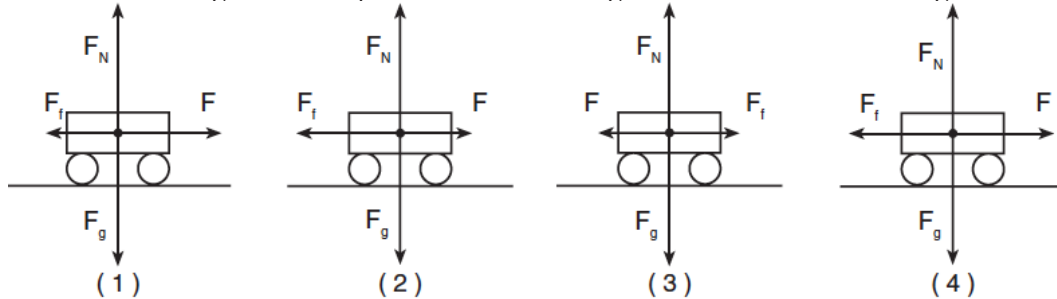


Dynamics-Friction

1. Which vector diagram best represents a cart slowing down as it travels to the right on a horizontal surface?



Base your answers to questions 2 and 3 on the information below.

A student and the waxed skis she is wearing have a combined weight of 850 newtons. The skier travels down a snow-covered hill and then glides to the east across a snow-covered, horizontal surface.



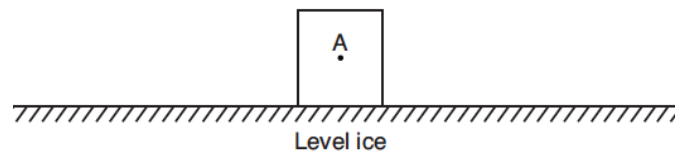
2. Determine the magnitude of the normal force exerted by the snow on the skis as the skier glides across the horizontal surface.
3. Calculate the magnitude of the force of friction acting on the skis as the skier glides across the snow-covered, horizontal surface. [Show all work, including the equation and substitution with units.]

4. The coefficient of kinetic friction between a 780-newton crate and a level warehouse floor is 0.200. Calculate the magnitude of the horizontal force required to move the crate across the floor at constant speed. [Show all work, including the equation and substitution with units.]

Base your answers to questions 5 through 8 on the information below.

An ice skater applies a horizontal force to a 20-kg block on frictionless, level ice, causing the block to accelerate uniformly at 1.4 m/s^2 to the right. After the skater stops pushing the block, it slides onto a region of ice that is covered with a thin layer of sand. The coefficient of kinetic friction between the block and the sand-covered ice is 0.28.

5. Calculate the magnitude of the force applied to the block by the skater.
6. On the diagram below, starting at point A, draw a vector to represent the force applied to the block by the skater. Begin the vector at point A and use a scale of $1 \text{ cm} = 10 \text{ newtons}$.



7. Determine the magnitude of the normal force acting on the block.
8. Calculate the magnitude of the force of friction acting on the block as it slides over the sand-covered ice. [Show all work, including the equation and substitution with units.]

Dynamics-Friction

Base your answers to questions 9 through 13 on the information below.

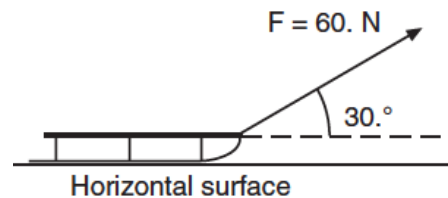
A manufacturer's advertisement claims that their 1,250-kilogram (12,300-newton) sports car can accelerate on a level road from 0 to 60 miles per hour (0 to 26.8 meters per second) in 3.75 seconds.



9. Determine the acceleration, in meters per second², of the car according to the advertisement.
10. Calculate the net force required to give the car the acceleration claimed in the advertisement. [Show all work, including the equation and substitution with units.]
11. What is the normal force exerted by the road on the car?
12. The coefficient of friction between the car's tires and the road is 0.80. Calculate the maximum force of friction between the car's tires and the road. [Show all work, including the equation and substitution with units.]
13. Using the values for the forces you have calculated, explain whether or not the manufacturer's claim for the car's acceleration is possible.

