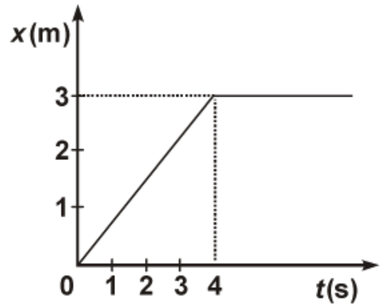
Date: 13/10/2021

Q1. A girl riding a bicycle along a straight road with a speed of $5\ m\,s^{-1}$ throws a stone of mass 0.5 kg which has a speed of $15\ m\,s^{-1}$ with respect to the ground along her direction of motion. The mass of the girl and bicycle is 50 kg. Does the speed of the bicycle change after the stone is thrown? What is the change in speed, if so?

Q2. A person of mass 50 kg stands on a weighing scale on a lift. If the lift is descending with a downward acceleration of $9\ m\,s^{-2}$, what would be the reading of the weighing scale? ($g = 10\ m\,s^{-2}$)

Q3. The position time graph of a body of mass 2 kg is as given in figure. What is the impulse on the body at $t = 0$ s and $t = 4$ s.



Q4. A person driving a car suddenly applies the brakes on seeing a child on the road ahead. If he is not wearing seat belt, he falls forward and hits his head against the steering wheel. Why?

Q5. The velocity of a body of mass 2 kg as a function of t is given by $v(t) = 2t\hat{i} + t^2\hat{j}$. Find the momentum and the force acting on it, at time $t = 2$s.

Q6. Why does a child feel more pain when she falls down on a hard cement floor, than when she falls on the soft muddy ground in the garden?

Q7. Why are porcelain objects wrapped in paper or straw before packing for transportation?

Q8. A block placed on a rough horizontal surface is pulled by a horizontal force F. Let f be the force applied by the rough surface on the block. Plot a graph of f versus F.

Q9. A woman throws an object of mass 500 g with a speed of $25\ m\,s^{1}$.

(a) What is the impulse imparted to the object?

(b) If the object hits a wall and rebounds with half the original speed, what is the change in momentum of the object?

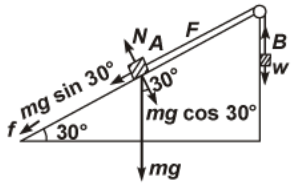
Q10. Why are mountain roads generally made winding upwards rather than going straight up?

Q11. A person in an elevator accelerating upwards with an acceleration of $2\ m\,s^{-2}$, tosses a coin vertically upwards with a speed of $20\ m\,s^{1}$. After how much time will the coin fall back into his hand? ($g = 10\ m\,s^{-2}$)

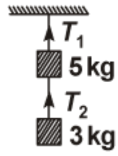
Q12. A 100 kg gun fires a ball of 1 kg horizontally from a cliff of height 500 m. It falls on the ground at a distance of 400m from the bottom of the cliff. Find the recoil velocity of the gun. (acceleration due to gravity = $10\ m\,s^{-2}$)

Q13. A block of mass M is held against a rough vertical wall by pressing it with a finger. If the coefficient of friction between the block and the wall is μ and the acceleration due to gravity is g, calculate the minimum force required to be applied by the finger to hold the block against the wall?

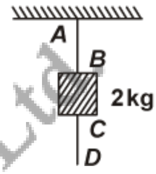
Q14. Block A of weight 100 N rests on a frictionless inclined plane of slope angle 30° (see figure). A flexible cord attached to A passes over a frictionless pulley and is connected to block B of weight W. Find the weight W for which the system is in equilibrium.



Q15. Two masses of 5 kg and 3 kg are suspended with help of massless inextensible strings as shown in figure. Calculate T_1 and T_2 when whole system is going upwards with acceleration = 2 m s^2 (use g = 9.8 m s^{-2}).

