PHYSICS-2

Elementary Physics of Energy

Homework 2 Solutions

A few more problems on Chapter 1 material:

1. Convert lbs to kg:

$$25\ lbs \times \frac{1\ kg}{2.205\ lbs} = 11.34\ kg$$

The force required to pick it up is:

$$F = ma = 11.34\ kg \times 9.8\ m/s^2 = 111\ N$$

To find the work done against gravity to carry the suitcase up 2 flights of stairs, first convert feet to meters,

$$20\ ft \times \frac{1\ m}{3.28\ ft} = 6.1\ m$$

Then,

$$W = F \times \mathrm{L} = 111\ N \times 6.1\ m = 677\ J$$

Calculate the power and convert to horsepower:

$$Power = Energy/Time = \frac{677\ J}{2.5\ min} \times \frac{1\ min}{60\ sec} = 4.51\ W$$

$$4.51\ W \times \frac{1\ HP}{746\ W} = 6.05 \times 10^{-3}\ HP$$

2. Say PG&E charges \$0.1188 per kWh, then 40 kWh costs \$4.75.
If the cost of gas is \$1.09 per Therm, then

$$40\ kWh \times \frac{1\ Therm}{29.3\ kWh} = 1.37\ Therms$$

which only costs \$1.49. In reality, gas dryers use about 0.21 Therms and 0.22 kWh for each load, but they're still the better deal.

3. On the moon, this person would weigh 130 $lbs \times 0.17 = 22.1\ lbs$. On Earth, their mass in kg is given by

$$130\ lbs \times \frac{1\ kg}{2.205\ lbs} = 58.9\ kg$$

.
Mass does not change with the strength of gravity, so on the moon they are also 58.9 kg. Note that the conversion factor 1 kg = 2.205 lbs is only true on Earth.

4. This problem uses the formula:

$$energy\ added = specific\ heat \times mass \times \Delta\mathrm{T}.$$

The specific heat of water is

$$\frac{4.184\ J}{gram \cdot {}^\circ\mathrm{C}} = \frac{1\ calorie}{gram \cdot {}^\circ\mathrm{C}}$$

Solve the above equation for the mass, i.e.

$$mass = \frac{energy\ added}{specific\ heat \times \Delta\mathrm{T}} = \frac{2 \times 10^6\ calories}{\frac{1\ calorie}{gram \cdot {}^\circ\mathrm{C}} \times 35\,{}^\circ\mathrm{C}} = 5.7 \times 10^4\ grams = 57\ kg$$

Questions from Chapter 2 on page 59 of Ristinen and Kraushaar:

1. Its probably largely a question of infrastructure at this point. Gas stations for distributing liquid fuel are widely available, while stations that provide compressed natural gas are not. As new sources of fuel are utilized, new means of distribution will develop.

3. Most of the oil underground is not in large liquid pools, but is trapped in layers of rock and sand. Oil is a viscous liquid that does not flow easily through small pores, or through regions of varying pore size. Injection of steam or carbon dioxide could help reduce viscosity and allow greater flow under added external pressure. Another problem is the high surface tension, which causes beading and can lock the oil into rock pores. Detergents and polymers can be used to reduce surface tension and extract the oil from the rock. Section 2.4.

5. Table 2.9 estimates that 113×10^9 bbl of oil remain worldwide, so the amount per person on Earth is:

$$\frac{1146 \times 10^9}{6.78 \times 10^9} = 169\ bbl/person$$

In the United States, the proved reserves (Table 2.2) divided by the U.S. population gives:

$$\frac{29.4 \times 10^9}{307 \times 10^6} = 95.8\ bbl/person$$

6. Oil shale, or marlstone, is rock that contains a waxy hydrocarbon substance called kerogen. When the shale is heated, the kerogen vaporizes. It can then be condensed and refined to produce useful fuels.

Multiple Choice Questions from Chapter 2:

1. g. From the time the jar was $\frac{1}{8}$ full, it would have to undergo three doublings to become full. Each doubling takes one minute, so the time in question was three minutes before noon, or 11:57 a.m.

5. a. From page 36, Q_∞ for oil is around 324 billion barrels.

7. c. 3 gallons of water per gallon of oil produced (page 56).

8. d. Tar sands contain oil in bitumen (page 57).