JUPITER ACADEMY

EXCELLENCE PRUDENCE

JEE Paper -2022

PHYSICS

1. If the separation between the plates of parallel plate capacitor C is halved, its new capacitance will be

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

(3) $4C$ (4) $\frac{C}{4}$

Sol. Answer (2)

$$C = \frac{\epsilon_0 A}{d}$$

New separation is $\frac{d}{2}$

$$C' = \frac{\epsilon_0 A}{\frac{d}{2}} = 2\frac{\epsilon_0 A}{d}$$

$$C' = 2C$$

2. Relationship between adiabatic coefficient (γ) and degree of freedom f is

(1) $\gamma = 1 + \frac{2}{f}$ (2) $\gamma = \frac{2}{f}$

(3) $\gamma = \frac{f}{2}$ (4) $\gamma = \frac{2}{1+f}$

Sol. Answer (1)

$$\gamma = \frac{C_p}{C_v}$$

$$C_p = \frac{fR}{2} + R$$

$$C_v = \frac{fR}{2}$$

$$\gamma = \frac{\frac{fR}{2} + R}{\frac{fR}{2}}$$

$$\gamma = 1 + \frac{2}{f}$$

3. Brewster's law is valid when

(1) When reflected ray & refracted ray are mutually perpendicular

(2) When reflected ray & refracted ray are parallel

(3) When both are in same medium

(4) None

Sol. Answer (1)

According to Brewster's law when refracted ray and reflected ray are perpendicular, then reflected ray is polarized.

4. A cube has surface area equal to 24 cm^2. If temperature is changed by 10ºC then change in its volume is equal to : $\alpha = 5 \times 10^{-4}\ ^{o}C^{-1}$

(1) 0.12 cm^3

(2) 0.84 cm^3

(3) 0.54 cm^3

(4) 1.12 cm^3

Sol. Answer (1)

Surface area of the cube

$$6a^2 = 24 \text{ cm}^2$$

Edge of the cube

$$a = 2 \text{ cm}$$

Volume of the cube

$$v = a^3 = 8 \text{ cm}^3$$

$$v = v_0[1 + \gamma\Delta T]$$

$$v - v_0 = v_0\gamma\Delta T = 3v_0\alpha\Delta T$$

$$\Delta v = 3v_0\alpha\Delta T$$

$$\Delta v = 3 \times 8 \times 5 \times 10^{-4} \times 10 \text{ cm}^3$$

$$\Delta v = 1200 \times 10^{-4} \text{ cm}^3$$

$$\Delta v = 0.12 \text{ cm}^3$$

5. If $I_1 : I_2 = 4:1$, then the value of $\frac{I_{max}+I_{min}}{I_{max}-I_{min}} = \frac{5}{x}$, the value of x is

(1) 3

(2) 4

(3) 2

(4) 5

Sol. Answer (2)

$$I_{max} = \left(\sqrt{I_1}+\sqrt{I_2}\right)^2$$

$$I_{min} = \left(\sqrt{I_1}-\sqrt{I_2}\right)^2$$

$$I_{max}+I_{min} = 2(I_1+I_2)$$

$$I_{max}-I_{min} = 4\sqrt{I_1}\sqrt{I_2}$$

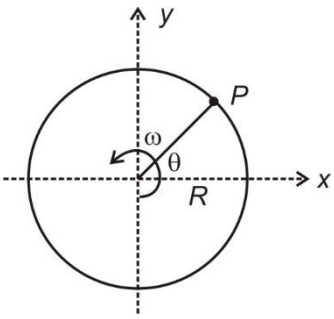
$$\frac{I_{max}+I_{min}}{I_{max}-I_{min}} = \frac{I_1+I_2}{2\sqrt{I_1}\sqrt{I_2}}$$

$$\frac{I_{max}+I_{min}}{I_{max}-I_{min}} = \frac{1}{2}\left(\sqrt{\frac{I_1}{I_2}}+\sqrt{\frac{I_2}{I_1}}\right)$$

$$\frac{I_{max}+I_{min}}{I_{max}-I_{min}} = \frac{1}{2}\left(\frac{2}{1}+\frac{1}{2}\right) = \frac{5}{4}$$

$x = 4$

6. Find the acceleration of particle P moving on a circle shown in the diagram with uniform angular velocity ω



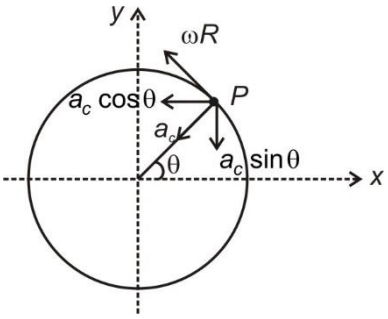
(1) $\omega^2 R\cos\theta\hat{i} + \omega^2 R\sin\theta\hat{j}$

(2) $-\omega^2 R\cos\theta\hat{i} - \omega^2 R\sin\theta\hat{j}$

(3) $-\omega^2 R\cos\theta\hat{i} + \omega^2 R\sin\theta\hat{j}$

(4) $\omega^2 R\cos\theta\hat{i} - \omega^2 R\sin\theta\hat{j}$

Sol. Answer (2)



Particle moves on circular path with uniform angular velocity, so, tangential acceleration of the particle is zero.

