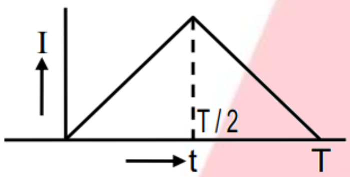
Physics

SECTION – A

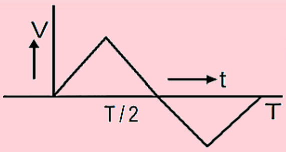
1. A balloon with mass 'm' is descending down with an acceleration 'a' (where a < g). How much mass should be removed from it so that it starts moving up with an acceleration 'a'? (Assume that it's volume does not change)

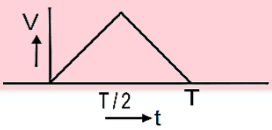
(1) $\frac{2ma}{g+a}$
(2) $\frac{2ma}{g-a}$
(3) $\frac{ma}{g+a}$
(4) $\frac{ma}{g-a}$

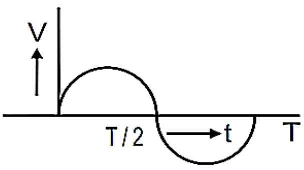
2. The current (I) in the inductor is varying with time according to the plot shown in figure.

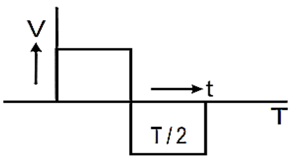


Which one of the following is the correct variation voltage with time in the coil?

(1) 

(2) 

(3) 

(4) 

3. The motion of a particle along a straight line is described by equation $x = 8 + 12t - t^3$ where x is in meter and t in second. The retardation of the particle when its velocity becomes zero is:

(1) $6\,ms^{-2}$
(2) $12\,ms^{-2}$
(3) $24\,ms^{-2}$
(4) zero

4. A stone fall freely under gravity. It covers distances $h_1\, h_2$ and h_3 in the first 5 seconds, the next 5 seconds and the next 5 seconds respectively. The relation between $h_1\, h_2$ *and* h_3 is:

(1) $h_1 = h_2 = h_3$
(2) $h_1 = 2h_2 = 3h_3$
(3) $h_1 = \frac{h_2}{3} = \frac{h_3}{5}$
(4) $h_2 = 3h_1 = h_3$

5. What is the dimension of electric flux

(1) $[ML^3T^{-3}A^{-1}]$
(2) $[ML^2T^{-3}A^{-1}]$
(3) $[ML^1T^{-3}A^{-1}]$
(4) $[ML^1T^{-2}A^{-1}]$

6. A stone is dropped from a height h. It hits the ground with a certain momentum P. If the same stone is dropped from a height 100% more than the previous height, the momentum when it hits the ground will change by:

(1) 68%
(2) 41%
(3) 200%
(4) 100%

7. The potential energy of a particle in a force field is: $U = \frac{A}{r^2} - \frac{B}{r}$

Where A and B are positive constants and r is the distance of particle form the center of the field. For stable equilibrium, the distance of the particle is:

(1) A/B
(2) B/A
(3) B/2A
(4) 2A/B

8. During an adiabatic process, the pressure of a gas is found to be proportional to the cube of its temperature. The ratio of $\frac{C_p}{C_V}$ for the gas is:

(1) $\frac{3}{2}$
(2) $\frac{4}{3}$
(3) 2
(4) $\frac{5}{3}$

9. A man of 50kg mass is standing in a gravity free space at a height of 10m above the floor. He throws a stone of 0.5kg mass downward with a speed 2m/s. When the stone reaches the floor, the distance of the man above the floor will be:

(1) 20 m
(2) 9.9 m
(3) 10.1 m
(4) 10 m

10. The instantaneous angular position of a point on a rotating wheel is given by the equation $\theta(t) = 2t^3 - 6t^2$ rad/s. The torque on the wheel becomes zero at:

(1) $t = 1s$
(2) $t = 0.5\ s$
(3) $t = 0.25\ s$
(4) $t = 2s$

11. A planet moving along an elliptical orbit is closest to the sun at a distance r_1 and farthest away at a distance r_2. If V_1 and V_2 are the linear velocities at these points respectively, then the ratio $\frac{V_1}{V_2}$ is:

(1) $(r_1/r_2)^2$
(2) r_2/r_1
(3) $(r_2/r_1)^2$
(4) r_1/r_2

12. The equation of a simple harmonic wave is given by

$y = 3\sin\frac{\pi}{2}(50t - x)$

Where x and y are in meters and t is in seconds. The ratio of maximum particle velocity to the wave velocity is:

