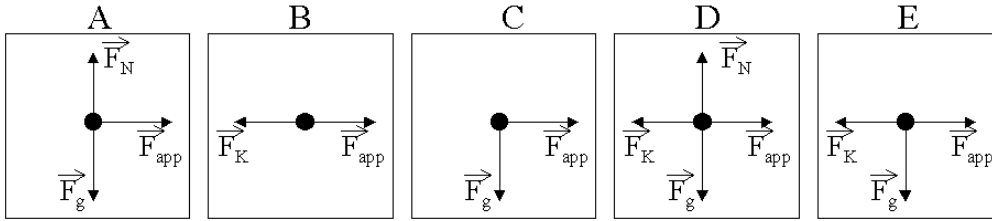


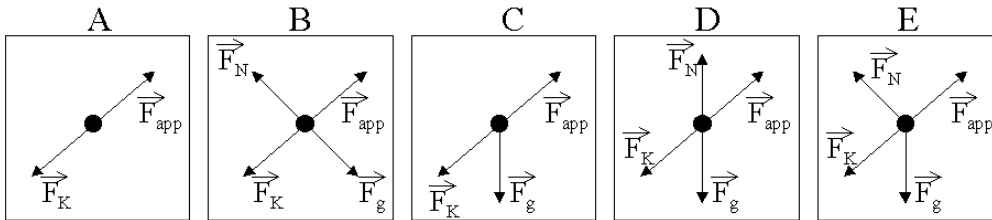
Review: Advanced Applications of Newton's Laws

1. The free-body diagram of a wagon being pulled along a horizontal surface is best represented by



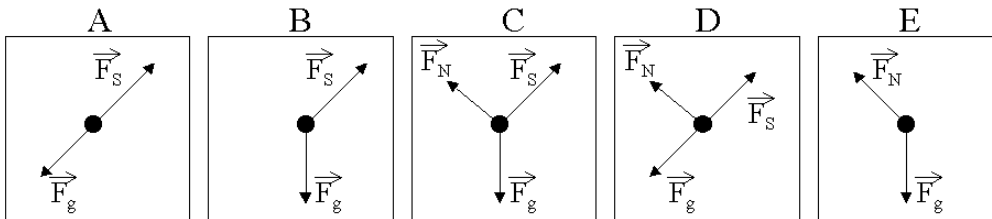
- a. A
b. B
c. C
d. D
e. E

2. The free-body diagram of a block being pushed up a rough ramp is best represented by



- a. A
b. B
c. C
d. D
e. E

3. An object sits at rest on a ramp. Which of the following free-body diagrams best represents the forces acting on the object?



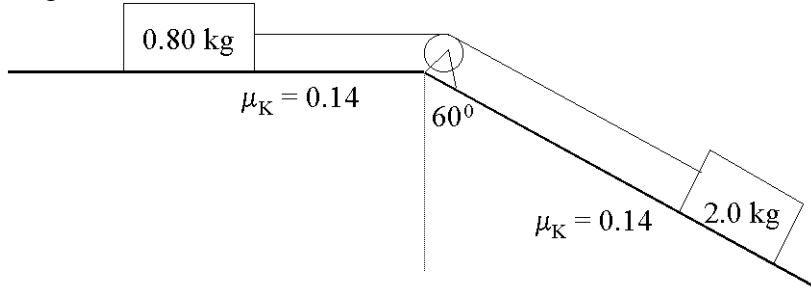
- a. A
b. B
c. C
d. D
e. E

4. A 4.0-kg object, A, and a 2.0-kg object, B, are connected with a rope. A force is applied to another rope attached to the 2.0-kg object that pulls both A and B along a horizontal surface. Which of the following statements is true?

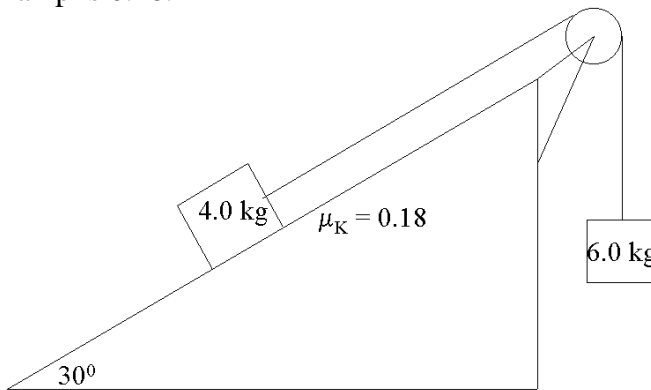
- a. The force that B exerts on A is greater than the force that A exerts on B.
b. The force that A exerts on B is greater than the force that B exerts on A.
c. The force that B exerts on A is equal to the force that A exerts on B provided that the system slides with uniform motion.
d. The force that B exerts on A is equal to the force that A exerts on B regardless of the motion of the system.

