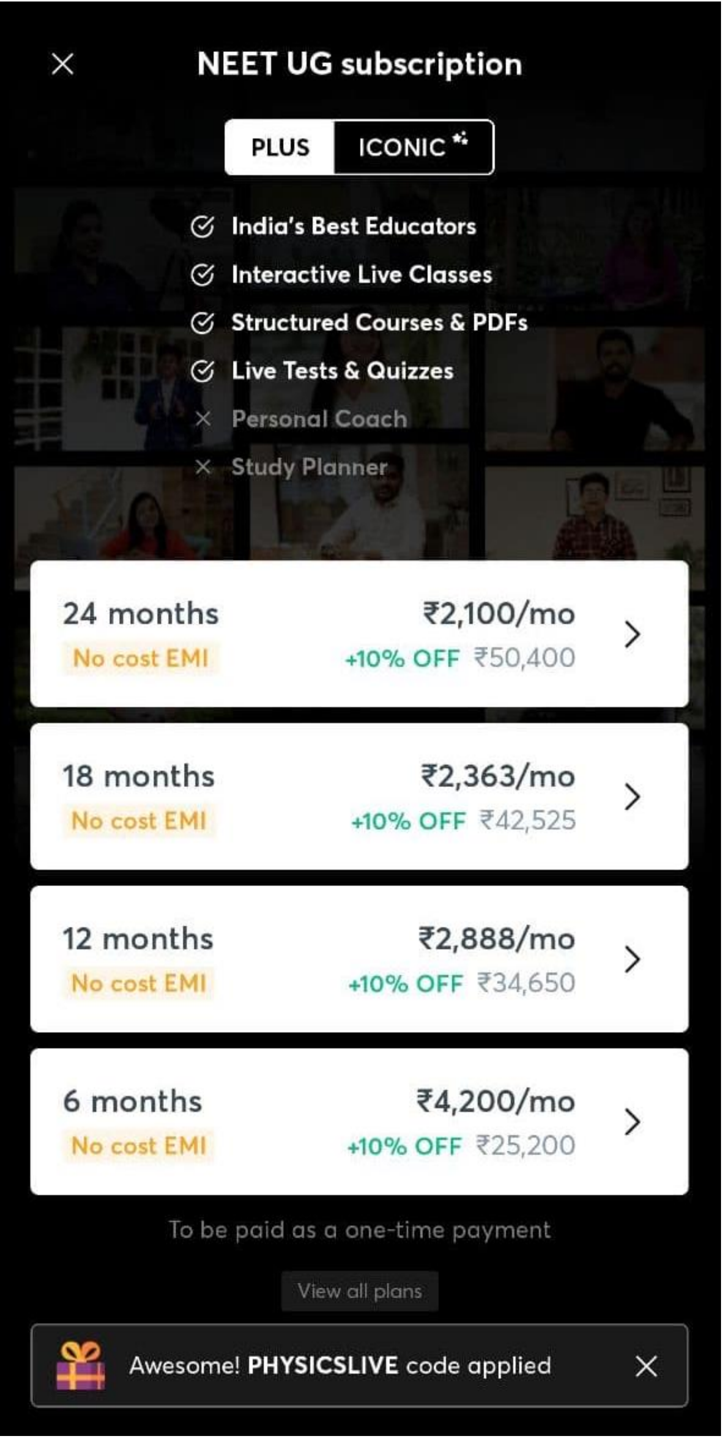
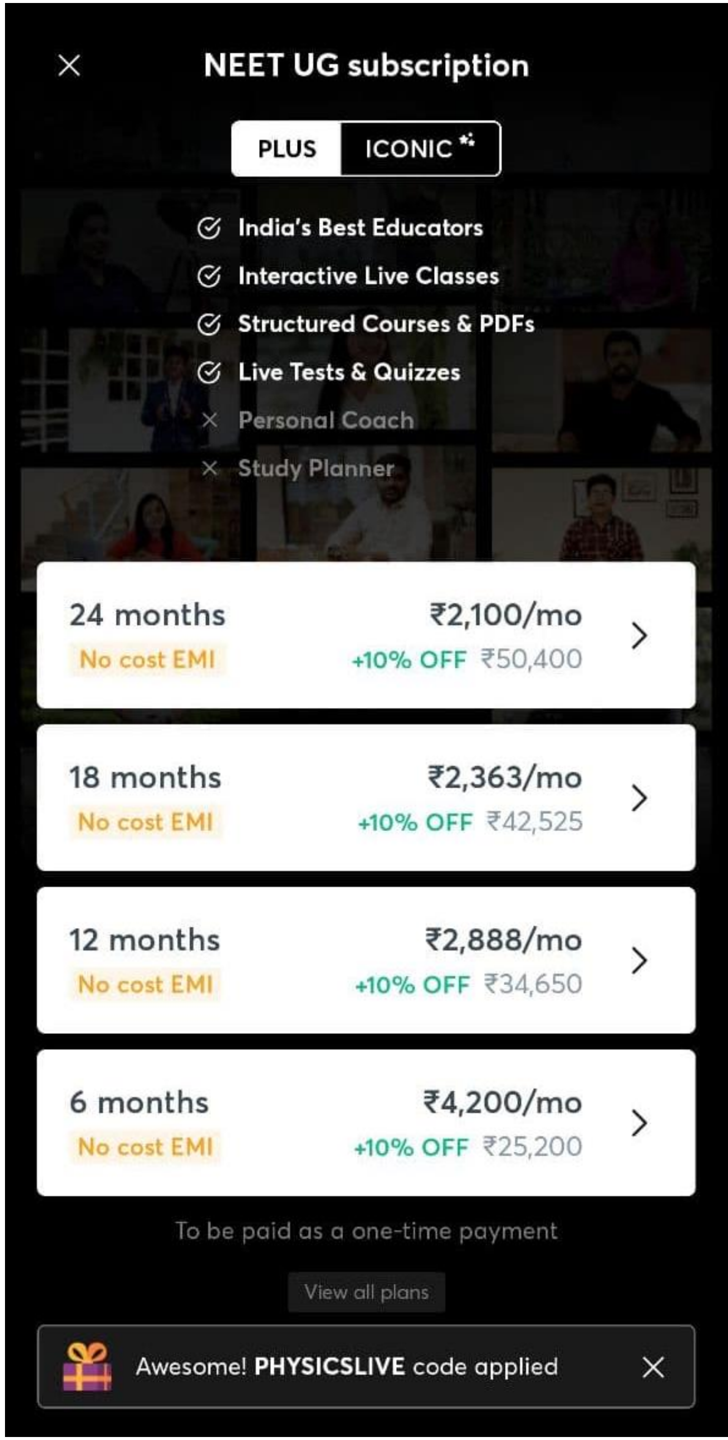
SIR PRATEEK JAIN

. Founder @ Physicsaholics
. Top Physics Faculty on Unacademy (IIT JEE & NEET)
. 8+ years of teaching experience in top institutes like FIITJEE (Delhi, Indore) , CP (KOTA) etc.
. Produced multiple Top ranks.
. Research work with HC Verma sir at IIT Kanpur
. Interviewed by International media.



