Sample Problem Set II Answers

Work and Energy

Additional Practice A

Givens	*Solutions*
1. $d = 3.00 \times 10^2$ m $W = 2.13 \times 10^6$ J $\theta = 0°$	$F = \frac{W}{d(\cos\theta)} = \frac{2.13 \times 10^6 \text{ J}}{(3.00 \times 10^2 \text{ m})(\cos 0°)} = \boxed{7.10 \times^3 \text{ N}}$
2. $d = 76.2$ m $W_{net} = 1.31 \times 10^3$ J $\theta = 0°$	$F_{net} = \frac{W_{net}}{d(\cos\theta)} = \frac{1.31 \times 10^3 \text{ J}}{(76.2 \text{ m})(\cos 0°)} = \boxed{17.2 \text{ N}}$
3. $W = 1800$ J $d_1 = 1.5$ m $d_2 = 5.0$ m $\theta = 0°$	$W = F_1\, d_1 = (\cos\theta) = F_2\, d_2\,(\cos\theta)$ $F_1 = \frac{W}{d_1(\cos\theta)} = \frac{1800 \text{ J}}{(1.5 \text{ m})(\cos 0°)} = \boxed{1.2 \times 10^3 \text{ N}}$ $F_2 = \frac{W}{d_2(\cos\theta)} = \frac{1800 \text{ J}}{(5.0 \text{ m})(\cos 0°)} = \boxed{3.6 \times 10^2 \text{ N}}$
4. $W_{net} = 4.27 \times 10^3$ J $d = 17$ m $\theta = 0°$	$F_{net} = \frac{W_{net}}{d(\cos\theta)} = \frac{4.27 \times 10^3 \text{ J}}{(17 \text{ m})(\cos 0°)} = \boxed{2.5 \times 10^2 \text{ N}}$
5. $F = 1.6$ N $d = 1.2$ m $\theta = 180°$	$W = Fd(\cos\theta) = (1.6 \text{ N})(1.2 \text{ m})(\cos 180°) = \boxed{-1.9 \text{ J}}$
6. $d = 15.0$ m $F_{applied} = 35.0$ N $\theta_1 = 20.0°$ $F_k = 24.0$ N $\theta_2 = 180°$	$W_{net} = F_{applied}\, d\,(\cos\theta_1) + F_k\, d\,(\cos\theta_2)$ $W_{net} = (35.0 \text{ N})(15.0 \text{ m})(\cos 20.0°) + (24.0 \text{ N})(15.0 \text{ m})(\cos 180°)$ $W_{net} = 493 \text{ J} + (-3.60 \times 10^2 \text{ J})$ $W_{net} = \boxed{133\text{J}}$ Alternatively, $W_{net} = F_{net}\, d\,(\cos\theta')$ $\theta' = 0°$ $F_{net} = F_{applied}(\cos\theta_1) - F_k$ $W_{net} = [F_{applied}(\cos\theta_1) - F_k]\, d\,(\cos\theta')$ $W_{net} = [(35.0 \text{ N})(\cos 20.0°) - 24.0 \text{ N}](15.0 \text{ m})(\cos 0°)$ $W_{net} = (32.9 \text{ N} - 24.0 \text{ N})(15.0 \text{ m}) = (8.9 \text{ N})(15.0 \text{ m}) = \boxed{130 \text{ J}}$

Givens	*Solutions*
7. $v_I = 88.9$ m/s $v_f = 0$ m/s $\Delta t = 0.181$ s $d = 8.05$ m $m = 70.0$ kg $\theta = 180°$	$W = Fd(\cos\theta)$ $F = ma$ $a = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{\Delta t}$ $W = \frac{m(v_f - v_i)}{\Delta t} d(\cos\theta) = \frac{(70.0\text{ kg})(0\text{ m/s} - 88.9\text{ m/s})}{(0.181\text{ s})}(8.05\text{ m})(\cos 180°)$ $W = \frac{(70.0\text{ kg})(88.9\text{ m/s})(8.05\text{ m})}{(0.181\text{ s})}$ $W = \boxed{2.77 \times 10^5\text{ J}}$
8. $F = 715$ N $W = 2.72 \times 10^4$ J $\theta = 0°$	$d = \frac{W}{F(\cos\theta)} = \frac{2.72 \times 10^4\text{ J}}{(715\text{ N})(\cos 0°)} = \boxed{38.0\text{ m}}$
9. $F_{net} = 7.25 \times 10^{-2}$ N $W_{net} = 4.35 \times 10^{-2}$ J $\theta = 0°$	$d = \frac{W_{net}}{F_{net}(\cos\theta)} = \frac{4.35 \times 10^{-2}\text{ J}}{(7.25 \times 10^{-2}\text{ N})(\cos 0°)} = \boxed{0.600\text{ m}}$
10. $W = 6210$ J $F = 2590$ N $\theta = 0°$	$d = \frac{W}{F(\cos\theta)} = \frac{6210\text{ J}}{(2590\text{ N})(\cos 0°)} = \boxed{2.398\text{ m}}$

