44 YEARS OF EXCELLENCE

NARAYANA EDUCATIONAL INSTITUTIONS

NARAYANA GRABS THE LION'S SHARE IN JEE-ADV.2022

5 RANKS in OPEN CATEGORY ONLY FROM NARAYANA IN TOP 10 AIR

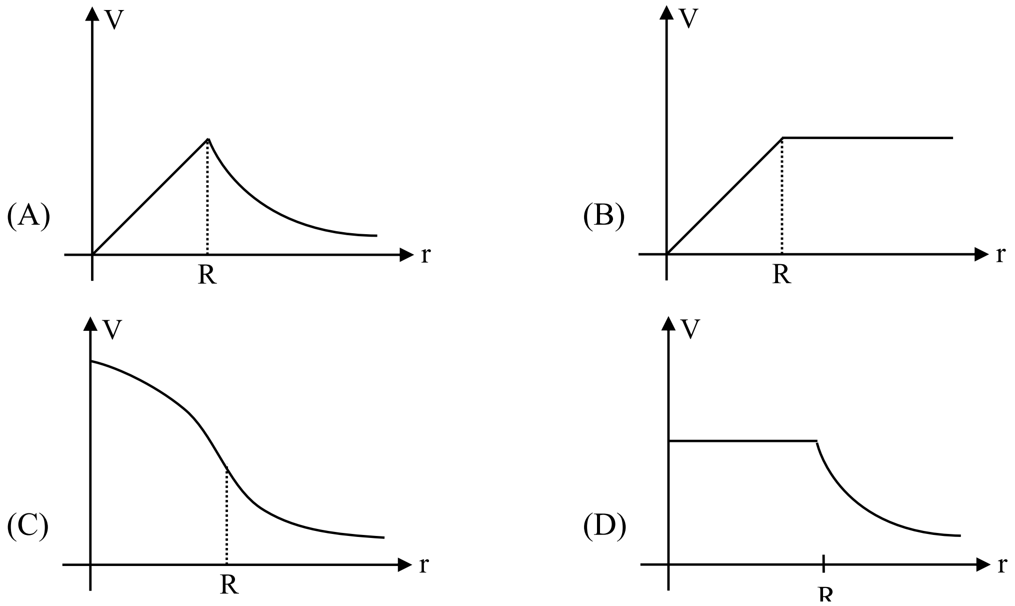
JEE MAIN (APRIL) 2023 (06-04-2023-FN)

Memory Based Question Paper

PHYSICS

PHYSICS

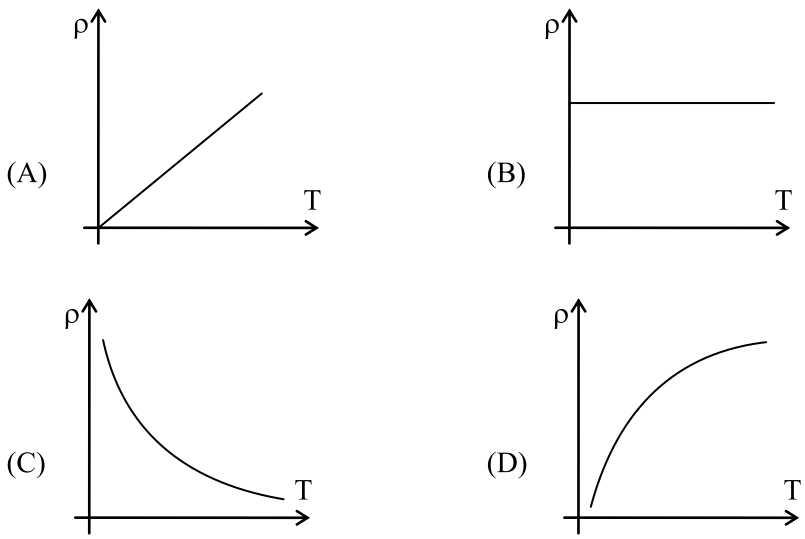
1. Choose correct graph of electric potential for uniformly charged hollow sphere.



