# Test 5: *Newton's Laws II*

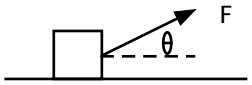
Equations and Constants:

$\bar{v} = \frac{\Delta x}{\Delta t}$ $v = \frac{dx}{dt}$ $\bar{a} = \frac{\Delta v}{\Delta t}$ $a = \frac{dv}{dt}$ $\bar{v} = \frac{1}{2}(v_i + v_f)$ $|g| = 10\ m/s^2$

$x = \frac{1}{2}at^2 + v_i t + x_i$ $v = at + v_i$ $v_f^2 = v_i^2 + 2a\Delta x$ $R = \frac{v^2 \sin 2\theta}{g}$ $a_c = \frac{v^2}{r}$

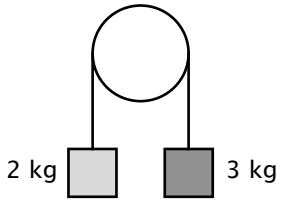
$\sum \vec{F} = m\vec{a}$ $w = mg$ $w_\perp = mg\cos\theta$ $w_\parallel = mg\sin\theta$ $f = \mu N$

**Multiple Choice:** *Choose the letter of the best answer. 3 points each.*




1. _____ A force with an increasing magnitude is pulling a box across the floor as shown in the diagram above. As the force F increases, what happens to the force of friction?
   a. It increases because the net force increases.
   b. It becomes less because the normal force decreases.
   c. It becomes less because the applied force is greater.
   d. It stays the same because the coefficient of friction stays the same.

2. _____ Two masses are connected with a string that is wrapped around a massless frictionless pulley, as shown in the diagram. About what is the tension (in N) in the string?
   a. $T < 10$. b. $10 < T < 20$ c. $20 < T < 30$.
   d. $30 < T < 50$. e. $T > 50$.




*Problems 3 and 4 refer to the following:*
A 10 kg box is on a horizontal table. The coefficient of frictions are $\mu_s = 0.7$ and $\mu_k = 0.5$.

3. _____ If the box were at rest, and a horizontal force of 55 N were applied to it, what would be the force of friction on the box?
   a. 0 N. b. 5 N. c. 15 N. d. 55 N. e. 70 N.

4. _____ What horizontally applied force would it take to keep the box moving at a constant speed?
   a. 0 N. b. 20 N. c. 50 N. d. 60 N. e. 70 N.

*Problems 5 to 7 refer to the following:*
A 1.5 kg rock is attached to a string and being spun in a vertical circle of radius 0.75 m with a constant speed.

5. _____ What would be the minimum speed needed so that the rock would just barely stay on the circle?
   a. 10.0 m/s. b. 7.50 m/s. c. 4.11 m/s. d. 2.74 m/s. e. None of those.

6. _____ Assuming the rock is going fast enough to make the circle, where would the rock be when the net force on the rock is the greatest?
   a. At its highest point. b. At its lowest point.
   c. When the string is horizontal. d. The net force is the same magnitude everywhere.

7. _____ Assuming the rock is going fast enough to make the circle, where would the rock be when the tension in the string is the least?
   a. At its highest point. b. At its lowest point.
   c. When the string is horizontal. d. The tension is the same everywhere.