- _____ 5. A 1.5-kg cart is pulled with a force of 7.3 N at an angle of 40° above the horizontal. If a kinetic friction force of 3.2 N acts against the motion, the cart's acceleration along the horizontal surface will be
 - a. 5.0 m/s^2
 - b. 2.7 m/s^2
 - c. 2.4 m/s^2
 - d. 1.6 m/s^2
- _____ 6. A 2.0-kg object is pulled horizontally by a force of 6.3 N along the floor where the coefficient of kinetic friction is 0.24. What is the object's acceleration?
 - a. 2.0 m/s^2
 - b. 2.0 m/s^2
 - c. 1.6 m/s^2
 - d. 0.80 m/s^2
- _____ 7. A 1.8-kg object is pulled along the floor with a force of 7.0 N acting horizontally. If the object accelerates at 2.4 m/s^2 , how much kinetic friction is acting?
 - a. 8.3 N
 - b. 30 N
 - c. 11 N
 - d. 2.7 N
- _____ 8. Which factor increases the force of friction acting on an object that is sliding down an incline?
 - a. decreasing the surface area in contact
 - b. increasing the angle of the incline plane
 - c. decreasing the angle of the incline plane
 - d. lubricating the surfaces in contact
- _____ 9. A 5.0 kg object is resting on a plane that is inclined at 15° to the horizontal. Determine the normal force acting on the object.
 - a. 189 N
 - b. 51 N
 - c. 49 N
 - d. 47 N
- _____ 10. An Atwood machine consists of two masses, 5.0 kg and 7.2 kg that are connected by a rope hanging over a pulley. When the two masses are released, what is the acceleration of the system?
 - a. 1.8 m/s^2
 - b. 3.0 m/s^2
 - c. 4.3 m/s^2
 - d. 5.8 m/s^2
- _____ 11. A dynamics cart, with a mass of 1.2 kg, is attached to a suspended mass of 250 g by a string that passes over a pulley. If friction is not a factor, determine the acceleration of the cart when the mass is released.
 - a. 1.7 m/s^2
 - b. 2.0 m/s^2
 - c. 6.4 m/s^2
 - d. 7.8 m/s^2
- _____ 12. A dynamics cart, with a mass of 1.5 kg, is attached to a suspended mass of 1.3 kg by a string that passes over a pulley. If the coefficient of friction between the lab desk and the cart is 0.58, determine the acceleration of the cart when the mass is released.
 - a. 4.9
 - b. 1.5
 - c. 4.1
 - d. 1.8

13. Two blocks are connected by a “massless” string over a “frictionless” pulley as shown in the diagram.

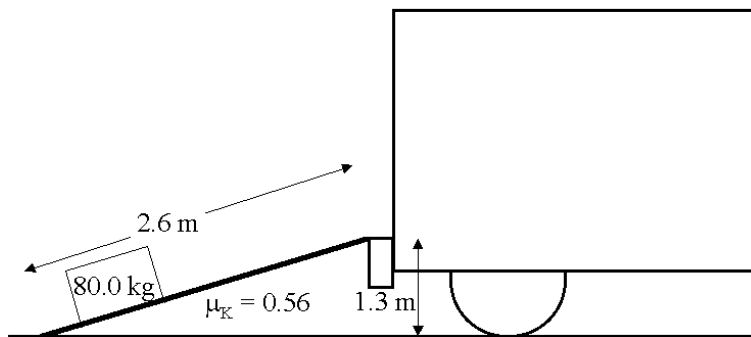


- Determine the acceleration of the blocks.
 - Calculate the tension in the string .
 - If the string broke, for what minimum value of the coefficient of static friction would the 2.0-kg block not begin to slide?
14. Two masses, 4.0 kg and 6.0 kg, are connected by a “massless” rope over a “frictionless” pulley as pictured in the diagram. The ramp is inclined at 30.0° and the coefficient of kinetic friction on the ramp is 0.18.



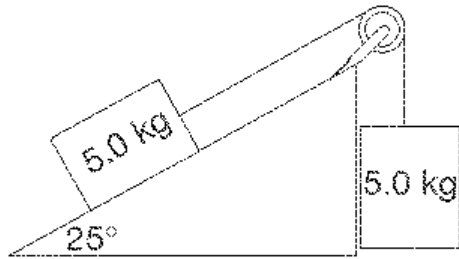
- Draw free-body diagrams of both masses.
 - Determine the acceleration of the system once it begins to slide.
 - Determine the tension in the rope.
 - If the rope breaks when the 4.0-kg mass is 3.0 m from the bottom of the ramp, how long will it take for the mass to slide all the way down? Include a new free-body diagram and assume the sliding mass starts from rest.
15. Two toboggans are pulled across the ice with a force of 1.2×10^2 N. The rope of the toboggan makes an angle of 55° with the horizontal. The first toboggan has a mass of 25 kg, and the second toboggan has a mass of 16 kg. Assume that the ice is smooth enough to be considered frictionless.
- What is the acceleration of the two toboggans?
 - What is the tension in the rope that connects the two toboggans?
16. A physics textbook is placed on an incline. The coefficient of static friction between the textbook and the ramp is 0.43. What is the maximum angle that the ramp can be raised before the textbook begins to slide down the incline?

