BLOCK ON BLOCK

1. In the figure shown, a block of weight 10 *N* resting on a horizontal surface. The coefficient of static friction between the block and the surface $\mu_s = 0.4$. 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

2. Two masses A and B of 10 *kg* and 5 *kg* respectively are connected with a string passing over a frictionless pulley fixed at the corner of a table as shown. The coefficient of static friction of A with table is 0.2. The minimum mass of C that may be placed on A to prevent it from moving is

    (a) 15 *kg*

    (b) 10 *kg*

    (c) 5 *kg*

    (d) 12 *kg*
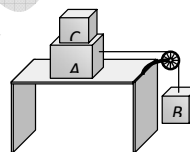
3. A block *A* with mass 100 *kg* is resting on another block *B* of mass 200 *kg*. As shown in figure a horizontal rope tied to a wall holds it. The coefficient of friction between *A* and *B* is 0.2 while coefficient of friction between *B* and the ground is 0.3. The minimum required force *F* to start moving *B* will be

    (a) 900 *N*

    (b) 100 *N*

    (c) 1100 *N*

    (d) 1200 *N*
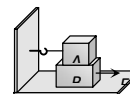
4. The blocks A and B are arranged as shown in the figure. The pulley is frictionless. The mass of *A* is 10 *kg*. The coefficient of friction of *A* with the horizontal surface is 0.20. The minimum mass of *B* to start the motion will be

    (a)   2 *kg*

    (b)   0.2 *kg*

   (c)   5 *kg*

    (d)   10 *kg*
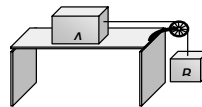
5. A block *P* of mass *m* is placed on a frictionless horizontal surface. Another block *Q* of same mass is kept on *P* and connected to the wall with the help of a spring of spring constant *k* as shown in the figure. μ_s is the coefficient of friction between *P* and *Q*. The blocks move together performing *SHM* of amplitude *A*. The maximum value of the friction force between *P* and *Q* is

    (a) kA

    (b) $\dfrac{kA}{2}$

    (c) Zero

    (d) $\mu_s\, mg$
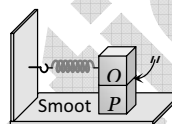
6. A 40 *kg* slab rests on a frictionless floor as shown in the figure. A 10 *kg* block rests on the top of the slab. The static coefficient of friction between the block and slab is 0.60 while the kinetic friction is 0.40. The 10 *kg* block is acted upon by a horizontal force 100 *N*. If $g = 9.8\, m/s^2$, the resulting acceleration of the slab will be

    (a) $0.98\, m/s^2$

    (b) $1.47\, m/s^2$

    (c) $1.52\, m/s^2$

    (d) $6.1\, m/s^2$
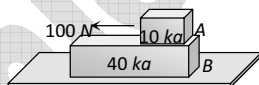
7. In the arrangement shown in figure, coefficient of friction between the two blocks is 0.5. The force of friction acting between the two blocks is

    a) 8N
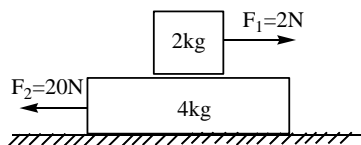
    b) 10N   c) 6N   d) 4N

8. A block of mass m is placed on the top of another block of mass M as shown in figure. The co–efficient of friction between them is μ , the maximum acceleration with which the block M may move so that m also moves along with it is

    a) gμ b) g/μ

    c) μ /g   d) μ^2g
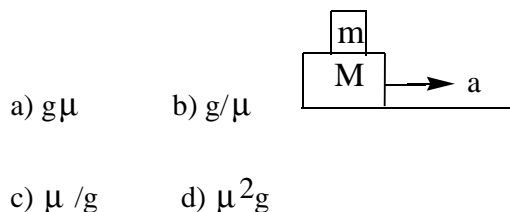
9. A 2kg block is placed over a 4kg block and both are placed on a smooth horizontal surface. The coefficient of friction between the blocks is 0.20. The acceleration of the two blocks if a horizontal force of 12N is   applied to the upper block (g=10ms^{-2})

    a) 4 ms^{-2}, 2 ms^{-2} b) 2 ms^{-2}, 2 ms^{-2} c) 3 ms^{-2}, 3 ms^{-2} d) 4 ms^{-2}, 1 ms^{-2}

