NARAYANA EDUCATIONAL INSTITUTIONS

PHYSICS

Topic:- FRICTION

Find the magnitude of frication force acting on the block of mass 5 kg in following cases $(\mu_s = 0.4 \, and \, \mu_k = 0.3)$ (Take $g = 10\, m/s^2$.

1. $\boxed{5kg}$ block at rest

1) 0 2) 1.5 3) 2 4) 5

2. 15 N $\rightarrow \boxed{5kg}$

1) 0 2) 20 3) 15 N 4) 30

3. 20 N $\rightarrow \boxed{5kg}$

1) 0 2) 20 3) 15 4) 10

4. $\xrightarrow{25N} \boxed{5kg}$ What is acceleration of the block? $(\mu_s = 0.4 \, \mu_k = 0.3)$

1) $2\, m/s^2$ 2) $5\, m/s^2$ 3) $1\, m/s^2$ 4) $0\, m/s^2$

5. $\xrightarrow{25N} \boxed{5kg} \xleftarrow{30N}$ Find is acceleration of the block? $(\mu_s = 0.4 \, \mu_k = 0.3)$

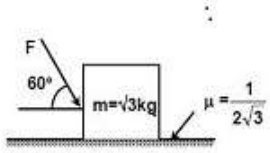
1) $2\, m/s^2$ 2) $0\, m/s^2$ 3) $4\, m/s^2$ 4) $5\, m/s^2$

6. An object of mass 10 kg is to be kept at rest on an inclined plane. Making an angle of 37^0 to the horizontal by applying a force F along the plane upwards as shown in the figure. Find minimum value of Force F such that the block does not move $(\mu_s = 0.2, g = 10\, m/s^2 \;\; \sin 37 = 0.6 \;\; \cos 37 = 0.8)$

1) 76 N 2) 50 N 3) 30 N 4) 44 N

7. A 5 kg block slides down a plane inclined at 30^0 to the horizontal find acceleration of block if co-efficient of kinetic frication is $\frac{1}{2\sqrt{3}}$ $\left(g = 10\, m/s^2\right)$

1) $\frac{5}{2}$ 2) $\frac{7}{2}$ 3) $\frac{3}{2}$ 4) $\frac{1}{2}$

8. 

Find max value of F such that the block does not move.

1) 10 2) 30 3) 20 4) 15

9. Determine the magnitude of frictional force and acceleration of block. $(\mu_k = 0.25 \quad \mu_s = 0.3)$

1) 20, 0 2) 30, 0 3) 15, 2 4) 20, 3

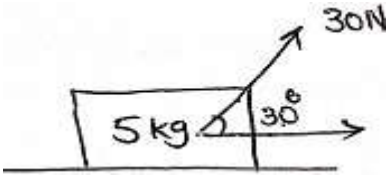
10. In the above problem if driving force acting on block in 60 N find acceleration of block

1) $3.5\, m/s^2$ 2) $0\, m/s^2$ 3) $4.5\, m/s^2$ 4) $5.5\, m/s^2$

11. A 20 kg mass is resting on a horizontal surface and horizontal force of 100 N is applied if $\mu_k = 0.2$. The ratio of acceleration without to with frication is $(g = 10 m/s^2$

1) $\frac{5}{3}$ 2) $\frac{3}{5}$ 3) 2 4) $\frac{1}{4}$

12. A 5 kg box is moving straight across the floor at a constant speed by a force of 30 N as shown in the figure. Find μ_k between the box and floor.

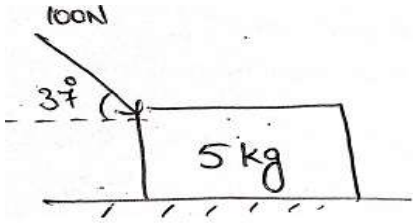


1) $\frac{2\sqrt{3}}{7}$ 2) $\frac{2}{7}$ 3) $\frac{3}{8}$ 4) $\frac{3\sqrt{3}}{7}$

13. A block of mass 4 kg is pressed against a rigid vertical wall by a horizontal force of 100 N If the co-efficient of static and kinetic frication are equal to 0.3. then find magnitude frictional on the block

