PHYSICS

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer:

1. It $I = I_A \sin\omega t + I_B \cos\omega t$, then find rms value of current

(1) $I_{rms} = I_A + I_B$

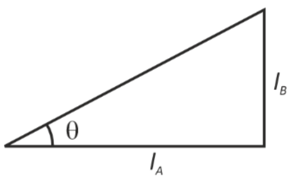
(2) $I_{rms} = \sqrt{I_A^2 + I_B^2}$

(3) $I_{rms} = \sqrt{\dfrac{I_A^2 + I_B^2}{2}}$

(4) $I_{rms} = \dfrac{1}{2}\sqrt{I_A^2 + I_B^2}$

Answer (3)

Sol.



$$I = \sqrt{I_A^2 + I_B^2}\,\sin(\omega t + \theta)$$

$$\tan\theta = \left(\frac{I_B}{I_A}\right)$$

$$\text{as } I_{rms} = \frac{I_0}{\sqrt{2}} \Rightarrow I_{rms} = \sqrt{\frac{I_A^2 + I_B^2}{2}}$$

2. What is relative shift of focal length of a lens when optical power is increased from 0.1 D to 2.5 D

(1) $\dfrac{24}{25}$

(2) $\dfrac{13}{10}$

(3) $\dfrac{21}{25}$

(4) $\dfrac{11}{10}$

Answer (1)

Sol. $f = \dfrac{1}{p}$

So, $f_1 = 10 \text{ m} = \dfrac{1}{p_1}$

And $f_2 = \dfrac{1}{p_2} = \dfrac{10}{25}\text{m}$.

So $\dfrac{|\Delta f|}{f_1} = \dfrac{24}{25}$

3. Satellite A is launched in a circular orbit of radius R. Satellite B is launched in circular orbit of radius $1.03R$. Time period of B is greater than A by approximately

(1) 9% (2) 4.5%

(3) 3% (4) 2.5%

Answer (2)

Sol. $T = 2\pi\sqrt{\dfrac{r^3}{Gm}}$

$$\frac{\Delta T}{T} = \frac{3}{2}\frac{\Delta R}{R}$$

$$\frac{\Delta T}{T}\times 100 = \frac{3}{2}\times\frac{0.03R}{R}\times 100$$

$= 4.5\%$

4. An electron jumps from principle quantum state A to C by releasing photon of wavelength 2000 Å and from state B to C by releasing of photon of wavelength 6000 Å, then final the wavelength of photon for transition from A to B.

(1) 3000 Å (2) 4000 Å

(3) 8000 Å (4) 2000 Å

Answer (1)

Sol. $E_{AC} = E_{AB} + E_{BC}$

$$\frac{\hbar C}{2000\,\text{Å}} = \frac{\hbar C}{\lambda} + \frac{\hbar C}{6000\,\text{Å}} \Rightarrow \frac{3-1}{6000} = \frac{1}{\lambda}$$

$\lambda = 3000\,\text{Å}$

5. An electron of mass m enters in a region of uniform electric field $\vec{E} = -E_0\hat{k}$ at $t = 0$ with an initial velocity $\vec{V} = V_0\hat{i}$. If the de-Broglie wavelength is λ_0 initially, the de-Broglie wavelength at a time t is

(1) $\lambda_0\sqrt{1+\dfrac{m^2V_0^2}{e^2E_0^2t^2}}$

(2) $\lambda_0\sqrt{1+\dfrac{e^2E_0^2t^2}{m^2V_0^2}}$

(3) $\dfrac{\lambda_0}{\sqrt{1+\dfrac{e^2E_0^2t^2}{m^2V_0^2}}}$

(4) $\dfrac{\lambda_0}{\sqrt{1+\dfrac{m^2V_0^2}{e^2E_0^2t^2}}}$

Answer (3)

Sol. $\lambda_0 = \dfrac{h}{mV_0}$ ...(i)

$$\vec{V} = V_0\hat{i} + \frac{(-e)(-E_0\hat{k})}{m}t$$

$$\vec{V} = V_0\hat{i} + \frac{eE_0t\hat{k}}{m}$$

$$|\vec{V}| = \sqrt{V_0^2 + \frac{e^2E_0^2t^2}{m^2}}$$

$$|\vec{P}_f| = \frac{h}{\lambda} = m|\vec{V}|$$

$$\lambda = \frac{h}{m|\vec{V}|}$$

$$= \frac{h}{m\sqrt{V_0^2 + \dfrac{e^2E_0^2t^2}{m^2}}}$$

$$= \frac{h}{mV_0\sqrt{1 + \dfrac{e^2E_0^2t}{m^2V_0^2}}}$$

$$= \frac{\lambda_0}{\sqrt{1 + \dfrac{e^2E_0^2t^2}{m^2V_0^2}}}$$

6. For an ideal mono atomic gas undergoing an isobaric process, the ratio of $\dfrac{\Delta Q}{\Delta U}$ is

(1) $\dfrac{5}{3}$

(2) $\dfrac{7}{5}$

(3) $\dfrac{4}{3}$

(4) $\dfrac{5}{4}$

Answer (1)

Sol. In an isobaric process,

$\Delta Q = nC_p\Delta T$

$\Delta U = nC_v\Delta T$

$\dfrac{\Delta Q}{\Delta U} = \dfrac{C_p}{C_v} = \gamma = \dfrac{5}{3}$ for a monoatomic

7. In a process pressure of the gas is directly proportional to temperature then choose correct option.

A : Process is isochoric.

B : Work done in process is zero.

C : Internal energy increase with increase in temperature.

(1) A and B are correct

(2) A and C are correct

(3) A, B and C are correct

(4) B and C are correct

Answer (3)

Sol. $P \times T$

V is constant

Work = 0

ΔU is positive

8. If the distance two parallel plate of a capacitor is d, A is the area of each plate, and E is the electric field. Find the energy stored in capacitor

(1) $\frac{1}{2}E^2 A\varepsilon_0 d$ (2) $\frac{1}{4}E^2 A\varepsilon_0 d$

(3) $\frac{3}{4}E^2 A\varepsilon_0 d$ (4) $E^2 A\varepsilon_0 d$

Answer (1)

Sol. Δu = Energy density × volume = $\frac{1}{2}\varepsilon_0 E^2 \cdot Ad$

9. In YDSE, lights of wavelength 600 nm and 480 nm are used. What is the minimum order of bright fringe of 480 nm coincides with bright fringe of 600 nm.

(1) 8 (2) 7

(3) 6 (4) 5

Answer (4)

Sol. For 480 nm $w_1 = \frac{480D}{d}$

For 600 nm = $w_2 = \frac{600D}{d}$

So, 5[th] order of 480 nm natcher

Clearly $5\Delta w_1 = 4\Delta w_2$

10. A body of mass m is projected with initial velocity v_0 at 45° with horizontal. Find it's angular momentum at highest point about point of projection.

(1) $\frac{mv_0^3}{4g}$ (2) $\frac{mv_0^3}{4\sqrt{2}g}$

(3) $\frac{mv_0^2}{4\sqrt{2}g}$ (4) $\frac{mv_0}{2\sqrt{2}g}$

Answer (2)

Sol.

$$L = \frac{mv_0}{\sqrt{2}}H$$

$$= \frac{mv_0}{\sqrt{2}} \cdot \frac{v_0^2 \cdot \frac{1}{2}}{2g}$$

$$L = \frac{mv_0^3}{4\sqrt{2}g}$$

11. A Plano convex lens of refractive index 1.5 & radius of curvature of curved surface of 20 cm present in air is having focal length of f_1. There is another Plano convex lens of refractive index of 1.5 & ROC of 30 cm placed in liquid of RI of 1.2 having focal length of f_2 the $\frac{f_1}{f_2}$ is

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

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

Answer (4)

