Physics - 2010

M.Sc. Physics

1. An object, initially at rest, explodes into three pieces which move off in the x–y plane. Two of the pieces have mass m and are ejected perpendicular to each other with a speed v. The third piece, of mass $3m$, has speed

   (a) $2v/\sqrt{3}$

   (b) $\sqrt{2}v/3$

   (c) $\sqrt{2/3}\,v$

   (d) $\sqrt{3/2}\,v$

2. The mass of a hypothetical planet is $1/100$ that of Earth and its radius is $1/4$ that of Earth. If a person weigh 75 N on Earth, what would he weigh on this planet ?

   (a) 75 N

   (b) 24 N

   (c) 12 N

   (d) 6 N

3. The flow of a liquid is said to be turbulent if its Reynold number is more than :

   (a) 3

   (b) 30

   (c) 300

   (d) 3000

4. Bernoulli's equation applies to :

   (a) An incompressible fluid, not neccesarily viscous

   (b) A static fluid only

   (c) An incompressible, nonviscous, nonturbulent fluid

   (d) An incompressible, viscous, and nonturbulent fluid

5. Which of the following statements is not completely correct about stationary waves ?

   (a) Stationary waves are formed by the superposition of two wave trains of the same frequency and amplitude travelling in opposite directions.

   (b) Stationary waves can be transverse or longitudinal

   (c) In longitudinal stationary waves, antinodes are the points where there is no pressure or density change

   (d) Stationary waves do not advance but there is net transfer of energy.

6. Two simple pendulums, A and B, have the same length, but the mass of A is twice the mass of B. Their vibrational amplitudes are equal. Their periods are T_A and T_B respectively and their energies are E_A and E_B. Choose the correct statement :

   (a) $T_A = T_B$ and $E_A > E_B$

   (b) $T_A < T_B$ and $E_A > E_B$

   (c) $T_A > T_B$ and $E_A < E_B$

   (d) $T_A = T_B$ and $E_A < E_B$

ELW–6742

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7. An inertial frame is a frame in which :
   (a) there are no forces
   (b) there are no accelerations without applied forces
   (c) relativistic mechanics holds good but the Newtonian mechanics does not
   (d) relativistic mechanics does not hold good but the Newtonian mechanics does

8. A stationary body explodes into two fragments each of mass 1 Kg that move apart at speeds of 0.8C relative to the original body. The rest mass of the original body is :
   (a) 3.3 Kg
   (b) 4.4 Kg
   (c) 2.5 Kg
   (d) 2.0 Kg

9. An astronaut in a rocket passes a metre stick moving parallel to its long dimension. The astronaut measures the metre stick to be 0.80 m long. How fast is the rocket moving with respect to the metre stick ?
   (a) 0.4 C
   (b) 0.6 C
   (c) 0.8 C
   (d) 0.9 C

10. Three identical particles travel with the velocities indicated in the following options. Which has the greatest kinetic energy ?
    (a) $\upsilon = 4i + 3j$
    (b) $\upsilon = -4i + 3j$
    (c) $\upsilon = 5i$
    (d) they are all the same

11. The value of a for which the vector $xi + 2yj + azk$ is solenoidal is :
    (a) 1
    (b) 3
    (c) −1
    (d) None of the above

12. Curl of the curl of a vector V [i.e. $\nabla \times (\nabla \times V)$] equals :
    (a) $\nabla (\nabla.V) - \nabla^2 V$
    (b) $\nabla (\nabla\cdot V) + \nabla^2 V$
    (c) $\nabla^2 V - \nabla(\nabla. V)$
    (d) 0

13. Two charged particles attract each other with a force of magnitude F acting on each. If the charge of both the particles is doubed and the distance separating the particles is also doubled, the force acting on each of the particles has the magnitude :
    (a) F
    (b) 2F
    (c) F/2
    (d) F/4

14. A capacitor stores charge Q at a potential difference V. If the voltage applied by a battery to the capacitor is doubled to 2V :
    (a) The capacitance falls to half of its initial value and the charge remains the same
    (b) The charge doubles and the capacitance remains the same
    (c) The capacitance and the charge both fall to half of their initial value
    (d) The capacitance and the charge both double

