Physics Code-O

41. The displacement of an object attached to a spring and executing simple harmonic motion is given by $x = 2 \times 10^{-2} \cos \pi t$ metres. The time at which the maximum speed first occurs is
(1) 0.5 s (2) 0.75 s
(3) 0.125 s (4) 0.25 s

Sol. **(1)**
$x = 2 \times 10^{-2} \cos \pi t$
$v = -0.02\pi \sin \pi t$
v is maximum at $t = \frac{1}{2} = 0.5\,\text{sec}$

42. In an a.c. circuit the voltage applied is $E = E_0 \sin \omega t$. The resulting current in the circuit is $I = I_0 \sin\left(\omega t - \frac{\pi}{2}\right)$. The power consumption in the circuit is given by
(1) $P = \frac{E_0 I_0}{\sqrt{2}}$ (2) P = zero
(3) $P = \frac{E_0 I_0}{2}$ (4) $P \sqrt{2} E_0 I_0$

Sol. **(2)**
$\cos \phi = 0$
So power = 0

43. An electric charge 10^{-3} μC is placed at the origin (0, 0) of X–Y co-ordinate system. Two points A and B are situated at $(\sqrt{2}, \sqrt{2})$ and (2, 0) respectively. The potential difference between the points A and B will be
(1) 9 volt (2) zero
(3) 2 volt (4) 4.5 volt

Sol. **(2)**
Both points are at same distance from the charge

44. A battery is used to charge a parallel plate capacitor till the potential difference between the plates becomes equal to the electromotive force of the battery. The ratio of the energy stored in the capacitor and the work done by the battery will be
(1) 1 (2) 2
(3) $\frac{1}{4}$ (4) $\frac{1}{2}$

Sol. **(4)**
$$\frac{\frac{1}{2}qv}{qv} = \frac{1}{2}$$

45. An ideal coil of 10H is connected in series with a resistance of 5 Ω and a battery of 5V. 2 second after the connection is made the current flowing in amperes in the circuit is
(1) (1 – e) (2) e
(3) e^{-1} (4) $(1 - e^{-1})$

Sol. **(4)**

$i = i_0\left(1 - e^{\frac{Rt}{L}}\right)$

$= \left(1 - e^{-1}\right)$

46. A long straight wire of radius 'a' caries a steady current i. The current is uniformly distributed across its cross section. The ratio of the magnetic field at $\frac{a}{2}$ and 2a is

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

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

Sol. **(3)**

$B2\pi\frac{a}{2} = \mu_0\frac{i}{\pi a^2}\left(\frac{\pi a^2}{4}\right)$

$B_1 = \frac{\mu_0 i}{4\pi a}$ ...(i)

$B_2 2\pi(2a) = \mu_0 i$

$B_2 = \frac{\mu_0 i}{4\pi a}$ ...(ii)

$\frac{B_1}{B_2} = 1$

47. A current I flows along the length of an infinitely long, straight, thin walled pipe. Then
(1) the magnetic field is zero only on the axis of the pipe
(2) the magnetic field is different at different points inside the pipe
(3) the magnetic field at any point inside the pipe is zero
(4) the magnetic field at all points inside the pipe is the same, but not zero

Sol. **(3)**
Use Ampere's law

48. If M_O is the mass of an oxygen isotope ${}_8O^{17}$, M_p and M_N are the masses of a proton and a neutron respectively, the nuclear binding energy of the isotope is

(1) $(M_O - 8M_P)C^2$ (2) $(M_O - 8M_P - 9M_N)C^2$

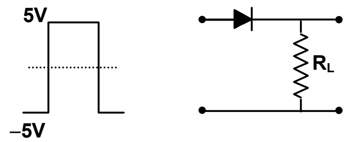
(3) M_OC^2 (4) $(M_O - 17M_N)C^2$

Sol. **(2)**
Binding energy = $(M_O - 8M_P - 9\,M_N)C^2$

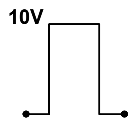
49. In gamma ray emission from a nucleus
(1) both the neutron number and the proton number change
(2) there is no change in the proton number and the neutron number.
(3) only the neutron number changes
(4) only the proton number changes

