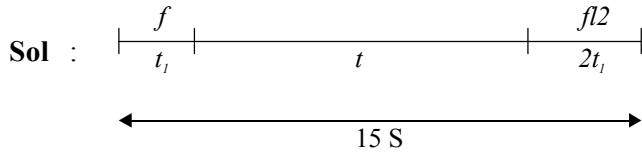


PHYSICS

1. A car, starting from rest, accelerates at the rate f through a distance S , then continues at constant speed for time t and then decelerates at the rate $\frac{f}{2}$ to come to rest. If the total distance traversed is $15S$, then

- 1) $S = \frac{1}{6} ft^2$ 2) $S = ft$ 3) $S = \frac{1}{4} ft^2$ 4) $S = \frac{1}{2} ft^2$



$$\frac{1}{2}ft_1^2 + ft_1t + \frac{1}{2}\frac{f}{2} \times 2t_1^2 = 15S$$

$$\Rightarrow S + ft_1t + 2S = 15S$$

$$\Rightarrow ft_1t = 12S \quad (1)$$

$$\frac{1}{2}ft_1^2 = S \quad (2)$$

Dividing (1) by (2), we get

$$t_1 = \frac{1}{6}$$

$$\Rightarrow S = \frac{1}{2}f\left(\frac{t}{6}\right)^2 = \frac{ft^2}{72}$$

None of the given options is correct

2. A particle is moving eastwards with a velocity of 5 ms^{-1} . In 10 seconds the velocity charges to 5 ms^{-1} northwards. The average acceleration in this time is

- 1) $\frac{1}{2} \text{ ms}^{-2}$ towards north 2) $\frac{1}{\sqrt{2}} \text{ ms}^{-2}$ towards north-east
 3) $\frac{1}{\sqrt{2}} \text{ ms}^{-2}$ towards north-west 4) zero

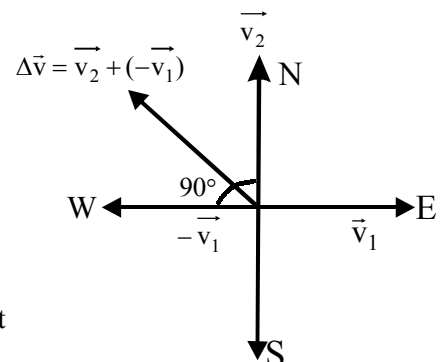
Sol: (2) Average acceleration = $\frac{\text{Change in velocity}}{\text{Time interval}} = \frac{\Delta\vec{v}}{t}$

$$\Delta\vec{v} = (\vec{v}_2 - \vec{v}_1) = \sqrt{v_1^2 + v_2^2 + 2v_1v_2\cos 90^\circ}$$

$$= \sqrt{5^2 + 5^2 + 0} \quad [\text{As } |v_1| = |v_2| = 5 \text{ m/s}]$$

$$= 5\sqrt{2} \text{ m/s}$$

$$\text{Average acceleration} = \frac{\Delta\vec{v}}{t} = \frac{5\sqrt{2}}{10} = \frac{1}{\sqrt{2}} \text{ m/s}^2 \text{ towards North - West}$$



3. Out of the following pair, which one does NOT have identical dimensions is
- 1) impulse and momentum
 - 2) angular momentum and Planck's constant
 - 3) work and torque
 - 4) moment of inertia and moment of force

Sol: (4)

4. The relation between time t and distance x is $t = ax^2 + bx$ where a and b are constants. The acceleration is
- 1) $2b/v^3$
 - 2) $-2ab/v^2$
 - 3) $2a/v^2$
 - 4) $-2av^3$

Sol: (4)

