Answers to Coursebook questions – Chapter 5.8

1 **a** From $\frac{V_P}{V_S}=\frac{N_P}{N_S}$ we get $\frac{220}{V_S}=\frac{500}{200} \Rightarrow V_S=\frac{200\times 220}{500}=88\text{ V}$.

The frequency is unchanged so it stays at 50 Hz.

b The power in the primary is $P=V_P I_P=220\times 6.0=1320\text{ W}$ and so that in the secondary is $0.70\times 1320=924\text{ W}$. Hence the current is $\frac{924}{88}=10.5\text{ A}$.

2 **a** The current produced is $I=\frac{P}{V}=\frac{300\times 10^6}{80\times 10^3}=3750\text{ A}$.

The power lost in the cables is then $5.0\times 3750^2=7.0\times 10^7\text{ W}$, a fraction $\frac{7.0\times 10^7}{300\times 10^6}=0.23$ of the power produced.

b At 100 kV, the current is $I=\frac{P}{V}=\frac{300\times 10^6}{100\times 10^3}=3000\text{ A}$ and the power lost is $5.0\times 3000^2=4.5\times 10^7\text{ W}$ representing a smaller fraction $\frac{4.5\times 10^7}{300\times 10^6}=0.15$ of the total power produced.

3 The rms voltage is given by $V_{rms}=\frac{\omega NBA}{\sqrt{2}}$ and $\omega=2\pi f=100\pi\text{ s}^{-1}$.

Hence $B=\frac{V_{rms}\sqrt{2}}{\omega NA}=\frac{220\sqrt{2}}{100\pi\times 300\times 0.20^2}=0.0825\text{ T}$.

4 The answer can be obtained by finding the maximum slope of the flux graph (for example at 0.45 ms and then dividing by $\sqrt{2}$. Alternatively, the formula for flux is $\phi=10\cos(\frac{2\pi t}{0.9\times 10^{-3}})$ and so the formula for induced emf is

$\text{emf}=-10\times\frac{2\pi}{0.9\times 10^{-3}}\sin(\frac{2\pi t}{0.9\times 10^{-3}})$ so that the peak emf is

$\text{emf}=10\times\frac{2\pi}{0.9\times 10^{-3}}=69.8\text{ kV}$. The rms voltage is then $\frac{69.8}{\sqrt{2}}=49\text{ kV}$.

5 **a** The current produced is $I = \dfrac{P}{V} = \dfrac{150 \times 10^3}{1.0 \times 10^3} = 150\text{ A}$.

The power lost in the cables is then $2.0 \times 150^2 = 4.5 \times 10^4\text{ W}$, a fraction $\dfrac{4.5 \times 10^4}{150 \times 10^3} = 0.30$ of the power produced.

b At 5000 V, the current is $I = \dfrac{P}{V} = \dfrac{150 \times 10^3}{5.0 \times 10^3} = 30\text{ A}$ and the power lost is $2.0 \times 30^2 = 1.8 \times 10^3\text{ W}$ representing a smaller fraction $\dfrac{1.8 \times 10^3}{150 \times 10^3} = 0.012$ of the total power produced.

6 It would be DC, i.e. the electrons would move in the same direction but the current would not be constant.

7 **a** The peak power is 20 W and so the average power is 10 W.

Hence

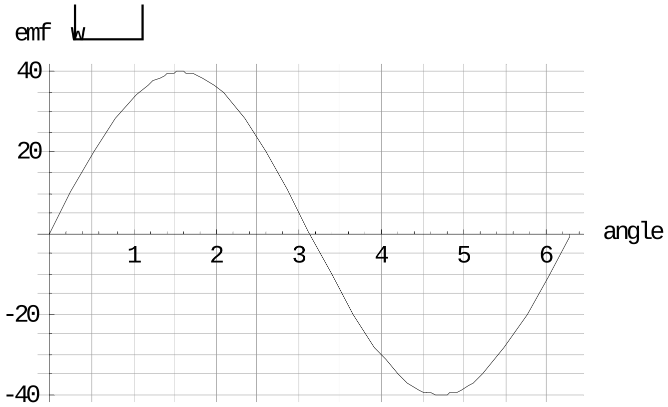
$$\overline{P} = RI^2_{\text{rms}} \Rightarrow I_{\text{rms}} = \sqrt{\frac{10}{2.5}} = 2.0\text{ A}$$

b $R = \dfrac{V_{\text{rms}}}{I_{\text{rms}}} \Rightarrow V_{\text{rms}} = 2.0 \times 2.5 = 5.0\text{ V}$

c The period is 1.0 s (there are two peaks within one period).

d At double the rotation speed the period will halve and the peak power will increase by a factor of 4, leading to the graph in the answers (see page 806 in *Physics for the IB Diploma*). This is because at double the rotation speed the induced emf doubles and so the power (that depends on the square of the induced emf) increases by a factor of 4.

8 **a** The graph of emf versus angle is shown below. The vertical axis is actually the emf divided by the angular speed of rotation.



b There will no be change in the graph shown in Figure 8.12 in the textbook.

c The new graph for emf (divided by angular speed) is shown below along with the original graph.