Name Answer Key Date ________

Unit 5 Review: Work, Energy & Power Academic Physics

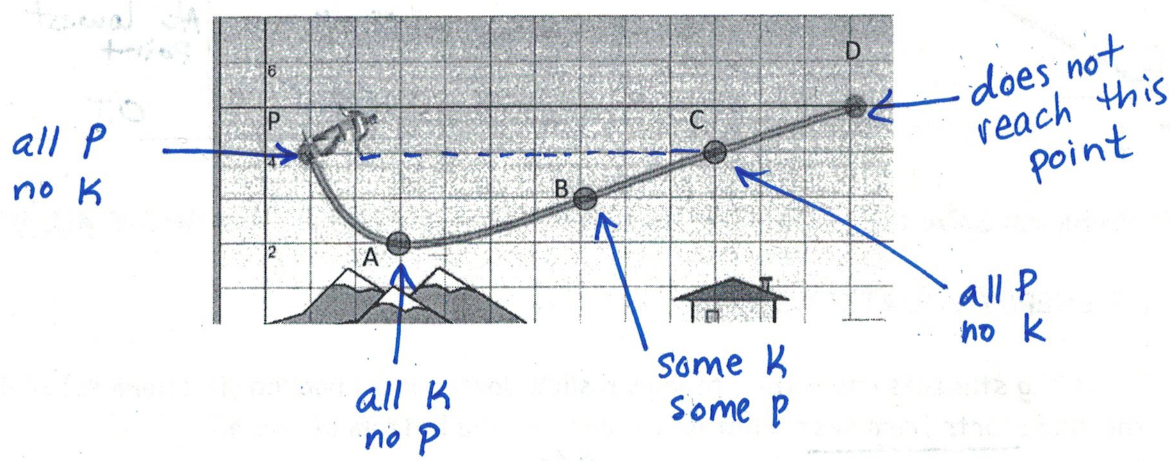
Part I: Conceptual

1. Define:
   a. Work: The product of a force applied over a distance
   b. Total (Mechanical) Energy: The sum of kinetic plus potential energy
   c. Kinetic Energy: Energy of motion
   d. Gravitational Potential Energy: Energy of position (height)
   e. Power: Rate at which energy is transferred/work is done

2. Circle all of the following situations where the specified force work on the specified object.

   I. A student lifting a **backpack** with an upward **applied force.**
   II. The upward **normal force** on a **hockey puck** as it slides across the ice.
   III. The **tension force** acting on a **pendulum** as it swings back and forth
   IV. A student exerts an **applied force** to slide a **cart** across the floor.

3. A skateboarder starts at rest at point P. Describe the energy and motion of the skateboarder below at each point marked. Disregard the effects of friction.

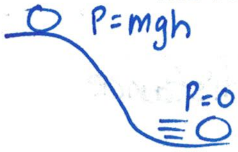


4. What (in terms of energy conservation) would cause the skateboarder in the example above to slow down?

The skateboarder slows down when the potential energy increases (this occurs when he is going uphill). The total Energy remains constant, so an increase in P causes a decrease in K, and therefore a decrease in V.

m   P (top)

5. A 20kg child starts from rest at the top of a slide with a potential energy of 500J. What will be the velocity of the child at the bottom of the slide which is at ground level?



	K	+	P	=	E
Top:	0J	+	500J	=	500J
Bottom:	500J	+	0J	=	500J

K = 500J on the ground.

$K = \frac{1}{2}mv^2$

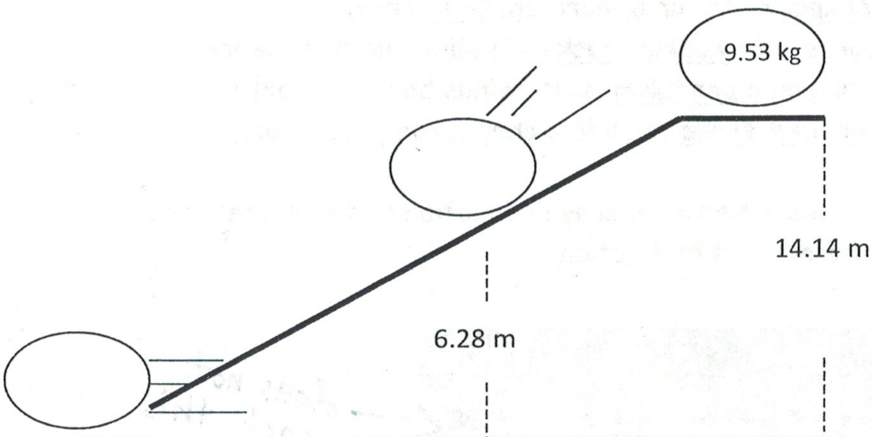
$500J = \frac{1}{2}(20kg)v^2 \Rightarrow$ **$v = 7.07 \frac{m}{s}$**

