vec{E}.dV$

(c) $\oint_C \vec{E}.d\vec{l} = \int curl\vec{E}.d\vec{l}$

(d) $\oint_{surface} \vec{E}.\hat{n}dS = \iiint_{volume} div\vec{E}.dV$

12. Consider an infinitely long straight wire of radius R carrying a current I. The magnetic induction at any point inside the wire at a distance r from its axis is given by:

(a) $B = \frac{\mu_o Ir}{2\pi R^2}$

(b) $B = \frac{\mu_o I}{2\pi r}$

(c) $B = \frac{\mu_o I}{2\pi R}$

(d) $B = \frac{\mu_o I}{2\pi R^2}$

13. A conductor of capacity 20 mF is charged to a potential of 1000 volts. The energy stored in the conductor.

(a) 10 J
(b) 10^2 J
(c) 10^3 J
(d) 10^4 J

14. If a battery of emf 100V is connected in series with a inductance of 10 mH, a capacitance of 0.05 μF, and a resistance of 100Ω then the circuit is:

(a) oscillatory
(b) dead beat
(c) critically damped
(d) none of the above

15. What should be the state of polarization of light when the x and y components of the electric field are given by the following equations:

$$E_x = E_o \cos(\omega t + kz)$$
$$E_y = E_o \sin(\omega t + kz)$$ is

(a) linearly polarized
(b) elliptically polarized
(c) circularly polarized
(d) unpolarized

51. If a proton is accelerated to kinetic energy 5 GeV, its total energy will be approximately:

(a) 4 GeV
(b) 6 GeV
(c) 8 GeV
(d) 10 GeV

52. Which of the following properties is not true for cooper pair?

(a) It is fermion
(b) A single wave function represents this system
(c) Its total linear momentum is zero
(d) Any number of pair can exist in a quantum state.

53. If ν is the frequency of radiation, the ratio between the probabilities for spontaneous and stimulated emissions varies as:

(a) ν^2
(b) ν^1
(c) ν^4
(d) ν^3

54. Electron spin resonance (ESR) spectroscopy is performed in

(a) x-ray region of radiation
(b) visible region of radiation
(c) radio frequency region of radiation
(d) microwave region of radiation

55. A screw symmetry is a combination of

(a) rotation and translation
(b) rotation and reflection
(c) reflection and translation
(d) rotation and inversion

56. The crystal unit cell with parameters a = 3.1 A°, b = 3.1 A°, c = 5.2 A° and $\alpha = \beta = \gamma = 90°$ belongs to

(a) cubic crystal system
(b) triclinic crystal system
(c) monoclinic crystal system
(d) tetrogonal crystal system

57. The range of k-values, in which first Brillouin zone exists, lie between

(a) $-\frac{\pi}{a}$ and $+\frac{\pi}{a}$
(b) 0 and 1
(c) $-\infty$ and ∞
(d) $-\frac{2\pi}{a}$ and $+\frac{2\pi}{a}$

40. The product of generalized coordinate and its conjugate momenta has the dimension of

(a) force
(b) energy
(c) linear momentum
(d) angular momentum

41. An electron of rest mass m_o gains energy so that its mass becomes $2m_o$. Its relativistic speed is:

(a) $\frac{\sqrt{3}}{2}$
(b) $\frac{3}{4}$
(c) $\frac{3}{2}$
(d) $\sqrt{\frac{3}{2}}$

42. At a given instant of time, a rigid rotator is in the state $\psi(\theta,\phi) = \sqrt{3/4\pi}\sin\theta\sin\phi$. According to measurement, which of the following is possible values of the z-component of the angular momentum, L_z?

