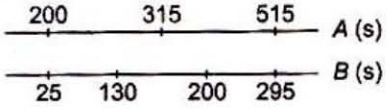
1. How far must you travel in degrees of latitude until your watch must be reset by 2 h ?
   (a) 15° (b) 30°
   (c) 45° (d) 60°

2. Two digital clocks A and B run at different rates and do not have simultaneous readings of zero as shown in the figure. If two events are 800 s apart on clock A, how far apart in second are they on clock B ?



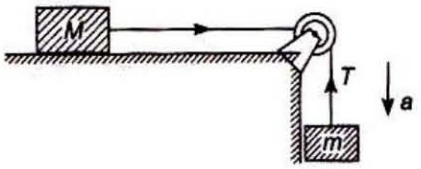
   (a) 795 (b) 350
   (c) 815 (d) 660

3. A man walks for 2 s at speed of 2.5 m/s and then runs for 4 s at a speed of 3.5 m/s. What is the average speed ?
   (a) 3.05 m/s (b) 2.75 m/s
   (c) 3.16 m/s (d) 3.25 m/s

4. A car is travelling at 72 km/h and is 20 m from a barrier when the driver puts on the brakes. The car hits the barrier 2 s later. What is the magnitude of the constant deceleration ?
   (a) 7.2 m/s^2 (b) 10 m/s^2
   (c) 36 m/s^2 (d) 15 m/s^2

5. Two boys are standing at the ends A and B of a ground where $AB = a$. The boy at B starts running in a direction perpendicular to AB with velocity v_1. The boy at A starts running simultaneously with velocity v and catches the other boy in a time t, where t is
   (a) $\frac{a}{\sqrt{v^2 + v_1^2}}$ (b) $\sqrt{\frac{a^2}{v^2 - v_1^2}}$
   (c) $\frac{a}{v - v_1}$ (d) $\frac{a}{v + v_1}$

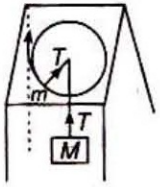
6. Two blocks of masses M and m are connected by a string passing over a pulley as shown in the figure. The downward acceleration of the block with mass m is



   (a) $\frac{M}{(m + M)g}$ (b) $\frac{mg}{(m + M)}$
   (c) $\frac{(m + M)}{mg}$ (d) $\frac{(m + M)}{Mg}$

7. A 80 kg person is parachuting and is experiencing a downward acceleration of 2.8 m/s^2. The mass of the parachute is 5 kg. The upward force on the open parachute is (Take $g = 9.8\ m/s^2$)
   (a) 595 N (b) 675 N
   (c) 456 N (d) 925 N

8. A particle of mass m is rotating in a horizontal circle of radius R and is attached to a hanging mass M as shown in the figure. The speed of rotation required by the mass m to keep M steady is



   (a) $\sqrt{\frac{mgR}{M}}$ (b) $\sqrt{\frac{MgR}{m}}$
   (c) $\sqrt{\frac{mg}{MR}}$ (d) $\sqrt{\frac{mR}{Mg}}$

9. A force of 1200 N acts on a 0.5 kg steel ball as a result of collision lasting 25 ms. If the force is in a direction opposite to the initial velocity of 14 m/s, then the final speed of the steel ball would be
   (a) 24 m/s (b) 35 m/s
   (c) 12 m/s (d) 46 m/s

10. A 1.5 kg ball drops vertically on a floor hitting with a speed of 25 m/s. It rebounds with an initial speed of 15 m/s. If the ball was in contact for only 0.03 s, the force exerted on the floor by the ball is

(a) 2000 N (b) 3000 N
(c) 3500 N (d) 4000 N

11. A thin uniform circular disc of mass m and radius R is rotating in a horizontal plane about an axis passing through its centre and perpendicular to the plane with an angular velocity ω. Another disc of same dimensions but of mass $\frac{1}{4}m$ is placed gently on the first disc co-axially. The angular velocity of the system is

(a) $\sqrt{2}\,\omega$ (b) $\frac{4}{5}\omega$
(c) $\frac{3}{4}\omega$ (d) $\frac{1}{3}\omega$

12. What is the magnitude of torque acting on a particle moving in the xy-plane about the origin if its angular momentum is $4.0\sqrt{t}$ kg-m^2/s ?

