PHYSICS

DPP

DAILY PRACTICE PROBLEMS

AVIRAL CLASSES

DPP No. 19 to 24

Total Marks : 30

Max. Time : 30 min.

Solution

DPP NO. - 19

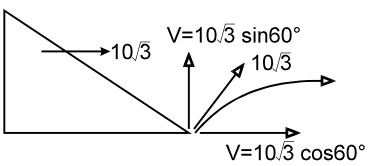
2. In (A) $x_f - x_i$

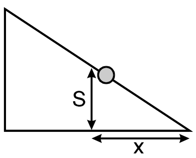
$0 - x = -x = -ve$

So average velocity is – ve.

3. From the graph ; we observe that slope is non–zero positive at t = 0 & slope is continuously decreasing with time and finally becomes zero. Hence we can say that the particle starts with a certain velocity, but the motion is retarded (decreasing velocity)

4. Suppose particle strikes wedge at height 'S' after time t. $S = 15t - \frac{1}{2}10\,t^2 = 15t - 5\,t^2$. During this time distance travelled by particle in horizontal direction $= 5\sqrt{3}$ t. Also wedge has travelled travelled extra distance





$$x = \frac{S}{\tan 30^\circ} = \frac{15t - 5t^2}{1/\sqrt{3}}$$

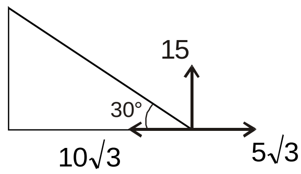
Total distance travelled by wedge in time

$t = 10\sqrt{3}$ t. $= 5\sqrt{3}\,t + \sqrt{3}\,(15 - 5t^2)$

$\Rightarrow$ t = 2 sec.

Alternate Sol.

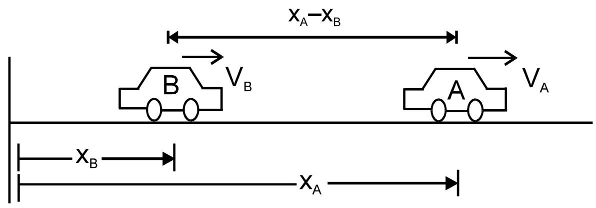
(by Relative Motion)



$$T = \frac{2u\sin 30^\circ}{g\cos 30^\circ} = \frac{2x10\sqrt{3}}{10} \times \frac{1}{\sqrt{3}} = 2 \text{ sec.}$$

$\Rightarrow$ t = 2 sec.

5.



As given

$(V_A - V_B) \propto x_A - x_B$

$(V_A - V_B) = K(x_A - x_B)$

when $x_A - x_B = 10$ We have $V_A - V_B = 10$

We get

$10 = K10 \Rightarrow K = 1$

$\Rightarrow V_A - V_B = (x_A - x_B)$.........(1)

Now Let

$x_A - x_B = y$ ....(2)

On differentiating with respect to 't' on both side.

$\Rightarrow \frac{dx_A}{dt} - \frac{dx_B}{dt} = \frac{dy}{dt} \Rightarrow V_A - V_B = \frac{dy}{dt}$ .... (3)

$\Rightarrow$ Using (1) , (2), (3)

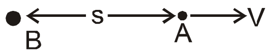
We get $\frac{dy}{dt} = y$

Here y represents sepration between two cars

$$\Rightarrow \int_{10}^{20} \frac{dy}{y} = \int_0^t dt \quad \Rightarrow \quad [\log_e y]_{10}^{20} = t$$

$t = (\log_e 2)$ sec ***Required Answer.***

Alter.



