AIEEE - 2004 Analysis

Physics

16. A ball is throuwn from a point with a speed 'v_0' at an elevation anglel of θ . From the same point and at the same instant ,a person starts running with a constant speed.' $V_0/2$ ' to catch the ball. Will the person be able to catch the ball? If yes, What should be the angle of projection θ ?
a) Yes ,60^0
b) Yes , 30^0
c) No
d) Yes, 45^0

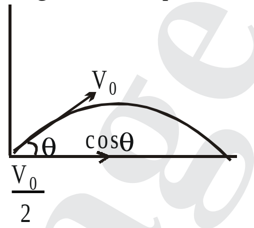
➢ a

The person has to catch the ball as both are moving as starting from same point & same instant

$$\frac{V_0}{2} = V_0 \cos\theta$$

$$\cos\theta = \frac{1}{2}$$

$$\theta = 60^0$$



17. One solid sphere A and another hollow sphere B are of same mass and same outer radii. Their moment of inertia about their diameters are respectively I_A and I_B such that
a) $I_A = I_B$
b) $I_A > I_B$
c) $I_A < I_B$
d) $\frac{I_A}{I_B} = \frac{d_A}{d_B}$

Where d_A and d_B are their densities

➢ c

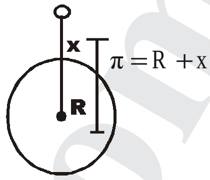
AS I_A (solid sphere) = $\frac{2}{5} MR^2$

I_B (hollow sphere) = $\frac{2}{3} MR^2$

$I_A < I_B$.

18. A satellite of mass m revolves around the earth of radius R at a height x from its surface. If g is hte acceleration due to gravity on surface of the earth. the orbital speed of the satellite is
a) gx
b) $\frac{gR}{R - x}$
c) $\frac{gR^2}{R + x}$
d) $\left(\frac{gR^2}{R + x}\right)^{1/2}$

➢ d



orbital velocity (V_0) = $\sqrt{\frac{GM}{\pi}}$

but GM = gR^2 and π = hight of satellite from coutre of earth

$\therefore V_0 = \sqrt{\frac{gR^2}{R+x}}$

19. The time period of an earth satellite in circular orbit is independent of
a) the mass of the satellite
b) radius of its orbit
c) both the mass and radius of the orbit
d) neither the mass of the satellite nor the radius of its orbit

➢ a

T = $2\pi\sqrt{\frac{\pi^3}{GM}}$

M is mass of earth not that of satellite
$\therefore$ T does not depend on the mass of the satellite

20. If 'g' the acceleration due to gravity on the earth's surface, the gain in the pontial energy of an object of mass 'm' raised from the surface of the earth to a height eqaal to the radius 'R' of the earth is
a) 2 mgR
b) $\frac{1}{2}$mgR
c) $\frac{1}{4}$mgR
d) mgR

➢ b

$PE_1 = \frac{-GM}{R}$; $PE_2 = \frac{-GMm}{R+R} = \frac{-GMm}{2R}$

$\Delta PE = PE_2 - PE_1$

$= \frac{-GMm}{2R} + \frac{GMm}{R}$

$= \frac{GMm}{2R}$

but GM = gR^2

$\therefore \Delta PE = \frac{gR^2 \times m}{2R} = \frac{1}{2} mgR$

21. Suppose the gravitational force varies inversely as the n^{th} power of distance. Then the time period of a planet in circular orbit of radius 'R' around the sun will be proportional to

a) $R^{\left(\frac{n+1}{2}\right)}$

b) $R^{\left(\frac{n-1}{2}\right)}$

c) R^{n}

d) $R^{\left(\frac{n-2}{2}\right)}$

➢ a

Gratstatrind force = $F = \frac{GMm}{R^n} = mRw^2$

$\therefore GM = R^{n+1}.\frac{4\pi^2}{T^2}$

$T^2 = R^{n+1}.\frac{4\pi^2}{GM}$

$\frac{4\pi^2}{GM}$ is constant $\therefore T^2 \; \alpha \; R^{n+1}$

$\therefore \; T \alpha R\left(\frac{n+1}{2}\right)$

22. A wire fixed at the upper end stretches by length l by applying a force F. The work done in stretching is

a) $\frac{F}{2l}$

b) Fl

c) 2Fl

d) $\frac{Fl}{2}$

➢ d

$dh = F\,.dx = \frac{YA}{L}.x.dx$

x = eytausian

$W = \int \frac{YA}{L}.x.dx = \frac{YA}{L}.\frac{L}{2}$

$= \frac{YA}{L}.L.\frac{L}{2} = \frac{FL}{2}$

23. Spherical balls of radius 'R' are falling in a viscous fluid of viscosity ' η ' with a velocity 'v' the retarding viscous acting on the spherical ball is
a) directly proportional to 'R' but inversely proportional to 'v'
b) directly proportional to both rasius 'R' and velocity 'v'
c) inversely proportional to both radius 'R' and velocity 'v'
d) inversely proportional to 'R' but directly proportional to velocity 'v'

➢ b.