6. In terms of energy, what would make choosing a small hybrid car over a large SUV a good choice?

Small hybrid, because it would require less work to change the kinetic energy. (thus accelerating the car)

$W = K_f - K_i \Rightarrow W = (\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2)$ ← depends on mass

7. Complete the table for the three different heights as the ball goes down the ramp. V_0 = 0m/s



K $\frac{1}{2}mv^2$	P mgh	E K+P
At rest 0J	(9.53)(9.8)(14.14) = 1321 J	K + P = 1321J
E - K = 734J	(9.53)(9.8)(6.28) = 587J	1321J
E - K = 1321J	At lowest Point 0J	1321J

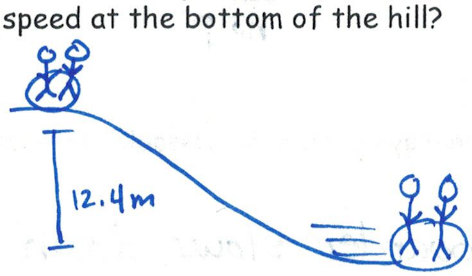
Part II Problems: Solve the following using methods demonstrated in class. **SHOW ALL WORK**.

USE THE ENERGY EQUATIONS

8. Two 65kg students and a 12kg toboggan slide down a snow packed (frictionless) 12.4m high hill. If the sled starts from rest, what is its speed at the bottom of the hill?

m = 65kg + 65kg + 12kg = 142kg

h = 12.4m



	K	+ P	= E
TOP	0J	mgh = 17,256 J	17,256J
BOTTOM	17,256J	0	17,256J

$K = \frac{1}{2}mv^2$

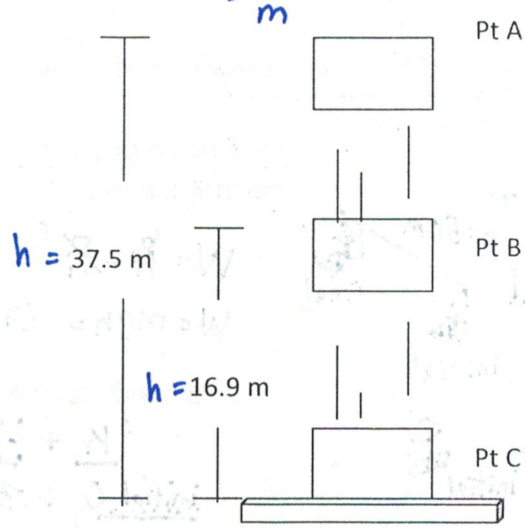
$17,256 J = \frac{1}{2}(142kg)v^2$

$V = 15.6 \frac{m}{s}$

9. Determine the Potential Energy, Kinetic Energy **and velocity** at each point for a 1000 kg block that is released from rest. Be sure to show all work!

m

	K	+ P	= E
A	0 J	367,500 J	367,500 J
B	201,880 J	165,620 J	367,500 J
C	367,500 J	0 J	367,500 J

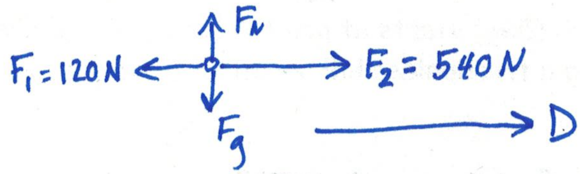


$P = mgh \quad P_A = (1000\,kg)(9.8\,\frac{m}{s^2})(37.5\,m)$

$= 367,500\,J$

$P_B = (1000\,kg)(9.8\,\frac{m}{s^2})(16.9\,m) = 165,620\,J$

10. A 750 kg motorcycle accelerates from rest to 14m/s under the actions of two forces. One is the forward force of 540 N provided by the traction between the wheels and the road. The other is a 120 N resistive force due to various frictional forces.
   a. How far does the motor cycle travel?
   b. How long does it take for the motorcycle to reach this speed (hint: this requires equations from previous units)?



a) $W = K_f - K_i$

$-F_1 D + F_2 D = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$-(120N)D + (540N)D = \frac{1}{2}(750kg)(14\frac{m}{s})^2 - \frac{1}{2}(750kg)(0\frac{m}{s})^2$

$(420N)D = 73,500J$ b) last page

$D = 175\,m$

11. Lightly and Flighty, two petite athletes, decide to race each other up the 5.5m high bleachers. Lightly, whose mass is 50 kg, makes the climb in 4.25 seconds; while Flighty, 65 kg, took 3.5 seconds to make the climb.

   a. Calculate the work done to raise each athlete to top of the bleachers.