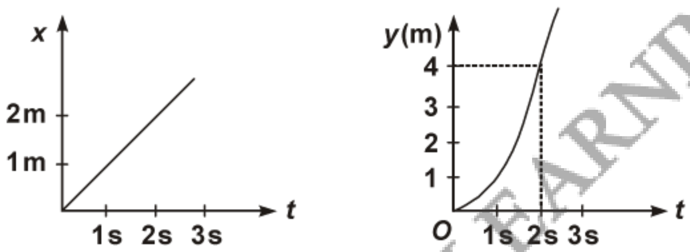


Q16. A mass of 2 kg is suspended with thread AB (see figure). Thread CD of the same type is attached to the other end of 2 kg mass. Lower thread is pulled gradually, harder and harder in the downward direction so as to apply force on AB. Which of the threads will break and why?



Q17. In the above given problem if the lower thread is pulled with a jerk, what happens?

Q18. Figure shows (x, t), (y, t) diagram of a particle moving in 2-dimensions.



(a) (b)

If the particle has a mass of 500 g, find the force (direction and magnitude) acting on the particle.

Q19. There are three forces F_1, F_2 and F_3 acting on a body, all acting on a point P on the body. The body is found to move with uniform speed.

(a) Show that the forces are coplanar.

(b) Show that the torque acting on the body about any point due to these three forces is zero.

Q20. A cricket bowler releases the ball in two different ways

(a) giving it only horizontal velocity, and

(b) giving it horizontal velocity and a small downward velocity.

The speed vs at the time of release is the same. Both are released at a height H from the ground. Which one will have greater speed when the ball hits the ground? Neglect air resistance.

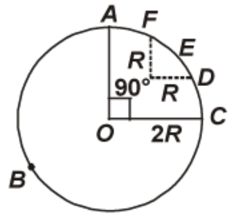
Q21. When a body slides down from rest along a smooth inclined plane making an angle of 45° with the horizontal, it takes time T. When the same body slides down from rest along a rough inclined plane making the same angle and through the same distance, it is seen to take time pT, where p is some number greater than 1. Calculate the co-efficient of friction between the body and the rough plane.

Q22. The displacement vector of a particle of mass m is given by $r(t) = \hat{i} A \cos \omega t + \hat{j} B \sin \omega t$.

(a) Show that the trajectory is an ellipse.

(b) Show that $F = -m\omega^2 r$.

Q23. A racing car travels on a track (without banking) *ABCDEFA* (see figure). *ABC* is a circular arc of radius 2*R*. *CD* and *FA* are straight paths of length *R* and *DEF* is a circular arc of radius $R = 100$ m. The co-efficient of friction on the road is $\mu = 0.1$. The maximum speed of the car is 50 m s^{-1}. Find the minimum time for completing one round.



Q24. A rectangular box lies on a rough inclined surface. The co-efficient of friction between the surface and the box is μ. Let the mass of the box be m.

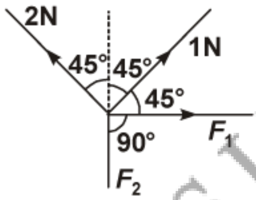
(a) At what angle of inclination θ of the plane to the horizontal will the box just start to slide down the plane?

(b) What is the force acting on the box down the plane, if the angle of inclination of the plane is increased to $\alpha > \theta$?

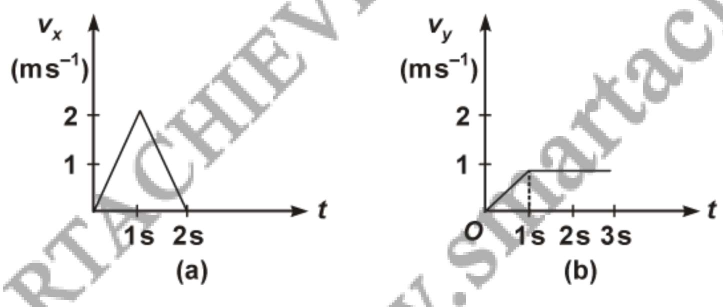
(c) What is the force needed to be applied upwards along the plane to make the box either remain stationary or just move up with uniform speed?

(d) What is the force needed to be applied upwards along the plane to make the box move up the plane with acceleration a?