(1) $\frac{3}{2}\pi$
(2) 3π
(3) $\frac{2}{3}\pi$
(4) 2π

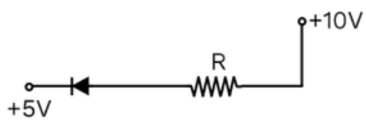
13. Certain quantity of water cools from $70°C$ to $60°\ C$ in the first 5 minutes and to $54°C$ in the next 5 minutes. The temperature of the surrounding is:

(1) $42°C$
(2) $10°C$
(3) $45°C$
(4) $20°C$

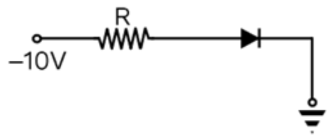
14. When a biconvex lens of glass having refractive index 1.47 is dipped in a liquid, it acts as a plane sheet of glass. This implies that the liquid must have refractive index

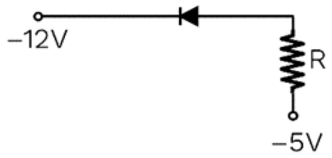
(1) Less than that of glass
(2) Equal to that of glass
(3) Less than one
(4) Greater than that of glass

15. In the following figure, the diodes which are forward biased are:



(a)

(b) 

(c) 

(d) 

(1) only (a) and (b) are forward bias
(2) only (b) and (d) are forward bias
(3) only (a) and (c) are forward bias
(4) only (b) and (c) are forward bias

16. A charge Q is enclosed by a Gaussian spherical surface of radius R. If the radius is doubled, then the outward electric flux will:
(1) increase four times
(2) be reduced to half
(3) remain the same
(4) be doubled

17. Two metallic spheres of radii 1 cm and 3 cm are given charges of $-1 \times 10^{-2}\ C$ and 5×10^{-2} C, respectively. If these are connected by a conducting wire, the final charge on the bigger sphere is:
(1) $2 \times 10^{-2} C$
(2) $3 \times 10^{-2} C$
(3) $4 \times 10^{-2} C$
(4) $1 \times 10^{-2} C$

18. If voltage across a bulb rated 220 Volt-100 Watt drops by 2.5% of its rated value, the percentage of the rated value by which the power would decreases is:
(1) 20%
(2) 2.5%
(3) 5%
(4) 10%

19. The internal resistance of a 2.1 V cell which give a current of 0.2 A through a resistance of 10Ω is:
(1) 0.5Ω
(2) 0.8Ω
(3) 1.0Ω
(4) 0.2Ω

20. If $|\vec{A} \times \vec{B}| = \sqrt{3}\, \vec{A}.\vec{B}$, then the value of $|\vec{A} + \vec{B}|$ is
(1) $\left(A^2 + B^2 + \frac{AB}{\sqrt{3}}\right)^{1/2}$
(2) $A + B$
(3) $\left(A^2 + B^2 + \sqrt{3}\, AB\right)^{1/2}$
(4) $(A^2 + B^2 + AB)^{1/2}$

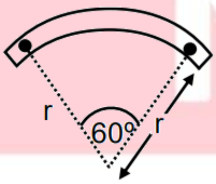
21. Two parallel metal plates having charges $+Q$ and $-Q$ face each other with a certain separation between them. If the plates are now dipped in kerosene oil tank, the electric field between the plates will:
(1) Increases
(2) Decrease
(3) Remain same
(4) Become zero

22. A car of mass 1000 kg negotiates a banked curve of radius 90 m on a frictionless road. If the banking angle is 45°, the speed of the car is:
(1) $5\ ms^{-1}$
(2) $10\ ms^{-1}$
(3) $20\ ms^{-1}$
(4) $30\ ms^{-1}$

23. **Assertion: -** Parallel current in wires attracts each other due to magnetic force.
Reason: - Two electron beams moving parallel to each other repels to each other due to electric force.
(1) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(2) Both Assertion and Reason are true but Reason is not correct explanation of Assertion.
(3) Assertion is true but Reason is false.
(4) Both Assertion and Reason are false.

24. Two similar coils of radius R are lying concentrically with their planes at right angles to each other. The currents flowing in them are I and 2I respectively. The resultant magnetic field induction at the center will be:
(1) $\frac{\mu_0 I}{2R}$
(2) $\frac{\mu_0 I}{2R}$
(3) $\frac{\sqrt{5}\mu_0 I}{2R}$
(4) $\frac{3\mu_0 I}{2R}$

25. A bar magnet of length l and magnetic dipole moment M is bent in the form of an arc as shown in figure. The new magnetic dipole moment will be:



(1) 3 M/π
(2) 2 M/π
(3) $M/2$
(4) M

26. In an ac circuit an alternation voltage $e = 200\sqrt{2}$ sin 100 t volts is connected to a capacitor of capacity 1 μF. The r.m.s value of the current in the circuit is:
(1) 20 mA
(2) 10 mA
(3) 100 mA
(4) 200 mA

