9 A cycle of changes in pressure, volume and temperature of gas inside a cylinder of a petrol engine is illustrated in Fig. 9.1. The gas is assumed to be ideal.

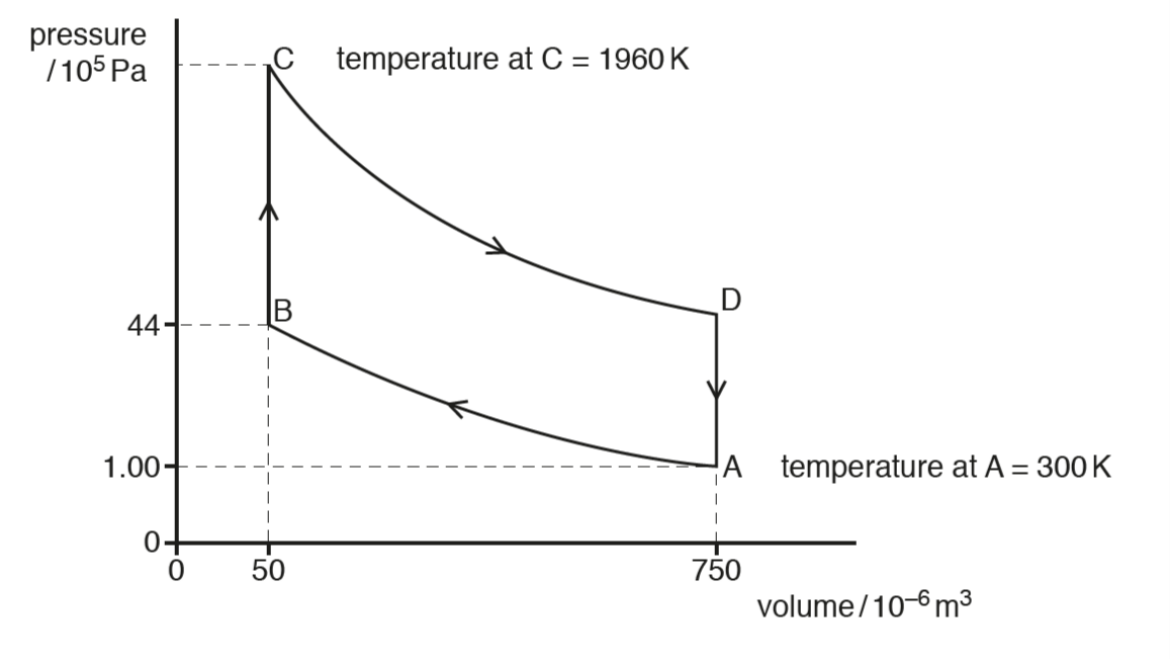

Fig. 9.1 (not to scale)

There are four stages in the cycle.

stage	description
A to B	Rapid compression of the gaseous petrol/air mixture with the temperature rising from 300 K at A. The pressure at B is 44 × 10^5 Pa.
B to C	The petrol/air mixture is exploded, resulting in an almost instant rise in pressure. At C the temperature is 1960 K.
C to D	Rapid expansion and cooling of the hot gases.
D to A	Return to the initial state of the cycle.

(a) (i) Using appropriate values from Fig. 9.1, determine the number of moles present in the gases in the cycle.

number of moles = ... mol [2]

(ii) Calculate the temperature of the gas at B.

temperature = ...K [2]

(iii) Calculate the pressure of the gas at C.

pressure = ...Pa [2]

(iv) State

1. the numerical value of work done by the gas from B to C,

..... [1]

2. what is represented by the area ABCD enclosed by the graph.

.....

.....

..... [2]

(b) Complete Table 9.1, which shows the work done on the gas, the heat supplied to the gas and the increase in internal energy of the gas, during the four stages in the cycle.

Table 9.1

stage	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			

[4]

(c) The efficiency of this engine is the ratio of the net work done by the gas to the heat supplied to the gas. Calculate the efficiency of this cycle.

efficiency = ... % [1]

(d) Using the First Law of Thermodynamics, explain whether the r.m.s. speed of the molecules of the gas will increase, decrease or remains the same when the gas expands rapidly from C to D.

.....

.....

.....

.....

.....

.....

..... [2]

(e) Explain, in terms of the collision of the molecules of the gas with the walls of the container, why an expansion results in a change in the kinetic energy of the molecules from C to D.

.....

.....

.....

.....

..... [2]

(f) Calculate the total kinetic energy of the molecules of the gas at C.

total kinetic energy = ... J [2]

[Total: 20]

End of Paper