Q25. There are four forces acting at a point *P* produced by strings as shown in figure, which is at rest. Find the forces F_1 and F_2.



Q26. Figure shows (v_x, t), and (v_y, t) diagrams for a body of unit mass. Find the force as a function of time.



Q27. A helicopter of mass 2000kg rises with a vertical acceleration of 15 m s^{-2}. The total mass of the crew and passengers is 500 kg. Give the magnitude and direction of the ($g = 10 \text{ m s}^{-2}$)

(a) force on the floor of the helicopter by the crew and passengers.

(b) action of the rotor of the helicopter on the surrounding air.

(c) force on the helicopter due to the surrounding air.

Date: 13/10/2021

S1. Given, total mass of girl, bicycle and stone $m_1 = (50 + 0.5)$ kg = 50.5 kg.

Velocity of bicycle $u_1 = 5$ m/s, Mass of stone $m_2 = 0.5$ kg

Velocity of stone $u_2 = 15$ m/s, Mass of girl and bicycle $m = 50$ kg

Yes, the speed of the bicycle changes after the stone is thrown.

Let after throwing the stone the speed of bicycle be v m/s.

According to law of conservation of linear momentum,

$$m_1 u_1 = m_2 u_2 + mv$$

$$50.5 \times 5 = 0.5 \times 15 + 50 \times v$$

$$252.5 - 7.5 = 50v$$

or $$v = \frac{245.0}{50}$$

$$v = 4.9 \text{ m/s}$$

Change in speed = 5 – 4.9 = 0.1 m/s.

S2. When a lift descends with a downward acceleration a the apparent weight of a body of mass m is given by

Weight measured by the machine is the reaction R.

$$W' = R = m(g - a)$$

Mass of the person, $m = 50$ kg

Descending acceleration, $a = 9$ m/s^2

Acceleration due to gravity, $g = 10$ m/s^2

Apparent weight of the person, $R = m(g - a)$

$= 50(10 - 9)$

$= 50$ N

$\therefore$ Reading of the weighing scale = $\frac{R}{g} = \frac{50}{10}$ = 5 kg.

S3. Given, mass of the body (m) = 2 kg

From the position-time graph, the body is at $x = 0$ when $t = 0$, *i.e.*, body is at rest.

$\therefore$ Impulse at $t = 0$, $s = 0$, is zero.

From $t = 0s$ to $t = 4s$, the position-time graph is a straight line, which shows that body moves with uniform velocity.

Beyond t = 4s, the graph is a straight line parallel to time axis, *i.e.*, body is at rest (v = 0).

$$\text{Velocity of the body} = \text{Slope of position-time graph}$$

$$= \tan\theta = \frac{3}{4} \text{ m/s}$$

$$\text{Impulse (at } t = 4s) = \text{Change in momentum}$$

$$= mv - mu$$

$$= m(v - u)$$

$$= 2\left(0 - \frac{3}{4}\right)$$

$$= -\frac{3}{2} \text{ kg m/s} = -1.5 \text{ kg m/s.}$$

S4. The only retarding force that acts on him, if he is not using a seat belt comes from the friction exerted by the seat. This is not enough to prevent him from moving forward when the vehicle is brought to a sudden halt.