(Assume to be at rest)

$V \propto s$

$V = ks$

$V = 10,\ s = 10,\ k = 1$

$$\frac{ds}{dt} = s \qquad \int_{10}^{20} \frac{ds}{s} = \int_0^t dt$$

6 to 8. At t = 2 sec (t = 2 sec i j)

$v_x = u_x + a_x t = 0 + 10 \times 2 = 20$ m/s

$v_y = u_y + a_y t = 0 - 5 \times 2 = -10$ m/s

$$v = \sqrt{v_x^2 + v_y^2} = \sqrt{(20)^2 + (-10)^2} = 10\sqrt{5} \text{ m/s}$$

From t = 0 to l St = 4 sec

$$x = \left[\frac{1}{2}(10)(2)^2\right]_{(0 \to 2)} + \left[(10 \times 2)2 - \frac{1}{2}(10)(2)^2\right]_{(2 \to 4)}$$

$x = 40$ m

$$y = \left[-\frac{1}{2}5(2)^2\right]_{(0 \to 2)} - \left[(10(2) - \frac{1}{2}(10)(2)^2\right]_{(2 \to 4)}$$

$y = -10$ m

Hence, average velocity of particle between t = 0 to t = 4 sec is

$$v_{av} = \frac{\Delta x}{\Delta t} = \frac{\sqrt{(40)^2 + (-10)^2}}{4}$$

$$v_{av} = \frac{5}{2}\sqrt{17} \text{ m/s}$$

At t = 2 sec u = 10 × 2 = 20 m/s

After t = 2sec

$v = u + at$

$0 = 20 - 10t$

$t = 2$ sec.

Hence, at t = 4 sec. the particle is at its farthest distance from the y-axis.

The particle is at farthest distance from y-axis at $t \geq 4$. Hence the available correct choice is t = 4.

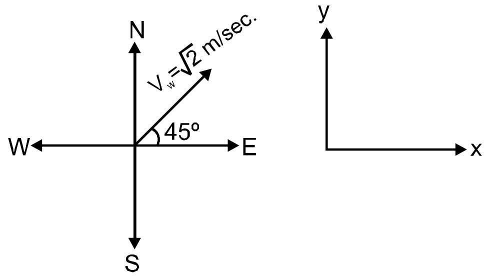
DPP NO. - 20

1. If speed of a particle changes, the velocity of the particle definitely changes and hence the acceleration of the particle is nonzero.

Velocity of a particle change without change in speed.

When speed of a particle varies, its velocity cannot be constant.

2. $V_w = 1\hat{i} + 1\hat{j}$



$V = at$

$V = (0.2)\ 10$

$= 2$ m/sec.

$V_{boat} = 2\hat{i} + 2\hat{j}$

$V_{w/boat} = V_w - V_{boat}$

$V_{w/boat} = (1\hat{i} + 1\hat{j}) - (2\hat{i} + 2\hat{j}) = -1\hat{i} - 1\hat{j}$

So, the flag will flutter towards south–west.

3. The retardation is given by

$$\frac{dv}{dt} = -av^2$$

integrating between proper limits

$\Rightarrow \; -\int_u^v \frac{dv}{v^2} = \int_0^t a\,dt$ or $\frac{1}{v} = at + \frac{1}{u}$

$\Rightarrow \; \frac{dt}{dx} = at + \frac{1}{u}$ $\Rightarrow$ $dx = \frac{u\ dt}{1+aut}$

integrating between proper limits

$\Rightarrow \; \int_0^s dx = \int_0^t \frac{u\,dt}{1+aut}$ $\Rightarrow$ $S = \frac{1}{a} \ln(1 + aut)$

4. V = a + bx
(V increases as x increases)

$\frac{dV}{dt} = b\ \frac{dx}{dt} = bV$

hence acceleration increases as V increases with x.

6. $\vec{v} = -\hat{i} + \hat{j} + 2\hat{k}$

$\vec{a} = 3\hat{i} - \hat{j} + \hat{k}$

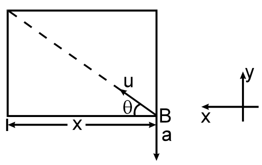
$\vec{a}.\vec{v} = -3 - 1 + 2 < 0$

hence $\theta > 90°$ between $\vec{a}$ and $\vec{v}$
so speed is decreasing

$\vec{a}.\vec{v} = -3 - 1 + 2 < 0$

7. Solving the problem in the frame of train. Taking origin as corner 'B'
Along x axis x-
x = u cosθt ....(1)
Along y axis y-

$y = u_y\, t + \frac{1}{2} a_y\, t^2$



$0 = u \sin\theta\ t - \frac{1}{2} at^2$ ....(2)

As the ball is thrown towards 'D'

$\tan\theta = \frac{\ell}{x}$ .....(3)

From equation (1), (2) & (3) we get

$t = \sqrt{\frac{2\ell}{a}}$ required time after which ball hit the corner.