Sol. **(2)**

50. If in a p-n junction diode, a square input signal of 10V is applied as shown



Then the output signal across R_L will be

(1)


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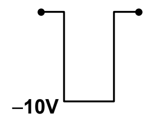

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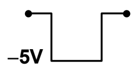

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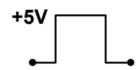


Sol. **(4)**

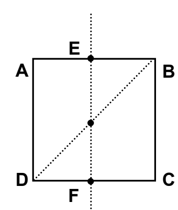
51. Photon of frequency ν has a momentum associated with it. If c is the velocity of light, the momentum is
(1) ν/c
(2) $h\nu c$
(3) $h\nu/c^2$
(4) $h\nu/c$

Sol. **(4)**
$$P = \frac{h}{\lambda} = \frac{h\nu}{c}$$

52. The velocity of a particle is $v = v_0 + gt + ft^2$. If its position is x = 0 at t = 0, then its displacement after unit time (t = 1) is
(1) $v_0 + 2g + 3f$
(2) $v_0 + g/2 + f/3$
(3) $v_0 + g + f$
(4) $v_0 + g/2 + f$

Sol. **(2)**
$$\int_0^x dx = \int_0^1 (V_0 + gt + ft^2)dt$$
$$x = v_0 + g\left(\frac{1}{2}\right) + f\left(\frac{1}{3}\right)$$

53. For the given uniform square lamina ABCD, whose centre is O,
(1) $\sqrt{2}I_{AC} = I_{EF}$
(2) $I_{AD} = 3I_{EF}$
(3) $I_{AC} = I_{EF}$
(4) $I_{AC} = \sqrt{2}I_{EF}$



Sol. **(3)**
$I_{AC} = I_{EF}$ (from $\perp^{rd}$ axis theorem)

54. A point mass oscillates along the x-axis according to the law $x = x_0 \cos(\omega t - \pi/4)$. If the acceleration of the particle is written as
$a = A\cos(\omega t + \delta)$
(1) $A = x_0$, $\delta = -\pi/4$
(2) $A = x_0\omega^2$, $\delta = -\pi/4$
(3) $A = x_0\omega^2$, $\delta = -\pi/4$
(4) $A = x_0\omega^2$, $\delta = 3\pi/4$

Sol. **(4)**

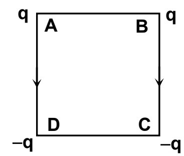
$v = -x_0\omega \sin(\omega t - \pi/4)$

$a = -x_0\omega^2 \cos\left(\omega t + \pi - \frac{\pi}{4}\right)$

$a = A\cos(\omega t + \delta)$

$A = x_0\omega^2; \quad \delta = \frac{3\pi}{4}$

55. Charges are placed on the vertices of a square as shown. Let $\vec{E}$ be the electric field and V the potential at the centre. If the charges on A and B are interchanged with those on D and C respectively, then



(1) $\vec{E}$ remains unchanged, V changes
(2) Both $\vec{E}$ and V change
(3) $\vec{E}$ and V remains unchanged
(4) $\vec{E}$ changes, V remains unchanged

Sol. **(4)**

As $\vec{E}$ is a vector quantity

56. The half-life period of a radio-active element X is same as the mean life time of another radio-active element Y. Initially they have the same number of atoms. Then
(1) X will decay faster than Y
(2) Y will decay faster than X
(3) X and Y have same decay rate initially
(4) X and Y decay at same rate always.

Sol. **(2)**

$t_{1/2} = \frac{\ln 2}{\lambda_x}$

$\tau_{mean} = \frac{1}{\lambda_y}; \ \frac{dN}{dt} = -\lambda N$

$\frac{\ln 2}{\lambda_x} = \frac{1}{\lambda_y} \Rightarrow \lambda_x = \lambda_y(0.6932) \Rightarrow \lambda_y > \lambda_x$

57. A Carnot engine, having an efficiency of $\eta = 1/10$ as heat engine, is used as a refrigerator. If the work done on the system is 10 J, the amount of energy absorbed from the reservoir at lower temperature is
(1) 99 J
(2) 90 J
(3) 1 J
(4) 100 J

