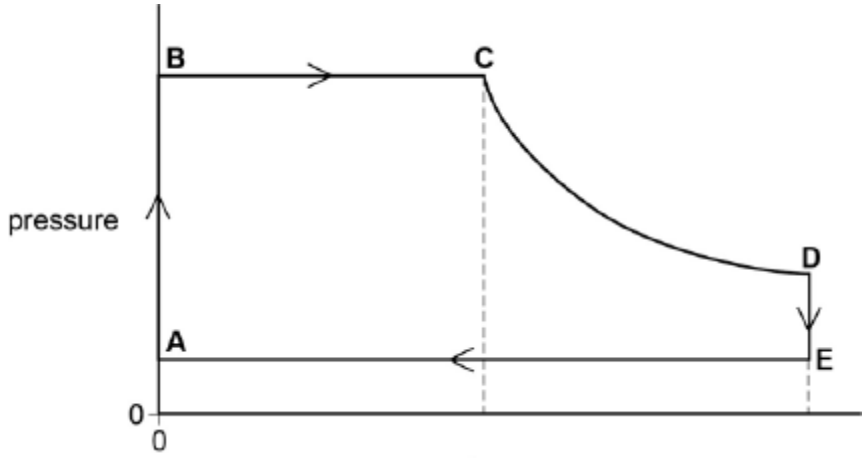
Name of the Student:_____
Max. Marks : 20 Marks **Time : 20 Minutes**

Q1.

A single-cylinder air motor running on compressed air has the theoretical indicator diagram shown in **Figure 1**.

Figure 1



- From **B** to **C** the high-pressure air pushes a piston down a cylinder, doing work.
- At **C**, a valve cuts off the supply of air and the air in the motor expands adiabatically to D, pushing the piston further down the cylinder.
- At **D** an exhaust valve opens and from **D** to **E** to **A** the air is exhausted to the surrounding atmosphere as the piston moves up the cylinder.
- At **A** the exhaust valve closes and the inlet valve opens connecting the cylinder to the supply of compressed air.

(a) Use the first law of thermodynamics to explain why the temperature falls during the adiabatic change between **C** and **D**.

_____

_____

_____

_____

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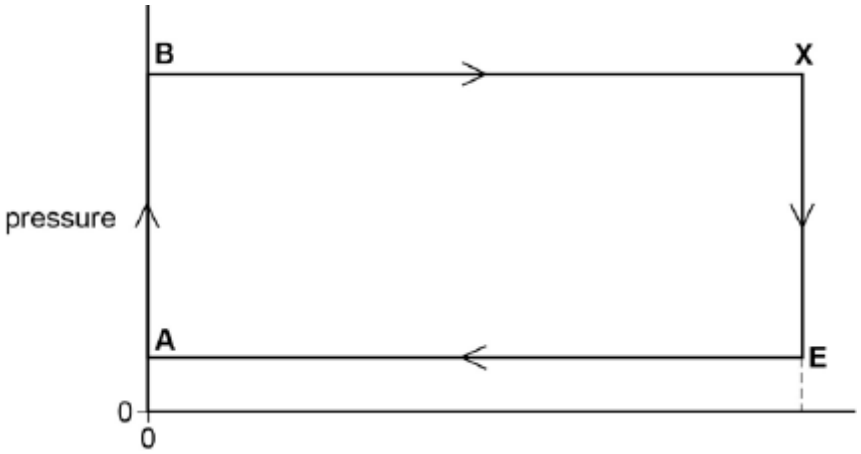
(3)

(b) In practice the cut-off point **C** can be altered without changing points **A**, **B** and **E**.

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Figure 2 shows the theoretical indicator diagram of the motor when the air is admitted for the complete stroke, so that the inlet valve opens at **A** and closes at **X**. The exhaust valve opens at **X** and closes at **A**.

Figure 2



Compare **Figures 1** and **2** and discuss the effect this change has on the operation of the motor, assuming that it continues to run at about the same speed and with air at the same pressure.

You should include in your answer how the change affects:

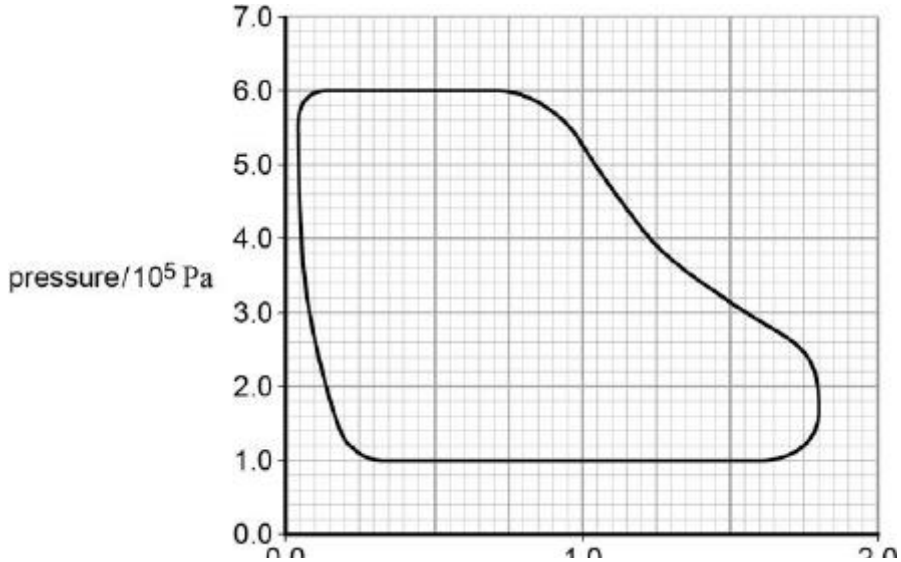
- the rate of consumption of air
- the output torque and power
- the overall efficiency.

(6)

Figure 3 shows the actual indicator diagram for the air motor.

Figure 3

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(c) The motor was running at 20 cycles per second when the indicator diagram was recorded.

Determine the indicated power of the motor.

power = _____ W

(4)

(d) Explain why the indicated power for the air motor is different from the output power.

_____

_____

_____

(1)

(Total 14 marks)

Q2.

A company claims to be able to provide a combined heat and power plant for a market garden that requires both electrical power and space heating for greenhouses. The engine-driven generator will operate between temperatures of 1450 K and 310 K.

(a) Show that the maximum theoretical efficiency of any heat engine operating between temperatures of 1450 K and 310 K is about 80%.

(1)

(b) The company makes the following two claims about the performance of the plant:

- **Claim 1** When consuming biogas of calorific value 55.5 MJ m^{-3} at the rate of 5.00×10^{-3}

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$m^3\ s^{-1}$, the electrical power output will be 210 kW.

- **Claim 2** At the same time the engine will provide heating for greenhouses at the rate of at least 55.0 kW.

Discuss the extent to which the company's claims are justified.

(5)

(Total 6 marks)

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