27. Match the following

	Column-I	Column-II
a	To increase current in a series RL cut	(p). Decrease R
b	To increase phase angle in a series RL circuit	(q). Increase R
c	To decrease the phase angle in series RL circuit	(r). Increase frequency
d	To decrease the current RL circuit in a series	(s). Connect C in series

(1) $A \to P,S; B \to P,R; C \to Q; D \to Q,R$
(2) $A \to Q,S; B \to P,R; C \to Q; D \to Q,R$
(3) $A \to Q,S; B \to P,R; C \to P; D \to Q,S$
(4) $A \to P,R; B \to Q,S; C \to P; D \to Q,S$

28. The electric field associated with an EM wave in vacuum is given by $\vec{E} = 40$ cos $(kz - 6 \times 10^8 t)\hat{\imath}$, where E, z and t are in volt/m, meter and seconds respectively. The value of wave vector k is:
(1) 6 m^{-1}
(2) 3 m^{-1}
(3) 2 m^{-1}
(4) 0.5 m^{-1}

29. The velocity of water flowing in a non-uniform tube is 20 cm/s at a point where the tube radius is 0.2 cm. The velocity at another point, where the radius is 0.1 cm is:
(1) 80 cm/s
(2) 40 cm/s
(3) 20 cm/s
(4) 5 cm/s

30. The magnifying power of a telescope is 9. When it is adjusted for parallel rays the distance between the objective and eyepiece is 20 cm. The focal lengths of lenses are:
(1) 11 cm, 9 cm
(2) 10 cm, 10 cm
(3) 15 cm, 5 cm
(4) 18 cm, 2 cm

31. A parallel beam of fast-moving electrons is incident normally on a narrow slit. A fluorescent screen is placed at a large distance from the slit. If the speed of the electrons is increased, which of the following statements is correct?
(1) Diffraction pattern is not observed on
the screen in the case of electrons
(2) The angular width of the central maximum of the diffraction pattern will increase
(3) The angular width of the central maximum will decrease
(4) The angular width of the central maximum will be unaffected

32. The wavelength of the first line of Lyman series for hydrogen atom is equal to that of the second line of Balmer series for a hydrogen like ion. The atomic number Z of hydrogen like ion is:
(1) 3
(2) 4
(3) 1
(4) 2

33. In the Davisson and Germer experiment, the velocity of electrons emitted from the electron gun can be increased by:
(1) increasing the potential difference between the anode and filament
(2) increasing the filament current
(3) decreasing the filament current
(4) decreasing the potential difference between the anode and filament

34. The binding energy per nucleon of ${}_{3}^{7}\text{Li}$ and ${}_{3}^{7}\text{He}$ nuclei are 5.60 MeV and 7.06 MeV, respectively. In the nuclear reaction ${}_{3}^{7}\text{Li} + {}_{1}^{1}\text{H} \rightarrow 2\,{}_{2}^{4}\text{He} + \text{Q}$, the value of energy Q released is:
(1) 19.6 MeV
(2) -2.4 MeV
(3) 8.4 MeV
(4) 17.3 MeV

35. A wire of length $2m$ is bent into a circular loop. When a current of $1A$ is passed through the loop, then the magnetic moment of the loop is
(1) $2\pi\ Am^2$
(2) $\frac{\pi}{2} Am^2$
(3) $\frac{\pi}{4} Am^2$
(4) $\frac{1}{\pi} Am^2$

SECTION – B

36. **Assertion:** Electrons in the atom are held due to coulomb forces,
Reason: The atom is stable only because the centripetal force due to Colomb's law is balanced by the centrifugal force.
(1) Both assertion and reason are true and reason is the correct explanation of the assertion
(2) Both assertion and reason are true but reason is not the correct explanation of the assertion.
(3) Assertion is true but reason is false
(4) Both assertion and reason are false.

37. The stopping potential for a metallic surface illuminated by monochromatic light of wavelength λ is $4V_0$ while for another light of wavelength 3λ it is V_0. Threshold wavelength of the surface for photoelectric emission is
(1) λ
(2) 3λ
(3) 9λ

(4) $\frac{\lambda}{9}$

38. An object thrown vertically upwards from the top of a building reaches the ground in time t_1. It takes time t_2 if thrown vertically downward with same speed. If the time of free fall is t, when released from the rest, then