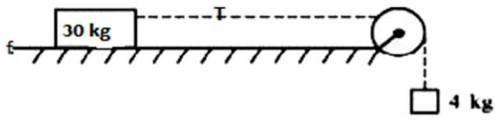
1) 30 N 2) 100 N 3) 20 N 4) 40 N

14. Find the nature, magnitude of acceleration of block $\left(\mu_k = 0.3 \;\; \mu_s = 0.4 \;\; g = 10\,m/s^2\right)$



1) Static, $9.4\,m/s^2$ 2) keneli, $9.4\,m/s^2$ 3) Static, $10\,m/s^2$ 4) Kineti, $10\,m/s^2$

15. A block of mass 30 kg slides over a rough surface when a mass of 4 kg is suspended through an inextensible mass less string passing over a friction less pulley as shown below the acceleration of block is $\left(\mu_k = 0.02 \;\; g = 10\,m/s^2\right)$



1) $2\,m/s^2$ 2) $4\,m/s^2$ 3) $5\,m/s^2$ 4) $1\,m/s^2$

16. A block of mass 6 kg is placed at rest on a table of rough surface now, if a force of 60 N is applied on the direction Parallel to surface of table the block slides through a distance of 25m in an time interval of 10 sec. co-efficient of kinetic friction is $\left(g = 10\,m/s^2\right)$

1) 0.4 2) 0.3 3) 0.5 4) 0.6

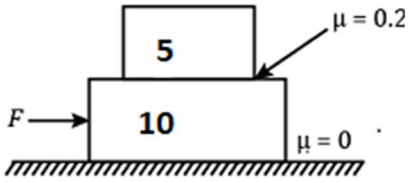
17. A body of mass 10 kg is moving with an initial speed of 30 m/s the body stops after 5 sec due to friction between body and the floor. The value of co-efficient of friction is $\left(g = 10\,m/s^2\right)$

1) 0.4 2) 0.6 3) 0.5 4) 0.1

18. A block of mass m slides down the plane inclined at angle 60^0 with an acceleration $\frac{\sqrt{3}g}{4}$. The value of co-efficient of kinetic friction is

1) $\frac{\sqrt{3}}{2}$ 2) $\sqrt{3}$ 3) $5\sqrt{3}$ 4) $\frac{3\sqrt{3}}{4}$

19. Find the maximum value of Force F such that both blocks move together

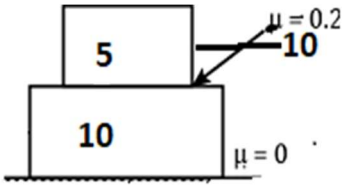


1) 20 N 2) 10 N 3) 30 N 4) 6 N

20. In the above problem force is applied on 5 kg block. Find F_{mcx} so that blocks move together.

1) 15 N 2) 20 N 3) 10 N 4) 5 N

21. Find acceleration of the both the blocks



1) $\frac{2}{3}$ 2) $\frac{3}{2}$ 3) $\frac{4}{5}$ 4) $\frac{5}{4}$

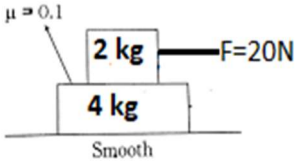
22. A 4 kg block is placed over 5 kg block on a smooth ground friction co-efficient between 5 kg and 4 kg is 0.5 A force F is applied on 5 kg block. Find at what value of F sliding will start between two blocks

1) 45 N 2) 50 N 3) 35 N 4) 25 N

23. In the above problem if force is applied on 4 kg block then find at what value of F sliding will start between the blocks

1) 45 N 2) 36 N 3) 40 N 4) 50 N

24. The acceleration of upper block relative to lower block is

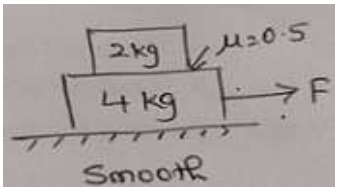


1) $1.25\,m/s^2$ 2) $2.5\,m/s^2$ 3) $3.75\,m/s^2$ 4) $5\,m/s^2$

25. In the above problem what is the acceleration of 4 kg block

1) $1.25\,m/s^2$ 2) $2.5\,m/s^2$ 3) $3.75\,m/s^2$ 4) $5\,m/s^2$

26. Find out the maximum value of F for which both the blocks will more together

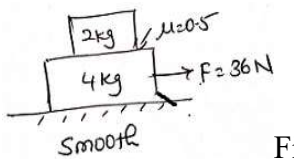


1) 20 N 2) 30 N 3) 10 N 4) 5 N

27. In the above question find the acceleration of both the blocks when F = 18 N applied on 4 kg mass.

1) $3\,m/s^2$ 2) $2\,m/s^2$ 3) $0\,m/s^2$ 4) $1\,m/s^2$

28.



