CHAPTER 8

Transformers

Answers to revision questions

1. (a) See Chapter 8.

   (b) An induction coil.

2. (a) Using the turn ratio equation:

   $$\frac{n_p}{n_s} = \frac{V_p}{V_s}$$

   Known quantities:
   $n_p = 50$ turns

   $n_s = 75$ turns

   $V_p = 11$ V

   $$\frac{50}{75} = \frac{11}{V_s}$$
   $$V_s = 16.5 \text{ V}$$

   (b) Using the turn ratio equation:

   $$\frac{n_p}{n_s} = \frac{V_p}{V_s}$$

   Known quantities

   $n_p = 2000$ turns

   $n_s = 6500$ turns

   $V_s = 66$ kV $= 66000$ V

   $$\frac{2000}{6500} = \frac{V_p}{66000}$$
   $$V_p \approx 20308 \text{ V}$$
   $$V_p \approx 20 \text{ kV}$$

   (c) Using the turn ratio equation:

   $$\frac{n_p}{n_s} = \frac{V_p}{V_s} = \frac{I_s}{I_p}$$

   Known quantities:

   $n_p = 825$ turns

   $n_s = 175$ turns

   $I_p = 12$ mA $= 0.012$ A

   $$\frac{825}{175} = \frac{I_s}{0.012}$$
   $$I_s = 0.057 \text{ A}$$
   $$I_s = 57 \text{ mA}$$

3. (a) Step-down: the output voltage is smaller than the input voltage.

(b) Using the turn ratio equation:

$$\frac{n_p}{n_s} = \frac{V_p}{V_s}$$

Known quantities:

$n_p = 500$ turns

$V_p = 240$ V

$V_s = 12$ V

$$\frac{500}{n_s} = \frac{240}{12}$$

$n_s = 25$ turns

(c) Initially there are 240 V and 2 A, using the power equation:

$$P_p = I_p V_p$$
$$P_p = 240 \times 2 = 480 \text{ W}$$

Since it is only 80% energy efficient, only 80% of the input power can be obtained at the output (P_s).

$$P_s = 0.8 \times 480 = 384 \text{ W}$$

The output has a voltage of 12 V, thus the current can be determined using the power equation.

$$P_s = I_s V_s$$
$$384 = I_s \times 12$$
$$I_s = 32 \text{ A}$$

(d) There are significant amounts of heat lost in the coils and the core, thus this reduces the energy efficiency.

4. See Chapter 8.

5.
- a TV
- an oven

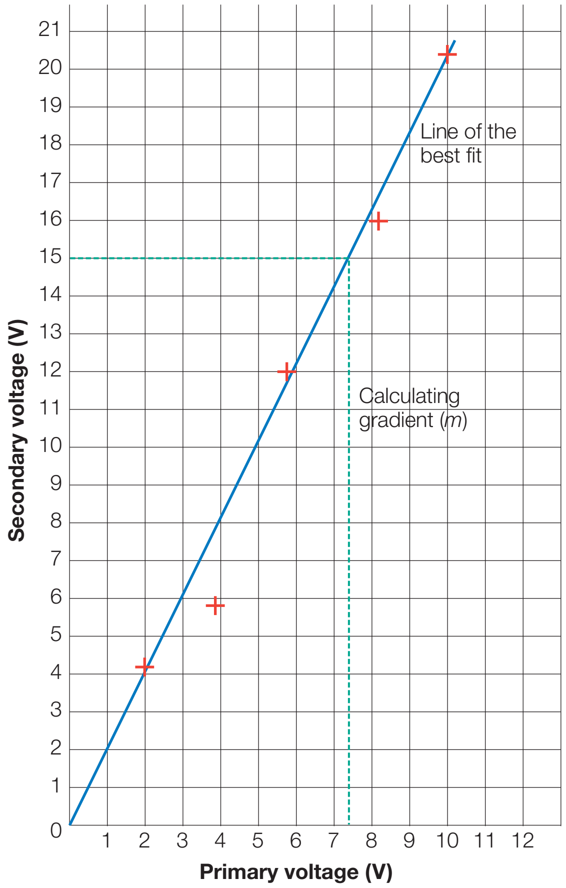
6. Support your arguments with real examples and statistics. Although you can argue on both positive and negative aspects, you should reach some kind of conclusion at the end.

See the *Higher verb questions* on this CD for support in constructing your answer.

7. (a) So the flux is linked better since this reduces the separation by air.

(b) It concentrates the magnetic field.

(c) To find the ratio of the primary coil and the secondary coil, we need to plot a graph of secondary voltage versus primary voltage. (Refer to graph.)



The gradient of the line equals the ratio:

$$\frac{V_s}{V_p}$$

$$m = \frac{15-0}{7.4-0} = 2.03$$

This means $\frac{n_s}{n_p}$ will also equal 2.03.

Since $n_p = 50$ turns

$$\frac{n_s}{50} = 2.03$$

$$n_s = 101 \text{ turns}$$

(d) Taking the last set of data:

$$P = IV$$

$$P_p = 10.0 \times 5.1 = 51 \text{ W}$$

$$P_s = 20.3 \times 2.4 \times 48.72 \text{ W}$$

Therefore power efficiency $= 100\% \times \frac{48.72}{51} = 96\%$

The transformer is 96% efficient, which means it's not perfectly efficient since 4% of energy is lost as heat from the coils and the iron core.

(e) Laminate the soft iron core.