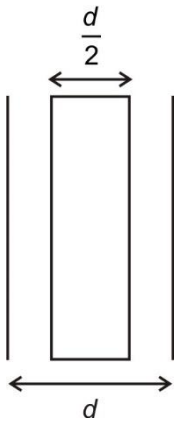
Particle has centripetal acceleration only toward centre

$$\vec{a} = \vec{a_c} = \omega^2 R\hat{u}_R$$

$$= \omega^2 R[\cos\theta(-\hat{i}) + \sin\theta(-\hat{j})]$$

$$= -\omega^2 R(\cos\theta\hat{i} + \sin\theta\hat{j})$$

7. A metal of thickness $\frac{d}{2}$ is inserted between plates of capacitor having capacitance C and distance between plate d. If new capacitance is C' the value of $\frac{C}{C'}$ is



(1) 1 : 2

(2) 2 : 1

(3) 1 : 1

(4) 2 : 3

Sol. Answer (1)

$$C = \frac{\epsilon_0 A}{d}$$

$$C' = \frac{\epsilon_0 A}{d-t} = \frac{\epsilon_0 A}{d-\frac{d}{2}}$$

$$C' = \frac{2\epsilon_0 A}{d}$$

$$\frac{C}{C'} = \frac{1}{2}$$

8. For a solenoid no. of turns double and current is halved, new magnetic field is

(1) Doubled

(2) Half

(3) Four times

(4) Remain same

Sol. Answer (4)

Magnetic field inside the solenoid is $B = \mu_0 n\mathrm{I}$

If number of turn is doubled and current is halved

$$B' = \mu_0 (2n)\left(\frac{\mathrm{I}}{2}\right)$$

$$B' = \mu_0 n\mathrm{I}$$

$$B = B'$$

Magnetic field remain same

9. 4 objects have mass M and radius R. Moment of inertia of sphere about diameter is I_1 that about the axis of cylinder is I_2 , about diameter of disc is I_3 and about diameter of ring is I_4 are related as $2(\mathrm{I}_2 + \mathrm{I}_3) + \mathrm{I}_4 = x\mathrm{I}_1$ the value of x is

(1) 3

(2) 4

(3) 5

(4) 6

Sol. Answer (3)

Four objects are sphere, cylinder, disc and ring of same mass and radius

$$\mathrm{I}_1 = \frac{2}{5}MR^2$$

$$\mathrm{I}_2 = \frac{1}{2}MR^2$$

$$\mathrm{I}_3 = \frac{1}{4}MR^2$$

$$\mathrm{I}_4 = \frac{1}{2}MR^2$$

$$2(\mathrm{I}_2 + \mathrm{I}_3) + \mathrm{I}_4 = 2\left(\frac{1}{2}MR^2 + \frac{1}{4}MR^2\right) + \frac{1}{2}MR^2$$

$$= \frac{3}{2}MR^2 + \frac{1}{2}MR^2$$

$$= 2MR^2 = 5.\frac{2}{5}MR^2$$

$$= 5\mathrm{I}_1$$

$$x = 5$$

10. 27 identical droplets 22 volts each coalesce together to form a bigger drop then find potential of the bigger drop is

(1) 216

(2) 198

(3) 324

(4) 72

Sol. Answer (2)

Let the charge on each drop is q and radius of each drop is r

$$v_0 = \frac{kq}{r}$$

$$v_0 = 22 \text{ V}$$

If 27 drops coalesce

$Q = 27q$

$$\frac{4}{3}\pi R^3 = 27\frac{4}{3}\pi r^3$$

$$R = 3r$$

$$v = \frac{kQ}{R} = \frac{k(27q)}{3r}$$

$$v = 9\frac{kq}{r} = 9v_0 = 9 \times 22$$

= 198 V

11. Assertion (A) : For a fix value of range R if u is same, the projectile can achieve height H_1 and H_2 then $R = 4\sqrt{H_1 H_2}$

Reason (R) : $H_1 \times H_2 = \frac{u^2 \sin^2\theta}{2g} \times \frac{u^2 \cos^2\theta}{2g}$

(1) A and R are true and R is the correct explanation of R

(2) A and R are true but R is not the correct explanation of A

(3) A is true R is false

(4) A is false and R is true

Sol. Answer (1)

For fixed value of range projectile should get fired at complementary angle.

