Physicsaholics

DPP – 2 (Friction)

Video Solution on Website:- https://physicsaholics.com/home/courseDetails/40

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Written Solution on Website:- https://physicsaholics.com/note/notesDetalis/41

Q 1. A body of mass 5kg, is at rest on a table of coefficient of friction 0.1. If a horizontal pull force 4N acts on body, the acceleration of the body is (g = 10 m/s^2)

(a) 5 m/s^2 (b) $\frac{1}{5}$ m/s^2

(c) 0.5 m/s^2 (d) zero

Q 2. A block of mass 5 kg is lying on a rough horizontal surface. The coefficient of static and Kinetic friction is 0.3 and 0.1 and g=10m/s^2 If a horizontal force of 50N is applied on the block, the frictional force is

(a) 5 N (b) 10 N

(c) 15 N (d) 50 N

Q 3. A block of 1 kg is stopped against a wall by applying a force F perpendicular to the wall. If μ=0.2 then minimum value of F will be (g = 9.8 m/s^2)

(a) 980 N (b) 49 N

(c) 98 N (d) 490 N

Q 4. A body is lying on an inclined plane. If the box starts sliding when the angle of inclination is 60°, what is the coefficient of static friction of the box and the plane?

(a) $\sqrt{3}$ (b) $\frac{1}{\sqrt{3}}$

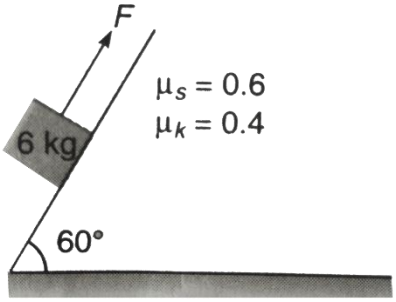
(c) $\sqrt{2}$ (d) $\sqrt{5}$

Q 5. A body of mass 60 kg is pushed with just enough force to start moving on a rough surface with coefficient of static and kinetic friction 0.5 and 0.4 respectively. On applying the same force, what is the acceleration? (g = 9.8 m/s^2)

(a) 0.98 m/s^2 (b) 1 m/s^2

(c) 9.8 m/s^2 (d) 4 m/s^2

Q 6. 6 kg block is kept on an inclined rough surface as shown in figure. Find the force required to move the block downwards with constant velocity. (g = 10 m/s^2)

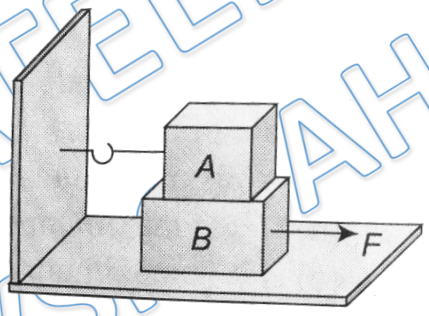


(a) 40 N (up) (b) 36 N (down)
(c) 20 N (up) (d) 16 N (down)

Q 7. The minimum force required to moves body up an inclined plane is three times to minimum force required to prevent it from sliding down the plane. If the coefficient of friction between the body and the inclined plane is $\frac{1}{2\sqrt{3}}$, the inclination of the inclined plane is (in both cases force is parallel to inclined plane):
(a) 60^0 (b) 45^0
(c) 30^0 (d) 15^0

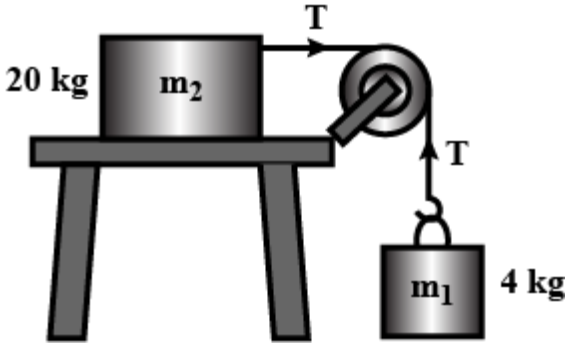
Q 8. A block is placed on rough inclined plane which inclination is changing gradually from 0^0 *to* 90^0. Angle of friction (angle between normal and contact force)
(a) Increases continuously
(b) Decreases continuously
(c) First increases then decreases
(d) First increases then slightly decreases and becomes constant

Q 9. A block A with mass 100kg is resting on another block B of mass 200kg. As shown in figure a horizontal rope tied to a wall hold it. The coefficient of friction between A and B is 0.2 while coefficient of friction between B and the ground is 0.3. The minimum required force F to start moving B will be. Take g=10m/s^2



(a) 900 N (b) 200 N
(c) 1100 N (d) 1200 N

Q 10. The coefficient of kinetic friction is 0.3 in the diagram where mass m_2 = 20kg and m_1 = 4kg. The acceleration of the block shall be (g = 10 m/s^2)



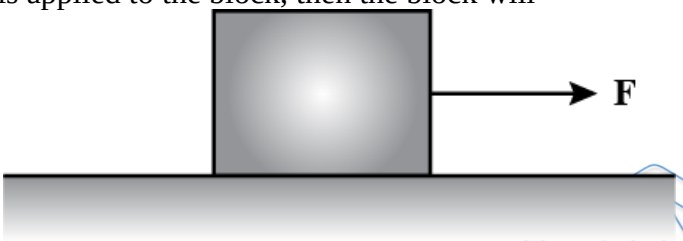
(a) 10 m/s^2 (b) 2.7 m/s^2
(c) 7.2 m/s^2 (d) zero

Q 11. Pulling force making an angle θ to the horizontal is applied on a block of weight W placed on a horizontal table. If the limiting angle of friction is α, then the magnitude of force required to move the body is equal to

(a) $\frac{W \sin\alpha}{g \tan(\theta-\alpha)}$ (b) $\frac{W \cos\alpha}{\cos(\theta-\alpha)}$

(c) $\frac{W \sin\alpha}{\cos(\theta-\alpha)}$ (d) $\frac{W \tan\alpha}{sin(\theta-\alpha)}$

Q 12. In the figure shown, a block of weight 10 N is resting on a horizontal surface. The coefficient of static friction between the block and the surface μ_s= 0.4. A force of 3.5 N will keep the block in uniform motion, once it has been set in motion. A horizontal force of 3 N is applied to the block, then the block will



