9 **(a)** An alternating voltage of period 10 ms is being applied directly across a resistor of 5.0 Ω in a circuit. The variation with time t of voltage V is shown in Fig. 9.1.

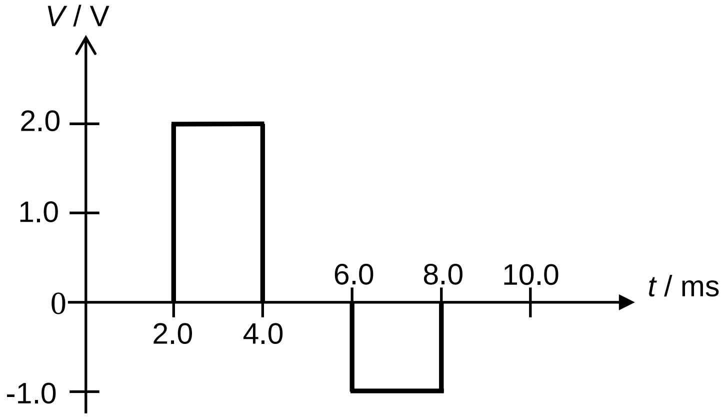

Fig. 9.1

Calculate the steady voltage passing through the same resistor that would produce an identical heating effect.

voltage = ... V [2]

(b) Explain why it is necessary to use high voltages for the efficient transmission of electrical energy.

....

....

.... [2]

(c) A sinusoidal root-mean-square voltage input of 6.5 mV and 50 Hz is now connected to the primary coil of a transformer as shown in Fig. 9.2. The transformer is assumed to be ideal and its turns ratio, $\frac{N_s}{N_p}$ is 71. The secondary coil is connected to a resistor R. An average power of 0.040 W is produced in resistor R.

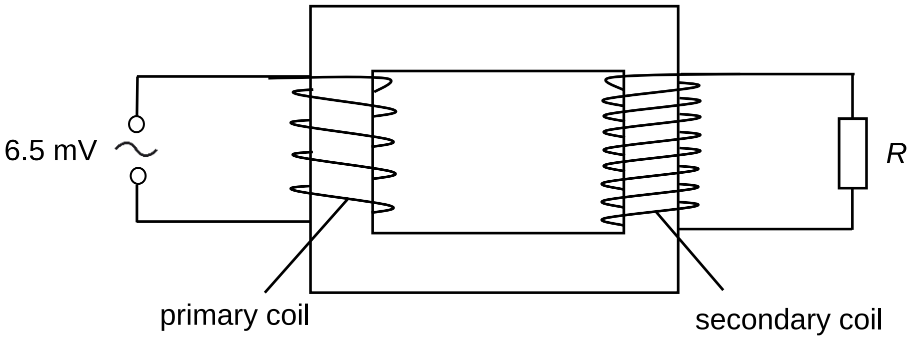

Fig. 9.2

(i) Calculate the r.m.s output voltage supplied to resistor *R*.

r.m.s. voltage = ………………….. V [1]

(ii) In Fig. 9.3, sketch the variation with time *t* of the power *P* dissipated in the resistor *R* over one period. Label all values on the axes.

[2]

Fig. 9.3

(iii) An ideal diode is now connected to the secondary coil with resistor *R* as shown in Fig. 9.4.

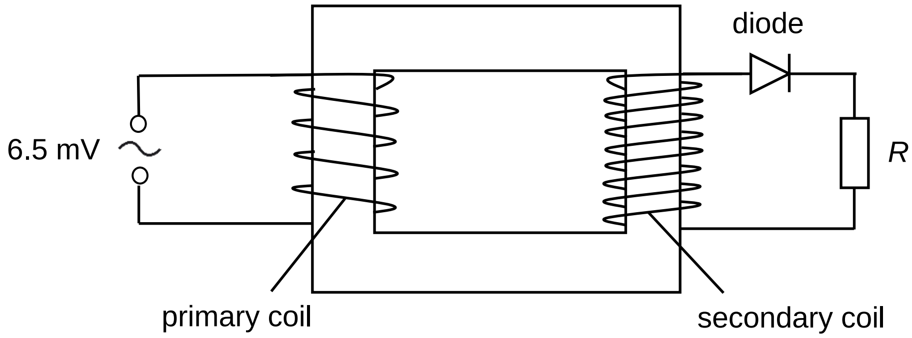

Fig. 9.4

Describe the variation with time of the direction of the current flow through resistor *R*.

………………………………………………………………………………………………

………………………………………………………………………………………………

……………………………………………………………………………………………… [2]

(iv) In practice, the core of some transformers is made of laminated soft iron.

Explain how the lamination of the core reduces energy losses.

....

....

.... [2]

(d) A cycle of changes in pressure, volume and temperature of a mixture of gases inside a cylinder of a petrol engine is illustrated in Fig. 9.5. The mixture of gases is assumed to be ideal.

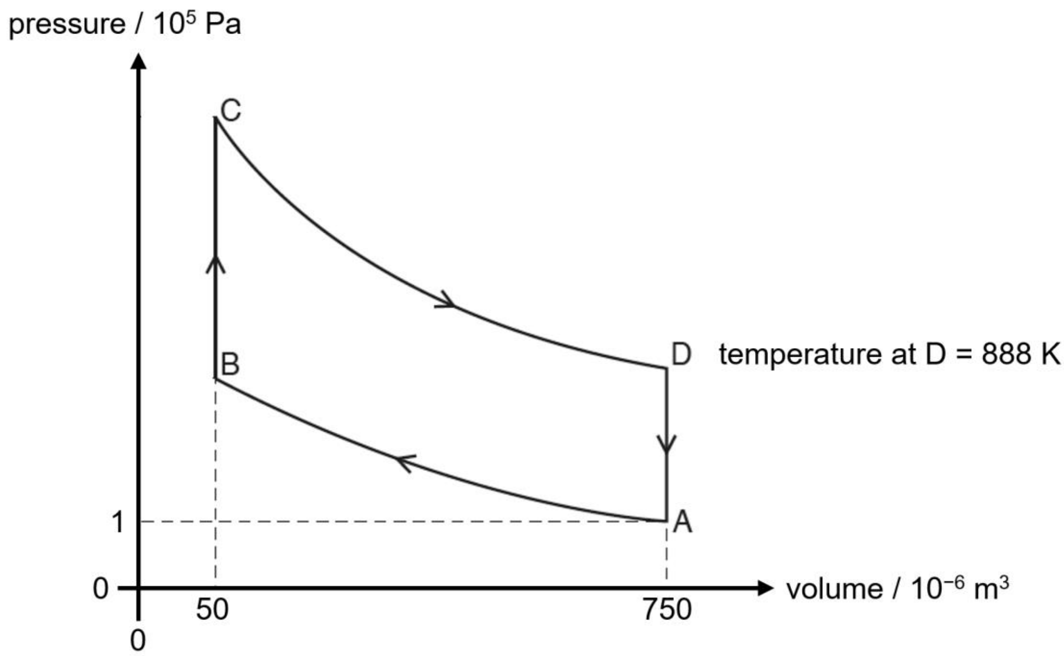

Fig. 9.5 (not to scale)

process	**description**
A to B	Rapid compression of the gaseous petrol and air mixture with both temperature and pressure rising from A to B.
B to C	The petrol and air mixture is combusted, resulting in an almost instant rise in pressure.
C to D	Rapid expansion and cooling of the hot gases.
D to A	Return to the starting point of the cycle.

(i) State what is meant by an *ideal gas*.

....

.... [1]

(ii) Complete the table in Fig. 9.6 showing the work done on the gas, the heat supplied to the gas and the increase in the internal energy of the gas, during the four stages of one cycle.

[4]

process	work done **on** gas / J	heat supplied **to** gas / J	**increase** in internal energy of gas /J
A to B	+ 360	0	
B to C		+ 670	
C to D		0	− 810
D to A			

Fig. 9.6

(iii) Use Fig. 9.5 and your answers in **(d)(ii)** to determine the number of moles present in the gases in the cycle.

number of moles = …………………….... mol [2]

(iv) Explain qualitatively how molecular movement causes the fall in temperature of the gas during the process C to D.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………………… [2]

[Total: 20]

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