Friction

Date: 22/06/2023

Subject: Other

Class: Standard XII

Topic : Friction

Time: 00:20 hrs

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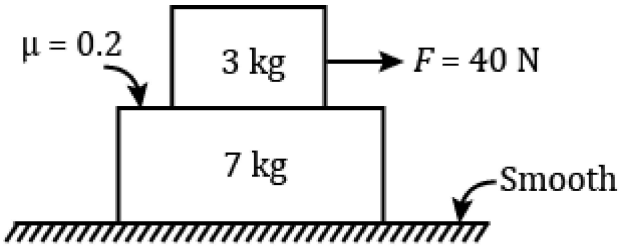
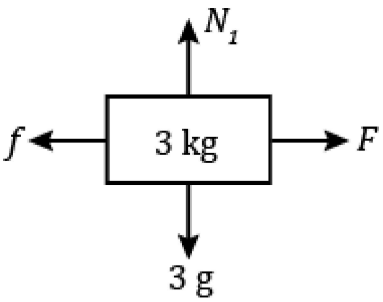
1. Find the frictional force between the two blocks. Take $g = 10\ \mathrm{m/s^2}$.

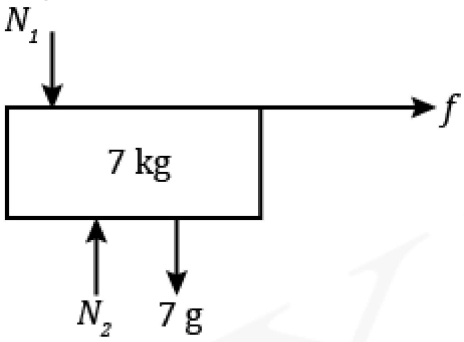


- ✔ **A.** $6\ \mathrm{N}$
- ✘ **B.** $28\ \mathrm{N}$
- ✘ **C.** $30\ \mathrm{N}$
- ✘ **D.** $70\ \mathrm{N}$

By FBD,



In y - direction,
$N_1 = 3\ \mathrm{g}$
$f_{\max} = \mu N_1 = (0.2)(3\ \mathrm{g})$
$= 6\ \mathrm{N}$

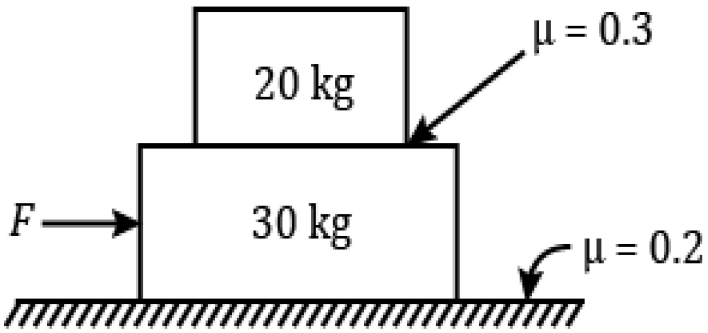


Assume them to move together with common acceleration,

$$a_c = \frac{F}{m_1 + m_2} = \frac{40}{10} = 4\ \mathrm{m/s^2}$$

For $7\ \mathrm{kg}$ body: $f = 7a_c = 28\ \mathrm{N}$ is required to make them move together, which is not possible because maximum force supplied by friction is f_{max} which is equal to $6\ N$. Hence the blocks moves seperately and the friction is kinetic in nature and equals to limiting friction in this case.

2. Find the maximum force F to be applied for the system shown, so that the two blocks move together. Take $g = 10\ \mathrm{m/s^2}$.