(a) 0
(b) $\hbar/2$, $-\hbar/2$
(c) $\hbar$, $-\hbar$
(d) $\hbar$, 0, $-\hbar$

43. For the Hydrogen atom in the first excited state $E_2 = -3.4$ eV, the all possible wavefunctions are:

(a) ψ_{210}, ψ_{211}, ψ_{21-1}
(b) ψ_{200}, ψ_{210}, ψ_{211}, ψ_{21-1}
(c) ψ_{200}, ψ_{210}, ψ_{211}
(d) None of the above

44. Which of the following can never have a normalizable wave function?

(a) Hydrogen atom
(b) Harmonic oscillator
(c) Free particle
(d) Infinite well

45. In Stern-Gerlach experiment, the splitting shown in silver atoms is

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

64. $\oint \frac{dz}{z}$ around a circle of radius 'a' with centre at the origin is equal to

(a) $2\pi i$
(b) πi
(c) $2\pi ai$
(d) πai

65. The dynamical equation of S.H.O.

$$\frac{d^2y}{dx^2} + w^2 y = 0$$

is transformed into an integral equation

$$y(x) = x + \omega^2 \int_0^x (t - x) y(t) dt$$

which is identified as

(a) Fredholm equation of the first kind.
(b) Volterra equation of the second kind.
(c) Fredholm equation of the second kind
(d) Volterra equation of the first kind

66. The product of any generalized momentum and the associated (or conjugate) coordinate must have the dimensions of

(a) energy
(b) angular momentum
(c) linear momentum
(d) force

67. A covariant tensor A_μ in Minkowski space has 256×256 components. The rank of tensor is:

(a) 8
(b) 12
(c) 16
(d) 256

68. A particle of mass m, moves under the action of a central force whose potential is $V(r) = kmr^3 (k > 0)$, then energy for which the orbit will be a circle of radius 'a', about the origin is

(a) $\frac{3}{2} mka^3$
(b) $\frac{3}{2} mka^2$
(c) $\frac{1}{2} mka$
(d) $\frac{1}{2} mka^2$

2014-15

1. Three point masses m_1, m_2 and m_3 are placed at the three vertices A, B and C respectively of an equilateral triangle having sides of length L. The moment of inertia of the system about the right bisector of side BC is

(a) $\frac{\ell^2}{4}(m_1 + m_2 + m_3)$

(b) $\frac{\ell^2}{2}(m_2 + m_3)$

(c) $\frac{\ell^2}{4}(m_2 + m_3)$

(d) $\frac{\ell^2}{4}(m_1 + m_2)$

2. If the distance between the sun and the earth were half of its present value, the number of days in a year would have been about:

(a) 64.5
(b) 129
(c) 182.5
(d) 730

3. The displacement y of a particle executing periodic motion is given by:

$$y = 4\cos^2(\frac{1}{2}t)\sin(1000t)$$

This expression may be considered to be a result of superposition of

(a) two
(b) three
(c) four
(d) five

independent harmonic motions.

4. Spacecraft A is moving at 0.9c with respect to the earth. If spacecraft B is to pass A at a relative speed of 0.5c in the same direction, what speed must B have w.r.t. earth:

(a) c
(b) 0.7c
(c) 0.97c
(d) 1.4c

5. A distant galaxy in the constellation Hydra is receding from the earth at 6.12×10^7 ms^{-1}. A green spectral line of wavelength 500 nm emitted by this galaxy shifted towards the red end of the spectrum by

(a) 500 nm
(b) 105 nm
(c) 115 nm
(d) 110 nm

2014-2015

DEPARTMENTAL TEST
for
Admission
to
M. Sc. Physics

Course Number	7	1	1
Q. Paper Series		A	
Paper Code	7		1

Particulars to be filled in by the Candidate

1. Centre Code

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2. Roll Number (in Figures)

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3. Application Number

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4. Name of the candidate

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5. Date of Test

SIGNATURE OF INVIGILATOR

Duration: : Two Hours

Maximum Marks: : 200

Instructions for the candidate:

1. The paper consists of Two **Sections** A and B.
2. Section-A contains seventy objective type questions, each of 2 marks. Correct answer should be marked on the OMR sheet.
3. Incorrect answers in objective type questions shall result in a negative score of 25 percent.
4. Blank space in the question booklet Section-A may be used for rough work.
5. Section–B has 10 short answer type questions. Each question is of 6 marks.
6. Re-evaluation of the answer sheet will not be entertained.
7. Mobile phone / pager / calculator or any other electronic gadget are not allowed inside the Examination Hall. Candidates are advised not to wear their wrist watches in the Examination Room/Hall and they may keep the same on their respective Desk/Table.

