PRAYAS

JEE 2025

Lecture - 09

Physics

Laws Of Motion

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Topics to be covered

1. (onstraint modion (string)
2.
3.
4.

ATDB.uno

$$T - 90 = 9a$$

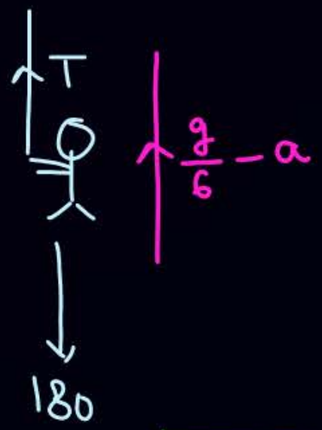
Q

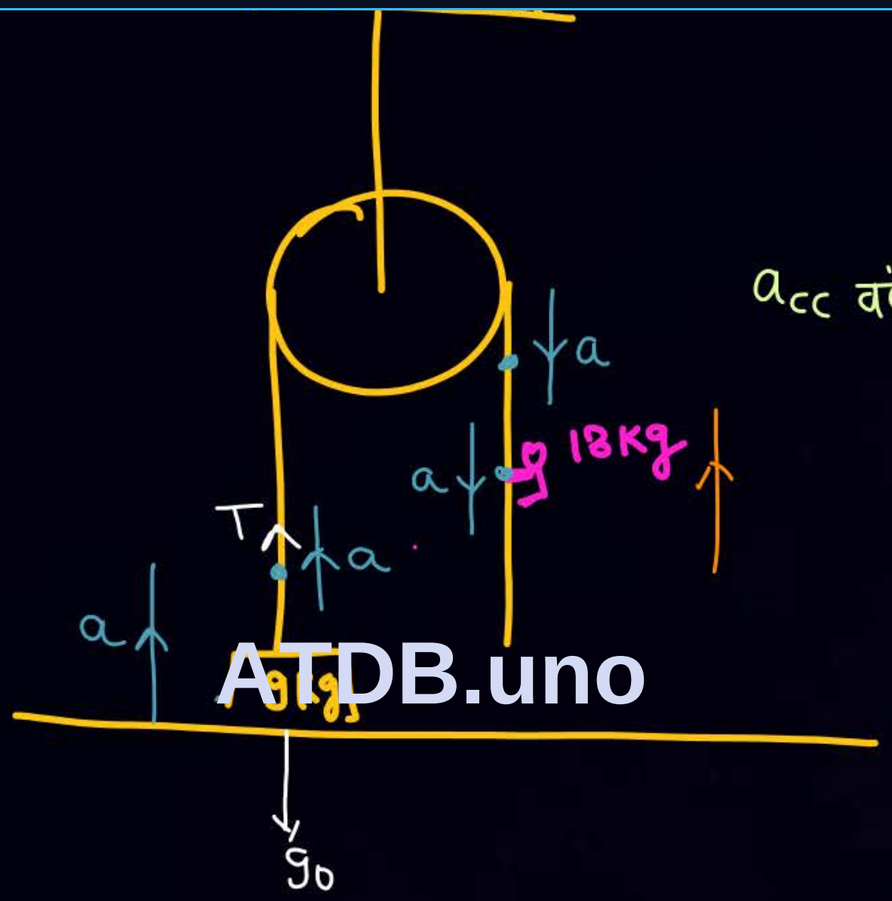
$$T - 180 = 18\left(\frac{g}{6} - a\right)$$

$$9a + 90 - 180 = 30 - 18a$$

$$-90 - 30 = -27a$$

$$\boxed{a = \frac{120}{27} = \frac{40}{9}}$$





a_{cc} बंदर wrt rope $= g/6$

$a_{bandar/rope} = \frac{g}{6}$ ऊपर

$a_{bandar} - (-a) = g/6$

$a_{bandar} = \frac{g}{6} - a$

$$\boxed{T = 90 + 9 \times \frac{40}{9} = 90 + 40 = 130}$$

Fig. 1.15, if its mass is η times as great as the mass of bar 1 and the angle that the inclined plane forms with the horizontal is equal to α. The masses of the pulleys and the threads, as well as the friction, are assumed to be negligible. Look into possible cases.

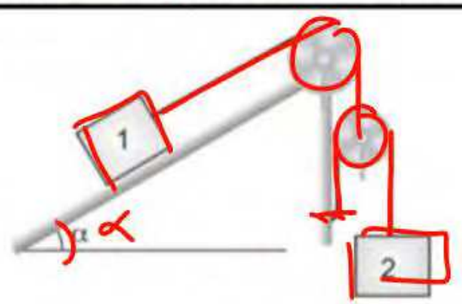


Fig. 1.15

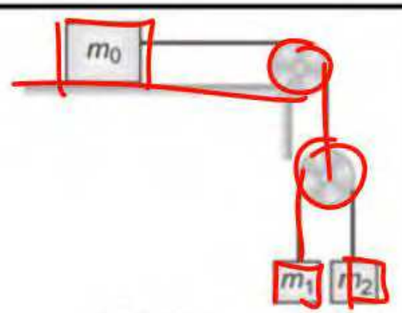


Fig. 1.16

Ans : **72.** $w = 2g\,(2\eta - \sin\alpha)/(4\eta + 1)$.

68. At the moment $t = 0$ the force $F = at$ is applied to a small body of mass m resting on a smooth horizontal plane (a is a constant).
The permanent direction of this forms an angle α with the horizontal (Fig. 1.14). Find :

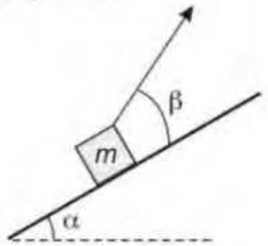


Fig. 1.13

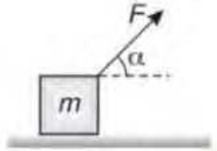


Fig. 1.14

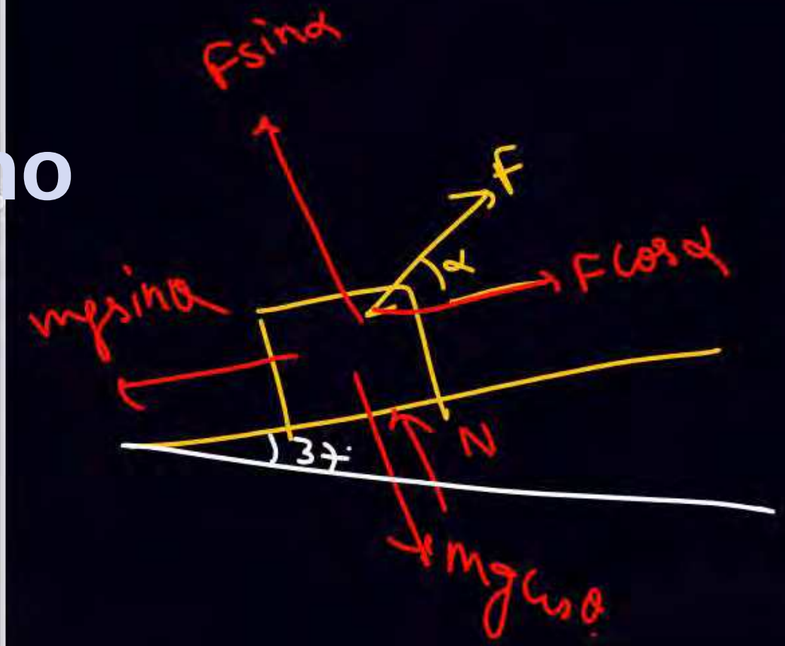
(a) the velocity of the body at the moment of its breaking off the plane;
(b) the distance traversed by the body up to this moment.

Ans : **68.** (a) $v = \dfrac{mg^2 \cos\alpha}{2a \sin^2\alpha}$; (b) $s = \dfrac{m^2 g^3 \cos\alpha}{6a^2 \sin^3\alpha}$.

$$F = at$$

$$F\sin\alpha = mg\cos\theta$$

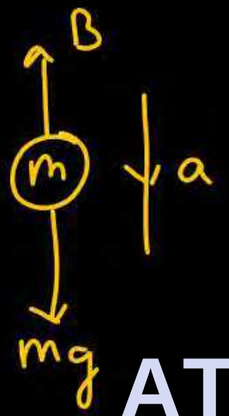
$$a = \frac{F\cos\alpha - mg\sin\theta}{m}$$

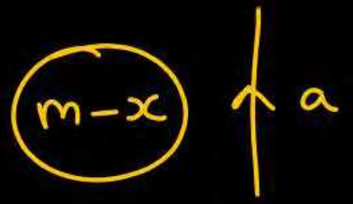


59. An aerostat of mass m starts coming down with a constant acceleration w. Determine the ballest mass to be dumped for the aerostat to reach the upward acceleration of the same magnitude. The air drag is to be neglected.

Hw

$mg - B = ma$





$B - (m-x)g = (m-x)a$

Ans : **59.** $\Delta m = 2mw/(g + w)$.

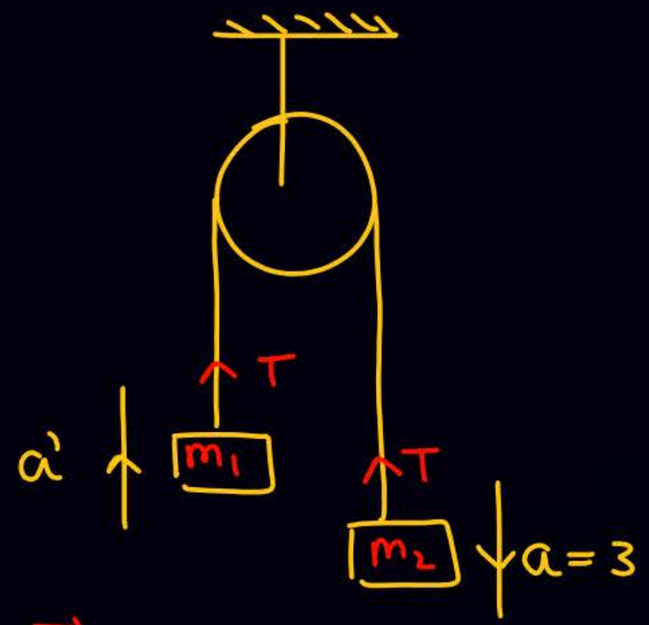
$$\sum \vec{T}\cdot\vec{x} = 0$$

$$\vec{T}_1\cdot\vec{x}_1 + \vec{T}_2\cdot\vec{x}_2 + \vec{T}_3\cdot\vec{x}_3 + \cdots = 0$$

$$\vec{T}_1\cdot\vec{v}_1 + \vec{T}_2\cdot\vec{v}_2 + \vec{T}_3\cdot\vec{v}_3 + \cdots = 0$$

$$\vec{T}_1\cdot\vec{a}_1 + \vec{T}_2\cdot\vec{a}_2 + \vec{T}_3\cdot\vec{a}_3 + \cdots = 0$$

(1)

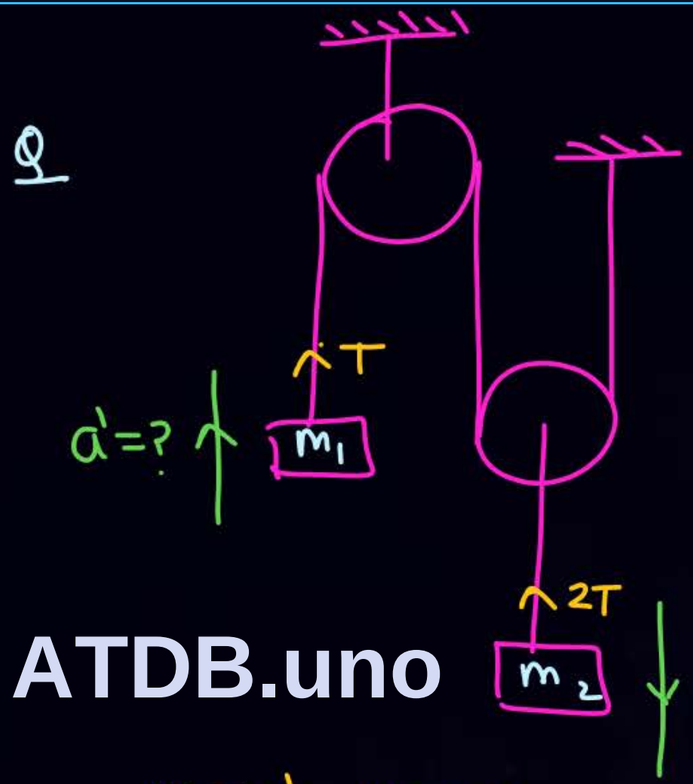


$\vec{T_1}\cdot\vec{a_1} + \vec{T_2}\cdot\vec{a_2} = 0$

$T \cdot a' + T \times 3 \cos 180 = 0$

$\boxed{a' = 3}$

Q



$+T \cdot a' - 2T \times 3 = 0$

$\boxed{a' = 6}$

If $m_2 = 10\,kg$
find m_1

$m_2 g - 2T = m_2 a$

$100 - 2T = 10 \times 3$

$\boxed{T = 35}$

$T - m_1 g = m_1 a'$

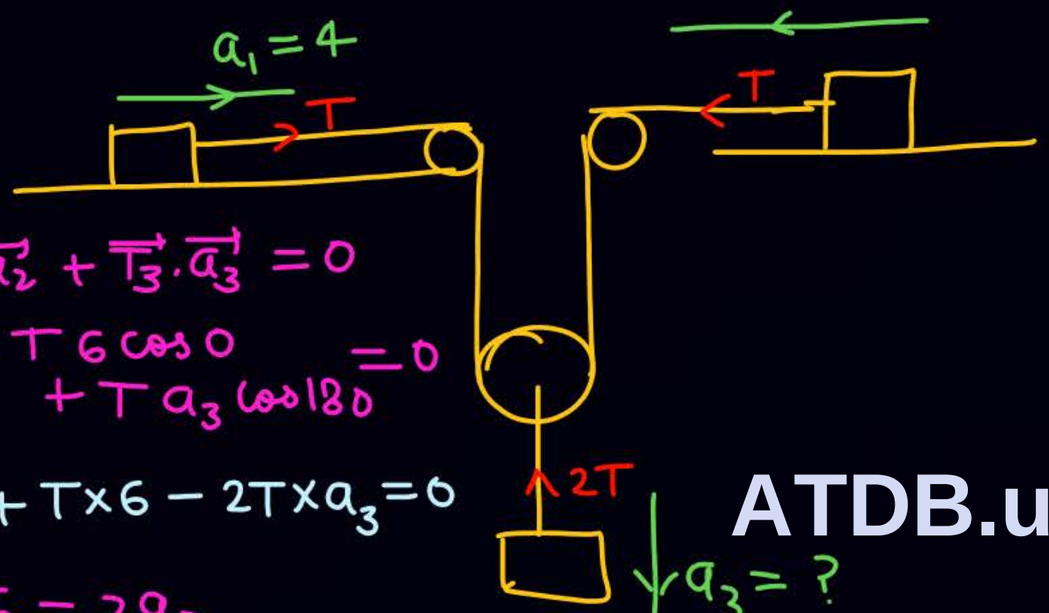
$35 - m_1 \times 10 = m_1 \times 6$

$m_1 = \frac{35}{16}$

find acc in following qns

Q

② $a_1 = 4$



$\vec{T}\cdot\vec{a_1} + \vec{T}\cdot\vec{a_2} + \vec{T_3}\cdot\vec{a_3} = 0$

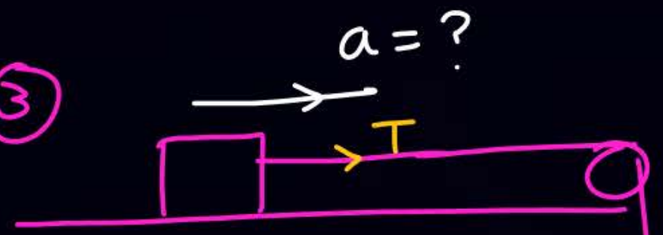
$T \cdot 4 \cos 0 + T\,6 \cos 0 + T\,a_3 \cos 180 = 0$