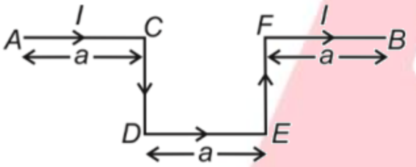
(1) $t = \sqrt{t_1 t_2}$

(2) $t = \sqrt{t_1^2 + t_2^2}$

(3) $t = \frac{t_1+t_2}{2}$

(4) $t = \frac{t_1 t_2}{t_1+t_2}$

39. A uniform magnetic field $\vec{B} = B_0\hat{k}$ exists in a region. A current carrying wire is placed in x-y plane as shown in the figure. The force acting on the wire AB, if each section of wire is of length 'a', will be



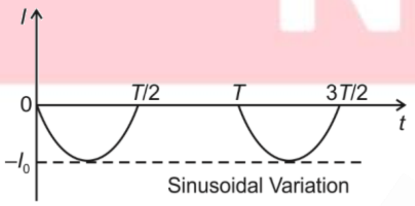
(1) $5IaB_0\hat{j}$

(2) $-5IaB_0\hat{j}$

(3) $-3IaB_0\hat{k}$

(4) $-3IaB_0\hat{j}$

40. The r.m.s value of current over a complete cycle for a current variation shown by the graph is



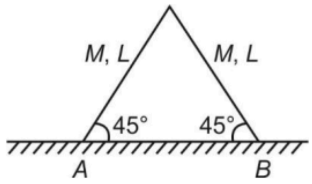
(1) I_0

(2) $\frac{I_0}{\sqrt{2}}$

(3) $\frac{I_0}{2}$

(4) Zero

41. Two identical ladders are arranged as shown in the figure. Mass of each ladder is M and length is L. The system is in equilibrium. The magnitude of frictional force on each ladder is



(1) Mg

(2) $\frac{Mg}{2}$

(3) $\frac{Mg}{3}$

(4) $\frac{Mg}{4}$

42. A force $\vec{F} = (\hat{\imath} + 2\hat{\jmath} + 3\hat{k})N$ displaces a particle from position $\vec{r}_1 = (\hat{\imath} + \hat{\jmath} + \hat{k})m$ to position $\vec{r}_2 = (\hat{\jmath} + \hat{k})m$.

The work done by the force in doing so is

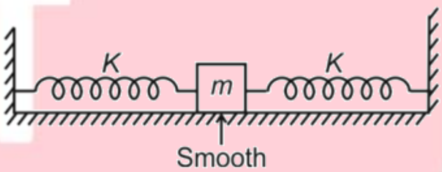
(1) $-1\,J$

(2) $-2\,J$

(3) $1\,J$

(4) $3\,J$

43. A mass *m*, connected with two identical springs, has oscillation frequency f. If one of the springs is removed, then the new oscillation frequency of the mass will be



(1) f

(2) $\sqrt{2}f$

(3) $\frac{f}{2}$

(4) $\frac{f}{\sqrt{2}}$

44. Two identical bodies of mass *m*, initially at rest, are large distance apart. They approach each other due to gravitational interaction. The relative speed of

approach at the instant when they are at distance 'a' apart is

(1) $2\sqrt{\frac{Gm}{a}}$

(2) $\sqrt{\frac{2Gm}{a}}$

(3) $\sqrt{\frac{Gm}{2a}}$

(4) $\sqrt{\frac{5Ga}{m}}$

45. A liquid drop of radius R breaks into 27 tiny drops each of radius r. If the surface tension of liquid is T, then gain in surface energy is
(1) $8\pi R^2T$
(2) $12\pi R^2T$
(3) $28\pi R^2T$
(4) $16\pi R^2T$

46. A Carnot engine working between 300 K and 600 K has a work output 600 J per cycle. The amount of heat energy supplied to the engine from the source in each cycle is
(1) 1200 J
(2) 600 J
(3) 3600 J
(4) 2400 J

47. When boron is added to silicon semiconductor, then the resulting material is
(1) conductor
(2) n – type semiconductor
(3) p – typed semiconductor
(4) insulator

48. A train moves towards a stationary observer with speed 32 m/s. The train sounds whistle and its frequency perceived by observer is f_1. If train speed is reduced to 16 m/s. the frequency perceived is f_2.
The ratio of $\frac{f_1}{f_2}$ is (take speed of sound 320 m/s)
(1) $\frac{18}{19}$
(2) $\frac{19}{18}$
(3) $\frac{17}{18}$
(4) $\frac{18}{17}$

49. A long solenoid with 40 turns per cm carries a current of 1 A. The magnetic energy stored per unit volume is ____ J/m^3
(1) $3.2\,\pi$
(2) $32\,\pi$
(3) $1.6\,\pi$
(4) $6.4\,\pi$

50. The condition of minimum deviation is achieved in an equilateral prism kept on the prism table of a spectrometer. If the angle of incidence is 53°, the angle of deviation is
(1) 40°
(2) 46°
(3) 53°
(4) 43°