Find acceleration of the blocks

1) 5, 6.5 2) 5, 5 3) 3, 5 4) 4, 3

29. Find the *mcx* value of force F in which both the blocks move together

1) 60 2) 60 3) 36 4) 40

30. Find the *mcx* value of force F in which both the blocks move together

1) 20 1) 10 3) 30 4) 90

PHYSICS

1	2	3	4	5	6	7	8	9	10
1	**3**	**2**	**1**	**2**	**4**	**1**	**2**	**1**	**1**
11	12	13	14	15	16	17	18	19	20
1	**4**	**1**	**2**	**4**	**3**	**2**	**1**	**3**	**1**
21	22	23	24	25	26	27	28	29	30
1	**1**	**2**	**4**	**2**	**2**	**1**	**1**	**3**	**4**

HINTS

1. There is no external force trying to move block therefore there is no friction
2. $F_{applied} < (fs)_{mcx}$. Hence block is at rest static frictional force acts on the block $f_{statis} = 15\,N$
3. $F_{applied} < (fs)_{mcx}$. Hence block is at rest static frictional force acts on the block $f_{statis} = 20\,N$
4. $(f_s)_{mcx} = \mu(mg) = 0.4 \times 5 \times 10 = 20N$

   $F_{applied} > (fs)_{\max}$. So block will move and frictional force acting on block is kinetic acceleration

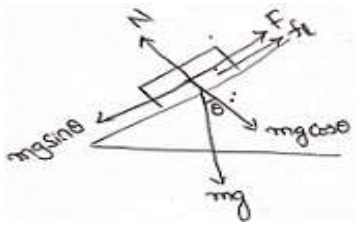
   $(a) = \dfrac{F - f_k}{m}$ $\qquad f_k = \mu_k N$

   $a = \dfrac{25 - 15}{m}$ $\qquad f_k = \mu_k mg$

   $a = \dfrac{10}{5} = 2m/s^2$ $\qquad f_k = 0.3 \times 5 \times 10 \quad \therefore\ f_k = 15\,N$
5. $F_{net} = 5N$

   $F_{net} < (f_s)_{\max}$ Hence block will not move $\Rightarrow a = 0$
6. Frictional force alone is unable to balance $mg\sin\theta$ Hence F is required for balancing limiting friction

   $f_l = \mu N = \mu mg\cos 37 = 0.2 \times 10 \times 10 \times 0.8 = 16\,N$

   $mg\sin 37 = 10(10)(0.6) = 60N$

   If block is at rest then,

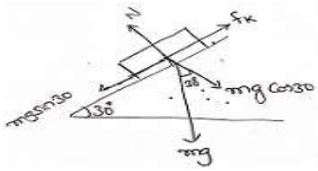
   $F + f_l = 60$

   F + 16 =60

   F = 60 – 16 = 44 N
7. $m = 5kg$

   $N = mg\cos 30$

   $N = 5(10)\dfrac{\sqrt{3}}{2} = 25\sqrt{3}$



$$f_k = \mu_k N = \frac{1}{2\sqrt{3}}\left(25\sqrt{3}\right) = \frac{25}{2}$$

$$F_{net} = mg\sin 30 - f_k$$

$$ma = 5(10)\left(\frac{1}{2}\right) - \frac{25}{2}$$

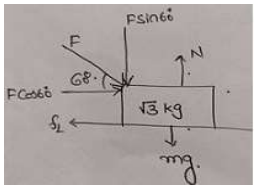
$$5(a) = 25 - \frac{25}{2}$$

$$5a = \frac{25}{2}$$

$$a = \frac{25}{2\times 5}$$

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

8.