(a) $8t^{3/2}$ (b) $4.0/\sqrt{t}$
(c) $2.0/\sqrt{t}$ (d) $3/2\sqrt{t}$

13. An asteroid of mass m is approaching earth, initially at a distance of 10 R_e with speed v_i. It hits the earth with a speed v_f (R_e and M_e are radius and mass of earth), then

(a) $v_f^2 = v_i^2 + \frac{2Gm}{M_eR}\left(1 - \frac{1}{10}\right)$

(b) $v_f^2 = v_i^2 + \frac{2GM_e}{R_e}\left(1 + \frac{1}{10}\right)$

(c) $v_f^2 = v_i^2 + \frac{2GM_e}{R_e}\left(1 - \frac{1}{10}\right)$

(d) $v_f^2 = v_i^2 + \frac{2Gm}{R_e}\left(1 - \frac{1}{10}\right)$

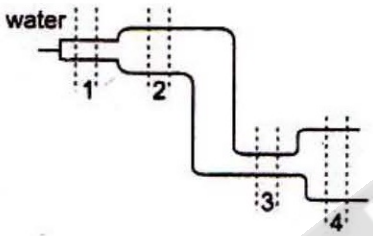
14. A rocket is sent vertically up with a velocity v less than the escape velocity from the earth. Taking M and R as the mass and radius of earth, the maximum height h attained by the rocket is given by the following expression

(a) $v^2R^2/(2GR - Mv)$
(b) $v^2R^2/(2GM + v^2R)$
(c) $v^2R^2/(2GM - v^2R)$
(d) $v^2R^2/(2Gv + RM)$

15. An iceberg is floating in water. The density of ice in the iceberg is 917 kg/m^3 and the density of water is 1024 kg/m^3. What percentage fraction of the iceberg would be visible ?

(a) 5% (b) 10%
(c) 12% (d) 8%

16. Water is flowing smoothly through a pipe as shown in the figure. Rank the four numbered sections of the pipe according to the water pressure p, greatest first



(a) $p_1 > p_3 > p_2 > p_4$
(b) $p_3 > p_4 > p_2 > p_1$
(c) $p_4 > p_3 > p_2 > p_1$
(d) $p_4 > p_1 > p_2 > p_3$

17. A particle is undergoing a one dimensional simple harmonic oscillation of amplitude X_m about the origin on X-axis with time period T and is at $-X_m$ at $t = 0$ s. What is the position of the particle after a time interval $t = 3.15T$?

(a) Between $-X_m$ and O
(b) Between O and $+X_m$
(c) At the origin
(d) At $+X_m$

18. Two springs of the same force constant k are joined in series to a block of mass m. What is the frequency of oscillation of the block ?

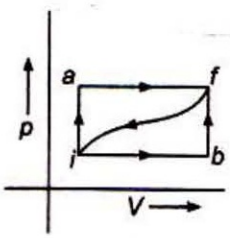
(a) $f = \frac{1}{2\pi}\sqrt{\frac{2k}{m}}$ (b) $f = \frac{1}{2\pi}\sqrt{\frac{k}{2m}}$

(c) $f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$ (d) $f = \frac{1}{\pi}\sqrt{\frac{k}{m}}$

19. A whistle of frequency 540 Hz is moving in a horizontal circle of radius 60 cm at an angular speed of 15 rad/s. The lowest and highest frequencies heard by a listener a long distance away with respect to the centre of the circle is

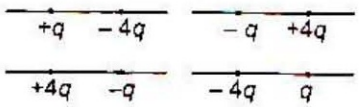
(a) 520 Hz and 560 Hz
(b) 500 Hz and 580 Hz
(c) 526 and 555 Hz
(d) 515 Hz and 565 Hz

20. When a system is taken from a state i to f along the path iaf (as shown in the figure). $Q = 50$ cal and $W = 20$ cal; along path ibf, $Q = 36$ cal



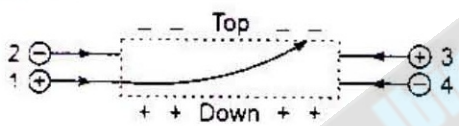
(i) What is W along path ibf ?
(ii) If $W = 13$ cal for path fi, what is Q for the path fi ?
(iii) Take $E_{int,i} = 10$ cal then what is $E_{int,f}$?
a) 30, 20 40, cal
b) 6, – 43, 40 cal
c) 10, – 20, 30, cal
d) 15, 35, 25 cal

The figure shows four situations in which charges as indicated ($q > 0$) are fixed on an axis. In which situation is there a point to the left of the charges where an electron would be in equilibrium ?