15. Impedance Z offered by an ac circuit containing resistance R, inductance L and capacitance C is given by :

    (a) $Z = \sqrt{R^2 + \left(L\omega + \dfrac{1}{C\omega}\right)^2}$ 　　(b) $Z = \sqrt{R^2 - \left(L\omega + \dfrac{1}{C\omega}\right)^2}$

    (c) $Z = \sqrt{R^2 + \left(L\omega - \dfrac{1}{C\omega}\right)^2}$ 　　(d) $Z = \sqrt{R^2 + (L\omega)^2 + (C\omega)^2}$

16. An LC circuit oscillates with a period T for a capacitance C and an inductance L. If the capacitance is changed to C/8 and the value of the inductance is halved to L/2, what is the new period of oscillation ?
    (a) T/16 　　　　　　　　(b) T/4
    (c) T/2 　　　　　　　　(d) 2T

17. A particle with mass m and charge q moving with a velocity v perpendicular to a uniform magnetic field B follows a circular path of radius :
    (a) mv/qB 　　　　　　(b) qB/mv
    (c) qm/Bv 　　　　　　(d) mB/qv

18. The magnitude of the induced emf in a circuit equals the time rate of change of magnetic flux through the circuit. This is a statement of :
    (a) Faraday's laws 　　　　(b) Lenz's law
    (c) Guass's law 　　　　　(d) Amphere's law

19. The speed of propagation of an electromagnetic wave in free space of permeability μ_0 and permittivity ϵ_0 is :
    (a) $1/\sqrt{\mu_0 \epsilon_0}$ 　　　　　(b) $\sqrt{\mu_0 \epsilon_0}$
    (c) $\sqrt{\mu_0/\epsilon_0}$ 　　　　　(d) $\sqrt{\epsilon_0/\mu_0}$

20. For an Ideal gas undergoing an adiabatic process, the pressure P, the Volume V and the ratio of the specific heats $\gamma = Cp/Cv$ are related as :

    (a) $PV/\gamma = Constant$ (b) $PV^\gamma = Constant$

    (c) $VP^\gamma = Constant$.   (d) $(VP)^\gamma = Constant$

21. The mean length of the path travelled by a gas molecule as a free particle depends chiefly upon :

    (a) Temperature and Pressure

    (b) Volume and number of particles

    (c) Size of the molecules and their number density

    (d) Temperature, Pressure and Volume

22. In the following, V_m stand for molar volume, a and b are van der *Wall's* constants, and R is the molar gas constant. The correct form of the van der *Wall's* equation of state is :

    (a) $\left(P - \dfrac{a}{V_m}\right)\left(V^2_m + b\right) = RT$ (b) $\left[P - \dfrac{a}{V_m}\right]\left(V^2 m - b\right) = RT$

    (c) $\left[P + \dfrac{a}{V_m}\right]\left(V^2_m - b\right) = RT$ (d) $\left[P + \dfrac{a}{V^2_m}\right]\left(V_m - b\right) = RT$

23. Critical point in a PVT diagram is the point where :

    (a) a solid goes directly to vapour on heating

    (b) vapours and liquids become indistinguishable

    (c) vapour, liquid and solid can co–exist together in thermal equilibrium

    (d) the melting point decreases as pressure increases

24. If H is enthalpy, T is temperature, S is entropy, U is internal energy and F is Helmholtz free energy, which of the following expressions represents the Gibbs Free Energy, G ?

    (a) H – TS   (b) U + TS

    (c) U + PV   (d) H – U

25. The correct Maxwell relation between the thermodynamic variables P, V, S, and T is :

    (a) $(\partial P/\partial T)|_V = (\partial S/\partial V)|_T$ (b) $(\partial T/\partial V)|_S = -(\partial P/\partial S)|_V$

    (c) $(\partial T/\partial P)|_S = (\partial V/\partial S)|_P$ (d) All of these are correct

26. Read the following statements :
    i.   Heat never flows spontaneously from a colder body to a hotter body
    ii. No engine can have 100% efficiency
    iii. The entropy of the universe never decreases
    Among the above statements, the following is a correct set of various statements of the second law of thermodynamics :
    (a) i. and ii. only   (b) i. and iii. only
    (c) ii. and iii. only   (d) all i., ii. and iii.