$$f_L = F\cos 60$$

$$\mu N = F\left(\frac{1}{2}\right)$$

$$\Rightarrow \mu N = \frac{F}{2} \quad -----(1)$$

$$N = F\sin 60 + mg$$

$$N = F\left(\frac{\sqrt{3}}{2}\right) + \sqrt{3}(10)$$

$$N = \sqrt{3}\left[\frac{F}{2} + 10\right] \quad ------(2)$$

From eqns (1) & (2)

$$\mu N = \frac{F}{2}$$

$$\frac{1}{2\sqrt{3}}\left(\sqrt{3}\right)\left(\frac{F}{2} + 10 = \frac{F}{2}\right)$$

$$\Rightarrow F = 20$$

9. $f_{limiting} = \mu N = \mu mg = 0.3\times 10\times 10 = 30N$

$f_{limiting} > F_{extend}$

$\Rightarrow$ block is at rest

$\Rightarrow$ acceleration a = 0

Friction will be of statis nature

$\Rightarrow$ friction force = 20 N

10. $f_k = \mu_k N = \mu_k mg = 0.25\times 10\times 10 = 25N$

$$a = \frac{F - f_k}{m}$$

$$a=\frac{60-25}{10}=\frac{35}{10}=3.5\,m/s^2$$

11. (i) without friction

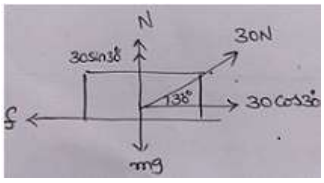
$$a_1=\frac{F}{m}=\frac{100}{20}=5$$

(ii) with frication,

$$a_2=\frac{F-f_k}{m}=\frac{F-\mu N}{m}=\frac{F-\mu_k(mg)}{m}=\frac{100-0.2(20)(10)}{20}\Rightarrow a_2=3$$

$$\Rightarrow\frac{a_1}{a_2}=\frac{5}{3}$$

12.



$$mg=5g=50N$$

$$f_2=30\cos 30=30\frac{\sqrt{3}}{2}=15\sqrt{3}$$

$$N+30\sin 30=mg$$

$$N+30\left(\frac{1}{2}\right)=5(10)$$

$$N+15=50$$

$$N=35$$

$$f_k=\mu_k N$$

$$15\sqrt{3}=35\,N$$

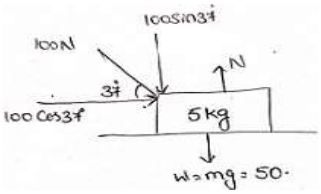
$$N=\frac{15\sqrt{3}}{35}\Rightarrow N=\frac{3\sqrt{3}}{7}$$

13. $N=100$

$$f=\mu N$$

$$f=0.3(100)=30N$$

14.



$$N=100\sin 37+50$$

$$N=110$$

$$(f_s)_{mcx}=\mu N=0.4\times 110=44N$$

$$f_k=\mu_k N=0.3\times 110=33N$$

$$100\cos 37=80>(f_s)_{mcx}$$

Hence block will move and friction acting on block will be kinetic

$$a=\frac{100\cos 37-f_k}{m}$$

$$a=\frac{80-33}{5}=\frac{47}{5}=9.4\,m/s^2$$

15. Frictional force on block 30 kg is $f=\mu N=\mu mg=0.02(30)(10)=6N$

$$T-f=ma$$

$T-6=30a$ ----(1)

$4g-T=4a$ ----(2)