8. At position A balloon drops first particle So,
$u_A = 0$, $a_A = -g$, t = 3.5 sec.

$S_A = \left(\frac{1}{2} gt^2\right)$ . ...(i)

Balloon is going upward from A to B in 2 sec.so distance travelled by balloon in 2 second.

$\left(S_B = \frac{1}{2} a_B t^2\right)$ ....(ii)

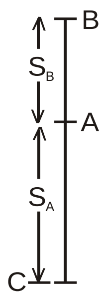
$a_B = 0.4\ m/s^2$, t = 2 sec.

S_1 = BC = (SB + SA) ....(iii)

Distance travell by second stone which is droped from balloon at B

$u_2 = u_B = a_B t = 0.4 \times 2 = 0.8$ m/s
t = 1.5 sec.

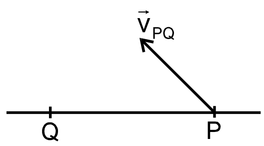
$\left(S_2 = u_2 t - \frac{1}{2} gt^2\right)$ ....(iv)



Distance between two stone
$\Delta S = S_1 - S_2$.

DPP NO. - 21

1.



Q measures acceleration of P to be zero.

∴ Q measures velocity of P, i.e. $\vec{v}_{PQ}$, to be constant. Hence Q observes P to move along straight line.

∴ For P and Q to collide Q should observe P to move along line PQ.
Hence PQ should not rotate.

2. Let initial and final speeds of stone be u and v.

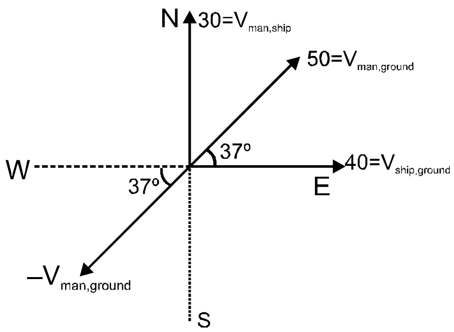
$\therefore \quad v^2 = u^2 - 2gh$ ....(1)

and $v \cos 30° = u \cos 60°$ ....(2)

solving 1 and 2 we get $u = \sqrt{3gh}$

3. Flag will flutter in the direction of wind and opposite to the direction of velocity of man

i.e. in the direction of V_{wm}



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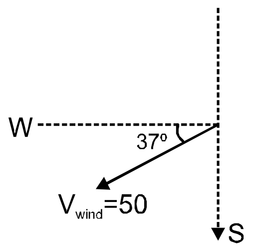

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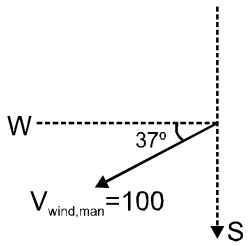
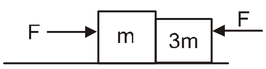
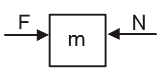


4. (i)

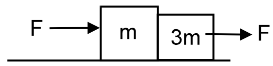


a = 0

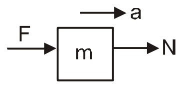


N = F.

