Chapter 7: WORK, ENERGY, AND ENERGY solutions to homework set.. (odd numbered problems 1-15)

1. How much work does a supermarket checkout..

Solution $W = Fd\cos\theta = (5.00\,\text{N})\,(0.600\,\text{m})\cos 0° = \underline{3.00\,\text{J}}$

$$W = 3.00\,\text{J} \times \frac{1\,\text{kcal}}{4186\,\text{J}} = \underline{7.17 \times 10^{-4}\ \text{kcal}}$$

3 ***(a) Calculate the work done on a 1500-kg elevator car..***

Solution

(a)
$$W_c = Fd\cos\theta = (mg + F_f) \times d$$
$$= \left[(1500\,\text{kg})(9.80\,\text{m/s}^2) + 100\,\text{N}\right] \times 40.0\,\text{m} = \underline{5.92 \times 10^5\ \text{J}}$$

(b) $W_g = -mgh = (1500\ \text{kg})\,(-9.80\ \text{m/s}^2)\,(40.0\ \text{m}) = \underline{-5.88 \times 10^5\ \text{J}}$

(c) The net force is zero, since the elevator moves at a constant speed. Therefore, the total work done is $0\,\text{J}$.

5 ***Calculate the work done by an 85.0-kg man..***

Solution
$$W = Fd = (mg\sin\theta + 500\,\text{N}) \times d$$
$$= \left[(85.0\,\text{kg})\,(9.80\,\text{m/s}^2)\,(\sin 20°) + 500\,\text{N}\right] \times 4.00\,\text{m} = \underline{3.14 \times 10^3\ \text{J}}$$

7 ***A shopper pushes a grocery cart 20.0 m at constant..***

Solution

(a) $W_f = Fd\cos\theta = 35.0\,\text{N} \times 20.0\,\text{m} \times \cos 180° = \underline{-700\,\text{J}}$

(b) $W_g = Fd\cos\theta = 35.0\ \text{N} \times 20.0\ \text{m} \times \cos 90° = \underline{0\ \text{J}}$

(c) net $W = W_s + W_f = 0$, or $W_s = \underline{700\ \text{J}}$

(d) $W_s = Fd\cos\theta$ where $\theta = 25°$, so that:

$$F = \frac{W_s}{d\cos\theta} = \frac{700\,\text{J}}{20.0\,\text{m} \times \cos 25°} = 38.62\,\text{N} = \underline{38.6\,\text{N}}$$

(e) net $W = W_f + W_s = -700\ \text{J} + 700\ \text{J} = \underline{0\ \text{J}}$

9 ***Compare the kinetic energy of a 20,000-kg truck..***

Solution

$$27500\text{ km/h}\times\frac{1000\text{ m}}{1\text{ km}}\times\frac{1\text{ h}}{3600\text{ s}}=7.638\times10^{3}\text{ m/s}$$

$$110\text{ km/h}\times\frac{1000\text{ m}}{1\text{ km}}\times\frac{1\text{ h}}{3600\text{ s}}=30.56\text{ m/s}$$

$$\text{KE}_{\text{tr}}=\frac{1}{2}mv^2=0.5\,(20{,}000\text{ kg})\,(30.56\text{ m/s})^2=9.336\times10^{6}\text{ J}=\underline{9.34\times10^{6}\text{ J}}$$

$$\text{KE}_{\text{as}}=\frac{1}{2}mv^2=0.5\,(80.0\text{ kg})\,(7.638\times10^{3}\text{ m/s})^2=2.334\times10^{9}\text{ J}=\underline{2.33\times10^{9}\text{ J}}$$

$$\frac{\text{KE}_{\text{tr}}}{\text{KE}_{\text{as}}}=\frac{9.34\times10^{6}\text{ J}}{2.33\times10^{9}\text{ J}}=\underline{\frac{1}{250}}$$

11 ***Confirm the value given for the kinetic energy of an aircraft..***

Solution

$$90{,}000\text{ metric ton}\times\frac{2240\text{ lb}}{1\text{ metric ton}}\times\frac{0.4539\text{ kg}}{1\text{ lb}}=9.1506\times10^{7}\text{ kg};$$

$$30\text{ knot}\times\frac{1.1516\text{ mi/h}}{1\text{ knot}}\times\frac{1609\text{ m}}{1\text{ mi}}\times\frac{1\text{ h}}{3600\text{ s}}=15.44\text{ m/s}$$

$$\text{KE}=\frac{1}{2}mv^2=0.5\,(9.1506\times10^{7}\text{ kg})\,(15.44\text{ m/s})^2=1.091\times10^{10}\text{ J}=\underline{1.1\times10^{10}\text{ J}}$$

(to two significant figures)

13 ***A car's bumper is designed to withstand a 4.0-km/h (1.12-m/s) collision..***

Solution

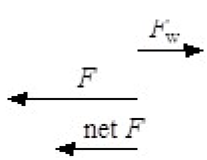
Using the work energy theorem, $\text{net }W=\frac{1}{2}mv^2-\frac{1}{2}mv_0^{\,2}=Fd\cos\theta$,

$$F=\frac{mv^2-mv_0^{\,2}}{2d\cos\theta}=\frac{(900\text{ kg})\,(0\text{ m/s})^2-(900\text{ kg})\,(1.12\text{ m/s})^2}{2\,(0.200\text{ m})\cos0^\circ}=\underline{-2.8\times10^{3}\text{ N}}$$

The force is negative because the car is decelerating.

15 ***Using energy considerations, calculate the average..***

Solution



$$\text{net }F\times d=\frac{1}{2}mv^2-\frac{1}{2}mv_0^{\,2}=\frac{1}{2}m\,(v^2-v_0^{\,2})$$

$$\text{net }F=\frac{m}{2d}(v^2-v_0^{\,2})=\frac{60.0\text{ kg}}{2\times25.0\text{ m}}\left[(8.00\text{ m/s})^2-(2.00\text{ m/s})^2\right]=72.0\text{ N}$$

$$\text{net }F=F-F_{\text{W}}\Rightarrow F=\text{net }F+F_{\text{W}}=72.0\text{ N}+30.0\text{ N}=\underline{102\text{ N}}$$