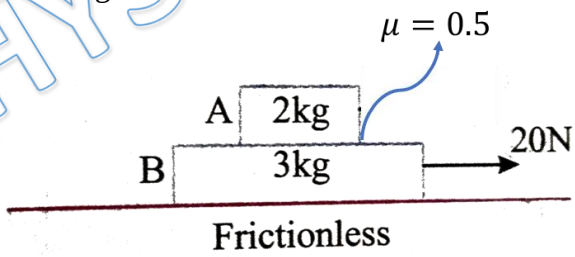
(a) Move over the surface with constant velocity
(b) Move having accelerated motion over the surface
(c) Not move
(d) First it will move with a constant velocity for some time and then will have accelerated motion

Q 13. A body of mass 40kg resting on a rough horizontal surface is subjected to a force P which is just enough to start the motion of the body. If μ_s= 0.5, μ_k = 0.4, g = 10m/s^2 and the force P is continuously applied on the body, then the acceleration of the body is. (g = 10 m/s^2)

(a) zero (b) 1 m/s^2

(c) 2 m/s^2 (d) 2.4 m/s^2

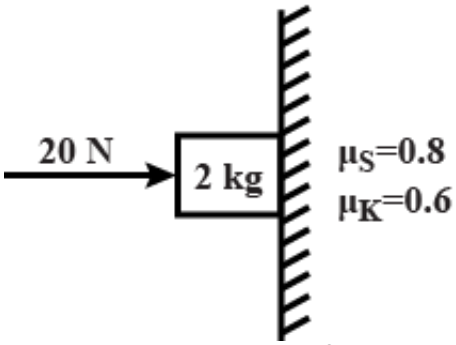
Q 14. Two block A and B are placed one over other. Blocks B is acted upon by a force of 20N which displaces it through 5m. Find frictional force on block A



(a) 8 N (b) 10 N

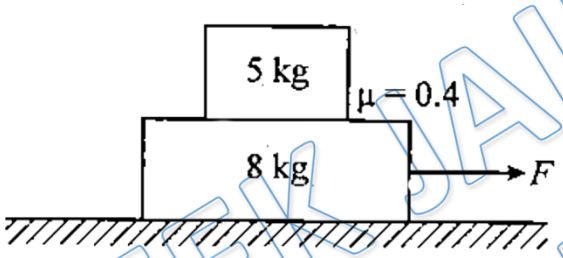
(c) 15 N (d) 20 N

Q 15. A 2kg block is present against a rough wall by a force F=20N as shown in figure. Find acceleration of the block and force of friction acting on it. (Take g = 10 m/s^2)



(a) 4 m/s^2 (b) 1 m/s^2
(c) zero (d) 6 m/s^2

Q 16. Find the maximum possible force which can be applied to the 8 kg block shown in figure to move both the blocks together if bottom surface is having friction coefficient 0.3. Take g=10m/s^2



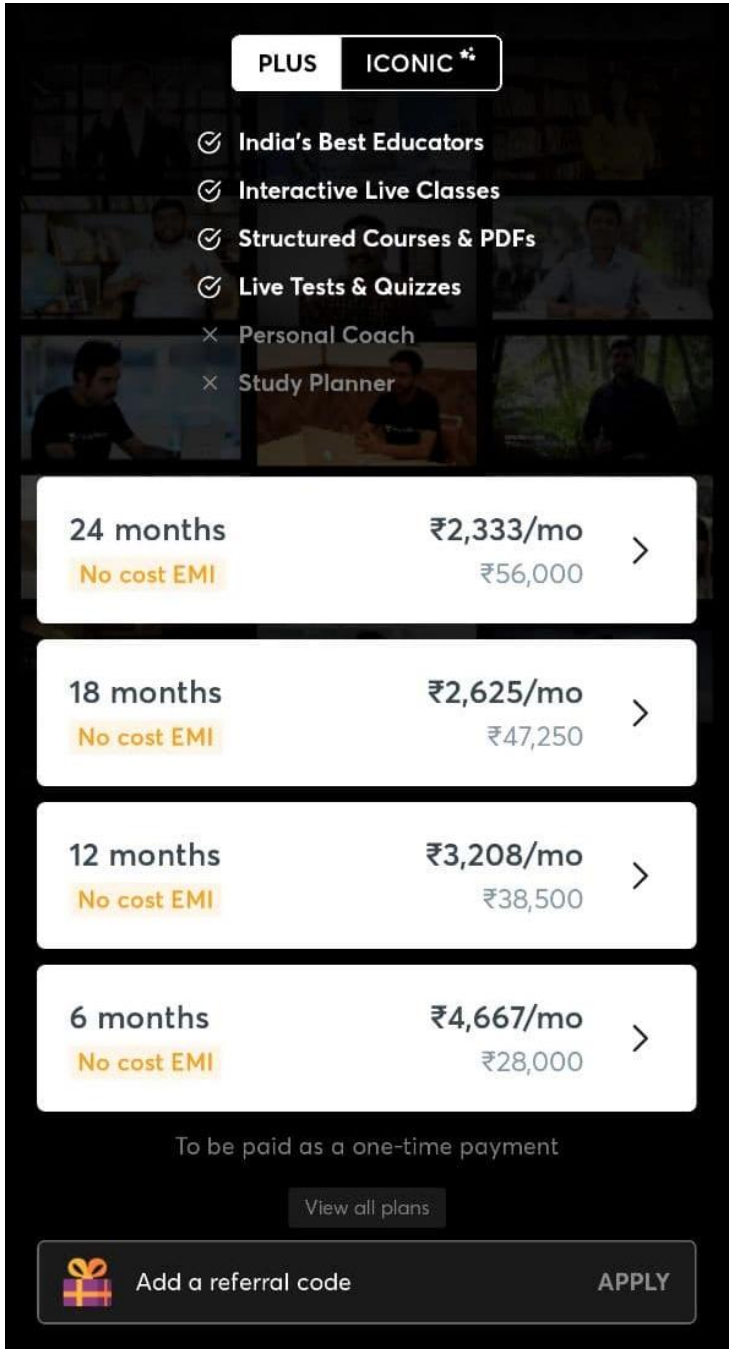
(a) 19 N (b) 80 N
(c) 64 N (d) 91 N

Q 17. A block A of mass 2 kg rests on another block B of mass 8 kg which rests on a horizontal floor. The coefficient of friction between A and B is 0.2 while that between B and floor is 0.5. When horizontal force F = 25 N is applied on the block B, the force of friction between A and B is (in N) (Take g = 10m/s^2)
(a) 2 N (b) 3 N
(c) 4 N (d) zero

