ENTRANCE EXAMINATION FOR ADMISSION, MAY 2011.

M.Sc. (PHYSICS)

COURSE CODE : 374

Register Number :

Signature of the Invigilator
(with date)

COURSE CODE : 374

Time : 2 Hours Max : 400 Marks

Instructions to Candidates :

1. Write your Register Number within the box provided on the top of this page and fill in the page 1 of the answer sheet using pen.
2. Do not write your name anywhere in this booklet or answer sheet. Violation of this entails disqualification.
3. Read each question carefully and shade the relevant answer (A) or (B) or (C) or (D) in the relevant box of the ANSWER SHEET using HB pencil.
4. Avoid blind guessing. A wrong answer will fetch you –1 mark and the correct answer will fetch 4 marks.
5. Do not write anything in the question paper. Use the white sheets attached at the end for rough works.
6. Do not open the question paper until the start signal is given.
7. Do not attempt to answer after stop signal is given. Any such attempt will disqualify your candidature.
8. On stop signal, keep the question paper and the answer sheet on your table and wait for the invigilator to collect them.
9. Use of Calculators, Tables, etc. are prohibited.

1. Which relation between restoring force (F) and displacement (y) is true for a Simple Harmonic Oscillator (SHO)?

(A) F = constant (k) (B) F = ky (C) F = –ky (D) $F = -ky^2$

2. S.I. Unit of acoustic intensity is

(A) Bel (B) Decibel (C) Watt (D) $Watt/m^2$

3. For dispersive medium the relation between wave-phase velocity (v) and wave-group velocity (v_g) is

(A) $v = v_g$ (B) $v \neq v_g$ (C) always $v_g > v$ (D) always $v_g < v$

4. Propagation of sound wave through air medium is

(A) isothermal process (B) adiabatic process

(C) isobaric process (D) isochoric process

5. The phase velocity of a plane progressive wave given by y = 10 sin (25t - 20x) m is

(A) 1 m/s (B) 1.25 m/s (C) 1 .50 m/s (D) 25 m/s

6. The frequency of a SHO with mass 0.2 g, amplitude 4 cm and velocity at mean position 1 m/s is

(A) 1 Hz (B) 2 Hz (C) 3 Hz (D) 4 Hz

7. The fundamental frequency of wave vibration (velocity v) in a pipe of length l open at both ends is

(A) v/l (B) $v/2l$ (C) $v/4l$ (D) $3v/4l$

8. The fourth harmonic produced by a 10 m long cable of mass 10 kg and tension 49000 N is

(A) 4 Hz (B) 14 Hz (C) 24 Hz (D) 34 Hz

9. The distance between two consecutive nodes of a standing wave is

(A) 2λ (B) λ (C) $\lambda/2$ (D) $\lambda/4$

10. Musicians use key note at a frequency

(A) 20 Hz (B) 264 Hz (C) 256 Hz (D) 20 kHz

11. Which of the following is the closest to the wavelength of X-rays?

(A) 1 nm (B) 1 cm (C) 1 km (D) 1 pm

12. Ultraviolet light of energy 3.5 eV and intensity 100 W/m^2 is directed at a potassium surface (Work function of potassium is 2.2 eV). Find the maximum kinetic energy of the photo electrons.

(A) 1.0 eV (B) 1.20 eV (C) 1.30 eV (D) 1.23 eV

13. The smallest angle of Bragg scattering in potassium chloride (KCl) is 28.4° for 0.30 nm X-rays. Find the distance between atomic planes in potassium chloride.

(A) 0.32 nm (B) 0.5 nm

(C) 20 Angstroms (D) 30 Angstroms

14. The distance between adjacent atomic planes in Calcite is 0.3 nm. Find the smallest angle of Bragg scattering for 0.03 nm X-rays.