A. $500\ \mathrm{N}$

B. $250\ \mathrm{N}$

C. $150\ \mathrm{N}$

D. $300\ \mathrm{N}$

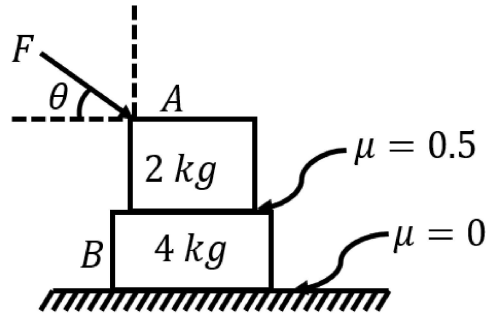
We know that by formula,
$F = (m_1 + m_2)(\mu_1 g + a_s)$ Where $a_s = \mu_2 g$

$(m_1 = 30\ \mathrm{kg};\ m_2 = 20\ \mathrm{kg};\ \mu_1 = 0.2;\ \mu_2 = 0.3)$

$= (50)(0.5)10 = 250\ \mathrm{N}$

Hence the maximum force is for the system (Both blocks) to move together is $250\ \mathrm{N}$

3. If the system is initially at rest. Find the acceleration of $2\ kg$ and $4\ kg$ masses, where it is given that $2\ kg$ mass does not slide on $4\ kg$ mass for the figure shown. The external force F acting on the mass $2\ kg$ at an angle $\theta = 37^{\circ}$. (Take $g = 10\ m/s^2$)



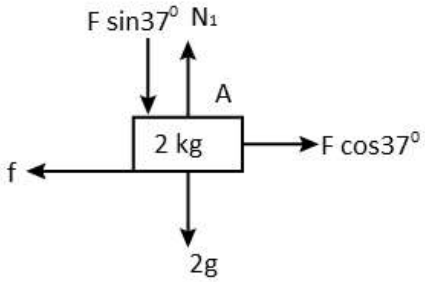
A. $a_A = a_B = \frac{4}{3} m/s^2$

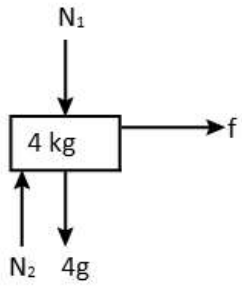
B. $a_A = a_B = \frac{8}{3} m/s^2$

C. $a_A = a_B = \frac{3}{4} m/s^2$

D. $a_A = a_B = \frac{10}{3} m/s^2$

The FBDs of the masses are as shown





from the FBD we have

$N_1 = F\sin 37^\circ + 2g = \left(\frac{3F}{5} + 20\right)\ \text{N}$

As per the given condition i.e. mass $2\ kg$ will not slide on the mass $4\ kg$, we have

Limiting friction $f_{\max} = \mu N_1 = 0.5\left(\frac{3F}{5} + 20\right)\ \text{N}$

Also, $\text{Horizontal applied force} \le f_{\max}$

$\Rightarrow\ F\cos 37^\circ \le 0.5\left(\frac{3F}{5} + 20\right)$

$\Rightarrow\ \frac{4F}{5} \le 0.5\left(\frac{3F}{5} + 20\right)$

$\Rightarrow\ \left(\frac{4F}{5} - \frac{3F}{10}\right) \le 10$

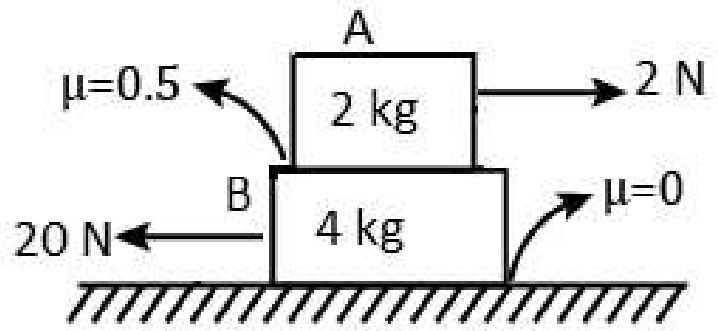
$\Rightarrow\ F \le 20\ \text{N}$

Thus, the maximum value of applied external force can be $F_{\max} = 20\ \text{N}$

$\therefore$ common acceleration of the masses is

$a_c = \frac{F\cos 37^\circ}{m_A + m_B} = \frac{20 \times 0.8}{6} = \frac{16}{6} = \frac{8}{3} m/s^2$