Q 18. A block of mass 2kg rests on a rough inclined plane making an angle of 30° with the horizontal. The coefficient of static friction between the block and the plane is 0.7. The frictional force on the block is (Take g = 10m/s^2)
(a) 10 N (b) $7\sqrt{3}$ N
(c) $10\sqrt{3}$ N (d) 12.12 N

Answer Key

Q.1 d	**Q.2 a**	**Q.3 b**	**Q.4 a**	**Q.5 a**
Q.6 a	**Q.7 c**	**Q.8 d**	**Q.9 c**	**Q.10 d**
Q.11 c	**Q.12 c**	**Q.13 b**	**Q.14 a**	**Q.15 a**
Q.16 d	**Q.17 d**	**Q.18 a**		



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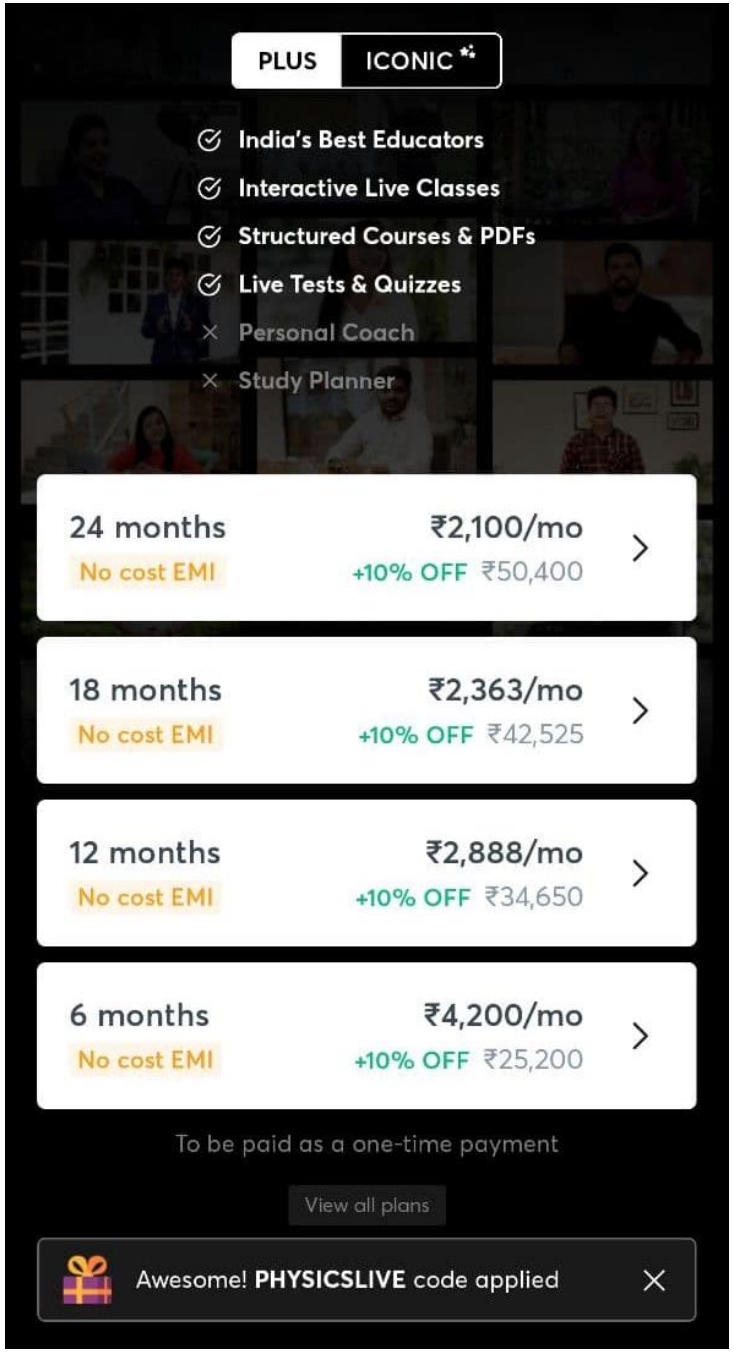
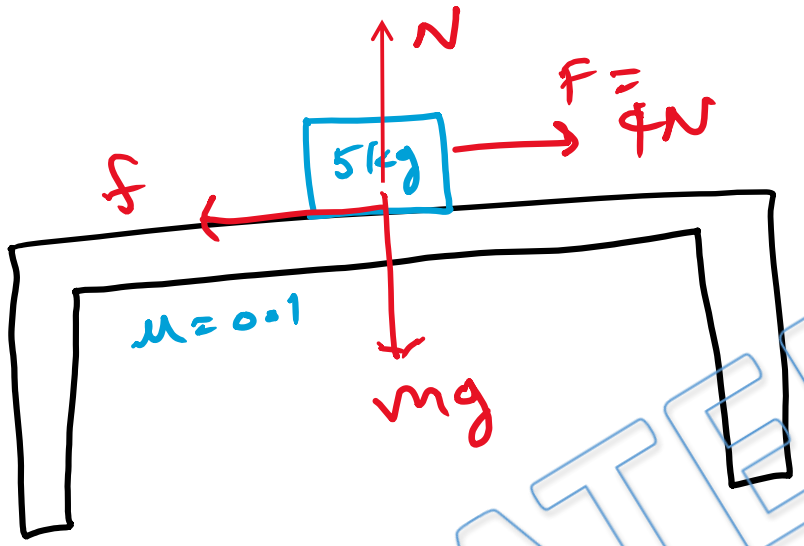


Written Solution

DPP- 2: Friction- Limiting Friction, Angle of repose, Angle of Friction, Block over Block Problems