17. Crates of mass 80.0 kg are loaded onto a truck, a vertical lift of 1.3 m. To make the work easier, a 2.6 m long ramp is used and the crates are pushed along the ramp from the ground onto the truck. The coefficient of friction between the crates and the ramp is 0.56.

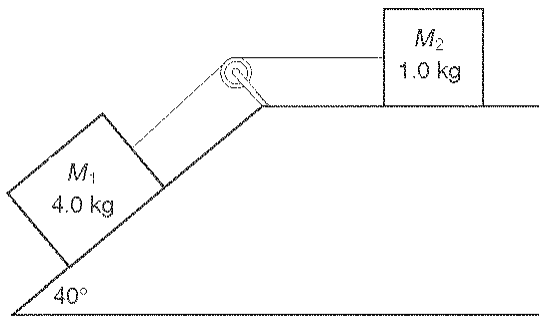


- (a) Determine the minimum force required to push a crate along the ramp. Include an appropriate free-body diagram.
- (b) If a crate is let go from rest at the top of the ramp and begins to slide, how long will it take to reach the bottom of the ramp? Include a new free-body diagram.
- (c) What minimum value for the coefficient of static friction will prevent the crate from beginning to slide if it is let go at the top of the ramp?
18. Two boxes, A and B, are side by side on a table. The mass of box A is 3.20 kg, and the mass of box B is 2.10 kg. A horizontal force of 10.5 N is applied to box A, pushing it against box B. There is a frictional force of 2.00 N between box A and the table, and a force of friction of 1.00 N acting on box B. Find the magnitude of the force of contact between the two boxes.
19. Two objects are connected by a rope that runs over a pulley. The first object has a mass of 5.0 kg, and the second object has a mass of 3.5 kg.
- a) Where the two objects are released, what is their acceleration?
- b) What is the tension in the rope?
20. A dynamics cart has a mass of 875 g. It is connected to a suspended 300 g mass by a string that is threaded through a frictionless pulley. The coefficient of friction between the lab desk and the dynamics cart is 0.25.
- a) Determine the acceleration of the dynamics cart when the 300 g mass is released.
- b) If the dynamics cart takes 1.3 s to reach the pulley, what distance does it travel?
21. A skier, with a mass of 73 kg, starts from rest at the top of a hill. The hill has an incline of 22° and is 53 m long. If the coefficient of friction between the skis and the snow is 0.18, what is the speed of the skier at the bottom of the hill?
22. A saltshaker is pushed to make it slide across a cafeteria table. Its initial velocity is 1.2 m/s. Eventually, it slows down and comes to a stop. If the coefficient of friction between saltshaker and the table is 0.20, calculate the distance the saltshaker travelled before it stopped.

23. Two boxes are connected with a rope, as shown in the diagram below. The coefficient of friction between the boxes and the inclined surface is 0.30. Determine the acceleration of the boxes.



24. Two masses are connected with a rope that passes through a pulley. The coefficient of friction between the objects and the surface is 0.60. Assume that there is no friction in the pulley.



- Calculate the acceleration of the system when the masses are released.
- Determine the force of tension in the rope that connects the two masses.

Answer Section
MULTIPLE CHOICE

1. ANS: D
2. ANS: E
3. ANS: C
4. ANS: D
5. ANS: D
6. ANS: D
7. ANS: D
8. ANS: C
9. ANS: D
10. ANS: A
11. ANS: A
12. ANS: B
13. ANS:
 - (a) **The system will accelerate at 2.3 m/s^2 .**
 - (b) **The tension in the string is 2.9 N .**
 - (c) **The minimum coefficient of static friction required is 0.58 .**
14. ANS:
 - (a)
For the 4.0-kg mass:
Free-body diagram: F_N acting perpendicular to the ramp (upward)
 F_g acting down
 F_T acting up along the ramp
 F_K acting down along the ramp

For the 6.0-kg mass:
Free-body diagram: F_g acting down
 F_T acting up
 - (b) **The acceleration of the 4.0-kg mass along the ramp is 3.3 m/s^2 .**
 - (c) **The tension in the cable is 39 N .**
 - (d) $a = 3.37 \text{ m/s}^2$
It would take 1.3 s to reach the bottom of the ramp.
15. ANS:
 - (a) 1.7 m/s^2
 - (b) 27 N
16. $\theta = 23^\circ$

17. ANS:

(a) **The minimum force required to push is 772 N up the ramp.**

(b) $a = 0.147 \text{ m/s}^2$

It would take 5.9 s to reach the bottom of the ramp.

(c) **The minimum coefficient of static friction required is 0.58.**

18. ANS:

$$a = 1.42 \text{ m/s}^2$$

$$m_{\text{total}} = 5.30 \text{ kg}$$

$$F_{\text{BA}} = 3.98 \text{ N}$$

19.

a) 1.7 m/s^2

b) 41 N

20. ANS:

a) 0.68 m/s^2

b) 0.57 m or 57 cm

21. $a = 2.0 \text{ m/s}^2$

$$v_2 = 15 \text{ m/s}$$

22. 0.37 m or 37 cm

23. 1.5 m/s^2

24. (a) 0.26 m/s^2

(b) 6.2 N