Ans. (D)

Sol. Theoretical

2. Choose correct graph of resistivity and temperature for semi-conductor material.

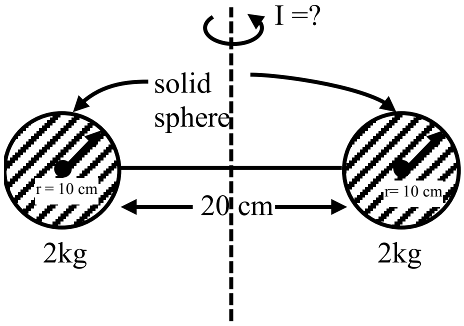


Ans. (C)

Sol. $\rho = \frac{m}{ne^2\tau}$

As T increases τ decreases but n increases but n is dominant over τ so ρ decreases with increase in temperature

3. Find moment of inertia about axis shown which is equidistant from both spheres



Ans. $\frac{88}{500}(kg - m^2)$

Sol. $I = \left[\frac{2}{5}Mr^2 + M(0.2)^2\right] \times 2$

$= \left[\frac{2}{5} \times 2 \times (0.1)^2 + 2 \times (0.2)^2\right] \times 2$

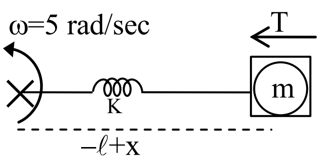
$= \left[\frac{4}{500} + \frac{8}{100}\right] \times 2$

$= \frac{44 \times 2}{500} = \frac{88}{500}(kg - m^2)$

4. A block of mass 100 g is attached with spring of natural length 20 cm and force constant 7.5 N/m. Now system is rotated with constant angular velocity 5 radian/s on horizontal plane. Find out tension in the spring?

Ans. 0.75 N

Sol.



ℓ = 20 cm (natural length of spring)

m = given 100 gm

k = 7.5 N/m

$mw^2(\ell + x)$

$Kx = mw^2(\ell + x)$

$$x=\frac{m\omega^2\ell}{K-m\omega^2}$$

$$T=Kx=\left|\frac{m\omega^2\ell K}{K-m\omega^2}\right|$$

$$T=\frac{0.1\times25\times0.2\times7.5}{7.5-0.1\times25}$$

$$T=\frac{7.5\times0.1\times5}{5}$$

T = 0.75 N

5. **Assertion :** Range is maximum at $\theta = 45^o$.

Reason : Range is maximum when sin $(2\theta) = 1$.

(A) Both assertion and reason are true & reason is the correct explanation of assertion.

(B) Both assertion and reason are true but reason is not correct explanation of assertion.

(C) Assertion is true and reason is false.

(D) Assertion is false and reason is false.

Ans. **(A)**

Sol. $$R=\frac{u^2\sin(2\theta)}{g}$$

For R_{max} sin $(2\theta) = 1$

$2\theta = 90^o$

$\theta = 45^o$

6. **Assertion :** The Moon doesn't have atmosphere.

Reason : Escape velocity of the Moon is less than that of the Earth.

(A) Both assertion and reason are true & reason is the correct explanation of assertion.

(B) Both assertion and reason are true but reason is not correct explanation of assertion.

(C) Assertion is true and reason is false.

(D) Assertion is false and reason is true.

Ans. **(A)**

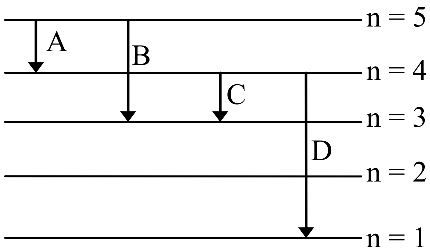
Sol. $$V_{esc}=\sqrt{\frac{2GM}{R}}=\sqrt{\frac{2G}{R}\times\frac{\rho 4}{3}\pi R^3}$$

$V_{esc} \propto R$.

Since moon's radius is very small compared to earth.

V_{esc} at moon is quite low and gas molecules attains escape velocity at normal temperature on moon.

7. For below transition of e^{-1} of H-atom find out shortest wavelength out of given transition

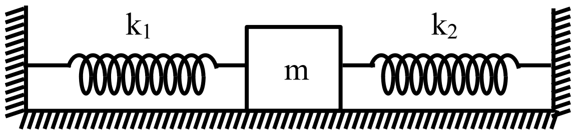


(A) A (B) B (C) C (D) D

Ans. **(D)**

Sol. Energy from n = 4 to 1 is maximum so wavelength is minimum.

