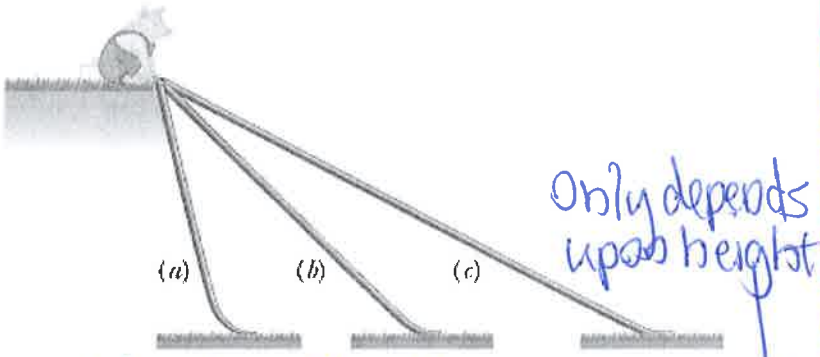
Name: Key

Chapter 7 Test 2015-2016

I. MULTIPLE CHOICE - Assume $g = 10\ m/s^2$ for the multiple choice questions.

1. A greased pig has a choice of three frictionless slides along which to slide to the ground. On which slide will the pig have the greatest velocity at the bottom.
   A. Slide A
   B. Slide B
   C. Slide C
   D. The pig's velocity will be the same at the bottom of all three slides.

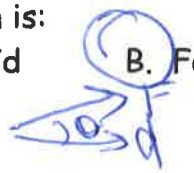


Only depends upon height

$K_i + U_i = K_f + U_f$

$0 + mgh = \frac{1}{2}mv^2 + 0 \Rightarrow v = \sqrt{2gh}$

2. A man pulls a sled along a rough horizontal surface by applying a constant force F at an angle θ above the horizontal. In pulling the sled a horizontal distance d, the work done by the man is:
   A. Fd B. Fd cos θ C. Fd sin θ D. Fd/cos θ E. Fd/sin θ



$W = \vec{F} \cdot \vec{d} = Fd\cos\theta$

3. Power is
   A. joules per second.
   B. work per unit of time.
   C. the rate at which work is done.
   D. all of the above.

$P = \frac{W}{t}$

4. The amount of work (done by an external force) required to stop a moving object is equal to the:
   A. velocity of the object.
   B. mass of the object times its acceleration.
   C. kinetic energy of the object.
   D. mass of the object times its velocity.
   E. square of the velocity of the object.

5. A woman lifts a barbell 2.0 m in 3.0 s. If she now lifts the same barbell the same distance in 6.0 s, the work done by her is:
   A. four times as great
   B. two times as great
   C. the same
   D. half as great
   E. one-fourth as great

$W = mgh$

6. A woman lifts a barbell 2.0 m in 3.0 s. If she now lifts the same barbell the same distance in 6.0 s, the power of this lift is:
   A. one-fourth as great
   B. half as great
   C. the same
   D. two times as great
   E. four times as great

$P = \frac{W}{t}$ $\quad t \uparrow 2x \Rightarrow P \downarrow 2x$

7. A 2.0 kg ball is raised to a height of 3.0 m above the ground and then released. (Assume that U = 0 at ground level.) After the ball hits the ground, bounces a few times and then comes to rest, which statement is true?
   A. U = 0 J, K = 0 J and Q = 0 J
   B. U = 60 J, K = 0 J and Q = 60 J
   C. U = 0, K = 0 and Q = 60 J
   D. U = 0 J, K = 60 J and Q = 0

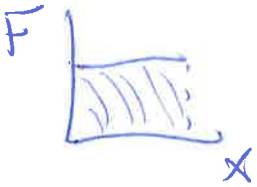
$U_i = mgh = (2.0\,kg)\left(10\,\frac{m}{s^2}\right)(3.0\,m) = 60\,J$

8. A simple pendulum with a string length of 0.60 m and a mass of 2.0 kg swings back and forth. At the lowest point in the swing,
   A. U is a maximum and K is a minimum.
   B. U is a minimum and K is a minimum.
   C. U is a maximum and K is a maximum.
   D. U is a minimum and K is a maximum.