Sol. **(2)**

$W = Q_2\left(\frac{T_1}{T_2} - 1\right) \qquad \eta = 1 - \frac{T_2}{T_1}$

$10 = Q_2\left(\frac{10}{9} - 1\right) \qquad \frac{1}{10} = 1 - \frac{T_2}{T_1} \Rightarrow \frac{T_2}{T_1} = 1 - \frac{1}{10} = \frac{9}{10}$

$10 = Q_2\left(\frac{1}{9}\right) \qquad \Rightarrow \frac{T_1}{T_2} = \frac{10}{9}$

$Q_2 = 90$ J

58. Carbon, silicon and germanium have four valence electrons each. At room temperature which one of the following statements is most appropriate?
(1) The number of free conduction electrons is significant in C but small in Si and Ge.
(2) The number of free conduction electrons is negligible small in all the three.
(3) The number of free electrons for conduction is significant in all the three.
(4) The number of free electrons for conduction is significant only in Si and Ge but small in C.

Sol. **(4)**

59. A charged particle with charge q enters a region of constant, uniform and mutually orthogonal fields $\vec{E}$ and $\vec{B}$ with a velocity $\vec{v}$ perpendicular to both $\vec{E}$ and $\vec{B}$, and comes out without any change in magnitude or direction of $\vec{v}$. Then
(1) $\vec{v} = \vec{E} \times \vec{B}/B^2$
(2) $\vec{v} = \vec{B} \times \vec{E}/B^2$
(3) $\vec{v} = \vec{E} \times \vec{B}/E^2$
(4) $\vec{v} = \vec{B} \times \vec{E}/E^2$

Sol. **(1)**
$\vec{v} \times \vec{B} = -\vec{E}$

60. The potential at a point x (measured in μm) due to some charges situated on the x-axis is given by V(x) = 20/(x^2 – 4) Volts. The electric field E at x = 4 μm is given by
(1) 5/3 Volt/μm and in the –ve x direction
(2) 5/3 Volt/μm and in the +ve x direction.
(3) 10/9 Volt /μm and in the –ve x direction
(4) 10/9 Volt/μm and in the +ve x direction.

Sol. **(4)**
$$V_x = \frac{20}{x^2 - 4}$$
$$E = -\frac{dV}{dx} = \frac{20}{(x^2-4)^2}(2x - 0) \;= \frac{160}{144} = \frac{10}{9}$$

61. Which of the following transitions in hydrogen atoms emit photons of highest frequency?
(1) n = 2 to n = 6
(2) n = 6 to n = 2
(3) n = 2 to n = 1
(4) n = 1 to n = 2

Sol. **(3)**
$$h\nu = Rhcz^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

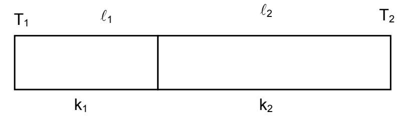
62. A block of mass 'm' is connected to another block of mass 'M' by a spring (massless) of spring constant 'k'. The blocks are kept on a smooth horizontal plane. Initially the blocks are at rest and the spring is unstretched. Then a constant force 'F' starts acting on the block of mass 'M' to pull it. Find the force on the block of mass 'm'
(1) $\frac{mF}{M}$
(2) $\frac{(M+m)F}{m}$
(3) $\frac{mF}{(m+M)}$
(4) $\frac{MF}{(m+M)}$

Sol. **(3)**
$$Kx = ma = \frac{mF}{m+M}$$

63. Two lenses of power -15 D and + 5D are in contact with each other. The focal length of the combination is
(1) –20 cm
(2) – 10 cm
(3) + 20 cm
(4) + 10 cm

Sol. **(2)**
$P = P_1 + P_2 = -10$
$$f = \frac{1}{P} \Rightarrow -0.1 \text{ m} \Rightarrow -10 \text{ cm}$$

64. One end of a thermally insulated rod is kept at a temperature T_1 and the other at T_2. The rod is composed of two sections of lengths ℓ_1 and ℓ_2 and thermal conductivities k_1 and k_2 respectively. The temperature at the interface of the two sections is