From eqns 1 & 2

$4g-6=34a$

$40-6=34a$

$34=34a$

$a=1m/s^2$

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

$a=\dfrac{60-\mu mg}{m}=\dfrac{60-\mu(6)(10)}{6}$

$a=\dfrac{60-60\mu}{6}$

$a=1-\mu$

We have, $S=ut+\dfrac{1}{2}at^2$

$25=0+\dfrac{1}{2}(1-\mu)(10)^2$

$25=\dfrac{1}{2}(1-\mu)(100)$

$1-\mu=\dfrac{50}{100}=\dfrac{1}{2}$

$\mu=1-\dfrac{1}{2}=\dfrac{1}{2}=0.5$

17. $V=U+at$

$0=30+(-\mu g)5$

$0=30-\mu(10)(5)$

$30=50\mu$

$\mu=\dfrac{30}{50}=\dfrac{3}{5}=0.6$

18. $a=g(\sin\theta-\mu_k\cos\theta)$

$\dfrac{\sqrt{3}g}{4}=g\left(\sin 60-\mu_k\cos 60\right)$

$\dfrac{\sqrt{3}}{4}=\sin 60-\mu_k\cos 60$

$\dfrac{\sqrt{3}}{4}=\dfrac{\sqrt{3}}{2}-\mu_k\left(\dfrac{1}{2}\right)$

$\Rightarrow \mu_k=\dfrac{\sqrt{3}}{2}$

19. $\boxed{5kg}\rightarrow f_l$

$f_l=\mu mg=0.2\times5\times10=10N$

$a_{mcx}=\dfrac{f_l}{m}=\dfrac{10}{5}=2m/s^2$

$f\leftarrow\boxed{10}\rightarrow F$

$F-10=F_{net}$

$F-10=10a_{mcx}$

$F-10=10(2)$

$F-10=20$

$F=30N$

20. $f_l=10N$

$f_L \leftarrow \boxed{5kg} \rightarrow F$

$F-f_L=5a$

$F-10=5a--(1)$

$a_{mcx}=\frac{f_L}{m}=\frac{10}{10}=1m/s^2$

Hence $F-10=5$

$\Rightarrow F_{mcx}=15$

21. $a_{common}=\frac{F}{Total\ mass}$

$a_c=\frac{10}{10+5}=\frac{10}{15}=\frac{2}{3}$

22. Common acceleration (a) $a_m=\frac{F}{5+4}=\frac{F}{9}$

Limiting friction $f_L=0.5\times4\times10=20N$

For 4 kg block

$f=4\left(\frac{F}{9}\right)$

$20=4\left(\frac{F}{9}\right)$

$F=45N$

23. $f_{\lim iting}=\mu mg=0.5\times4\times10=20N$

Common acceleration $a=\frac{F}{9}$

For 5 kg,

$f=5\left(\frac{F}{9}\right)$

$20=5\left(\frac{F}{9}\right)$

$\Rightarrow F=36$

24. $f \leftarrow \boxed{2kg} \rightarrow F=20N$

$F-f=F_{Net}$

$20-\mu mg=ma_1$

$20-0.5\times2\times10=2a_1$

$20-10=2a_1$

$10=2a, \quad a_1=5m/s^2$

25. $\overset{\rightarrow f}{\boxed{4kg}} \rightarrow a_2$

$f=ma_2$

$10=4a_2$

$a_2=\frac{10}{4}=2.5m/s^2$

26. $F_{mcx}=(m_1+m_2)a_{mcx}$

$F_{mcx} = (2+\mu)\mu_s g$

$F_{mcx} = 6 \times 0.5 \times 10 = 30N$ (or)

The maximum acceleration of 2 kg block is $\boxed{2kg} \rightarrow f_{mcx}$

$f_{mcx} = \mu N = \mu mg$

$f_{mcx} = 0.5 \times 2 \times 10 = 10$

$a_{mcx} = \frac{f_{mcx}}{m} = \frac{10}{2} = 5\,m/s^2$

For 4 kg

$f \leftarrow \boxed{4kg} \rightarrow F$

$F - f = F_{Net}$

$F - 10 = 4a$

$F - 10 = 4(5)$

$F = 30N$

27. If $F_{applied} < F_{mcx}$ then both the blocks will move together

$\therefore\ a = \frac{F_{applied}}{Total\ mass}$

$a = \frac{18}{2+4} = \frac{18}{6} = 3\,m/s^2$

28. If $F_{applied} > F_{mcx}$ then both the blocks will move separately

For 2 kg blocks

$\boxed{2kg} \rightarrow f$

$f = 2a_1$

$f = 2a_1$

$a_1 \frac{10}{2} = 5\,m/s^2$

For 4 kg block,

$f = 10N \leftarrow \boxed{4kg} \rightarrow F = 36N$

$F - f = 4a_2$

$36 - 10 = 4a_2$

$26 = 4a_2$

$a_2 = \frac{26}{9} = 6.5\,m/s^2$

29. $F_{mcx} = (m_1 + m_2)(\mu_1 + \mu_2)g$

$F_{mcx} = (2+4)(0.5+0.1)10$

$F_{mcx} = 6(0.6)(10)$

$F_{mcx} = 36N$

30. $F_{mcx} = (m_1 + m_2)(\mu_1 + \mu_2)g$

$F_{mcx} = (10+20)(0.1+0.2)10$

$= 30 \times 3 = 90N$