9. The potential energy of a box on a shelf, relative to the floor, is a measure of
   A. the work done putting the box on the shelf from the floor.
   B. the weight of the box times the distance above the floor.
   C. the energy the box has because of its position above the floor.
   D. all of these.

10. What does the area under a force versus position (F vs. x) graph represent?

A. work
B. kinetic energy
C. power
D. potential energy



11. A truck weighs twice as much as a car, and is moving at twice the speed of the car. Which statement is true about the truck's kinetic energy compared to that of the car?

A. All that can be said is that the truck has more kinetic energy.
B. The truck has 8 times the kinetic energy of the car.
C. The truck has 4 times the kinetic energy of the car.
D. The truck has twice the kinetic energy of the car.

$K_{car} = \frac{1}{2}mv^2$

$K_{truck} = \frac{1}{2}(2m)(2v)^2 = 8K_{car}$

12. A body of mass 2.0 kg is launched upwards with a velocity 20 m/s. It momentarily comes to rest after attaining a height of 18 m. How much energy is lost due to air friction?

A. 20 J
B. 40 J
C. 60 J
D. 80 J

$K_i = \frac{1}{2}mv^2 = \frac{1}{2}(2.0kg)(20\frac{m}{s})^2 = 400J$

$U_f = mgh = (2.0kg)(10\frac{m}{s^2})(18m) = 360J$

$Q = 40J$

13. A planet of constant mass orbits the Sun in an elliptical orbit. What happens to the planet's kinetic energy?

A. It remains constant.
B. It increases continually.
C. It decreases continually.
D. It increases when the planet approaches the Sun, and decreases when it moves farther away.

14. An acorn falls from a tree. What can be said about the acorn's kinetic energy K and its potential energy U?

A. K increases and U decreases.
B. K decreases and U decreases.
C. K increases and U increases.
D. K decreases and U increases.

15. A 8000-N car is traveling at 10 m/s along a horizontal road when the brakes are applied. The car skids to a stop in 4.0 s. How much kinetic energy does the car lose in this time?

A. 5.0×10^3 J
B. 6.0×10^6 J
C. 4.0×10^4 J
D. 2.0×10^5 J
E. 8.0×10^5 J

$K = \frac{1}{2}mv^2 = \frac{1}{2}\left(\frac{8000\,N}{10\,\frac{m}{s^2}}\right)\left(10\,\frac{m}{s}\right)^2$

$= 4 \times 10^4\,J$

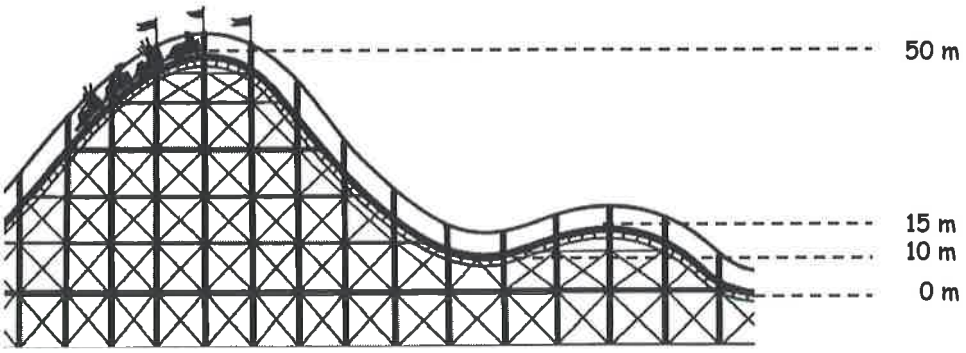
16. A 3-kg object is moving at 9 m/s. A 4-N force is applied in the direction of motion and then removed after the object has traveled an additional 5 m. The work done by this force is:

A. 20 J
B. 18 J
C. 15 J
D. 12 J
E. 27 J

$W = Fd = (4N)(5m) = 20J$

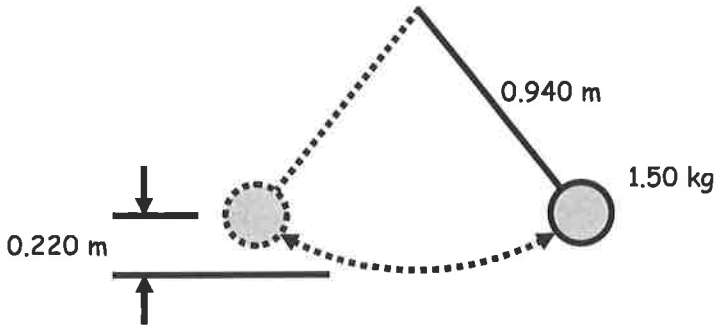
II. **PROBLEMS** - For full credit, your starting equation(s) must be clearly shown before substituting in numbers. Circle your answer and have the correct number of significant figures. Assume g = 9.80 m/s^2 for these problems. All work must be done on a separate sheet of paper.

1. Roller Coaster



At the top of the roller coaster (h = 50.0 m), v_i = 10.00 m/s. Find the velocity of the roller coaster when h = 15.0 m.

2. Find the velocity of a 1.50-kg the pendulum at its lowest point in the swing given a difference of 0.220 m between the highest point and the lowest point of the swing.



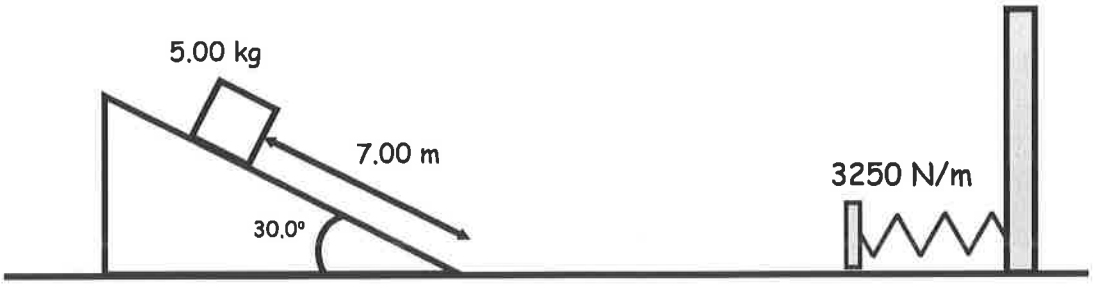
3. A 4.50×10^5-kg subway train is brought to a stop from a speed of 0.500 m/s in 0.660 m by a large spring bumper at the end of its track. What is the force constant k of the spring?

4. A large household air conditioner may consume 25.0 kW of power. What is the cost of operating this air conditioner 8.00 h per day for one month (30.0 days) if the cost of electricity is \$0.150 per kW·h?

5. An alkaline D-cell battery contains 20.8 watt-hours of energy. How high could this energy lift a 62.0 kg person above the ground?

6. A 7.00-kg block from a height of 3.00 m slides down a track starting from rest where the coefficient of friction between the block and the track is 0.280. The track is inclined at an angle of 55.0°. What is the speed of the block at the bottom of the track?

7. Starting at rest, a 5.00-kg block slides 7.00 m down a frictionless ramp. The ramp makes a 30.0° angle with the horizontal. The block then slides along a horizontal frictionless surface until it strikes a spring with a spring constant k = 3250 N/m attached to a rigid wall.



A. What is the speed of the block on the horizontal surface?

B. After the block strikes the spring, how far the spring is compressed from its equilibrium position at maximum compression?