By Physicsaholics Team

Solution: 1



$N = mg = 5 \times 10 = 50N$

$\boxed{N = 50N}$

limiting friction

$f_l = \mu N = 0.1 \times 50$

$\boxed{f_l = 5N}$

$F = 4N < f_l$

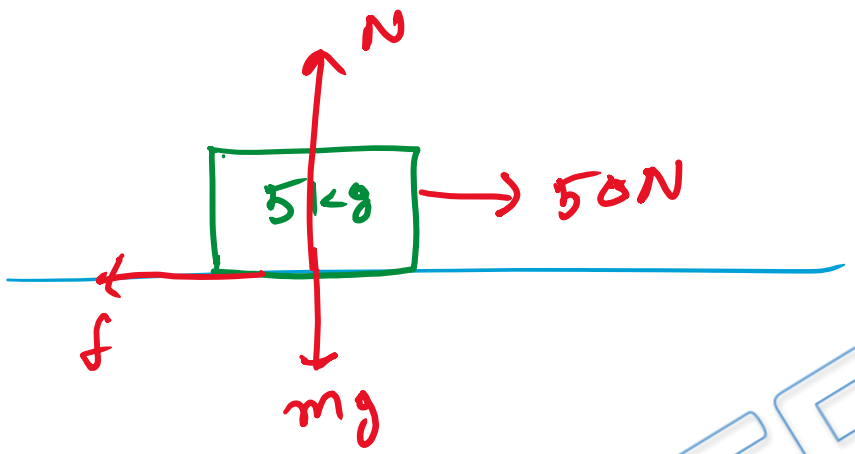
$\therefore \boxed{f = F = 4N}$

$\Rightarrow F_{net} = 0$

$\boxed{a = 0}$ Ans

Ans. d

Solution: 2



$f_{lim} = \mu_s N$

$N = mg$

$f_{lim} = 0.3 \times 5 \times 10 = 15N$

As $F = 50N > 15N$

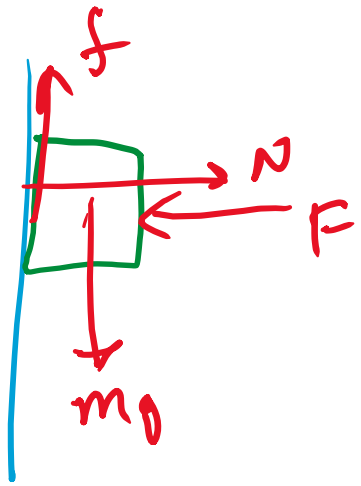
So, $f = f_k = \mu_k N$

$= 0.1 \times 5 \times 10 = 5N$

$\Rightarrow$ $\boxed{f = f_k = 5N}$ Ans.

Ans. a

Solution: 3



$F = N$

$f = \mu N = \mu F$

$f = mg$ (To hold the block)

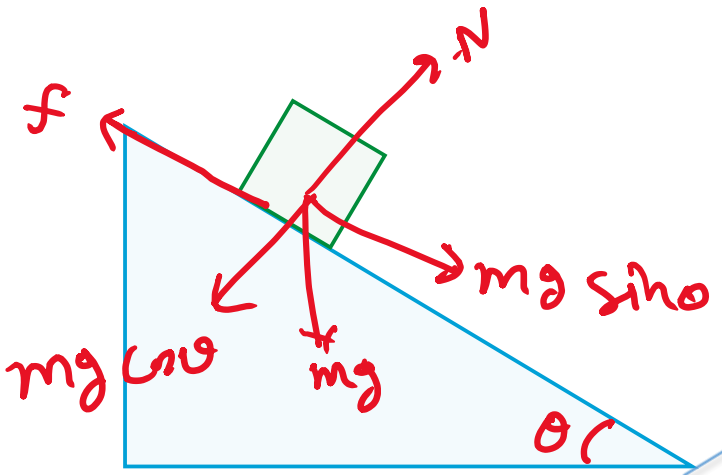
$\mu F = mg$

$F = \frac{1 \times 9.8}{0.2}$

$F = 49\ N$ Ans

Ans. b

Solution: 4



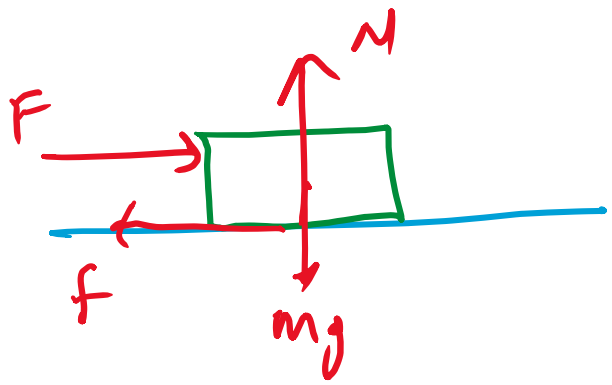
$\mu = \tan\theta$

$\mu = \tan 60^\circ$

$\boxed{\mu = \sqrt{3}}$ Ans.