(A) 28.4° (B) 8.4° (C) 2.8° (D) 4.4°

15. Find the de Broglie wavelength of an electron with a velocity of 10^7 m/s.

(A) 7.3×10^{-10} m (B) 7.3×10^{-11} m

(C) 7.3×10^{-12} m (D) 7.3×10^{-13} m

16. What is the expression for the energy E_n of a particle in a box of length L?

(A) $E_n = n^2 h^2 / 2mL^2$ (B) $E_n = n^2 h^4 / 4mL^4$

(C) $E_n = n^2 h^4 / 6mL^2$ (D) $E_n = n^2 h^2 / 8mL^2$

17. An electron is in a cubical box of side 0.10 nm. Find its permitted energy.

(A) $E_n = 38n^2$ eV (B) $E_n = 36n^2$ eV

(C) $E_n = 34n^2$ eV (D) $E_n = 37n^2$ eV

18. Find the expectation value of position x of a particle trapped in a box of side L. The wave function of the particle is given by $\psi(x) = \sqrt{(2/L)} \sin(n\pi x / L)$.

(A) L (B) L/2 (C) L/3 (D) L/4

19. Find the transmission probability of electron with energy 1.0 eV incident on a barrier 10.0 eV high and 0.5 nm wide.

(A) $T = 1.3 \times 10^{-7}$ (B) $T = 1.0 \times 10^{-7}$ (C) $T = 1.2 \times 10^{-7}$ (D) $T = 1.1 \times 10^{-7}$

20. The zero point energy of harmonic oscillator is

(A) $0.5\ h\nu$ (B) $2/3\ h\nu$ (C) $3/2\ h\nu$ (D) $h\nu$

21. Find the S, L, J values that correspond to the state as represented by spectral notation : $^3P_2$

(A) 0, 1, 2 (B) ½, 1, 1 (C) 2, 1,1 (D) 1, 1, 2

22. Find the drift velocity V_d of the free electrons in a copper wire whose cross-sectional area is A = 1.0 mm^2 when the wire carries a current of 1.0 A. Assume that each copper atom contributes one electron to the electron gas. (The electron density of copper is 8.48×10^{28} electrons/m^3).

(A) 2.0×10^{-5} m/s (B) 4.5×10^{-5} m/s (C) 6.1×10^{-4} m/s (D) 7.4×10^{-4} m/s

23. Find out how many times greater the mass of electron whose velocity is 0.99c (c is velocity of light) than that of its rest mass $m_0 = 9.1 \times 10^{-31}$ kg.

(A) 5 times (B) 6 times (C) 7 times (D) 8 times

24. How many electrons can a *f* sub-shell occupy?

(A) 7 electrons (B) 10 electrons (C) 14 electrons (D) 28 electrons

25. What are the possible orientations of J for $j = ½$ and $l = 1$?

(A) –1/2, 0, 1/2 (B) –1/2, 1/2 (C) –1, 0,1 (D) None

26. One of the following phenomena that cannot be explained by particle nature of light is

(A) reflection (B) refraction

(C) diffraction (D) rectilinear propagation

27. Observation of an intense bright spot at the centre of the shadow of an opaque circular object is an example for

(A) wave nature of light (B) particle nature of light

(C) polarization nature of light (D) total internal reflection

28. Penumbra observed during eclipse is produced due to

(A) refraction (B) scattering

(C) total Internal reflection (D) diffraction

29. Propagation of light waves through fiber optic cables for extremely long distance is possible due to

(A) refraction (B) scattering

(C) total internal reflection (D) diffraction

30. The direction of vibrations of electric field in a transverse un-polarized electromagnetic waves is

(A) parallel to the direction of propagation

(B) perpendicular to the direction of propagation

(C) at an angle of 35 degree to that of propagation direction

(D) more than 180 degree to that of propagation direction

31. Consider a lightbeam of central frequency 6×10^{14} Hz a spectral width of 7000 MHz is incident normally on a resonator with $n_0 = 1$, d = 10 cm. The spacing of two adjacent modes will be

(A) 6500 MHz (B) 750 MHz (C) 3000 MHz (D) 1500 MHz

32. The radius of the first dark ring of the Fraunhoffer diffraction pattern produced by a circular aperture of radius 0.02 cm at the focal plane of a convex lens of focal length 20 cm for incident light of wavelength 600 nm

