Work and Energy

WORKSHEET #1

Name: ______________________

1. How much work is done on a 55 N package you carry horizontally for a distance of 12 m?

$W = F \cdot d \cdot \cos\theta = 55\text{ N} \cdot 12\text{ m} \cdot \cos(90°) = \boxed{0.00\text{ J}}$

2. How much work is done on a 625 N rock that you lift 0.85 m?

$W = F \cdot d \cdot \cos\theta = 625\text{ N} \cdot 0.85\text{ m} \cdot \cos(0°) = 531.25\text{ J} = \boxed{530\text{ J}}$

3. You apply a 225 N force to a heavy crate with a rope that makes a 27.0° angle with the horizontal, if you pull the crate a distance of 3.50 m, how much work was done?

$W = F \cdot d \cdot \cos\theta = 225\text{ N} \cdot 3.50\text{ m} \cdot \cos(27.0°) = 701.6676378\text{ J} = \boxed{702\text{ J}}$

4. You pull a 55.5 kg wooden box with a rope that makes a 28.0° angle with the horizontal at a constant speed. The coefficient of kinetic friction between the box and the deck is 0.330. You pull the crate a distance of 2.25 m. How much work was done?

$F_{fric} = F_{pull} \cdot \cos(28.0°)$ {forces in the x-direction}

$F_N + F_{pull} \cdot \sin(28.0°) = w$ {forces in the y-direction}

$F_{fric} = w / (1/\mu + \tan(28.0°))$ combining above 2 equations

$W = F_{fric} \cdot d$

$W = d \cdot mg / (1/\mu + \tan(28.0°))$

$W = 2.25\text{ m} \cdot 55.5\text{kg} \cdot 9.8\text{ m/s}^2 / (1/0.330 + \tan(28.0°)) = 152.6945809\text{ J} = \boxed{153\text{ J}}$

5. A bear with a mass of 218 kg runs up a hill. At the top of the hill, she has gained 23.5 kJ of potential energy. How high was the hill?

$PE = mgh$

$h = PE/mg = 23.5\ kJ/(218\ kg \cdot 9.8\ m/s^2) = 10.99981277\ m = \boxed{11.0\ m}$

6. A 1.25 kg rock is thrown with a velocity of 12.5 m/s at an angle of 43.0° to the horizontal. (a) How much kinetic energy does it have when it is initially released? (b) What is its kinetic energy at the highest point in its trajectory? (c) How far does it travel in the horizontal direction?

a. $KE = \frac{1}{2} mv^2 = 0.5 \cdot 1.25\ kg \cdot (12.5\ m/s)^2 = 97.65625\ J = \boxed{97.7\ J}$

b. $v_{horiz} = v\cos(43.0°) = 12.5\ m/s \cdot \cos(43.0°) = 9.14192127\ m/s$

$KE = \frac{1}{2} mv^2 = 0.5 \cdot 1.25\ kg \cdot (9.14192127\ m/s)^2 = 52.23420282\ J = \boxed{52.2\ J}$

c. $v_{vert} = v\sin(43.0°) = 12.5\ m/s \cdot \sin(43.0°) = 8.5249795\ m/s$

$v = v_i + at$

$t = (v-v_i)/a = (8.5249795\ m/s - (-8.5249795)\ m/s)/9.8\ m/s^2 = 1.7397917\ s$

$d_{horiz} = 9.14192127\ m/s \cdot 1.7397917\ s = 15.905039\ m = \boxed{15.9\ m}$

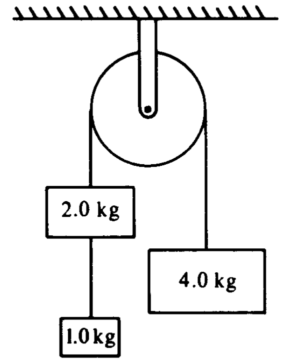
7. A 15.0 kg bullet leaves the barrel of a gun at a speed of 240.0 m/s. (a) Find the bullet's kinetic energy, (b) find the average force exerted on the bullet by the expanding gases as the bullet moves through the length of the 50.0 cm barrel.

a. $KE = \frac{1}{2} mv^2 = 0.5 \cdot 15.0\ kg \cdot (240.0\ m/s)^2 = 432\ 000\ J = \boxed{432\ kJ}$

b. $W = \Delta KE = F \cdot d$

$F = \Delta KE/d = 432\ kJ\ /\ 0.5\ m = \boxed{864\ kN}$

8. Three blocks of masses 1.0, 2.0, and 4.0 kilograms are connected by massless strings, one of which passes over a frictionless pulley of negligible mass, as shown below. Calculate each of the following: (a) The acceleration of the 4.0 kilogram block. (b) The tension in the string supporting the 4.0 kilogram block. (c) The tension in the string connected to the 1.0 kilogram block.



a. $a = F_{net\ sys} / m_{sys} = 9.8\ N / 7.0\ kg = \boxed{1.4\ m/s^2}$

b. $F_{net} = ma = 4.0\ kg \cdot 1.4\ m/s^2 = 5.6\ N$

$F_{net} = w - T$

$T = w - F_{net} = 39.2\ N - 5.6\ N = 33.6\ N = \boxed{34\ N}$

c. $F_{net} = ma = 1.0\ kg \cdot 1.4\ m/s^2 = 1.4\ N$

$F_{net} = T - w$

$T = F_{net} + w = 1.4\ N + 9.8\ N = 11.2\ N = \boxed{11\ N}$