Ans. a

Solution: 5



F = force to start moving

$\Rightarrow F = f_{s_{lim}} = \mu_s mg$

$F = 0.5 \times 60 \times 9.8$

$\boxed{F = 294\ N}$

Now block starts moving

then $\mu = \mu_k$

& $f = f_k$

$f = f_k = \mu_k mg = 0.4 \times 60 \times 9.8$

$\boxed{f = 235.2\ N}$

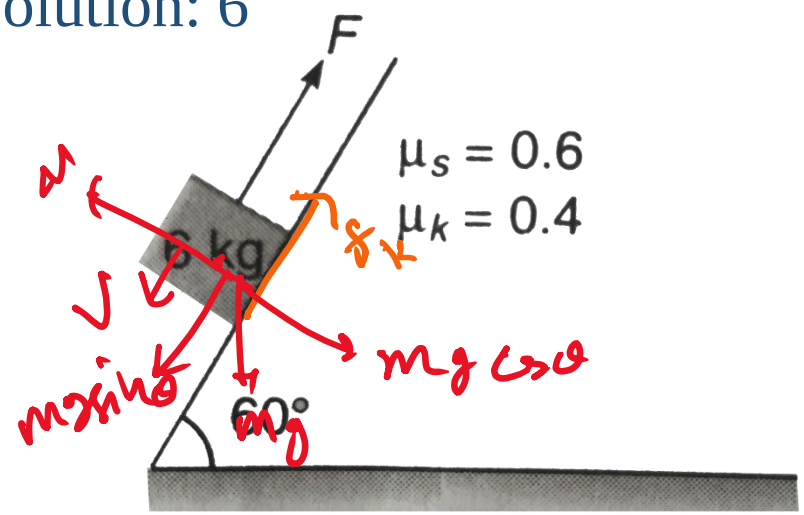
$a = \dfrac{F - f}{m}$

$a = \dfrac{294 - 235.2}{60}$

$\boxed{a = 0.98\ m/s^2}$ Ans

Ans. a

Solution: 6



In moving condition

$f = f_k = \mu_k mg\cos\theta$

$f = 0.4 \times 6 \times 10 \times \cos 60^\circ$

$\boxed{f = 12\,N}$

for Constant velocity

$a = 0$

$F_{net} = 0$

$\Rightarrow F + f = mg\sin\theta$

$F + 12 = 6 \times 10 \times \sin 60^\circ$

$F + 12 = 60 \times \frac{\sqrt{3}}{2} = 30\sqrt{3}$

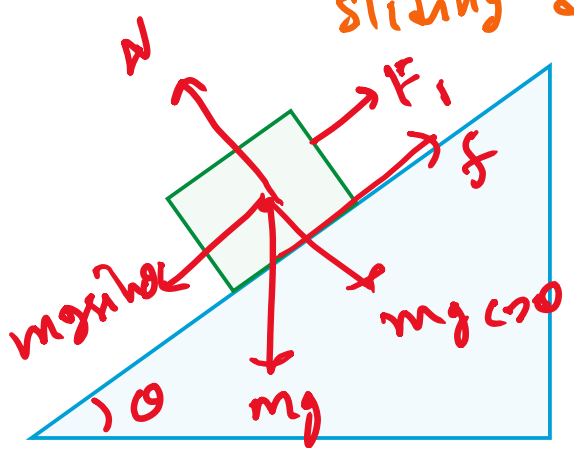
$F = 52 - 12$

$\boxed{F = 40\,N\ (UP)}$ Ans

Ans. a

Solution: 7

Case-1 : To prevent it from sliding down-

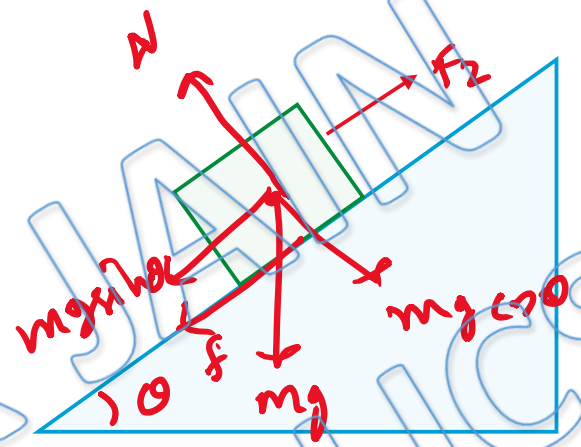


$f = \mu N = \mu mg\cos\theta$

$F_1 + f = mg\sin\theta$

$F_1 = mg(\sin\theta - \mu\cos\theta)$ — (1)

Case-2 : To pull block UP



$F_2 = mg\sin\theta + f = mg(\sin\theta + \mu\cos\theta)$ — (2)

$\therefore F_2 = 3F_1 \Rightarrow mg(\sin\theta + \mu\cos\theta) = 3mg(\sin\theta - \mu\cos\theta)$

$\Rightarrow \sin\theta + \mu\cos\theta = 3\sin\theta - 3\mu\cos\theta$

$2\sin\theta = 4\mu\cos\theta$

$\tan\theta = 2\mu = 2 \times \frac{1}{2\sqrt{3}} = \frac{1}{\sqrt{3}}$

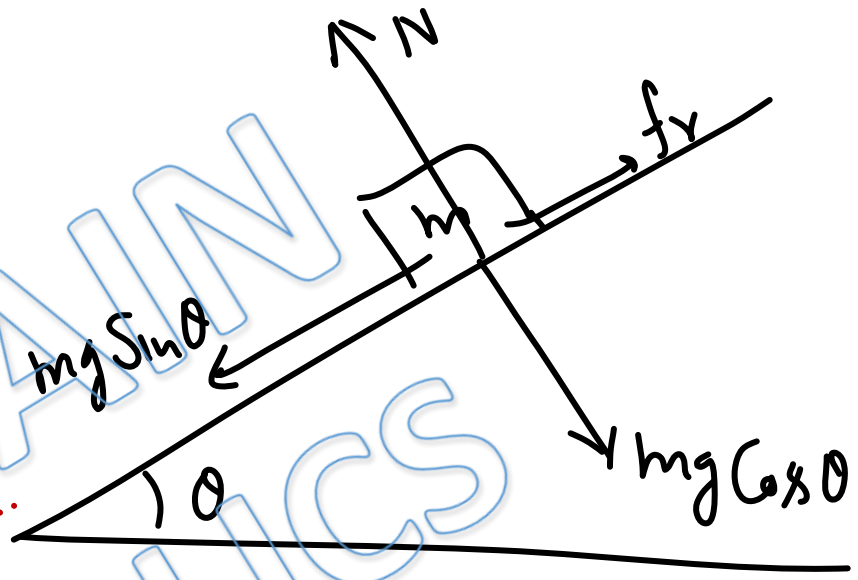
$\boxed{\theta = 30^\circ}$ Ans.

Ans. c

Solution: 8

$\phi \rightarrow$ angle of friction

$$\tan\phi = \frac{f_r}{N}$$



for $\theta \leq \tan^{-1}(\mu_s)$, block will not slide.

$\Rightarrow f_r = mg\sin\theta$

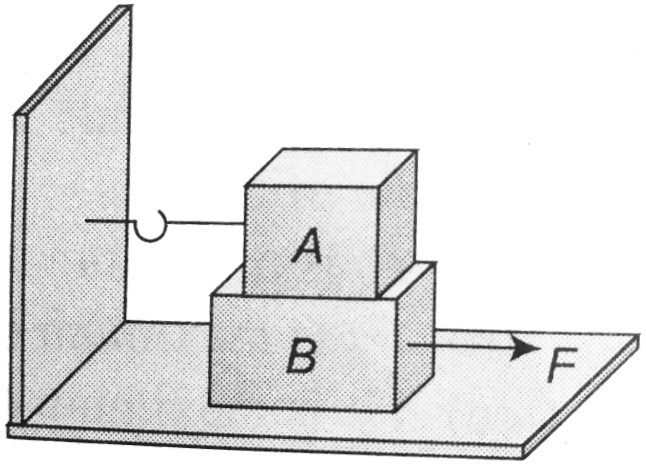
$\Rightarrow \tan\phi = \frac{mg\sin\theta}{mg\cos\theta} = \tan\theta \Rightarrow \phi = \theta$