Name:______________________________Class:__________________ Date: _________________

Work and Energy

Problem A

WORK PROBLEM

A girl playing tug-of-war with her dog pulls the dog a distance of 8.0 m by exerting a force at an angle of 18° with the horizontal. If the amount of work the girl does in pulling the dog is 190 J, what is the magnitude of the force?

SOLUTION

Given: $W = 190$ J

$d = 8.0$ m

$\theta = 18°$

Unknown: $F = ?$

Use the equation for work done by a constant force, and rearrange it to solve for *F*.

$$W = Fd(\cos\theta)$$

$$F = \frac{W}{d(\cos\theta)} = \frac{190\ \text{J}}{(8.0\ \text{m})(\cos 18°)}$$

$$F = \boxed{25\ \text{N}}$$

ADDITIONAL PRACTICE

1. A roller coaster must do work raising its cars to the highest point on the ride. From there, the cars coast at varying speed until they return to the starting point. Suppose a loaded roller coaster car must be pulled 3.00×10^2 m from the ride's starting point to the top of the first rise. If 2.13×10^6 J of work must be done on the car during this stage of the ride, how large is the force exerted on the car by the raising mechanism?
2. A building under construction requires building materials to be raised to the upper floors by cranes or elevators. An amount of cement is lifted 76.2 m by a crane, which exerts a force on the cement that is slightly larger than the weight of the cement. If the network done on the cement is 1.31×10^3 J, what is the magnitude of the net force exerted on the cement?
3. Two workers load identical refrigerators into identical trucks by different methods. One worker has the refrigerator lifted upward onto the back of the truck, which is 1.5 m above the ground. The other worker uses a ramp to slide the refrigerator onto the back of the truck. The ramp is 5.0 m long, and raises the refrigerator 1.5 m above the ground. The amount of work done by both workers is the same: 1800 J. What are the magnitudes of the forces each worker must exert to load the refrigerators?

4. A sunken treasure has a mass of 2140 kg, most of which is due to silver and gold coins. In order to make it easier to raise the treasure, a diver descends 17 m to where the treasure is located and attaches balloon-like bladders to each corner of the treasure chest. The diver then inflates these bladders, so they provide buoyancy to the chest. The chest is still too heavy to float upward, but its weight has been largely counteracted by the inflated bladders, so that now it can be easily lifted by 4.27×10^3 J of work. What is the magnitude of the net force that is exerted on the treasure in order to raise it to the water's surface?
5. A wrench slides off a tilted shelf, although if a force of 1.6 N is applied opposite the wrench's motion the wrench will slide down the shelf with a constant velocity. If the shelf is 1.2 m long, what is the work done by the applied force on the wrench?
6. A girl pulls a wagon along a level path for a distance of 15.0 m. The handle of the wagon makes an angle of 20.0° with the horizontal, and the girl exerts a force of 35.0 N on the handle. Friction provides a force of 24.0 N. Find the network that is done on the wagon.
7. In 1947, a deceleration sled was built to test the effects of extreme forces on humans and equipment. In this sled, a test pilot undergoes a sudden negative acceleration of about 50.0 times free-fall acceleration (g). In 0.181 s, through a distance of 8.05 m, the pilot's speed decreases from 88.9 m/s to 0 m/s. If the pilot's mass is 70.0 kg, how much work is done against the pilot's body during the deceleration?
8. A car has run out of gas. Fortunately, there is a gas station nearby. You must exert a force of 715 N on the car in order to move it. By the time you reach the station, you have done 2.72×10^4 J of work. How far have you pushed the car?
9. A catcher picks up a baseball from the ground. If the net upward force on the ball is 7.25×10^{-2} N and the network done lifting the ball is 4.35×10^{-2} J, how far is the ball lifted?
10. At the 1996 Summer Olympics in Atlanta, Georgia, a mass of 260 kg was lifted for the first time ever in a clean-and-jerk lift. The lift, performed by Russian weightlifter Andrei Chemerkin, earned him the unofficial title as "the world's strongest man." If Chemerkin did 6210 J of work in exerting a force of 2590 N, how high did he lift the mass?