PHYSICSLIVE

Use code PHYSICSLIVE to get 10% OFF on Unacademy PLUS and learn from India's Top Faculties.



For Video Solution of this DPP, Click on below link

Video Solution on Website:- https://physicsaholics.com/home/courseDetails/53

Video Solution on YouTube:- https://youtu.be/5hJdZ_raBLQ unacademy

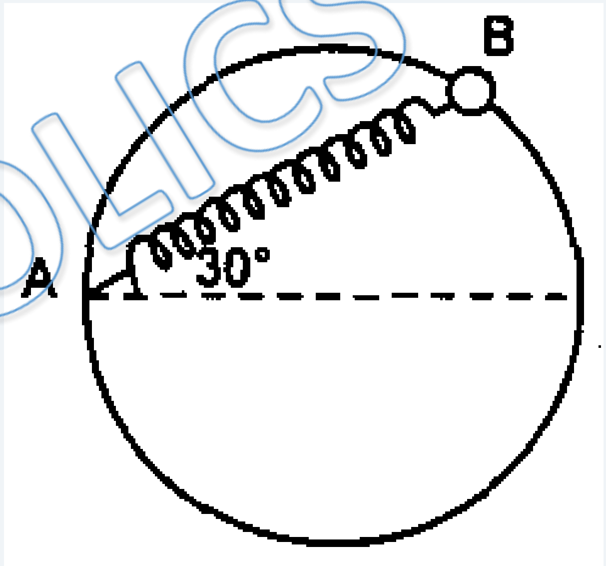
JEE Main & Advanced, NSEP, INPhO, IPhO

Physics DPP

DPP-5 NLM: Spring Force

By Physicsaholics Team

Q) A bead of mass in is attached to one end of a spring of natural length R and spring constant $k = \frac{(\sqrt{3}+1)mg}{R}$. The other end of the spring is fixed at point A on a smooth vertical ring of radius R as shown in figure. The normal reaction at B just after it is released to move is:



(a) $\frac{mg}{2}$

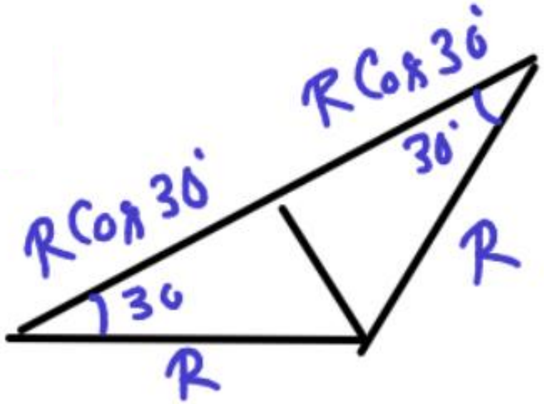
(b) $\sqrt{3}mg$

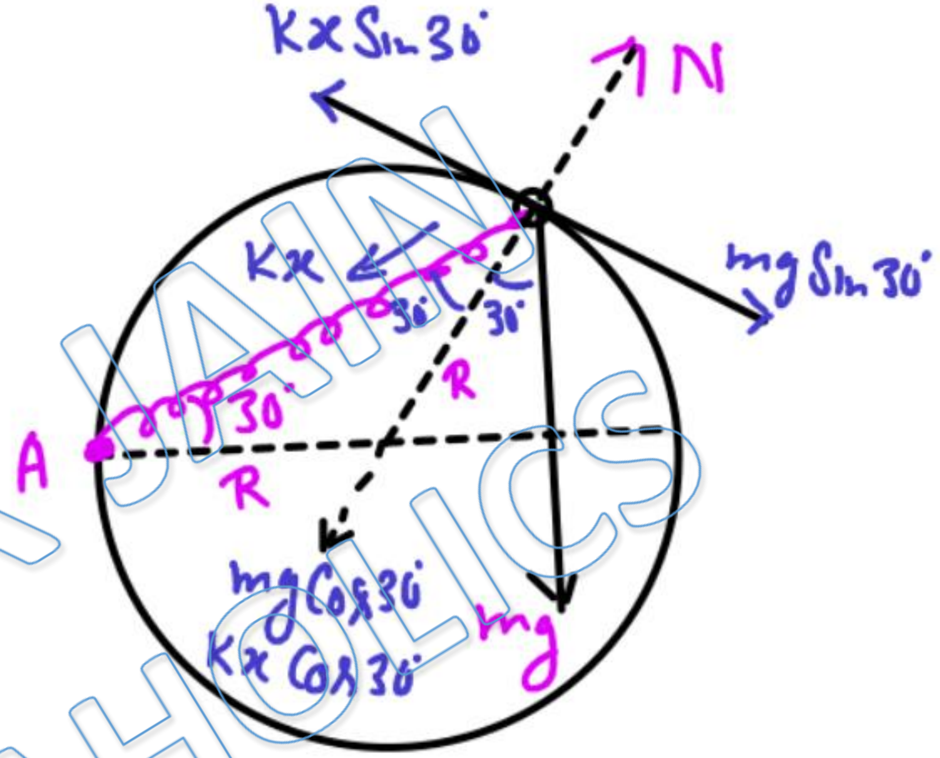
(c) $3\sqrt{3}mg$

(d) $\frac{3\sqrt{3}mg}{2}$

Ans. d

Solution:





length of spring

$= 2R\cos 30^\circ = R\sqrt{3}$

elongation in spring $= R\sqrt{3} - R = R(\sqrt{3}-1)$

spring force $Kx = (\sqrt{3}+1)\frac{mg}{R} \times R(\sqrt{3}-1)$

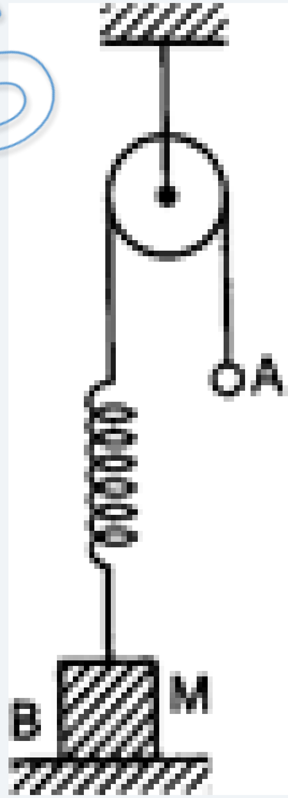
$= 2mg$

$N = mg\cos 30 + Kx\cos 30^\circ = \frac{mg\sqrt{3}}{2} + 2mg\frac{\sqrt{3}}{2}$

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

(D)

Q) In the figure, the ball A is released from rest when the spring is at its natural (unstretched) length. For the block B, of mass M to leave contact with the ground at some stage, the minimum mass of A must be



