Name & Number (if applicable): ______________________________

*1: _______/22 + ______ late*

*2: _______/17 + ______ late*

*3: _______/16 + ______ late*

*4: _______/7 + ______ late*

*Incorrect/incomplete: –______*

*Scaled score: ______/40*

# Unit 4 Learning Goals – Energy

## Goal Set 1:

**Students will be able to qualitatively and quantitatively analyze mechanical energy.**

| | |
|---|---|
| 4.0 | I can analyze complex scenarios and problems involving mechanical energy. |
| **3.0** | **I can qualitatively and quantitatively analyze mechanical energy.** |
| 2.0 | I can recognize, recall, and explain specific vocabulary and concepts including:<br>• Energy<br>• Mechanical energy, nonmechanical energy<br>• System<br>• Potential energy, gravitational potential energy, elastic potential energy<br>• Kinetic energy<br>I am able to…<br>• Distinguish between mechanical and nonmechanical energy by comparing and contrasting them.<br>• Distinguish between the different types of nonmechanical energy by comparing and contrasting them.<br>• Distinguish between the different types of mechanical energy by comparing and contrasting them.<br>• Distinguish objects from systems.<br>• Explain why objects can have kinetic energy but not potential energy. |
| 1.0 | With help, partial success at 2.0 content |

***Check yourself:***

## Level 2.0

1.) Define energy and state its SI units.

2.) Contrast mechanical energy from nonmechanical energy.

3.) Briefly describe the following types of nonmechanical energy.

a. Thermal

b. Nuclear

c. Chemical

d. Electromagnetic

4.) What is a system?

5.) What does it mean when we describe energy as being potential energy?

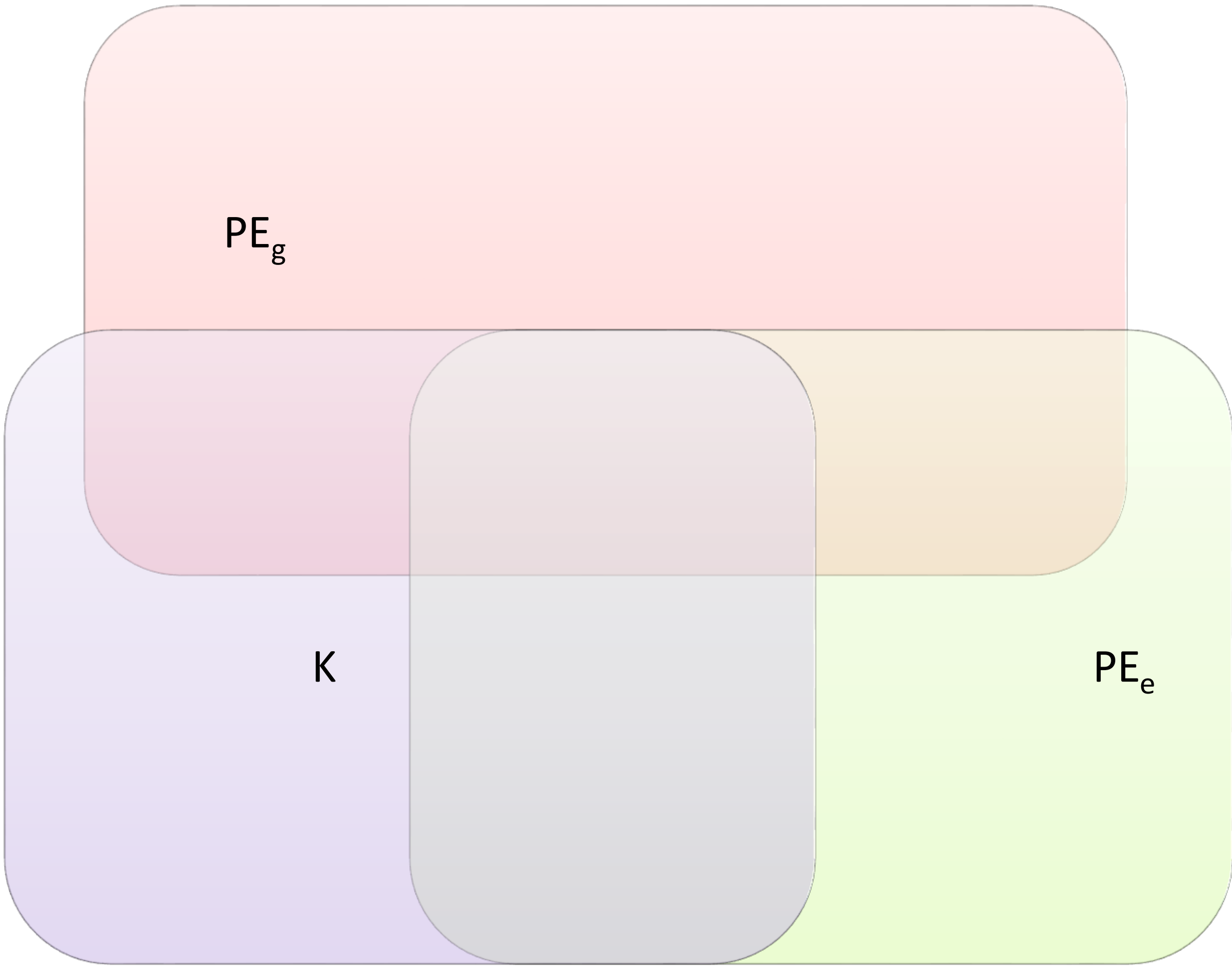
6.) Briefly describe the following types of mechanical energy

a. Gravitational potential energy

b. Elastic potential energy

c. Kinetic energy

7.) Complete this sweet Venn diagram.