8. Find period of oscillation if mass 'm' is displaced parallel to earth's surface & released?



(A) $2\pi\sqrt{\frac{k_1+k_2}{m}}$ (B) $2\pi\sqrt{\frac{k_1k_2}{m(k_1+k_2)}}$ (C) $2\pi\sqrt{\frac{m}{k_1+k_2}}$ (D) $2\pi\sqrt{\frac{m(k_1+k_2)}{k_1k_2}}$

Ans. **(C)**

Sol. $k_{eq} = k_1 + k_2$ (since springs are parallel)

$$T = 2\pi\sqrt{\frac{m}{k_{eq}}} = 2\pi\sqrt{\frac{m}{k_1+k_2}}$$

9. A planet has density same as that of Earth and mass is twice that of Earth. If the weight of an object on Earth is "W" then the weight on the planet is :

(A) $2^{\frac{2}{3}}W$ (B) $2^{\frac{1}{3}}W$ (C) $2^{\frac{4}{3}}W$ (D) W

Ans. **(B)**

Sol. Planet with mass M has radius R

Planet with mass 2M has radius R'

$$\rho\frac{4}{3}\pi R^3 = M$$

$\rho\ \frac{4}{3}\pi R'^3 = 2M$

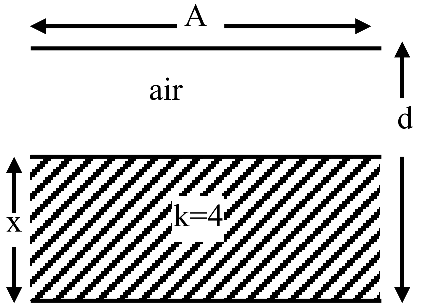
$\Rightarrow R' = 2^{\frac{1}{3}} R$

$= 2\frac{GM}{2^{\frac{2}{3}}R^2} = 2^{\frac{1}{3}}\frac{GM}{R^2} = 2^{\frac{1}{3}}W$

$\therefore\ W' = 2^{\frac{1}{3}}W$

10. When $x = \frac{d}{3}$ then capacitance is $C_1 = 2\mu f$

then if $x = \frac{2d}{3}$ then capacitance C_2 will be (in μC)



Ans. (3)

Sol. $\frac{1}{C_{eq}} = \frac{1}{C_{air}} + \frac{1}{C_{di}}$

$\frac{1}{C_{eq}} = \frac{2d}{3(\epsilon_0 A)} + \frac{d}{(3)4\epsilon_0 A} = \frac{3d}{4A\epsilon_0}$

$C_{eq} = \frac{4A\epsilon_0}{3d} = 2\mu F$

$\frac{A\epsilon_0}{d} = 1.5\mu F$

$\frac{1}{C'_{eq}} = \frac{d}{3(\epsilon_0 A)} + \frac{2d}{(3)4\epsilon_0 A} = \frac{(4+2)d}{12\epsilon_0 A} = \frac{6d}{12\epsilon_0 A} \Rightarrow C'_{eq} = 2\left[\frac{\epsilon_0 A}{d}\right] = 3\mu F$

11. In which condition EMF will be induced in loop.

Situation-S1 : A loop is moving with uniform velocity in a uniform magnetic field perpendicular to its plane.

Situation-S2 : A loop is moving with non-uniform velocity in a uniform magnetic field perpendicular to its plane.

Situation-S3 : A loop is rotating about its diameter in a uniform magnetic field.

Situation-S4 : Area of loop is changing in a uniform magnetic field.

(A) S2, S3

(B) S1, S3

(C) S2, S4

(D) S3, S4

Ans. (D)

Sol. S1, S2 $\rightarrow$ Flux remains constant

S3 $\rightarrow \phi = BA\cos\theta$ [θ is changing]

S4 $\rightarrow$ Area is changing $\rightarrow$ EMF induces

12. If height of antenna is increased by 21%. Find % rise in its range ?

Ans. 10%

Sol. $\mathbf{d} = \sqrt{2Rh}$, $d \propto \sqrt{h}$

$d' \propto \sqrt{1.21\ h} = 1.1\ h$

%tage change in d = 10%

13. $E = E_0 \sin(\omega t - kx)$

$B = B_0 \sin(\omega t - kx)$,

then ratio of energy density of electric field to magnetic field is :

(A) 1 : 1 (B) 1 : 3 (C) 1 : 2 (D) 2 : 1

Ans. (A)

Sol. In EM wave,

Energy density)$_{\text{magnetic field}}$ = Energy density)$_{\text{electric field}}$

14. A uniform current carrying cylindrical wire carries current I having radius 'a'. Magnetic field with distance x varies with relation given :

