Study Guide Unit 6 Work and Energy

BE ABLE TO SOLVE THE FOLLOWING TYPES OF PROBLEMS:

1. A 20 kg rock is at the edge of a 40 m high cliff.

   a. What is its potential energy?

   PE_g

   $PE_g = m \cdot g \cdot h$
   $= (20\,kg)(9.8\,m/s^2)(40\,m) = \boxed{7840\,J}$

   b. How fast is it going half way down?

   $PE_g + KE$

   $PE_{g1} = PE_{g2} + KE$
   $m \cdot g \cdot h_1 = m \cdot g \cdot h_2 + \frac{1}{2} m v^2$ → $(9.8\,m/s^2)(40\,m) = (9.8\,m/s^2)(20\,m) + \frac{1}{2} v^2$
   $196 = \frac{1}{2} v^2$ → $v = \sqrt{2(196)} = \boxed{19.8\,m/s}$

   c. How fast is it going the instant before it hits the ground?

   KE (only!)

   $PE_g = KE$
   $PE_g = \frac{1}{2} m v^2$ → $7840\,J = \frac{1}{2}(20\,kg) v^2$
   $v^2 = 784\,m^2/s^2$ → $v = \sqrt{784} = \boxed{28\,m/s}$

2. What is the kinetic energy of a 25 kg gazelle running at 15 m/s?

   $KE = \frac{1}{2} m v^2$
   $= \frac{1}{2}(25\,kg)(15\,m/s)^2 = \boxed{2812.5\,J}$

3. A 25 kg girl on a bicycle exerts a force of 1000 N for a distance of 2 meters.

   a. How much work did she do?

   $W = F \cdot d$
   $= (1000\,N)(2\,m) = \boxed{2000\,J}$

   b. How much kinetic energy does she have after the work is done?

   $W = \Delta KE$ (@ start, $KE = 0$)
   $\therefore KE = \boxed{2000\,J}$

4. A person who weighs 750 N falls from a 10 m **high** diving board into a pool below. When she is 2 meters above the surface of the pool find:

   a. her gravitational potential energy

   PE_g

   $PE_{g2} = m \cdot g \cdot h = (750\,N)(2\,m) = \boxed{1500\,J}$

   a. her kinetic energy

   $PE_g + KE$

   $PE_{g1} = PE_{g2} + KE$
   $KE = PE_{g1} - PE_{g2}$ → $KE = m \cdot g \cdot h_1 - PE_{g2}$
   $KE = (750\,N)(10\,m) - 1500\,J = \boxed{6000\,J}$

   b. her total mechanical energy

   total mech energy $= 1500\,J + 6000\,J = \boxed{7500\,J}$

   c. her speed

   $KE = \frac{1}{2} m v^2$ → $6000\,J = \frac{1}{2}\left(\frac{750\,N}{9.8\,m/s^2}\right) v^2$
   $F_g = m \cdot g$ → $m = \frac{F_g}{g}$
   $6000 = 38.27 v^2$ → $\sqrt{v^2} = \sqrt{\frac{6000}{38.27}}$
   $v = \boxed{12.52\,m/s}$

5. A gazelle is launched from a cannon off a cliff with an initial velocity of 200 m/s at a 30 degree angle to the horizontal. If the cliff is 30 m high, how fast is the gazelle traveling when he hits the ground?

   

   $PE_g + KE_1 = KE_2$
   $m \cdot g \cdot h + \frac{1}{2} m v_1^2 = \frac{1}{2} m v_2^2$
   $2\left[(9.8)(30) + \frac{1}{2}(200)^2\right] = \left[\frac{1}{2} v^2\right] 2$
   $2(9.8)(30) + 200^2 = v^2$
   $v = \sqrt{40588} = \boxed{201.46\,m/s}$

6. Wile E. Coyote zooms horizontally off a 20 m high cliff while traveling at a speed of 15 m/s. Assuming that his rocket skates then run out of fuel, how fast will he be moving when he strikes the ground?