12. An astronaut is standing in a spacecraft parallel to its direction of motion. An observer on the earth finds that the speed of spacecraft is 0.60C and the astronaut is 1.3m tall. The astronaut height as measured in the spacecraft is

(a) 1.6 m
(b) 0.832 m
(c) 3.2 m
(d) 1.3 m

13. The electric field just outside the surface of a charged conductor carrying a surface charge density σ is

(a) 0
(b) $\epsilon_0 \sigma$
(c) ϵ_0 / σ
(d) σ / ϵ_0

14. A compass needle is placed near a box and experiences deflection. The box does not have a magnet inside. It may have

(a) a charge body inside
(b) capacitor fully charged
(c) current carrying conductor
(d) none of these

15. An electric dipole consists of two opposite charges of magnitude $q = 2.0\times10^{-6}$ C, separated by 2.0 cm. The dipole is placed in an external field of 2.0×10^{5} N/C. Maximum torque on the dipole is given by

(a) 8.0×10^{2} Nm
(b) 8.0×10^{3} Nm
(c) 8.0×10^{-3} Nm
(d) 8.0×10^{-2} Nm

16. If 'q' be the charge, uniformly distributed over a spherical shell of radius R, the electric field 'E' at a point inside the charged spherical shell will be

(a) $E = \frac{1}{4\pi\epsilon_0}\frac{q}{R^2}$
(b) $E = 0$
(c) $E = \frac{1}{4\pi\epsilon_0}\frac{q}{R}$
(d) $E = \frac{1}{4\pi\epsilon_0}\frac{q}{R^3}$

17. In a resistive circuit, if the load resistance is varied, maximum power is absorbed when

(a) the load resistance equals the source resistance
(b) the load resistance is twice the source resistance
(c) the load resistance is half the source resistance
(d) none of the above

18. The differential form of Ampere's circuital law for steady current is

(a) $\vec{\nabla}.\vec{B}=0$
(b) $\vec{\nabla}\times\vec{B}=\mu_o\vec{J}$
(c) $\vec{\nabla}.\vec{B}=\rho$
(d) $\vec{\nabla}\times\vec{B}=0$

19. A current $I_m \sin(\omega t)$ passes through a resistance R. The power dissipated in the resistance is

(a) $\frac{1}{2}RI_m^2$
(b) RI_m^2
(c) $\frac{1}{4}RI_m^2$
(d) 0

20. In double slit diffraction pattern if slit width is a and separation between the slits is b and $a = b/2$, the missing orders of the interference maxima will be

(a) 1, 3, 5, etc.
(b) 2, 4, 6, etc.
(c) 3, 6, 9, etc.
(d) 4, 8, 12, etc.

21. If v_o and v_e represent the speeds of o-ray and e-ray in a negative crystal; μ_o and μ_e are refractive indices of the crystal for o-ray and e-ray. Which of the following is true for all directions except alone optic axis?

(a) $v_e > v_o$ and $\mu_e < \mu_o$
(b) $v_e < v_o$ and $\mu_e < \mu_o$
(c) $v_e > v_o$ and $\mu_e > \mu_o$
(d) $v_e < v_o$ and $\mu_e > \mu_o$ ✓

22. The state of polarization of the resultant of the polarized light beams with electric vectors, $E_x = \frac{E_o}{\sqrt{2}}\cos(\omega t + kz)$ and $E_y = E_o \sin(\omega t + kz)$ is

(a) linearly polarized
(b) circularly polarized
(c) elliptically polarized
(d) unpolarized

69. The degree of freedom of bob of simple pendulum oscillating in plane is

(a) one
(b) two
(c) three
(d) four

70. If the Lagrangian of a system does not depend on time explicitly then

(a) the Hamiltonian is constant
(b) the kinetic energy

16. A step-wise optical fiber has core and cladding refractive indexes as n_1 and n_2 respectively. The maximum semi-angle of the cone of incident light to be guided into the fiber is