$+T\times 4 + T\times 6 - 2T\times a_3 = 0$

$4 + 6 = 2a_3$

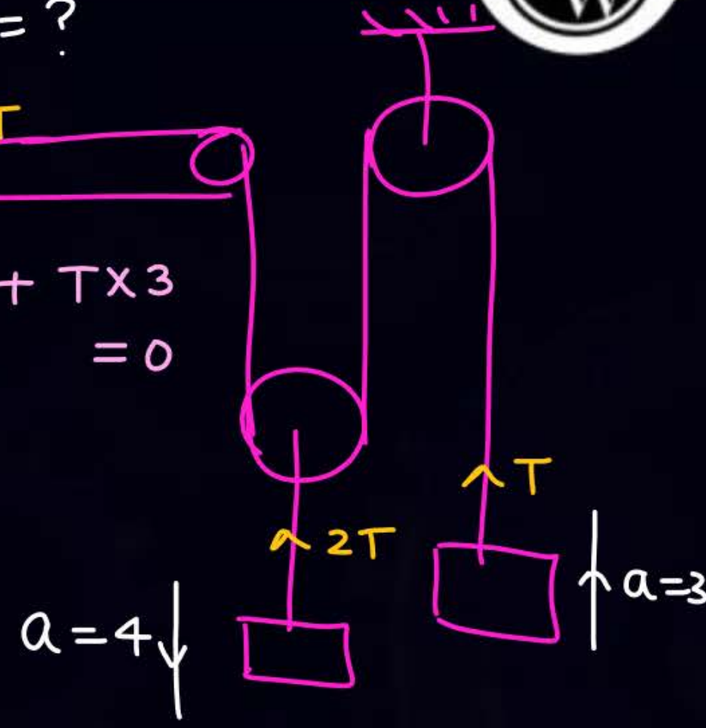
$a_3 = 5$

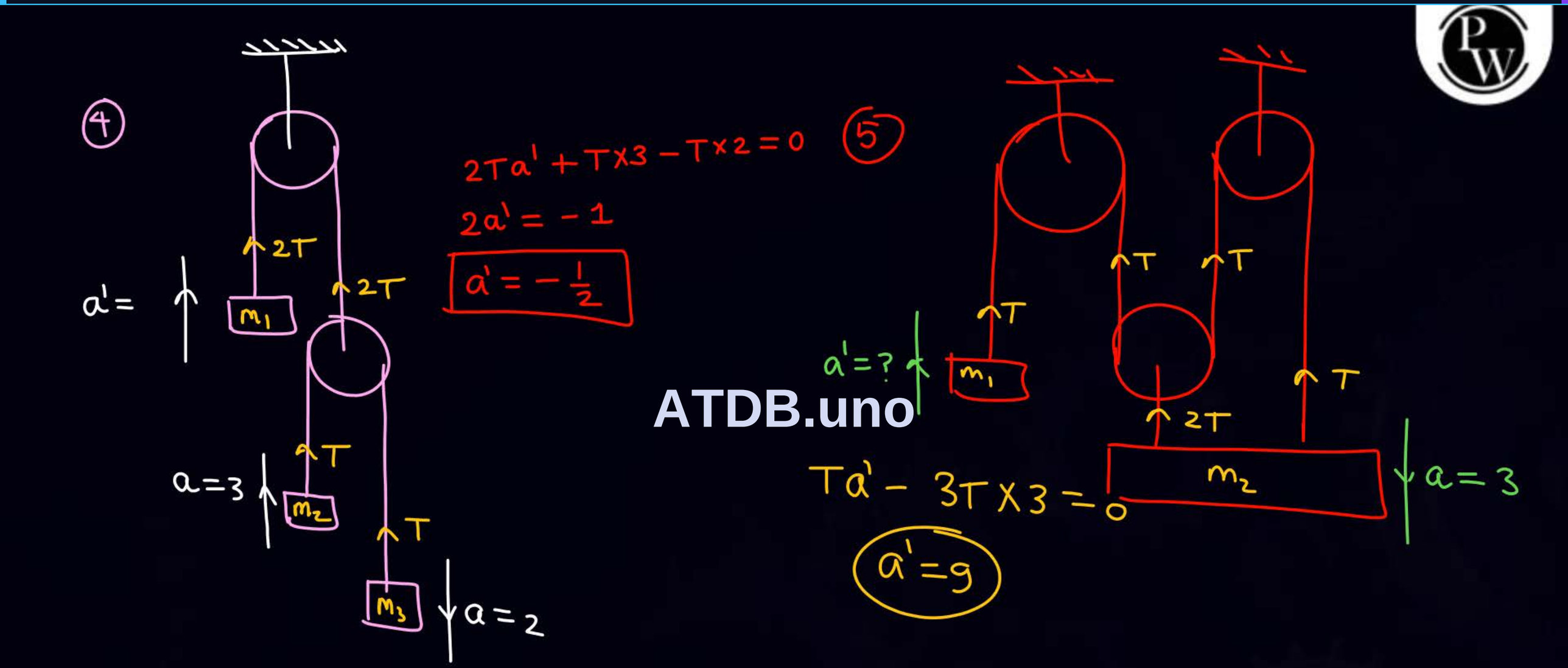
③ $a = ?$



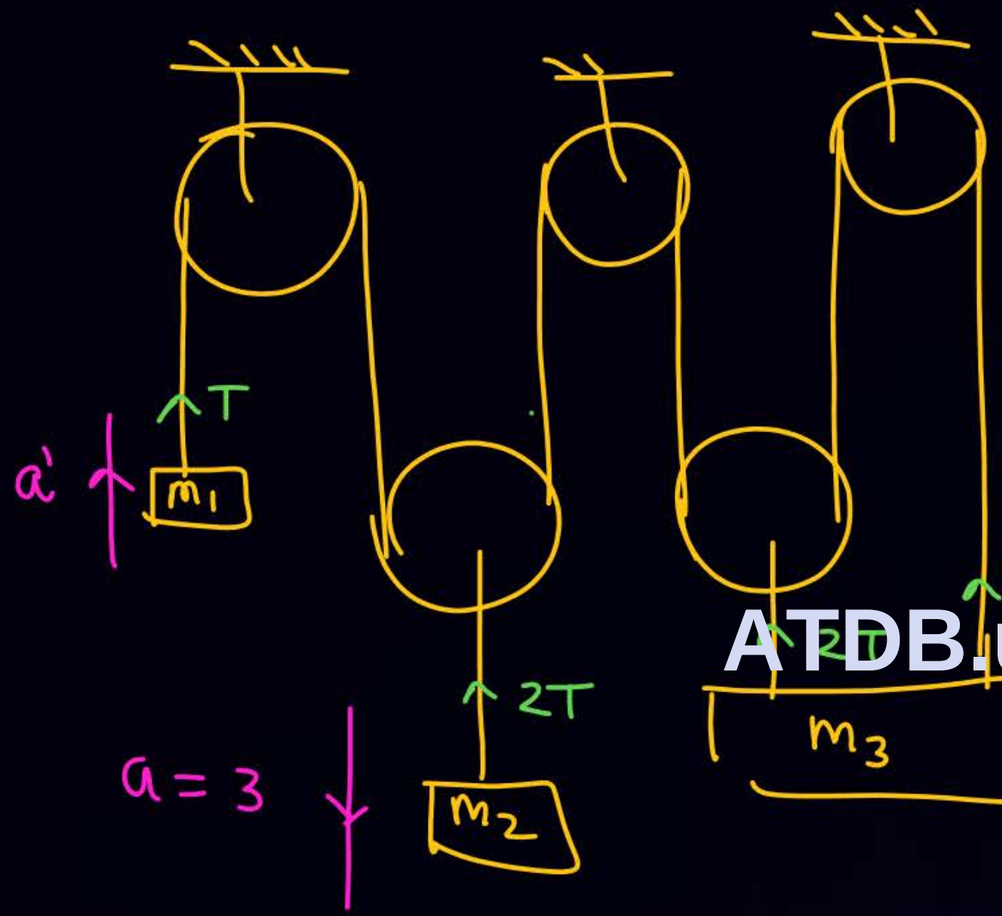
$Ta - 2T\times 4 + T\times 3 = 0$

$a = 5$





6



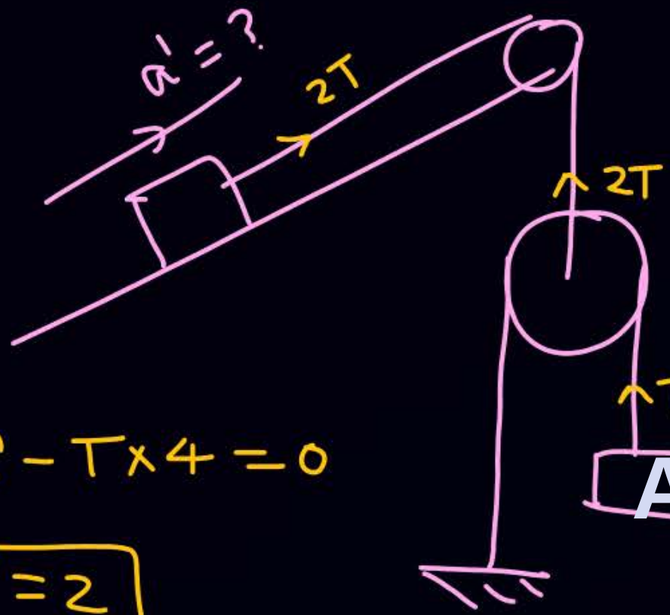
$$Ta' - 2T \times 3 - 3T \times 2 = 0$$

$$\boxed{a' = 12}$$

Q If $m_1 = 10\,kg$
find m_2 & m_3

$$T - 100 = 10 \times a' \qquad \boxed{T = 220}$$

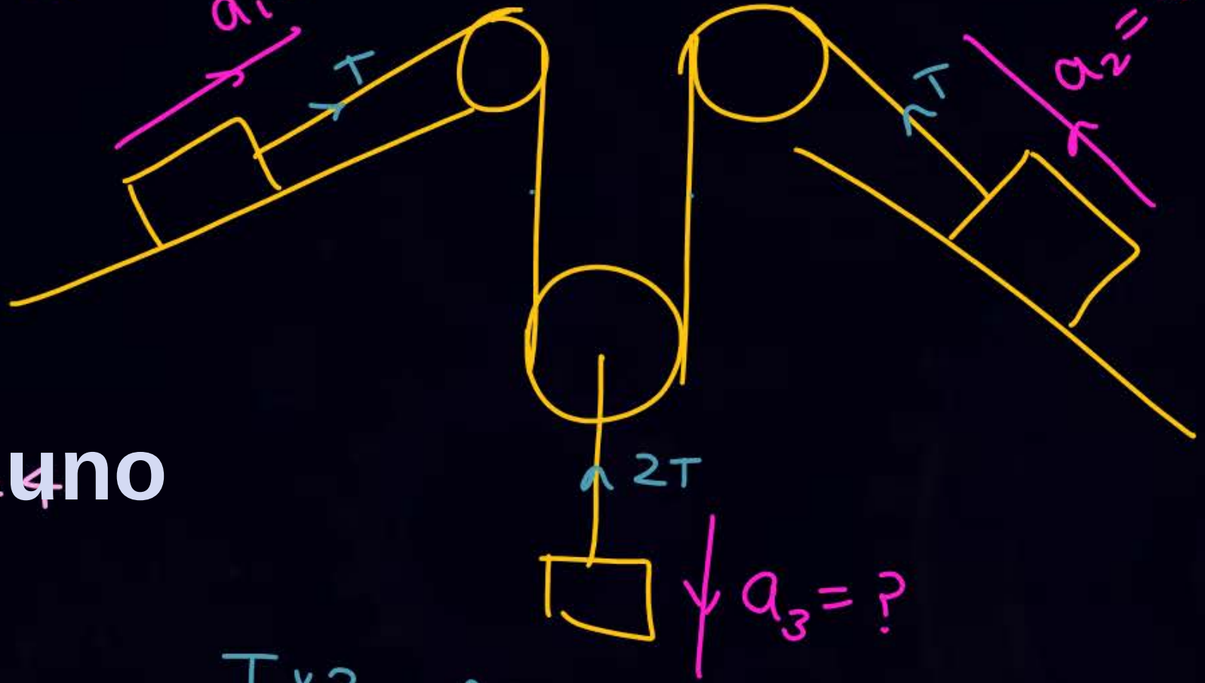
(7)



$+2Ta' - Tx4 = 0$

$a' = 2$

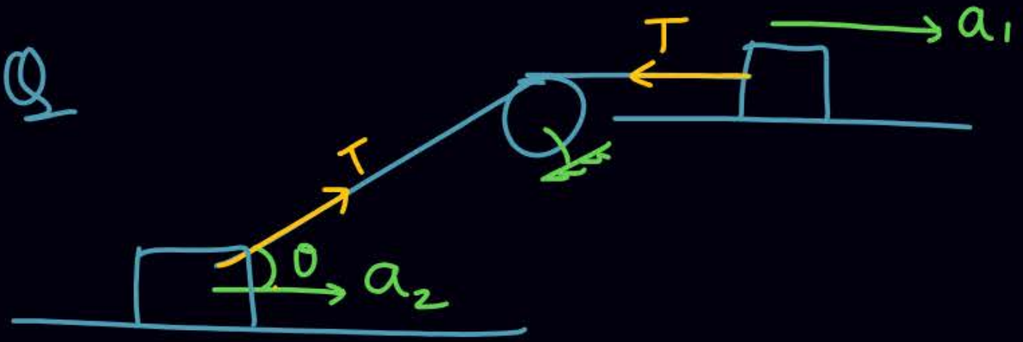
(8)