Sol. $\frac{1}{f_1} = (1.5-1)\left\{\frac{1}{R}\right\} = \frac{0.5}{20}$

$$f_1 = \frac{20}{0.5} = 40$$

$$\frac{1}{f_2} = \left(\frac{1.5}{1.2}-1\right)\left(\frac{1}{R}\right) = \frac{0.3}{1.2} \times \frac{1}{30} = \frac{1}{120}$$

$$\frac{f_1}{f_2} = \frac{40}{120} = \frac{1}{3}$$

12. Acceleration of solid cylinder purely rolling an inclined plane of inclination of θ is

(1) $\frac{2}{5}g\sin\theta$ (2) $\frac{3}{2}g\sin\theta$

(3) $\frac{2}{3}g\sin\theta$ (4) $\frac{1}{3}g\sin\theta$

Answer (3)

Sol. $a = \frac{g\sin\theta}{1+\frac{k^2}{r^2}} = \frac{g\sin\theta}{1+\frac{1}{2}} = \frac{2}{3}g\sin\theta$

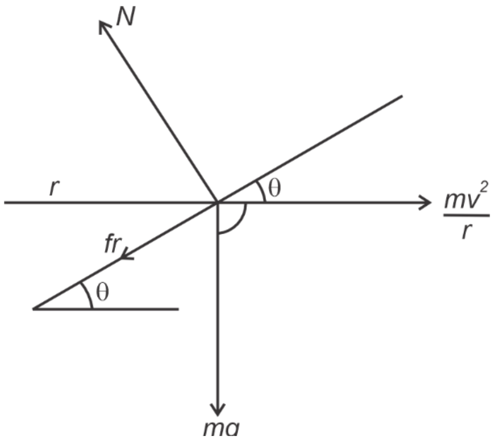
13. Find the maximum possible speed for the given angle of banking 'θ' on a curved road of radius r having coefficient of friction μ.

(1) $v_{max} = \sqrt{\dfrac{gr(\mu + \tan\theta)}{(1 - \mu\tan\theta)}}$ (2) $v_{max} = \sqrt{\dfrac{gr(\mu - \tan\theta)}{(1 - \mu\tan\theta)}}$

(3) $v_{max} = \sqrt{\dfrac{gr(1 + \mu\tan\theta)}{(1 - \mu\tan\theta)}}$ (4) $v_{max} = \sqrt{\dfrac{gr(\mu - \tan\theta)}{(1 + \mu\tan\theta)}}$

Answer (1)

Sol.



$$\Rightarrow \quad N = \frac{mv^2}{r}\sin\theta + mg\cos\theta$$

Also $\dfrac{mv^2}{r}\cos\theta = \mu N + mg\sin\theta$

$$\Rightarrow \quad \frac{mv^2}{r}\cos\theta = \mu\frac{mv^2}{r}\sin\theta + \mu mg\cos\theta + mg\sin\theta$$

$$\Rightarrow \quad v^2\left[\frac{\cos\theta}{r} - \frac{\mu\sin\theta}{r}\right] = g(r\cos\theta + \sin\theta)$$

$$\Rightarrow \quad v = \sqrt{\frac{gr(\sin\theta + \mu\cos\theta)}{(\cos\theta - \mu\sin\theta)}}$$

$$v = \sqrt{\frac{gr(\tan\theta + \mu)}{(1 - \mu\tan\theta)}}$$

14. In a parallel plate capacitor length l and width b are 3 cm and 1 cm respectively. Separation between plates d is 3 μm. By which of the following values capacitance increases by a factor of 10.

(A) $l = 6$ cm, $b = 5$ cm, $d = 3$ μm

(B) $l = 5$ cm, $b = 2$ cm, $d = 1$ μm

(C) $l = 5$ cm, $b = 1$ cm, $d = 30$ μm

(D) $l = 1$ cm, $b = 1$ cm, $d = 30$ μm

(1) A, B (2) A, C

(3) B, C (4) B, C, D

Answer (1)

Sol. $C = \dfrac{A\varepsilon_0}{d}$

$$C = \frac{lb\varepsilon_0}{d}$$

$$C_i = \frac{3\times1}{3}\varepsilon_0 \times 10^2 = 10^2\varepsilon_0$$

15. In SHM given by equation $x = A\sin\omega t$ of time period 2 sec and amplitude 1 cm, ratio of $\dfrac{\text{distance}}{\text{displacement}}$ in first 1.25 sec is