$KE_1 + PE_g = KE_2$

$\frac{1}{2}mv_1^2 + m \cdot g \cdot h = \frac{1}{2}mv_2^2 \rightarrow \frac{1}{2}(15)^2 + (9.8)(20) = \frac{1}{2}v^2$

$\sqrt{617} = \sqrt{v^2}$ $v = \boxed{24.84\ m/s}$

7. You move a 25 kg box 3 meters by applying a continuous horizontal force of 235 N. How much work have you done on the box?

$W = F \cdot d$

$= (235)(3)$

$= \boxed{705\ J}$

8. A 15 kg crate of gazelle toys sits at the top of an 8 meter long incline with an angle of 32 degrees to the horizontal.

a. What is the gravitational potential energy of the crate?

$h = (8)(\sin 32°) = 4.24\ m$

$PE_g = m \cdot g \cdot h = (15)(9.8)(4.24) = \boxed{623.19\ J}$

b. The coefficient of friction between the crate and the incline is 0.25. How fast is the crate going at the bottom of the incline?

$PE_g = Q_i + KE$

$m \cdot g \cdot h = m \cdot g \cdot \mu \cos\theta \cdot d + \frac{1}{2}mv^2 \rightarrow (9.8)(4.24) = (9.8)(0.25)(\cos 32)(8) + \frac{1}{2}v^2$

$\frac{1}{2}v^2 = 41.55 - 16.62 = 24.93$

$\sqrt{v^2} = \sqrt{2(24.93)}$ $v = \boxed{7.06\ m/s}$

9. How much **force** would be required to compress a 4000 N/m spring by 3.5 m?

$F = -KX$

$F = -(4000\ N/m)(3.5\ m) = \boxed{-14000\ N}$

10. A block of mass 0.55 kg is placed against a horizontal spring of constant k = 7500 N/m and is pushed until the spring is compressed by 0.25 m. The coefficient of friction is 0.3. If the spring is then released,

a. how fast is the block moving after it has traveled 1 m from the compressed spring? (d = 1, not 1.25)

$PE_s = Q_L + KE$

$\frac{1}{2}kx^2 = m \cdot g \cdot \mu \cdot d + \frac{1}{2}mv^2$ (mult. both sides by 2...)

$(7500)(0.25) = 2(0.55)(9.8)(0.3)(1) + (0.55)v^2$

$v = \sqrt{\frac{1875 - 3.234}{0.55}}$ $v = \boxed{58.34\ m/s}$

b. how far will the block travel before coming to a rest? (no KE @ end)

$PE_s = Q_L$

$\frac{1}{2}kx^2 = m \cdot g \cdot \mu \cdot d \rightarrow \frac{1}{2}(7500)(0.25)^2 = (0.55)(9.8)(0.3)(d)$

$d = \frac{234.375}{1.617} = \boxed{144.94\ m}$

Review your notes and the online notes. Make sure you understand the concepts related to work, energy, and conservation of energy. The test will be multiple choice. Some questions will be conceptual and some will involve problem solving.

The following list is meant to help focus your studies from your **NOTES.**

Work	Energy	Mechanical Energy	Potential Energy
Energy of Position		Gravitational Potential Energy	
Elastic Potential Energy		Spring Potential Energy	
Kinetic Energy		Energy of Motion	Conservation of Energy
Hooke's Law		Spring Constant	Solving COE Problems

Some formulas you MAY want to review:

$W = Fd = mad = E = Q$ $ME = KE + \Sigma PE$ $PE_G = mgh$ $KE = \frac{1}{2}mv^2$

$\Sigma W = \Delta KE$ $W_F = F_F d = F_N \mu d$ $Q_{level} = mg\mu d$ $Q_{incline} = mg\cos\theta\mu$

$PE_S = \frac{1}{2}KX^2$ $F = KX$