Physics 200 Chapter 7
2015-2016

① Roller Coaster

$$K_i + U_i = K_f + U_f$$

$$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$$

$$v_f = \sqrt{v_i^2 + 2g(h_i - h_f)}$$

$$= \sqrt{\left(10.0\frac{m}{s}\right)^2 + 2\left(9.8\frac{m}{s^2}\right)(50.0m - 15.0m)}$$

$$= \boxed{28.0\frac{m}{s}}$$

② Pendulum

$$K_i + U_i = K_f + U_f$$

$$0 + mgh = \frac{1}{2}mv^2 + 0 \Rightarrow v = \sqrt{2gh}$$

$$v = \sqrt{2\left(9.8\frac{m}{s^2}\right)(0.220m)} = \boxed{2.08\frac{m}{s}}$$

③ Subway Train

$$K_i + U_i = K_f + U_f$$

$$\frac{1}{2}mv^2 + 0 = 0 + \frac{1}{2}kx^2 \Rightarrow k = \frac{mv^2}{x^2}$$

$$k = \frac{\left(4.50\times10^5 kg\right)\left(0.500\frac{m}{s}\right)^2}{(0.660m)^2} = \boxed{2.58\times10^5\frac{N}{m}}$$

(4) Air Conditioner

$$\text{Cost} = 25.0\,\text{kW}\left(\frac{8.00\,\text{h}}{\text{d}}\right)(30.0\,\text{d})\left(\frac{\$0.15}{\text{kWh}}\right) = \boxed{\$900.}$$

(5) D-Cell

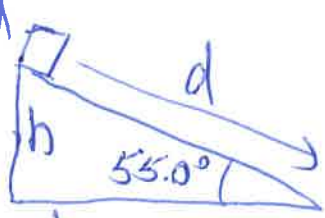
$$K_i + U_i = K_f + U_f$$

$$0 + U_{\text{Battery}} = 0 + mgh \Rightarrow h = \frac{U_{\text{battery}}}{mg}$$

$$h = \frac{20.8\,\text{W-h}\left(\frac{3600\,\text{s}}{\text{h}}\right)}{(62.0\,\text{kg})\left(9.80\,\frac{\text{m}}{\text{s}^2}\right)} = \boxed{123\,\text{m}}$$

(6) Ramp with Friction

$$K_i + U_i = K_f + U_f + Q \quad (Q = F_f d)$$



$$0 + mgh = \frac{1}{2}mv^2 + 0 + \mu mg\cos\theta d \qquad \sin\theta = \frac{h}{d}$$

$$v = \sqrt{2gh - 2\mu g\cos\theta d} = \sqrt{2gh - 2\mu g\cos\theta \frac{h}{\sin\theta}}$$

$$= \sqrt{2\left(9.80\,\frac{\text{m}}{\text{s}^2}\right)(3.00\,\text{m}) - 2(0.280)\left(9.80\,\frac{\text{m}}{\text{s}^2}\right)(\cos 55.0^\circ)\left(\frac{3.00\,\text{m}}{\sin 55.0^\circ}\right)}$$

$$= \boxed{6.88\,\frac{\text{m}}{\text{s}}}$$

3.66 m

(7) Ramp & Spring

A. $K_i + U_i = K_f + U_f$

$0 + mgh = \frac{1}{2}mv^2 + 0 \Rightarrow v = \sqrt{2gh}$

$v = \sqrt{2\left(9.80\frac{m}{s^2}\right)(7.00\,m \sin 30.0°)} = \boxed{8.28\frac{m}{s}}$

↳ 3.50 m

$8.283\frac{m}{s}$

B. $K_i + U_i = K_f + U_f$

$\frac{1}{2}mv^2 + 0 = 0 + \frac{1}{2}kx^2$

$x = \sqrt{\frac{m}{k}}v = \sqrt{\frac{5.00\,kg}{3250\frac{N}{m}}}\,8.283\frac{m}{s}$

$= \boxed{0.325\,m}$