2. Approximately 30 million mobile devices were sold in 1998 in the United States. The number sold increased to 180 million devices in 2007.

   (a) **Calculate** the percent increase of mobile device sales from 1998 to 2007.

   (b) Each mobile device sold in 2007 contained an average of 0.03 gram of gold. **Calculate** the number of grams of gold that were used in the production of the mobile devices sold in 2007.

   (c) Assume that the average mass of each mobile device was 0.1 kilogram. The United States Environmental Protection Agency estimates that about 10 percent of the mobile devices sold in 2007 were recycled. **Calculate** the mass (in kilograms) of the mobile devices sold in 2007 that were <u>not</u> recycled.

   (d) Discarded mobile devices become part of the electronic waste stream (e-waste). Mercury is often present in e-waste. **Identify** one negative human health effect, other than death, associated with exposure to mercury.

   (e) Improper disposal of e-waste has harmed human health and caused environmental damage in developing countries.

     (i) **State** TWO reasons why large quantities of e-waste from the United States are shipped to developing countries rather than being recycled in the United States.

     (ii) Retailers or manufacturers could take specific steps to dramatically reduce the amount of e-waste. **Describe** a realistic change in current practices that would accomplish this.

Question 2

Approximately 30 million mobile devices were sold in 1998 in the United States. The number sold increased to 180 million devices in 2007.

(a) Calculate the percent increase of mobile device sales from 1998 to 2007.

(2 points: 1 point for a correct setup and 1 point for the correct answer)

$$\frac{(180 \text{ million} - 30 \text{ million})}{30 \text{ million}} \times 100\% = 500\%$$

OR

$$\frac{(180 - 30)}{30} \times 100\% = 500\%$$

(Note: Students must show the calculation in order to receive credit for the correct answer. Math setup must be shown for second point.)

(b) Each mobile device sold in 2007 contained an average of 0.03 gram of gold. **Calculate** the number of grams of gold that were used in the production of the mobile devices sold in 2007.

(2 points: 1 point for a correct setup and 1 point for the correct answer)

$$1.8 \times 10^8 \text{ devices} \times \frac{3 \times 10^{-2} \text{ grams}}{\text{device}} = 5.4 \times 10^6 \text{ grams or } 5,400,000 \text{ grams}$$

OR

$$180,000,000 \text{ devices} \times \frac{0.03 \text{ grams}}{\text{device}} = 5,400,000 \text{ grams or } 5.4 \times 10^6 \text{ grams}$$

(Note: Students must show the calculation to receive credit for the correct answer. Math setup must be shown for second point. Mass units and correct numbers must be shown for second point.)

(c) Assume that the average mass of each mobile device was 0.1 kilogram. The United States Environmental Protection Agency estimates that about 10 percent of the mobile devices sold in 2007 were recycled. **Calculate** the mass (in kilograms) of the mobile devices sold in 2007 that were <u>not</u> recycled.

(2 points: 1 point for a correct setup and 1 point for the correct answer)

$$1.8 \times 10^8 \text{ devices} \times \frac{0.1 \text{ kg}}{\text{device}} \times 0.9 = 1.62 \times 10^7 \text{ kg or } 16,200,000 \text{ kg}$$

OR

$$180,000,000 \text{ devices} \times \frac{0.1 \text{ kg}}{\text{device}} \times 0.9 = 16,200,000 \text{ kg or } 1.62 \times 10^7 \text{ kg}$$

OR

$$\left(1.8 \times 10^8 \text{ devices} \times \frac{0.1 \text{ kg}}{\text{device}}\right) - \left(1.8 \times 10^8 \text{ devices} \times \frac{0.1 \text{ kg}}{\text{device}} \times 0.1\right) = 1.62 \times 10^7 \text{ kg or } 16,200,000 \text{ kg}$$

OR

$$\left(180,000,000 \text{ devices} \times \frac{0.1 \text{ kg}}{\text{device}}\right) - \left(180,000,000 \text{ devices} \times \frac{0.1 \text{ kg}}{\text{device}} \times 0.1\right)$$

$$= 16,200,000 \text{ kg or } 1.62 \times 10^7 \text{ kg}$$

(Note: Students must show the calculation to receive credit for the correct answer. Math setup must be shown for second point. Mass units and correct numbers must be shown for second point.)

(d) Discarded mobile devices become part of the electronic waste stream (e-waste). Mercury is often present in e-waste. **Identify** one negative human health effect, other than death, associated with exposure to mercury.

(1 point earned for identification of a specific health effect associated with mercury. Identification of the specific form of Hg responsible for the health effect is not required)

- Birth defects
- Nervous system damage
- Brain damage
- Learning disabilities
- Mental retardation
- Paralysis
- Attention deficit disorder
- Reproductive system damage
- Low sperm counts

- Kidney damage
- Hearing loss
- Minimata disease
- Mad Hatter's disease
- Seizures
- Visual impairment
- Skin disorders
- Headaches
- Mental illness

(e) Improper disposal of e-waste has harmed human health and caused environmental damage in developing countries.

(i) **State** TWO reasons why large quantities of e-waste from the United States are shipped to developing countries rather than being recycled in the United States.

(2 points: 1 point for each of two reasons why e-waste is shipped to developing countries. Acceptable responses include a variety of potential answers, but the key is to include a reason why the U.S. sends the material, not why the receiving country would want it)

Economic
- Lower labor costs in developing countries
- Disposal is cheaper in developing countries
- Shipment/recycling/disposal in developing countries is cheaper than transporting and landfill tipping fees within the U.S.
- Corruption of officials allows evasion of more expensive recycling and disposal options

(Note: "Cheaper" earns only one point unless two distinct reasons are given.)

Public Relations
- Recycling or disposal inside of the U.S. may be a public relations problem (NIMBY)
- When e-waste is shipped outside of the U.S., companies often avoid internal scrutiny

Regulatory/Liability
- Laws and enforcement may be lax
- Environmental impacts of disposal in the U.S. (pollution) may be more visible long-term
- U.S. workers are more likely to be able to sue successfully over health problems
- "Watchdog" organizations common in U.S. may be less common in developing countries

(ii) Retailers or manufacturers could take specific steps to dramatically reduce the amount of e-waste. **Describe** a realistic change in current practices that would accomplish this.
(1 point for a realistic change)

- Encourage recycling/reuse (trade-in incentives, rebates, repurchase/buy-back, mail-in)
- Reduce planned obsolescence as a design objective
- Production of modular units that can be reused/refurbished or parts (i.e. power supplies) that can be reused
- Make devices smaller and/or more durable
- Shift toward service flow economy
- Establish cradle-to-grave and/or cradle-to-cradle tracking of manufactured products