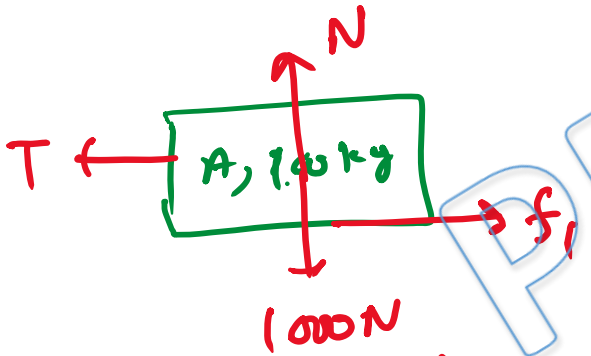
for $\theta > \tan^{-1}(\mu_s)$, block will slide, $f_r = \mu_k mg\cos\theta$

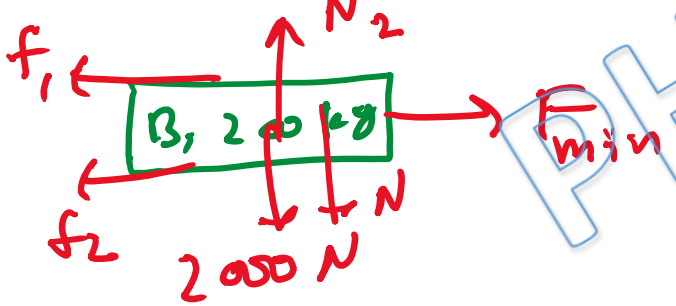
$\Rightarrow \tan\phi = \frac{\mu_k mg\cos\theta}{mg\cos\theta} = \mu_k \Rightarrow \phi =$ Constant

Ans (d)

Solution: 9







To start moving 'B'

Both f_1 & f_2 are max.

So; $f_1 = 0.2 \times 1000 = 200N$

$N = 1000N$ & $N_2 = N + 2000$

$\boxed{N_2 = 3000N}$

$f_2 = 0.3 \times 3000 = 900N$

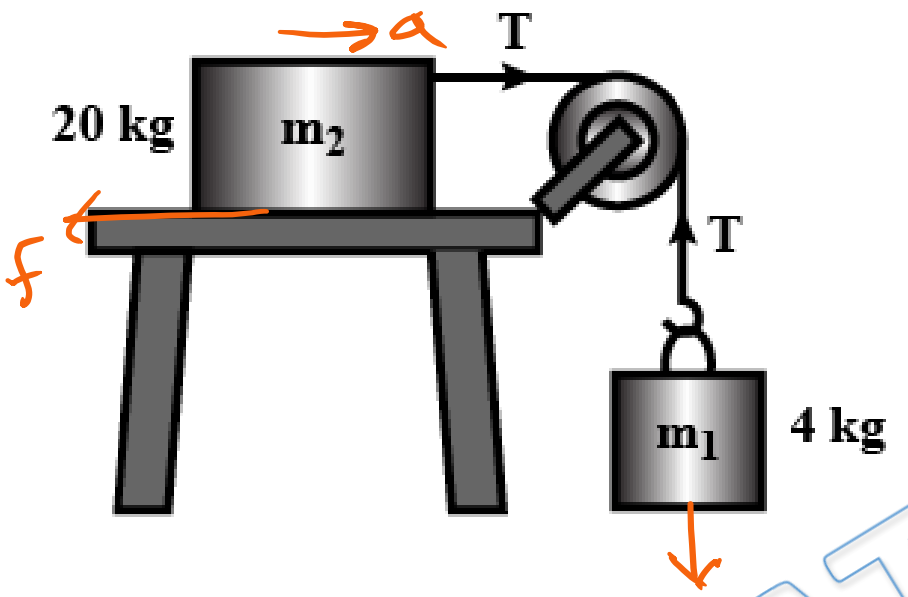
So; $F_{min} = f_1 + f_2$

$F_{min} = 900 + 200$

$\boxed{F_{min} = 1100\ N}$ Ans.

