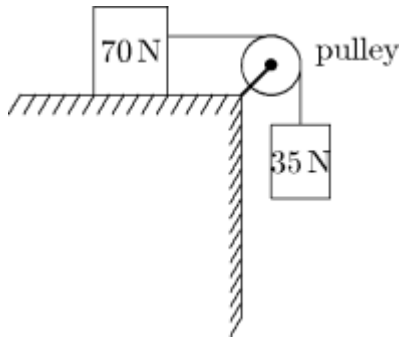Name: _____   Date: _____

1. A crate resting on a rough horizontal floor is to be moved horizontally. The coefficient of static friction is 0.40. To start the crate moving with the weakest possible applied force, in what direction should the force be applied?

   A) Horizontal
   B) 24° below the horizontal
   C) 22° above the horizontal
   D) 24° above the horizontal
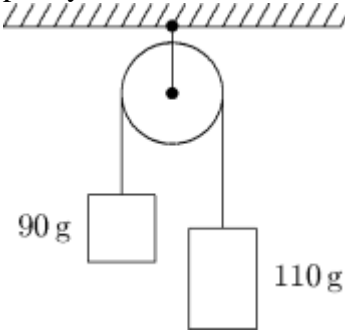   E) 66° below the horizontal

2. A 70-N block and a 35-N block are connected by a string as shown. If the pulley is massless and the surface is frictionless, the magnitude of the acceleration of the 35-N block is:
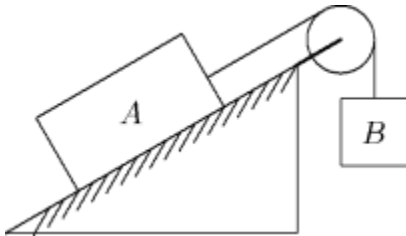

   A) 1.6 m/s²
   B) 3.3 m/s²
   C) 4.9 m/s²
   D) 6.7 m/s²
   E) 9.8 m/s²

3. Two blocks are connected by a string and pulley as shown. Assuming that the string and pulley are massless, the magnitude of the acceleration of each block is:

A) 0.049 m/s^2
B) 0.020 m/s^2
C) 0.0098 m/s^2
D) 0.54 m/s^2
E) 0.98 m/s^2

4. Block A, with a mass of 10 kg, rests on a 35° incline. The coefficient of static friction is 0.40. An attached string is parallel to the incline and passes over a massless, frictionless pulley at the top. The largest mass m_B of block B, attached to the dangling end, for which A remains at rest is:

A) 2.5 kg
B) 3.5 kg
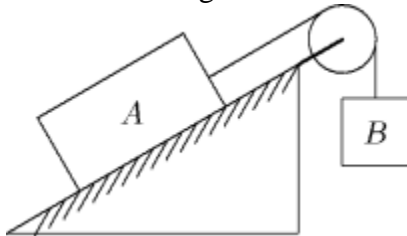**C)** 5.9 kg
D) 9.0 kg
E) 10.5 kg

5. When a 40-N force, parallel to the incline and directed up the incline, is applied to a crate on a frictionless incline that is 30° above the horizontal, the acceleration of the crate is 2.0 m/s², up the incline. The mass of the crate is:

   A) 3.8 kg
   B) 4.1 kg
   C) 5.8 kg
   D) 6.2 kg
   E) 10 kg

6. A 90-kg man stands in an elevator that has a downward acceleration of 1.4 m/s². The force exerted by him on the floor is about:

   A) zero
   B) 90 N
   C) 760 N
   D) 880 N
   E) 1010 N

7. Block A, with a mass of 10 kg, rests on a 30° incline. The coefficient of kinetic friction is 0.20. The attached string is parallel to the incline and passes over a massless, frictionless pulley at the top. Block B, with a mass of 8.0 kg, is attached to the dangling end of the string. The acceleration of B is:
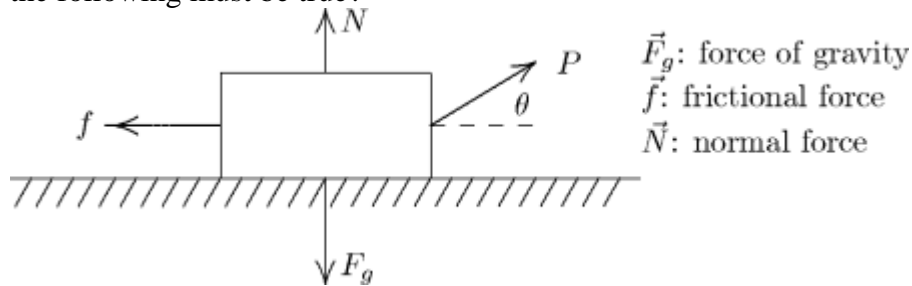

   A) 0.69 m/s², up the plane
   B) 0.69 m/s², down the plane
   C) 2.6 m/s², up the plane
   D) 2.6 m/s², down the plane
   E) 0

8. A force $\vec{F}$ (larger than the largest possible force of static friction) is applied to the left to an object moving to the right on a horizontal surface. Then:
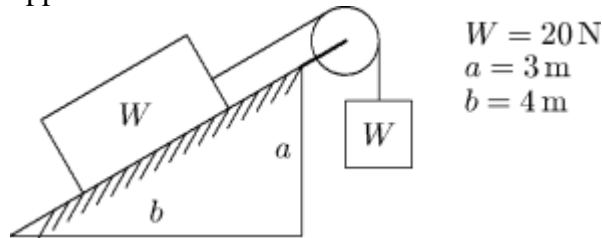
A) the object must be moving at constant speed

B) $\vec{F}$ and the friction force act in opposite directions

C) the object must be slowing down

D) the object must be speeding up

E) the object must come to rest and remain at rest

9. A boy pulls a wooden box along a rough horizontal floor at constant speed by means of a force $\vec{P}$ as shown. In the diagram f is the magnitude of the force of friction, N is the magnitude of the normal force, and F_g is the magnitude of the force of gravity. Which of the following must be true?

$\vec{F_g}$: force of gravity
$\vec{f}$: frictional force
$\vec{N}$: normal force

A) $P = f$ and $N = F_g$

B) $P = f$ and $N > F_g$

C) $P > f$ and $N < F_g$

D) $P > f$ and $N = F_g$

E) none of these

10. The system shown remains at rest. Each block weighs 20 N. The force of friction on the upper block is:
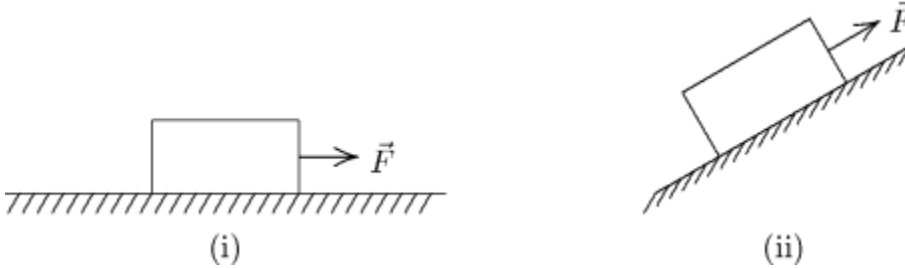

$W = 20\,\text{N}$
$a = 3\,\text{m}$
$b = 4\,\text{m}$

A) 4 N

B) 8 N

C) 12 N

D) 16 N

E) 20 N

Write the letter for the correct answer on the answer sheet. Write clearly.