4. In the arrangement shown in the figure, the coefficient of friction between the two blocks is $\mu = 0.5$ and the surface is smooth. The force of friction acting between the two blocks is



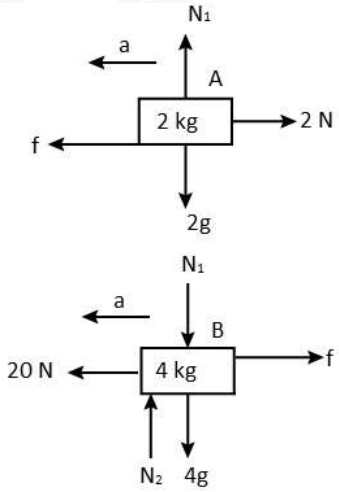
A. $10\ \text{N}$

B. $12\ \text{N}$

C. $8\ \text{N}$

D. $4\ \text{N}$

The FBDs of the blocks are as shown

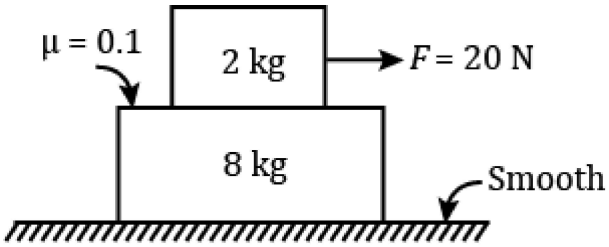


From the FBD we have
$N_1 = 2g = 20\ \text{N}$
Maximum friction between the two blocks is
$f_{\max} = \mu N_1 = 0.5 \times 20 = 10\ \text{N}$

Let us assume that the blocks move together towards left with the common acceleration. Then,
$a = \dfrac{f-2}{2} = \dfrac{20-f}{4}$
$\Rightarrow\ 2f - 4 = 20 - f \Rightarrow\ f = 8\ \text{N}$
Since, $8\ \text{N} < 10\ \text{N}$ i.e. $f < f_{\max}$, our assumption is right.

Hence, friction between the two blocks is $f = 8\ \text{N}$

5. Find the frictional force between the two blocks. Take $g = 10\ \mathrm{m/s^2}$.



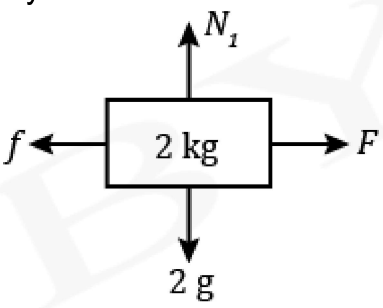
A. $2\ \mathrm{N}$

B. $1.5\ \mathrm{N}$

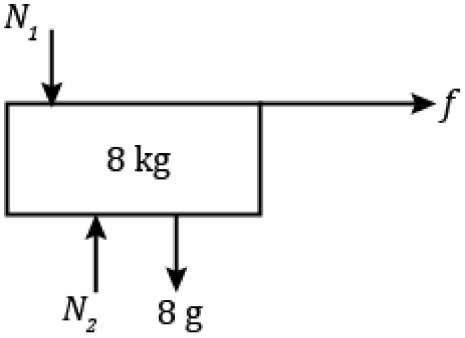
C. $1\ \mathrm{N}$

D. $3\ \mathrm{N}$

By FBD we write the force eqution,



$N_1 = 2\mathrm{g} = 20\ \mathrm{N}$
$f_{\max} = \mu N_1 = 0.1 \times 20$
$= 2\ \mathrm{N}$



Assume them to move together with common acceleration
$a_c = \dfrac{F}{m_1 + m_2} = \dfrac{20}{10} = 2\ \mathrm{m/s^2}$
For $8\ \mathrm{kg}$ body: $f = 8a_c = 16\ \mathrm{N}$ is required to make them move together. But maximum frictional force act between two surface is equal to limiting friction ($f_{max} = 2\ N$). Hence, the blocks separate and frictional force act between two surfaces is equal to $2\ \mathrm{N}$.