27. A coin is flipped one hundred times and the outcomes recorded. How many macrostates and microstates are there respectively ?
    (a) 1 and 2   (b) 2 and 2
    (c) 1 and 100   (d) 2 and 100

28. If the temperature of an ideal gas is doubled while holding the pressure constant, the rms speed of the molecule :
    (a) is also doubled
    (b) becomes $\sqrt{2}$ times the original speed
    (c) becomes 4 times the original speed
    (d) becomes 8 times the original speed

29. Of the following properties of a wave, the one that is independent of the others is its :
    (a) frequency   (b) wavelength
    (c) speed   (d) amplitude

30. Humans with excellent hearing can hear in the frequency range :
    (a) 0 Hz – 20 KHz   (b) 20 Hz – 20 KHz
    (c) 20 KHz – 20 MHz   (d) 20 Hz – 20 MHz

31. Two thin lenses of magnification m_1 and m_2 (with $m_1 > m_2$) are used in combination. The magnification of the combined system is :
    (a) $m_1 + m_2$ (b) $m_1 - m_2$
    (c) $m_1 m_2$ (d) m_1 / m_2

32. A curved mirror surface can have :
    (a) both chromatic and spherical abberations
    (b) chromatic abberation but not spherical abberations
    (c) spherical abberation but not chromatic abberation
    (d) neither chromatic nor spherical abberations

33. Two coherent, monochromatic light waves, each of intensity I, are incident on a point. The total intensity at that point is :

    (a)   0

    (b)   I

    (c)   4I

    (d)   The given information is insufficient

34. In a double slit experiment using light of wavelength 500 nm, the slit spacing is 1 mm and the screen is 2 m from the slit. Assuming small–angle approximation, the distance along the screen between adjuscent bright fringes is :

    (a)   1 cm   (b)   0.50 cm

    (c)   0.10 cm   (d)   0.01 cm

35. A LASER produces :

    (a)   a parallel, coherent and monochromatic beam of light

    (b)   a parallel, non–coherent and monochromatic beam of light

    (c)   a parallel, coherent but not neccessarily monochromatic beam of light

    (d)   an anti–parallel, coherent and monochromatic beam of light

36. According to Rayleigh's criterion, the minimum angle of resolution θ for a circular aperture of diameter D is :

    (a) $\theta = \dfrac{1.22D}{\lambda}$ (b) $\theta = \dfrac{D}{1.22\lambda}$

    (c) $\theta = \dfrac{\lambda}{1.22D}$ (d) $\theta = \dfrac{1.22\lambda}{D}$

37. A light ray inside a glass prism is incident at Brewester's angle on the surface of the prism with air outside. Choose the correct statement from the following :

    (a)   There is no transmitted ray; the reflected ray is plane polarised

    (b)   There is no reflected ray; the transmitted ray is plane polarised

    (c)   Transmitted ray is partially polarized; the reflected ray is plane polarised

    (d)   The reflected ray is partially polarized; the transmitted ray is plane polarised

38. An electron and a proton have the same de Broglie wavelength. Which of the following are also the same for the two particles ?

    (a)   momentum   (b)   momentum and kinetic energy

    (c)   speed and kinetic energy   (d)   momentum and speed

39. A paritcle is trapped in a 1–D infinite square potential well with perfectly rigid walls. If E_0 is the energy of the partitcle in the ground state, then the difference in energy between the ground state and the first excited state is :
    - (a) E_0
    - (b) $2E_0$
    - (c) $3E_0$
    - (d) $4E_0$

40. Identify the momentum operator from the following :
    - (a) $i\hbar\nabla$
    - (b) $-i\hbar\nabla$
    - (c) $i\hbar\nabla^2$
    - (d) $-i\hbar\nabla^2$

41. Depending upon the orientation of the spin vector S, the energy of an atomic electron will be higher or lower then its energy without spin–orbit coupling, by the term (μ_B is the Bohr Magneton)
    - (a) $\mu_B B$
    - (b) $\mu_B B^2$
    - (c) μ_B/B^2
    - (d) $\mu_B B^3$

42. For the hydrogen atom in the $l = 3$ state, the magnitude of the orbital angular momentum L is :
    - (a) $\sqrt{3}\hbar$
    - (b) $2\sqrt{3}\hbar$
    - (c) $3\sqrt{2}\hbar$
    - (d) $\sqrt{2}\hbar$

