Work-Energy Relationships

Read from **Lesson 2** of the **Work, Energy and Power** chapter at **The Physics Classroom:**

http://www.physicsclassroom.com/Class/energy/u5l2a.html

MOP Connection: Work and Energy: sublevel 5

Important Background: As an object moves, either its total mechanical energy is conserved or mechanical energy is transferred to non-mechanical forms (such as thermal energy, light energy, electrical energy, etc.). Whether there is an energy transfer or an energy conservation depends on whether or not external (a.k.a. non-conservative) forces are doing work. If external forces (or non-conservative forces) are doing work, then the total mechanical energy of the object is not conserved - energy is transferred between mechanical and non-mechanical forms. On the other hand, if external forces do not do work, the total mechanical energy of the object is conserved.

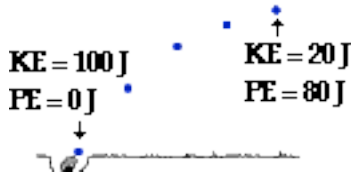
1. Categorize the following force types as being either internal or external forces: F_{grav}; F_{norm}; F_{frict}; F_{air}; F_{app}; F_{tens}; and F_{spring}.

Internal Forces	External Forces

2. Identify the following as being either always true (**AT**), never true (**NT**) or might be true (**MBT**).

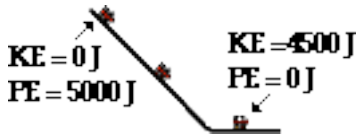
AT, NT, MBT?	Statement:
	a. If gravity does work upon an object, then its total mechanical energy (TME) is conserved.
	b. If gravity is the only force doing work upon an object, then its total mechanical energy (TME) is conserved.
	c. If a normal force acts upon an object, then its TME will change.
	d. If sliding friction does work upon an object, then its TME will decrease.
	e. If only external forces are doing work upon an object, then its TME will be conserved.
	f. If both internal and external forces are doing net work upon an object, then more information is needed to tell if its TME will be conserved.
	g. If a quantity such as the total mechanical energy is conserved, then that means that it does not change over the course of a motion.

3. Consider the three situations below. Identify whether or not the total mechanical energy (TME) is being conserved. Then indicate if external forces (non-conservative) are doing work.



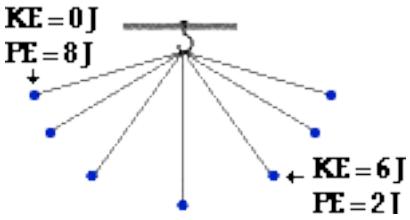
TME Conserved? _____

Ext. forces doing work? _____



TME Conserved? _____

Ext. forces doing work? _____



TME Conserved? _____

Ext. forces doing work? _____

4. For each statement, identify which forces (F_{grav}; F_{norm}; F_{frict}; F_{air}; F_{app}; F_{tens}; and F_{spring}) are doing work. Then state whether the total mechanical energy will be conserved.

a. A bungee jumper rapidly decelerates as he reaches the end of his spring-like bungee cord. Ignore the effect of air resistance.  Forces doing work? _____ TME Conserved? Yes No	b. A girl releases a softball from rest from a height of 2 meters above the ground; the ball free-falls to the ground.  Forces doing work? _____ TME Conserved? Yes No
c. A weightlifter briskly raises a 200-pound barbell above his head.  Forces doing work? _____ TME Conserved? Yes No	d. A swimmer pushes off the blocks to accelerate forward at the beginning of a race.  Forces doing work? _____ TME Conserved? Yes No

For questions #5-#13, a physical situation is described. For each situation determine whether the total mechanical energy (TME) of the object (in **bold-face text**) is conserved, increases, or decreases.

_____ 5. A force is applied to a **root beer mug** to accelerate it across a level countertop.
a. TME conserved b. TME increases c. TME decreases

_____ 6. A force is applied to a **cart** to raise it up an inclined plane at constant speed.
a. TME conserved b. TME increases c. TME decreases

_____ 7. A **marble** starts from rest and rolls down an inclined plane. Ignore friction.
a. TME conserved b. TME increases c. TME decreases

_____ 8. A **physics student** runs up a flight of stairs at constant speed.
a. TME conserved b. TME increases c. TME decreases

_____ 9. A **baseball** makes its flight through the air. (Neglect F_{air}.)
a. TME conserved b. TME increases c. TME decreases

_____ 10. A **coffee filter** is released from rest and falls with a terminal velocity.
a. TME conserved b. TME increases c. TME decreases

_____ 11. A **car** skids to a stop while traveling down a steep hill.
a. TME conserved b. TME increases c. TME decreases

_____ 12. A **pendulum bob** is tied to a string and swings back and forth. (Neglect F_{air}.)
a. TME conserved b. TME increases c. TME decreases

_____ 13. A **marble** hits a note card and slides to a stop.
a. TME conserved b. TME increases c. TME decreases

