PHYSICS

1. Find the radius of 5th orbit of a Li^{+2} ion. Radius of first orbit of H atom is 0.529Å.

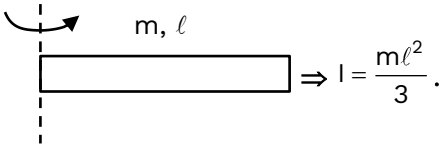
Ans. 4.408 Å

Sol. $r = 0.529\frac{n^2}{Z} = 0.529 \times \frac{25}{3} = 4.408$ Å

2. What is the moment of inertia of a rod about the axis passing through its one end?

Ans. $\frac{m\ell^2}{3}$

Sol.



$\Rightarrow I = \frac{m\ell^2}{3}$.

3. **Assertion:** For a projectile motion, range is maximum at $\theta = 45°$.

Reason: For range to be maximum, $\sin 2\theta$ needs to be 1.

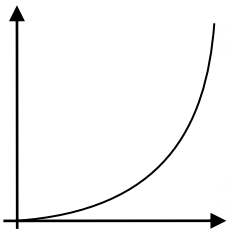
Ans. Both are true

Sol. $R = \frac{u^2 \sin 2\theta}{g} \Rightarrow$ for maximum value, $\sin 2\theta = 1$

i.e. $\theta = 45°$.

4. Which graph represents the relationship between conductivity and temperature for a semiconductor?

Ans.



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

For semiconductor on increasing temperature, n increase & t decreases. But effect of n is dominating, So graph will be

5. In a thermodynamics process, wok done by the gas is 1000 J, heat released during the process is 200 J. Find the change in internal energy.

Ans. 1200J

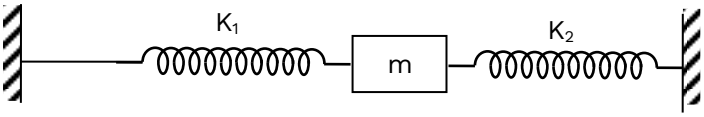
Sol. $\Delta Q = \Delta U + W$

$\Delta U = W - \Delta Q$

$= -1000 - 200$

$= -1200$ J

6. In the given setup, if the block is slightly displaced it undergoes SHM. Find its time period.



Ans. $2\pi\sqrt{\frac{m}{k_1+k_2}}$

7. Centers of two spheres of mass 2 kg and radius 10 cm are connected with a massless rod of 40 cm. Find the moment of inertia about an axis passing through the center of the rod.

Ans. 0.176

Sol. diagram

$$Z_0 = 2\left[\frac{2}{5}mR^2 + m(d)^2\right]$$

$$= 2\left[\frac{2}{5}\times 2\times 10^{-2} + 2\times 4\times 10^{-2}\right]$$

$$= \frac{88}{5}\times 10^{-2}$$

$= 17.6 \times 10^{-2}$

$Z_0 = 0.176$ kg m^2

8. Three particles α, e^- and proton with kinetic energy 2k, 4k and k respectively. Then find the order of de-Broglie wavelength.

Ans. $\lambda_e > \lambda_P > \lambda_\alpha$

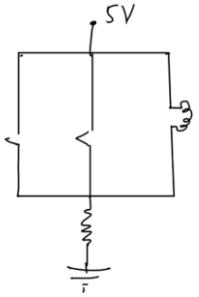
Sol. $$\lambda = \frac{h}{\sqrt{2mK}}$$

$$\lambda_e = \frac{h}{\sqrt{2m_e(2K)}}$$

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

$$\lambda_\alpha = \frac{h}{\sqrt{2(4m)(4K)}}$$

9. Identify the logic gate in the given arrangement.



Ans. NOR gate

Sol.

0	1	0
1	0	0
0	0	1
1	1	0

This is truth table of NOR gate.

