Multiple Choice

Chapter 1

7. $3000 \frac{Cal}{day} = \left(3000 \frac{Cal}{day}\right)\left(10^3 \frac{cal}{Cal}\right)\left(4.184 \frac{J}{cal}\right)\left(\frac{1 \text{ day}}{24 \text{ hours}}\right)\left(\frac{1 \text{ hour}}{3600 s}\right) \simeq 145.28 W \Rightarrow$ **b)**

8. **d)**

9. From page 17, $\frac{\text{Fossil Fuel}}{\text{Total}} = \frac{84.34 \text{ QBtu}}{98.16 \text{ QBtu}} \approx 85.92\% \Rightarrow$ **c)**

11. $1 \text{ lb} = \frac{1}{2.2} \text{ kg} \Rightarrow E = mc^2 = \left(\frac{1}{2.2} \text{kg}\right)\left(299792458 \text{ m/s}\right)^2 \approx 4.1 \times 10^{16} J \Rightarrow$ **b)**

14. a. E b. P c. P d. N e. N f. P g. P h. E i. E j. N

Chapter 2

2. Again, from page 17 Coal Consumption = 22.71 QBtu; Natural Gas = 22.51 QBtu; Petroleum = 39.07 QBtu $\Rightarrow$ **a)**

4. Once more, from page 17, $\Rightarrow$ **b)**

Questions and Problems

Chapter 1

8. $80 W = \left(80 \frac{J}{s}\right)\left(\frac{1}{4.184} \frac{cal}{J}\right) \simeq 19.1 \frac{cal}{s} \Rightarrow$ Energy expended = (Power)(time) = $\left(19.1 \frac{cal}{s}\right)(5 \text{ minutes})\left(60 \frac{s}{min}\right) = 5700 \text{ cal}$

Note these are not food calories (or Calories)!
In Calories, the energy expended is ~5.7 Cal

10. Intensity = $\frac{\text{Power}}{\text{Area}} = 1000 \frac{W}{m^2}$; 90% is absorbed.

Absorbed intensity = $(0.9)\left(1000 \frac{W}{m^2}\right) = \left(900 \frac{J}{s m^2}\right)\left(\frac{1}{1055} \frac{Btu}{J}\right)\left(3600 \frac{s}{h}\right) \approx 3070 \frac{Btu}{h \cdot m^2}$

11. Power = 1400 W; 100% efficient. How long does it take to heat 40 gallons of water by 50°F?

$1 \text{ Btu} = (1 \text{ lb } H_2O)(1°F)$ $\rho_{H_2O} \approx 8.3 \text{ lbs/gal} \Rightarrow E = (40 \text{ gal})(8.3 \text{ lbs/gal})(50°F) = 16600 \text{ Btu}$

$1400 W = \left(1400 \frac{J}{s}\right)\left(\frac{1}{1055} \frac{Btu}{J}\right) \approx 1.33 \frac{Btu}{s} \Rightarrow t = \frac{E}{P} = \frac{16600 \text{ Btu}}{1.33 \text{ Btu/s}} \approx 12500 s \left(\frac{1}{3600} \frac{h}{s}\right) = 3.5 \text{ hours}$

Chapter 2

1. Historical reasons aside, the main problem is in ease of delivery and distribution, and the dangers naturally associated with compressed tanks of gas.

3. Oil is extracted in the primary process either by pumping or from natural geological pressure. Liquid petroleum can still exist underground however, and in the secondary extraction water or gas is pumped into the well to force it out. Petroleum can still exist within the surrounding rock, trapped by surface tension, porosity, and the natural viscosity of the oil. The tertiary process uses a variety of techniques to extract the locked-in fuel, depending on the nature of what's holding it back. Some examples are heating, detergent washing, and further gas injection.

4. From lecture, we know that the US consumes roughly 7.2 billion bbl/year of petroleum.

$\Rightarrow t = \frac{30 \times 10^9 \text{ bbl}}{7.2 \times 10^9 \text{ bbl/yr}} = 4.2 \text{ years}$

7. From page 44, for natural gas, the cost to energy ratio is $\frac{\$12.83}{10^6 \text{ Btu}}$. (continued on next page ⟶)

Questions and Problems

Chapter 2

7. (continued) Your home requires 10^6 Btu, so the furnace must provide $\frac{10^6 \text{ Btu}}{0.6} \approx 1.67 \times 10^6$ Btu (since it's only 60% efficient).

$\Rightarrow \text{cost} = \left(\frac{\$12.83}{10^6 \text{ Btu}}\right)\left(\frac{10^6 \text{ Btu}}{0.6}\right) \approx \$21.39$

12. A person can work for 8 hours at 50W $\Rightarrow$ Energy expended $= (50 \frac{J}{s})(8 \text{ hours})(\frac{3600 s}{1 \text{ hour}}) = 1.44 \times 10^6$ J

From the front cover of the book, 1 ton of coal = 2000 lbs of coal = 2.81×10^{10} J $\Rightarrow$ 1 lb of coal = 1.405×10^7 J

$\Rightarrow$ Energy expended $= \frac{1.44 \times 10^6 J}{1.405 \times 10^7 J/lb} \approx 0.1025$ lbs. of coal ≈ 0.1 lbs of coal

1 bbl petroleum = 42 gallons petroleum = 6.12×10^9 J $\Rightarrow$ 1 gallon oil = 1.46×10^8 J

$\Rightarrow$ Energy expended $= \frac{1.44 \times 10^6 J}{1.46 \times 10^8 J/gal} \approx 0.00986$ gal petroleum ≈ 0.01 gallons of petroleum

Online Questions

1. From the front cover of the book, 1 gallon of gasoline = 36.6 kWh $\Rightarrow$ 15 gallons of gasoline = 549 kWh.

2. Electricity is ~~\$0.12~~ $\frac{\$0.12}{1 \text{ kWh}} \Rightarrow \frac{\$0.12}{1 \text{ kWh}}(549 \text{ kWh}) \approx \$65.88$

Gas costs about $\frac{\$4.30}{1 \text{ gal}} \Rightarrow \frac{\$4.30}{1 \text{ gal}}(15 \text{ gal}) \approx \$64.50$

electricity is slightly more expensive, but not by much.

3. [insert opinion here]