PART : PHYSICS

1. For a transistor in common emitter mode, if the base current is changed from 100 μA to 200 μA, the collector current is changing from 10 mA to 19 mA. Find the current gain (β_{AC})

(1) 100 (2) 95 (3) 90 (4) 110

Ans. (3)

Sol. $\beta_{AC} = \frac{\Delta i_C}{\Delta i_B} = \frac{(19-10)\times10^{-3}}{(200-100)\times10^{-6}} = 90$

2. The equation of the carrier wave is 10 sin (1000πt) and equation of the modulating wave is 5 sin (5πt). The resultant modulated wave will contain which of the following frequencies:

(I) 500 Hz (II) 498 Hz (III) 502 Hz (IV) 496 Hz

(1) Only I (2) Only I, II (3) Only I, II, III (4) I, II, III, IV all

Ans. (3)

Sol. $C(t) = 10\sin(1000\pi t) \Rightarrow \omega_C = 1000\pi = 2\pi f_c$

$f_c = 500$ Hz

$m(t) = 5\sin(4\pi t) \Rightarrow \omega_m = 4\pi = 2\pi f_m$

$f_m = 2$Hz

The frequencies contained in the resultant amplitude modulated wave:-

f_c, $f_c + f_m$, $f_c - f_m$

= 500 Hz, 502 Hz, 496 Hz

3. A particle is projected from ground with initial velocity 150 m/s vertically upwards. Find ratio of velocities of the particle at time t = 3 sec. & t = 5 sec. respectively. ($g = 10\ m/s^2$)

(1) $\frac{3}{5}$ (2) $\frac{6}{5}$ (3) $\frac{2}{5}$ (4) $\frac{4}{5}$

Ans. (2)

Sol. $v = u + at$

$v_1 = 150 - 10 \times 3 = 120$ m/s

$v_2 = 150 - 10 \times 5 = 100$ m/s

$\frac{v_1}{v_2} = \frac{120}{100} = \frac{12}{10} = \frac{6}{5}$

4. Find ratio of de-Broglie wavelength of a proton & an α-particle, when accelerated through a potential difference of 2V & 4V respectively.

(1) 4 : 1 (2) 2 : 1 (3) 3 : 1 (4) 4 : 3

Ans. (1)

Sol. $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mk}} = \frac{h}{\sqrt{2mqV}}$

$\frac{\lambda_\alpha}{\lambda_p} = \sqrt{\frac{m_\alpha}{m_p}\frac{q_\alpha}{q_p}\frac{V_\alpha}{V_p}} = \sqrt{\frac{4}{1}\times\frac{2}{1}\times\frac{4}{2}} = 4$

5. Mass of a planet is 16 times the mass of the earth & radius of the planet is 4 times the radius of the earth find ratio of escape velocity for planet & the earth :

(1) 4 : 1 (2) 2 : 1 (3) 2 : 3 (4) 3 : 4

Ans. (2)

Sol. $v = \sqrt{\frac{2GM}{R}}$

$$\frac{v_p}{v_e} = \sqrt{\frac{M_p}{M_e}\frac{R_e}{R_p}} = \sqrt{16 \times \frac{1}{4}} = 2$$

6. A body of mass 5 kg is in equilibrium under the forces of $F_1 = 10N$, $F_2 = 6N$ & $F_3 = 8N$. Forces F_2 & F_3 are mutually perpendicular. Find acceleration of the body if the force F_1 is removed :

(1) $2m/s^2$ (2) $3m/s^2$ (3) $4m/s^2$ (4) $5m/s^2$

Ans. (1)

Sol. Net force after F_1 is removed

$F_{net} = \sqrt{6^2 + 8^2} = 10$

so $a = \frac{10}{5} = 2m/s^2$

7. A particle is performing SHM. If at any moment displacement of the particle form mean position is half of the amplitude then find the ratio of its potential energy & kinetic energy

(1) 1 : 3 (2) 1 : 2 (3) 2 : 3 (4) 3 : 4

Ans. (1)

Sol. $U = \frac{1}{2} m\omega^2 x^2$ & $k = \frac{1}{2} m\omega^2 (A^2 - x^2)$

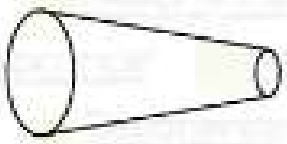
$$\text{so } \frac{U}{K} = \frac{x^2}{A^2 - x^2} = \frac{(A/2)^2}{A^2 - (A/2)^2} = \frac{1/4}{1 - 1/4} = \frac{1}{4} \times \frac{4}{3} = \frac{1}{3}$$