(a) $\cos^{-1}\left(\frac{n_1^2 - n_2^2}{n_1^2}\right)^{1/2}$

(b) $\cos^{-1}\left(n_1^2 - n_2^2\right)^{1/2}$

(c) $\sin^{-1}\left(n_1^2 - n_2^2\right)^{1/2}$

(d) $\sin^{-1}\left(\frac{n_1^2 - n_2^2}{n_1^2}\right)^{1/2}$

17. In principal series doublet of sodium (D_1 and D_2)

(a) transition $^2P_{1/2} - ^2S_{1/2}$ is stronger

(b) transition $^2P_{3/2} - ^2S_{1/2}$ is stronger

(c) both transitions appear with same intensity

(d) transition $^2P_{3/2} - ^2S_{1/2}$ is faint satellite

18. In N slit Fraunhoffer diffraction due to monochromatic light, number of secondary maxima between any two primary maxima is:

(a) N + 1

(b) N

(c) N – 1

(d) N – 2

19. Which of the following Maxwell's equations implies the absence of magnetic monopoles?

(a) $\vec{\nabla}.\vec{E} = \frac{\rho}{\epsilon_o}$

(b) $\vec{\nabla}.\vec{B} = 0$

(c) $\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$

(d) $\vec{\nabla} \times \vec{H} = \vec{J} + \frac{\partial \vec{D}}{\partial t}$

20. A hydrogen atom is ground state absorbs 10.20 eV of energy. The orbital angular momentum of the electron is increased by

(a) 1.05×10^{-34} J-s

(b) 2.11×10^{-34} J-s

(c) 3.16×10^{-34} J-s

(d) 4.22×10^{-34} J-s

39. For a scattering between particles that are in their respective s-states, $\ell = 0$, the total cross section is given by:

(a) $\sigma = \frac{4\pi}{k} \sin \delta_o$

(b) $\sigma = \frac{1}{k^2} \sin^2 \delta_o$

(c) $\sigma = \frac{2\pi}{k^2} \sin \delta_o$

(d) $\sigma = \frac{4\pi}{k^2} \sin^2 \delta_o$

40. Which of the following relations is true for Pauli matrices?

(a) $\sigma_j \sigma_k + \sigma_k \sigma_j = \hat{I} \qquad (j \neq k)$

(b) $\sigma_j \sigma_k + \sigma_k \sigma_j \neq \hat{0} \qquad (j \neq k)$

(c) $\sigma_j \sigma_k + \sigma_k \sigma_j = \hat{0} \qquad (j \neq k)$

(d) $\sigma_j \sigma_k \pm \sigma_k \sigma_j = \hat{0} \qquad (j \neq k)$

41. For a free particle, the relation between the group (v_g) and phase (v_{ph}) velocities is:

(a) $v_{ph.} = v_g$

(b) $v_{ph.} = 2v_g$

(c) $v_{ph.} = \frac{1}{2} v_g$

(d) $v_{ph.} = \sqrt{2}\, v_g$

42. In some limit quantum mechanics becomes classical. This happens in

(a) uncertainty principle
(b) pair production
(c) Ehrenfest's theorem
(d) wave-particle duality

43. Photoelectric effect leads to quantum mechanics because it

(a) demonstrates particle nature for radiation.
(b) demands wave nature for particles.
(c) demonstrates uncertainty principle.
(d) demonstrates discrete energy spectrum.

1. What is displacement current? Discuss its significance.

2. Define inertial frames of reference. Show that all the frames of reference, moving with a constant velocity with respect to the inertial frame, are also inertial frames of reference.

3. What are chromatic and spherical aberrations? Explain how these can be minimized in Huygens eyepiece.

4. State the characteristics of an ideal OP AMP.

5. What will be the various eigen values of $\hat{S}_z^2$ for $s = \frac{3}{2}\hbar$ states? Symbols have their usual meanings.