(ii)



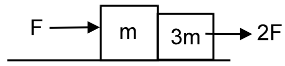
$$a = \frac{2F}{4m} = \frac{F}{2m}$$



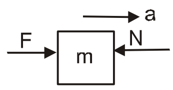
F – N = ma

$$N = F - m\left(\frac{F}{2m}\right) = \frac{F}{2}.$$

(iii)



$$a = \frac{3F}{4m}$$



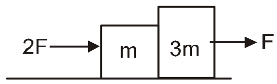
F – N = ma

N = F – ma

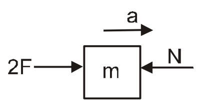
$$N = F - m\left(\frac{3F}{4m}\right)$$

$$N = \frac{F}{4}.$$

(iv)



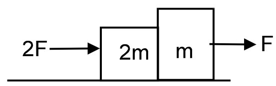
$$a = \frac{3F}{4m}$$



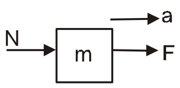
2F – N = ma $\qquad N = 2F - m\left(\frac{3F}{4m}\right)$

$$N = \frac{5F}{4}.$$

(v)



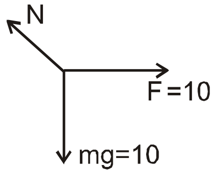
$$a = \frac{3F}{3m} = \frac{F}{m}$$



$N + F = ma \qquad N + F = m\left(\frac{F}{m}\right)$

$N = 0.$

5. F.B.D. of block



$N^2 = F^2 + (mg)^2$

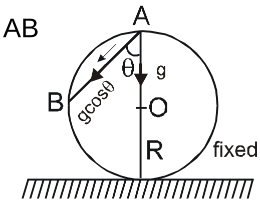
$N = 10\sqrt{2}$ N

6. $AB = 2R\cos\theta$

acceleration along AB

$a = g\cos\theta$

$u = 0$ from A to B



$S = ut + \frac{1}{2}at^2$

$2R\cos\theta = 0 + \frac{1}{2}(g\cos\theta)t^2$

$t = 2\sqrt{\frac{R}{g}}$

7. Unit vector in direction of (1,0,0) to (4,4,12) is

$\frac{(4-1)\hat{i} + (4-0)\hat{j} + (12-0)\hat{k}}{13}$

Hence position of particle at t = 2 sec is :

$\vec{r}_f = \vec{r}_i + \vec{v} \times 2 = 31\hat{i} + 40\hat{j} + 120\hat{k}$

8. $a = \frac{F}{m} \qquad V^2 = u^2 + 2as \quad (u = 0)$

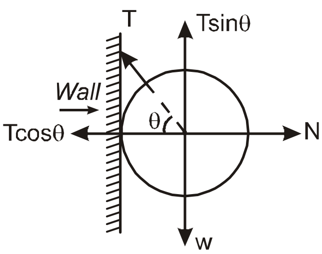
$V \propto \sqrt{2\left(\frac{F}{m}\right)S} \quad V \propto \frac{1}{\sqrt{m}}.$

DPP NO. - 22

1. From geometry :

$\cos\theta = \frac{3}{5}$

$\sin\theta = \frac{4}{5}$



As sphere is at equilibrium,

$T\sin\theta = w$

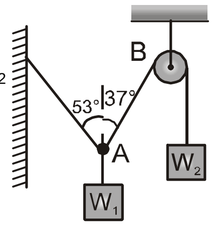
$T\left(\frac{4}{5}\right) = w$

$T = \frac{5w}{4}.$

2. Resolving forces at point A along string AB

$w_1 \cos 37° = w_2$

$\frac{w_1}{w_2} = \frac{5}{4}$



3. $v = 0 \Rightarrow x^2 - 5x + 4 = 0$

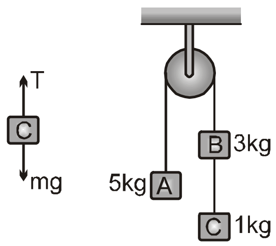
$x = 1m \ \& \ 4m$

$\frac{dv}{dt} = (2x - 5)v = (2x - 5)(x^2 - 5x + 4)$

at x = 1 m and 4m ; $\frac{dv}{dt} = 0$

4. $a = \left(\frac{5-4}{5+4}\right)g = \frac{g}{9}$

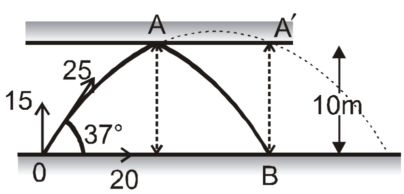
$T - mg = ma$



$T = m(g + a)$

$= 1\left(g + \frac{g}{9}\right) = \frac{10g}{9}.$

5. Time taken by ball from O to A is same as that from A to B.



$10 = 15\,t - \frac{1}{2}(10)\,t^2$

$5t^2 - 15\,t - 10 = 0$

$t^2 - 3t - 2 = 0$

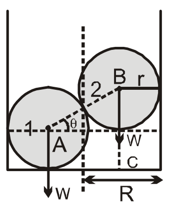
$t = 1,\ 2$

t = 2 is invalid as it is the time taken by the ball to come at A' if there was no roof.

