MAHARAJA RANJIT SINGH PUNJAB TECHNICAL UNIVERSITY BATHINDA (Pb) - 151001

(State Univ. Estb by Punjab Govt. Act No. 5 (2015) and Approved u/s 2(f) & 12(B) of the UGC Act of 1956)

Discipline: PHYSICS (Faculty of Sciences)

3rd PhD ENTRANCE TEST (PET-2018)

Roll No: _____ Date: **3rd June 2018** Signature of the Candidate._____

1. The operator corresponding to the kinetic energy is:

(a) $i\hbar\frac{\partial}{\partial t}$

✓(b) $-\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2}$

(c) $\frac{\hbar}{i}\frac{\partial}{\partial x}$

(d) $i\hbar\frac{\partial^2}{\partial x \partial t}$

2. A particle limited to the x-axis has the wave function, $\psi = a\,x$, between $x = 0$ and $x = 1$; and $\psi = 0$ elsewhere. The expectation value of the particle's position, $< x >$, is:

(a) a^2x^2 (b) a^2 (c) 1 ✓(d) $a^2/4$

3. In a He-Ne gas laser:

(a) The population inversion is in atoms of Ne and laser transition is in atoms of He

(b) Both the population inversion and laser transition are in atoms of He

(c) The population inversion is created in atoms of He and laser transition is in atoms of Ne

✓(d) Both the population inversion and laser transition are in atoms of Ne

4. For an electromagnetic wave, impedance of free space and a medium characterized by permeability μ and permittivity ε is:

(a) 100 Ω and $\sqrt{\varepsilon/\mu}$ (b) 377 Ω and $\sqrt{\mu\varepsilon}$

✓(c) 377 Ω and $\sqrt{\mu/\varepsilon}$ (d) 377 Ω and $\sqrt{\varepsilon/\mu}$

5. In SiO_2 optical fibre generally used for communication purposes, the preferred wavelength used is

✓(a) 1550 nm (b) 630 nm (c) 540 nm (d) 400 nm

6. Phonons propagate in a solid with:

(a) Fermi velocity (b) Velocity of light

✓(c) Velocity of sound (d) Root mean square velocity of the atoms in the solid

7. Coercivity is defined as:

(a) Reverse field required to zero the magnetic induction remaining after an applied magnetic field is reduced from saturation to zero
(b) The magnetic induction remaining after an applied magnetic field is removed
(c) Magnetic field required to achieve saturation value in magnetic induction
(d) Reverse field required to demagnetize a given magnet

8. The de-Broglie wavelength of an electron accelerated to non-relativistic velocities across a potential difference V is proportional to:

(a) 1/V (b) V (c) $V^{1/2}$ (d) $V^{-1/2}$

9. A 600 nm monochromatic light is made to pass through glass slab of refractive index 1.5. The frequency of the light inside the glass slab is:

(a) 3.3×10^{12} (b) 5.0×10^{14} (c) 7.5×10^{14} (d) 3.3×10^{14}

10. The population inversion in a semiconductor laser can be achieved at the:

(a) Metastable state of the GaAs atoms
(b) Metastable state of the Si atoms
(c) Junction of heavily doped of p and n-type GaAs materials
(d) Junction of heavily doped of p and n-type Si materials

11. The commutator $[L_z, P_x]$ is:

(a) $i\hbar P_y$ (b) 0 (c) $i\hbar y$ (d) 1

12. Silicon is not suitable for fabrication of light emitting diodes because it is:

(a) Direct band gap semiconductor
(b) Narrowband gap semiconductor
(c) An indirect band gap semiconductor
(d) Wideband gap semiconductor

13. An approximate sinusoidal-wave oscillator can be realized using an op-amp comparator based rectangular wave generator followed by:

(a) Cascade of a differentiator and an integrator
(b) Amplifier
(c) Cascade of two integrators
(d) Multivibrator

14. A 8 bit ADC is used to convert analog voltage of 0 to 10 V into digital. The resolution is:

(a) 39.2 mV (b) 3.92 mV (c) 1.25 V (d) 2.55 mV

15. Root mean square value of $x(t) = 10\,[\,2 + \sin(-t)\,]$ is:

(a) 21.2 (b) 5.1 (c) 12.2 (d) 17.3

16. The shape of orbits in inverse square force field can be:

(a) Circular only
(b) Elliptical only
(c) Hyperbola, Parabola or Ellipse
(d) Elliptical only

17. Transverse electric (TE) waves have:

(a) Magnetic field component H in the direction of propagation and no component of electric field E in this direction
(b) Electric field component E in the direction of propagation and no component of magnetic field H in this direction
(c) Electric field component E and magnetic field component H in the direction of propagation
(d) Magnetic field component H in the direction of propagation

18. The Laplace transform function f(t) is F(s), then Laplace transform of $\int_0^t f(t)dt$ w.r.t. 't' is:

(a) s F(s) + f(0)
(b) F(s) / s
(c) s / F(s) – f(0)
(d) F(s) / s^2

19. The secondary cosmic rays reaching the earth consist of:

(a) Pions, muons, electrons, neutrons, protons and positrons
(b) About 90% protons, rest are deuterons, alpha particles and heavier nuclei
(c) Muons and electrons
(d) Pions