(a) 2M

(b) M

(c) M/2

(d) a function of M and the force constant of the spring

Ans. c

Solution:

maximum elongation in spring

= maximum Displacement of A

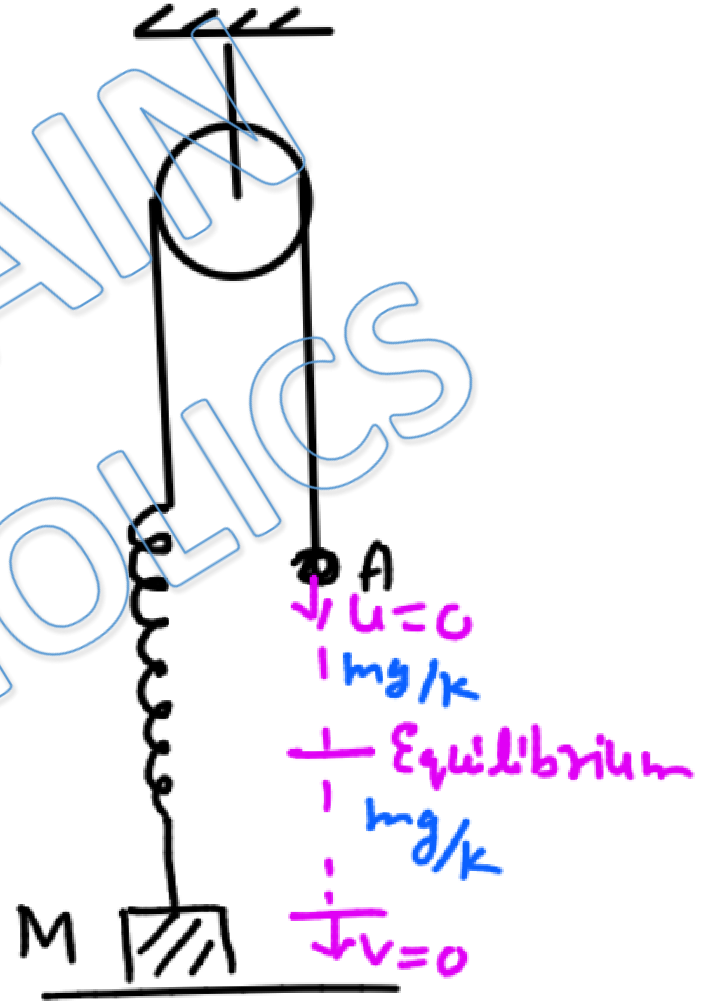
$= 2mg/k$

maximum spring force

$= k \times \frac{2mg}{k} = 2mg$

If this force is greater than or equal to Mg, it will lift.

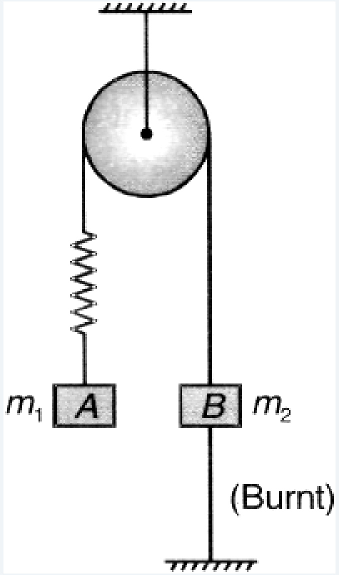
$2mg \geq Mg \Rightarrow m \geq M/2$



(c)

unacademy

Q) In the system shown $m_1 > m_2$. System is held at rest by thread BC. Just after lower thread is burnt, C



(a) Acceleration of m_2 is upwards

(b) Magnitude of acceleration of both blocks will be $\left(\frac{(m_1 - m_2)}{(m_1 + m_2)}\right) g$

(c) Acceleration of m_1 will be equal to zero

(d) Magnitudes of acceleration of two blocks will be non-zero & unequal

Ans. a, c

Solution:

Since spring is directly connected to string.

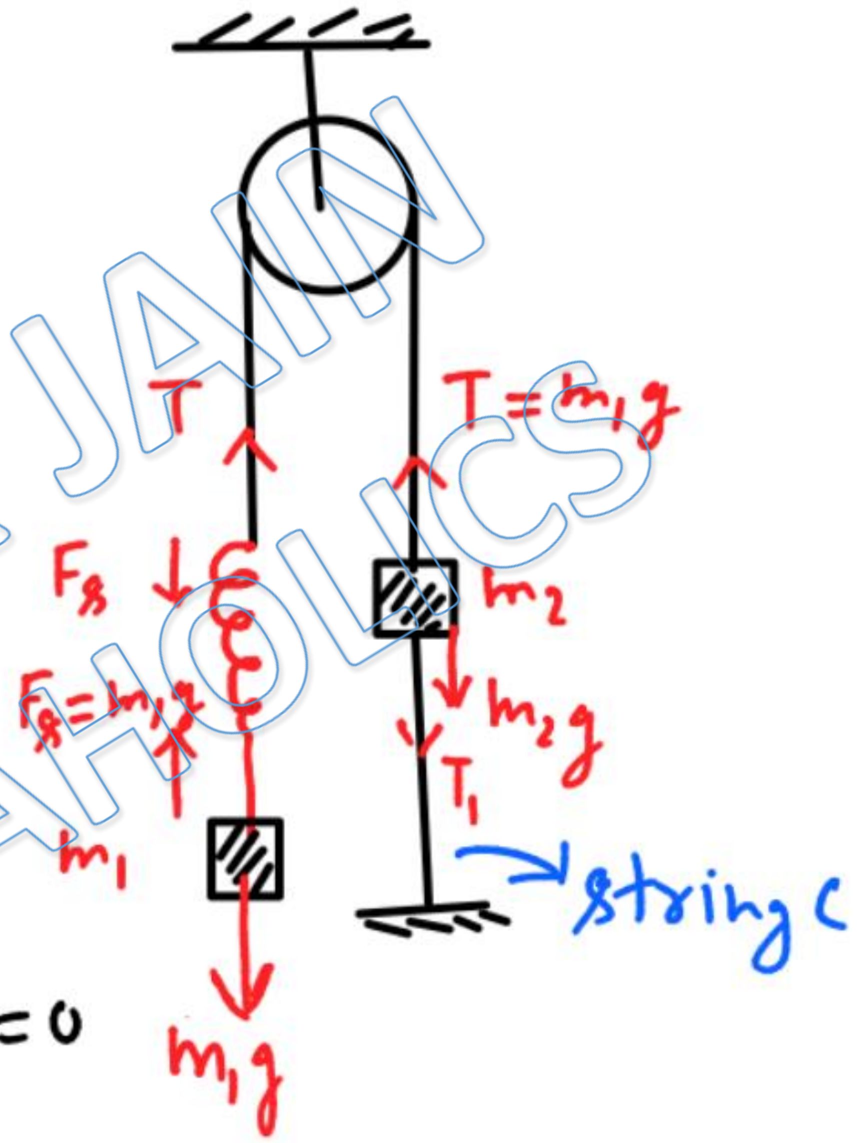
$T = F_s = m_1 g$

After burning string C, $T_1 = 0$ but all other forces will remain same.