43. In an X–ray tube, as the energy of the electrons striking the metal target is increased, the wavelength of the characteristic X–rays :
    - (a) increases
    - (b) decreases
    - (c) does not change
    - (d) increases for metals with odd number of valance electrons and decreases for metals with even number of valance electrons

44. Homomorphic molecules that lack permanent dipole moments can have :
    - (a) rotational spectra
    - (b) vibrational spectra
    - (c) electronic spectra
    - (d) None of the above

45. In the harmonic oscillator approximation, the selection rules for transition between vibrational states is (v is the vibrational quantum number)
    - (a) $\Delta v = 1, 2, 3$
    - (b) $\Delta v = 0, 1, 2, 3$
    - (c) $\Delta v = 1, 2, 3, 4$
    - (d) $\Delta v = \pm 1$

46. If the radius of a nucleus is doubled, the mass number A increases by a factor of :
    - (a) 8
    - (b) 4
    - (c) 2
    - (d) $2^{2/3}$

47. A certain nuclide X decays into a daughter nuclide Y with the emission of an α particle and two β particles. The mass number A and the atomic number Z of the daughter compared to the parent :
    (a) Z reduced by 4 units, A remains unchanged
    (b) A reduced by 4 units, Z remains unchanged
    (c) A reduced by 4 units, Z reduced by 2 units
    (d) A reduced by 4 units, Z increased by 2 units

48. Only one particle among the following has an integral spin. It is :
    (a) Proton   (b) Neutron
    (c) Electron   (d) Photon

49. For a Tetragonal lattice system, the restrictions on the conventional Cell Axes and Angles are :
    (a) $a \neq b \neq c, \alpha = \beta = \gamma = 90^0$ (b) $a = b = c, \alpha \neq \beta \neq \gamma$
    (c) $a = b \neq c, \alpha \neq \beta \neq \gamma$ (d) $a = b \neq c, \alpha = \beta = \gamma = 90^0$

50. The reciprocal lattice to a simple cubic lattice is a :
    (a) Simple cubic lattice   (b) *bcc* lattice
    (c) *fcc* lattice   (d) *gcc* lattice

51. The magnetic susceptibility of diamagnetic, paramagnetic and ferromagnetic substances respectively is
    (a) positive but small, positive and large, negative
    (b) negative, positive but small, positive and large
    (c) negative, positive and large, positive but small
    (d) positive and large, negative, positive but small

52. According to Debye's law, the vibrational specific heat of solids at very low temperature varies as
    (a) T (b) T^2
    (c) T^3 (d) T^4

53. The forbidden energy gap in a solid is of the order of 1eV. The solid is most likely :
    (a) An insulator at absolute zero
    (b) A semiconductor at room temperature
    (c) A conductor at low temperature
    (d) Both (a) and (b)

54. A phonon is :
    (a) a quantum of lattice vibrations   (b) a quantum of light
    (c) a particle of half integral spin   (d) a lepton

55. When a current carrying conductor is placed across a magnetic field, a potential difference is generated in a direction :
    (a) parallel to the current and perpendicular to the magnetic field
    (b) parallel to the magnetic field and perpendicular to the current
    (c) parallel to both the magnetic field and the current
    (d) perpendicular to both the magnetic field and the current

56. A piece of silver and another of germanium are cooled from room temperature to liquid nitrogen temperature. The resistance of :
    (a) each of them increases
    (b) each of them decreases
    (c) increases for silver and decreases for germanium
    (d) decreases for silver and increases for germanium

57. Both the inputs of a logic gate are HIGH, and the output is LOW; the gate is :
    (a) an AND gate   (b) an OR gate
    (c) a NAND gate   (d) None of these

58. A Zener diode is mainly used as :
    (a) an amplifier   (b) a voltage regulator
    (c) an oscillator   (d) a filter

59. In a class C amplifer,
    (a) the output current is zero for more than one–half of an input sinusoidal signal cycle
    (b) the output current is zero for less than one–half of an input sinusoidal signal cycle
    (c) the output current is zero for the whole signal cycle
    (d) the output current flows for the whole signal cycle

60. In the common collector transistor configuration, the current gain and the voltage gain are :
    (a) both high   (b) both low
    (c) high and low respectively   (d) low and high respectively