(A) $B \propto x$ for $x < a$

$B \propto \frac{1}{x}$ for $x > a$

(B) $B \propto x$ for $x < a$

B is constant for $x > a$

(C) B is constant for $x < a$

$B \propto \frac{1}{x}$ for $x > a$

(D) $B \propto \frac{1}{x}$ for $x < a$

$B \propto x$ for $x > a$

Ans. (A)

15. An electron, proton and α-particle are moving with kinetic energy 4K, K and 2K respectively. Relation between De-Broglie wavelength is :

(A) $\lambda_p > \lambda_e > \lambda_\alpha$ (B) $\lambda_p > \lambda_\alpha > \lambda_e$ (C) $\lambda e > \lambda_p > \lambda_\alpha$ (D) $\lambda_\alpha > \lambda_e > \lambda_p$

Ans. (C)

Sol. $\lambda_e = \frac{h}{\sqrt{\frac{2\times m}{2000}\times 4K}} = \frac{10\sqrt{20}h}{2\sqrt{2mK}}$

$\lambda_p = \frac{h}{\sqrt{2mK}} = \frac{h}{\sqrt{2mK}}$

$\lambda_\alpha = \frac{h}{\sqrt{2\times 4m\times 2K}} = \frac{h}{4\sqrt{mK}}$

$\lambda_e > \lambda_p > \lambda_\alpha$

16. $R_1 = (15 \pm 0.5)\ \Omega$

$R_2 = (10 \pm 0.5)\ \Omega$

Find % error in equivalent resistance if resistors R_1 and R_2 are connected in parallel ?

(A) 5% (B) 4.33 % (C) 3% (D) 3.33 %

Ans. (B)

Sol. $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$ & $_{eq} = \frac{\quad}{25} = \quad \Omega$

$$\frac{dR_{eq}}{R_{eq}^2} = \frac{dR_1}{R_1^2} + \frac{dR_2}{R_2^2}$$

$$\frac{dR_{eq}}{R_{eq}} = R_{eq}\left[\frac{dR_1}{R_1^2} + \frac{dR_2}{R_2^2}\right]$$

$$= 6\left[\frac{0.5}{15^2} + \frac{0.5}{10^2}\right]$$

$$\therefore \quad \%\frac{dR_{eq}}{R_{eq}} = 6\times0.5\times100\left[\frac{1}{225} + \frac{1}{100}\right] = 6\times0.5\times100\times\frac{325}{225\times100} = 4.33\%$$

17. Two identical current carrying coils with same centre are placed with their planes perpendicular to each other. If i = $\sqrt{2}$A and radius of coil R = 1 m, then magnetic field at centre C is equal to :

(A) μ_0 (B) $\frac{\mu_0}{2}$ (C) $2\mu_0$ (D) $\sqrt{2}\ \mu_0$

Ans. **(A)**

Sol. $B_0 = \sqrt{B_1^2 + B_2^2}$

$$B_0 = \sqrt{2}B$$

$$B_0 = \sqrt{2}\frac{\mu_0 I}{2R} = \sqrt{2}\frac{\mu_0\times\sqrt{2}}{2\times1} = \mu_0$$

18. If the length of a conductor is increased by 20% and cross-sectional area is decreased by 4%, find the percentage change in the resistance of the conductor.

Ans. 25

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

$$R' = \frac{\rho 1.2\ell}{0.96A} = \frac{1.25\rho\ell}{A} = 1.25\ R$$

19. A car is moving with speed of 15 m/sec towards a stationary wall. A person in the car press the horn and experience the change in frequency of 40 Hz due to reflection from stationary wall. Find the frequency of horn. (Use $V_{\text{sound wave}}$ = 330 m/sec)

Ans. **420 Hz**

Sol. $f = f_0\left(\frac{V+V_C}{V-V_C}\right)$

$f = f_0\left(\frac{330+15}{330-15}\right)$

$f = f_0\frac{345}{315}$

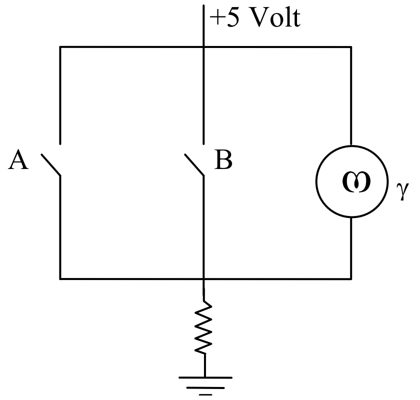
$f - f_0 = 40$

$f_0\left(\frac{345-315}{315}\right) = 40$

$f_0 = \frac{40\times 315}{30}$

$f_0 = 420$ Hz

20. Which logic gate is specified by given circuit



(A) AND (B) OR (C) NAND (D) NOR

Ans. **(D)**

Sol.