$\therefore$ t = 1 seconds.

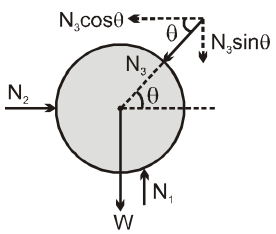
During this the ball will travel V × t = 20 × 2 = 40 m on the floor.

6.



r = 5cm ; R = 8cm

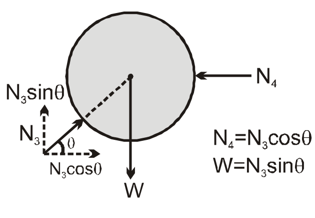
FBD of sphere 1



$N_1 = W + N_3 \sin\theta$

$N_2 = N_3 \cos\theta$

FBD of sphere 2



AC = 2R – 2r

AB = 2r

$\cos\theta = \frac{AC}{AB} = \frac{R-r}{r}$

$N_4 = N_3 \cos\theta$

$W = N_3 \sin\theta$

Ans. $N_4 = W \cot\theta$

$N_3 = W \operatorname{cosec}\theta$

$N_2 = W \cot\theta$

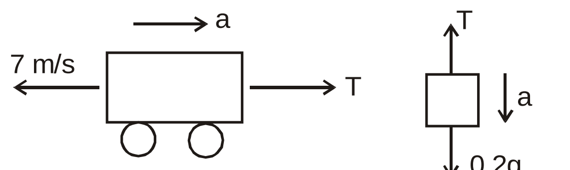
$N_1 = 2W.$

7. $\Rightarrow$ 0.2 g = 0.7 a

$\Rightarrow a = \frac{2g}{7}$ m/s^2

For the case, it comes to rest when V = 0

$0 = 7 + \left(-\frac{2g}{7}\right)t \quad \Rightarrow \quad t = \frac{49}{2g} = 2.5$ s



T = 0.5 a

0.2 - T = 0.2 a

Distance travelled till it comes to rest

$0 = 7^2 + 2\left(-\frac{2g}{7}\right)s$

S = 8.75 m

So in next 2.5s, it covers 8.75 m towards right.

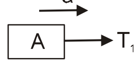
Total distance = 2 x 8.75 = 17.5 m

After 5s, it speed will be same as that of initial (7 m/s) but direction will be reversed.

8. Acceleration of system $a = \frac{F}{m_A + m_B + m_C}$

$a = \frac{60}{10+20+30} = 1\text{m/s}^2$

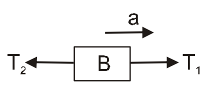
FBD of A :



$T_1 = m_A.a$

$T_1 = 10(1) = 10N$

FBD of B :



$T_2 - T_1 = m_B a$

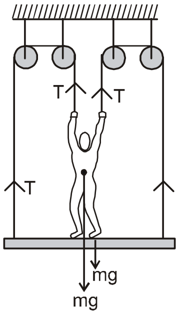
$T_2 - 10 = 20(1)$

$T_2 = 30$ N.