$\Rightarrow$ acceleration of $m_1 = 0$

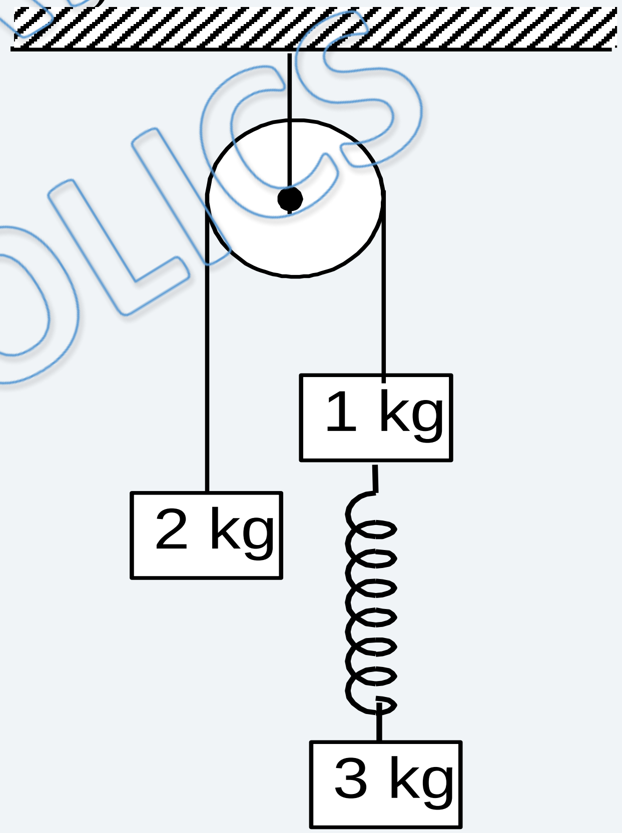
acceleration of m_2

$= \dfrac{m_1 g - m_2 g}{m_2} \uparrow$



(A, C)

Q) From the fixed pulley, masses 2 kg, 1 kg and 3 kg are suspended as shown is figure. Find the extension in the spring when acceleration of 3kg and 1kg is same if spring constant of the spring $k = 100$ N/m. ($g = 10$ m/s^2)



(a) 10 cm

(b) 20 cm

(c) 30 cm

(d) 25 cm

Ans. **b**

Solution:

$$a = \frac{\text{supporting} - \text{opposing}}{\text{total mass}}$$

$$a = \frac{4g - 2g}{6} = g/3$$

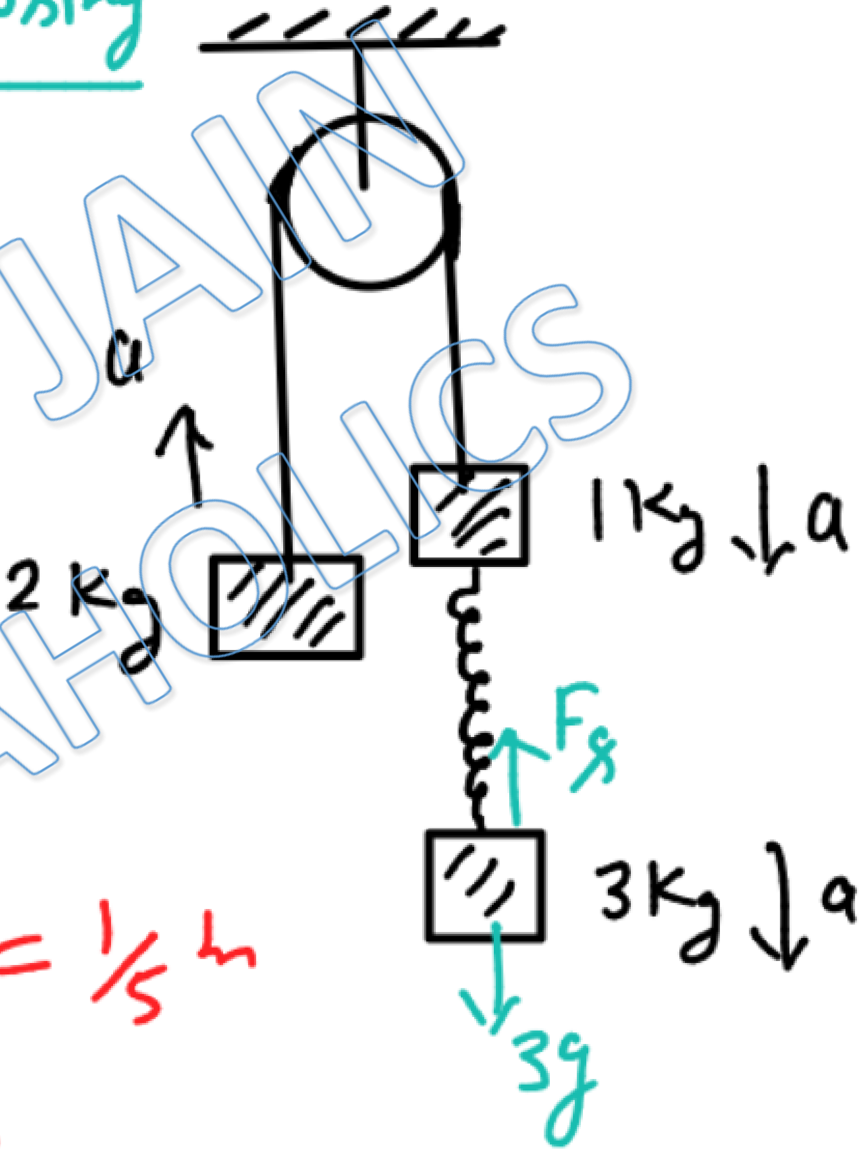
from F.B.D of 3kg

$$3g - F_s = 3a$$

$$3g - 100x = g$$

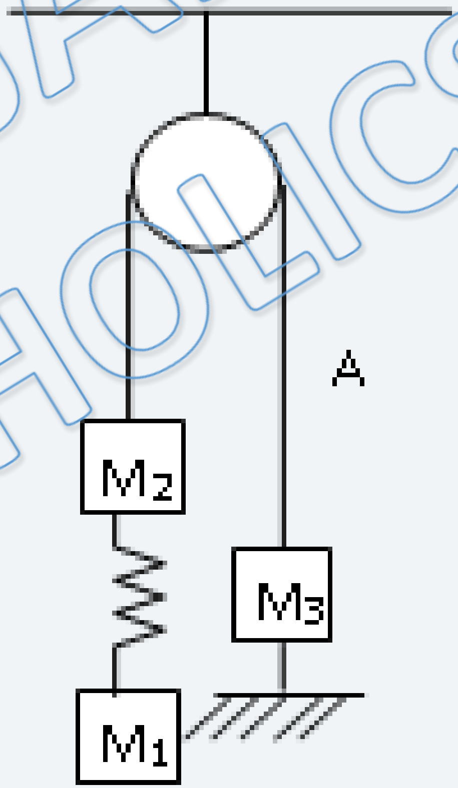
$$x = 2g/100 = 1/5 \text{ m}$$

$$x = 20 \text{ cm}$$



(B)