$Tx3 - 2Ta_3 + Tx7 = 0$

$a_3 = 5$

Q

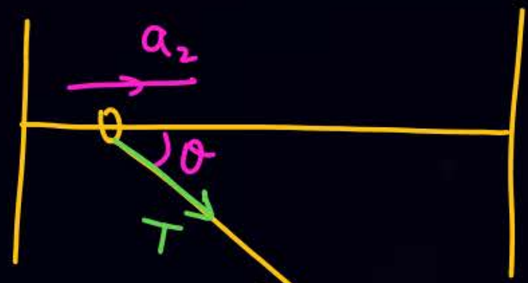


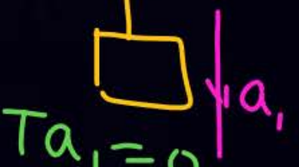
$$\vec{T}\cdot\vec{a_1} + \vec{T}\cdot(-\vec{a_2}) = 0$$

$$-Ta_1 + Ta_2\cos\theta = 0$$

$$\boxed{a_1 = a_2\cos\theta}$$

Q

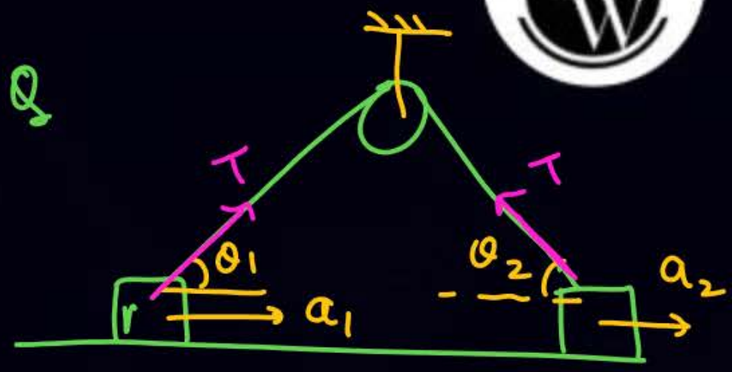




$$Ta_2\cos\theta - Ta_1 = 0$$

$$\boxed{a_1 = a_2\cos\theta}$$

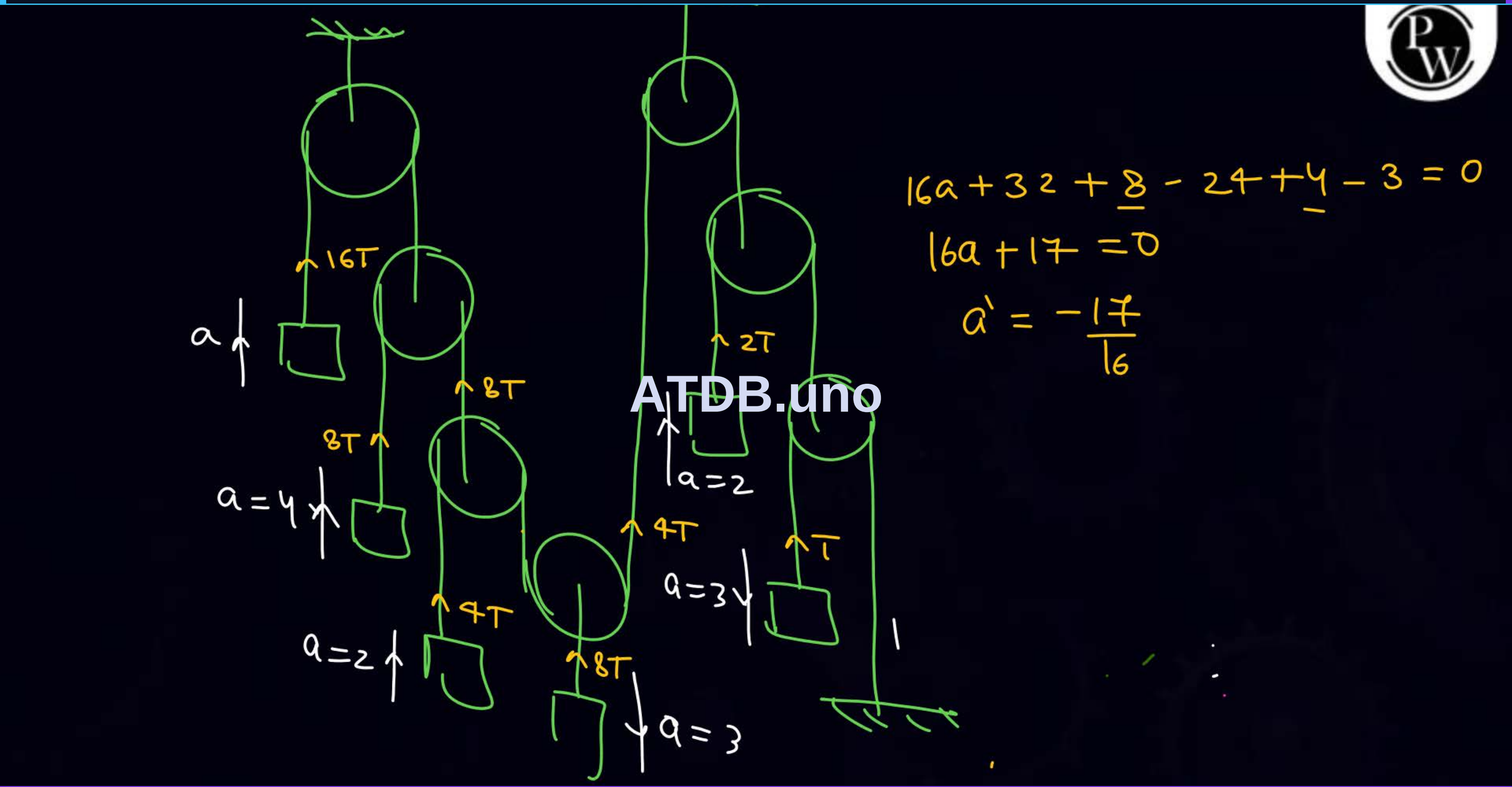
Q



$$Ta_1\cos\theta_1 + Ta_2\cos(180-\theta_2) = 0$$

$$a_1\cos\theta_1 = a_2\cos\theta_2$$

$$v_1\cos\theta_1 = v_2\cos\theta_2$$

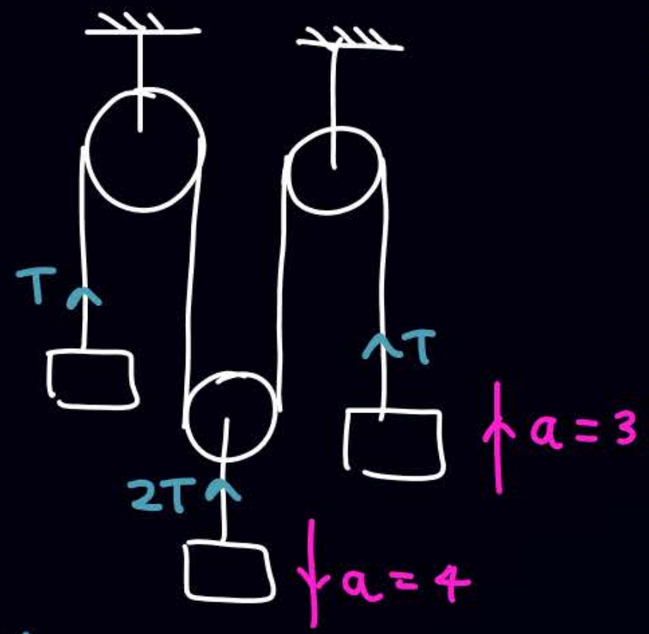


$$16a + 32 + 8 - 24 + 4 - 3 = 0$$

$$16a + 17 = 0$$

$$a = -\frac{17}{16}$$

(13)

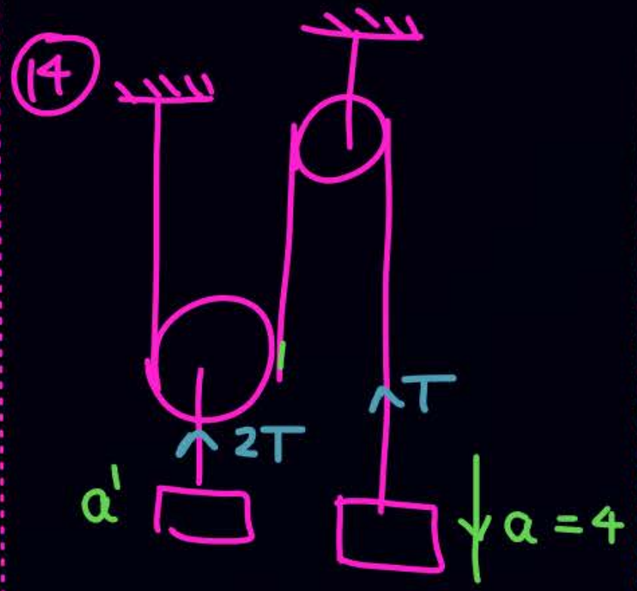


$?=a'$

$Ta' - 2T\times 4 + T\times 3 = 0$

$a' = 5$

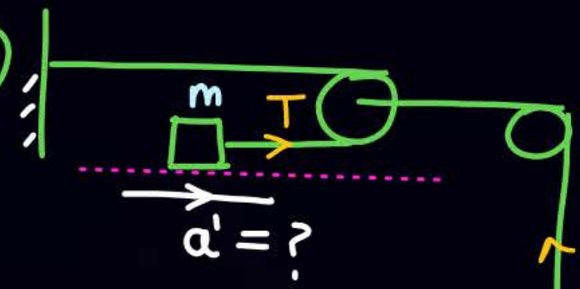
(14)

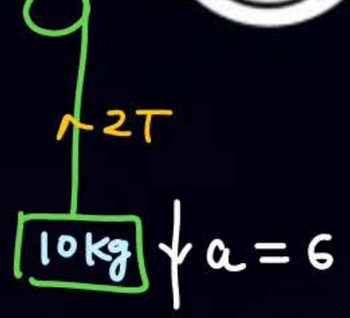


$2Ta' - 2T\times 4 = 0$

$a' = 2$

(15)





find a' & m

$Ta' - 2T\times 6 = 0$

$a' = 12$

10kg $\Rightarrow$ $100 - 2T = 10\times 6$

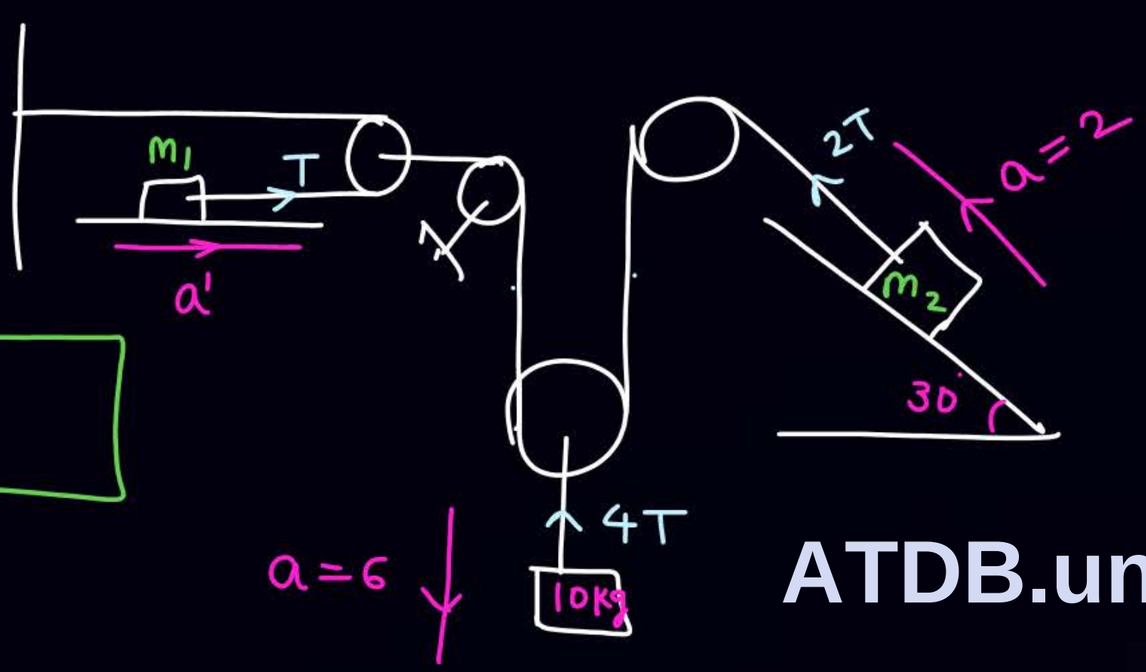
$T = 20$

(m) $\Rightarrow$ $T = ma'$

$20 = m\times 12$

$m = \frac{20}{12}$

16



find a'