S5. Given, Mass of the body $m = 2$ kg

Velocity of the $v(t) = 2t\hat{i} + t^2\hat{j}$

∴ Velocity of the body at $t = 2s$

$$\boldsymbol{v} = 2 \times 2\hat{i} + (2)^2\hat{j} = (4\hat{i} + 4\hat{j})$$

$$\text{Momentum of the body } (p) = m\boldsymbol{v}$$

$$= 2(4\hat{i} + 4\hat{j}) = (8\hat{i} + 8\hat{j}) \text{ kg m/s}$$

$$\text{Acceleration of the body } (a) = \frac{d\boldsymbol{v}}{dt}$$

$$= \frac{d}{dt}(2t\hat{i} + t^2\hat{j})$$

$$= (2\hat{i} + 2t\hat{j})$$

At $t = 2s$

$$\boldsymbol{a} = (2\hat{i} + 2 \times 2\hat{j})$$

$$= (2\hat{i} + 4\hat{j})$$

$$\text{Force acting on the body } (\boldsymbol{F}) = m\boldsymbol{a}$$

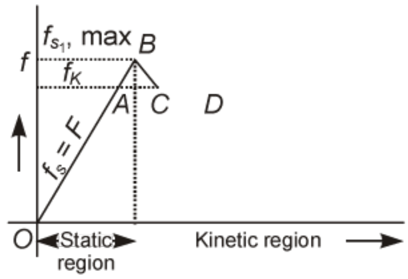
$$= 2(2\hat{i} + 4\hat{j})$$

$$= (4\hat{i} + 8\hat{j}) \text{ N}$$

S6. The body of the child is brought to a sudden halt when she/he falls on a cement floor. The mud floor yields and the body travels some distance before it comes to rest , which takes some time. This means the force which brings the child to rest is less for the fall on a mud floor, as the change in momentum is brought about over a longer period.

S7. In transportation, the vehicle say a truck, may need to halt suddenly. To bring a fragile material, like porcelain object to a sudden halt means applying a large force and this is likely to damage the object. If it is wrapped up in say, straw, the object can travel some distance as the straw is soft before coming to a halt. The force needed to achieve this is less, thus reducing the possibility of damage.

S8. The approximate graph is shown in the diagram



The frictional force f is shown on vertical axis and the applied force F is shown on the horizontal axis. The portion OA of graph represents static friction which is self adjusting. In this portion $f = F$.

The point B corresponds to force of limiting friction which is the maximum value of static friction. $CD \parallel OX$ represents kinetic friction, when the body actually starts moving. The force of kinetic friction does not increase with applied force, and is slightly less than limiting friction.

S9. Mass of the object (m) = 500 g = 0.5 kg

Speed of the object (v) = 25 m/s

(a) Impulse imparted to the object = Change in momentum

$$= mv - mu$$

$$= m(v - u)$$

$$= 0.5\,(25 - 0) = 12.5 \text{ N s}$$

(b) Velocity of the object after rebounding

$$= -\frac{25}{2} \text{ m/s}$$

$$v' = -12.5 \text{ m/s}$$

∴ Change in momentum $= m(v' - v)$

$$= 0.5\,(-12.5 - 25) = -18.75 \text{ N s.}$$

S10. $f = \mu R = \mu\, mg \cos\theta$ is the force of friction, if θ is angle made by the slope. If θ is small, force of friction is high and there is less chance of skidding. The road straight up would have a larger slope.

S11. Here, Initial speed of the coin (u) = 20 m/s

Acceleration of the elevator (a) = 2 m/s^2

Acceleration due to gravity (g) = 10 m/s^2

∴ Effective acceleration $a' = g + a = 10 + 2 = 12$ m/s^2 [Here, acceleration is w.r.t. the lift]

If the time of ascent of the coin is t, then

$$v = u + at$$

$$0 = 20 + (-12) \times t$$

or $$t = \frac{20}{12} = \frac{5}{3}\text{ s}$$

Time of ascent = Time of descent

$\therefore$ Total time after which the coin fall back into hand

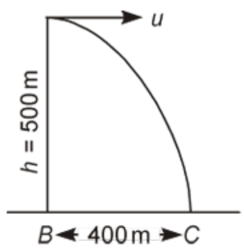
$$= \left(\frac{5}{3} + \frac{5}{3}\right)\text{s} = \frac{10}{3}\text{ s} = 3.33\text{ s.}$$

S12. Given, Mass of the gun (m_1) = 100 kg

Mass of the ball (m_2) = 1 kg

Height of the cliff (h) = 500 m

Horizontal distance travelled by the ball (x) = 400 m



From $$h = \frac{1}{2}gt^2 \qquad [\because \text{ Initial velocity in downward direction is zero}]$$

$$500 = \frac{1}{2} \times 10\,t^2$$

$$t = \sqrt{100} = 10\text{s}$$

From $$x = ut, \quad u = \frac{x}{t} = \frac{400}{10} = 40\ m/s$$

If v is recoil velocity of gun, then according to principle of conservation of linear momentum,

