

Use the friction on your pen and write your name! key

AP Physics: 4.2 Friction & Acceleration on Flat Surfaces

1. A box with a mass of 55-kg sits on a flat table.

a. What is the box's weight and normal force? (ans: $mg = -539 \text{ N}$, $F_N = 539 \text{ N}$)

$$\vec{W} = m\vec{g} = (55)(-9.8) = -539 \text{ N}$$

b. The box has a friction force of 14N and someone pulls the box horizontally with a force of 70N, calculate the acceleration of the box. (ans: 1.02 m/s^2)

$$a = \frac{\Sigma F}{m} = \frac{70 - 14}{55} = 1.02 \text{ m/s}^2$$

c. Which of the two graphs below would be a flat zero sloped line?

position-time velocity-time acceleration-time Force-time

d. Calculate the friction coefficient of the box and the table. (ans: 0.026)

$$f \leq \mu F_N \Rightarrow 14 = \mu(539)$$
$$\mu = .026$$

e. If the box began from rest, calculate the velocity of the box after it traveled a distance of 3 meters. (ans: 2.47 m/s)

$$v_x^2 = v_0^2 + 2a(x - x_0)$$

2. A force of 490 N pulls a 30-kg box horizontally across the floor, with a friction coefficient of $\mu_k = 0.1$.

a. What is the kinetic friction force? (Answer: $f \leq 29.4 \text{ N}$)

$$f \leq \mu F_N$$

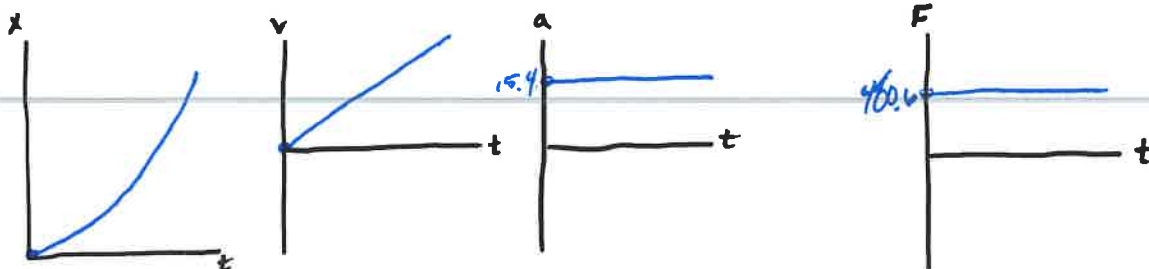
b. Calculate the acceleration of the box. (Answer: 15.4 m/s^2)

$$a = \frac{\Sigma F}{m} = \frac{490 - f}{30} = 15.4 \text{ m/s}^2$$

c. Which graph below would have a slope equal to 15.4?

position-time velocity-time acceleration-time Force-time

d. Sketch the graphs for position, velocity, acceleration and force for the box.



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3. An amazon box with a weight of 686-N is slid along the floor by a horizontal 400-N force. The value of the friction coefficient between the box and the floor is 0.50.

- a. Calculate the mass of the box. (ans: 70 kg)

$$w = mg$$

- b. Calculate the friction force? (Answer: 343 N)

$$f \leq \mu F_N = .5(686) = 343 \text{ N}$$

- c. Calculate the acceleration of the amazon box. (Answer: 0.814 m/s²)

$$a = \frac{\Sigma F}{m} = \frac{400 - 343}{m} = .814 \text{ m/s}^2$$

- d. Which of the graphs would be a curved exponentially increasing function?

position-time ___ velocity-time ___ acceleration-time ___ Force-time

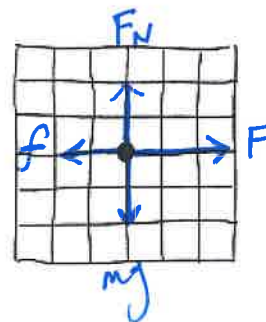
- c. If the box initially had a velocity of 1.2 m/s, how much time would it have taken to travel a distance of 17 meters? (ans: 5.15 seconds)

$$x = x_0 + v_0 t + \frac{1}{2} a t^2$$

$$17 = 0 + 1.2t + \frac{1}{2} (.814)t^2$$

4. A box of mass M is pushed along the floor, to the right, by a horizontal force with value F. The value of the friction coefficient is μ_k between the box and the floor. Gravity can be used as g.

- a. Draw a free body diagram of all the forces acting on the box to the right. Be sure to label the forces correctly and give vectors correct lengths.



- b. Calculate the kinetic friction force in terms of values given.

$$f \leq \mu F_N \quad \underline{f = \mu_k Mg}$$

- c. Calculate the net force acting on the box in terms of values given.

$$\Sigma F = F - \mu_k Mg$$

- d. Calculate the acceleration of the box in terms of values given.

$$a = \frac{\Sigma F}{m} = \frac{F - \mu_k Mg}{m}$$

- e. If the horizontal force F and the frictional force were equal, mark the correct comment

acceleration would be zero ___ the box wouldn't be moving ___ the box would be moving

It might not be moving but it will either be at rest or moving at a constant velocity.