a=6

$a' - 24 + 4 = 0$

$a' = 20$

$100 - 4T = 10 \times 6$

$T = 10$

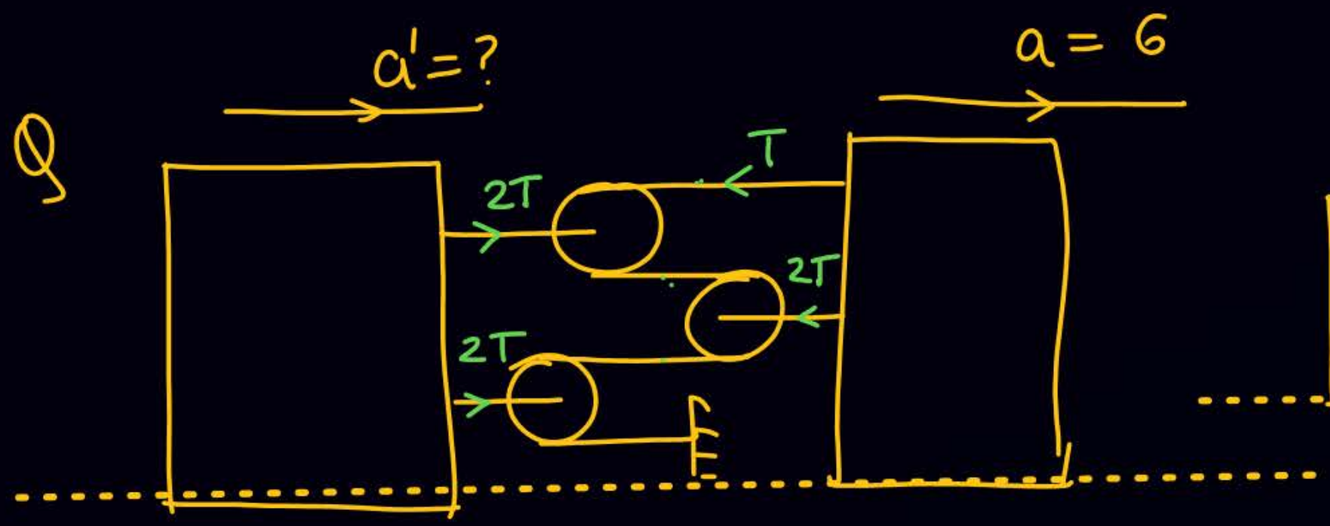
$T = m_1 a'$

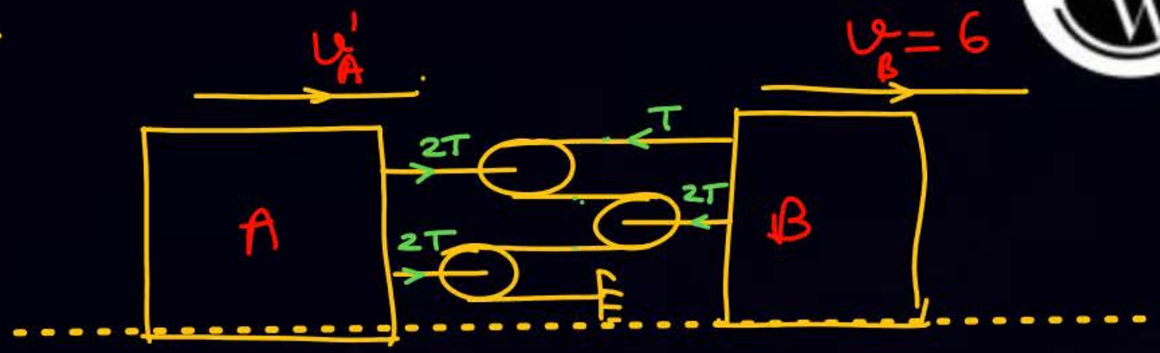
$2T - m_2 g \sin 30° = m_2 a$

Q

$-7T \times 6 + T a' = 0$

$a' = 42$





$$+4Ta' - 3T \times 6 = 0$$

$$a' = \frac{18}{4}$$

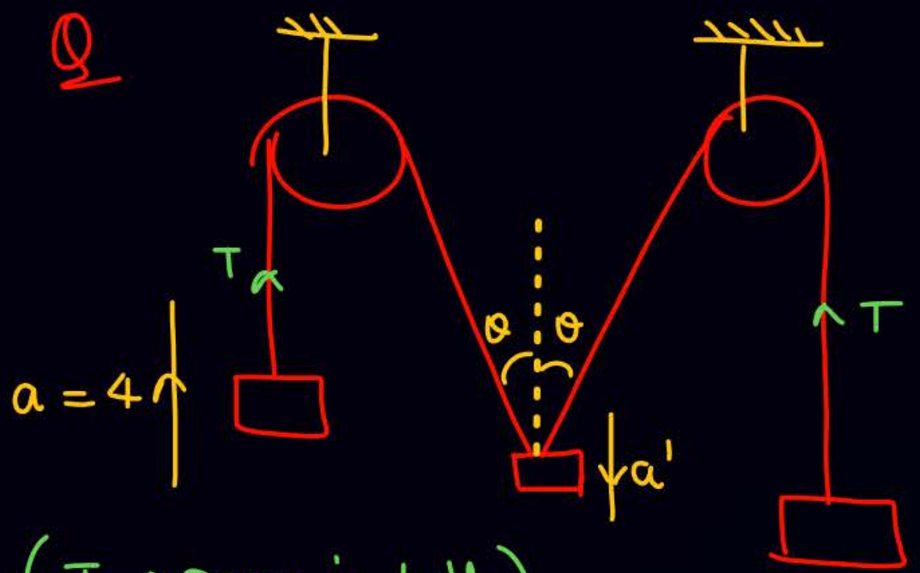
$$+4TV_A - 3TV_B = 0$$

$$4 \times V_A' - 3 \times 6 = 0$$

$$V_A' = \frac{18}{4}$$

SKC
v, a, x

Q

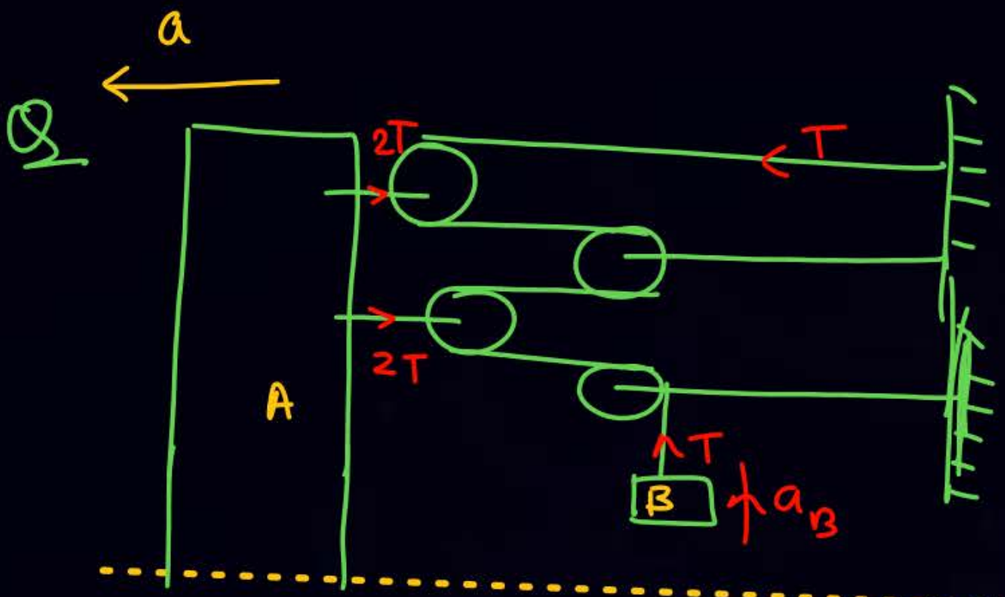


(T → same in both String given)

$$T \times 4 - 2T\cos\theta \times a' + T \times 6 = 0$$

$$a' = \frac{5}{\cos\theta}$$

Q



find a_B wrt A

$$-4Ta + Ta_B = 0 \qquad \boxed{a_B = 4a}$$

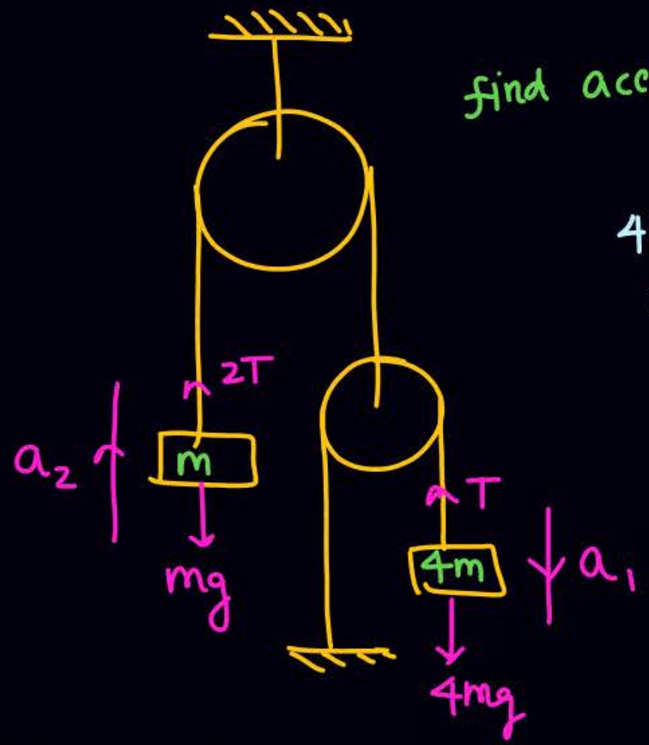
$$\vec{a}_{B/a} = \vec{a}_B - \vec{a}_A$$

$$\vec{a}_{B/A} = 4a\hat{j} - (-a\hat{i}) = a\hat{i} + 4a\hat{j}$$

$$a_{B/A} = \sqrt{a^2 + (4a)^2} = a\sqrt{17}$$

Q

find acc of each mass.



