Practice Question Set For A-Level
Subject : Physics
Paper-3 Topic: Section B (Section 11_ Engineering Physics)

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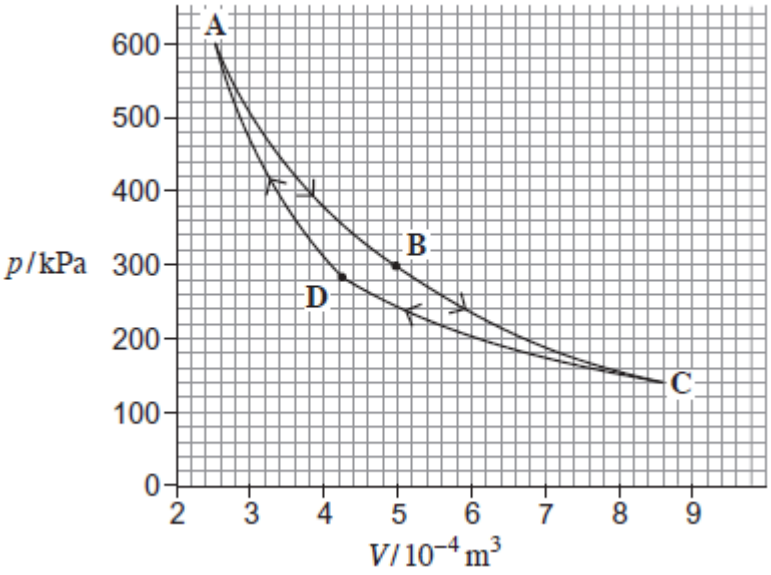
Name of the Student:_____
Max. Marks : 23 Marks **Time : 23 Minutes**

Q1.

The Carnot cycle is the most efficient theoretical cycle of changes for a fixed mass of gas in a heat engine.

The graph below shows the pressure−volume ($p-V$) diagram for a gas undergoing a Carnot cycle of changes **ABCDA**.



(a) (i) Show that during the change **AB** the gas undergoes an isothermal change.

(3)

(ii) Explain how the first law of thermodynamics applies to the gas in the change **BC**.

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_____

_____

_____

_____

(3)

(iii) Determine the ratio $\frac{T_A}{T_C}$,

where T_A is the temperature of the gas at **A** and T_C is the temperature of the gas at **C**.

ratio _____

(3)

(b) Show that the work done during the change **AB** is about 110 J.

(2)

(c) When running at a constant temperature, one practical engine goes through 2400 cycles every minute. In one complete cycle of this engine, 114 J of energy has to be removed by a coolant so that the engine runs at a constant temperature. The temperature of the coolant rises by 18 °C as it passes through the engine.

Calculate the volume of the coolant that flows through the engine in one second.

specific heat capacity of coolant = 3.8×10^3 J kg^{-1} K^{-1}
density of coolant = 1.1×10^3 kg m^{-3}

volume flowing in one second _____ m^3

(3)
(Total 14 marks)

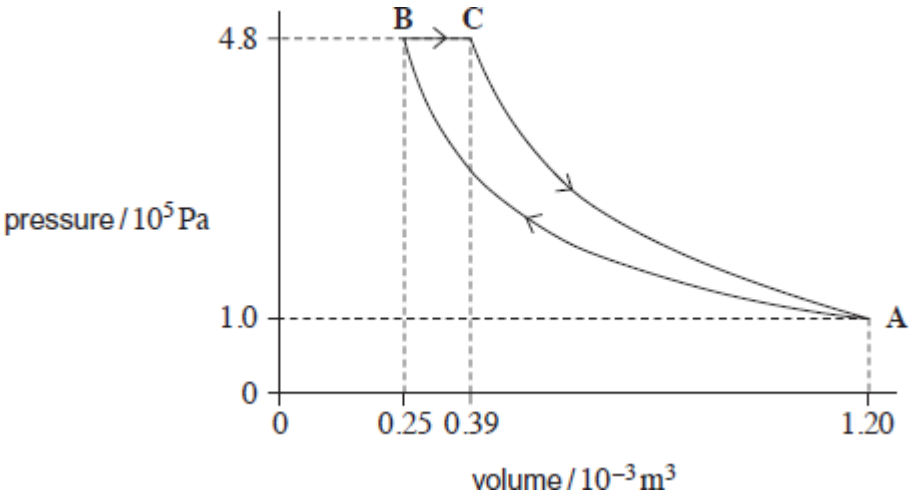
Q2.

The figure below shows a theoretical engine cycle in which a fixed mass of ideal gas is taken through the following processes in turn:

A → B: isothermal compression from volume 1.20×10^{-3} m^3 and pressure 1.0×10^5 Pa to a volume 0.25×10^{-3} m^3 and maximum pressure of 4.8×10^5 Pa.

B → C: expansion at constant pressure with heat addition of 235 J.

C → A: adiabatic expansion to the initial pressure and volume at **A**.



(a) (i) Show that process **A** → **B** is isothermal.

(2)

(ii) Calculate the work done by the gas in process **B** → **C**.

work done _____ J

(1)

(b) Complete the table. Apply the first law of thermodynamics to determine values of Q, W and ΔU for each process and for the whole cycle. Use a consistent sign convention.

	Q / J	W / J	ΔU / J
process A → B		–188	
process B → C	+235		
process C → A		+168	
whole cycle		+47	0

(3)

(c) The overall efficiency of an engine is defined as

$$\frac{\text{net work output in one cycle}}{\text{energy supplied by heating from an external source in one cycle}}$$

Calculate the overall efficiency of the cycle.

overall efficiency _____

(1)

(d) Describe **two** problems that would be encountered in trying to design a real engine based on this cycle.

_____

_____

_____

_____

_____

(2)
(Total 9 marks)