Answer on Question #48676, Physics, Mechanics | Kinematics | Dynamics

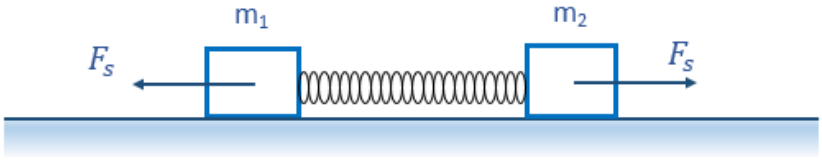
A light spring with force constant 3.35 N/m is compressed by 8.16 cm as it is held between a 0.239 kg block on the left and a 0.478 kg block on the right, both resting on a horizontal surface. The spring exerts a force on each block, tending to push them apart. The blocks are simultaneously released from rest. Find the acceleration with which each block starts to move, given that the coefficient of kinetic friction between each block and the surface is the following values. (Let the coordinate system be positive to the right and negative to the left. Be sure to include the sign to indicate the direction of the acceleration.)

(a) μ = 0
heavier block m/s^2
lighter block m/s2

(b) μ = 0.060
heavier block m/s^2
lighter block m/s^2

(c) μ = 0.137
heavier block m/s^2
lighter block m/s^2

Solution:



(a) The equations of motion for blocks are

$$-F_s = -m_1 a_1$$
$$F_s = m_2 a_2$$

Hooke's Law is a law that shows the relationship between the forces applied to a spring and its elasticity.

$$F_s = kx$$

Thus,

$$a_1 = \frac{kx}{m_1} = \frac{3.35 * 0.0816}{0.239} = 1.14 \frac{\text{m}}{\text{s}^2}$$

$$a_2 = \frac{kx}{m_2} = \frac{3.35 * 0.0816}{0.478} = 0.57 \frac{\text{m}}{\text{s}^2}$$

(b) The force from the spring is $F_s = kx = 3.35 * 0.0816 = 0.27336$ N.

Calculate the frictional forces on both blocks and you will find that the block on the right with larger mass won't move and the block on the left with less mass will have acceleration in the negative direction.

The maximum amount of friction force that a surface can exert upon an object can be calculated using the formula below:

$$f_{fr} = \mu F_{norm} = \mu mg$$

μ is the coefficient of kinetic friction.

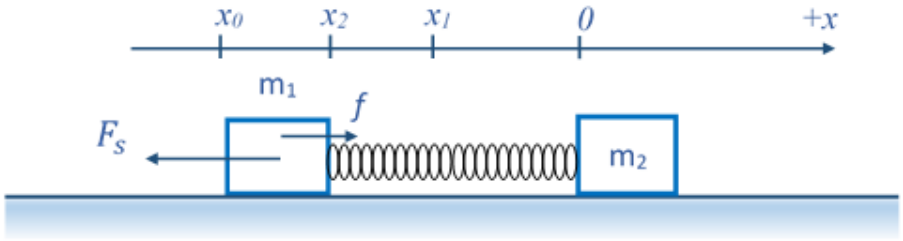
Thus,

$$f_{fr1} = \mu m_1 g = 0.060 * 0.239 * 9.81 = 0.1406754 \text{ N}$$
$$F_{fr1} < F_s$$

$$f_{fr2} = \mu m_2 g = 0.060 * 0.478 * 9.81 = 0.2813508 \text{ N}$$
$$F_{fr2} > F_s$$

Now the question becomes one block on the left moving and accelerating to the left with a frictional force to the right and a spring force to the left.

Now we need to set up a clear coordinate system as shown below.



The equation of motion for block 1 is

$$-m_1 a_1 = -F_s + f_{fr1}$$

Thus,

$$a_1 = \frac{F_s - f_{fr1}}{m_1} = \frac{0.27336 - 0.1406754}{0.239} = 0.56 \text{ m/s}^2$$

(c)

Frictional forces on both blocks are larger than the spring force so none of the blocks is moving.

$$f_{fr1} = \mu m_1 g = 0.137 * 0.239 * 9.81 = 0.3212 \text{ N}$$
$$F_{fr1} > F_s$$

$$f_{fr2} = \mu m_2 g = 0.137 * 0.478 * 9.81 = 0.6424 \text{ N}$$
$$F_{fr2} > F_s$$

Thus,

$$a_1 = a_2 = 0$$