(1) $2\sqrt{2}+1$ (2) $2\sqrt{2}-1$

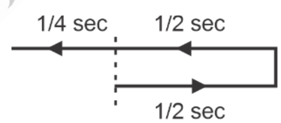
(3) $\dfrac{1}{\sqrt{2}}$ (4) $\dfrac{1}{2\sqrt{2}}$

Answer (1)

Sol. $x = A\sin\dfrac{2\pi}{2} \times 1.25$

$$X = A\sin\frac{5\pi}{4}$$

$$|s| = \frac{A}{\sqrt{2}}$$



$$d = 2A + \frac{A}{\sqrt{2}}$$

$$\frac{d}{|s|} = (2\sqrt{2}+1)$$

16.

17.

18.

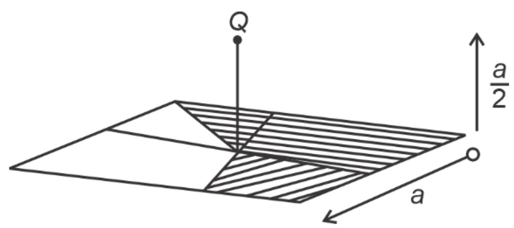
19.

20.

SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. The electric flux through the shaded area of square plate of side a due to point charge placed at distance of $\frac{a}{2}$ from it as shown in figure, is $\frac{NQ}{48\varepsilon_0}$. Then N is



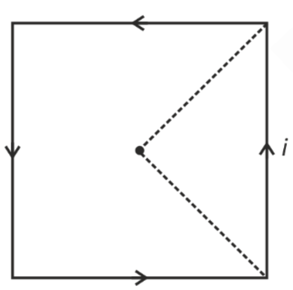
Answer (5)

Sol. $\left(\frac{Q}{6\varepsilon_0}\right)\frac{1}{4}+\left(\frac{Q}{6\varepsilon_0}\right)\frac{1}{4}+\left(\frac{Q}{6\varepsilon_0}\right)\frac{1}{4}\times\frac{1}{2}=\frac{5Q}{48}$

22. In a square loop of side length $\frac{1}{\sqrt{2}}$ m, a current of 5 A is flowing. Find magnetic field at its centre in (μT).

Answer (8)

Sol.



$$B=4\left(\frac{\mu_0 i}{4\pi\frac{1}{2\sqrt{2}}}\right)(\sin 45^\circ+\sin 45^\circ)$$

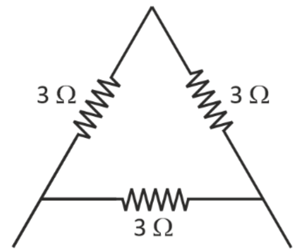
$$=4\left(\frac{4\pi\times10^{-7}\times5}{4\pi}\cdot2\sqrt{2}\sqrt{2}\right)$$

$= 8 \times 10^{-6}$ T

23. A wire of resistance 9 Ω is bent in form of an equilateral triangle. Find equivalent resistance between two vertices of triangle.

Answer (2)

Sol.



$$R_{eq}=3\,||\,6$$

$$R_{eq}=\frac{3\times6}{9}=2\,\Omega$$

24. Work done required to break a drop of radius R to 27 drops of equal radius is 10 J. Then work done to break drop of radius R in 64 drops of equal radii is X J, then X is

Answer (15)

Sol. For 27 $R\to\frac{R}{3}$; for 64 $R\to\frac{R}{4}$

$$\frac{S\left(27\,4\pi\left(\frac{R}{3}\right)^2-4\pi R^2\right)}{S\left(64\,4\pi\left(\frac{R}{4}\right)^2-4\pi R^2\right)}=\frac{10}{x}=\frac{2}{3}$$

X = 15 J

25. A particle moves on a straight line under the influence of a force $F=\alpha+\beta x^2$ where x is the displacement, and β = –12 SI units. If the total work done for a displacement x = 1m is 12 J, then α is _____ SI units.

Answer (16)

Sol. $w=\int_0^1 F_x\,dx$

$$=\int_0^1(\alpha+\beta x^2)dx$$

$$=\alpha+\frac{\beta}{3}$$

$$12=\alpha-\frac{12}{3}$$

α = 16