8. Glycerine of density 1.25×10^3 kg/m^3 is flowing in conical shaped horizontal pipe. Cross-sectional area of the pipe at its both the ends is 10 cm^2 & 5 cm^2 respectively. Pressure difference at both the ends is 3 N/m^2. Find rate of flow of the liquid in the pipe :

(1) 4×10^{-5} m^3/s (2) 2×10^{-5} m^3/s (3) 5×10^{-5} m^3/s (4) 6×10^{-5} m^3/s

Ans. (1)

Sol.



$A_1V_1 = A_2V_2$

$\Rightarrow 10V_1 = 5V_2 \quad \Rightarrow V_2 = 2V_1$

and $P_1 + \frac{1}{2}\rho V_1^2 = P_2 + \frac{1}{2}\rho V_2^2$

$\Rightarrow P_1 - P_2 = \frac{1}{2}\rho(V_2^2 - V_1^2)$

$\Rightarrow 3 = \frac{1}{2} \times 1.25 \times 10^3 \times 3 V_1^2$

$\Rightarrow V_1^2 = \frac{200}{125 \times 10^3} = \frac{1}{625}$

$\Rightarrow V_1 = \frac{1}{25}$ m/s

So rate of flow $Q = A_1V_1 = 10 \times 10^{-4} \times \frac{1}{25} = 4 \times 10^{-5}$ m³/s

9. Warm water is placed in a surrounding of temperature 20°C. If the time taken to fall the temperature of water from 80 °C to 60°C is 5 minutes, then find the time taken to fall the temperature of water from 60 °C to 40°C

(1) 5 min. (2) 8.3 min. (3) 10.3 min. (4) 12.p3 min.

Ans. (2)

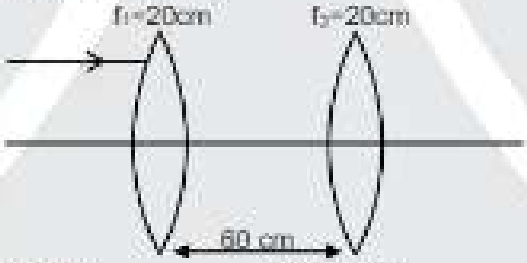
Sol. $\frac{dQ_{loss}}{dt} = -ms\frac{dt}{dt} = KA(T - T_0)$

$ms\frac{(80-60)}{5\text{min.}} = KA\left(\frac{80+60}{2} - 20\right)$

$ms\frac{(60-40)}{\Delta t} = KA\left(\frac{60+40}{2} - 20\right)$

$\frac{\Delta t}{5} = \frac{50}{30} \Rightarrow \Delta t = \frac{25}{3} = 8.3$ minutes

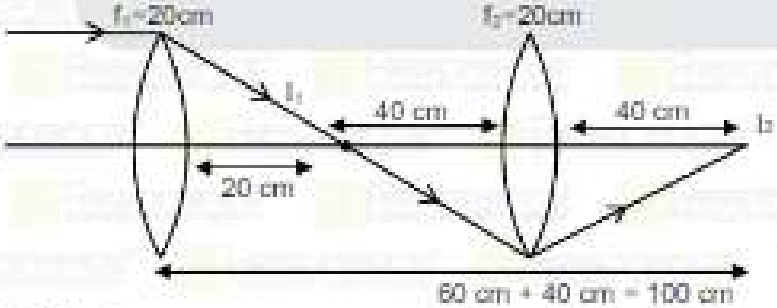
10. Locate the final image position from fist lens.



(1) 60 cm (2) 60 cm (3) 100 cm (4) 120 cm

Ans. (3)

Sol.



For 2nd lens

$\frac{1}{v} - \frac{1}{4} = \frac{1}{f}$; $\frac{1}{v} - \frac{1}{40} = \frac{1}{20}$; $\frac{1}{v} = \frac{1}{20} + \frac{1}{40}$; $v = 40$ cm

∴ Distance of final image from first lens = (60 + 40) cm = 100 cm

11. A wire has resistance 160 Ω. Its length is reduced to one fourth of its initial value keeping the volume constant. Find final resistance of the wire.