8.) Why can a system have potential energy but an object cannot?

9.) While objects alone cannot have potential energy, they *can* have kinetic energy. Explain why.

## Level 3.0

1.) The Polar Express passes over a bridge. If the mass of the train is $5.03 \times 10^5$ kg, it is going 24.0 m/s, and the height of the bridge is 115m…

a. What is the train's kinetic energy?

b. What is the train-Earth system's gravitational potential energy?

c. What is the train-Earth system's elastic potential energy?

d. What is the train-Earth system's total mechanical energy?

2.) To catch a falling star ornament, a 25 kg elf jumps off of the top of a giant tree while attached to a bungee cord with a spring constant of 1200 N/m. As the elf falls, the cord stretches 8.2 m from its resting (unstretched) length. At this moment the elf stops falling and momentarily comes to a stop at a height of 3.4 m above the ground.

a. What is the elf's kinetic energy?

b. What is the elf-cord-Earth system's gravitational potential energy?

c. What is the elf-cord-Earth system's elastic potential energy?

d. What is the elf-cord-Earth system's total mechanical energy?

## Level 4.0

A 75.0 kg skier rides a 2830 m long lift to the top of a mountain. The lift makes an angle of $14.6^{o}$ with the horizontal. What is the change in the skier's gravitational potential energy?

# Goal Set 2:

### Students will be able to utilize the concept of work as well as the work-energy theorem to analyze energy transfer involving systems and objects.

| | |
|---|---|
| 4.0 | I can utilize the work-energy theorem to analyze complex situations. |
| **3.0** | **I can utilize the concept of work as well as the work-energy theorem to analyze energy transfer involving systems and objects.** |
| 2.0 | I can recognize, recall, and explain specific vocabulary and concepts including:<br>• Energy, mechanical energy, gravitational potential energy, elastic potential energy, kinetic energy, systems, force, velocity, displacement, work, work-energy theorem<br>I am able to…<br>• Distinguish systems from the objects that are inside or outside the system.<br>• Calculate gravitational potential energy, elastic potential energy, and kinetic energy.<br>• Calculate work given the applied force, the displacement, and the angle between the applied force and the displacement.<br>• Use the work energy theorem to calculate initial or final velocity of an object when work is done on the object. |
| 1.0 | With help, partial success at 2.0 content |

***Check yourself:***

## Level 2.0

1.) Define force.

2.) Define mechanical energy.

3.) Define work.

4.) In your own words state the work-energy theorem.

5.) In physics, what do we mean by the concept “system”?

6.) A forklift raises a 230 kg crate from the ground to a 3.5 m high shelf in a warehouse.

a. How much force did the forklift have to apply to raise the crate? (Assume the crate moved with a constant velocity.)

b. Calculate how much work the forklift did.

c. What was the change in gravitational potential energy in the system as the crate moved from the ground to the shelf?

7.) A pinball machine's launcher applies 18.0 N of force to a 0.080 kg pinball. The spring launch mechanism was originally compressed 0.035 m so that it applies the force to the pinball while moving 0.0350m. (In other words, the force is applied over 0.0350 m, after which the pinball has launched off of the spring launch mechanism.)

   a. How much work does the launching mechanism do on the pinball?

   b. Assume the table is horizontally level. How fast is the pinball moving as it leaves the launcher?

## **Level 3.0**

1.) Why can work change the gravitational potential energy of a system but not of an object?

2.) However, why *can* work change the kinetic energy of an object?

3.) Referring to level 2.0 question 6:

   a. What is in the system in this scenario?

   b. What is not in the system?

   c. Does the system gain or lose energy when the forklift does the work? Explain.

   d. Refer back to your answers to b & c in question 6. Explain why these answers are the same.

4.) Refer back to level 2.0 question 7. If the table were not horizontally level and were instead angled upward…
    a. Would all of the work done by the launcher transfer kinetic energy to the pinball?
       Yes        No
    b. Would the pinball be going as fast as it left the launcher?
       Yes        No
    c. Where else could the work done by the launcher transfer energy to?

## Level 4.0

Look back at level 2.0 question 7.

1.) How long was the launching mechanism in contact with the pinball?

2.) If the table were tilted at a $5^{o}$ angle…
    a. What would the gain in gravitational potential energy in the system be as the launcher acted on the pinball?
    b. Therefore what would the new value for the pinball's kinetic energy be?

c. Therefore how fast would the pinball be going when it left the launcher?

d. Level 5.0 (LOL!) Assume that the pinball could move in the machine in a straight line until it came to a natural stop at the top of its motion. How high vertically would it go?