10. A 4 kg block A is placed at the top of 8 kg block B which rests on a smooth table. A just slips on B when a force of 20 N is applied on A. The maximum horizontal force F required to make both A & B move together is

    a) 36 N   b) 5 N

    c) 40 N   d) 60 N
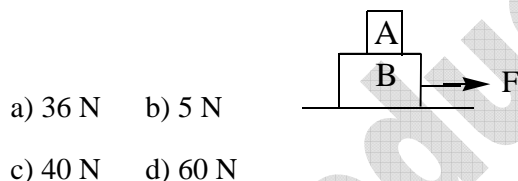
KEY

1)c   2) a   3) c   4) a   5)b   6) a   7) a   8) a   9) d   10) d

HINTS

1. (c) $F_l = \mu_s R = 0.4 \times mg = 0.4 \times 10 = 4N$ *i.e.* minimum 4*N* force is required to start the motion of a body.

But applied force is only 3*N*. So the block will not move.

2. (a) For limiting condition $\mu = \dfrac{m_B}{m_A + m_C} \Rightarrow 0.2 = \dfrac{5}{10 + m_C} \Rightarrow 2 + 0.2m_C = 5 \Rightarrow m_C = 15kg$
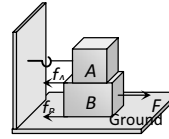
3. (c) $F = f_{AB} + f_{BG}$

$= \mu_{AB} m_a g + \mu_{BG}(m_A + m_B)g$

$= 0.2 \times 100 \times 10$

$\quad\quad +0.3(300) \times 10$

$= 200 + 900 = 1100 \ N$

4. (a) $\mu = \dfrac{m_B}{m_A} \Rightarrow 0.2 = \dfrac{m_B}{10} \Rightarrow m_B = 2kg$

5. (b) When two blocks performs simple harmonic motion together then at the extreme position (at amplitude =*A*)

Restoring force $F = KA = 2ma \Rightarrow a = \dfrac{KA}{2m}$

There will be no relative motion between *P* and *Q* if pseudo force on block *P* is less than or just equal to limiting friction between *P* and *Q*.

i.e. $m\left(\dfrac{KA}{2m}\right) = $ Limiting friction

$\therefore$ Maximum friction $= \dfrac{KA}{2}$

6. (a) Limiting friction between block and slab $= \mu_s m_A g$

$$= 0.6 \times 10 \times 9.8 = 58.8 N$$

But applied force on block *A* is 100 *N*. So the block will slip over a slab.

Now kinetic friction works between block and slab $F_k = \mu_k m_A g = 0.4 \times 10 \times 9.8 = 39.2 \ N$

This kinetic friction helps to move the slab

$\therefore$ Acceleration of slab $= \dfrac{39.2}{m_B} = \dfrac{39.2}{40} = 0.98 \ m/s^2$

7. Let the acceleration of both the blocks towards left is 'a', then

$$a = \frac{f-2}{2} = \frac{20-f}{4}$$

The maximum friction between the two blocks can be.

$$\therefore f = 8N$$

Friction between the two blocks is 8N

$$f_{max} = \mu mg$$

$$f_{max} = (0.5)\,2(10) = 10N$$

$$\therefore f < f_{max}$$

8. For the block in does not slip on M.

ma = f$_{max}$

ma = μ mg

a = μ g

9. For 2kg block

$$12 - \mu mg = ma$$

12 - 0.2 (2) (10) = 2a

8 = 2a

a = 4 ms^{-2}

The 4 kg block moves towards right because of frictional force

f = 4a

0.2 (2) 10 = 4a

a = 1 ms^{-2}

10. 20 = 4a

a = 5 ms^{-2}

F = (m$_1$ + m$_2$) a

F = (4 + 8) 5

F = 60 N