(1) 20 Ω (2) 10 Ω (3) 2 Ω (4) 5 Ω

Ans. (2)

Sol. $R = \frac{\rho \ell}{A} = 160\Omega$

$R' = \frac{\rho \frac{\ell}{4}}{4A} = \frac{\rho \ell}{16A}$ {v = /A = constant}

$\Rightarrow R' = \frac{R}{16} = \frac{160}{16} = 10\Omega$

12. A conducting circular ring is placed in a uniform and constant magnetic field of 0.4 Tesla which is perpendicular to the plane. The ring is expended such that its radius is increasing at constant rate of 1mm/sec. Find induced emf in the loop when its radius becomes 2 cm in μ volt

(1) 20 (2) 30 (3) 40 (4) 50

Ans. (4)

Sol. $\phi = BA = (0.4)\pi r^2$

$emf = \frac{d\phi}{dt} \times (0.4\pi)(2r\frac{dr}{dt})$

$emf = 0.8\pi r\left(\frac{dr}{dt}\right)$

$emf = 0.8 \times 3.14 \times (2 \times 10^{-2})(1 \times 10^{-3})$

$emf = 50\mu$ volt

13. **Assertion :** An engine is working between the steam point and ice point of water. Its efficiency (η) must be $\eta \leq 26.8\%$.

Reason : The Carnot cycle is the maximum efficient cycle working between the given temperature of the source and sink.

(1) Both A and R are correct but R is not the correct explanation of A

(2) A is correct but R is not correct

(3) A is not correct but R is correct

(4) Both A and R are correct and R is the correct explanation of A

Ans. (4)

Sol. Carrot efficiency

$\eta = 1 - \frac{T_{less}}{T_{more}} = 1 - \frac{273}{373} = 26.8\ \%$

so for all cycles working between 100°C and 0°C

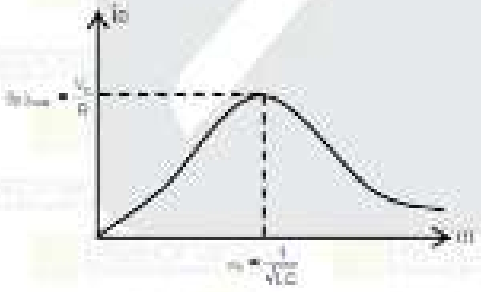
$\eta = \leq 26.8\%$

Both assertion and reason are true and the reason is the correct explainer of the assertion

14. **Statement-1** : An electric dipole is placed in a closed surface then total flux passing through the closed surface is zero.
Statement-2: Both the charges of an electric dipole have same magnitude with opposite sign or nature
(1) Statement-1 is true, Statement-2 is false
(2) Statement-1 is false, Statement-2 is true
(3) Both Statement-1 and Statement-2 are true
(4) Both Statement-1 and Statement-2 are false
Ans. **(3)**
Sol. Both the statements are correct.

15. A truck of mass 500 kg is moving with constant velocity 80 km/h coefficient of rolling friction between the road & the truck is 0.04. Find work done by engine of the truck to maintain the velocity 80 km/h for 4 km distance.
(1) 4×10^5J (2) 8×10^5J (3) 3×10^3J (4) 4×10^5J
Ans. **(2)**
Sol. The value of rolling friction
$F = \mu mg = 0.04 \times 500 \times 10 = 200N$
So, $W = Fs = 200 \times 4 \times 10^3 = 8 \times 10^5$ J

16. **Statement (1):** In L-C-R alternating circuit, if the frequency of the source is increased, the amplitude of current initially increases and then decreases.
Statement (2): Power factor of L-C-R circuit is always 1.
(1) Statement-1 is true, Statement-2 is false
(2) Statement-1 is false, Statement-2 is true
(3) Both Statement-1 and Statement-2 are true
(4) Both Statement-1 and Statement-2 are false
Ans. **(1)**
Sol.



Power factor
$\cos\phi = \frac{R}{|Z|}$ need not be always 1.