## Goal Set 3:

### Students will be able to analyze the physical situations from the perspective of the law of conservation of mechanical energy.

| | |
|---|---|
| 4.0 | I can analyze complex problems involving the law of conservation of mechanical energy. |
| **3.0** | **I can analyze the physical situations from the perspective of the law of conservation of mechanical energy.** |
| 2.0 | I can recognize, recall, and explain specific vocabulary and concepts including:<br>• Systems, mechanical energy, gravitational potential energy, elastic potential energy, kinetic energy, velocity, law of conservation of mechanical energy.<br>I am able to…<br>• Distinguish systems from the objects that are inside or outside the system.<br>• Distinguish between the types of mechanical energy.<br>• Perform calculations involving gravitational potential energy, elastic potential energy, and kinetic energy. |
| 1.0 | With help, partial success at 2.0 content |

***Check yourself:***

## Level 2.0

1.) Explain how a system can gain or lose mechanical energy.

2.) Explain the conditions under which a system will conserve mechanical energy.

## Level 3.0

1.) A student writes, "The objects in a system can add energy to the system." Do you agree with this statement? Justify your answer.

2.) A ball falls.

   a. What is in the system?

   b. What types of mechanical energy are involved in the situation?

   c. What *external* force(s) from a source *outside* of the system could rob the system of mechanical energy? If that happened, what form would the transformed mechanical energy take?

3.) A spring-loaded launching mechanism launches a rubber chicken upward at an angle. The spring adds energy to the system by doing this.

   a. What is in the system?

   b. What types of mechanical energy are involved in the situation?

c. What *external* forces from a source *outside* of the system could rob the system of mechanical energy? If that happened, what form would the transformed mechanical energy take?

4.) A worker shoves a crate up a ramp so that the crate continues to move up the ramp after the worker finishes pushing it. Eventually the crate comes to a stop. If we *only* consider the system to contain the crate and Earth…

a. What roles does the worker play in the situation with regard to the mechanical energy in the system?

b. What role does the ramp play in the situation with regard to the mechanical energy in the system?

5.) LeBron launches a field goal. If a basketball's mass is 0.625 kg, the ball rises 2.21 m above his release point at the top of its arc, and at the top of the arc the ball has a velocity of 4.40 m/s…

a. How much work did he do to the ball-Earth system?

b. How fast was the ball going when it left his hands?

6.) A 590 N Olympic diver steps off of the 10.0 m diving platform. (Assume there is no upward jump.)

a. How fast is she going when she is halfway down the dive?

b. How fast is she going when she strikes the water?

c. How much work does the water need to do to stop her?

## Level 4.0

Refer back to level 3.0 question 6 AND to the first question from assignment 3. What do you notice about your answers to each set of problems? What do you notice about the weights of the divers? Show semi-quantitatively that any diver, regardless of mass, would be going the same velocity as our original diver went when she entered the water. (Of note, this is another proof that all things, regardless of mass, fall at the same rate.)

# Goal Set 4:

## Students will be able to analyze physical situations involving power.

| | |
|---|---|
| 4.0 | I can analyze complex scenarios involving power. |
| **3.0** | **I can analyze physical situations involving power.** |
| 2.0 | I can recognize, recall, and explain specific vocabulary including:<br>• Force, velocity, energy, work, power.<br>I am able to…<br>• Calculate work.<br>• Perform calculations involving power, work, energy, and time.<br>• Perform calculations involving power, force, and velocity. |
| 1.0 | With help, partial success at 2.0 content |

***Check yourself:***

## Level 2.0

1.) Define power qualitatively and semi-quantitatively.

2.) A crane lifts a 350 kg beam up 25 m.

a. How much work does it do?

b. If the crane can dissipate 1500 Watts of power, how long does it take the crane to lift the beam?

3.) A $2.0 \times 10^2$ Watt engine pushes a piston that launches a ball bearing with a force of 25 N. How fast does the ball bearing move at the end of the push?

## Level 3.0

1.) In the previous problem (level 2.0 question 3)…

a. How would the final velocity compare if the piston still applied 25 N of force but the engine were more powerful?

b. How would the time the piston was in contact with the ball compare if the piston still applied 25 N of force but the engine were more powerful?

2.) Refer back to level 2.0 question 2. If the crane were more powerful, how would the time it takes to lift the beam compare to your answer in question 2?

## Level 4.0

1.) Refer back to level 2.0 question 3.

a. Let's say that the piston moves 0.020 m (2.0 cm) while it's in contact with the ball. How long did it take the piston to push the ball? (In other words, how long was the piston in contact with the ball?)

b. What is the mass of the ball?

# Chart your Progress



Goal Set 3
Average Self-Assessment
4
3.5
3
2.5
2
1.5
1
0.5
0
Date


Goal Set 4
Average Self-Assessment
4
3.5
3
2.5
2
1.5
1
0.5
0
Date