A	B	γ
0	0	1
1	0	0
0	1	0
1	1	0

21. A block of mass 100 gm is placed on a smooth surface and is moving with acceleration of a = 2x.

If change in kinetic energy can be given as $\left(\frac{x^n}{10}\right)$, find the value of n :

Ans. **(2)**

Sol. $V\frac{dv}{dx} = 2x \Rightarrow \therefore \int_0^v vdv = 2\int_0^x xdx$

$\therefore \frac{v^2}{2} = x^2$

$\therefore \frac{1}{2}mv^2 = mx^2$

$= (0.1)\,x^2 = \frac{x^2}{10}$

$n = 2$

22. A sphere of density ρ & mass m is moving down with constant velocity in viscous liquid of density ρ_0 find out viscous force on sphere

(A) $mg\left(\frac{1-\rho_0}{\rho}\right)$ (B) $2mg\left(\frac{1-\rho_0}{\rho}\right)$ (C) $mg\left(\frac{1-3\rho_0}{\rho}\right)$ (D) $mg\left(\frac{1+\rho_0}{\rho}\right)$

Ans. (A)

Sol. $F = mg - F_b$

$F = mg - \rho_0 \frac{mg}{\rho}$

$F = mg\left(\frac{1-\rho_0}{\rho}\right)$

23. If light incident in air at an angle of incidence 45° and refracted in other medium at an angle of refraction 30°. If wavelength in air is λ_1 and frequency is ν_1 and in medium wavelength is λ_2 and frequency is ν_2 then correct possible options are :

(A) $\lambda_1 = \frac{\lambda_2}{\sqrt{2}}, \nu_1 = \nu_2$ (B) $\lambda_1 = \lambda_2, \nu_1 = \frac{\nu_2}{\sqrt{2}}$ (C) $\lambda_1 = \lambda_2, \nu_2 = \nu_1$ (D) $\lambda_2 = \frac{\lambda_1}{\sqrt{2}}, \nu_2 = \nu_1$

Ans. (D)

Sol. $1\sin 45^o = \mu \sin 30^o$

$\mu = \sqrt{2}$

$\lambda_2 = \frac{\lambda_{air}}{\mu} = \frac{\lambda_1}{\sqrt{2}}$

and frequency does not change with medium.

24. A wire of length 2 m, radius of cross-section 20 mm and Young's Modulus 2×10^{11} N/m is subjected to a force of 62.8 kN. The change in length of the wire is $p \times 10^{-5}$ (in m). Find P.

Ans. **(50)**

Sol. $\Delta L = \frac{FL}{AY} = \frac{62.8 \times 1000 \times 2}{3.14 \times 20 \times 20 \times 10^{-6} \times 2 \times 10^{11}} = 50 \times 10^{-5}$ m

25. In a thermodynamic process work done by gas is 1000 J & heat supplied is 200 J. Find change in internal energy of gas?

(A) 800 J (B) –800 J (C) 1200 J (D) –1200 J

Ans. **(B)**

Sol. $Q = \Delta U + \Omega$

$\therefore 200 = \Delta U + 1000$

$\therefore \Delta U = -800$ J

26. A particle moves in a circular path with uniform speed v. When it turns by 90º, find ratio of $\frac{v}{|<\vec{v}>|}$?

(A) $\frac{\pi}{\sqrt{2}}$ (B) $\frac{2\pi}{\sqrt{2}}$ (C) $\frac{\pi}{2}$ (D) 2π

Ans. **(A)**

Sol. $|<\vec{v}>| = \frac{|\text{displacement}|}{\text{time}} = \frac{\sqrt{2}R}{(\pi R / v)} = \frac{\sqrt{2}v}{\pi}$

$$\therefore \quad \frac{v}{|<\vec{v}>|} = \frac{v}{\left(\frac{\sqrt{2}v}{\pi}\right)} = \frac{\pi}{\sqrt{2}}$$

27. Find out 5^{th} orbit radius (in pm) of Li^{++} if ground orbit radius of H-atom is 51 pm.

Ans. **(425)**

Sol. $r_0 = 51$ pm

$$r = r_0 \times \frac{n^2}{Z}$$

$$r = 51 \text{ pm} \times \frac{5^2}{3} = 425$$