I. The following equations represent the position of two people.

Bob: \[ x(t)_{\text{Bob}} = (20 \text{ m}) + (-0.75 \text{ m/s})t + (-1.2 \text{ m/s}^2)t^2 \]

Abel: \[ x(t)_{\text{Abel}} = (-10 \text{ m}) + (-0.75 \text{ m/s})t \]

a) Describe the most important features of the motions of the Bob and Abel in words.

Bob: STARTS AT 20 m IN POSITIVE DIRECTION FROM ORIGIN. MOVING AT 0.75 m/s IN NEGATIVE DIRECTION INITIALLY. SPEEDING UP AT 1.2 m/s² EACH SECOND.

Abel: STARTS AT 10 m IN NEGATIVE DIRECTION FROM ORIGIN. MOVING AT 0.75 m/s IN NEGATIVE DIRECTION INITIALLY.

b) Will Bob and Abel ever meet? If yes, then when?

\[ x(t_{\text{meet}})_{\text{Bob}} = x(t_{\text{meet}})_{\text{Abel}} \]

\[ 20 \text{ m} + (-0.75 \text{ m/s})t + (-1.2 \text{ m/s}^2)t^2 = -10 \text{ m} + (-0.75 \text{ m/s})t \]

\[ t^2 = \frac{30 \text{ m}}{1.2 \text{ m/s}^2} \Rightarrow [t_{\text{meet}} = 5 \text{ s}] \]

c) If they meet, where will Bob and Abel meet? If they won’t meet, then explain why not.

\[ x(t_{\text{meet}})_{\text{Bob}} = 20 \text{ m} + (-0.75 \text{ m/s})(5 \text{ s}) + (-1.2 \text{ m/s}^2)(25 \text{ s}^2) \]

\[ = -13.75 \text{ m} \]

\[ x(t_{\text{meet}})_{\text{Abel}} = -10 \text{ m} + (-0.75 \text{ m/s})(5 \text{ s}) = -13.75 \text{ m} \]

\[ x_{\text{meet}} = -14 \text{ m} \]
II. You have a spring and when you pull it with 75 N of force it stretches 5.0 cm. You place the spring at the bottom of a frictionless inclined plane that makes an angle \( \theta = 20^\circ \) with the horizontal, as shown below. You push a 2-kg block against the spring, compressing it by 12 cm and you hold the block in the position shown below.

![Diagram of a spring and block on an inclined plane]

a) Find the spring constant of the spring.

\[
F = kA \Delta x \quad \frac{F}{\Delta x} = \frac{75 \text{ N}}{0.05 \text{ m}} = 1.5 \times 10^3 \text{ N/m}
\]

b) If you release the block, how far along the incline will it slide before turning around and sliding back down?

\[ \frac{U_s}{U_g} = \frac{1}{2} kA x^2 = mg \Delta \theta \quad \text{and} \quad h = l \sin \theta \]

So \[ \frac{1}{2} kA x^2 = mg \sin \theta \Rightarrow l = \frac{kA x^2}{2 mg \sin \theta} \]

\[ l = \frac{(1.5 \times 10^3)(0.12)^2}{(2)(2)(10) \sin 20^\circ} = 1.6 \text{ m} \]

c) How far along the incline would it slide if there were friction between the inclined plane and the block such that \( \mu = 0.2 \)?

\[ \frac{U_s}{U_g} = \frac{1}{2} \mu mg \cos \theta \]

So \[ \frac{1}{2} kA x^2 = mg \sin \theta + \mu mg \cos \theta \]

\[ \Rightarrow l = \frac{kA x^2}{2mg (\sin \theta + \mu \cos \theta)} \]

\[ l = \frac{(1.5 \times 10^3)(0.12)^2}{(2)(2)(10)(\sin 20^\circ + 0.2 \cos 20^\circ)} \]

\[ l = 1.0 \text{ m} \]
III. A 3000-kg car traveling to the right at 20 m/s is chasing a second car of mass 2000 kg that is traveling to the right at 10 m/s.

a) When the larger car runs into the smaller one, they collide and stick together. What is their velocity just after the collision?