$t = ax^2 + bx$; diff. with respect to time (t)

$$\frac{d}{dt}t = a \frac{d}{dt}(x^2) + b \frac{dx}{dt} = a \cdot 2x \frac{dx}{dt} + b \cdot v.$$

$$1 = 2axv + bv = v(2ax + b)$$

$$2ax + b = \frac{1}{v} \dots \text{diff.}$$

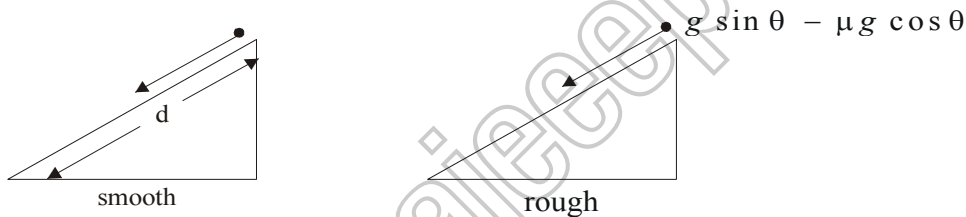
$$2av = -\frac{1}{v^2} f$$

$$f = -2av^3$$

5. A smooth block is released at rest on a 45° incline and then slides a distance 'd'. The time taken to slide is 'n' times as much a slide on rough incline than on a smooth incline. The coefficient of friction is

- 1) $\mu_k = \sqrt{1 - \frac{1}{n^2}}$
- 2) $\mu_k = 1 - \frac{1}{n^2}$
- 3) $\mu_k = \sqrt{1 - \frac{1}{n^2}}$
- 4) $\mu_k = 1 - \frac{1}{n^2}$

Sol: 2)



$$d = \frac{1}{2} (g \sin \theta) t^2$$

$$d = \frac{1}{2} g \sin \theta \cdot t^2$$

$$t_1 = \sqrt{\frac{2d}{g \sin \theta}} \quad t_2 = \sqrt{\frac{2d}{g \sin \theta - \mu g \cos \theta}}$$

$$n \sqrt{\frac{2d}{g \sin \theta}} = \sqrt{\frac{2d}{g \sin \theta - \mu g \cos \theta}}$$

$$n = \frac{1}{\sqrt{1 - \mu}}$$

$$n^2 = \frac{1}{1 - \mu}$$

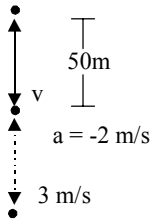
$$1 - \mu = \frac{1}{n^2}$$

$$\mu = 1 - \frac{1}{n^2}$$

6. A parachutist after bailing out falls 50 m without friction. When parachute opens, it decelerates at 2 m/s^2 . He reaches the ground with a speed of 3 m/s . At what height, did he bail out?

- a) 182 m 2) 91 m 3) 111 m 4) 293 m

Sol : (4)



$$v = \sqrt{2gh}$$

$$v = \sqrt{2 \times 9.8 \times 50} = 14\sqrt{5}$$

$$S = \frac{v^2 - u^2}{2 \times a} = \frac{3^2 - 980}{4} \approx 244 \text{ m}$$

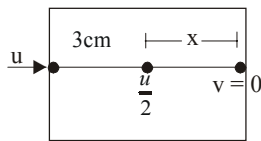
Initially he has fallen 50 m

$$\therefore \text{Total height from where he bailed out} = 244 + 50 = 294 \text{ m}$$

7. A bullet fired into a fixed target loses half of its velocity after penetrating 3 cm. How much further it will penetrate before coming to rest further it will penetrate before coming to rest assuming that it faces constant resistance to motion ?

- 1) 2.0 m 2) 3.0 m 3) 1.0 m 4) 1.5 m

Sol: (3)



$$\left(\frac{u}{2}\right)^2 - u^2 = 2 \cdot a \cdot 3$$

$$\frac{3u^2}{4} = 2 \cdot a \cdot 3$$

$$a = \frac{u^2}{8}$$

$$0 - \left(\frac{u}{2}\right)^2 = 2 \cdot a \cdot x$$

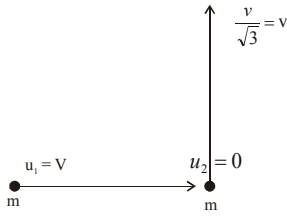
$$\frac{u^2}{4} = 2 \cdot \frac{u^2}{8} \times x$$

$$x = 1 \text{ cm}$$

8. An annular ring with inner and outer radii R_1 and R_2 is rolling without slipping with a uniform angular speed. The ratio of the forces experienced by the two particles situated on the inner and outer parts of the ring, $\frac{F_1}{F_2}$ is

- 1) $\left(\frac{R_1}{R_2}\right)^2$ 2) $\frac{R_2}{R_1}$ 3) $\frac{R_1}{R_2}$ 4) 1

Sol: 4)



In x direction : $mv + 0 = m(0) + m(v_2)_x$

In y direction : $0 + 0 = m\left(\frac{v}{\sqrt{3}}\right) + m(v_2)_y$ is

$$(V_2)_y = -\frac{V}{\sqrt{3}} \quad (V_2)_x = V$$

$$\therefore V_2 = \sqrt{\left(\frac{V}{\sqrt{3}}\right)^2 + V^2} = \sqrt{\frac{V^2}{3} + V^2} = V\sqrt{\frac{4}{3}}$$

$$= \frac{2V}{\sqrt{3}}$$

12. A particle of mass 0.3 kg is subjected to a force $F = -kx$ with $k = 15 \text{ N/m}$. What will be its initial acceleration if it is released from a point 20 cm away from the origin ?

- 1) 15 m/s^2 2) 3 m/s^2 3) 10 m/s^2 4) 5 m/s^2

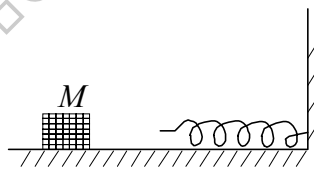
Sol: 3)

$$m = 0.3 \Rightarrow F = m.a. = -15x$$

$$a = -\frac{15}{0.3}x = -\frac{150}{3}x = -50x$$

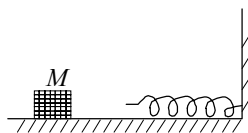
$$a = -50 \times 0.2 = 10 \frac{\text{m}}{\text{s}^2}$$

13. The block of mass M moving on the frictionless horizontal surface collides with the spring of spring constant K and compresses it by length L . The maximum momentum of the block after collision is



- 1) $\frac{KL^2}{2M}$ 2) $\sqrt{MK} L$ 3) $\frac{ML^2}{K}$ 4) Zero

Sol: 2)

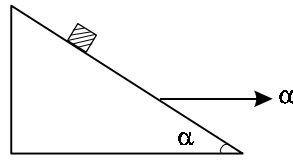


$$\frac{1}{2}mv^2 = \frac{1}{2}kl^2 : V = \sqrt{\frac{K}{m}} \cdot L$$

$$\text{Momentam} = m \times v = m \times \sqrt{\frac{K}{m}} \cdot L$$

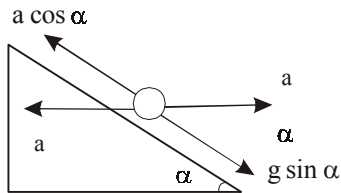
$$= \sqrt{km} \cdot L$$

14. A block is kept on a frictionless inclined surface with angle of inclination ' α '. The incline is given an acceleration ' α ' to keep the block stationary. Then α is equal to



- 1) $g \operatorname{cosec} \alpha$ 2) $g / \tan \alpha$ 3) $g \tan \alpha$ 4) g

Sol: 3)



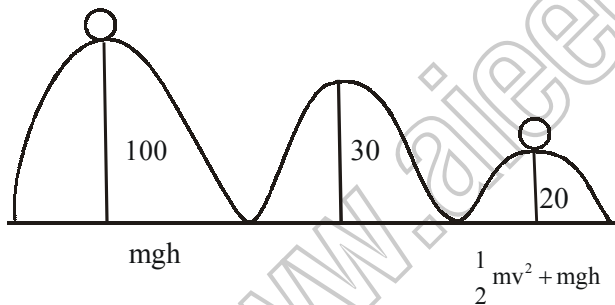
$$g \sin \alpha = a \cos \alpha$$

$$a = g \tan \alpha$$

15. A spherical ball of mass 20 kg is stationary at the top of a hill of height 100 m. It rolls down a smooth surface to the ground, then climbs up another hill of height 30 m and finally rolls down to a horizontal base at a height of 20 m above the ground. The velocity attained by the ball is

- 1) 20 m/s 2) 40 m/s 3) $10\sqrt{30}$ m/s 4) 10 m/s

Sol: 2)



$$10 \times 100 = \frac{1}{2} v^2 + 10 \times 20$$

$$\frac{1}{2} v^2 = 800, \quad v = \sqrt{1600} = 40 \frac{\text{m}}{\text{s}}$$