## Online Questions

1. Some points to consider are nuclear waste management, meltdown hazards, cheapness of the energy source, negligible $CO_2$ emissions,
2. A few arguments to look at are expansion of the lifespan of nuclear energy, Pu proliferation, etc.
3. $\lambda_{1/2} = 30$ years for $Cs^{137}$. For exponential decay $N(t) = N_0\, 2^{-t/\lambda_{1/2}}$

   In our case, $\frac{10}{10{,}000} = 2^{-t/\lambda_{1/2}} \Rightarrow -\lambda_{1/2} \frac{\log 10^{-3}}{\log 2} = t \Rightarrow t = 298.97\text{ years} \simeq 300\text{ years}$

4. From the lecture notes, you need uranium ore with 3% / 90% $U^{235}$ for a fission reactor/nuclear bomb (respectively).

5. From lecture, $F_{drag} = \frac{C_D A_F v^2}{370}$; with v in mph, $A_F$ in $ft^2$, and $F_{drag}$ in lbs.

   $\Rightarrow F_{drag} = \frac{(0.9)(3\,ft^2)(65\,mph)^2}{370} = 30.83\text{ lbs} \simeq 31$ lbs of force from the box alone.

## Questions and Problems

### Chapter 7

1. $T_{inside} = 68°F$; $T_{outside} = 16°F$; $R = 16.2\ \text{hr}\cdot ft^2\cdot°F/Btu$; $t = 8$ hours. Wall is 8 ft high and 24 ft long.

   The heat conducted (lost) is given by $Q = \frac{A}{R}(T_2 - T_1)(t)$ $\quad A = (8\,ft)(24\,ft) = 192\,ft^2$

   $\Rightarrow Q = \frac{(192\,ft^2)(68-16\,°F)(8\,hours)}{16.2\ \text{hr}\cdot ft^2\cdot°F/Btu} = 4930.37\text{ Btu} \simeq 4900$ Btu of heat lost

3. $A = 1500\,ft^2$; $R = 11\ \text{hr}\cdot ft^2\cdot°F/Btu$. How much energy is lost in 5600 degree day heating season?

   $Q = 24\cdot\frac{A}{R}(\text{degree days}) = \frac{(1500\,ft^2)(24\,\frac{hours}{day})(5600\,°F\,day)}{(11\ \text{hr}\cdot ft^2\cdot°F/Btu)} = 18330000\text{ Btu} \simeq 1.8\times10^7$ Btu lost

8. Payback period for installing single-pane → double pane in Fairbanks? Fuel costs \$15.50 / $10^6$ Btu, $\epsilon = 0.75$ for furnace, and double-paning costs \$4.00/$ft^2$.

   From page 215, Fairbanks has 14,160 degree days heating season.

   From page 216, { single pane has $R = 0.88\ \text{hr}\cdot ft^2\cdot°F/Btu$; double pane has $R = 2.27\ \text{hr}\cdot ft^2\cdot°F/Btu$ }

   $\frac{Q_{single\text{-}pane}}{A} = \frac{(24\,\frac{hrs}{day})(14{,}160\,°F\,day)}{0.88\ \text{hr}\cdot ft^2\cdot°F/Btu} = 386{,}182\ Btu/ft^2$

   $\frac{Q_{double\text{-}pane}}{A} = \frac{(24\,\frac{hrs}{day})(14160\,°F\,day)}{2.27\ \text{hr}\cdot ft^2\cdot°F/Btu} = 149709\ Btu/ft^2$

   } per heating season. ⇒ cost: single: $\frac{386182\ Btu/ft^2}{10^6\ Btu}\cdot\frac{\$15.50}{0.75} = \$7.98/ft^2$; double: $\frac{149{,}709\ Btu/ft^2}{10^6\ Btu}\cdot\frac{\$15.50}{0.75} + \$4.00/ft^2 = \$7.09/ft^2$

   ⇒ Within $\frac{7.09}{7.98} = 0.89$ heating seasons, the investment will have paid off.

17. Fluorescent bulb uses 15 W for 10,000 hours; costs \$4. ⇒ Total energy usage = 150 kWh for \$4 initial investment

   Incandescent bulb uses 75W for 1000 hours; costs \$0.50 ⇒ We need 10 bulbs to last as long as a fluorescent, so total energy is 750 kWh for \$5 initial investment.

   Energy costs \$0.10/kWh ⇒ { Fluorescent total cost = \$4 + (150 kWh)(\$0.10/kWh) = \$19; Incandescent total cost = \$5 + (750 kWh)(\$0.10/kWh) = \$80 } Large difference!

## Multiple Choice

### Chapter 7

2. g (from book 3, page 219)

3. d (from page 212)

5. $T_{outside} = 35°F$; $T_{inside} = 65°F$; $A = 100\ ft^2$. 8 inches of $R_1 = 1.6\ ft^2 \cdot hr \cdot °F/Btu$; 2 inches of $R_2 = 10.5\ ft^2 \cdot hr \cdot °F/Btu$ $R_T = R_1 + R_2$

$$\Rightarrow \frac{Q}{t} = \frac{A \cdot \Delta T}{R_T} = \frac{(100\ ft^2)(30°F)}{(12.1\ ft^2 \cdot °F \cdot hr/Btu)} \approx 247.9\ Btu/hr \approx 248\ Btu/hr \Rightarrow \boxed{d}$$

6. b (from page 217)

8. $(1\ ft^3/hr\ \text{natural gas}) \left(\frac{303\ kWh}{1000\ ft^3\ \text{natural gas}}\right) = 0.303\ kW = 303\ W \Rightarrow \boxed{e}$

9. From the conduction equation, $Q \propto \Delta T \Rightarrow 1 - \frac{Q_1}{Q_2} = 1 - \frac{\Delta T_1}{\Delta T_2} = 1 - \frac{(65°F - 0°F)}{(75°F - 0°F)} \approx 13.3\% \Rightarrow \boxed{b}$