(A) 3.6×10^{-2} cm (B) 1.8×10^{-2} cm (C) 7.2×10^{-2} cm (D) 6.7×10^{-2} cm

33. A source of sound is vibrating with a frequency of 256 Hz in air and propagating energy uniformly in all directions at the rate of 5 J per see. The amplitude of the wave at a distance of 25 m from the source (speed of sound in air = 330m per sec density of air =1.29 kg per/m^3)

(A) 0.63 micron (B) 3 m (C) 6.3 m (D) 0.3 micron

34. The spherical aberration of a combination of two thin lenses is minimum when their separation is ———— to the differences in their focal lengths

(A) equal (B) twice (C) half (D) one third

35. The light of wavelength 589.3 nm is incident on a calcite crystal having ordinary refractive index of 1.65836 and extraordinary refractive index of 1.48641. The optic axis is parallel to the incident light. The thickness of the quarter wave plate (QWP) would be

(A) 857 nm

(B) 857 micron

(C) that QWP cannot be constructed

(D) 0 mm

36. A focus of an ellipse is at the origin. The directrix is the line x = 4 and the eccentricity is 1/2. Then the length of the semi-major axis is

(A) 4/3 (B) 5/3 (C) 7/3 (D) 8/3

37. If x_1, x_2, x_3 and y_1, y_2, y_3 are both in geometric progression with the same common ratio, then the points (x_1, y_1) (x_2, y_2) and (x_3, y_3)

(A) lie on a straight line (B) lie on an ellipse

(C) lie on a circle (D) are vertices of a triangle

38. The graph of the function y = f(x) is symmetrical about the line x = 2, then

(A) $f(x+2) = f(x-2)$ (B) $f(2+x) = f(2-x)$

(C) $f(x) = f(-x)$ (D) $f(x) = -f(-x)$

39. The probability that A speaks truth is, while this probability for B is the probability that they contradict each other when asked to speak on a fact

(A) 3/20 (B) 1/5 (C) 7/20 (D) 4/5

40. If $x\,dy/dx = y(\log y - \log x + 1)$, then the solution of the equation is

(A) $y\log(x/y) = cx$ (B) $x\log(y/x) = cy$

(C) $\log(y/x) = cx$ (D) $\log(x/y) = cy$

41. The function f(x) = x/2 + 2/x has a local minimum at

(A) x = 1 (B) x = –2 (C) x = 0 (D) x = 2

42. If $(3^x)^2/3^2 = 3^8$, then $x =$

(A) 4 (B) 6 (C) 5 (D) 16

43. If a car travels x kilometers of a trip in h hours, in how many hours can it travel the next y kilometers at this rate?

(A) xy/h (B) hy/x (C) hx/b (D) $h + y/x$

44. Find a and b, where a and b are real numbers so that $a + ib = (2-i)^2$

(A) $a = 3, b = -4$ (B) $a = -3, b = 4$

(C) $a = -3, b = -4$ (D) $a = 3, b = 4$

45. The real solutions to the logarithmic equation $\ln(x) + \ln(2) = 3$

(A) $3/\ln(2)$ (B) $e^3/2$ (C) $e^3/\ln(2)$ (D) $3^e/2$

46. Which of the following statements is correct?

(A) A linear system can only have an infinite number of solutions if there are more variables than equations

(B) It is possible to construct a linear system with exactly 5 different solutions

(C) A linear system with more equations than unknowns cannot have solutions

(D) Suppose A is $n \times n$, x is $n \times 1$, and $Ax = 0$ has only the trivial solution. Then $Ax = b$ has solutions for any $n \times 1$ vector b

47. If m *and* p are positive integers and $(m + p)\, xm$ is even, which of the following must be true?

(A) If m is odd, then p is odd

(B) If m is odd, then p is even

(C) If m is even, then p is even

(D) If m is even, then p is odd

48. For positive integers a and b, let $a \Delta b$ be defined as a^{b+1}. If x and y are positive integers and $x \Delta y = 16$, which of the following could be a value of y?

(A) 1 (B) 2 (C) 1 and 3 (D) 2 and 3

49. A man driving his bike at 24 kmph reaches his office 5 minutes late. If he had driven 25% faster on an average he would have reached 4 minutes earlier than the scheduled time. How far is his office?