Q) The acceleration of masses m_1 and m_2 and m_3 shown in figure just after string is cut at point A is given by a_1, a_2 and a_3 choose the correct answer



(a) $a_1 = g, a_2 = g/2, a_3 = 0$

(b) $a_1 = \left(1 + \frac{m_2}{m_1}\right) g, a_2 = 0, a_3 = g$

(c) $a_1 = g, a_2 = \left(1 + \frac{m_1}{m_2}\right) g, a_3 = 0$

(d) $a_1 = 0, a_2 = \left(1 + \frac{m_1}{m_2}\right) g, a_3 = g$

Ans. d

Solution:

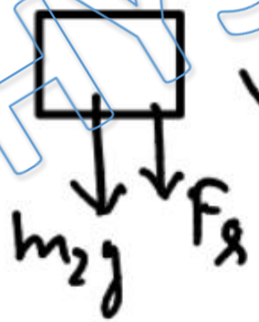
Just after cutting A, $T = 0$ & $T_1 = 0$

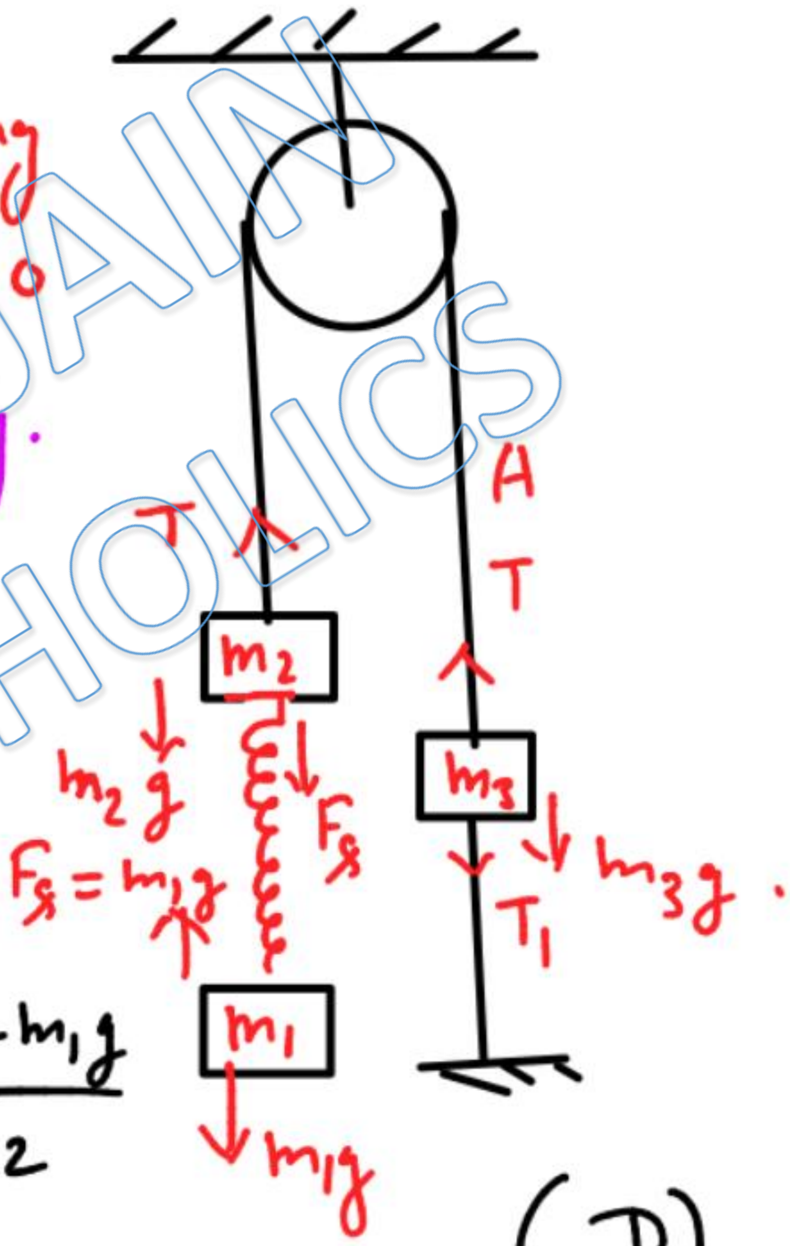
m_3 will fall freely.

m_1 will be in equilibrium

F.B.D of m_2

$$\downarrow a_2 = \frac{m_2 g + m_1 g}{m_2}$$





(D)

Q) Two identical bars of mass m each are connected by a weightless spring of stiffness *x* and length (in the non-deformed state) l_0 rest on a horizontal plane. A constant horizontal force *F* starts acting on one of the bar. Find the maximum elongation in spring during the subsequent motion of the system?

(a) F/k

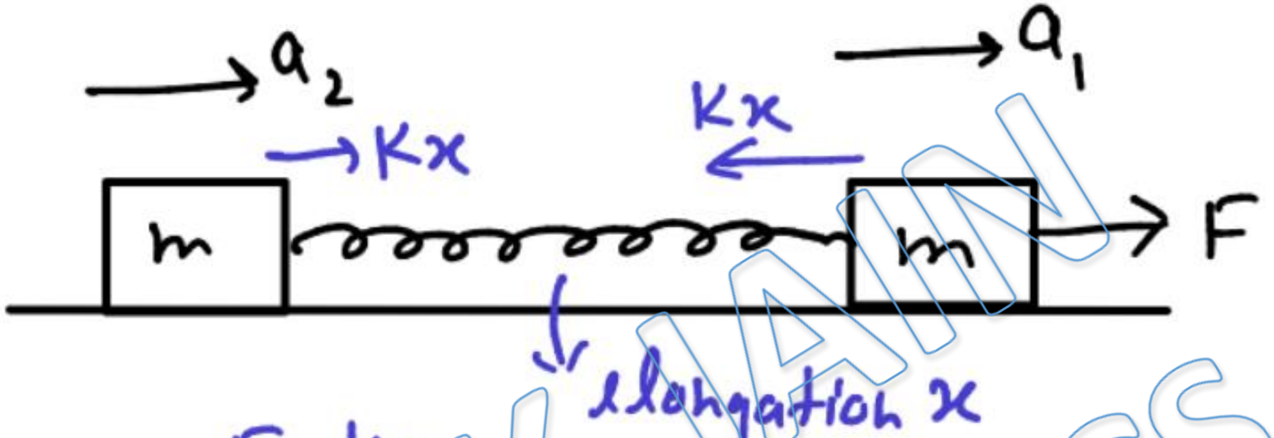
(b) F/2k

(c) 2F/k

(d) 3F/2k

Ans. a

Solution:



$$a_1 = \frac{F - Kx}{m}, \quad a_2 = \frac{Kx}{m}$$

relative acceleration $a = a_1 - a_2 = \dfrac{F - 2Kx}{m}$

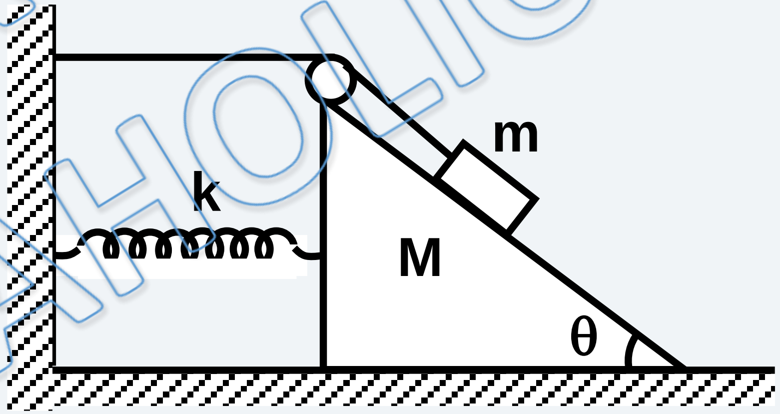
$\Rightarrow v\dfrac{dv}{dx} = \dfrac{F - 2Kx}{m}$ where v is relative velocity

at maximum elongation $v = 0$

$$\Rightarrow \int_0^0 v\,dv = \int_0^x \frac{F - 2Kx}{m}\,dx$$

$$\Rightarrow Fx - Kx^2 = 0 \Rightarrow x = F/K$$

Q) A wedge of mass 'M' and angle of inclination 'θ' and of mass 'm' is arranged in a manner shown in the figure. The spring of force constant 'k' attached to the wedge. Assuming the pulleys to be massless and all surfaces to be frictionless. Find the compression of the spring under equilibrium condition.



(a) $\dfrac{mg\sin\theta}{k}$

(b) $\dfrac{2mg\sin\theta}{k}$

(c) $\dfrac{mg\sin\theta}{2k}$

(d) none of these

Ans. a

Solution:

$$T\cos\theta + Kx = N\sin\theta + T$$

$$\Rightarrow N\sin\theta + T(1-\cos\theta) = Kx \quad \text{--- (i)}$$

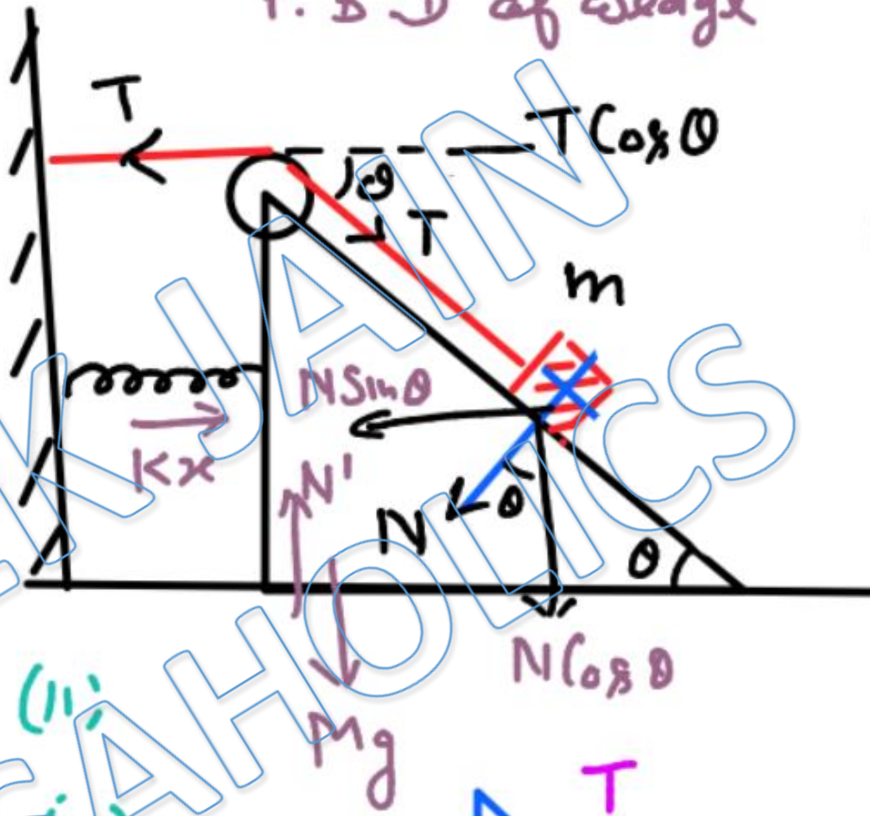
$$T = mg\sin\theta \quad \text{--- (ii)}$$

$$N = mg\cos\theta \quad \text{--- (iii)}$$

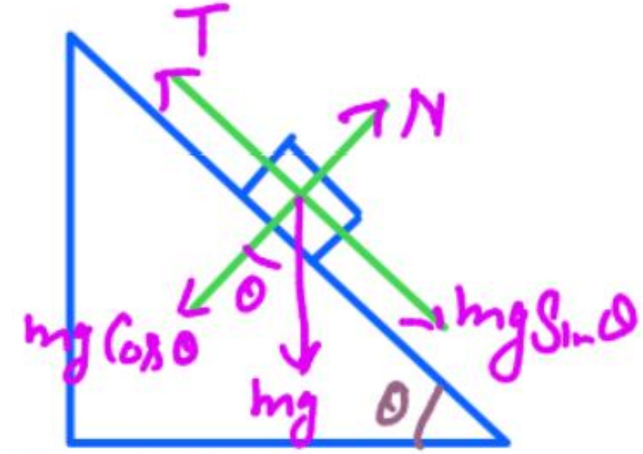
$$\Rightarrow mg\sin\theta\cos\theta + mg\sin\theta(1-\cos\theta) = K.x$$

$$\Rightarrow x = \frac{mg\sin\theta}{K}$$

F.B.D of wedge

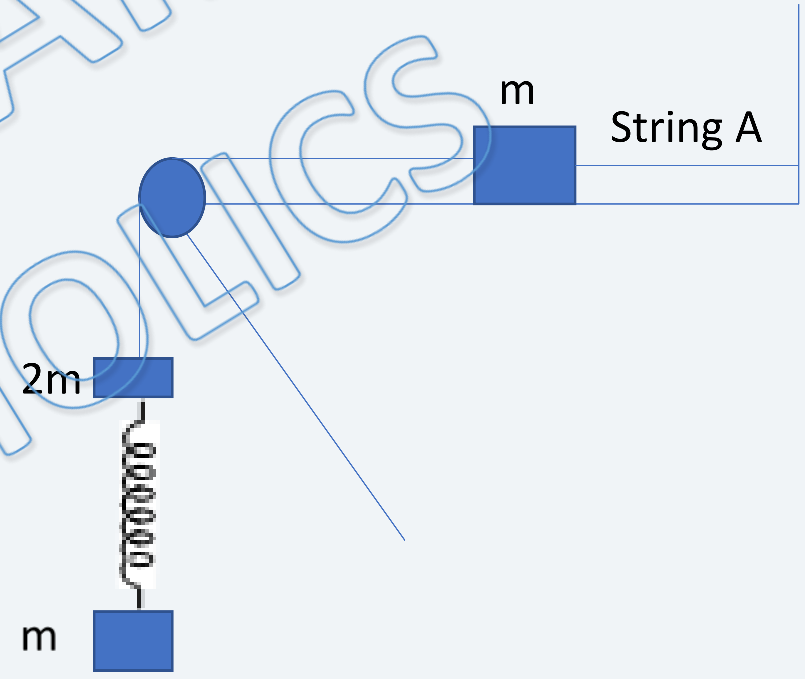


(A)



F.B.D of block

Q)Find acceleration of mass 2m just after burning string A ? Initially system was in equilibrium .