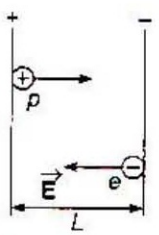
a) 1 and 2 (b) 2 and 4
c) 3 and 4 (d) 1 and 3

The figure shows the path of a positively charged particle 1 through a rectangular region of uniform electric field as shown in the figure. What is the direction of electric field and the direction of deflection of particles 2, 3 and 4 ?



a) Top, down, top, down
b) Top, down, down, top
c) Down, top, top, down
d) Down, top, down, down

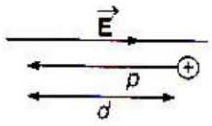
Two parallel copper plates as shown in the figure are L distance apart and have a uniform electric field E as shown. An electron is released from the negative plate and at the same time a proton is released from the positive plate. The distance from the + ve plate when they cross each other is



a) $\dfrac{L}{1+\dfrac{m_e}{m_p}}$ (b) $\dfrac{L}{1-\dfrac{m_e}{m_p}}$

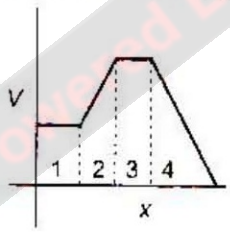
c) $\dfrac{L}{1-\dfrac{m_p}{m_e}}$ (d) $\dfrac{L}{1+\dfrac{m_e}{m_p}}$

24. In the figure, a proton moves a distance d in a uniform electric field $\vec{E}$ as shown is the figure. Does the electric field do a positive or negative work on the proton ? Does the electric potential energy of the proton increase or decrease ?



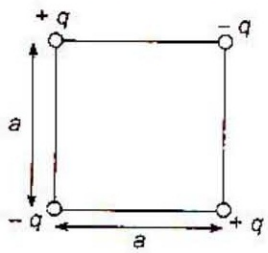
(a) Negative, increase
(b) Positive, decrease
(c) Negative, increase
(d) Positive, increase

25. The figure shows electric potential V as a function of x. Rank the four regions according to the magnitude of x-component of the electric field E within them, greatest first.



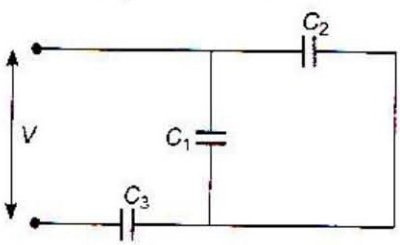
(a) $E_4 > E_2 > E_3 > E_1$
(b) $E_4 > E_2 > E_1 = E_3$
(c) $E_1 > E_2 > E_3 > E_4$
(d) $E_1 > E_3 > E_2 > E_4$

26. Work required to set up the four charge configuration (as shown in the figure) is



(a) $-0.21q^2/\varepsilon_0 a$ (b) $-1.29q^2/\varepsilon_0 a$
(c) $-1.41q^2/\varepsilon_0 a$ (d) $+2.82q^2/\varepsilon_0 a$

27. Three capacitors C_1, C_2 and C_3 are connected as shown in the figure to a battery of V volt. If the capacitor C_3 breaks down electrically the



change in total charge on the combination of capacitors is

(a) $(C_1 + C_2)\,V[1 - C_3/(C_1 + C_2 + C_3)]$

(b) $(C_1 + C_2)\,V[1 - (C_1 + C_2)/(C_1 + C_2 + C_3)]$

(c) $(C_1 + C_2)\,V[1 + C_3/(C_1 + C_2 + C_3)]$

(d) $(C_1 + C_2)\,V[1 + C_2/(C_1 + C_2 + C_3)]$

28. A battery has an emf of 15 V and internal resistance of 1 Ω. Is the terminal to terminal potential difference less than, equal to or greater than 15 V, if the current in the battery is (1) from negative to positive terminal, (2) from positive to negative terminal and (3) zero current ?

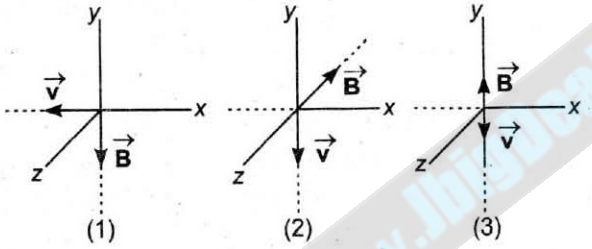
(a) Less, greater, equal

(b) Less, less, equal

(c) Greater, greater, equal

(d) Greater, less, equal

29. The figure shows three situations when an electron with velocity $\vec{\mathbf{v}}$ travels through a uniform magnetic field $\vec{\mathbf{B}}$. In each case, what is the direction of magnetic force on the electron ?



(a) + ve z-axis, − ve x-axis, + ve y-axis

(b) − ve z-axis, − ve x-axis and zero

(c) + ve z-axis, + ve y-axis and zero

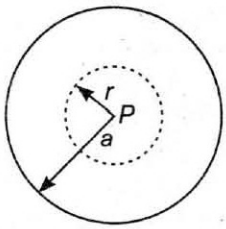
(d) − ve z-axis, + ve x-axis and zero

30. A charged particle of mass m and charge q enters a region of uniform magnetic field $\vec{\mathbf{B}}$ perpendicular to its velocity $\vec{\mathbf{v}}$. The particle initially at rest was accelerated by a potential difference V (volt) before it entered the region of magnetic field. What is the diameter of the circular path followed by the charged particle in the region of magnetic field ?