\[
\text{TOTAL MOMENTUM} = (3000 \text{ kg})(20 \text{ m/s}) + (2000 \text{ kg})(10 \text{ m/s}) = 90000 \text{ kg m/s}
\]

\[
\text{FINAL VELOCITY} = \frac{80000 \text{ kg m/s}}{5000} = 16 \text{ m/s}
\]

\[
v_{\text{after}} = 16 \text{ m/s}
\]

b) If the collision takes place in .03 seconds, determine the average force (magnitude and direction) experienced by each car during the collision. (*Let the positive direction be to the right*)

\[
\text{IMPULSE} = MV_f - MV_o = M(V_f - V_o)
\]

\[
\text{IMPULSE} = F_{\text{ave}} \Delta t
\]

\[
\text{SETTING EQUAL: } F_{\text{ave}} \Delta t = M(V_f - V_o) \Rightarrow F_{\text{ave}} = \frac{M(V_f - V_o)}{\Delta t}
\]

\[
F_{\text{ave},1} = \frac{(3000)(16 - 20)}{0.03} = -400000 \text{ N}
\]

\[
\text{Average force big car on small car} = 400 \text{ kN}
\]

\[
F_{\text{ave},2} = \frac{(2000)(16 - 10)}{0.03} = +400000 \text{ N}
\]

\[
\text{Average force small car on big car} = 400 \text{ kN}
\]

c) If the there is a coefficient of friction of 0.8 between the car tires and the road as they slide after the collision, how long will the skid marks be that they leave on the road?

\[
\frac{\pi}{k_x} = \Delta U_{\text{int}}
\]

\[
\frac{1}{2}mv^2_{\text{after}} = \mu mg \ell
\]

\[
\ell = \frac{V_{\text{after}}^2}{2\mu g} = \frac{(16)^2}{(2)(0.8)(10)} = \boxed{16 \text{ m}}
\]
1. \( F = \frac{\mu mg}{2} \) for \( g = \frac{1}{2} \) same for both.

2. Do not pick this answer.

3. There is no information to answer.

4. They both have the same amount.

5. Which of the following equations correctly depict two pulses on a digitonness tape?

6. The diagram depicts two pulses on a digitonness tape.

7. 0.5 m/s^2

8. 1.0 m/s^2

9. 1.5 m/s^2

10. 2.0 m/s^2

11. 2.5 m/s^2

12. Mass

13. \( M = N \) and \( g = \frac{f}{d} \)

14. A car has a maximum acceleration of 3.0 m/s^2. What would be the maximum acceleration be while turning a second car twice its longer?

15. \( M = N \) and \( g = \frac{f}{d} \)

16. \( M > N \) and \( g = \frac{f}{d} \)

17. \( M < N \) and \( g = \frac{f}{d} \)

18. \( M = N \) and \( g = \frac{f}{d} \)

19. None of the above choices.

20. True

21. A person pulls a block across a rough horizontal surface at a constant speed of 2.0 m/s. When the elevator is traveling upward at a constant speed of 0.4 m/s, the force exerted by the rope on block 1 will be greater than the force exerted by the rope on block 2. What is the tension force in the rope?
8. An airplane heads eastward. Flying at a speed of 120 mph into a 30 mph wind that is blowing 25° southward, what is the plane's resultant speed and direction?

- None of the other answers are correct.
- D. P, H, T, G, K
- C. P, T, G, H-K
- B. P, H, T, G, K
- F, H, T, G, K
- A. T, F, P, K

7. Five homogeneous spheres have relative masses and sizes shown in the figure. The radius of mass, from GREATES to LEAST, on the surface of each planet: WE = μ Ferrogy.

- p
- 0.5 p
- 0.25 p
- 0.125 p
- 0.0625 p
- 0.03125 p

6. A table lists two blocks on a frictionless surface.

- e
- d
- c
- b
- a

5. Between t=0 and t=1, the particle moves down.

- e
- d
- c
- b
- a

4. The particle always moves in the positive direction.

- e
- d
- c
- b
- a

3. The negative net force acts in the negative direction.

- e
- d
- c
- b
- a

2. The motion of a particle is described by $x(t) = (t^2 - 8t + 2)t$.

- e
- d
- c
- b
- a

1. The block and bullet slide into a spring (k=1000 N/m) and come to rest on a frictionless horizontal surface. After the collision, the block is short into a 4.0 kg block of wood that is initially at rest. A 4.0 kg bullet is shot into a 4.0 kg block of wood that is initially at rest.

- e
- d
- c
- b
- a

10. If two objects have the same momentum, which is a constant net force acting in the negative direction.

- e
- d
- c
- b
- a