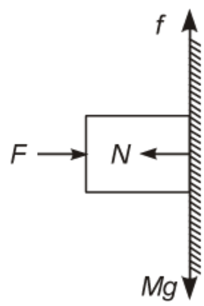
$$m_1 v = m_2 u$$

$$v = \frac{m_2 u}{m_1} = \frac{1}{100} \times 40 = 40\text{ m/s.}$$

S13. Given, mass of the block = M.

Coefficient of friction between the block and the wall = μ.

Let a force F be applied on the block to hold the block against the wall. The normal reaction of mass be N and force of friction acting upward be f, In equilibrium, vertical and horizontal forces should be balanced separately.



$\therefore$ $$f = Mg \qquad \text{... (i)}$$

and $$F = \text{N} \qquad \text{... (ii)}$$

But force of friction (f) = μN

$$= \mu F \qquad \text{[Using Eq. (ii)]} \quad \text{... (iii)}$$

From Eqs. (i) and (iii), we get

$$\mu F = Mg$$

$$F = \frac{Mg}{\mu}.$$

S14. In equilibrium, the force $mg \sin \theta$ acting on block A parallel to the plane should be balanced by the tension in the string, i.e,

$$mg \sin \theta = T = F \qquad [\because \ T = F \text{ given}] \qquad \dots \text{(i)}$$

and for block B, $$W = T = F \qquad \dots \text{(ii)}$$

where, W is weight of block B.

From, Eqs. (i) and (ii), we get

$$\therefore \quad W = mg \sin \theta$$

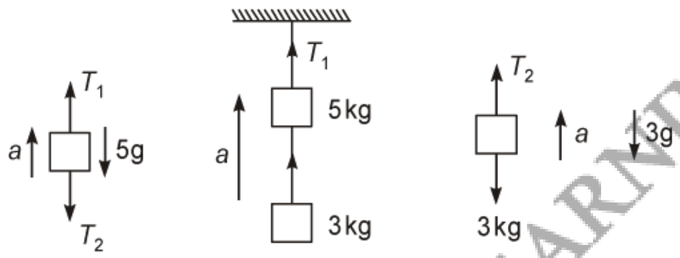
$$= 100 \times \sin 30° \qquad [\because \ mg = 100 \text{ N}]$$

$$= 100 \times \frac{1}{2} \text{ N} = 50 \text{ N}$$

Note: While finding normal reaction in such cases, we should be careful it will be N = $mg \cos \theta$, where θ is angle of inclination.

S15. Given, $$m_1 = 5 \text{ kg}, \quad m_2 = 3 \text{ kg}$$

$$g = 9.8 \text{ m/s}^2 \quad \text{and} \quad a = 2 \text{ m/s}^2$$



For the upper block $T_1 - T_2 - 5g = 5a$

$$\Rightarrow \quad T_1 - T_2 = 5(g + a) \qquad \dots \text{(i)}$$

For the lower block $T_2 - 3g = 3a$

$$\Rightarrow \quad T_2 = 3(g + a) = 3(9.8 + 2) = 34.4 \text{ N}$$

From Eq. (i) $$T_1 = T_2 + 5(g + a)$$

$$= 35.4 + 5(9.8 + 2) = 94.4 \text{ N}$$

S16. The thread AB will break earlier than the thread CD. This is because force acting on thread CD = applied force and force acting on thread AB = (applied force + weight of 2 kg mass).

Hence, force acting on thread AB is larger than the force acting on thread CD.

S17. If the force is large and sudden, thread CD breaks because as CD is jerked, the pull is not transmitted to AB instantaneously (transmission depends on the elastic properties of the body).

Therefore, before the mass moves, CD breaks.