11. A 25-kg crate is pushed across a frictionless horizontal floor with a force of 20 N, directed 20° below the horizontal. The acceleration of the crate is:

A) 0.27 m/s²
B) 0.75 m/s²
C) 0.80 m/s²
D) 170 m/s²
E) 470 m/s²

12. A car is traveling at 15 m/s on a horizontal road. The brakes are applied and the car skids to a stop in 4.0 s. The coefficient of kinetic friction between the tires and road is:

A) 0.38
B) 0.69
C) 0.76
D) 0.92
E) 1.11

13. A horizontal force of 5.0 N pushes a 0.50-kg book against a vertical wall. The book is initially at rest. If $\mu^{static} = 0.6$ and $\mu^{kin} = 0.80$ are the coefficients of friction, the magnitude of the frictional force is:

A) 0
B) 4.9 N
C) 3.0 N
D) 5.0 N
E) 4.0 N

14. Block A, with a mass of 10 kg, rests on a 35° incline. The coefficient of static friction is 0.40. An attached string is parallel to the incline and passes over a massless, frictionless pulley at the top. The largest mass m_B of block B, attached to the dangling end, for which A begins to slide down the incline is:
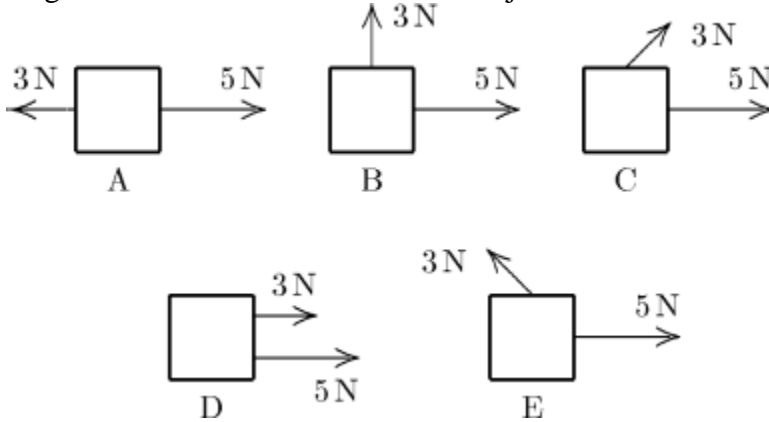

A) 2.5 kg
B) 3.5 kg
C) 5.9 kg
D) 9.0 kg
E) 10.5 kg

15. A heavy wooden block is dragged by a force $\vec{F}$ along a rough steel plate, as shown in the diagrams for two cases. The magnitude of the applied force $\vec{F}$ is the same for both cases. The normal force in (ii), as compared with the normal force in (i) is:

(i)   (ii)

A) the same
B) greater
C) less
D) less for some angles of the incline and greater for others
E) less or greater, depending on the magnitude of the applied force $\vec{F}$.

16. Two forces, one with a magnitude of 3 N and the other with a magnitude of 5 N, are applied to an object. For which orientations of the forces shown in the diagrams is the magnitude of the acceleration of the object the least?

A) A
B) B
C) C
D) D
E) E

17. A car rounds a 75-m radius curve at a constant speed of 18 m/s. A ball is suspended by a string from the ceiling the car and moves with the car. The angle between the string and the vertical is:

A) 0
B) 1.4°
C) 24°
D) 90°
E) cannot be found without knowing the mass of the ball

18. A brick slides on a horizontal surface. Which of the following will increase the frictional force on it?

A) Putting a second brick on top
B) Decreasing the surface area of contact
C) Increasing the surface area of contact
D) Decreasing the mass of the brick
E) None of the above

19. A crate is sliding down an incline that is 35° above the horizontal. If the coefficient of kinetic friction is 0.40, the acceleration of the crate is:

A) 0
B) 2.4 m/s^2
C) 5.8 m/s^2
D) 8.8 m/s^2
E) 10.3 m/s^2

20. A ball is thrown upward into the air with a speed that is greater than terminal speed. It lands at the place where it was thrown. During its flight the force of air resistance is the greatest:

A) just after it is thrown
B) halfway up
C) at the top of its trajectory
D) halfway down
E) just before it lands.

Write the letter for the correct answer on the answer sheet. Write clearly.

Answer Key

1. C
2. B
3. E
4. D
5. C
6. C
7. B
8. C
9. C
10. B
11. B
12. A
13. E
14. A
15. C
16. A
17. C
18. A
19. B
20. A