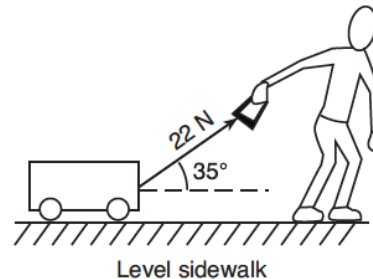
Base your answers to questions 14 and 15 on the information and diagram below.

A force of 60 newtons is applied to a rope to pull a sled across a horizontal surface at a constant velocity. The rope is at an angle of 30 degrees above the horizontal.



14. Calculate the magnitude of the component of the 60-newton force that is parallel to the horizontal surface. [Show all work, including the equation and substitution with units.]
15. Determine the magnitude of the frictional force acting on the sled.

16. A child pulls a wagon at a constant velocity along a level sidewalk. The child does this by applying a 22-newton force to the wagon handle, which is inclined at 35° to the sidewalk as shown below.



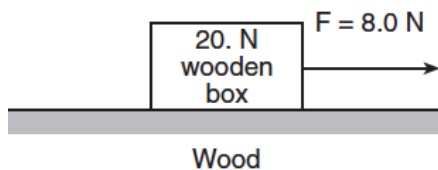
What is the magnitude of the force of friction on the wagon?

1. 11 N
2. 13 N
3. 18 N
4. 22 N

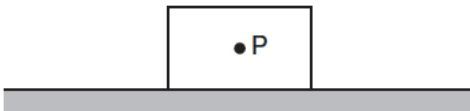
Dynamics-Friction

Base your answers to questions 17 through 21 on the information and diagram below.

A horizontal force of 8 newtons is used to pull a 20-newton wooden box moving toward the right along a horizontal, wood surface, as shown (not drawn to scale).

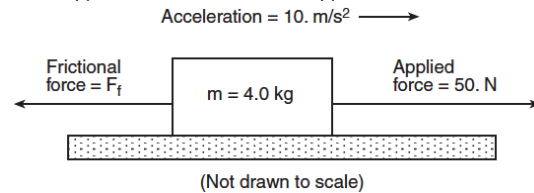


17. Starting at point P on the diagram below, use a metric ruler and a scale of 1 cm = 10 N to draw a vector representing the normal force acting on the box. Label the vector F_N .



18. Calculate the magnitude of the frictional force acting on the box. [Show all work, including the equation and substitution with units.]
19. Determine the magnitude of the net force acting on the box.
20. Determine the mass of the box.
21. Calculate the magnitude of the acceleration of the box. [Show all work, including the equation and substitution with units.]

22. The diagram below shows a 4-kilogram object accelerating at 10 m/s^2 on a rough horizontal surface.



What is the magnitude of the frictional force F_f acting on the object?

1. 5 N
 2. 10 N
 3. 20 N
 4. 40 N
23. A car's performance is tested on various horizontal road surfaces. The brakes are applied, causing the rubber tires of the car to slide along the road without rolling. The tires encounter the greatest force of friction to stop the car on
1. dry concrete
 2. dry asphalt
 3. wet concrete
 4. wet asphalt
24. When a 12-newton horizontal force is applied to a box on a horizontal tabletop, the box remains at rest. The force of static friction acting on the box is
1. 0 N
 2. between 0 N and 12 N
 3. 12 N
 4. greater than 12 N
25. A box is pushed toward the right across a classroom floor. The force of friction on the box is directed toward the
1. left
 2. right
 3. ceiling
 4. floor
26. A skier on waxed skis is pulled at constant speed across level snow by a horizontal force of 39 newtons. Calculate the normal force exerted on the skier.

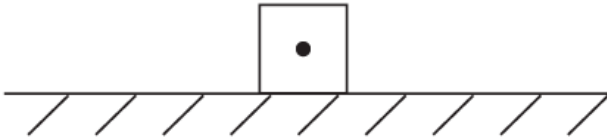
Dynamics-Friction

Base your answers to questions 27 through 31 on the information below. Show all work, including the equation and substitution with units.