S18. Clearly from diagram (a), the variation can be related as

$$x = t \quad \Rightarrow \quad \frac{dx}{dt} = 1 \text{ m/s}$$

$$a_x = 0$$

From diagram (b) $y = t^2$

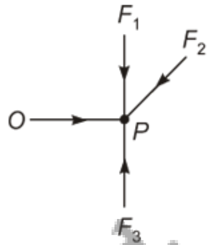
$$\Rightarrow \quad \frac{dy}{dt} = 2t \quad \text{or} \quad a_y = \frac{d^2y}{dt^2} = 2\,\text{m/s}^2$$

Hence, $F_y = ma_y = 500 \times 10^{-3} \times 2 = 1\text{N}$ [$\because$ $m = 500\,\text{g}$)

$F_x = ma_x = 0$

Hence, net force, $F = \sqrt{F_x^2 + F_y^2} = F_y = 1\,\text{N}$ [Along y-axis]

S19. (a) Since the body is moving with no acceleration, the sum of the forces is zero $\boldsymbol{F_1} + \boldsymbol{F_2} + \boldsymbol{F_3} = 0$. Let $\boldsymbol{F_1}, \boldsymbol{F_2}, \boldsymbol{F_3}$ be the three forces passing through a point. Let $\boldsymbol{F_1}$ and $\boldsymbol{F_2}$ be in the plane A (one can always draw a plane having two intersecting lines such that the two lines lie on the plane). Then $\boldsymbol{F_1} + \boldsymbol{F_2}$ must be in the plane A. Since $\boldsymbol{F_3} = -(\boldsymbol{F_1} + \boldsymbol{F_2})$, $\boldsymbol{F_3}$ is also in the plane A.



(b) Consider the torque of the forces about P. Since all the forces pass through P, the torque is zero. Now consider torque about another point 0. Then torque about 0 is

$$\text{Torque} = \boldsymbol{OP} \times (\boldsymbol{F_1} + \boldsymbol{F_2} + \boldsymbol{F_3})$$

Since, $\boldsymbol{F_1} + \boldsymbol{F_2} + \boldsymbol{F_3} = 0$, torque = 0.

S20. (a) **When ball is given only horizontal velocity:** Horizontal velocity at the time of release $(u_x) = v_s$.

During projectile motion, horizontal velocity remains unchanged,

Therefore, $v_x = u_x = v_s$

In vertical direction, $v_y^2 = u_y^2 + 2gH$

$v_y = \sqrt{2gH}$ [$\because$ $u_y = 0$]

$\therefore$ Resultant speed of the ball at bottom,

$$v = \sqrt{v_x^2 + v_y^2}$$

$$= \sqrt{v_s^2 + 2gH} \quad \text{... (i)}$$

(b) **When ball is given horizontal velocity and a small downward velocity**

Let the ball be given a small downward velocity u.

In horizontal direction $v'_x = u_x = v_s$

In vertical direction $v'^2_y = u^2 + 2gH$

or $v'_y = \sqrt{u^2 + 2gH}$

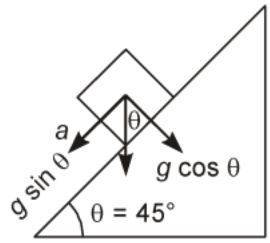
$\therefore$ Resultant speed of the ball at the bottom

$$v' = \sqrt{v_x^2 + v_y^2} = \sqrt{v_s^2 + u^2 + 2gH} \quad \text{... (ii)}$$

From Eqs. (i) and (ii), we get $v' > v$.

S21. Consider the diagram where a body slides down from along an inclined plane of inclination θ (= 45°)

On smooth inclined plane: Acceleration of a body sliding down a smooth inclined plane



$$a = g \sin\theta$$

Here, $\theta = 45°$

$\therefore$ $$a = g \sin 45° = \frac{g}{\sqrt{2}}$$

Let the travelled distance be s.