Retandiry its cous force accerdiry to Stokes law is F = 6 π^2RV

$\because F \alpha RV$

24. If two soap bubbles of different radii are connected by a tube,
a) air flows from the bigger bubble to the smaller bubble till the sizes become equal
b) air flows from bigger bubble to the smaller bubble till the sizes are interchanged
c) air flows from the smaller bubble to the bigger
d) there is no flow of air

➢ c

$$P = \frac{4T}{r}$$

$$P \alpha \frac{1}{r}$$

$\therefore$ air blows from smaller bubble to the bigger
$\therefore$ p of smaller is more then bigger

25. The bob of a simple pendulum executes simple harmonic motion in water with a period t, while the period of oscillation of the bob is t_0 in air. Neglectivg frictional force of water nad given that the density of the bob is $(4/3) \times 1000\ kg/m^3$. What relationship between t and t_o is true ?

a) $t = t_0$

b) $t = t_0 / 2$

c) $t = 2t_0$

d) $t = 4t_0$

➢ c

to $2\pi\sqrt{\frac{L}{g}}$

$$t = 2\pi\sqrt{\frac{L}{g^1}} = 2\pi\sqrt{\frac{L}{g(1-\frac{\sigma}{\rho})}}$$

In water

ρ - denisty of = $\frac{4}{3} \times 1000 kg/m^3$

σ - decisty of water = 1000 kg/m^3

$$\therefore t = 2\pi \frac{L}{g\left(1 - \frac{1000}{\frac{4}{3}\times 1000}\right)} = 2\pi\sqrt{\frac{L}{g\left(1-\frac{3}{4}\right)}}$$

$$= 2\pi\sqrt{\frac{L}{g\times\frac{1}{4}}} = 2\pi\sqrt{\frac{4L}{g}} \qquad = 2\times 2\pi\sqrt{\frac{L}{g}}$$

$t = 2\times t_0$

26. A particle at the end of a spring executes S.H.M. with a period t_1 while the corresponding period for another spring is t_2. If the period of oscillation with the two springs in series is T, then

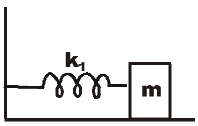
a) $T = t_1 + t_2$

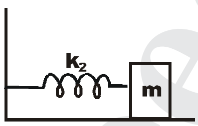
b) $T^2 = t_1^2 + t_2^2$

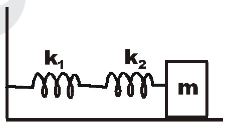
c) $T^{-1} = t_1^{-1} + t_2^{-1}$

d) $T^{-2} = t_1^{-2} + t_2^{-2}$

➢ d







$t_1 = 2\pi\sqrt{\frac{m}{k_1}}$ $\qquad t_2 = 2\pi\sqrt{\frac{m}{u_2}}$ $\qquad T = 2\pi\frac{m(k_1+k_2)}{k_1k_2}$

$$\frac{1}{k} = \frac{1}{k_1} + \frac{1}{k_2}$$

$$t_1^2 = 4\pi^2.\frac{m}{k_1} \qquad k_1 = 4\pi^2 m.\frac{1}{t_1^2}\ ;k_2 = 4\pi^2 m.\frac{1}{t_2^2}$$

$$\frac{1}{k} = \frac{1}{k_1} + \frac{1}{k_2}$$

$$4\pi^2 m.\frac{1}{T^2} = 4\pi^2 m.\frac{1}{t_1^2} + 4\pi^2 m.\frac{1}{t_2^2}$$

$$\Rightarrow T^{-2} = t_1^{-2} + t_2^{-2}$$

27. The total energy of a particle, executing simple harmonic motion is

a) α x

b) αx^2

c) independent of x

d) $\alpha x^{1/2}$

where x is the displacement from the mean position

➢ c

Total energy during SHM is constant and is grieus by , E = $\frac{1}{2} m Co^2 A^2$

Where A $\rightarrow$ Amptitide

$\therefore$ E does not depend on x

28. The displacement y of a particle in a medium can be expressed as $y = 10^{-6} \sin(100t + 20x + \pi/4)m$ where t is in second and x in meter. The speed of the wave is

a) 2000 m/s

b) 5 m/s

c) 20 m/s

d) 5 π m/s

➢ b.

Comparing is the standred of eq for displacement

y = A sin (cot + Kx + φ)

w = 100 = 2 π η ; η = $\frac{100}{2\pi}$

k= 20 = $\frac{2\pi}{\lambda}$; $\lambda = \frac{2\pi}{20}$

wave speed = $V = \eta\lambda = \frac{100}{2\pi} \times \frac{L\pi}{20} = 5m/s$

29. A particle of mass m is attached to a spring (of spring constant k) and has a natural angular frequency ω_0. A n external force F(t) proportional to cos ω t($\omega = \omega_0$) is applied to the oscillator. The time displacement of the oscillator will be proportional to

a) $m/(\omega_0^2 - \omega^2)$

b) $\frac{1}{m(\omega_0^2 - \omega^2)}$

c) $\frac{1}{m(\omega_0^2 + \omega^2)}$

d) $\frac{m}{m(\omega_0^2 - \omega^2)}$

➢ **c**

$\omega_o = \sqrt{\frac{k}{m}}$ $\quad\quad k = m\omega_o^2$

$F = \cos \omega t$

30. In forced oscillation of a particle the amplitude is maximum for a frequancy ω_1 of the force, while the energy is maximum for frequency ω_2 of the force; then

a) $\omega_1 = \omega_2$

b) $\omega_1 > \omega_2$

c) $\omega_1 < \omega_2$ when damping is small and $\omega_1 > \omega_2$ when damping is large

d) $\omega_1 < \omega_2$

➢ **a**

Both amplitude & energy get maximised when the frequency is equal to natural frequency i.e. the condition of reasonance.