20. The character of the $3^+ \rightarrow 0^+$ gamma transition is:

(a) Magnetic octupole
(b) Electric octupole
(c) Electric quadrupole
(d) Magnetic dipole

21. The quark model content of the neutron is:

(a) uud (b) uuu (c) udd (d) ddd

22. The value of the integral $\oint_C z^6 dz$, where C is the unit circle with origin at the centre, is:

(a) zero (b) $\frac{z^7}{7}$

(c) $\frac{1}{6}$ (d) $\frac{2\pi i}{6}$

23. A transformation (q , p) → (Q , P) is canonical if:

(a) pdQ – Pdq is a perfect differential (b) pdQ + Pdq is a perfect differential

(c) pdq – PdQ is a perfect differential (d) pdq + PdQ is a perfect differential

24. Neutrons of kinetic energy E and mass m can be used to study spatial features as small as:

(a) $e^2 / (mc^2)$

(b) $h / \sqrt{2mE}$

(c) $\sqrt{2mE} / h$

(d) h / m

25. Appropriate pump to produce vacuum of the order of 10^{-2} torr and suitable gauge to measure it are:

(a) Diffusion pump and penning gauge, respectively
(b) Rotary pump and penning gauge, respectively
(c) Rotary pump and pirani gauge, respectively
(d) Absorption pump and manometer, respectively

26. In the β^+ decay:

(a) The recoiling nucleus and β^+ particle are emitted in one direction, and the antineutrino moves in the opposite direction
(b) The recoiling nucleus moves in a direction out of the plane of emission of the β^+ particle and antineutrino
(c) The recoiling nucleus, β^- particle and antineutrino are emitted in a plane
(d) The recoiling nucleus, β^+ particle and neutrino are emitted in a plane

27. According to the liquid drop model, the volume energy and Coulomb energy (a_1 and a_2 being positive constants) contributions to binding energy are:

(a) a_1A and $-a_2Z^2(Z-1)A^{-1/3}$, respectively
(b) a_1 and $-a_2Z^2A^{-1/3}$, respectively
(c) a_1A and $-a_2Z(Z-1)A^{-1/3}$, respectively
(d) a_1A and $-a_2 Z(Z-1)A^{-2/3}$, respectively

28. For Bragg Reflections from a set of parallel adjacent planes separated by d, the wavelength of x-rays must be:

(a) Less than or equal to 2d
(b) Less than d
(c) Greater than d
(d) Greater than or equal to 2d

29. The effective mass of a photon of wavelength 10 nm is:

(a) 6.62×10^{-33} kg (b) 3.31×10^{-33} kg
(c) Zero (d) 2.2×10^{-22} kg

30. Which of the following is invariant under Lorentz transformations (symbols have usual meaning - p for momentum, E for energy and c for velocity of light):

(a) Volume element dx dy dz (b) $\left[p^2 - \frac{E^2}{c^2}\right]$
(c) $\left[p - \frac{E}{c^2}\right]$ (d) $\left[p - \frac{E}{c}\right]$

31. The speed of the particle whose kinetic energy is equal to its rest mass energy is:

(a) C (b) $1/2\ c$ (c) $\sqrt{3}/2\ c$ (d) $3/4\ c$

32. Fourier transform of Sin $\omega_o t$ is:

(a) $j\pi\ [\delta(\omega+\omega_o) + \delta(\omega-\omega_o)]$
(b) $\pi\ [\delta(\omega+\omega_o) + \delta(\omega-\omega_o)]$
(c) $j\pi\ [\delta(\omega+\omega_o) - \delta(\omega-\omega_o)]$
(d) $j\pi\ [\delta(\omega-\omega_o) - \delta(\omega+\omega_o)]$

33. When electrons are trapped in the crystal lattice in place of anion vacancy, the defect in the crystal is known as:

(a) Frenkel defect (b) Schottky defect (c) Dislocations (d) F- centre

34. A metal 'M' has FCC arrangement and edge length of the unit cell is 400 pm. The atomic radius of 'M' is:

(a) 200 pm (b) 141 pm (c) 173 pm (d) 100 pm

35. The $5x\frac{d}{dx}(\delta(x))$ is equal to

(a) $5\delta(x)$
(b) $5x\delta(x)$
(c) $-5\delta(x)$
(d) $-5x\delta(x)$

36. The exciting line in an Raman spectroscopy experiment is at 5000 Å and the observed Stokes line is 5100 Å. The wavelength of anti-Stokes line is:

(a) 4904 Å (b) 4896 Å (c) 5200 Å (d) 4900 Å

37. According to shell model, the predicted spin-parity for the ^{13}C (Z= 6) nucleus is:

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

38. The correct order of increasing wavelength is:

(a) X-rays, IR, Microwave, Visible (b) UV, IR, Microwave, X-rays

(c) Microwave, X-rays, UV, IR (d) X-rays, UV, IR, Microwave

39. In a micro canonical ensemble, a system A of fixed volume is in contact with a large reservoir B. Then

(a) A can exchange both energy and particles with B

(b) A can exchange neither energy nor particles with B

(c) A can exchange only particles with B

(d) A can exchange only energy with B

40. Which of the following term (state) is not a possible one in case of an atom?

(a) $2^2P_{5/2}$ (b) $2^2D_{3/2}$ (c) $3^2P_{1/2}$ (d) $3^2S_{1/2}$