A force of 10 newtons toward the right is exerted on a wooden crate initially moving to the right on a horizontal wooden floor. The crate weighs 25 newtons.

27. Calculate the magnitude of the force of friction between the crate and the floor.

28. On the diagram below, draw and label all vertical forces acting on the crate.



29. On the diagram above, draw and label all horizontal forces acting on the crate.

30. What is the magnitude of the net force acting on the crate?

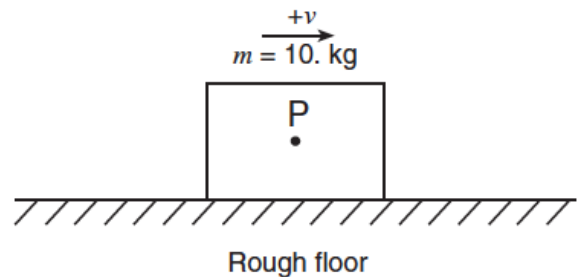
31. Is the crate accelerating? Explain your answer.

Base your answers to questions 32 through 34 on the information and diagram below.

A 10-kg box, sliding to the right across a rough horizontal floor, accelerates at -2 m/s^2 due to the force of friction.

32. Calculate the magnitude of the net force acting on the box. [Show all work, including the equation and substitution with units.]

33. On the diagram below, draw a vector representing the net force acting on the box. Begin the vector at point P and use a scale of $1 \text{ cm} = 10 \text{ newtons}$.

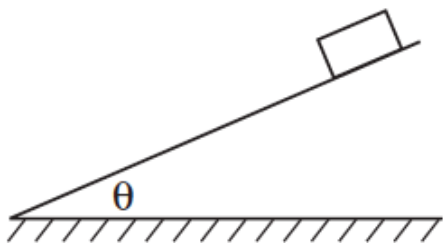


34. Calculate the coefficient of kinetic friction between the box and the floor. [Show all work, including the equation and substitution with units.]

35. A 10-kg rubber block is pulled horizontally at constant velocity across a sheet of ice. Calculate the magnitude of the force of friction acting on the block. [Show all work, including the equation and substitution with units.]

Dynamics-Friction

36. What is the magnitude of the force needed to keep a 60-newton rubber block moving across level, dry asphalt in a straight line at a constant speed of 2 meters per second?
1. 40 N
 2. 51 N
 3. 60 N
 4. 120 N
37. The force required to start an object sliding across a uniform horizontal surface is larger than the force required to keep the object sliding at a constant velocity. The magnitudes of the required forces are different in these situations because the force of kinetic friction
1. is greater than the force of static friction
 2. is less than the force of static friction
 3. increases as the speed of the object relative to the surface increases
 4. decreases as the speed of the object relative to the surface increases
38. The diagram below shows a block sliding down a plane inclined at angle θ with the horizontal.



- As angle θ is increased, the coefficient of kinetic friction between the bottom surface of the block and the surface of the incline will
1. decrease
 2. increase
 3. remain the same
39. An airplane is moving with a constant velocity in level flight. Compare the magnitude of the forward force provided by the engines to the magnitude of the backward frictional drag force.
40. An 80-kilogram skier slides on waxed skis along a horizontal surface of snow at constant velocity while pushing with his poles. What is the horizontal component of the force pushing him forward?
1. 0.05 N
 2. 0.4 N
 3. 40 N
 4. 4 N
41. Compared to the force needed to start sliding a crate across a rough level floor, the force needed to keep it sliding is
1. less
 2. greater
 3. the same
42. A 1500-kilogram car accelerates at 5 meters per second² on a level, dry, asphalt road. Determine the magnitude of the net horizontal force acting on the car.
43. A 0.50-kilogram puck sliding on a horizontal shuffleboard court is slowed to rest by a frictional force of 1.2 newtons. What is the coefficient of kinetic friction between the puck and the surface of the shuffleboard court?
1. 0.24
 2. 0.42
 3. 0.60
 4. 4.1