**Conceptual Questions:**

***\*\*Please consider significant figures and if possible, draw visual graphics\*\****

* Two forces **F1**and **F2** are acting on the box showing in the drawing *(sorry, I don’t know how to draw the angle* $θ$ *between the 2 lines!)*, causing the box to move across the floor. The two force vectors are drawn to scale. Which force does more work? Justify your answer.

**F2**

**F1**

* A box is moved with a velocity (***v→***) by a force ***P→*** (parallel to the *v*) along a level horizontal floor. The normal force is **FN**, the kinetic frictional force is **fk**, and the weight of the box is ***mg***. Decide which forces do positive, zero, or negative work. Provide a reason for each answer.
* A sailboat is moving at a constant velocity. (a) Is work being done by net external force acting on the boat? (b) Recognizing the net propels the boat forward and the water resists the boat motion, what does your answer in part (a) imply about the work done by the wind’s force by the compared to the work done by the water’s resistive force?
* A ball has a speed of 15 m/s. Only one external force acts on the ball. After this force acts, the speed of the ball is 7 m/s. has the force done positive or negative work? Explain.
* A slow- moving car may have more work kinetic energy than a fast moving motorcycle. How is this possible?
* A shopping bag is hanging straight down from your hands as you walk across a horizontal floor at a constant velocity. (a) Does the force that your hand exerts on the bag‘s handle do any work? Explain. (b) Does this force do any work while you are riding up an escalator at a constant velocity? Give a reason for your answer.
* The S*teel Dragon* ***(roller coaster)*** starts with a speed of 3.0 m/s at the top of the drop and attains a speed of 42.9 m/s when it reaches the bottom. If the roller coaster were then to start up an identical hill, would it’s speed be 3.0 m/s at the top of the hill? Assume the friction is negligible. Explain your answer in terms of energy concepts?
* A person is riding on a Ferris wheel. When the wheel makes one complete turn, is the net work done by the gravitational force a positive, negative or zero? Justify your answer.
* The drawing below shows an empty fuel tank about to release by different jet planes. At this moment of release, each plane has the same speed and each tank is the same height above the ground. However, the directions of travel are different. In the absence of air resistance, do the tanks have different speeds when they hit the ground? If so, which tank has the largest speed and which has the smallest speed? Explain

 **(a) (b) (c)**

*\*\*Fuel tank:*

\*\*Jet:

**Problems**

***(Work Done a Constant Force)***

* The brakes of a truck cause it to slow down by applying a retarding force of 3.0 x 103 Newton (N) to the truck over a distance of 850 m. What is the work done by this on the truck? Is the work positive or negative? Why?
* A 75.0-kg man is riding an escalator in a shopping mall. The escalator moves the man at a constant velocity from the ground level to the floor above, a vertical height of 4.60 m. What is the work being done on the man by (a) the gravitational force and (b) the escalator?

***(The Work-Energy Theorem)***

* Two cars, A and B, are traveling at the same speed of 40.0 m/s each having started from the rest. Car A has a mass of 1.20 x 103 kg. Compared to the work required to bring car A up to speed, how much *additional* work is required to bring car B up to speed?
* A fighter jet is launched from an aircraft carrier with the aid of its own engines and a steam-powered catapult. The thrust of its engines is 2.3 x 105 N. In being launched from rest it moves through a distance of 87 m and has a kinetic energy of 4.5 x 107 J at lift-off. What is the work done on the jet by the catapult?
* The *hammer throw* is a track-and-field event in which a 7.3-kg ball (the “hammer”), starting from rest, is whirled around in a circle several times and released. It then moves upward in the familiar curving path of the projectile motion. In one throw, the hammer is given a speed of 29 m/s. For a comparison, a .22 caliber bullet has a mass of 2.6 gram and, starting from rest, exits the barrel of a gun with a speed of 410 m/s. determine the work done to launch the motion of the (a) hammer and the (b) bullet.