10. The ratio of average electric energy density and magnetic energy density in electromagnetic wave is equals to:

Ans. 1 : 1

Sol. Average electric energy density = average magnetic energy density

$$\frac{1}{2}\varepsilon_0 E^2 = \frac{1}{2}\frac{B^2}{\mu_0}$$

11. If the height of a tower used for LOS communication is increased by 21%. Find the percentage change in range.

Ans. 10%

Sol. $R_{avg} = \sqrt{2h_T R_e}$

$R' = \sqrt{2(1.21)h_T R_e}$

$R' = 1.1\ R$

$\Rightarrow 10\%$

12. A block of mass 100 g is placed on a smooth surface is moving with an acceleration, a = 2x, if the change in kinetic energy is $\left(\frac{x^n}{10}\right)$. Find the value of n.

Ans. 2

Sol. $\frac{vdv}{\lambda x} = 2x \Rightarrow \int_x^v vdv = \int_0^x 2x\,dx$

$$\frac{v^2 - u^2}{2} = x^2$$

$$\frac{1}{2}\left(v^2 - u^2\right) = x^2$$

$$\frac{1}{2}m\left(v^2 - u^2\right) = mx^2$$

$\Delta kE = 0.1 \times x^2 = \frac{x^2}{10} = \frac{x^n}{10}$

$n = 2$

13. A particle of mass m, density ρ_0 is falling with constant velocity v in a liquid of density ρ. Find the viscous force acting on the particle.

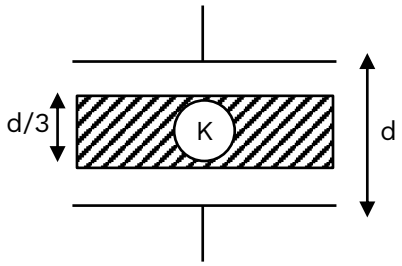
Ans. $F_v = mg\left(1 - \frac{\rho}{\rho_0}\right)$

Sol. $F_v = mg - \rho vg$

$$= mg\left(1 - \frac{\rho v}{m}\right)$$

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

14. Find the equivalent capacity of the capacitor if a dielectric plate of width $\frac{2d}{3}$ is placed between the conducting plates separated by a distance d. When width of dielectric plates was $\frac{d}{3}$, the capacitance was found to be 2 μF. (Value of k = 4).



Ans. 2

Sol. $$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{x}{k\varepsilon_0 A} + \frac{d-x}{\varepsilon_0 A}$$

$$\frac{1}{C_{eq}} = \frac{x + k(d-x)}{k\varepsilon_0 A}$$

$$C_{eq} = \frac{\varepsilon_0 A}{\frac{x}{k} + (d-x)}$$

For x = d/3, C_{eq} = 2μF

$$\frac{\varepsilon_0 A}{\frac{d}{12} + \frac{2d}{3}} = 2\mu F$$

15. We stretch a wire of resistance R such that its length increases by 20%. Then the percentage change in its resistance will be?

Ans. 44%

16. If the mass of a planet is increased to x times, keeping its density constant then the value of its new gravitational acceleration will be how much times the previous gravitational acceleration.(in term of x)

Ans. $x^{\frac{1}{3}}$

Sol. density, ρ = constant

m′ = mx

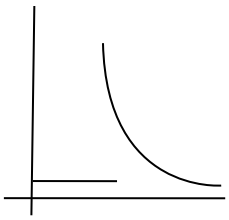
$$\frac{4}{3}\pi(R')^3\rho = \frac{4}{3}\pi R^3\rho.x$$

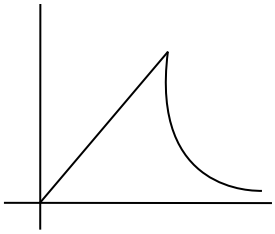
$$R' = (x)^{\frac{1}{3}}R$$

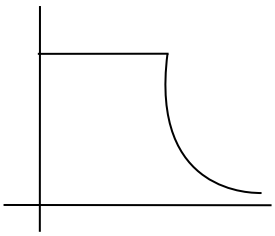
$$g' = \frac{Gm'}{(R')^2} = \frac{Gmx}{\left(Rx^{\frac{1}{3}}\right)^2} = g\frac{x}{x^{\frac{2}{3}}}$$

