KEY

MATH....WITHOUT A CALCULATOR

(Calm down. It's not that hard.)

1. Scientific evidence shows a direct relationship between sea level and the global mean atmospheric temperature at Earth's surface. Currently the average rate of increase in sea level is 3.0 mm/yr.

   Calculate the expected increase in sea level, in meters, during the next 50 years.

   $3.0 \frac{mm}{year} \times 50 \text{ years} = 150 \text{ mm} \times \frac{1 \text{ m}}{1000 \text{ mm}} = \frac{150 \text{ m}}{1000} = 0.15 \text{ m}$

2. Scientists and investors are promoting the potential of some of the smallest, oiliest critters on Earth (microalgae) as a solution to our energy problems. Although the humble organisms look like green goo, some species of microalgae are over 50% oil.

Gallons of oil per acre per year	
Corn	20
Soybeans	50
Safflower	83
Sunflower	102
Rapeseed	115
Oil palm	640
Microalgae	10,000

   Calculate the number of acres required to produce 1000 gallons of oil in one year from:

   i. microalgae

   $\frac{1 \text{ acre}}{10{,}000 \text{ gal}} \times 1000 \text{ gal} = \frac{1000 \text{ acre}}{10{,}000} = 0.1 \text{ acre}$

   ii. soybeans

   $\frac{1 \text{ acre}}{50 \text{ gal}} \times 1000 \text{ gal} = \frac{1000}{50} = 20 \text{ acres}$

3. The Cobb family of Fremont is looking at ways to decrease their home water and energy usage. Their current electric hot-water heater raised the water temperature to 140 degrees F, which requires 0.20 kWh/gallon at a cost of $0.10/kWh. Each person in the family of four showers once a day for an average of 10 minutes per shower. The shower has a flow rate of 5.0 gallons per minute.

   a. Calculate the total amount of water the family uses per year for taking showers.

   $10 \frac{min}{day} \times 5 \frac{gal}{min} \times 365 \frac{days}{year} \times 4 = 73{,}000 \text{ gal/year}$

   b. Calculate the annual cost of the electricity for the family showers, assuming that 2.5 gallons per minute of the water used is from the hot-water heater.

   $73{,}000 \text{ gal/year} \div 2 = 36{,}500 \text{ gal/year}$

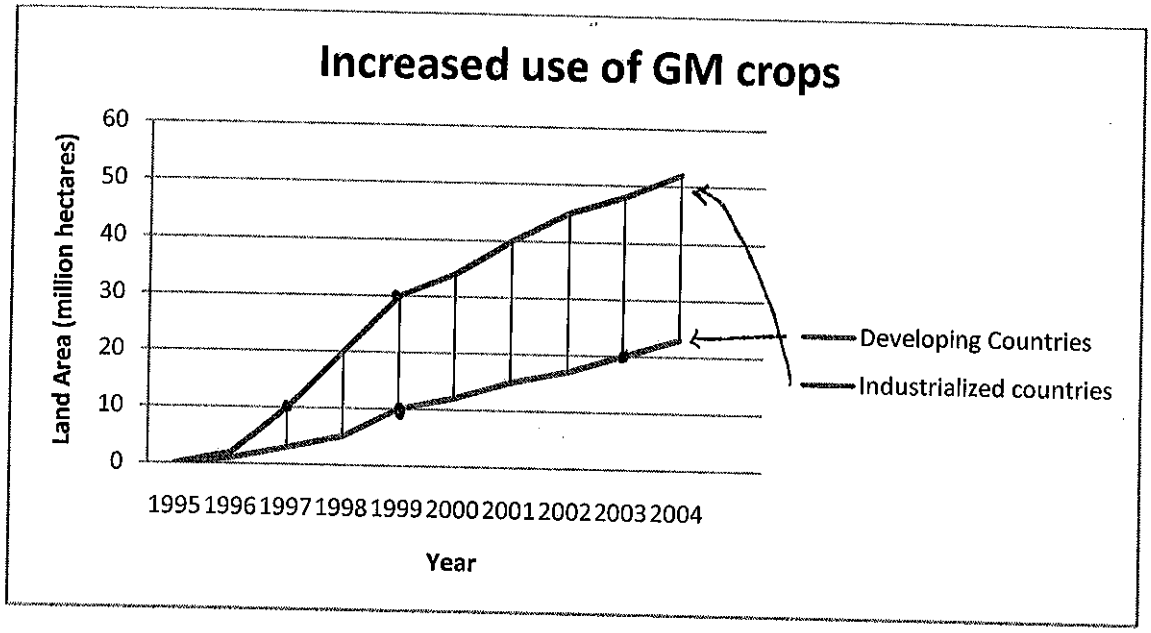
   $36{,}500 \frac{gal}{year} \times 0.20 \frac{kWh}{gal} \times \$0.10 \frac{}{kWh} = \$730/\text{year}$

   c. The family is considering replacing their current hot-water heater with a new energy efficient hot-water heater that costs $1000 and uses half the energy that their current hot water heater uses. How many days would it take for the new hot-water heater to recover the $1000 initial cost? $\$730 \frac{}{year} \times \frac{1 \text{ year}}{365 \text{ days}} = \$2/\text{day (old)} \; / \; \$1/\text{day (new)}$

   Savings = $1/day

   = 1000 days to pay off

4.



a. Calculate the increase in the area of land used for growing GM crops in developing countries from 1999-2003. Express your answer as a percentage of the 1999 value.

1999 = 10 mil ha
2003 = 20 mil ha = 100% increase

b. Calculate the annual rate of increase in land area used for growing GM crops in industrialized countries from 1997-1999.

1997 = 10 mil ha
1999 = 30 mil ha
30 - 10 = 20 mil ha / 2 years = 10 mil ha/year

c. Using the rate you calculated in part (b), project the area of land that would have been expected to be used for GM crops in industrialized countries in 2004.

1999 = 30 mil ha
5 years @ 10 mil ha/year = 50 mil ha
30 + 50 = 80 mil ha

5. The table below shows rate of wood consumption by termites, in mg per day per termite. Under optimal conditions, the emission rate of methane by termites is ~ 70 kg of CH_4 per year per 1000 termites.

	Relative Humidity		
Temp (C)	50%	70%	90%
20	0.04	0.05	0.05
25	0.05	0.07	0.10
30	0.12	0.13	0.27
35	0.09	0.13	0.15
40	0.00	0.00	0.00

a. Given a density of 4.5×10^7 termites/hectare and optimal conditions, calculate the annual amount of methane emitted, in kg, by the termites inhabiting a 2000 hectare rainforest.

$$2000\ \text{ha} \times \frac{4.5 \times 10^7\ \text{termites}}{\text{ha}} \times \frac{70\ \text{kg CH}_4/\text{year}}{1000\ \text{termites}} = 6.3 \times 10^9\ \frac{\text{kg CH}_4}{\text{yr}}$$

b. Suppose the temperature increases to 35 degrees C and the relative humidity decreases to 50%. Using the data, determine the amount of methane, in kg, that would be emitted by termites in a 2000 hectare rainforest.

$$\frac{0.09}{0.27} \times \frac{6.3 \times 10^9\ \text{kg CH}_4}{\text{year}} = 2.1 \times 10^9\ \text{kg CH}_4$$

↑ Rate of wood consumption is 1/3 that of optimal conditions

$\frac{630,000,000}{10000}$
$630 \times 10^7 = 6.3 \times 10^9$