Ans. c

Solution: 10



$f_1 = \mu m_2 g$

$f_1 = 0.3 \times 20 \times 10$

$f_1 = 60\ N$

$\therefore f_1 = 60\ N$

$T_{max} = 40\ N$

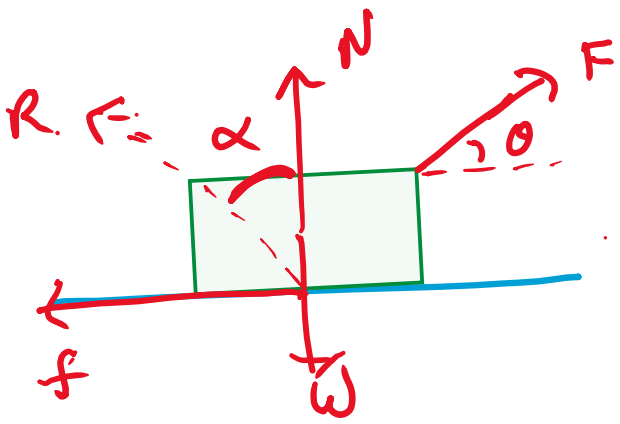
$f_1 > T_{max}$

Then blocks will not move

$\Rightarrow a = 0$ As

Ans. d

Solution: 11



$N + F\sin\theta = \omega$

$N = \omega - F\sin\theta$

$f = \mu N = \mu(\omega - F\sin\theta)$

$\therefore \tan\alpha = \frac{f}{N}$

$$\boxed{\tan\alpha = \mu}$$

To move the body

$F\cos\theta = f$

$F\cos\theta = \mu(\omega - F\sin\theta)$

$F\cos\theta + \mu F\sin\theta = \mu\omega$

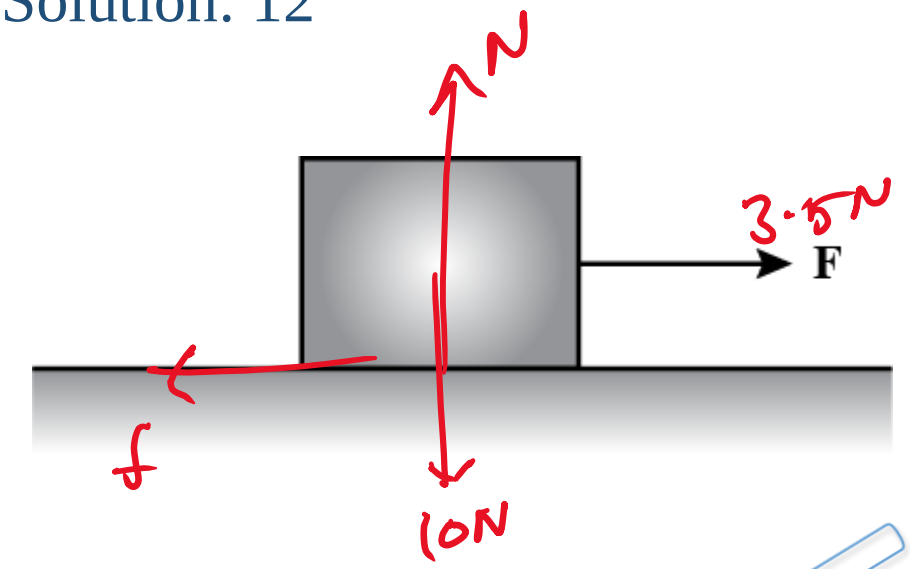
$$F = \frac{\mu\omega}{\cos\theta + \mu\sin\theta} = \frac{\omega(\tan\alpha)}{\cos\theta + \tan\alpha\sin\theta}$$

$$F = \frac{\omega\tan\alpha}{\cos\theta + \frac{\sin\alpha}{\cos\alpha}\sin\theta} = \frac{\omega\left(\frac{\sin\alpha}{\cos\alpha}\right)(\cos\alpha)}{\cos\theta\cos\alpha + \sin\theta\sin\alpha}$$

$$\boxed{F = \frac{\omega\sin\alpha}{\cos(\theta - \alpha)}}$$ Ans.

Ans. c

Solution: 12



applied force $f_a = 3.5\ N$

$f_a < f_l$

$\therefore$ block will not move.

$f_l = \mu_s N$

$f_l = 0.4 \times 10$

$\boxed{f_l = 4N}$

Ans.

Solution: 13

$\therefore P = f_s$

$a = \dfrac{f_s - f_k}{m}$

$a = \dfrac{\mu_s mg - \mu_k mg}{m}$

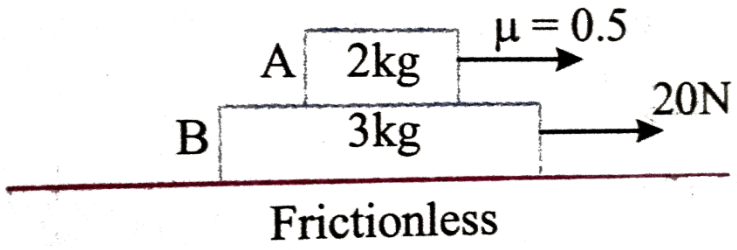
$a = (\mu_s - \mu_k) g$

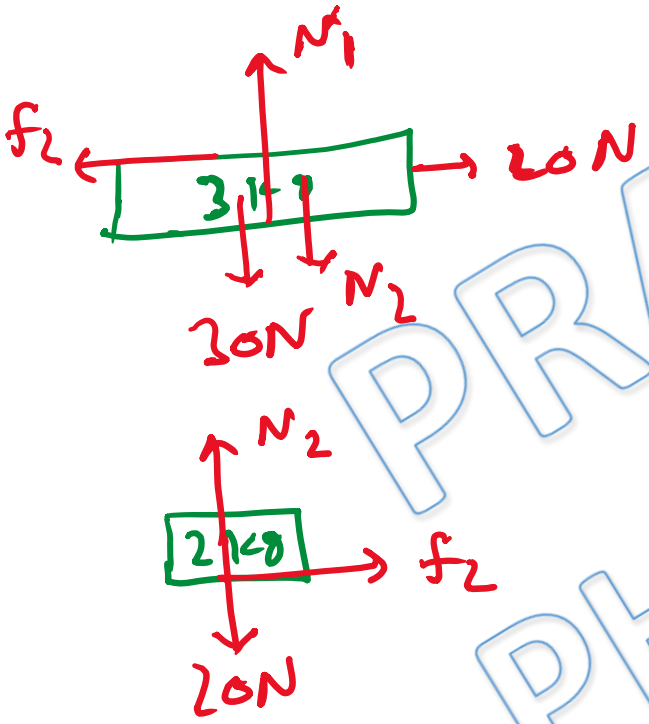
$a = (0.5 - 0.4) g$

$\boxed{a = 1\ m/s^2}$ Ans

Ans. b

Solution: 14





$N_2 = 20N$

$N_1 = N_2 + 30$

$N_1 = 50N$

$f_{lim} = 0.5 \times N_2 = 0.5 \times 20$

$f_{lim} = 10N$

when moving together.

$a = \frac{20}{2+3} = 4\ m/s^2$

$f = m_A a = 2 \times 4 = 8N$

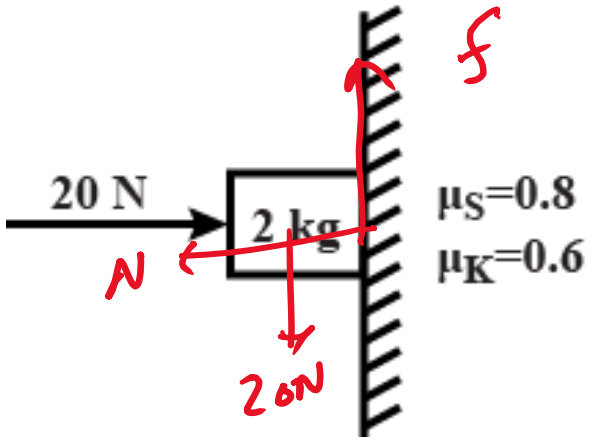
$\because f < f_{lim}$

$\Rightarrow$ both blocks will move together

and $f = 8N$ Ans.

