## Answers to Exercises in Chapter 2

2.1 Possible forms include:

2.2 Frequency $f=1 / T=1 / 10=0.1 \mathrm{~Hz}$.
2.3 Period $T=1 / f=1 / 25=40 \mathrm{~ms}$.
2.4 In this waveform, the peak-to-peak amplitude is twice the peak amplitude, which is $2.5 \times 2=5 \mathrm{~V}$.
2.5 If $i=10 \sin \theta$, then the peak current is 10 A , so the peak-to-peak current is 20 A .
$2.6 \omega=2 \pi f=2 \times \pi \times 10=62.8 \mathrm{rad} / \mathrm{s}$.
$2.7 f=\omega / 2 \pi=157 / 2 \pi=25 \mathrm{~Hz}$.
2.8


By inspection, the peak amplitude of this waveform is 5 V and therefore the peak-to-peak voltage is 10 V . The period $T$ is 4 ms , so the frequency $f=1 / T=$ 250 Hz and the angular frequency $\omega=2 \pi f=2 \times \pi \times 250=1571 \mathrm{rad} / \mathrm{s}$.
2.9 If $f=50 \mathrm{~Hz}$, then $\omega=2 \pi f=2 \times \pi \times 50=314 \mathrm{rad} / \mathrm{s}$. Therefore, a suitable equation is $v=5 \sin 314 t$.
2.10 If the peak-to-peak current is 16 A then the peak current is 8 A , and so a suitable equation would be $i=8 \sin 150 t$.
2.11 If $v=25 \sin 471 t$ the peak amplitude of the waveform is 25 V and the angular frequency $\omega=471 \mathrm{rad} / \mathrm{s}$. Therefore, the cyclic frequency is $471 / 2 \pi=75 \mathrm{~Hz}$.
2.12


The peak value of this waveform is equal to 5 V and the period is 10 ms . The frequency $f=1 / T=1 / 0.01=100 \mathrm{~Hz}$. Thus, it is clear that the angular frequency $\omega=2 \pi f=2 \times \pi \times 100=628 \mathrm{rad} / \mathrm{s}$. From the diagram, the phase angle at $t=0$ is $\phi=\pi / 2$ and therefore a suitable equation is $v=5 \sin (628 t+\pi / 2)$.
2.13 The average value is 0.637 times the peak value, which is 6.37 V .
2.14 The average value is 0.637 times the peak value, therefore the peak value is $5 / 0.637=7.85 \mathrm{~A}$.
2.15 This is discussed in Section 2.2 of the text, in the sub-section entitled 'the r.m.s. value of a sine wave'.
2.16 Because the power dissipated in a resistive circuit is directly related to the r.m.s. value rather than to the average value.
2.17 $P_{a v}=V_{r m s}{ }^{2} / R=\left(V_{p} / \sqrt{ } 2\right)^{2} / R=(10 / 1.414)^{2} / 25=2 \mathrm{~W}$.
$2.18 \quad P_{a v}=V_{r m s}{ }^{2} / R=10^{2} / 25=4 \mathrm{~W}$.
2.19 Most analogue multimeters multiply their reading of the average voltage by the form factor of a sine wave (1.11) so that they give a direct reading of the r.m.s. value. Therefore, the multimeter would read $6 \times 1.11=6.66 \mathrm{~V}$.
2.20 For a square wave, the average value is equal to the peak value. Therefore, in this case, the average value is 5 V .
2.21 The r.m.s. value of a square wave is equal to its peak value, therefore in this case the average power $P_{a v}=V_{r m s}{ }^{2} / R=5^{2} / 25=1 \mathrm{~W}$.
2.22 We need to reduce the sensitivity of the meter by a factor of

$$
\frac{250 \mathrm{~mA}}{50 \mu \mathrm{~A}}=5000
$$

Therefore, we want $1 / 5,000$ of the current to pass through the meter. Therefore, $R_{S H}$ must be equal to $R_{M} \div 4999=2 \mathrm{~m} \Omega$.
2.23 The required total resistance of the arrangement is given by the f.s.d. current divided by the full-scale input voltage. Hence

$$
R_{S E}+R_{M}=\frac{10 \mathrm{~V}}{50 \mu \mathrm{~A}}=200 \mathrm{k} \Omega
$$

Therefore

$$
\begin{aligned}
R_{S E} & =200 \mathrm{k} \Omega-R_{M} \\
& =199990 \\
& \approx 200 \mathrm{k} \Omega
\end{aligned}
$$

2.24 The reading will be about $11 \%$ too high.
2.25 The reading will be about 11.1 V .
2.26 This is described in Section 2.6 of the text.
2.27 Through the use of a true r.m.s. converter which produces a voltage that is directly related to the r.m.s. value of any waveform.
2.28 This is explained in Section 2.7 of the text.
2.29 Either by displaying the waveforms alternately at sufficient speed to give the illusion that both traces are being displayed continuously, or by switching between the waveforms so fast that the eye does not see the transitions.
2.30 In the ALT mode, the oscilloscope displays one complete 'trace' of one waveform, and then displays one complete trace of the other - the process then repeats. In the CHOP mode, the oscilloscope switches rapidly between the two waveforms during each trace.
2.31 The trigger circuit attempts to synchronise the beginning of the timebase sweep so that it always starts at the same point in a repetitive waveform - thus producing a stationary trace.
2.32 A sinusoidal signal with a peak-to-peak amplitude of 15 V has a peak amplitude of 7.5 volts and an r.m.s. value of 5.3 V . As the multimeter is configured to display, the r.m.s. value of a sinewave it should display 5.3 V .
2.33 On an oscilloscope, voltages are measured by comparing the displacement of the trace with a scale printed on the face of the display and this process generally limits the accuracy of readings to a few percent. While the accuracy of readings taken with an analogue multimeters will vary, they will generally be considerably more accurate than those taken with an oscilloscope.

### 2.34



Waveform $B$ leads waveform $A$ by about $60^{\circ}$.