$4mg - T = 4ma_1$

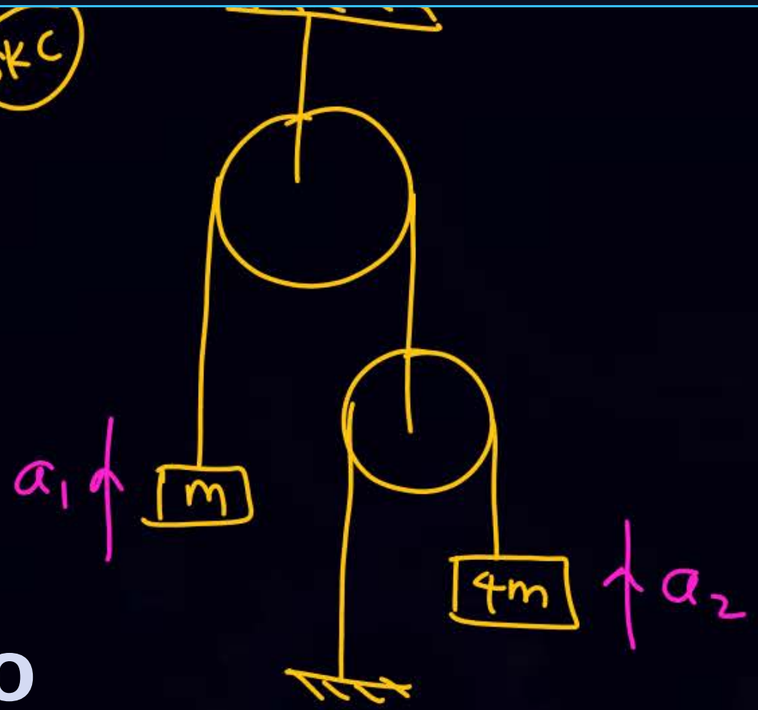
$2T - mg = ma_2$

$a_1 = 2a_2$

Solve & get

$+2Ta_2 - Ta_1 = 0$

SKC

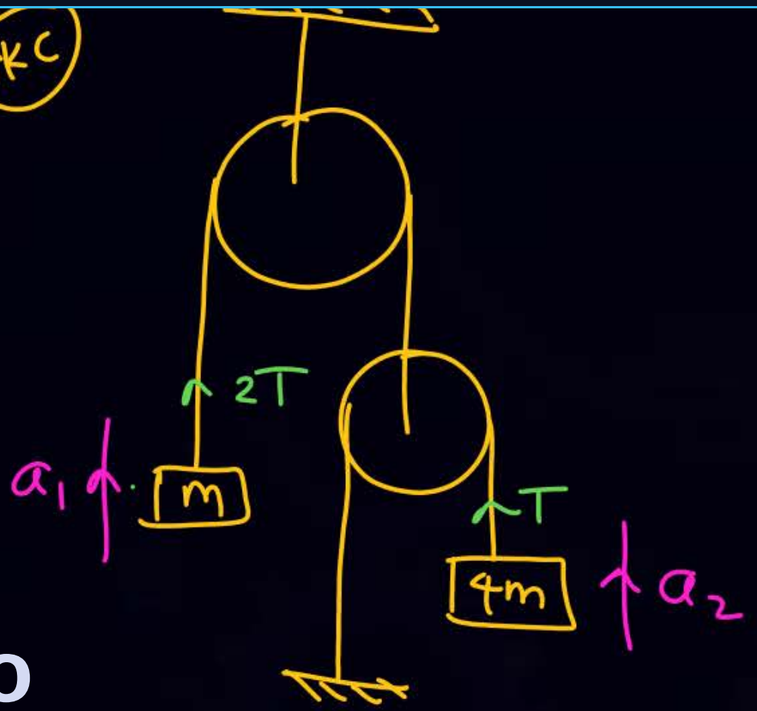


11

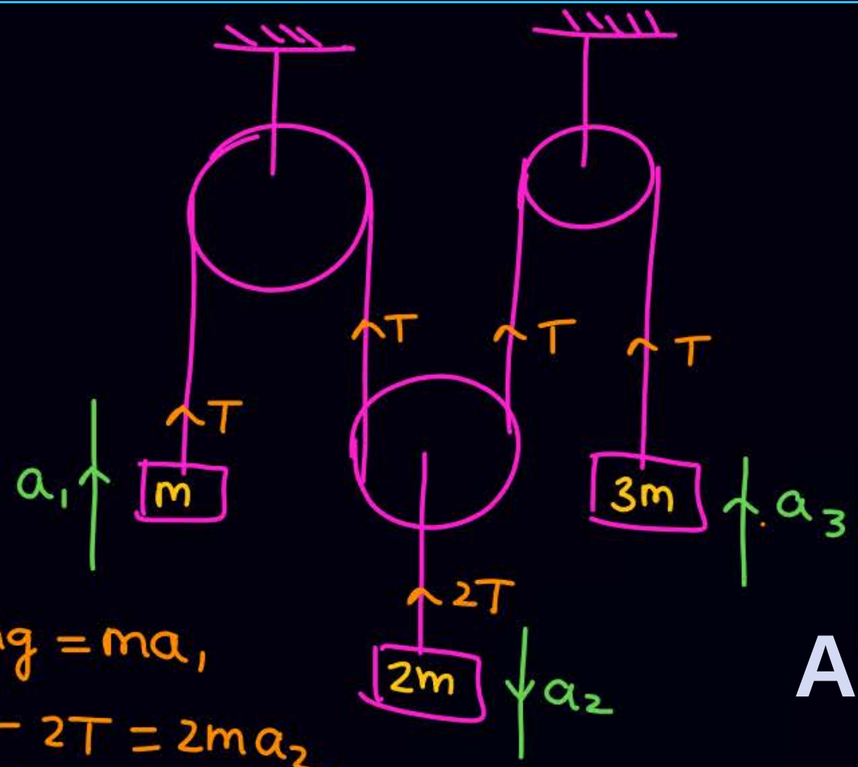
SKC

$$2a_1 + a_2 = 0$$

$$2\left(\frac{2T - mg}{m}\right) + \frac{T - 4mg}{4m} = 0$$



Q



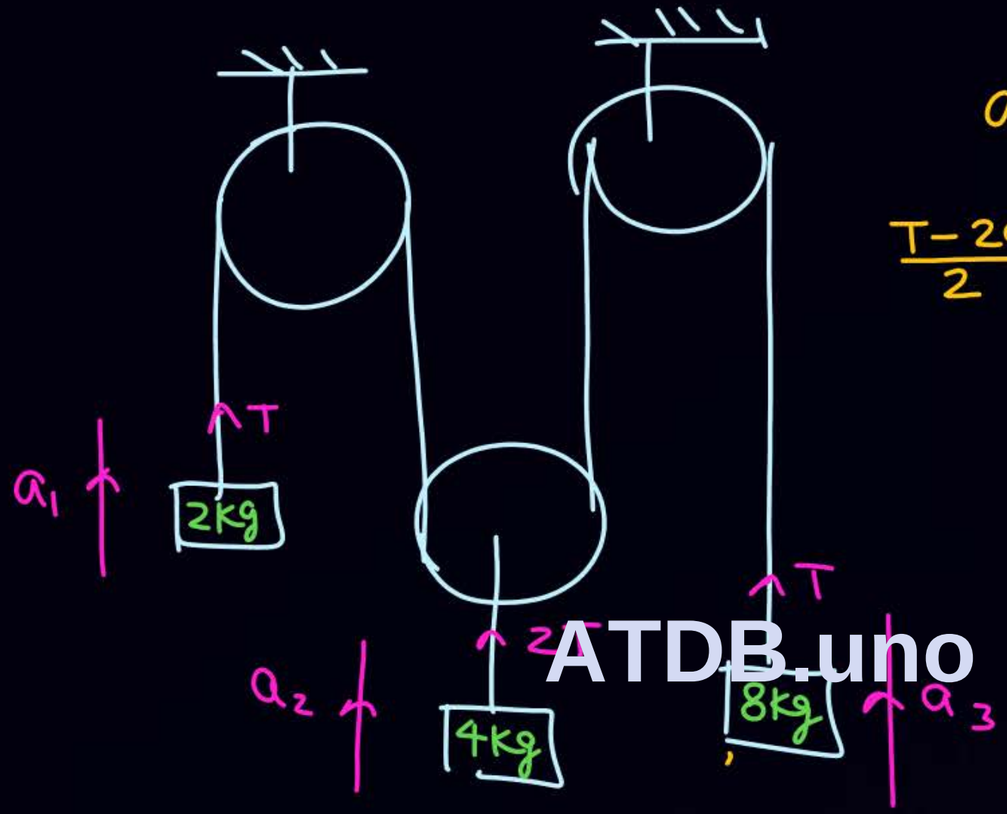
$$T - mg = ma_1$$

$$2mg - 2T = 2ma_2$$

$$T - 3mg = 3ma_3$$

$$a_1 - 2a_2 + a_3 = 0$$

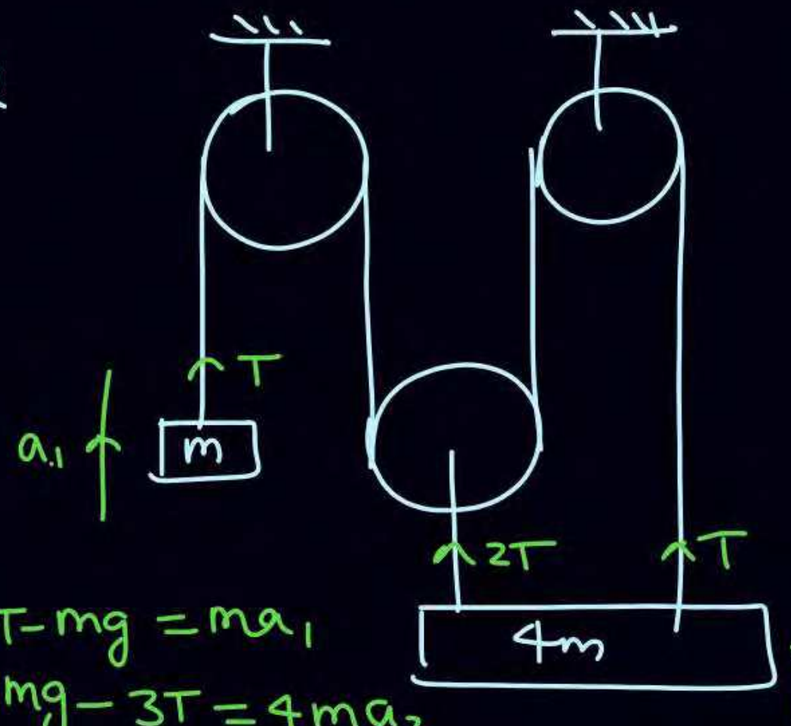
Q



$$a_1 + 2a_2 + a_3 = 0$$

$$\frac{T-20}{2} + 2\left(\frac{2T-40}{4}\right) + \frac{T-80}{8} = 0$$

Q

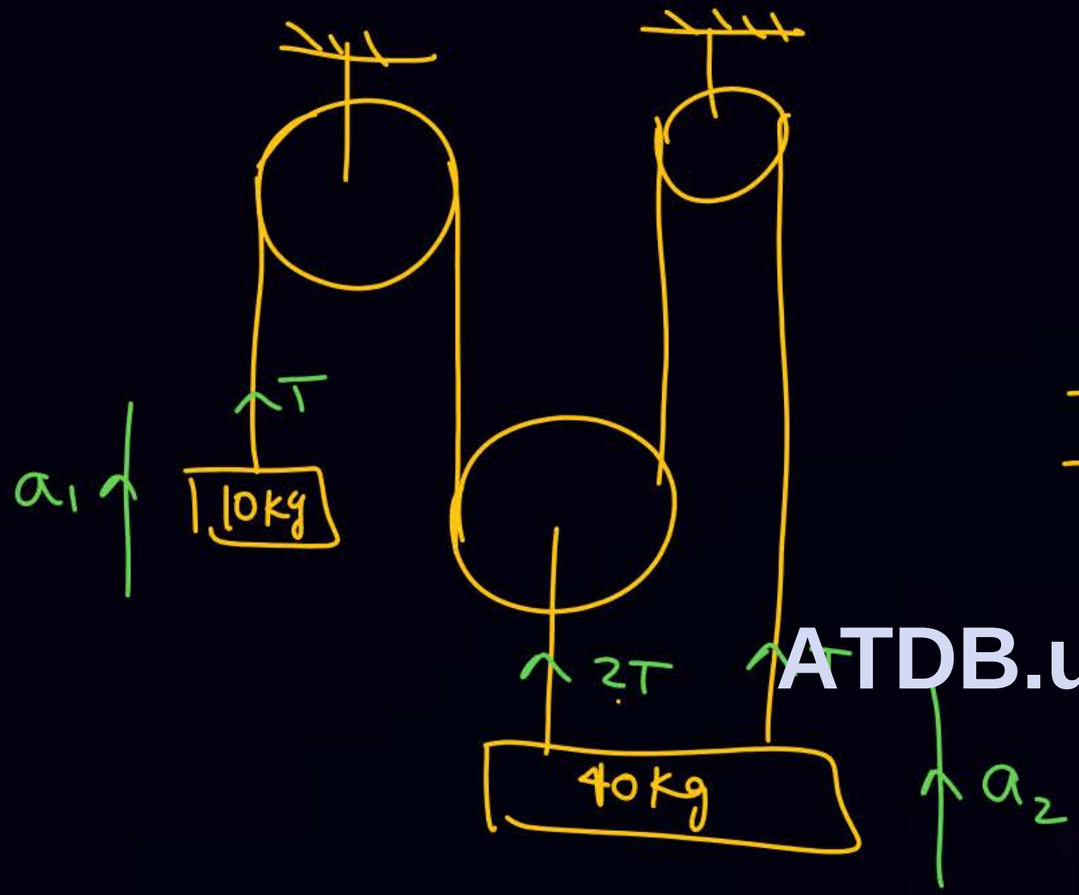


$T - mg = ma_1$

$4mg - 3T = 4ma_2$

$a_1 - 3a_2 = 0$

Q

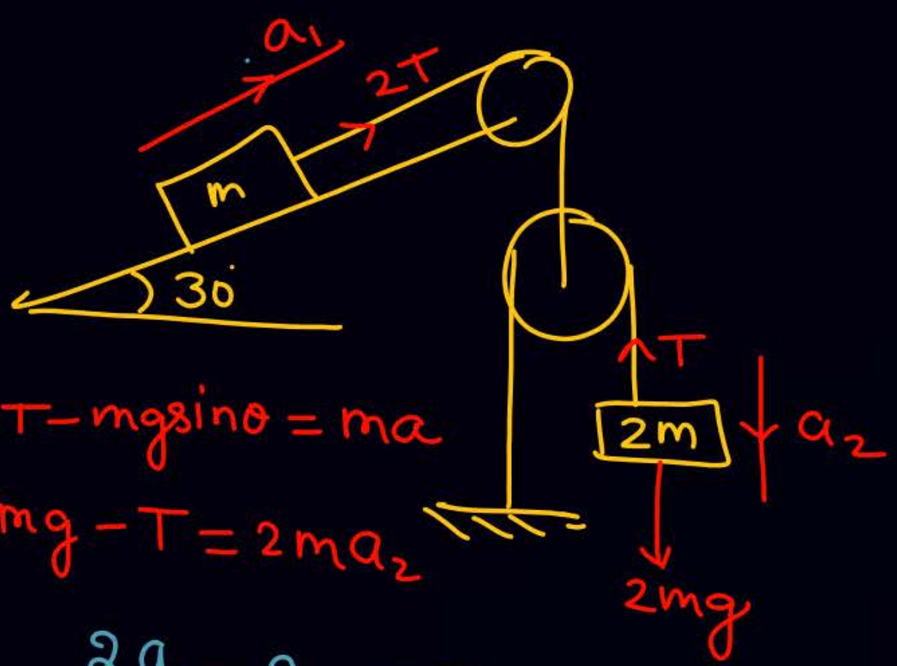


$$T a_1 + 3T a_2 = 0$$

$$a_1 + 3a_2 = 0$$

$$\frac{T-100}{10} + 3\frac{3T-400}{40} = 0$$

Q

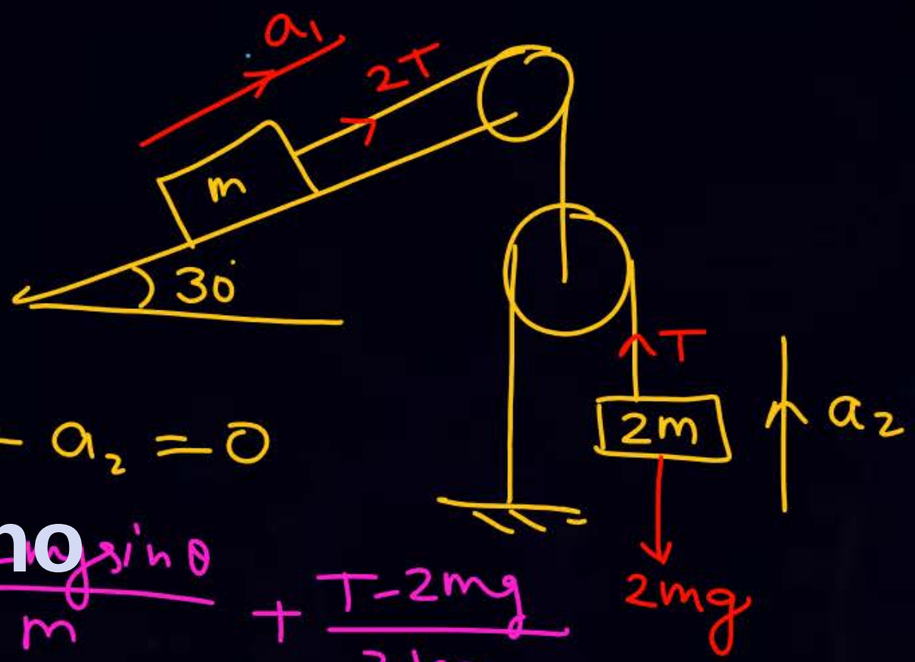


$2T - mg\sin\theta = ma$

$2mg - T = 2ma_2$

$2a_1 - a_2 = 0$

Q

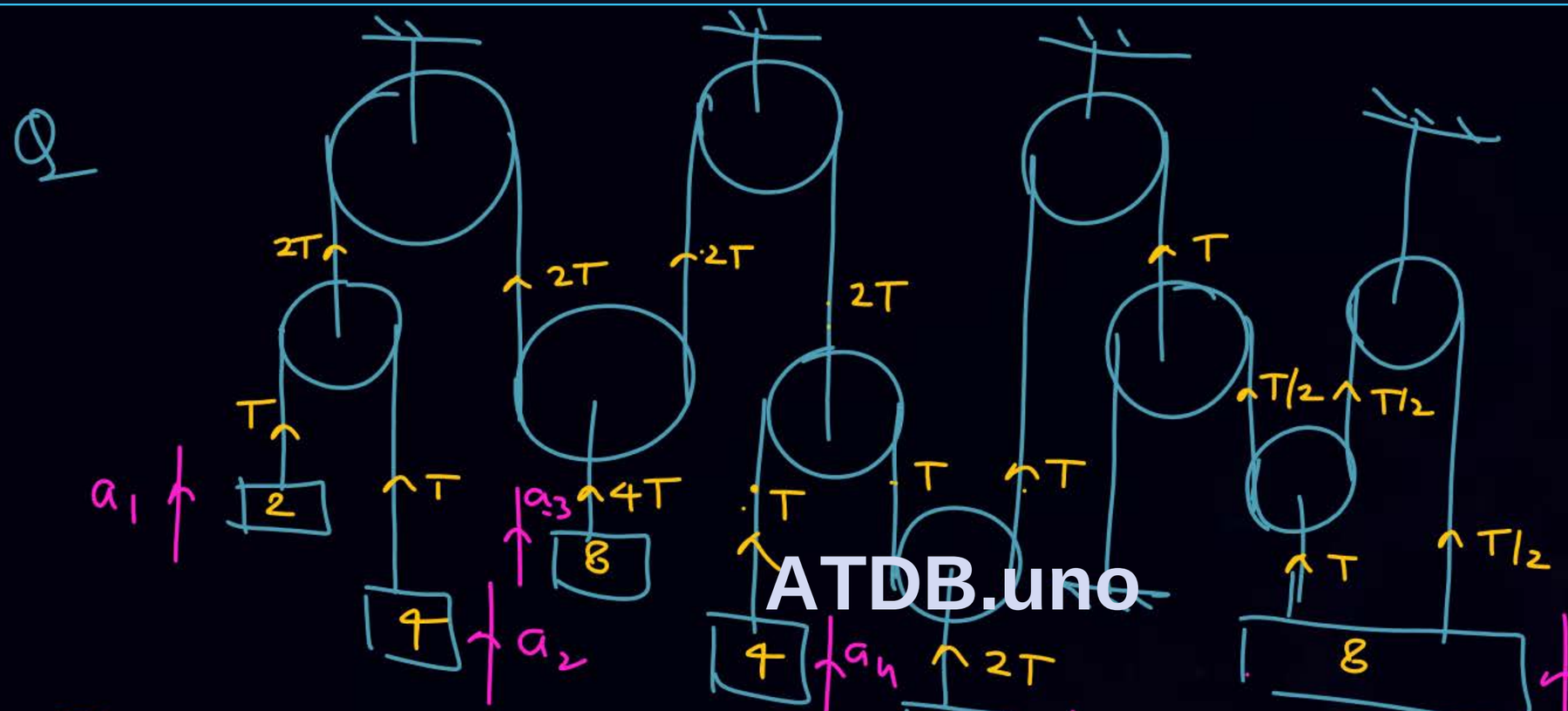


$2a_1 + a_2 = 0$

$2\left(\frac{2T - mg\sin\theta}{m}\right) + \frac{T - 2mg}{2m}$

$= 0$

Q



$$\frac{T-20}{2} + \frac{T-40}{4} + 4\left(\frac{4T-80}{8}\right) + \left(\frac{T-40}{4}\right) + 2\left(\frac{2T-20}{2}\right) + \frac{3}{2}\left(\frac{\frac{3T}{2}-80}{8}\right) = 0$$

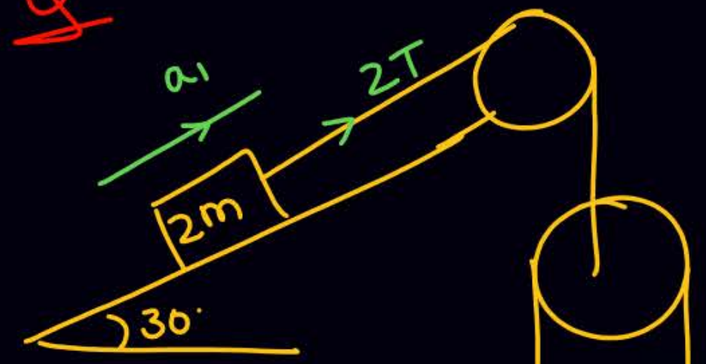
HCV

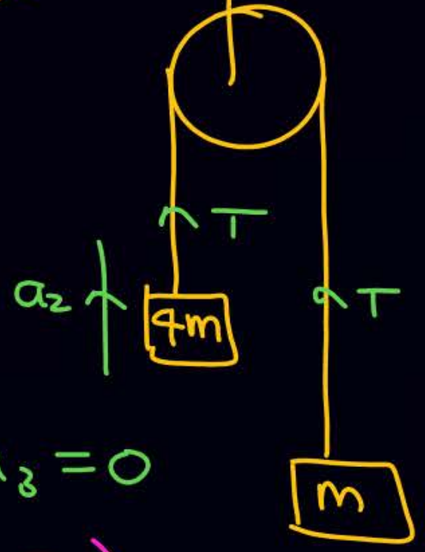
Q

$$2a_1 + a_2 + a_3 = 0.$$

$$2\left(\frac{2T-10}{1}\right) + \frac{T-20}{2} + \frac{T-30}{3} = 0$$

Q





$$2a_1 + a_2 + a_3 = 0$$

$$2\left(\frac{2T - 2mg\sin 30}{2m}\right) + \frac{T - 4mg}{4m} + \frac{T - mg}{m} = 0$$