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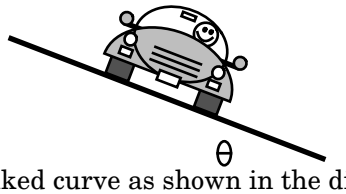
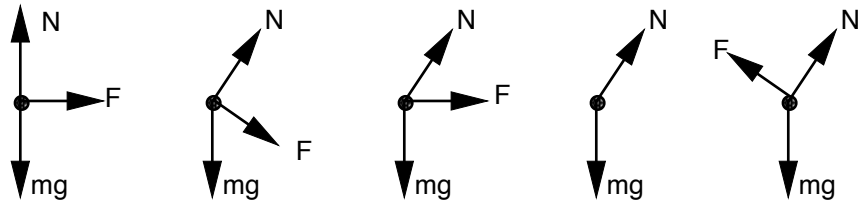
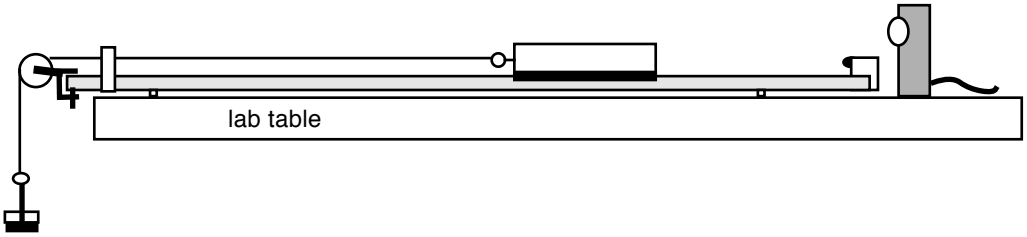
8. _____ Imagine you are at rest sitting in a chair and taking a physics test. What is the reaction to your weight?
   a. The chair holding you up.
   b. You pushing down on the chair.
   c. You pulling up on the earth.
   d. Friction between you and the chair.
   e. The force pulling you to the center of the earth.



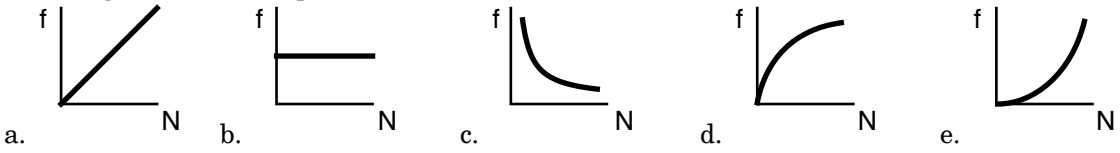

9. _____ A car is going around a banked curve as shown in the diagram above. If the curve is frictionless, what is the best free-body diagram that shows the forces acting on the car?




*Problems 10 to 12 refer to the following:*
Some students do a lab involving a wooden block being pulled across a horizontal track by a mass that is hanging from a string wrapped around a pulley, as shown in the diagram. They somehow figured out the force of friction acting on the block as they varied the normal force acting on the wooden block.




10. _____ They then graphed their results as the force of friction vs the normal force. Which of the following should best represent their results?




12. _____ If the coefficient of friction between the track and the block was 0.3 and the mass of the block was 0.5 kg, what would be the maximum mass of the hanger if the system were to remain at rest?
   a. 0.15 kg. b. 0.21 kg. c. 0.30 kg. d. 0.35 kg. e. 0.65 kg.

11. _____ If the mass of the hanger were 200 grams, the mass of the wooden block were 400 grams and the acceleration of the system was 1 $m/s^2$, what was the force of friction?
   a. 10 N. b. 2.6 N. c. 1.6 N. d. 1.4 N. e. 0.6 N.

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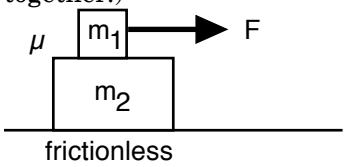
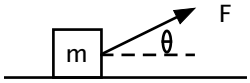
**Problem Solving:** Show all work, including a correct free-body diagram.

13. A box of mass $m_1$ is on top of a second box of mass $m_2$ which is on a frictionless table. The top box is being pulled with a horizontal force of 11 N. The contact force on the top box by the bottom box is $-9\mathbf{i} + 25\mathbf{j}$ N. What is the mass of the box on the bottom? (You can assume the masses stay together.)




14. A box of mass 30 kg is being pulled across the floor with a constant force of 250 N at an angle of 25° above the horizontal, as shown in the diagram. The coefficient of friction between the box and the floor is 0.4. If the box starts from rest, how fast is it going after being pulled 7 meters?

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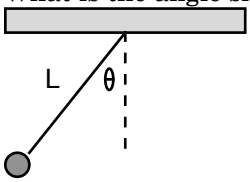
15. A conical pendulum of length L is spinning around in a circle such that its period of motion is T. What is the angle shown in the diagram?




16. A box of mass m is sliding down at constant speed on an inclined plane with base angle ø. There is a horizontal force F acting on the box. What is the coefficient of friction between the box and inclined plane?