6 **(a)** Two parallel plate capacitors C_1 and C_2 are connected to a supply that has a potential difference (p.d.) V_S. The capacitors may be connected in series or in parallel.

The supply provides charge Q_S and the plates of the two capacitors acquire charges Q_1 and Q_2 respectively. The p.d.s across the plates of the capacitors are V_1 and V_2 respectively.

Complete Table 6.1 to indicate how Q_S, Q_1 and Q_2 relate to each other, and how V_S, V_1 and V_2 relate to each other, for series and parallel connections of the capacitors to the supply.

Table 6.1

	relationship between charges	relationship between p.d.s
series		
parallel		

[4]

(b) An isolated capacitor of capacitance 470 μF stores 19 mJ of energy.

(i) Calculate the p.d. across the capacitor.

p.d. = ...V [2]

(ii) Calculate the charge on the capacitor.

charge = ... C [2]

(iii) The capacitor is now connected in parallel with a capacitor of capacitance 180 μF that is initially uncharged.

Determine the total energy, in mJ, now stored in the two capacitors.

energy = ... mJ [3]

[Total: 11]

6 Fig. 6.1 shows part of a bridge rectifier circuit that can be used for rectification of an alternating input voltage V_{IN}.

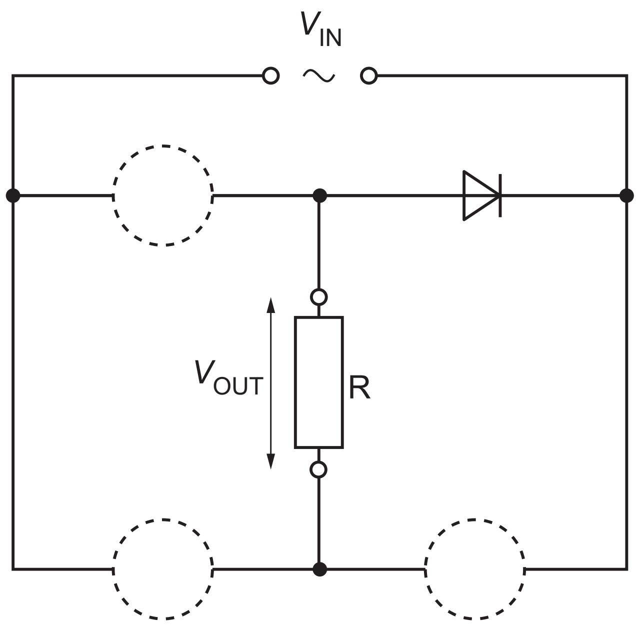

Fig. 6.1

The circuit contains four diodes, one of which is shown.
The rectified output voltage V_{OUT} is applied across load resistor R.

(a) **(i)** State what is meant by rectification.

....

.... [1]

(ii) State the name of the type of rectification produced by a bridge rectifier circuit.

.... [1]

(iii) Complete the circuit in Fig. 6.1 by drawing the three missing diodes inside the dashed circles. [2]

(b) The input voltage varies with time t according to the equation

$$V_{IN} = 34 \sin 18t$$

where V_{IN} is in V and t is in s.

(i) Show that the period of the input voltage is 0.35 s.

[2]

(ii) Calculate the root-mean-square (r.m.s.) input voltage.

r.m.s. voltage = ... V [1]

(iii) On Fig. 6.2, sketch the variation of V_{OUT} with t from $t = 0$ to $t = 0.35$ s.

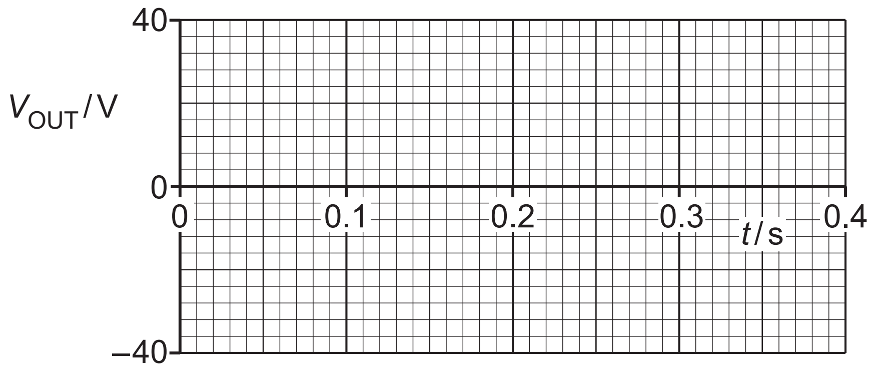

Fig. 6.2

[3]

(c) Resistor R has a resistance of 56 kΩ. A capacitor of capacitance 12 μF is connected into the circuit of Fig. 6.1 in order to smooth the output voltage.

(i) On Fig. 6.1, draw the capacitor correctly connected into the circuit. [1]

(ii) Calculate the time constant of the smoothing circuit.

time constant = ... s [2]

(iii) During each discharge cycle, the time for which the capacitor is discharging is 0.14 s.

Determine the minimum value of the smoothed output voltage.

minimum voltage = ... V [2]

[Total: 15]

7 Fig. 7.1 shows a circuit containing a capacitor of capacitance C and a resistor of resistance R.

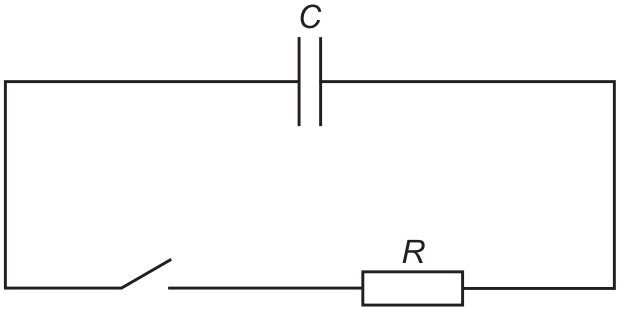

Fig. 7.1

Initially, the switch is open and the potential difference (p.d.) across the capacitor is 12 V.

The switch is closed at time $t = 0$ and the capacitor discharges through the resistor.

Fig. 7.2 shows the variation of the charge Q on the capacitor with the p.d. V_C across the capacitor as the capacitor discharges. Fig. 7.3 shows the variation of the current I in the resistor with the p.d. V_R across the resistor as the capacitor discharges.

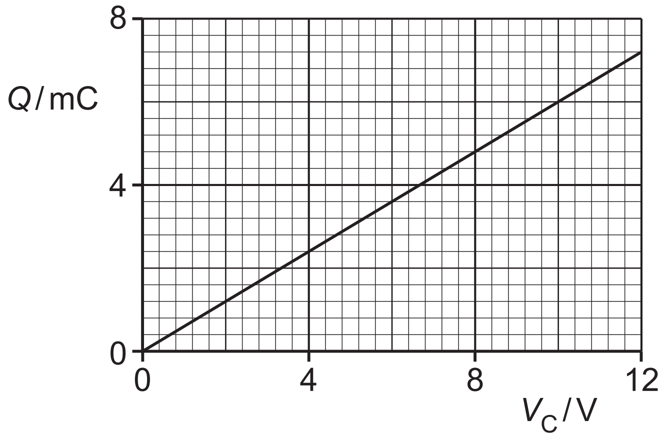

Fig. 7.2

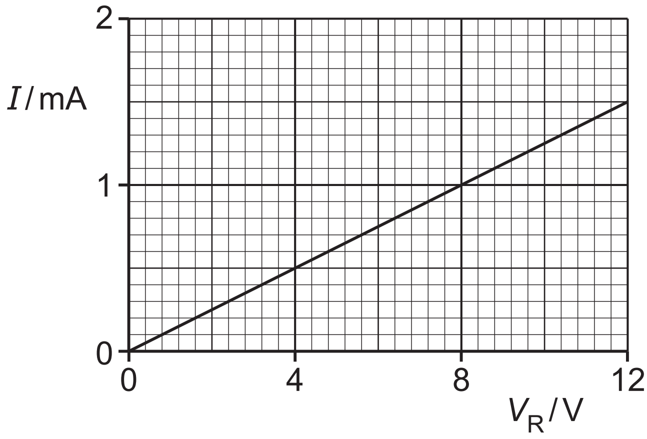

Fig. 7.3

(a) State the relationship between V_C and V_R.

.... [1]

(b) Determine:

(i) the capacitance C, in μF

C = ... μF [2]

(ii) the resistance R, in kΩ

R = ... kΩ [2]

(iii) the time constant τ of the circuit.

τ = ... s [2]

(c) Use Fig. 7.2, Fig. 7.3 and your answer in **(a)** to explain why the variation of Q with t is exponential in nature.

....

....

....

....

.... [3]

[Total: 10]