Q

$$a_1 + 2a_2 = 0$$

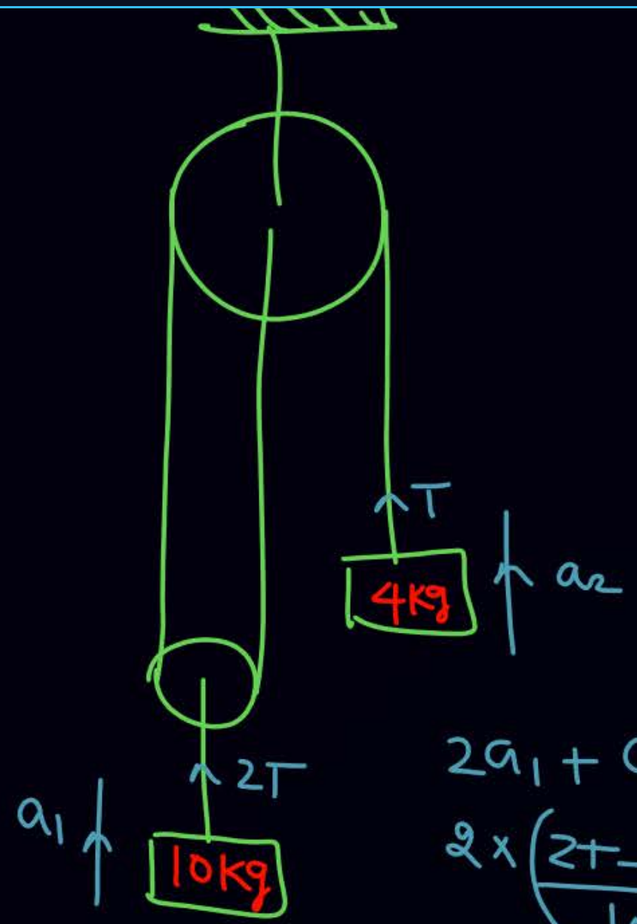
$$\frac{T}{4} + 2\left(\frac{2T - 100}{10}\right) = 0$$

$$5T + 8T - 400 = 0$$

$$T = \frac{400}{13}$$

$$a_2 = \frac{2 \times \frac{400}{13} - 100}{10} = \frac{-500}{130}$$

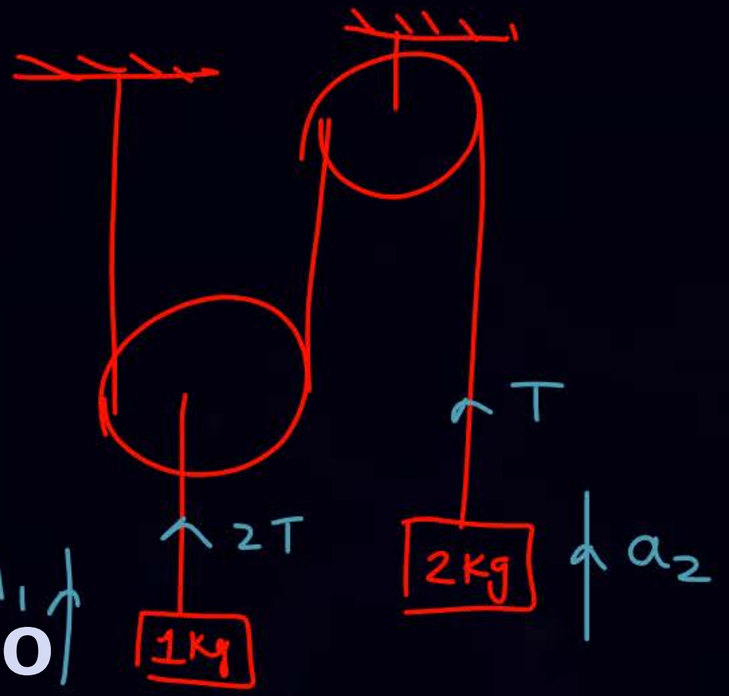
Q



$$2a_1 + a_2 = 0$$

$$2 \times \left(\frac{2T-100}{10}\right) + \frac{T-40}{4} = 0$$

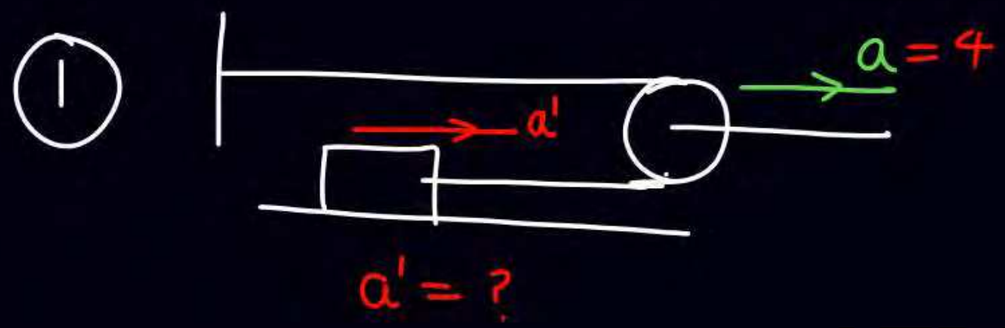
Q

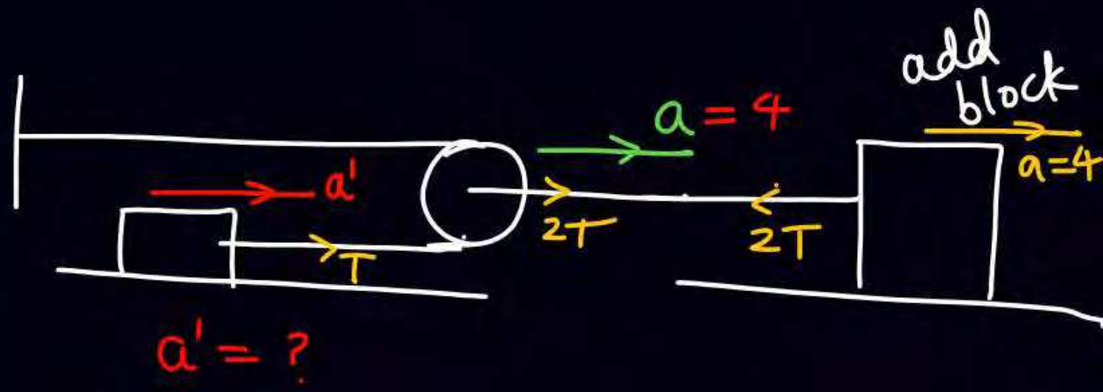


$$2a_1 + a_2 = 0$$

$$2\left(\frac{2T-10}{1}\right) + \frac{T-20}{2} = 0$$

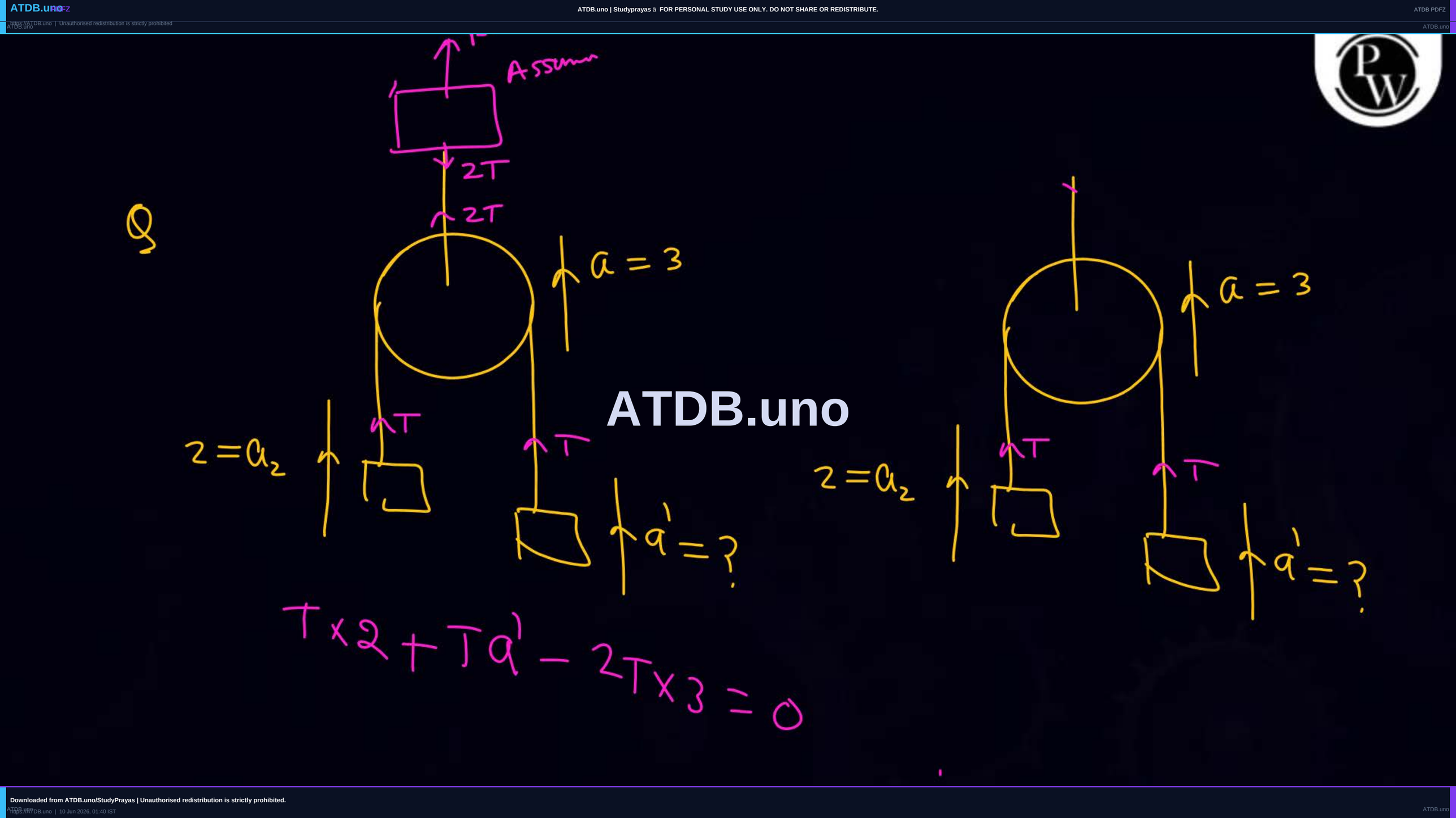
Imp चीज़ आधा अधूरा figure



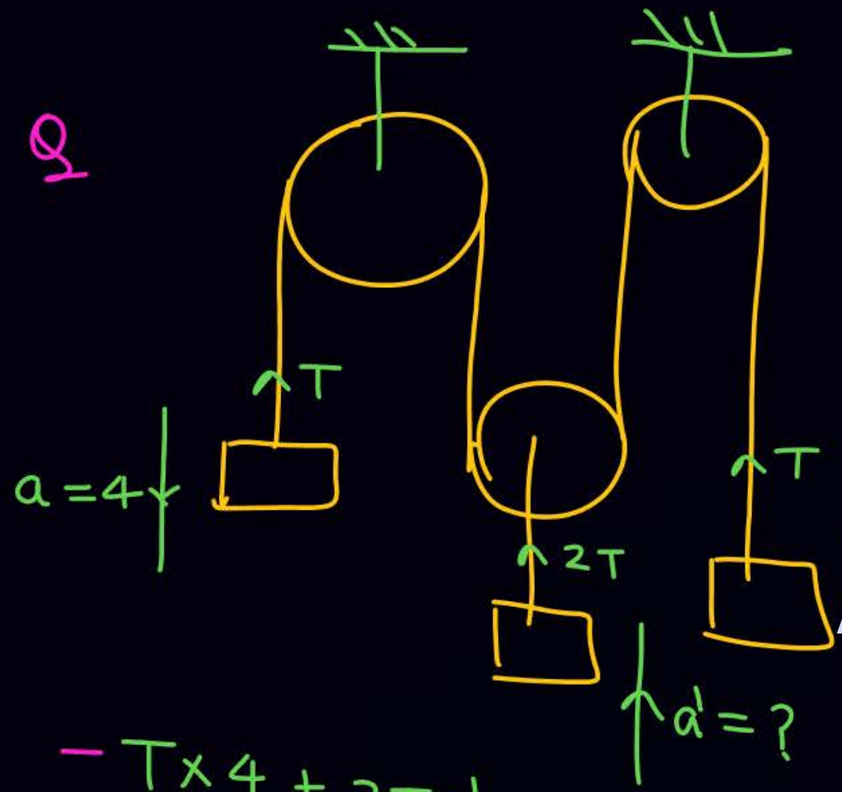


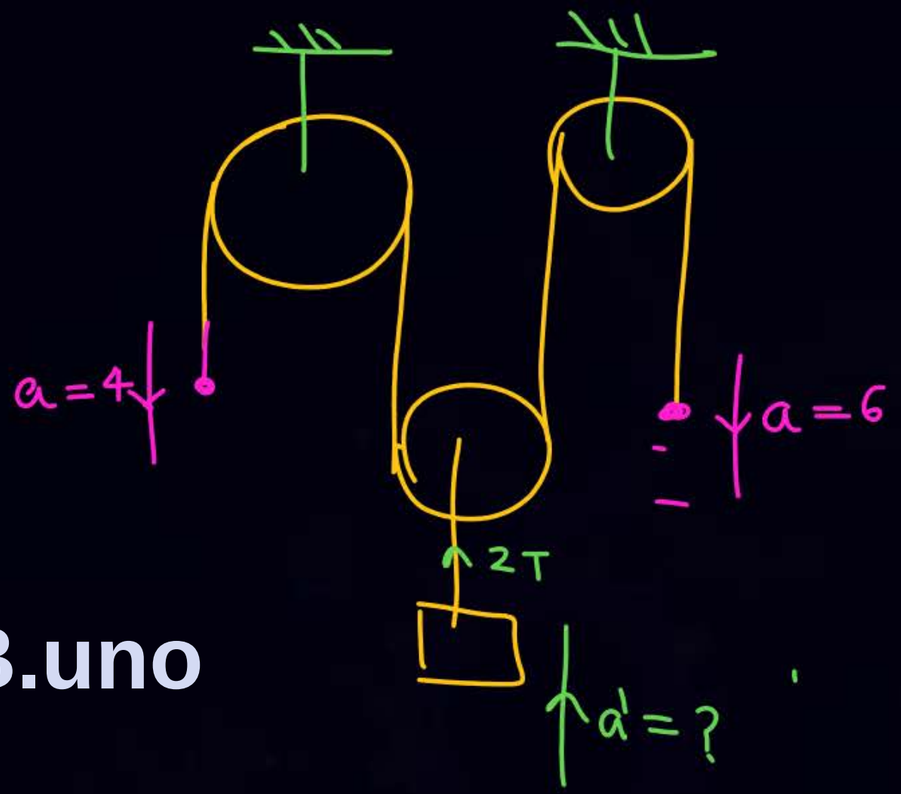
$$Ta' - 2T \times 4 = 0$$

$$a' = 8$$



Q





$$-T \times 4 + 2T a' - T \times 6 = 0$$

$$a' = 5$$

QUESTION

A person standing on a spring balance inside a stationary lift measures 60 kg. The weight of that person if the lift descends with uniform downward acceleration of $1.8\ m/s^2$ will be _____ N. $[g = 10\ m/s^2]$.

[JEE Main – 2021]

Ans : (492)

QUESTION

Two masses A and B, each of mass M are fixed together by a massless spring. A force acts on the mass B as shown in figure. If the mass A starts moving away from mass B with acceleration 'a', then the acceleration of mass B will be: **[JEE Main – 2021]**

1. $\frac{Ma - F}{M}$
2. $\frac{MF}{F + Ma}$
3. $\frac{F + Ma}{M}$
4. $\frac{F - Ma}{M}$

Ans : (4)

QUESTION

A boy pushes a box of mass 2 kg with a force $F = (20\hat{i} + 10\hat{j})$Nr on a frictionless surface. If the box was initially at rest, then _____ m is displacement along the x-axis after 10 s.

[JEE Main – 2021]

Ans : (500)

QUESTION

A body of mass 2 kg moves under a force of $(2\hat{\imath} + 3\hat{\jmath} + 5\hat{k})$N. It starts from rest and was at the origin initially. After 4s, its new coordinates are (8, b, 20). The value of b is _____. (Round off to the Nearest Integer)

[JEE Main – 2021]

Ans : (12)

QUESTION

A bullet of mass 0.1 kg is fired on a wooden block to pierce through it, but it stops after moving a distance of 50 cm into it. If the velocity of bullet before hitting the wood is 10 m/s and it slows down with uniform deceleration, then the magnitude of effective retarding force on the bullet is 'x' N. The value of 'x' to the nearest integer is _____.

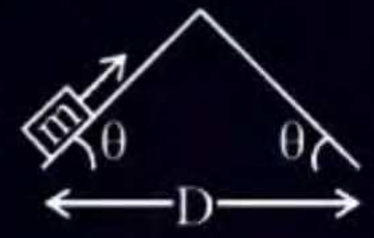
[JEE Main – 2021]

Ans : (10)

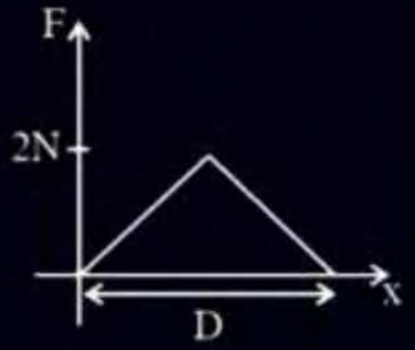
QUESTION

An object of mass 'm' is being moved with a constant velocity under the action of an applied force of 2N along a frictionless surface with following surface profile. The correct applied force vs distance graph will be:

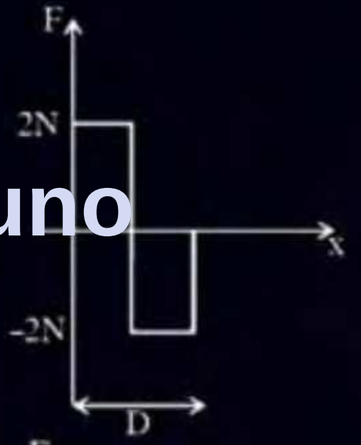
[JEE Main – 2021]



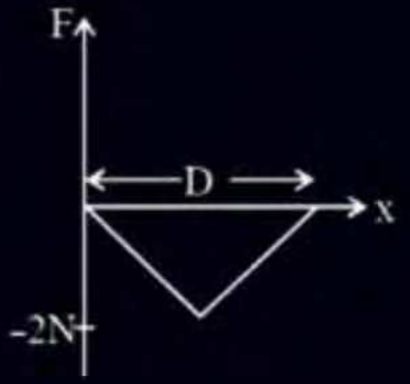
1



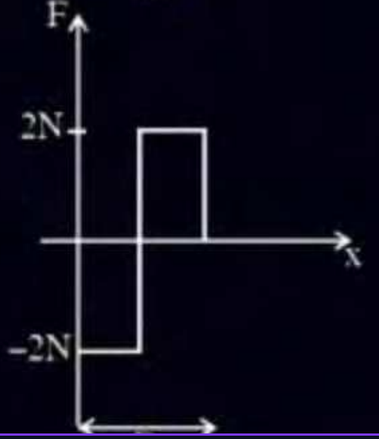
2



3



4



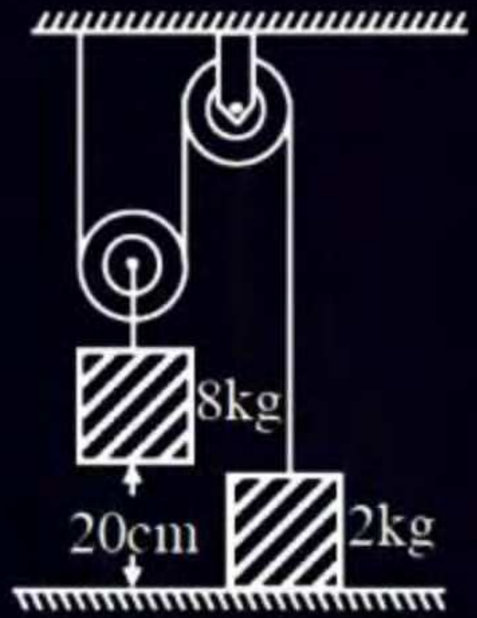
Ans : (2)

QUESTION

The boxes of masses 2 kg and 8 kg are connected by a massless string passing over smooth pulleys. Calculate the time taken by box of mass 8 kg to strike the ground starting from rest. (use $g = 10\ m/s^2$)

[JEE Main – 2021]

1. 0.34 s
2. 0.2 s
3. 0.25 s
4. 0.4 s

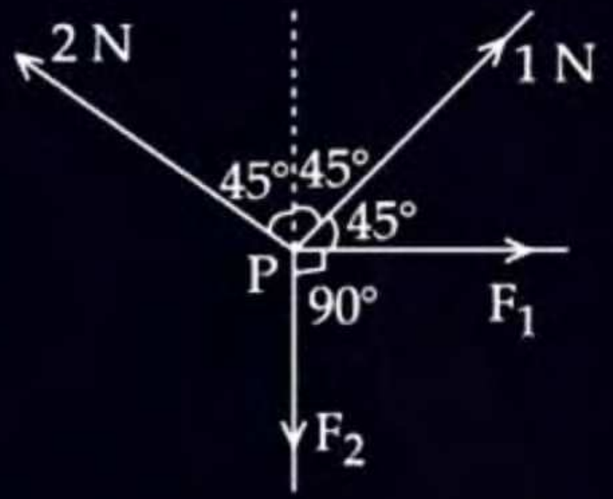


Ans : (4)

QUESTION

Four forces are acting at a point P in equilibrium as shown in figure. The ratio of force F_1 to F_2 is 1 : x where x = _____.

[JEE Main – 2022]

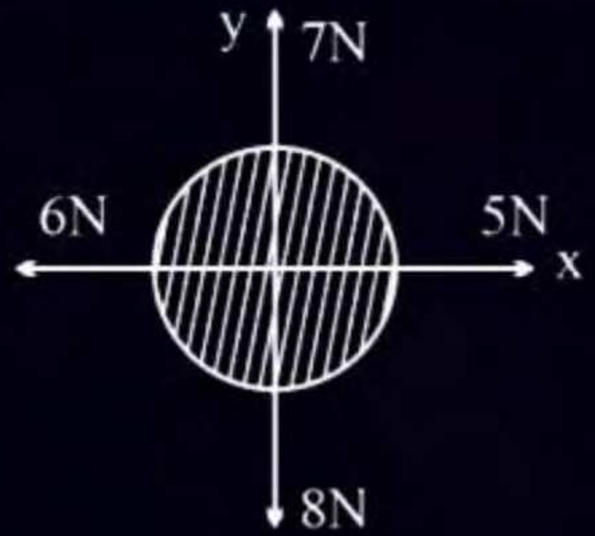


Ans : (3)

QUESTION

For a free body diagram shown in the figure, the four forces are applied in the 'x' and 'y' directions. What additional force must be applied and at what angle with positive x-axis so that the net acceleration of body is zero?

[JEE Main – 2022]



1. $\sqrt{2}$ N, 45°
2. $\sqrt{2}$ N, 135°
3. $\frac{2}{\sqrt{3}}$ N, 30°
4. 2 N, 45°

Ans : (1)

QUESTION

A monkey of mass 50 kg climbs on a rope which can withstand the tension (T) of 350 N. If monkey initially climbs down with an acceleration of 4 m/s^2 and then climbs up with an acceleration of 5 m/s^2. Choose the correct option ($g = 10\ m/s^2$) **[JEE Main – 2022]**

1. T = 700 N while climbing upward
2. T = 350 N while going downward
3. Rope will break while climbing upward
4. Rope will break while going downward

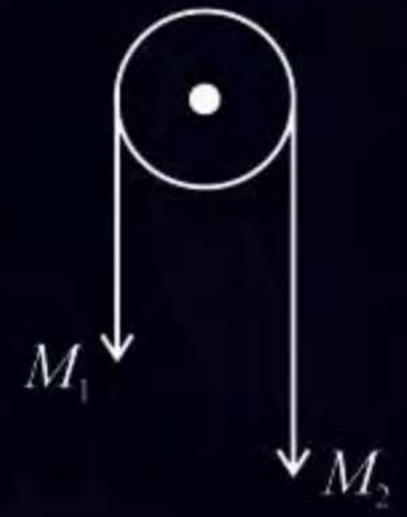
Ans : (3)

QUESTION

Two masses M_1 and M_2 are tied together at the two ends of a light inextensible string that passes over a frictionless pulley. When the mass M_2 is twice that of M_1. The acceleration of the system is a_1. When the mass M_2 is thrice that of M_1. The acceleration of the system is a_2. The ratio $\frac{a_1}{a_2}$ will be:

[JEE Main – 2022]

1. 1/3
2. 2/3
3. 3/2
4. 1/2



Ans : (2)

QUESTION

A block 'A' takes 2 s to slide down a frictionless incline of 30° and length 'l', kept inside a lift going up with uniform velocity 'v'. If the incline is changed to 45°, the time taken by the block, to slide down the incline, will be approximately: **[JEE Main – 2022]**

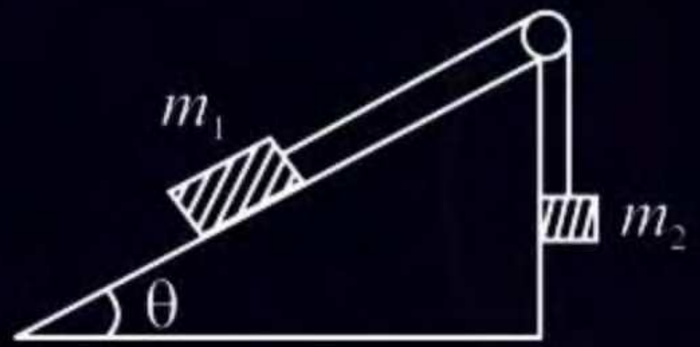
1. 2.66 s
2. 0.83 s
3. 1.68 s
4. 0.70 s

Ans : (3)

QUESTION

Two bodies of masses $m_1 = 5$ kg and $m_2 = 3$ kg are connected by a light string going over a smooth light pulley on a smooth inclined plane as shown in the figure. The system is at rest. The force exerted by the inclined plane of the body of mass m_1 will be: [Take $g = 10\ ms^{-2}$].

[JEE Main – 2022]



1. 30 N
2. 40 N
3. 50 N
4. 60 N

Ans : (2)

QUESTION

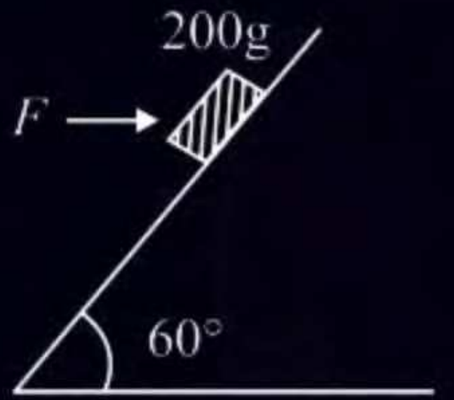
A force on object of mass 100 g is $(10\hat{i} + 5\hat{j})$N. The position of that object at t = 2 s is $(a\hat{i} + b\hat{j})$m after starting from rest. The value of $\frac{a}{b}$ will be _____. **[JEE Main – 2022]**

Ans : (2)

QUESTION

A block of mass 200 g is kept stationary on a smooth inclined plane by applying a minimum horizontal force $F = \sqrt{x}$N as shown in figure. The value of x = _____.

[JEE Main – 2022]

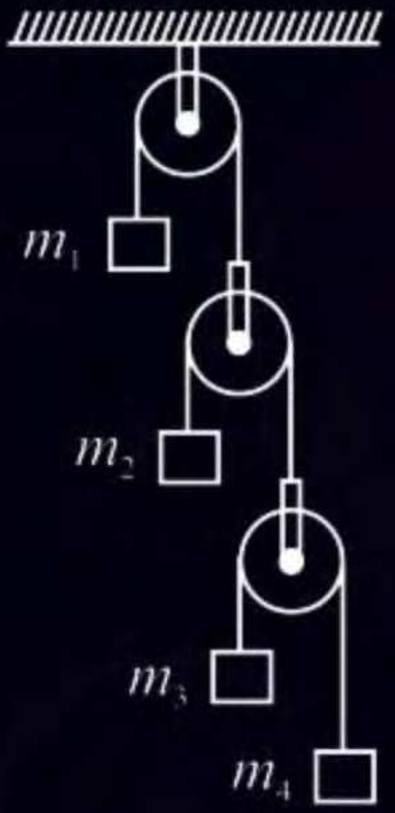


Ans : (12)

QUESTION

In the arrangement shown in figure a_1, a_2, a_3 and a_4 are the acceleration of masses m_1, m_2, m_3 and m_4 respectively. Which of the following relation is true for this arrangement?