(1) $(k_2\ell_2T_1 + k_1\ell_1T_2) / (k_1\ell_1 + k_2\ell_2)$
(2) $(k_2\ell_1 T_1 + k_1\ell_1T_2) / (k_2\ell_1 + k_1\ell_2)$
(3) $(k_1\ell_2 T_1 + k_2\ell_1T_2) / (k_1\ell_2 + k_2\ell_1)$
(4) $(k_1\ell_1 T_1 + k_2\ell_2T_2) / (k_1\ell_1 + k_2\ell_2)$

Sol. **(3)**

$$\frac{(T_1 - T)k_1}{\ell_1} = \frac{(T - T_2)k_2}{\ell_2}$$

$$T = \frac{T_1k_1\ell_2 + T_2k_2\ell_1}{k_1\ell_2 + k_2\ell_1}$$

65. A sound absorber attenuates the sound level by 20 dB. The intensity decreases by a factor of
(1) 1000
(2) 10000
(3) 10
(4) 100

Sol. **(4)**

$$B_1 = 10\log\left(\frac{I}{I_0}\right)$$

$$B_2 = \log\left(\frac{I'}{I_0}\right)$$

given $B_2 - B_1 = 20$

$$20 = 10 \log\left(\frac{I'}{I}\right)$$

$$I' = 100I$$

66. If C_p and C_v denote the specific heats of nitrogen per unit mass at constant pressure and constant volume respectively, then
(1) $C_p - C_v = R/28$
(2) $C_p - C_v = R/14$
(3) $C_p - C_v = R$
(4) $C_p - C_v = 28R$

Sol. **(1)**
Mayer Formula

67. A charged particle moves through a magnetic field perpendicular to its direction. Then
(1) the momentum changes but the kinetic energy is constant
(2) both momentum and kinetic energy of the particle are not constant
(3) both, momentum and kinetic energy of the particle are constant
(4) kinetic energy changes but the momentum is constant

Sol. **(1)**

68. Two identical conducting wires AOB and COD are placed at right angles to each other. The wire AOB carries an electric current I_1 and COD carries a current I_2. The magnetic field on a point lying at a distance 'd' from O, in a direction perpendicular to the plane of the wires AOB and COD, will be given by

(1) $\frac{\mu_0}{2\pi}\left(\frac{I_1 + I_2}{d}\right)^{1/2}$
(2) $\frac{\mu_0}{2\pi d}\left(I_1^2 + I_2^2\right)^{1/2}$
(3) $\frac{\mu_0}{2\pi d}\left(I_1 + I_2\right)$
(4) $\frac{\mu_0}{2\pi d}\left(I_1^2 + I_2^2\right)$

Sol. **(2)**

$$\frac{\mu_0 I}{2\pi d}\sqrt{(I_1^2 + I_2^2)}$$

69. The resistance of a wire is 5 ohm at 50°C and 6 ohm at 100°C. The resistance of the wire at 0 °C will be

(1) 2 ohm
(2) 1 ohm
(3) 4 ohm
(4) 3 ohm

Sol. **(3)**

$$\frac{5}{6} = \frac{1+50\alpha}{1+100\alpha}$$

$5 = R_0(1 + \alpha \times 50)$

$R_O = 4$

70. A parallel plate condenser with a dielectric of dielectric constant K between the plates has a capacity C and is charged to a potential V volts. The dielectric slab is slowly removed from between the plates and then reinserted. The net work done by the system in this process is

(1) ½ $(K-1)CV^2$
(2) $CV^2(K-1)/K$
(3) $(K-1)CV^2$
(4) zero

Sol. **(4)**

71. If g_E and g_m are the accelerations due to gravity on the surfaces of the earth and the moon respectively and if Millikan's oil drop experiment could be performed on the two surfaces, one will find the ratio $\frac{\text{electronic charge on the moon}}{\text{electronic charge on the earth}}$ to be

(1) 1
(2) 0
(3) g_E/g_m
(4) g_m/g_E

Sol. **(1)**

72. A circular disc of radius R is removed from a bigger circular disc of radius 2R such that the circumferences of the discs coincide. The centre of mass of the new disc is α/R from the centre of the bigger disc. The value of α is