$W = P_f - P_i$ Flighty: $W = (65kg)(9.8\frac{m}{s^2})(5.5m) = 3503J$

$W = mgh - 0$ Lightly: $W = (50kg)(9.8\frac{m}{s^2})(5.5m) = 2695J$

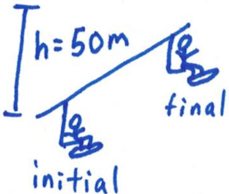
   b. Calculate the power of each.

$P = \frac{W}{\Delta t}$ Flighty: $P = \frac{3503J}{4.25s} = 1001W$

Lightly: $P = \frac{2695J}{3.5s} = 770W$

12. A 72kg snowboarder rides a ski lift up a 50m high hill. She hops out and stands at the top of the hill.

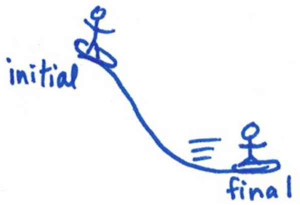
a. How much gravitational potential energy does the snowboarder possess? Follow up: How much work was done by the lift to raise her to the top of the hill?



$W = P_f - P_i^{\,0}$

$W = mgh = (72\,kg)(9.8\,\frac{m}{s^2})(50\,m) = 35{,}280\,J$

b. How fast will she be going at the bottom of the hill?



	K	+ P	= E
initial	0 J	35,280 J	35,280 J
final	35280 J	0 J	35280 J

final Kinetic Energy, K = 35280

$K = \frac{1}{2}mv^2$

$35{,}280\,J = \frac{1}{2}(72\,kg)v^2$

$v = 31.3\,\frac{m}{s}$

c. If she snowboards down the hill in 95 seconds, how much power is exerted by gravity?

$W_g = -(P_f - P_i) = -(0 - 35{,}280\,J) = 35{,}280\,J$

$P = \frac{W_g}{\Delta t} = \frac{35280\,J}{95\,s} = 371\,W$

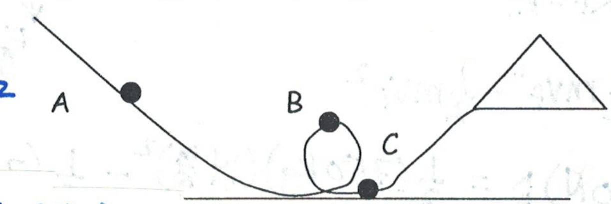
13. A ball (50g) starts at point A (35cm above the reference point) with a velocity of 5m/s and slides along a frictionless hill, eventually coming to a stop. Ignore friction. (Picture not drawn to scale)

Pt A:

$K = \frac{1}{2}mv^2 = \frac{1}{2}(0.050\,kg)(5\,\frac{m}{s})^2$

$K = 0.625\,J$

$P = mgh = (0.050\,kg)(9.8\,\frac{m}{s^2})(0.35\,m) = 0.1715\,J$



a. Find the total mechanical energy of the system.

0.7965 J

	K	+ P	= E
A	0.625 J	0.1715 J	0.7965 J
B	0.7132	0.0833 J	0.7965 J
C	0.7965 J	0 J	0.7965 J

b. Find the velocity at point B (h= 17cm).

Pt B: $P = mgh = (0.050\,kg)(9.8\,\frac{m}{s^2})(0.17\,m)$

$P = 0.0833\,J$

c. Find the velocity at point C (h = 0)

Pt C: $K = \frac{1}{2}mv^2$

$0.7965\,J = \frac{1}{2}(0.050\,kg)v^2 \Rightarrow v = 5.6\,\frac{m}{s}$

d. Find the maximum height the ball will go.

Ball reaches max height when K=0 and P=E. mgh=E

$(0.050\,kg)(9.8\,\frac{m}{s^2})(h) = 0.7965\,J$

$h = 1.63\,m$

b) $V_i = 0\,\frac{m}{s}$

$V_f = 14\,\frac{m}{s}$

$a =$

$\Delta X = 175\,m$

$\Delta t = ?$

$$\Delta x = \left(\frac{V_i + V_f}{2}\right)\Delta t$$

$$175\,m = \left(\frac{0\,\frac{m}{s} + 14\,\frac{m}{s}}{2}\right)\Delta t$$

$$\frac{175\,m}{7\,\frac{m}{s}} = \boxed{\Delta t = 25\,s}$$