Law of Conservation of Energy Solutions

1. A student lifts his 2.0 kg pet rock 2.8 m straight up. He then lets it drop to the ground. Use the Law of Conservation of Energy to calculate how fast the rock will be moving (a) half way down and (b) just before it hits the ground. **Use $\Delta E_p = \Delta E_k$ a) 5.2 m/s b) 7.4 m/s**

2. A 65 kg girl is running with a speed of 2.5 m/s. How much kinetic energy does she have? She grabs on to a rope that is hanging from the ceiling, and swings from the end of the rope. How high off the ground will she swing? **Use $\Delta E_p = \Delta E_k$ E_k = 203 J, E_p = 203 J therefore h = 0.32 m**

3. How much kinetic energy will an 80.0 kg skier sliding down a frictionless slope (vertical height = 60.0 m) have when he 2/3 of the way down?
Use $\Delta E_p = \Delta E_k$ ΔE_p = 31 360 J, therefore E_k = 31 360 J and velocity is 28 m/s

4. A golfer wishes to hit his drives further by increasing the kinetic energy of the golf club when it strikes the ball. Which would have the greater effect on the energy transferred to the ball by the driver --- doubling the mass of the club head or doubling the speed of the club head? Explain.
Doubling the mass only doubles the kinetic energy while doubling the velocity quadruples the kinetic energy.

5. How much work must be done to increase the speed of a 12 kg bicycle ridden by a 68 kg rider from 8.2 m/s to 12.7 m/s?
Total mass is 80.0 kg. Use W = ΔE_k then ΔE_k = 3760 J and hence work equals 3760 J

6. A truck moving with a speed of 90 km/h **25 m/s** loses it brakes but sees a "runaway" hill near the highway. If the driver steers his vehicle into the runaway hill, how far up the hill (vertically) will the vehicle travel before it comes to a stop? (Ignore friction.) If friction is taken into account, will the vertical distance the vehicle moves be less or greater than the 'ideal' distance you just solved for, neglecting friction? Explain.
Use $\Delta E_p = \Delta E_k$ which means $mgh = 0.5mv^2$. Note that the masses cancel out with $gh = 0.5v^2$!! Therefore $h = (0.5v^2)/g$ = 31.9 m. If friction were to be taken into account, we would expect that the height would be less since some energy would be lost (probably as heat or sound).

7. A rubber ball falls from a height of 2.0 m, bounces off the floor and goes back up to a height of 1.6 m. What percentage of its initial gravitational potential energy has been lost? **20%** Where does this energy go? **Lost as heat or sound** Has the Law of Conservation of Energy been 'violated'? **Absolutely not.**

Work/Energy Review Notes

$W = Fd$	• Used where the magnitude of the force and displacement are considered • The F and d must be parallel to each other for any work to be done. • If F and d are in the same direction, the work is positive; if F and d are in opposite directions, the work is negative... BUT this doesn't refer to direction... WORK is a scalar or non-vector quantity (no direction). • The unit for work is a **Joule**, $J = N{\cdot}m = kg{\cdot}m^2/s^2$.
$W_{NET} = W_1 + W_2 + ...$	• If more than one force is doing work on an object, the total or net work is the sum of the work done by all forces.
$W_{NET} = F_{NET}d$	• An alternative way to find the total or net work is to find the net force first!
$P = W/t$	• Power is the rate at which work is done. It describes how much work a machine can do in one second. • The unit for power is a **Watt**, W = J/s.
$W = \Delta E$	• The Work-Energy Principle: work done on an object will result in a change in energy of that object. • The unit for energy is J, too. • Conversely, energy is the ability to do work.
$W_{grav} = \Delta E_P$	• Work *against* gravity results in gain in gravitational E_P. • Work *done by* gravity results in a loss in gravitational E_P.
$E_P = mgh$	• E_P depends only on 1) the mass of an object, and 2) its vertical height. • The higher the object, the more potential to fall • The amount of E_P an object has in not physically important, the ΔE_P is! • Since E_P depends on height, a point where $E_P = 0$ must be chosen. It should be chosen where the forces on the object are zero.
$W_{NET} = \Delta E_K$	• The net work done an object will change in its kinetic energy.
$E_K = {}^1/_2 mv^2$	• A change in E_K means a change in velocity.
The Law of	• The total mechanical energy of an object will always be constant

Conservation of Energy	• $E_K + E_P$ = constant value... in other words, the total energy E_{TOT} of an object is always the same. • The total change in the mechanical energy of an object will always be zero... $\Delta E_K + \Delta E_P = 0$... in other words, if you lose E_P, you gain the same amount of E_K, and vice versa.