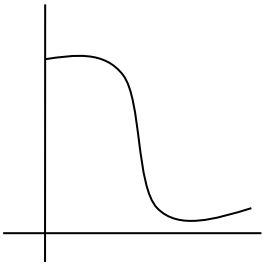
$$g' = \left(x^{\frac{1}{3}}\right)g$$

17. Which graph represents the potential inside a hollow sphere.

(A) 

(B) 

(C) 

(D) 

Ans. (C)

18. A ring of radius 1 m, carrying current of $\sqrt{2}$ A is situated in x-z plane with its centre at origin and another identical ring in y-z plane, placed concentrically. What will be the net magnetic field at origin.

Ans. μ_0

19. Two wires of resistance $R_1 = (10 \pm 0.5)\Omega$ and $R_2 = (15 \pm 0.5)\Omega$, respectively are connected in parallel. Find the equivalent resistance.

Ans. 6 ± 0.26

20. A car is moving with speed of 15 m/s 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 the stationary wall. Find the frequency of horn. (v_{sound} = 330 m/s).

Ans. 420 Hz

21. A particle is performing uniform circular motion. Ratio of instantaneous velocity and average velocity if particle turns by 90° is given by $\frac{\pi}{x\sqrt{2}}$. Find the value of x.

Ans. 2

Sol. $$v_{avg} = \frac{R\sqrt{2}}{\frac{\pi}{2\omega}}$$

$$v_{avg} = \frac{\omega R 2\sqrt{2}}{\pi}$$

$$\frac{\pi}{2\sqrt{2}} = \frac{v}{v_{avg}}$$

22. A spring (spring constant = 7.5 N/m) with its one end fixed and on the other end a block of mass 100 g is attached. Natural length of the spring is 20 cm. The block is performing circular motion in horizontal plane with angular velocity 5 rad/s. Then find the tension produced in the spring.

Ans. 0.75 N

Sol. $kx = m(l_0 + x)\,\omega^2$

$kx = ml_0\omega^2 + mx\omega^2$

$x(k - m\omega^2) = ml_0\omega^2$

$$x = \frac{ml_0\omega^2}{k - m\omega^2}$$

$$T = k\left(\frac{ml_0\omega^2}{k - m\omega^2}\right)$$

$$= 7.5\left(\frac{0.1\times 0.2\times 25}{7.5 - 0.1\times 25}\right)$$

= 0.75 N

23. A conducting coil is present in a constant magnetic filed. The current will induce in the coil in which of the given situation?

(A) moving with constant velocity (B) moving with non uniform velocity

(C) rotating about it's diameter (D) none of these

Ans. (C)

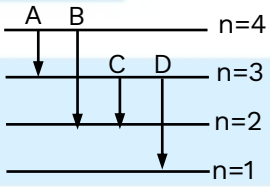
24. A ray undergoes refraction at boundary of a medium such that the incident angle is 45° while refraction angle is 30°. Wavelength and frequency of in incident rays are λ_1 and v_1 while for refracted ray are λ_2 and v_2, then

Ans. $\lambda_1 = \sqrt{2}\lambda_2, v_1 = v_2$

25. A rod is fixed at one end the other end is pulled with force F = 62.8 kN, Young's modulus of rod is 2×10^{11} N/m^2. If the radius of cross-section of rod is 20 mm the strain produced in rod is

Ans. 2.5×10^{-4}

26. In the given diagram, different types of transition are named as A, B, C and D, then which transition emits shortest wavelength.



Ans. D

Sol. Shortest wavelength corresponds to maximum energy.