(a) g

(b) g/2

(c) g/3

(d) g/4

Ans. a

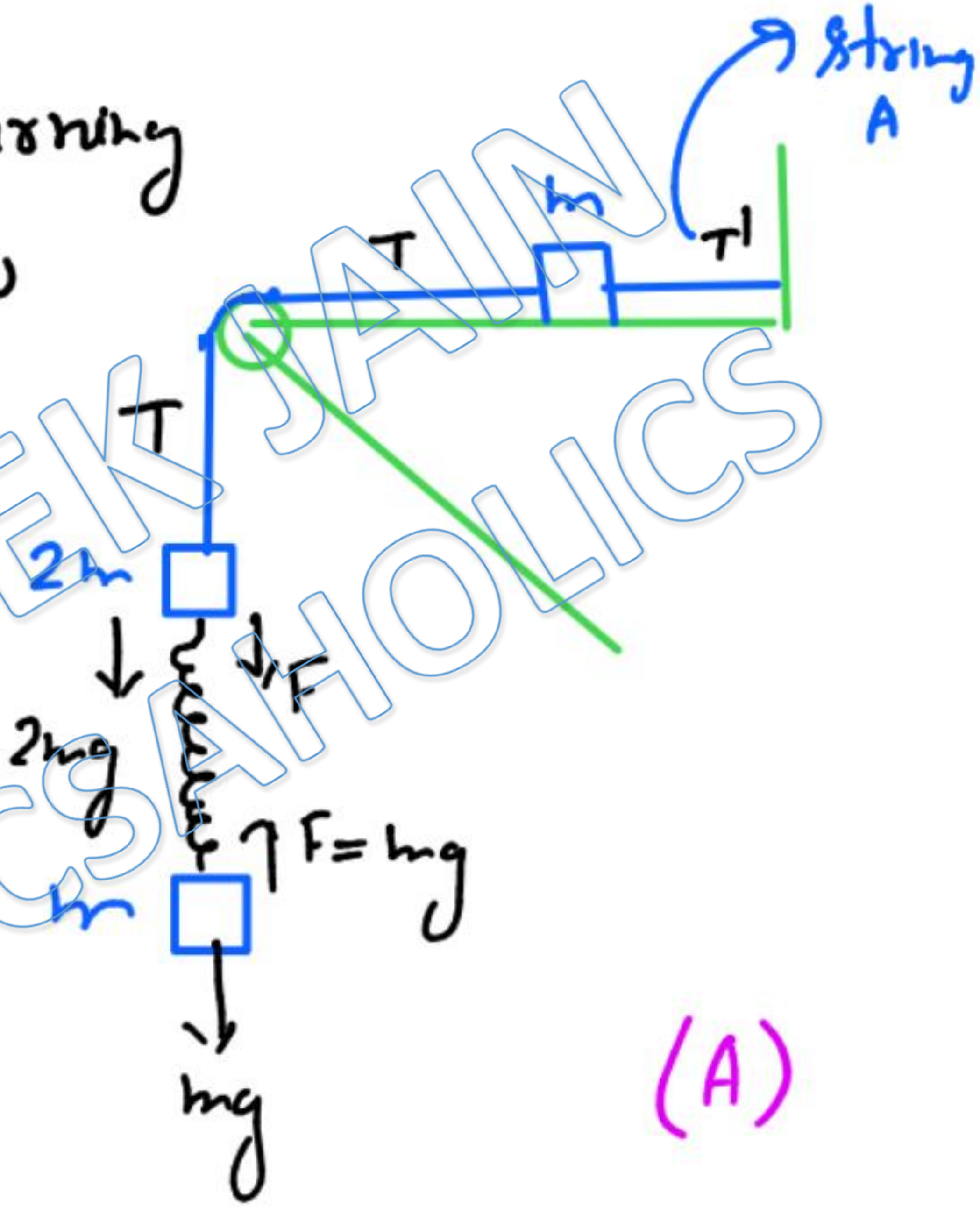
Solution

Just after burning string A, $T' = 0$

T will change & block 2m & upper block m move together

acceleration of 2m $= \frac{2mg + F}{3m}$

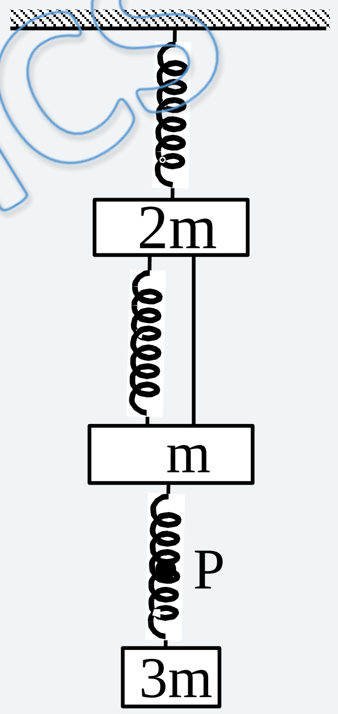
$= g \downarrow$



(A)