DPP NO. - 23

1. for (man + platform) system :

$2mg - 4T = 2m(a)$



$\Rightarrow \; 2mg - 4\left(\frac{mg}{2}\right) = 2m\,(a)$ [$\because$ T = $\frac{mg}{2}$]

$\Rightarrow \; a = 0$

2. Let a = acceleration of m_1

then acceleration of pulley = $\frac{a+0}{2} = \frac{a}{2}$

If acceleration of $m_2 = b$

Then $\quad 0 + \frac{b}{2} = \frac{a}{2}$

Hence $\; a = b$

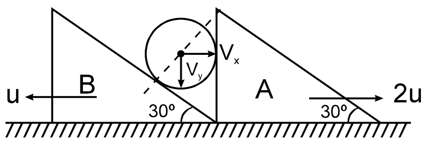
$T = m_1 a$, $m_2 g - T = m_2 a$

$\therefore \; a = \frac{m_2 g}{m_1 + m_2}$

3. **Method - I**

As cylinder will remains in contact with wedge A

$V_x = 2u$



As it also remain in contact with wedge B

$u \sin 30° = V_y \cos 30° - V_x \sin 30°$

$V_y = V_x \frac{\sin 30°}{\cos 30°} + \frac{U \sin 30°}{\cos 30°}$

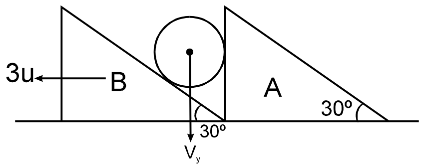
$V_y = V_x \tan 30° + u \tan 30°$

$V_y = 3u \tan 30° = \sqrt{3}\,u$

$V = \sqrt{V_x^2 + V_y^2} = \sqrt{7}$ **u Ans.**

Method - II

In the frame of A



$3u \sin 30° = V_y \cos 30°$

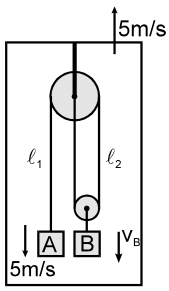
$\Rightarrow \; V_y = 3u \tan 30° = \sqrt{3}\,u$

and o $V_x = 2u$

$\Rightarrow \; V = \sqrt{V_x^2 + V_y^2} = \sqrt{7}\,u$ **Ans.**

4. $\ell_1 + 2\ell_2$ = constant

$\therefore \; \frac{d\ell_1}{dt} + \frac{2d\ell_2}{dt} = 0$



$(5 + 5) + 2\,(5 + v_B) = 0$ or $\; v_B = 10$ m/s

5. Assume that acceleration of particle is a_p

and acceleration of wedge is a_w

Then, $\; a_w = g\sin\theta$

From wedge constant

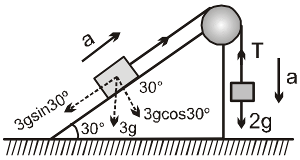
$a_p = a_w \sin\theta = g\sin^2\theta$

$h = \frac{1}{2} g \sin^2\theta\, t^2$

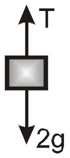
$t = \sqrt{\frac{2h}{g\sin^2\theta}}$.

6. From Newtons third law, the force exerted by table on block is equal to that exerted by block on the table. Therefore block exerts a 10 N force on table. Since the upward force on the block is larger than downward force, it moves upwards.

7.

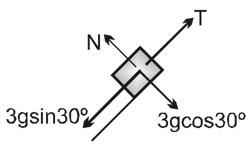


FBD of block M_2 = 2kg



$20 - T = 2a$ ....(i)

FBD of block M_1 = 3kg



$= \quad 3 \times \frac{10\sqrt{3}}{2}$

$= \quad 15\sqrt{3}$ N.

= 15 N

$T - 15 = 3a$ ....(ii)

(i) + (ii)

5 = 5a

$\Rightarrow$ a = 1m/s^2 ; T = 18 N.

8. (i) $a = \frac{2mg - mg}{3m} = \frac{g}{3}$

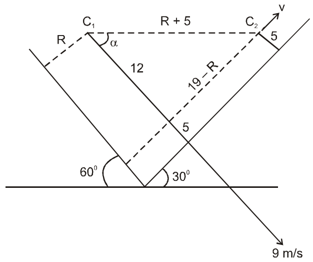
(ii) $a = \frac{2mg - mg}{m} = g$

(iii) $a = \frac{2mg}{m} = 2g$

(iv) $a = \frac{2g}{3}$

DPP NO. - 24

1.



