3 **(a)** **(i)** State what is meant by the *internal energy* of a system.

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

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

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

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

(ii) Explain why, for an ideal gas, the change in internal energy is directly proportional to the change in thermodynamic temperature of the gas.

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

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

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

…………………………………………………………………………………………………[3]

(b) A cylinder of volume 1.8×10^4 cm^3 contains helium gas at pressure 6.4×10^6 Pa and temperature 25°C.

Helium gas may be considered to be an ideal gas consisting of single atoms.

Calculate, for the helium gas in the cylinder,

(i) the mean kinetic energy of a single helium atom,

mean kinetic energy = ………………….. J [1]

(ii) the number of helium atoms,

number = ………………….. [2]

(iii) the total internal energy.

total internal energy = ………………….. J [1]

(c) Fig. 3.1 is an indicator diagram showing the cycle of changes of ideal gas pressure and volume in an engine. The cycle consists of two adiabatic changes and two isothermal changes. Adiabatic process is one whereby there is no net heat transfer to and from the system. Isothermal process is one whereby the temperature remains the same.

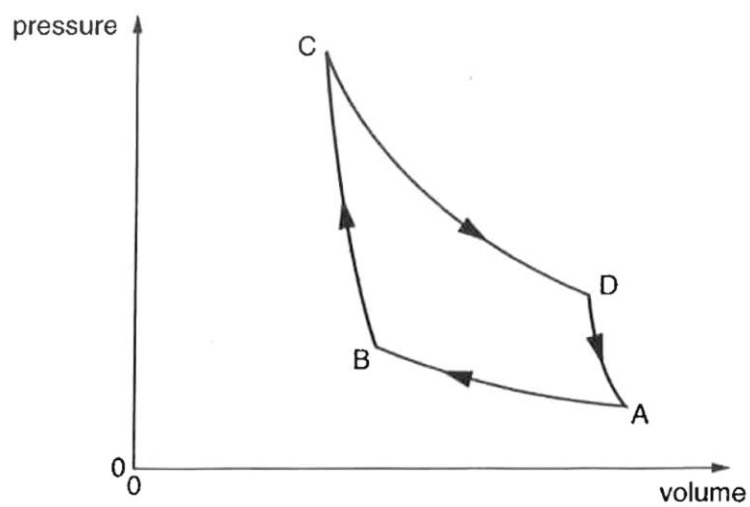

Fig. 3.1

(i) State which sections of the indicator diagram are the isothermal changes.

……………………………………………………………………………………….[1]

(ii) The coefficient of performance of the engine P is given by

$$P = \frac{\text{Heat delivered to gas (during change C to D)}}{\text{Work done on gas (during change A to B)}}$$

The heat delivered to gas (during change C to D) is 160 J.

Calculate the work done on gas during change A to B if the value of P is 1.6.

work done = ………………….. J [1]

(iii) Fig. 3.2 shows some of the energy changes taking place in the engine.

Sections	Increase in internal energy / J	Work done on gas / J	Heat supplied to gas / J
$A \rightarrow B$			
$B \rightarrow C$	+ 70		
$C \rightarrow D$			
$D \rightarrow A$			

Fig. 3.2

Complete Fig. 3.2. Show your working, if any, in the space provided below.

[5]

[Total: 16]

Please turn over for Question 4.