Using equation of motion, $s = ut + \frac{1}{2}at^2$, we get

$$s = 0.t + \frac{1}{2}\frac{g}{\sqrt{2}}T^2$$

or $$s = \frac{gT^2}{2\sqrt{2}} \quad \text{... (i)}$$

On rough inclined plane: Acceleration of the body $a = g(\sin\theta - \mu\cos\theta)$

$$= g(\sin 45° - \mu \cos 45°)$$

$$= \frac{g(1-\mu)}{\sqrt{2}} \quad \left[\text{As, } \sin 45° = \cos 45° = \frac{1}{\sqrt{2}}\right]$$

Again using equation motion, $s = ut + \frac{1}{2}at^2$, we get

$$s = 0(pT) + \frac{1}{2}\frac{g(1-\mu)}{\sqrt{2}}(pT)^2$$

or $$s = \frac{g(1-\mu)p^2T^2}{2\sqrt{2}} \quad \text{... (ii)}$$

From Eqs. (i) and (ii), we get

$$\frac{g(1-\mu)}{\sqrt{2}} = \frac{g(1-\mu)p^2T^2}{2\sqrt{2}}$$

or $$(1-\mu)p^2 = 1$$

or $$1 - \mu = \frac{1}{p^2}$$

or $$\mu = \left(1 - \frac{1}{p^2}\right).$$

S22. (a) Displacement vector of the particle of mass m is given by

$$\boldsymbol{r}(t) = \hat{\boldsymbol{i}} A \cos\omega t + \hat{\boldsymbol{j}} B \sin\omega t$$

$\therefore$ Displacement along x-axis is,

$$x = A\cos\omega t$$

or $$\frac{x}{A} = \cos \omega t \qquad \text{... (ii)}$$

Displacement along x-axis is,

and $$y = A \cos \omega t$$

or $$\frac{y}{B} = \cos \omega t$$

Squaring and then adding Eqs. (i) and (ii), we get

$$\frac{x^2}{A^2} = \frac{y^2}{B^2} = \cos^2 \omega t + \sin^2 \omega t = 1$$

This an equation of ellipse.

Therefore, trajectory of the particle is an ellipse.

(b) Velocity of the particle $\boldsymbol{v} = \frac{d\boldsymbol{r}}{dt}$

$$= -\hat{\boldsymbol{i}}\,[A(\sin \omega t) . \omega] + \hat{\boldsymbol{j}}\,[B(\cos \omega t) . \omega]$$

$$= -\hat{\boldsymbol{i}}\,A\omega \sin \omega t + \hat{\boldsymbol{j}}\,B\omega \cos \omega t$$

Acceleration of the particle ($\boldsymbol{a}$) = $\frac{d\boldsymbol{v}}{dt}$

or $$\boldsymbol{a} = -\hat{\boldsymbol{i}}\,A\omega \frac{d}{d}(\sin \omega t) + \hat{\boldsymbol{j}}\,B\omega \frac{d}{dt}(\cos \omega t)$$

$$= -\hat{\boldsymbol{i}}\,A\omega^2[\cos \omega t] . \omega + \hat{\boldsymbol{j}}\,B\omega[-\sin \omega t] . \omega$$

$$= -\hat{\boldsymbol{i}}\,A\omega^2 \cos \omega t + \hat{\boldsymbol{j}}\,B\omega^2 \sin \omega t]$$

$$= -\omega^2[\hat{\boldsymbol{i}}\,A \cos \omega t + \hat{\boldsymbol{j}}\,B \sin \omega t]$$

$$= -\omega^2 \boldsymbol{r}$$

∴ Force acting on the particle,

$$F = m\boldsymbol{a} = -\boldsymbol{m}\omega^2 \boldsymbol{r}.$$

S23. For DEF, $$\cancel{m}\frac{v^2}{R} = \cancel{m}\, g\mu$$

$$v_{max} = \sqrt{g\mu R} = \sqrt{100} = 10\,\text{m s}^{-1}$$

For ABC, $$\frac{v^2}{2R} = g\mu, \quad v = \sqrt{200} = 14.14\,\text{m s}^{-1}$$

$$\text{Time for } DEF = \frac{\pi}{2} \times \frac{100}{10} = 5\pi\,\text{s}$$

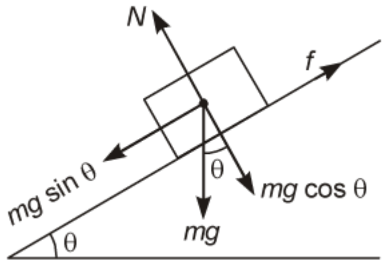
$$\text{Time for } ABC = \frac{3\pi}{2}\,\frac{200}{14.14} = \frac{300\pi}{14.14}\,\text{s}.$$