If one projectile is fired at θ, other should be fired

At $90^\circ - \theta$

$$H_1 = \frac{u^2 \sin^2 \theta}{2g}$$

$$H_2 = \frac{u^2 \sin^2 (90-\theta)}{2g} = \frac{u^2 \cos^2 \theta}{2g}$$

$$H_1 H_2 = \frac{u^4}{4g^2} \sin^2 \theta \cos^2 \theta$$

$$H_1 H_2 = \frac{u^4}{4g^2} \frac{\sin^2 2\theta}{4}$$

$$H_1 H_2 = \left(\frac{u^2 \sin\ 2\theta}{4g} \right)^2$$

$$H_1 H_2 = \left(\frac{R}{4} \right)^2$$

$$R = 4\sqrt{H_1 H_2}$$

Both *A* and *R* is true and *R* is the correct explanation of *A*.

12. Assertion (A): Magnetic susceptibility (χ_m) of ferro and para increases with increase in temperature

Reason (R): In diamagnetic material, orbital magnetic moment develop opposite to the outside field.

(1) A and R both are current and R is current explanation of A

(2) A and R both are correct and R is not correct explanation of A

(3) A is true R is false

(4) A is false R is true

Sol. Answer (4)

For Paramagnetic material magnetic susceptibility is inversely proportional to temperature

For diamagnetic material magnetic susceptibility does not depend on temperature

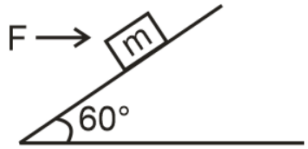
For Ferromagnetic material magnetic susceptibility is independent of temperature (below curies temperature)

A is False

In diamagnetic material net magnetic field is lesser than external magnetic field. This is due to opposite induced magnetization

R is true

13. Find the value of force *F* required to maintain the box in equilibrium on a smooth wedge as shown in diagram (*m* = 0.5kg)



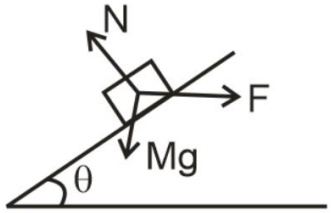
(1) 8.66

(2) 17.32

(3) 4.26

(4) 19.86

Sol. Answer (1)



F cos 60° = Mg sin60°

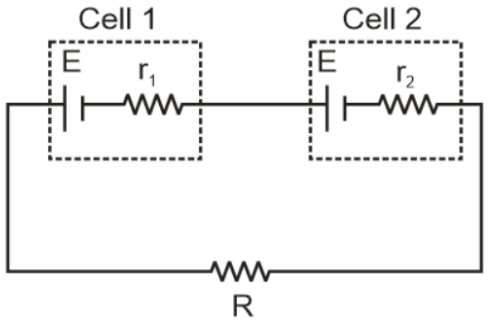
F = Mg tan60°

F = $\frac{1}{2} g \sqrt{3}$

F = $\frac{\sqrt{3}g}{2} N$

F = 8.66 N

14. Two cells both have emf's E and internal resistance r_1 and r_2 are connected with a resistance as shown in the diagram. The value of R such that potential difference across cell 2 is 0



(1) $r_2 - r_1$

(2) $2r_2 - r_1$

(3) $r_2 - 2r_2$

(4) $r_1 + r_2$

Sol. Answer (1)

Current in the circuit is

$$I = \frac{2E}{R + r_1 + r_2}$$

Pd across cell 2 is

$V = E - Ir_2$

$$V = E - \frac{2E r_2}{R + r_1 + r_2}$$

$$O = E\left[1 - \frac{2r_2}{R + r_1 + r_2}\right]$$

$R + r_1 + r_2 = 2r_2$

$R = r_2 - r_1$

15. Four particles electron (e^-), neutron (n), proton(p) and alpha particle (α) have same kinetic energy. If their associated de-broglie wavelength are λ_e, λ_n, λ_p and λ_α respectively, then

(1) $\lambda_e > \lambda_n > \lambda_p > \lambda_r$

(2) $\lambda_e > \lambda_p > \lambda_n > \lambda_\alpha$

(3) $\lambda_\alpha > \lambda_p > \lambda_n < \lambda_e$

(4) $\lambda_\alpha > \lambda_n > \lambda_p > \lambda_e$

Sol. Answer (2)

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

KE of each particle is same

So, $\lambda \propto \frac{1}{\sqrt{m}}$

$m_e < m_p < m_n < m_\alpha$

So, $\lambda_e > \lambda_p > \lambda_n > \lambda_\alpha$

16. Relative permeability of medium is 1 and speed of light in that medium is 2×10^8 m/sec, then relative permittivity of the medium is

(1) 4 (2) $\frac{9}{4}$

(3) 9 (4) $\frac{4}{9}$

Sol. Answer (2)