Ans. a

Solution: 15



$N = 20N$

$f_{lim} = \mu_K N = 0.8 \times 20$

$f_{lim} = 16\ N$

$20 > f_{lim}$

So, block will slide down

$\rightarrow f = f_k = \mu_K N = 0.6 \times 20$

$f = 12\ N$

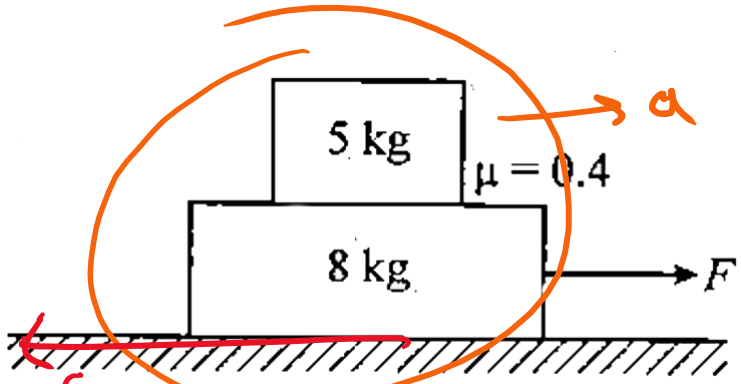
$a = \frac{20 - 12}{m}$

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

$a = 4\ m/s^2$

Ans. a

Solution: 16



$f = \mu(m_1+m_2)g$

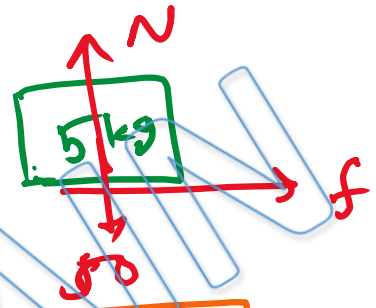
If both blocks moving together;

then: $F - \mu(5+8)g = (5+8)a$

$F = 13\mu g + 13a$

$= 13 \times 0.4 \times 10 + 13a$

$\boxed{F = 52 + 13a}$ — (1)



$\boxed{N = 50\ N}$

$f_1 = \mu N = 0.3 \times 50$

$\boxed{f_1 = 15\ N}$

For max F

$f = f_1$

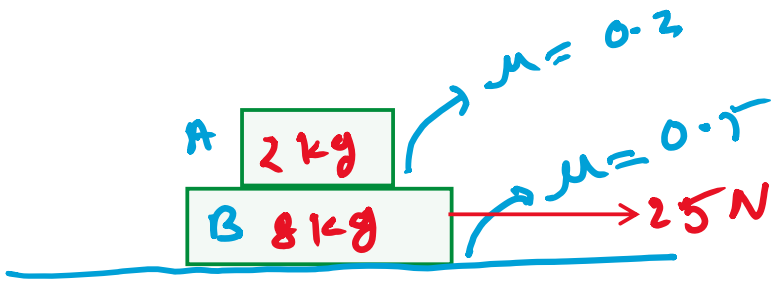
$a = \frac{f}{5} = \frac{15}{5} = 3\ m/s^2$

So; $F = 52 + 13 \times 3 = 52 + 39$

$\boxed{F = 91\ N}$ Ans.

Ans. d

Solution: 17



f_{lim} between A & B $\Rightarrow (f_1)_{lim} = 0.2 \times 20 = 4N$

$(f_2)_{lim} = 0.5 \times 100 = 50N$

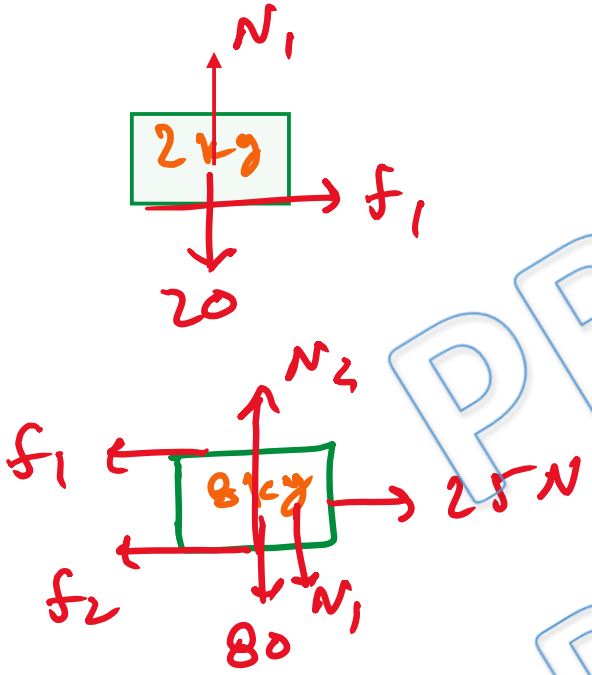
$\therefore (f_2)_{lim} > 25N$

blocks will not move

$a = 0$

then $f_1 = m_A \times 0$

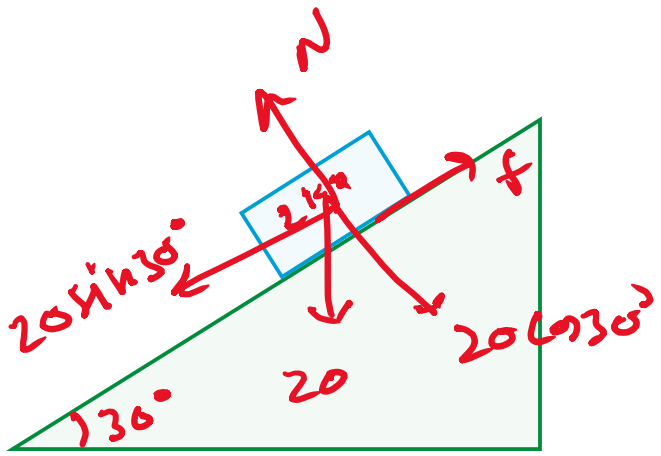
$f_1 = 0$



$N_2 = N_1 + 80 = 100N$

Ans. d

Solution: 18



$f_{lim} = \mu N$

$= 0.7 \times 20\cos 30°$

$= 14 \times \frac{\sqrt{3}}{2}$

$\boxed{f_{lim} = 12.12\ N}$

If $20\sin 30° = 20 \times \frac{1}{2} = 10\ N$

$\therefore 10\ N < f_{lim}$

$\Rightarrow \boxed{f = 10\ N}$ Ans.

and block does not move

Ans. a

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