6. What is Carnot engine? A Carnot's engine whose temperature of source is 400K takes 200 calories of heat at this temperature and rejects 150 calories of heat to the sink. What is the temperature of sink and efficiency of engine?

7. The lagrangian of a particle of mass m and charge q moving in a electromagnetic field $(\phi(\vec{r},t), \vec{A}(\vec{r},t)$ is given by

$$L = \frac{1}{2}mv^2 - q\phi + \frac{q}{c}\vec{v}.\vec{A}$$

Obtain the Hamiltonian.

8. Explain how conductors, semiconductors and insulators are distinguished from one another in terms of forbidden energy gap.

9. Distinguish between FISSION and FUSION.

10. Discuss the properties of laser beam.

23. In N-slit Fraunhoffer diffraction pattern, the number of secondary maxima between the two principal maxima is

(a) N + 1
(b) 2N + 1
(c) N – 2
(d) N – 1

24. Combination of two lenses of same material, having focal length f_1 and f_2, produces achromatism if they are separated by a distance, d given by relation

(a) $d = f_1 - f_2$
(b) $d = f_1 + f_2$
(c) $2d = f_1 + f_2$
(d) $2d = f_1 - f_2$

25. The focal length of an equiconvex is equal to the radius of curvature of either surface. Then refractive index of lens material is

(a) 1.32
(b) 1.25
(c) 1.50
(d) 1.23

26. Light with field vectors given by $\vec{E} = E_o \hat{x}\cos(kz - \omega t), \vec{H} = \hat{y}H_o \cos(kz - \omega t)$, where k is the propagation constant in air and ω is the angular frequency of light, is travelling in air. The poynting vector of this light will lie in

(a) x – direction
(b) y – direction
(c) z – direction
(d) x-y – plane

27. For a CC configuration of BJT, the voltage gain is

(a) less than equal to 1
(b) greater than 1 but less than 10
(c) greater than 10 but less than 100
(d) greater than 100

28. The total harmonic distortion of an amplifier is reduced from 15% to 3% when 4% negative feedback is used. The voltage gain without feedback is

(a) 40
(b) 60
(c) 80
(d) 100

2015-2016

DEPARTMENTAL TEST
for
Admission
to
M. Sc. Physics

Course Number	7	1	2
Q. Paper Series		A	
Paper Code	7		2

Particulars to be filled in by the Candidate

1. Centre Code

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2. Roll Number (in Figures)

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4. Name of the candidate

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5. Date of Test

SIGNATURE OF INVIGILATOR

Duration: : **Two Hours**

Maximum Marks: : **200**

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6. A top is spun on a floor with angular acceleration $\alpha = 5t^3 - 4t$, where the coefficients are in units compatible with seconds and radians. At t = 0, the top has angular velocity 5 rad/s. The angular velocity of the top is given by

(a) $\omega(t) = t^4 - 2t^2 + 5$

(b) $\omega(t) = \frac{5}{4}t^4 - 2t^2 + 8$

(c) $\omega(t) = t^4 - 5t^2 + 8$

(d) $\omega(t) = \frac{5}{4}t^4 - 2t^2 + 5$

7. The moment of inertia of a homogeneous circular disk about an axis through it centre and perpendicular to its plane is ½ MR^2. Its moment of inertia about its diameter will be:

(a) $I = \frac{1}{2}MR^2$

(b) $I = \frac{1}{3}MR^2$

(c) $I = \frac{1}{4}MR^2$

(d) $I = MR^2$

8. At 500Hz, an inductor and a capacitor have equal reactances. The ratio of the capacitive reactance to the inductive reactance at 50Hz will be:

(a) 50
(b) 100
(c) 150
(d) 200

9. Pure rotational spectra of diatomic molecules appear in

(a) microwave region
(b) visible region
(c) ultraviolet region
(d) x-ray region

10. A 10 cm long wire carrying a current of 10 A is held at an angle of 30° with the direction of a uniform magnetic field of strength 1 weber/m^2. The force acting on the wire is

(a) 0.5 N
(b) 1.0 N
(c) 1.5 N
(d) 2.0 N