(1) 1/3
(2) 1/2
(3) 1/6
(4) 1/4

Sol. **(1)**

In this question distance of centre of mass of new disc is αR not $\frac{\alpha}{R}$.

$$-\frac{3M}{4}\alpha R + \frac{M}{4}R = 0$$

$$\Rightarrow \alpha = \frac{1}{3}$$

73. A round uniform body of radius R, mass M and moment of inertia 'I', rolls down (without slipping) an inclined plane making an angle θ with the horizontal. Then its acceleration is

(1) $\dfrac{g\sin\theta}{1+\dfrac{I}{MR^2}}$ (2) $\dfrac{g\sin\theta}{1+\dfrac{MR^2}{I}}$

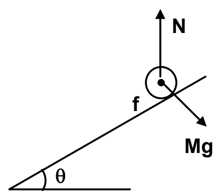
(3) $\dfrac{g\sin\theta}{1-\dfrac{I}{MR^2}}$ (4) $\dfrac{g\sin\theta}{1-\dfrac{MR^2}{I}}$

Sol. **(1)**

Mg sin θ – f = Ma

fR = I $\dfrac{a}{R}$

$\Rightarrow a = \dfrac{g\sin\theta}{\left(1+\dfrac{I}{MR^2}\right)}$



74. Angular momentum of the particle rotating with a central force is constant due to

(1) Constant Force (2) Constant linear momentum.

(3) Zero Torque (4) Constant Torque

Sol. **(3)**

75. A 2 kg block slides on a horizontal floor with a speed of 4 m/s. It strikes a uncompressed spring, and compresses it till the block is motionless. The kinetic friction force is 15 N and spring constant is 10,000. N/m. The spring compresses by

(1) 5.5 cm (2) 2.5 cm

(3) 11.0 cm (4) 8.5 cm

Sol. **(1)**

76. A particle is projected at 60° to the horizontal with a kinetic energy K. The kinetic energy at the highest point is

(1) K (2) Zero

(3) K/2 (4) K/4

Sol. **(4)**

77. In a Young's double slit experiment the intensity at a point where the path difference is $\dfrac{\lambda}{6}$ (λ being the wavelength of the light used) is I. If I_0 denotes the maximum intensity, $\dfrac{I}{I_0}$ is equal to

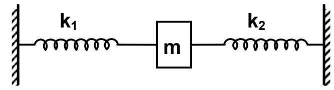
(1) $\dfrac{1}{\sqrt{2}}$ (2) $\dfrac{\sqrt{3}}{2}$

(3) 1/2 (4) 3/4

Sol. **(4)**

$$\frac{I}{I_{max}} = \cos^2\left(\frac{\phi}{2}\right)$$

78. Two springs, of force constants k_1 and k_2, are connected to a mass m as shown. The frequency of oscillation of the mass is f. If both k_1 and k_2 are made four times their original values, the frequency of oscillation becomes



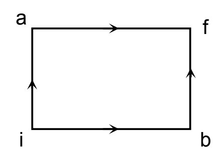
(1) f/2 (2) f/4
(3) 4f (4) 2f

Sol. **(4)**

$$f = \frac{1}{2\pi}\sqrt{\frac{k_1 + k_2}{m}}$$

$$f' = \frac{1}{2\pi}2\sqrt{\frac{k_1 + k_2}{m}} = 2f$$

79. When a system is taken from state i to state f along the path iaf, it is found that Q = 50 cal and W = 20 cal. Along the path' ibf Q = 36 cal. W along the path ibf is



(1) 6 cal (2) 16 cal.
(3) 66 cal. (4) 14 cal.

Sol. **(1)**

80. A particle of mass m executes simple harmonic motion with amplitude 'a' and frequency 'ν'. The average kinetic energy during its motion from the position of equilibrium to the end is

(1) $\pi^2 ma^2 \nu^2$ (2) $\frac{1}{4}\pi^2 ma^2 \nu^2$
(3) $4\pi^2 ma^2 \nu^2$ (4) $2\pi^2 ma^2 \nu^2$

Sol. **(1)**

$$\frac{1}{4}ma^2\omega^2 = \pi^2 f^2 ma^2$$

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