***(Gravitational Potential Energy and Conservative vs Nonconservsative Forces)***

* Relative to the ground, what is the gravitational potential energy of a 55.0-kg person who is at the top of the Sears tower, a height of 443 m above the ground?
* A shot-putter puts a shot (weight = 71.1 N) that leaves his hand at a distance of 1.52 m above the ground. (a) Find the work done by the gravitational force when the shot has risen to a height of 2.13 m above the ground. Include the correct sign for the work. (b) Determine the change (∆PE = PEf ─ PE0) in the gravitational potential energy of the shot.
* A bicyclist rides 5.0 km due east, while the resistive force from the air has a magnitude of 3.0 N and points due west. The rider then turns around and rides 5.0 km due west, back to her starting point. The resistive from the air on the return trip has a magnitude of 3.0 N and points due east. (a) Find the work done by the resistive force during the round trip. (b) Based on your answer to part (a), is the resistive force a conservative force? Explain.
* A 55.0-kg skateboarder starts out with a speed of 1.80 m/s. He does +80.0 J of work on himself by pushing with his feet against the ground. In addition, friction does **–** 265 J of work on him. In both cases, the forces doing the work are non-conservative. The final speed of the skateboarder is 6.00 m/s. (a) Calculate the change (∆PE = PEf ─ PE0) in the gravitational potential energy. (b) How much has the vertical height of the skater changed, and is the skater above or below the starting point?
* “Rocket man” has a propulsion unit strapped to his back. He starts from rest on the ground, fires the unit, and is propelled straight upward. At a height of 16 m, his speed is 5.0 m/s. His mass, including the propulsion unit, has approximately constant value of 136 kg. Find the work done by the force generated by the propulsion unit.

***(The Conservation of Mechanical Energy)***

* The skateboarder in the drawing starts down the left side of the ramp with an initial speed of 5.4 m/s. If non-conservative forces, such as kinetic friction and air resistance, are negligible, what would be the height *h* of the highest point reached by the skateboarder on the right side of the ramp.

\*\*Height:

*h*

***h***

*h*

***h***

* A 2.00-kg rock is released from rest at a height of 20.0 m. ignore the air resistance and determine the kinetic energy, gravitational potential energy, and the total mechanical energy at each of the following heights: 20.0, 10.0, and 0 m.
* A 47.0-g golf ball is driven from the tee with an initial speed of 52.0 m/s and rises to a height of 24.6 m. (a) Neglect air resistance and determines the kinetic energy of the ball at its highest point. (b) What is its speed when it is 8.0 m below its highest point?

***(Nonconservative Forces and the Work-Energy Theorem)***

* A 5.00 x 102-kg hot-air balloon takes off from the rest at the surface of the earth. The non-conservative wind and lift forces take the balloon up, doing +9.70 x 104 J of work on the balloon in the process. At what height above the surface of the earth does the balloon have a speed of 8.00 m/s?
* A roller coaster (375 kg) moves from *A* (5.00 m above the ground) to *B* (20.0 m above the ground). Two nonconservative forces are present: friction does -2.00 x 104 J of work on the car, and a chain mechanism does +3.00 x 104 J of work to help the car up a long climb. What is the change in the car’s kinetic energy, ∆KE = KEf ─ KE0, from *A* to *B*?
* One of the new events in the 2002 Winter Olympics was the sport of *skeleton* (please ***GOOGLE*** the image of the *skeleton* if you’re **not** familiar!)*.* Starting from the top of the steep, icy track, a rider jumps onto a sled (*skeleton*) and proceeds- belly down head first- to slide down the track. The track has fifteen turns and drops 104 m in elevation from top to bottom. (a) In the absence of nonconservative forces, such as friction and air resistance, what would be the speed of the rider at the bottom of the track? Assume that the speed of the rider at the beginning of the run is relatively small and can be ignored. (b) In reality, the best riders reach the bottom with a speed of 35.8 m/s (about 80 m/h). How much is done on an 86.0-kg rider and skeleton by nonconservative forces?
* The (nonconservative) force propelling a 1.50 x 103-kg car up a mountain road does 4.70 x 106 J of work on the car. The car starts from rest at sea level and has a speed of 27.0 m/s at an altitude of 2.00 x 102m above the sea level. Obtain the work done on the car by the combined forces of friction and air resistance, both of which are nonconservative forces.

***(Power)***

One kilowatt∙hour (KWh) is the amount of work or energy generated when one kilowatt of power is supplied for a time of one hour. A kilowatt∙hour is the unit of energy used by power companies when figuring your electrical bill. Determine the number of joules of energy in one kilowatt∙hour.