Energy Model Worksheet 4:

Energy Conservation & Transfer

1. A cart moving at 5 m/s collides with a spring. At that instant the cart is motionless, what is the largest amount that the spring could be compressed? Assume no friction.

 a. Define the system with the energy flow diagram, then complete the pie charts qualitatively.



 b. Quantitative Energy Conservation Equation:

 c. Determine the maximum compression of the spring.

2. A rock is shot straight up into the air with a slingshot that had been stretched 0.30 m. Assume no air resistance.

 a. Qualitatively complete the energy flow diagram and the pie charts.



 b. Quantitative Energy Conservation Equation:

 c. Determine the greatest height the rock could reach.

3. Determine final velocity of the rollercoaster, assuming a 10% loss to friction.



4. In the situation shown below, a spring with a constant of 500 N/m launches a 0.15 kg toy roller coaster cart from rest on a frictionless track into a 0.25 m high vertical loop.

A

B

1. Draw a set of pie charts for the energy in the system.
2. Energy conservation equation:

c. How much must the spring be compressed in order for the cart to have a speed of 1.85 m/s at the top of the loop?

5. In the situation shown below, a spring with a constant of 500 N/m launches a 0.15 kg toy roller coaster cart from rest on a track into a vertical loop. 20% of the carts energy is dissipated as a result of friction and as a result the car stops before making it all the way to point B.

A

B

1. Draw a set of pie charts for the energy in the system.
2. Energy conservation equation:

c. If the spring is compressed 4 cm, how high will the cart make it up the loop?

6. A 70 kg bungee jumper falls off the 40 m platform and reaches the limit of stretch of the cord when he is 8 m above the ground. Analyze this situation for a frictionless system that consists of the jumper, the earth, and the cord.

y

A

B

hA > 0

vA = 0

hB > 0

vB = 0

0

y

0

B

1. Draw a set of pie charts for the jumper.
2. Energy conservation equation:
3. If the spring constant of the bungee cord is 600 N/m, how far will the cord stretch from its rest position?
4. If the same jumper used a bungee cord with a constant of 400 N/m and it stretched 12 m, would he be able to safely make the jump? Explain.

7. The moon could be an ideal spaceport for exploring the solar system. A moon launching system could consist of a magnetic rail gun that shoots items into moon orbit. How much energy would be needed from the rail gun to get a 10,000 kg capsule into an orbit 100 km above the moon surface? The moon’s gravitational field strength is 1.6 N/kg and the orbital velocity for this altitude is 1700 m/s. Hint: Put the rail gun outside of the system.

8. A student eats a tasty school lunch containing 700 Calories. (One food Calorie = 4186 Joules.) Due to basal metabolism, the student radiates about 100 Joules per second into the environment.

a. How long would the student have to sit on a couch to radiate away all of the energy from lunch?

b. If all of the energy from the student’s lunch did something useful, like lifting pianos weighing 5000 N to the top of a 10 meter tall apartment building, how many pianos could be lifted with the energy from lunch? (Ignore the energy radiated by the student.) Complete pie charts below to aid your solution.

Energy Conservation Equation:

9. Jill pulls on a rope to lift a 12 kg pail out of a well, while the clumsy Jack watches. For a 10 meter segment of the lift, she lifts the bucket straight up at constant speed. How much power is required to complete this task in 5 seconds? Complete pie charts as part of your solution.

Energy Conservation Equation:

10. Hulky and Bulky are two workers being considered for a job at the UPS loading dock. Hulky boasts that he can lift a 100 kg box 2.0 meters vertically, in 3.0 seconds. Bulky counters with his claim of lifting a 200 kg box 5.0 meters vertically, in 20 seconds. Which worker is more powerful?

11. The trains on the Boss are raised from 10 m above ground at the loading platform to a height of 60 m at the top of the first hill in 45 s. Assume that the train (including passengers) has a mass of 2500 kg. Ignoring frictional losses, how powerful should the motor be to accomplish this task? Complete pie charts.

Energy Conservation Equation: