Alternating Current and Voltage

Exercise 6.1 Peak and r.m.s.

1. The r.m.s. current from a mains supply is I.
   What is the peak current?

2. Mains electricity is supplied to our homes at 230 V r.m.s.
   What is the peak value of this voltage?

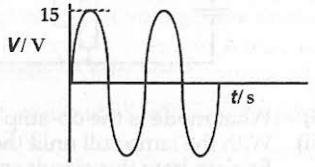
3. An oscilloscope connected across a 2 Ω resistor records a peak voltage of 5 V.
   What is the value of the r.m.s. current through the resistor?

4. An alternating current of r.m.s. 2 A flows through a resistor. A steady direct current I in an identical resistor generates heat at the same rate as the first resistor.
   State the value of I?

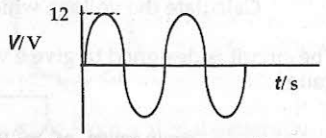
5. An immersion heater is used to heat water in an insulated container. An a.c. supply and a d.c. supply both produce the same rate of heating from the heater. The a.c. supply has a peak voltage of 10 V.
   Calculate the p.d. of the d.c. supply.

6. The output voltage from a step-down mains transformer is to be monitored.
   a) What instrument would you use to measure the r.m.s. voltage of the supply?
   b) What instrument would you use to measure the peak voltage of the supply?
   c) If the r.m.s. voltage is 12 V, what is the peak voltage?

7. The graph represents a sinusoidal alternating voltage.
   a) Calculate the r.m.s. voltage.
   b) If the voltage is applied to a 3.3 kΩ resistor, find the peak current through the resistor.



8. An immersion heater can be operated either from an a.c. supply or a d.c. supply. The graph represents the a.c. supply voltage.
   What d.c. supply would produce the same rate of heating from this heater?



9. In the specification of a certain non-electrolytic capacitor the maximum operating voltage is given as 63 V d.c.
   What therefore is the greatest r.m.s. voltage allowed when this capacitor is used in an a.c. circuit?

10. An a.c. voltage has a d.c. equivalent voltage of 15 V.
    Calculate the peak voltage.

Exercise 6.2 Frequency

Questions 1 to 3 refer to the following diagrams which represent oscilloscope screens, with the grid lines all 1 cm apart.

Diagram A

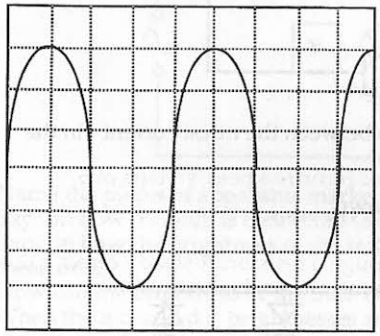
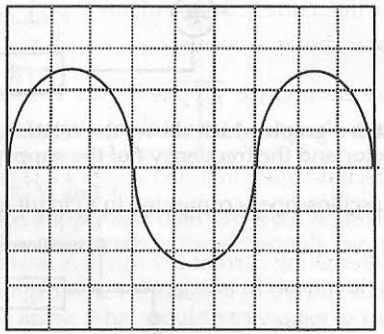


Diagram B

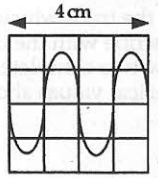


1. Diagram **A** represents an a.c. supply.
   The voltage gain is set at 5 V cm^{-1} and the time base at 5 ms cm^{-1}.
   a) What is the peak voltage of the supply?
   b) What is the r.m.s. voltage of the supply?
   c) What is the frequency of the supply?

2. Diagram **B** represents an a.c. supply.
   The voltage gain is set at 20 V cm^{-1} and the time base at 2.5 ms cm^{-1}.
   a) What is the peak voltage of the supply?
   b) What is the r.m.s. voltage of the supply?
   c) What is the frequency of the supply?

3. If diagram **A** represents the mains voltage, calculate
   a) the setting of the voltage gain of the oscilloscopes, in V cm^{-1},
   b) the time base setting of the oscilloscope, in ms cm^{-1}.

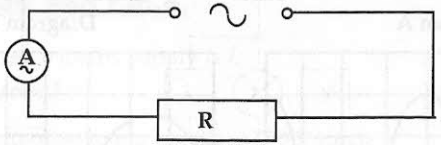
4. An alternating signal is applied to an oscilloscope which has its time-base set at 10 ms cm^{-1}. Two complete waves appear on the screen, which is 4 cm wide, as shown. The time base setting is changed with all other controls kept the same as before.



   State how many waves will appear on the screen when
   a) the time-base is set at 1 ms cm^{-1},
   b) the time-base is set at 5 ms cm^{-1},
   c) the time-base is set at 20 ms cm^{-1},
   d) the time-base is set at 50 ms cm^{-1}.

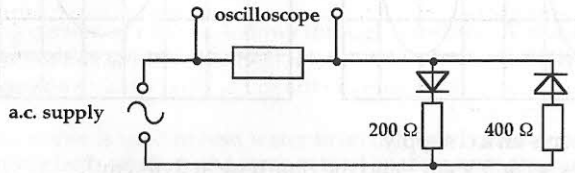
Exercise 6.3 Mixed Problems

1. A resistor R is connected in a circuit as shown. The frequency of the alternating supply can be varied but the peak voltage is kept constant.



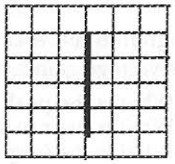
Sketch a graph which shows the relationship between the r.m.s. current *I* in the resistor and the frequency *f* of the supply.

2. An oscilloscope is connected in a circuit as shown.



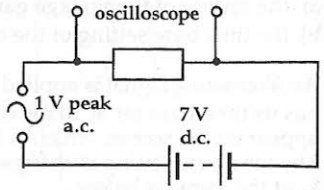
Sketch the trace obtained on the oscilloscope.

3. An oscilloscope being used as a voltmeter has its time base switched **off** and its Y-gain set at 2 V cm^{-1}. The trace obtained is shown.



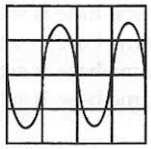
What is the value of the peak voltage being measured?

4. An a.c. supply of 1 V peak value and a d.c. supply of 7 V are connected in series as shown.



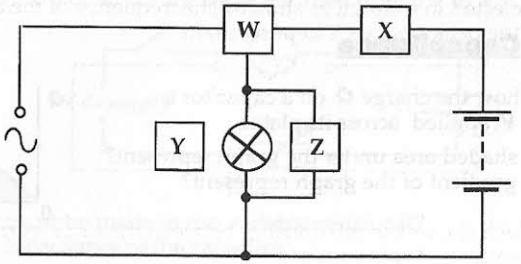
Sketch the trace which could be seen on the oscilloscope with the time base suitably adjusted to show two complete waves of the a.c. supply. (Numerical values should be shown on the voltage axis.)

5. The trace shown is produced by a signal generator on an oscilloscope screen, with 1 cm squares.



a) The Y-gain is set at 20 V cm^{-1}.
Calculate the peak voltage of the signal generator.
b) The time-base is set at 10^{-3} s cm^{-1}.
Calculate the frequency of the signal generator.
c) How many squares in **each** direction would be required to display one complete wave of mains voltage if the controls remain on the same settings?

6. The diagram illustrates an experiment to compare the a.c. and d.c. voltages which will produce the same brightness in the lamp.



a) Name the pieces of apparatus marked W, X, Y, and Z.
b) Explain how the bulb is connected to the a.c. supply and then to the d.c. supply.
c) Explain how the brightness of the bulb when connected to the a.c. supply can be measured.
d) How can the brightness of the bulb be changed when connected to the d.c. supply?
e) When the a.c. and d.c. brightnesses are the same, what would you expect to see on the screen of component Z?