(A) 24 km (B) 72 km (C) 18 km (D) 48 km

50. A square matrix which has all zeros below the main diagonal is called

(A) upper triangular

(B) singular

(C) lower triangular

(D) invertable

51. Which of the following functions is NOT a transcendental function?

(A) trigonometric (B) algebraic (C) logarithmic (D) exponential

52. The limit of the fraction 1/x as x approaches infinity is

(A) 1

(B) infinity

(C) 0

(D) none of these

53. If two sides of a quadrilateral are parallel and the other two sides are equal but NOT parallel, the quadrilateral is known as a

(A) parallelogram (B) triangle (C) square (D) trapezoid

54. If $\log_x 81 = 6$, then x is equal to

(A) 3 (B) 9 (C) 1/3 (D) 9

55. The equation : $[(x-2)^2/6]-[(y-3)^2/5]=2$ defines which of the following?

(A) ellipse (B) hyperbola (C) spiral (D) parabola

56. For insulators an increase in temperature will result in a ————in the resistance

(A) increase (B) decrease

(C) no change (D) none of the above

57. The fifth color band of fixed molded composition resistor represents

(A) Reliability (B) Tolerance

(C) Number of zeros (D) No such band exits

58. If an ammeter reads 2.5 A for a period of 4 min. then the charge that has passed through the meter is

(A) 500°C (B) 100°C (C) 10°C (D) 600°C

59. A voltage-dependent, non-linear resistor used to suppress high voltage transients

(A) Rectifier (B) Varistor (C) Regulator (D) Transistor

60. The values of V_2, R_1 and R_3 in the given circuit (Figure 1) are

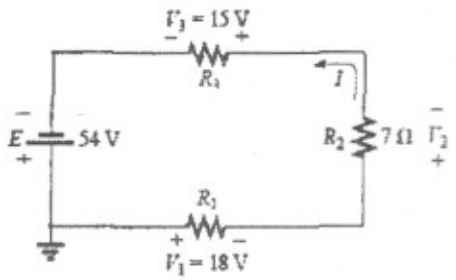


Figure 1

(A) 21 V, 5 Ω, 6 Ω (B) 21 V, 5 Ω, 5 Ω

(C) 21 V, 6 Ω, 5 Ω (D) 12 V, 5 Ω, 5 Ω

61. The currents I_3 and I_5 in Figure 2 are

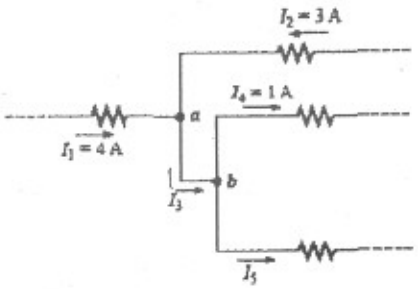


Figure 2

(A) 7A, 6A (B) 6A, 7A (C) 4A, 6A (D) 7A, 7A

62. The values of V_1, V_2, V_{ab} in Figure 3 are

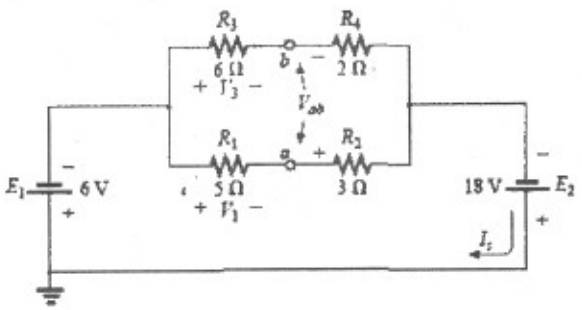


Figure 3

(A) 1.5 V, 9 V, 7.5 V, 3 A (B) 7.5 V, 1 V, 9 V, 3 A
(C) 6.5 V, 9 V, 1.5 V, 3 A (D) 7.5 V, 9 V, 1.5 V, 3 A

63. The potential across 4 Ω resistor in Figure 4 is

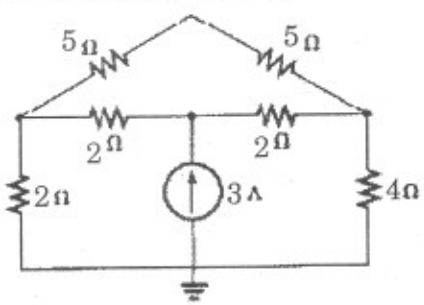


Figure 4

(A) 4.645 V (B) 3.645 V (C) 4.5 V (D) 4.0 V

64. The ———— theorem states that "if the voltage across and the current through any branch of a dc bilateral network are known, this branch can be replaced by any combination of elements that will maintain the same voltage across and current through the chosen branch"