(a) $\frac{2}{B}\sqrt{\frac{mV}{q}}$ (b) $\frac{2}{B}\sqrt{\frac{2mV}{q}}$

(c) $B\sqrt{\frac{2mV}{q}}$ (d) $\frac{B}{q}\sqrt{\frac{2mV}{B}}$

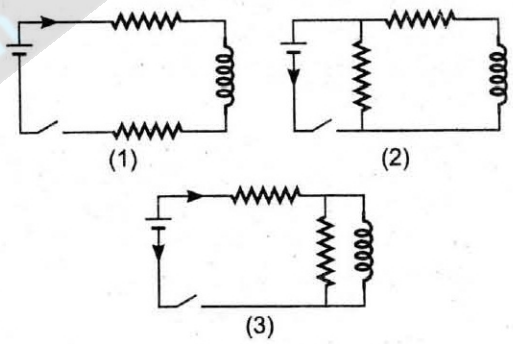
31. The figure shows the cross-section of a long cylindrical conductor of radius a carrying a uniformly distributed current I. The magnetic field due to current at P is



(a) $\frac{\mu_0 Ir}{(2\pi a^2)}$ (b) $\frac{\mu_0 Ir^2}{(2\pi a)}$

(c) $\frac{\mu_0 Ia}{(2\pi r^2)}$ (d) $\frac{\mu_0 Ia^2}{(\pi r^2)}$

32. The figure shows three circuits with identical batteries, inductors and resistances. Rank the currents according to the currents through the battery just after the switch is closed, greatest first



(a) $i_2 > i_3 > i_1$ (b) $i_2 > i_1 > i_3$

(c) $i_1 > i_2 > i_3$ (d) $i_1 > i_3 > i_2$

33. An inductance L and a resistance R are connected in series with a battery of emf ε. The maximum rate at which the energy is stored in the magnetic field is

(a) $\frac{\varepsilon^2}{4R}$ (b) $\frac{\varepsilon^2}{2R}$

(c) $\frac{2R}{\varepsilon}$ (d) $\frac{4R}{\varepsilon}$

34. What direct current will produce the same amount of thermal energy in a resistance $R = 2\Omega$ as an alternating current that a peak value of 4.24 A and frequency 50 Hz ?

(a) 3 A (b) 2 A

(c) 5 A (d) 4 A

35. A ray of light is incident on the surface of a glass plate of thickness t. If the angle of incidence θ is small, the emerging ray would be displaced sideways by an amount
(Take μ = refractive index of glass)
(a) $\frac{t\theta\mu}{(\mu+1)}$ (b) $\frac{t\theta(\mu-1)}{\mu}$
(c) $\frac{t\theta\mu}{(\mu-1)}$ (d) $\frac{t\theta(\mu+1)}{\mu}$

36. A parallel beam of light is incident on a solid transparent sphere of a material of refractive index μ. If a point image is produced at the back of the sphere, the refractive index of the material of sphere is
(a) 2.5 (b) 1.5
(c) 1.25 (d) 2.0

37. The wavelength of a certain colour in air is 600 nm. What is the wavelength and speed of this colour in glass of refractive index 1.5 ?
(a) 500 nm and 2×10^{10} cm/s
(b) 400 nm and 2×10^{8} m/s
(c) 300 nm and 3×10^{9} cm/s
(d) 700 nm and 1.5×10^{8} m/s

38. An electron and a neutron can have same (1) kinetic energy, (2) momentum and (3) speed. Which particle has the shorter de-Broglie wavelength ?
(a) Neutron, same, neutron
(b) Neutron, electron, same
(c) Electron, same, neutron
(d) Electron, neutron, electron

39. What is the maximum wavelength of light emitted in Lyman series by hydrogen atom ?
(a) 691 nm (b) 550 nm
(c) 380 nm (d) 122 nm

40. In a *p-n* junction diode acting as a half-wave rectifier, which of the following statements is not true ?
(a) The average output voltage over a cycle is non-zero
(b) The drift current depends on biasing
(c) The depletion zone decreases in forward biasing
(d) The diffusion current increases due to forward biasing

Answer – Key

1. b	2. d	3. c	4. b	5. b	6. b	7. a	8. b	9. d	10. a
11. b	12. c	13. c	14. c	15. b	16. a	17. b	18. b	19. c	20. a
21. a	22. a	23. c	24. a	25. b	26. a	27. a	28. d	29. b	30. b
31. a	32. a	33. a	34. a	35. b	36. d	37. b	38. a	39. d	40. d