[JEE Main – 2022]



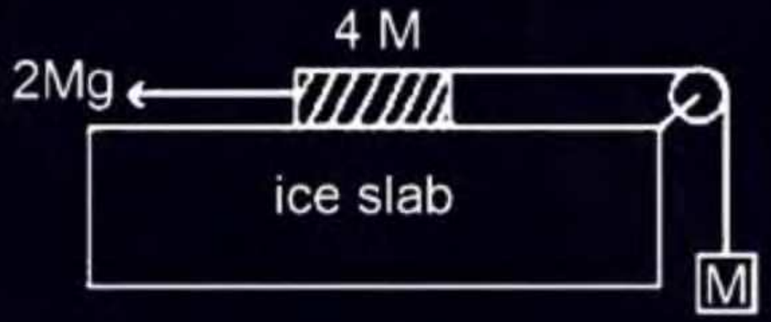
1. $4a_1 + 2a_2 + a_3 + a_4 = 0$
2. $a_1 + 4a_2 + 3a_3 + a_4 = 0$
3. $a_1 + 4a_2 + 3a_3 + 2a_4 = 0$
4. $2a_1 + 2a_2 + 3a_3 + a_4 = 0$

Ans : (1)

QUESTION

A hanging mass M is connected to a four times bigger mass by using a string-pulley arrangement. as shown in the figure. The bigger mass is placed on a horizontal ice-slab and being pulled by 2Mg force. In this situation tension in the string is $\frac{x}{5}$ mg for x = _____. Neglect mass of the string and friction of the block (bigger mass) with ice slab. (Given g = acceleration due to gravity).

[JEE Main – 2022]



Ans : (6)

QUESTION

A block of mass M placed inside a box descends vertically with acceleration 'a'. The block exerts a force equal to one-fourth of its weight on the floor of the box. The value of 'a' will be _____.

[JEE Main – 2022]

1. $\frac{g}{4}$
2. $\frac{g}{2}$
3. $\frac{3g}{4}$
4. g

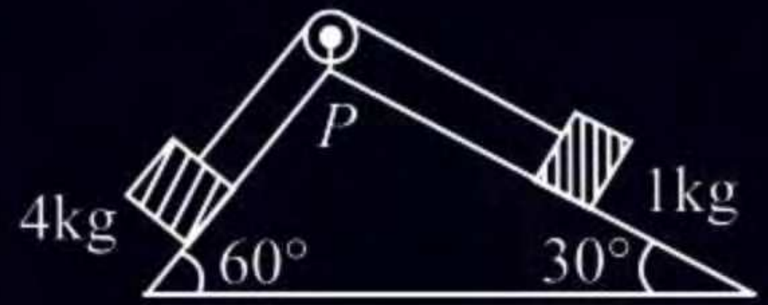
Ans : (3)

QUESTION

As per given figure, a weightless pulley P is attached on a double inclined frictionless surface. The tension in the string (massless) will be: (if $g = 10\ m/s^2$).

[24 January 2023 - Shift 1]

1. $(4\sqrt{3}+1)N$
2. $4(\sqrt{3}+1)N$
3. $4(\sqrt{3}-1)N$
4. $(4\sqrt{3}-1)N$



Ans : (2)

QUESTION

Given below are two statements:

Statement-I: An elevator can go up or down with uniform speed when its weight is balanced with the tension of its cable.

Statement-II: Force exerted by the floor of an elevator on the foot of a person standing on it is more than his/her weight when the elevator goes down with increasing speed.

In the light of the above statements, choose the correct answer from the options given below:

[24 January 2023 - Shift 1]

1. Both statement I and statement II are false
2. Statement I is true but Statement II is false
3. Both Statement I and Statement II are true
4. Statement I is false but Statement II is true

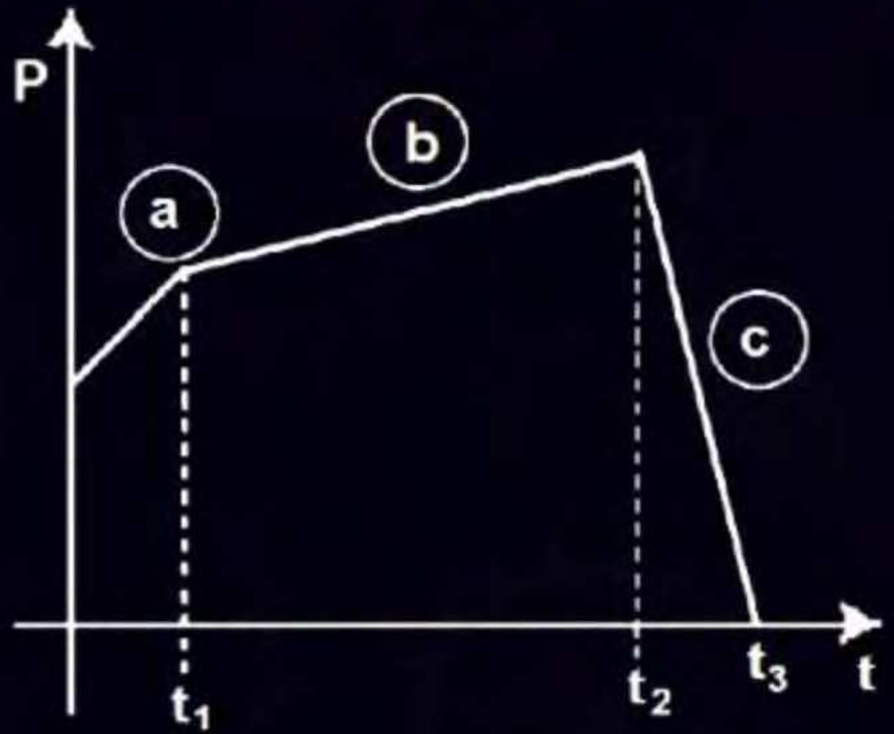
Ans : (2)

QUESTION

The figure represents the momentum time (p–t) curve for a particle moving along an axis under the influence of the force. Identify the regions on the graph where the magnitude of the force is maximum and minimum respectively?
If $(t_3 - t_2) < t_1$.

[30 January 2023 - Shift 1]

1. c and a
2. b and c
3. c and b
4. a and b

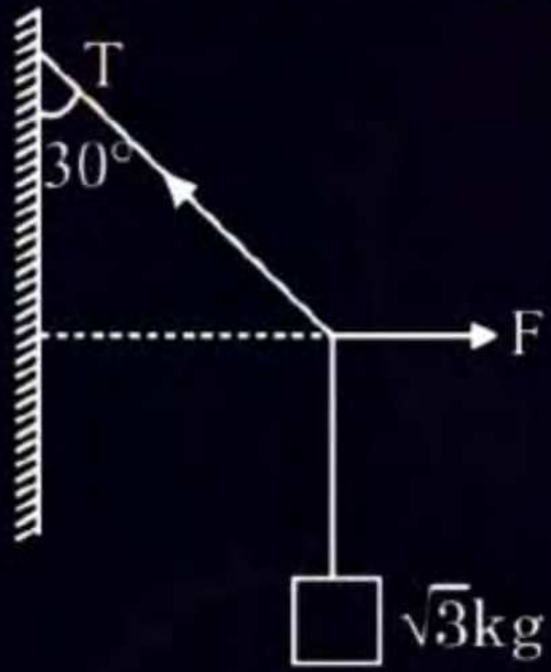


Ans : (3)

QUESTION

A block of $\sqrt{3}$ kg is attached to a string whose other end is attached to the wall. An unknown force F is applied so that the string makes an angle of 30° with the wall. The tension T is:
(Given g = 10 ms^{-2}).

[30 January 2023 - Shift 2]



1. 20 N
2. 25 N
3. 10 N
4. 15 N

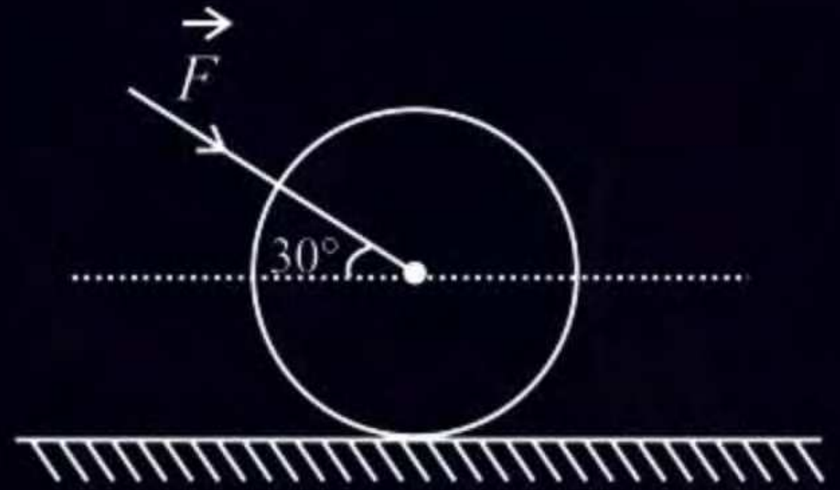
Ans : (1)

QUESTION

As shown in figure, a 70 kg garden roller is pushed with a force of $\vec{F}$ = 200 N at an angle of 30° with horizontal. The normal reaction on the roller is _____.
(Given g = 10 m s^{-2}).

[31 January 2023 - Shift 1]

1. $800\sqrt{2}$ N
2. 600 N
3. 800 N
4. $200\sqrt{3}$ N



Ans : (3)

QUESTION

A mass m is attached to two springs as shown in figure. The spring constants of two springs are K_1 and K_2. For the frictionless surface, the time period of oscillation of mass m is _____.

[06 April 2023 - Shift 1]

1. $2\pi\sqrt{\frac{m}{K_1+K_2}}$
2. $\frac{1}{2\pi}\sqrt{\frac{K_1-K_2}{m}}$
3. $2\pi\sqrt{\frac{m}{K_1-K_2}}$
4. $\frac{1}{2\pi}\sqrt{\frac{K_1+K_2}{m}}$

Ans : (1)

QUESTION

At any instant the velocity of a particle of mass 500 g is $(2t\hat{i} + 3t^2\hat{j})$ ms^{-1}. If the force acting on the particle at t = 1 s is $(\hat{i} + x\hat{j})$ N. Then the value of x will be:

[08 April 2023 - Shift 1]

1. 3
2. 4
3. 2
4. 6

Ans : (1)

QUESTION

The position vector of a particle related to time t is given by $\vec{r} = (10t\hat{i} + 15t^2\hat{j} + 7\hat{k})$ m.
The direction of net force experienced by the particle is:

[15 April 2023 - Shift 1]

1. Positive x-axis
2. In x-y plane
3. Positive y-axis
4. Positive z-axis

Ans : (3)

QUESTION

A body of mass 4 kg experiences two forces $\vec{F}_1 = 5\hat{i} + 8\hat{j} + 7\hat{k}$ and $\vec{F}_2 = 3\hat{i} - 4\hat{j} - 3\hat{k}$. The acceleration acting on the body is:

[01 Feb. 2024 - Shift 2]

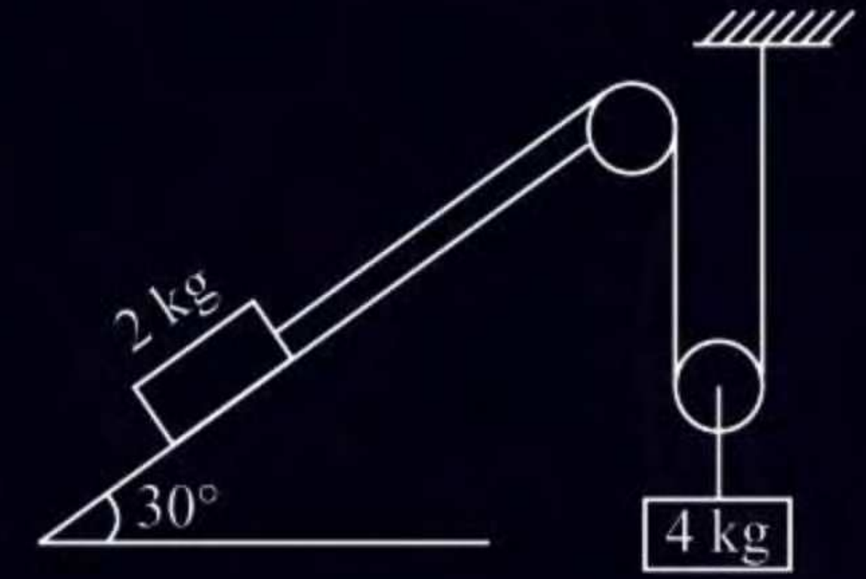
1. $-2\hat{i} - \hat{j} - \hat{k}$
2. $4\hat{i} + 2\hat{j} + 2\hat{k}$
3. $2\hat{i} + \hat{j} + \hat{k}$
4. $2\hat{i} + 3\hat{j} + 3\hat{k}$

Ans : (3)

QUESTION

All surfaces shown in figure are assumed to be frictionless and the pulleys and the string are light. The acceleration of the block of mass 2 kg is: **[30 Jan. 2024 - Shift 1]**

1. g
2. g/3
3. g/2
4. g/4

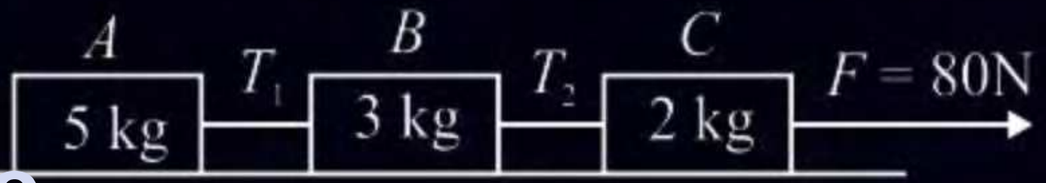


Ans : (2)

QUESTION

Three blocks A, B and C are pulled on a horizontal smooth surface by a force of 80 N as shown in figure. The tensions T_1 and T_2 in the string are respectively:

[30 Jan. 2024 - Shift 2]



1. 40 N, 64 N
2. 60 N, 80 N
3. 88 N, 96 N
4. 80 N, 100 N

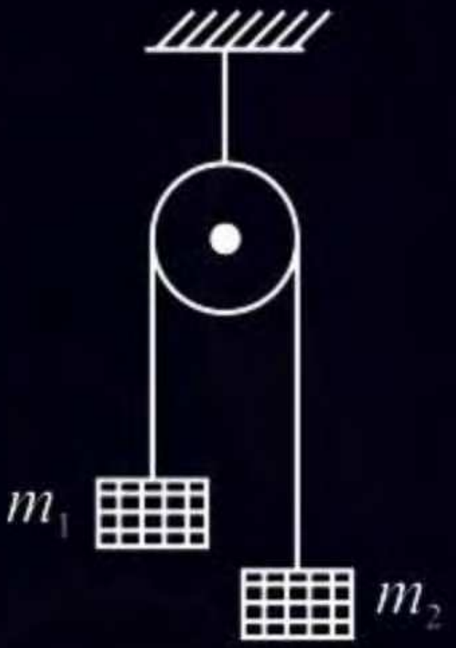
Ans : (1)

QUESTION

A light string passing over a smooth light fixed pulley connects two blocks of masses m_1 and m_2. If the acceleration of the system is g/8, then the ratio of masses is:

[31 Jan. 2024 - Shift 2]

1. 9/7
2. 8/1
3. 4/3
4. 5/3



Ans : (1)

H.W

- Jm PYQ are attached (must try)
- HCV → must try ⇒ 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36 page 86
- DPP = (must try)

DPP – 06