(A) Superposition (B) Millman (C) Substitution (D) Reciprocity

65. Find the voltage across and charge on each capacitor of the network of Figure 5 after each has charged upto its final value

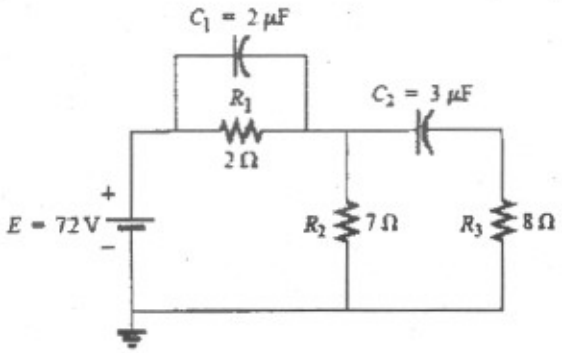


Figure 5

(A) 56 V, 16 V, 168 μC, 32 μC

(B) 56 V, 16 V, 32 μC, 68 μC

(C) 6 V, 56 V, 32 μC, 168 μC

(D) 16 V, 56 V, 32 μC, 168 μC

66. Consider one dimensional motion of a particle. The total energy of a particle of mass $m = 1$ is $\frac{1}{2}mv^2 - \frac{1}{2}x^2$.

If the particle is kept at $x = 0$ and disturbed slightly, then,

(A) The point $x = 0$ is an unstable equilibrium point.

(B) The point $x = 0$ is a stable equilibrium point.

(C) The point $x = 0$ is a turning point.

(D) The given information is insufficient to get the answer.

67. Which of the following statement is true?

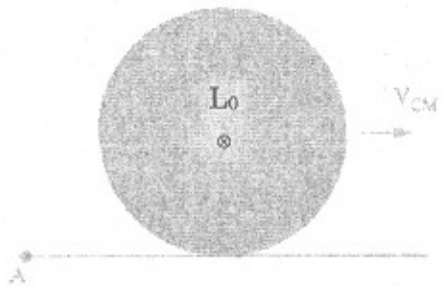
(A) The linear momentum of an isolated single particle is not conserved

(B) Gravitational force is a non conservative force

(C) The potential $U = -\frac{\alpha}{r^n}$ with $\alpha, n > 0$ is a central force

(D) Cylindrical polar coordinate system is a non orthogonal coordinate system

68. A wheel of mass M and radius R is rolling without slipping on a xy plane with an angular velocity Ω as shown in the figure below. Then, the angular momentum of the wheel is



(A) about its center of mass is $\frac{3}{2} M R^2 \Omega \hat{z}$

(B) about the point A is $\frac{3}{2} M R^2 \Omega \hat{z}$

(C) about the bottom most point touching the surface is $\frac{1}{2} M R^2 \Omega \hat{z}$

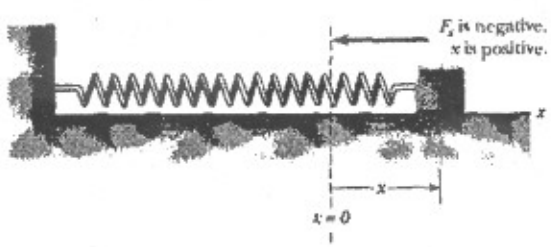
(D) about its center of mass is $M R^2 \Omega \hat{z}$

69. A solid cube of aluminum (density 2.70 g.cm^{-3} has a volume of 0.200 cm^3. It is known that 27.0 g of aluminum contains 6.02×10^{23} atoms. How many aluminium atoms are contained in the cube?

