Multiple Choice

Chapter 2

6. d) (100 QBtu/year is a number you should know by now)
7. From page 56, 3 gallons of water are needed for every gallon of oil ⇒ c)
10. From page 50, c)
11. From page 55, coal has abt 8 times more energy ⇒ a)

Chapter 3

8. The most efficient engine is a Carnot engine, which has efficiency of $\epsilon = 1 - \frac{T_c}{T_h} = 1 - \frac{225°C+273}{850°C+273} = 0.5565 \approx 56\% \Rightarrow$ b)
11. From page 83, efficiency of coal → electricity is abt 38% ⇒ f)
12. c) (definitionally)
16. The chemical equation is balanced for us, so we see that $\frac{[CO_2]}{[CH_4]} = 1$. So 1 mol CH_4 produces 1 mol CO_2.

    1 mol CH_4 weighs $(1\text{ mol})(1 \cdot M_C + 4\, M_H) = 16.042\text{g}$
    1 mol CO_2 weighs $(1\text{ mol})(1 \cdot M_C + 2 \cdot M_O) = 44.01\text{g}$
    $\Rightarrow \frac{44.01\text{g}}{16.042\text{g}} = 2.74 \Rightarrow$ a)
17. b) energy isn't extracted from heat differences!
18. b)
21. c) (from page 83)

Questions and Problems

Chapter 3

1. $T_C = \frac{5}{9}(T_F - 32°F)$; $T_K = T_C + 273°C \Rightarrow T_C = \frac{5}{9}(68-32) = 20°C$, $T_K = 293\text{K}$

4. An ideal heat engine's efficiency is given by $\epsilon = 1 - \frac{T_c}{T_H} = 1 - \frac{(20+273)\text{K}}{(150+273)\text{K}} \approx 0.30733 \approx 31\% < 45\%$. claim ⇒ He's full of lies!

15. EER is defined as (page 80) $\frac{\text{rate at which heat is removed Btu/h}}{\text{rate at which energy is consumed W}} = 10$ in this case. Convert the top to W as well.

    $\Rightarrow \frac{10\text{ Btu/h}}{1\text{W}}\left(\frac{1055\text{ J/Btu}}{1\text{ h/3600 s}}\right) = 293\text{ W} = \frac{Q_c}{W}$

    So for every 1 W consumed from the power company, 293 W are removed from the box, and $Q_h = Q_c + W = 393\text{W}$ are rejected as heat into the environment.

Online Questions

1. From lectures: 1 trillion barrels of oil left ($= 10^{12}$ bbl oil) $\approx$ 5800 QBtu $\approx$ 194 TW years
   (and look for conversions) 6200 Tcf of natural gas $\approx$ 6000 QBtu $\approx 10^{12}$ boe $\approx$ 200 TW years
   984 Gtonne of coal $\approx$ 1085 Gtons of oil $\approx$ 28900 QBtu $\approx 5\times10^{12}$ boe $\approx$ 967 TW years
   $(1\text{ TW yr} = (10^{12}\text{W})(3600 \cdot 24 \cdot 365\text{s}) = 3.15\times10^{19}\text{J} = 29.89\text{QBtu})$
2. From oil only: 58 years
   From natural gas only: 60 years
   From coal only: 289 years