$9 \cos\alpha = v \sin\alpha \quad \rightarrow \quad$ (i)

$\frac{19 - R}{12} = \tan\alpha \quad \rightarrow \quad$ (ii)

$(R + 5)^2 = (12)^2 + (19 - R)^2$

$\Rightarrow$ R = 10

Hence from (i) and (ii)

v = 12 m/s^2

2. Acceleration of boy and block will be same equal to 1.25 m/s^2 w.r.t. ground. Hence

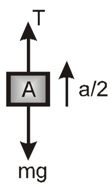
$10 = \frac{1}{2}(1.25)\, t^2$

$\Rightarrow$ t = 4 sec.

3. From constraint relation , if acceleration of mass B is a then acceleration of mass A will be a/2 :

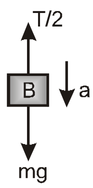
FBD of A :

$T - mg = \frac{ma}{2}$ ....(i)



FBD of B :

$mg - \frac{T}{2} = ma$ ....(ii)

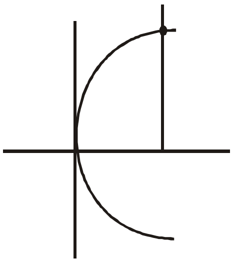


From (i) & (ii)

$a = \frac{2g}{5}$

4. $x = 4y^2$

$\frac{dx}{dt} = 8y\frac{dy}{dt}$



$V_x = 8y\,V_y$

$V_x = 4$

$a_x = 0$

$0 = a_x = 8[y.a_y + V_y^2]$

$-y\,a_y = V_y^2$

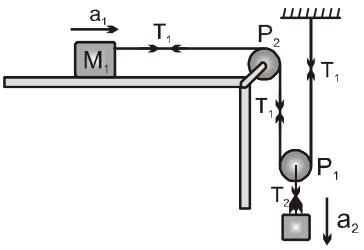
$|a_y| = \frac{v_y^2}{y}$

$|a_y| = \frac{v_x^2}{64y^3} = \frac{16}{64 \times y^3}$

at $y = 1 \Rightarrow |a_y| = \frac{1}{4}$

$y = 1 \Rightarrow |a_y| = \frac{1}{4}$

5.



Relative between a_1 & a_2

$a_1 = 2a_2 = 2a$

Relative between T_1 & T_2

$T_2 = 2T_1 = 2T$

$T_1 = M_1a_1$ ....(i)

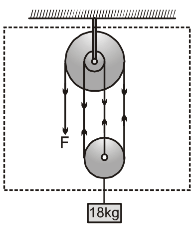
$M_2g - T_2 = M_2a_2$ ....(ii)

$2T = 4M_1a$

$M_2g - 2T = M_2a$

$M_2g = a(4M_1 + M_2) \Rightarrow a = \frac{M_2g}{4M_1 + M_2}$.

6.



$3F = 180$

$F = 60$ N

$T = 4F = 210$ N

Force balance on system

$T = F + 180$

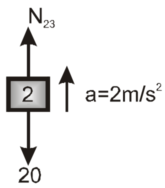
$T = 60 + 180 = 240$ N.

7. False There acceleration may be different.

True $T = \frac{W}{V}$ to minimize T, V will be maximum.

i.e whole effort of swimmer must towards opposite bank.

8. (i) FBD of 2kg

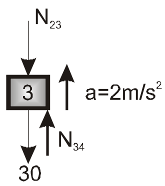


$N_{23} - 20 = 2(2)$

$N_{23} = 24$ N

(ii) FBD of 3 kg

$N_{34} - N_{23} - 30 = 3(2)$

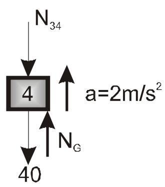


$N_{34} = N_{23} + 30 + 6$

$N_{34} = 24 + 30 + 6 = 60$ N

FBD of 4kg

$N_G - N_{34} - 40 = 4(2)$



$N_G = N_{34} + 40 + 8$

$N_G = 60 + 40 + 8 = 108$ N