17. Match the column according to the correct dimension.

(i) Stress	(p) $M^0L^2T^{-1}$
(ii) Angular speed	(q) $M^1L^2T^{-1}$
(iii) Angular momentum	(r) $M^1L^0T^{-2}$
(iv) Spring constant	(s) $M^1L^{-1}T^{-2}$

(1) (i) – q, (ii) – r, (iii) – p, (iv) – s
(2) (i) – r, (ii) – s, (iii) – p, (iv) – q
(3) (i) – q, (ii) – p, (iii) – r, (iv) – s
(4) (i) – s, (ii) – p, (iii) – q, (iv) – r

Ans. (4)

Sol. Stress $= \frac{\text{Force}}{\text{Area}} = \frac{M^1L^1T^{-2}}{L^2} = M^1L^{-1}T^{-2}$

Angular speed $\omega = \frac{d\theta}{dt} = \frac{1}{T} = M^0L^0T^{-1}$

Angular momentum $L = mvr = (M)(L/T)(L) = M^1L^2T^{-1}$

spring constant $K = \frac{F}{x} = \frac{M^1T^1T^{-2}}{L^1} = M^1L^0T^{-2}$

18. Two satellites A and B are revolving in same orbit around the earth. Mass of A is two times that of the B. Which of the quantity is same for both the satellites :

(1) Potential Energy (2) Kinetic Energy (3) Speed (4) Total Energy

Ans. (3)

Sol. $V = \sqrt{\frac{GM}{r}}$ (Same for both the satellites)

19. Photons of energy 12.75 eV is incident on a sample of H-atoms which are initially in their ground state. Find the number of spectral lines observed in the emission spectrum :

(1) 6 (2) 10 (3) 3 (4) 8

Ans. (1)

Sol. 12.75 eV is the gap between n = 1 and n = 4, so by this much energy, the electrons will be excited to n = 4. In emission spectrum, the number of spectral lines will be :

$$\frac{n(n-1)}{2} = \frac{(4)(4-1)}{2} = 6$$

20. A magnet having a magnetic dipole moment M is placed in two magnetic fields B_1 and B_2 respectively. If it is displaced slightly from the equilibrium position, it oscillates 60 times in 20 second in B_1 and 60 times in 30 second in B_2. Find the ratio of B_1 and B_2.

(1) $\frac{B_1}{B_2} = \frac{9}{4}$ (2) $\frac{B_1}{B_2} = \frac{4}{9}$ (3) $\frac{B_1}{B_2} = \frac{2}{3}$ (4) $\frac{B_1}{B_2} = \frac{3}{2}$

Ans. (1)

Sol. $T = 2\pi\sqrt{\frac{I}{MB}} \propto \frac{1}{\sqrt{B}}$

$T_1 = \frac{20}{60} \propto \frac{1}{\sqrt{B_1}}$

$T_2 = \frac{30}{60} \propto \frac{1}{\sqrt{B_2}} \Rightarrow \frac{B_1}{B_2} = \frac{9}{4}$

21. 64 identical conducting drops each having a potential of 10 m volt, are joined to form a bigger drop. Find the potential of the bigger drop.

(1) 80 m volt (2) 160 m volt (3) 320 m volt (4) 5 m volt

Ans. **(2)**

Sol.

Charge on the bigger drop = nq

Radius of the bigger drop = $n^{1/3}R$

$V \propto \frac{q}{R} = \frac{n}{n^{1/3}} = n^{2/3}$ time = $(64)^{2/3}$ = 16 times

= 16 × 10 m volt = 160 m volt

22. Potential difference across a conducting wire is kept constant. At 0°C the current in the wire is 2A. At 100°C the current in the wire is 1.2A. Find the current in the wire at 50°C :

(1) 1.6A (2) 1.5A (3) 1.25A (4) 1.45A

Ans. **(2)**

Sol. $R_2 = R_1 (1 + \alpha\Delta T)$

let resistance of wire at 0°C is R

So, $2R = 1.2\,R (1 + \alpha\, 100)$

$\Rightarrow \quad \alpha = 1/150$

and $2R = iR (1 + \alpha 50)$

$\Rightarrow \quad 2 = i(1 + 1/150 \times 50) = i(1 + 1/3)$

$\Rightarrow \quad 2 = \frac{4}{3}i \Rightarrow i = 3/2 = 1.5A$

23. A spherical shell rolls without sliding on a horizontal surface. Ratio of its rotational kinetic energy & translatery kinetic energy is x/3. Find value of x.

(1) 2 (2) 1 (3) 4 (4) 5

Ans. **(1)**

Sol. $K_{Tr} = \frac{1}{2}mv$

$K_{rot} = \frac{1}{2}I\omega^2 = \frac{1}{2} \times \frac{2}{3} mR^2 (\frac{V}{R})^2 = 1/3\, mv^2$

So $\frac{K_{rot.}}{K_{Tr.}} = \frac{2}{3}$