For $$FA \text{ and } DC = 2 \times \frac{100}{50} = 4\,\text{s}.$$

$$\text{Total time} = 5\pi + \frac{300\pi}{14.14} + 4 = 86.3\,\text{s}.$$

S24. (a) Consider the adjacent diagram, force of friction on the box will act up the plane.

For the box to just starts sliding down



$$mg \sin\theta = \mu N = \mu\, mg \cos\theta$$

or $$\tan\theta = \mu \quad \Rightarrow \quad \theta = \tan^{-1}(\mu)$$

(b) When angle of inclination is increased to $\alpha > \theta$, then net force acting on the box, down the plane is

$$F_1 = mg \sin\alpha - f = mg \sin\alpha - \mu N$$

$$= mg\,(\sin\alpha - \mu \cos\alpha).$$

(c) To keep the box either stationary or just move it up with uniform speed, upward force needed, $F_2 = mg \sin\alpha + f = mg\,(\sin\alpha + \mu\cos\alpha)$ (in this case, friction would act down the plane).

(d) If the box is to be moved with an upward acceleration a, then upward force needed, $F_3 = mg\,(\sin\alpha + \mu\cos\alpha) + ma$.

S25. Resolving into horizontal and vertical components

$$F_2 = \frac{F_3 + F_4}{\sqrt{2}} = \frac{2+1}{\sqrt{2}} = \frac{3}{\sqrt{2}}\,\text{N}$$

$$F_1 + \frac{F_3}{\sqrt{2}} = \frac{F_4}{\sqrt{2}}$$

$$F_1 = \frac{F_4 - F_3}{\sqrt{2}} = \frac{1}{\sqrt{2}}\,\text{N}.$$

S26.

$v_x = 2t$	$0 < t \le 1$	$v_y = t$	$0 < t < 1\text{s}$
$= 2\,(2 - t)$	$1 < t < 2$	$= 11 < t$	
$= 0$	$2 < t$		
$F_x = 2;$	$0 < t < 1$	$F_y = 1$	$0 < t < 1\text{s}$
$= -2;$	$1\text{s} < t < 2\text{s}$	$= 0$	$1\text{s} < t$
$= 0;$	$2\text{s} < t$		

$\boldsymbol{F} = 2\hat{\boldsymbol{i}} + \hat{\boldsymbol{j}}$	$0 < t < 1\text{s}$
$= -2\hat{\boldsymbol{i}}$	$1\text{s} < t < 2\text{s}$
$= 0$	$2\text{s} < t$

S27. Given, Mass of helicopter $(m_1) = 2000\,\text{kg}$

Mass of the crew and passengers $m_2 = 500\,\text{kg}$

Acceleration in vertical direction $a = 15\ \text{m/s}^2\,(\uparrow)$ and $g = 10\,\text{m/s}^2\,(\downarrow)$

(a) Force on the floor of the helicopter by the crew and passengers

$$m_2(g + a) = 500\,(10 + 15)\,\text{N}$$

$$500 \times 25\,\text{N} = 12500\,\text{N}$$

(b) Action of the rotor of the helicopter on the surrounding air = $(m_1 + m_2)(g + a)$

$$= (2000 + 500) \times (10 + 15) = 2500 \times 25$$

$$= 62500 \text{ N (downward)}$$

(c) Force on the helicopter due to the surrounding air

= reaction of force applied by helcopter.

= 62500 N (upward)

Note: We should be very clear when we are balancing action and reaction forces. We must know that which part is action and which part is reaction due to the action.