(A) $N = 1.22 \times 10^{22}$ atoms (B) $N = 0.54 \times 10^{22}$ atoms

(C) $N = 1.22 \times 10^{23}$ atoms (D) $N = 0.8333 \times 10^{22}$ atoms

70. A block of mass 1.6 kg is attached to a horizontal spring that has a force constant of 1000 N/m, as shown in figure. The spring is compressed 2.0 cm and is then released from rest. Calculate the speed of the block as it passes through the equilibrium position x = 0 if the surface is frictionless.



(A) 0.5 cm/s (B) 0.39 m/s (C) 0.1521 m/s (D) 0.5 m/s

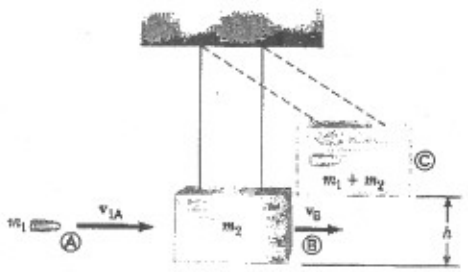
71. The potential energy associated with the force between two neutral atoms in a molecule can be modeled by the Lennard-Jones potential energy function

$$U(x)=4\in\left[\left(\frac{\sigma}{x}\right)^{12}-\left(\frac{\sigma}{x}\right)^{6}\right]$$

where x is the separation of the atoms. The function $U(x)$ contains two parameters σ and $\in$ that are determined from experiments. Sample values for the interaction between two atoms in a molecule are $\sigma=0.263$ nm and $\in=1.51\times10^{-22}$ J. Find the equilibrium distance between the two atoms of the molecule.

(A) $x_0=2.95$ nm (B) $x_0=2.95$ Å (C) $x_0=0.295$ nm (D) $x_0=29.5$ Å

72. The ballistic pendulum (see Figure) is an apparatus used to measure the speed of a fast-moving projectile, suchas a bullet. A bullet of mass m_1 is fired into a large block of wood of mass m_2 suspended from some light wires. The bullet embeds in the block, and the entire system swings through a height h. Determine the speed of the bullet.



(A) $v=\left(\frac{m_1+m_2}{m_2}\right)\sqrt{2gh}$ (B) $v=\left(\frac{m_1}{m_1+m_2}\right)\sqrt{2gh}$

(C) $v=\left(\frac{m_1-m_2}{m_2}\right)\sqrt{2gh}$ (D) $v=\left(\frac{m_1}{m_1-m_2}\right)\sqrt{2gh}$

73. Three particles of masses $m_1=m_2=1.0$ kg and $m_3=2.0$ kg are located on a plane. The coordinates of the masses are respectively (1, 0), (2, 0) and (0, 2) for m_1, m_2, and m_3. Calculate the center of mass (x, y) of this three-particle system.

(A) (1.0, 1.0) (B) (1.0, 0.75) (C) (0.75, 0.75) (D) (0.75, 1.0)

74. All fluids are

(A) Gases (B) Liquids (C) Gases or liquids (D) Transparent

75. Which of the following statement is false?

(A) Heat supplied to a thermodynamic system is a state variable

(B) Gibbs free energy can be obtained through Legendre transformation of internal energy function

(C) The change in entropy is zero for a reversible adiabatic process

(D) Pressure and temperature are intensive thermodynamic variables

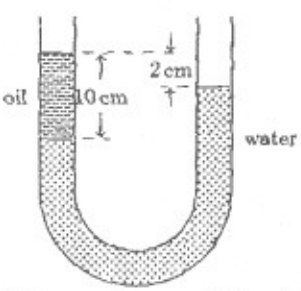
76. Which of the following statement is true?
(A) The efficiency of a Carnot engine is 100%
(B) Carnot engine is not a perfect or ideal engine.
(C) The internal energy of an ideal gas is a function of pressure and temperature.
(D) For a cyclic process, the change in internal energy is not zero.