$v = 2 \times 10^8$ m/s

$c = 3 \times 10^8$ m/s

$$\mu = \frac{c}{v} = \frac{3}{2}$$

$$\mu = \sqrt{\mu_r \in_r}$$

$$\sqrt{\mu_r \in_r} = \frac{3}{2}$$

$$\mu_r \in_r = \frac{9}{4}$$

$$1 \times \in_r = \frac{9}{4}$$

$$\in_r = \frac{9}{4}$$

17. Two satellite are revolving around a planet in a circular orbit. If v_1 is speed of a satellite having radius 800 km and v_2 is speed of satellite having radius 3200 km, then $\frac{v_1}{v_2} = x$, then value of x is

(1) 6 (2) 4

(3) 3 (4) 2

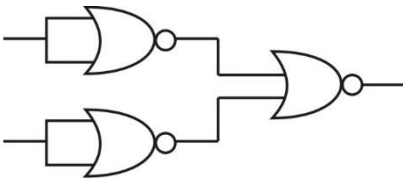
Sol. Answer (4)

$$v_0 = \sqrt{\frac{GM}{R}}$$

$$\frac{v_{0_1}}{v_{0_2}} = \sqrt{\frac{R_2}{R_1}} = \sqrt{\frac{3200}{800}}$$

$$\frac{v_{0_1}}{v_{0_2}} = 2$$

$$\frac{v_1}{v_2} = 2$$

18. 

The gate shown in figure behaves like

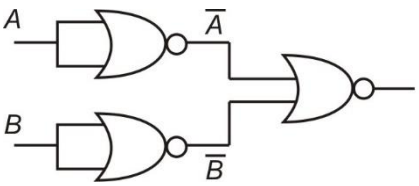
(1) AND

(2) OR

(3) NOT

(4) NOR

Sol. Answer (1)



$Y = \overline{\overline{A} + \overline{B}}$

$$Y = \overline{\overline{A} + \overline{B}}$$

$$Y = \overline{\overline{A}} \cdot \overline{\overline{B}}$$

$$Y = AB$$

AND gate

19. 5 kg vessel of copper at 500º C is placed on an ice at 0º C. Assume exchange of heat between ice and vessel only then the amount of ice that melts is (S_{copper} = 0.39 J/gmºC and L_{ice} = 335 J/gm)

(1) 2.9 kg (2) 5.8 kg

(3) 1.45 kg (4) 0.5 kg

Sol. Answer (1)

Heat lost by copper = heat gained by ice

$M_c S\Delta T = mL$

$m = \frac{M_c S\Delta T}{L}$

$m = \frac{5000 \times 0.39 \times 500}{335}$

$m = 2910$ gm

$m = 2.9$ kg

20. Length of a cylindrical conductor is doubled keeping the volume constant. Percentage change in the value of its resistance across its ends is equal to

(1) 100 (2) 200

(3) 300 (4) 50

Sol. Answer (3)

Volume is constant

$AL = A'L'$

$AL = A'.2L$

$A' = \frac{A}{2}$

$R = \rho\frac{L}{A}$

$R' = \rho\frac{L'}{A'} = \rho\frac{2L}{\frac{A}{2}} = 4\rho\frac{L}{A}$

$R' = 4R$

$\Delta R = R' - R = 3R$

$\%\Delta R = \frac{\Delta R}{R} \times 100$

$= \frac{3R}{R} \times 100$

= 300%

21. A graph is drawn between log of radius of nucleus and log of atomic mass number for various elements. The slope of the graph is equal to ____.

Sol. Answer ($\frac{1}{3}$)

We know that radius of nucleus is given by

$r = r_0 A^{\frac{1}{3}}$ .....(1)

$r_0 = 1.2 \times 10^{-15}$ m

A = mass number

Apply log to b/s, we get

$\log r = \log r_0 + \frac{1}{3}\log A$

Compare with equation of straight line

$y = c + mx$

$m = \frac{1}{3}$

22. On a level road maximum speed of a car to take a turn of 75 m radius is 30 m/s then maximum speed of car to take a turn of 48 m in m/s is ____.

Sol. Answer (24 m/s)

$f = \frac{mv^2}{r}$ (static friction provides necessary centripetal force)

$f \le \mu mg$ (condition to prevent slipping)

$\frac{mv^2}{r} \le \mu mg$

$v \le \sqrt{r\mu g}$

$v_{max} = \sqrt{r\mu g}$

$\frac{(v_{max})_{r_2}}{(v_{max})_{r_1}} = \sqrt{\frac{r_2}{r_1}}$

$\frac{(v_{max})_{r_2}}{30} = \sqrt{\frac{48}{75}} = \sqrt{\frac{16}{25}}$

$(v_{max})_{r_2} = 24$ m/s