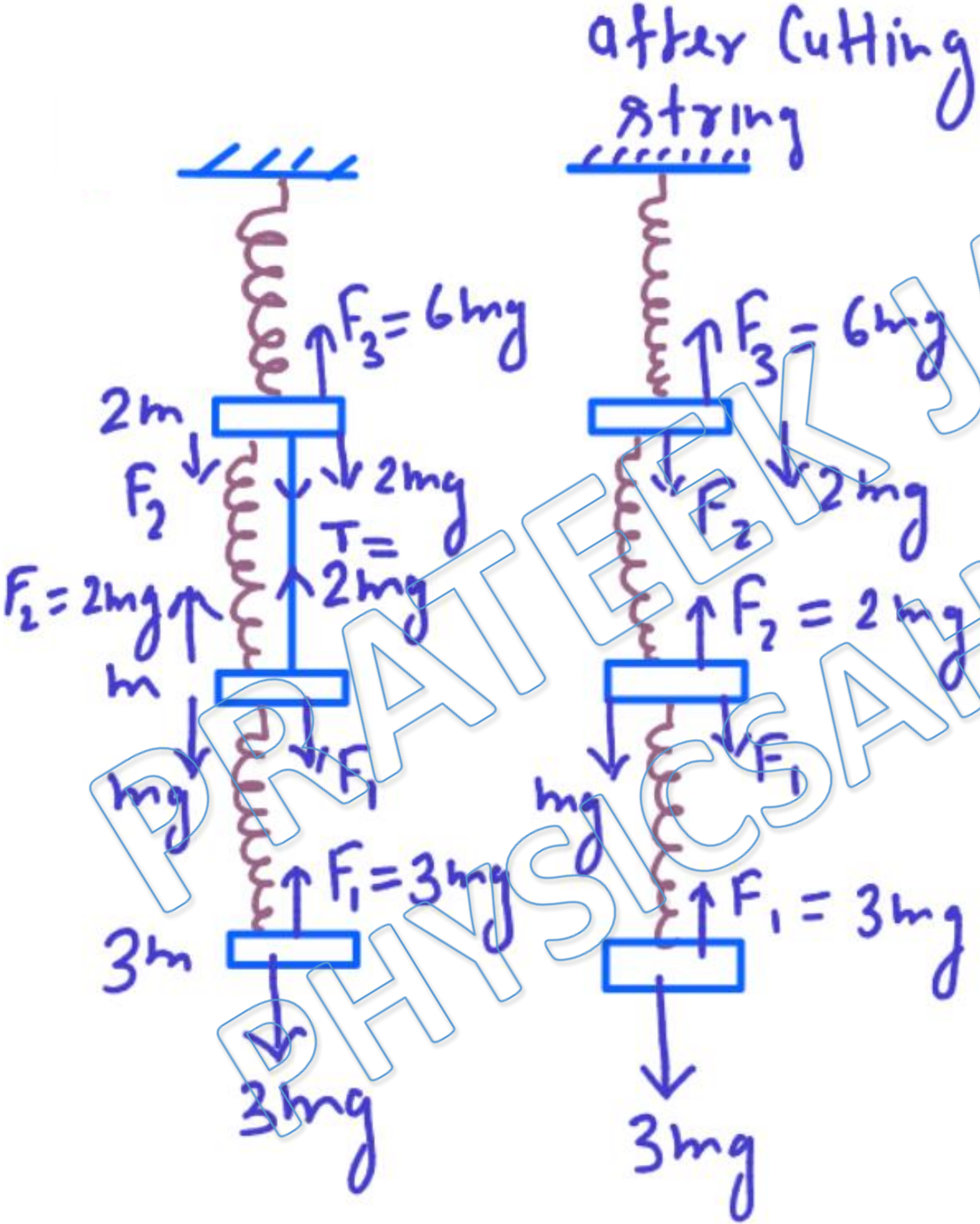
Q) Find relative acceleration of block m and 2m just after burning string ? Initially syatem was in equilibrium and tension in string was 2mg.

(a) g
(b) 2g
(c) 3g
(d) 4g



Ans. c

Solution:



acceleration of m

$$= \frac{2mg}{m} = 2g \downarrow$$

acceleration of 2m

$$= \frac{2mg}{2m} = g \uparrow$$

relative acceleration

$$= 3g$$

(c)

Q) Two springs of stiffness k and 2k are connected in series. Free end of first spring (stiffness k) is fixed and free end of second spring is pulled by an external agent with constant velocity v. Find velocity of joint of springs ?

(a) v/3

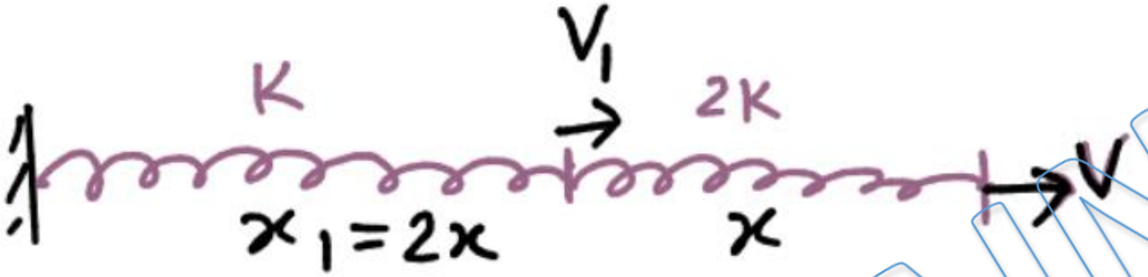
(b) 2v/3

(c) v

(d) none of these

Ans. b

Solution:



Let elongation in 2K is x & that of K is x_1.

Since net force on joint is zero.

$$Kx_1 = 2Kx \Rightarrow x_1 = 2x$$

$$V = \frac{d}{dt}(3x) = 3\frac{dx}{dt}$$

$$V_1 = \frac{d}{dt}(2x) = 2\frac{dx}{dt} = \frac{2V}{3} \quad (b)$$

Q) Two ends of a spring of natural length l and stiffness k are being pulled apart by external agents with constant velocities v and 2v. Find velocity of mid point of spring ?

(a) v

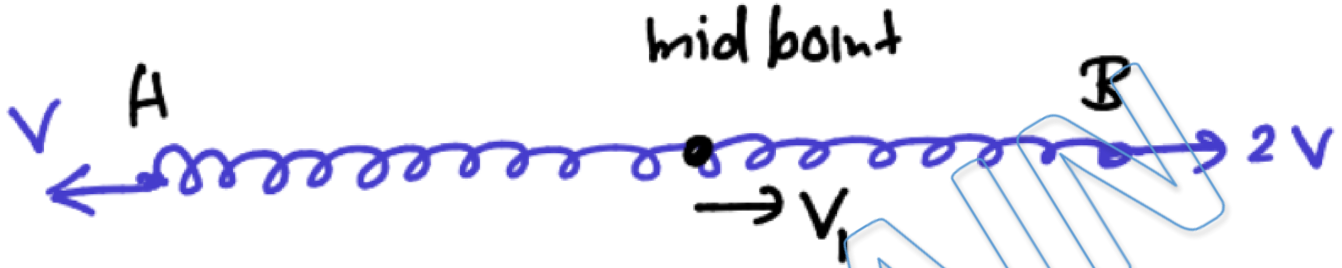
(b) v/2

(c) 3v/2

(d) zero

Ans. b

Solution:



w.r.t. A

* all parts of spring elongate uniformly.

$$V_1 + V = \frac{dx}{dt}$$

$$3V = \frac{d}{dt}(2x) = 2\frac{dx}{dt}$$

$$\Rightarrow \frac{dx}{dt} = \frac{3V}{2}$$

$$V_1 + V = 3V/2$$

$$V_1 = V/2$$

For Video Solution of this DPP, Click on below link

Video Solution on Website:-

https://physicsaholics.com/home/courseDetails/53

Video Solution on YouTube:-

https://youtu.be/5hJdZ_raBLQ

Chalo Niklo