77. How much heat must be absorbed by ice of mass 720 g at –10°C to take to water at 15°C? [Given data: heat of fusion is 333 kJ/kg; specific heat of ice at –10° is 2220 J/(kg.K).
(A) 300 kJ (B) 45.25 kJ (C) 239.8 kJ (D) 15.98 kJ

78. A Carnot engine operates between the temperatures 850 K and 300 K. Each cycle of the engine takes 0.25 sec and performs 1200 J of work in each cycle. Calculate the net entropy change of the working substance for one cycle of operation of the engine.
(A) $+4.36\ JK^{-1}$ (B) $+2.18\ JK^{-1}$ (C) $-2.18\ JK^{-1}$ (D) Zero

79. Suppose that 1.00kg of water at 0°C is mixed with an equal mass of water at 100°C. After equilibrium is reached, the mixture has a uniform temperature of 50.0°C. What is the change in entropy of the system? (Heat capacity of water is 4.186 J / (kg. K).
(A) $\Delta S = 704\ JK^{-1}$ (B) $\Delta S = 102\ JK^{-1}$
(C) $\Delta S = 602\ JK^{-1}$ (D) $\Delta S = 1306\ JK^{-1}$

80. The density of water is 1.0 g cm^3. The density of oil in the shown in the figure is



(A) 0.20 g cm^3 (B) 0.80 g cm^3 (C) 1.0 g cm^3 (D) 1.3 g cm^3

81. A uniform ladder of length l rests against a smooth, vertical wall (see Fig). If the mass of the ladder is m and the coefficient of static friction between the ladder and the ground is $\mu_s = 0.40$, find the minimum angle θ_{min} at which the ladder does not slip.

(A) $\theta_s = \frac{1}{2}\tan^{-1}\frac{1}{\mu_s}$ (B) $\theta_s = 39^\circ$ (C) $\theta_s = \sin^{-1}(2\mu_s)$ (D) $\theta_s = 51^\circ$

82. The size of nitrogen molecule is 2 Å. Assuming that nitrogen gas is an ideal gas, calculate the mean free path of nitrogen gas at 1 atm and 293 K.

(A) 2.25×10^{-7} m (B) 2.25×10^{-6} m (C) 3.4×10^{-9} m (D) 225 Å

83. An ideal gas has molar specific heat C_p at constant pressure. When the temperature of n moles is increased by ΔT the increase in the internal energy is

(A) $nC_p \Delta T$ (B) $n(C_p + R)\Delta T$

(C) $n(C_p - R)\Delta T$ (D) $n(2C_p + R)\Delta T$

84. Monatomic, diatomic, and polyatomic ideal gases each undergo slow adiabatic expansions from the same initial volume and the same initial pressure to the same final volume. The magnitude of the work done by the environment on the gas

(A) is greatest for the polyatomic gas

(B) is greatest for the diatomic gas

(C) is greatest for the monatomic gas

(D) is the same only for the diatomic and polyatomic gases

85. Consider a gas containing N molecules whose individual speeds are $v_1, v_2, v_3, \ldots v_N$. The r.m.s speed of these molecules is

(A) $\frac{1}{N}\sqrt{v_1^2 + v_2^2 + v_3^2 + \ldots v_N^2}$ (B) $\frac{1}{N}\sqrt{v_1 + v_2 + v_3 + \ldots v_N}$

(C) $\frac{\sqrt{v_1^2 + v_2^2 + v_3^2 + \ldots v_N^2}}{N-1}$ (D) $\frac{\sqrt{v_1^2 + v_2^2 + v_3^2 + \ldots v_N^2}}{N}$

86. For forming a single nucleus of He from two deuterium nuclei, the amount of energy released is

(A) 24 MeV (B) 200 MeV (C) 5000 eV (D) 0.001 eV

87. The important condition to be fulfilled for atom bomb is

(A) the collision of fast neutrons on a nucleus.

(B) the reaction of critical mass nuclei.

(C) the formation of compound nucleus.

(D) the formation of critical mass of product nuclei.

88. In Compton effect, the difference in the wavelength of two scattered X- rays increases with

(A) the angle of scattering

(B) the incident energy of X-rays

(C) the atomic number of element which scatters them.

(D) the wavelength of incident X-rays

89. The energy difference between the spin-up and spin down states of a proton in a magnetic field of 1000 Tesla is

(A) 1.761×10^{-5} eV (B) 1.761×10^{-6} eV

(C) 1.761×10^{-7} eV (D) 1.761×10^{-8} eV

90. The binding energy of a neon isotope $^{20}Ne_{10}$ is 160.647 MeV. The atomic mass is

(A) 18.882 u (B) 19.992 u (C) 16.662 u (D) 15.552 u

91. The helium isotope $^{6}He_{2}$ is unstable. What kind of decay would this isotope emit?

(A) negative beta decay (B) positive beta decay

(C) alpha decay (D) all of the above

92. A piece of a very old wood was found to have a ^{14}C activity of 13 disintegrations per minute per gram of its carbon content. The ^{14}C activity of living wood is 16 disintegrations per minute per gram. The age of the old wood is

(A) 17 years (B) 170 years (C) 1700 years (D) 17000 years

93. The atomic ratio of uranium isotopes ^{238}U and ^{234}U in a mineral sample is found to be 1.8×10^{4}. The half life of ^{234}U is 2.5×10^{5} years. The half life of ^{238}U is

(A) 1.5×10^{9} years (B) 2.5×10^{9} years

(C) 3.5×10^{9} years (D) 4.5×10^{9} years

94. Two point charges $q_1 = 1$ mC and $q_2 = -2$ mC are located respectively at $(3,2,-1)$ and $(-1,-1,4)$. What is the electric force on a 10 mC charge located at $(0,3,1)$?

(A) $F = (-6.507i - 3.817j + 7.506k) \times 10^{-3}\, N$

(B) $F = (-6.507i - 3.817j + 7.506k) \times 10^{-6}\, N$

(C) $F = (-6.507i + 3.817j + 7.506k) \times 10^{-3}\, N$

(D) $F = 0\, N$

95. Which of the following relations is *always* true?

(A) $\nabla \cdot E = \frac{\rho}{\epsilon_0}$ (B) $\nabla \cdot B = 0$

(C) $\nabla \times B = \mu_0 J + \mu_0 \epsilon_0 \frac{\partial E}{\partial t}$ (D) $\nabla \cdot J = 0$

96. The electric field $E = (3x^2 + y)i + xj\,kV/m$ exists in a certain region of space. Calculate the work done in moving a $-2\mu C$ charge from (0, 5, 0) to (2, –1, 0) along the path $y = 5 - 3x$

(A) 0.12 J (B) 1.2 J (C) 0.012 J (D) 0.0012 J

97. When a steady potential difference is applied across the ends of a conducting wire

(A) All electrons move with a constant velocity.

(B) There will be an average constant velocity for all electrons.

(C) All electrons move with a constant acceleration.

(D) There will be a non-zero constant acceleration for each electron.

98. A rectangular block of iron has dimensions $(1.2 \times 1.2 \times 15)$ cm. If the resistivity of iron is $\rho = 9.68 \times 10^{-8}\ \Omega.m$, calculate the resistance of the iron bar. [Assume that the voltage will be applied across the square face of the iron bar].

(A) 10 $m\Omega$ (B) 0.1 $\mu\Omega$ (C) 100 $\mu\Omega$ (D) 6.5 $\mu\Omega$

99. A uniform magnetic field $|B| = 1.2$ mT is directed vertically upward in a chamber. A proton with kinetic energy 5.3 MeV enters the chamber, moving horizontally from south to north. Calculate the initial acceleration of the proton. (Mass of proton = 1.67×10^{-27} kg).

(A) $|a| = 3.7 \times 10^{12}\ ms^{-2}$ (B) $|a| = 6.1 \times 10^{-15}\ ms^{-2}$

(C) $|a| = 3.2 \times 10^{7}\ ms^{-2}$ (D) $|a| = 6.1 \times 10^{7}\ ms^{-2}$

100. A steady current i flows in a circular loop of radius R. The magnetic field at the center of the loop is

(A) Zero (B) $\frac{\mu_0 i}{2R}$ (C) $\frac{\mu_0 i}{4\pi R}$ (D) $\frac{\mu_0 i}{2\pi R}$
