

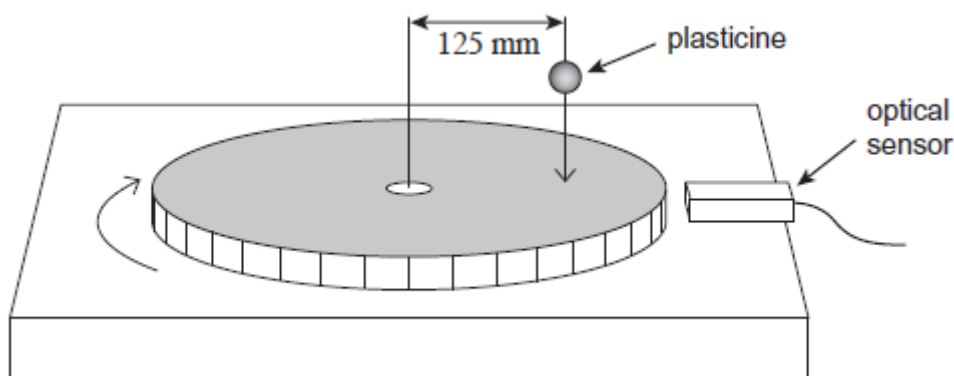
Name of the Student: _____

Max. Marks : 22 Marks

Time : 22 Minutes

Q1.

A student carries out an experiment to determine the moment of inertia of a turntable. The diagram shows the turntable with a small lump of plasticine held above it. An optical sensor connected to a data recorder measures the angular speed of the turntable.



The turntable is made to rotate and then it rotates freely. The lump of plasticine is dropped from a small height above the turntable and sticks to it. Results from the experiment are as follows.

mass of plasticine = 16.0 g

radius at which plasticine sticks to the turntable = 125 mm

angular speed of turntable immediately before plasticine is dropped = 3.46 rad s^{-1}

angular speed of turntable immediately after plasticine is dropped = 3.31 rad s^{-1}

The student treats the plasticine as a point mass.

(a) Explain why the turntable speed decreases when the plasticine sticks to it.

(3)

(b) Use the results of the experiment to determine the moment of inertia of the turntable.

Give your answer to an appropriate number of significant figures.

moment of inertia _____ kg m^2 (3)

- (c) (i) Calculate the change in rotational kinetic energy of the turntable and plasticine from the instant before the plasticine is dropped until immediately after it sticks to the turntable.

change in kinetic energy _____ J (2)

- (ii) Explain the change in rotational kinetic energy.

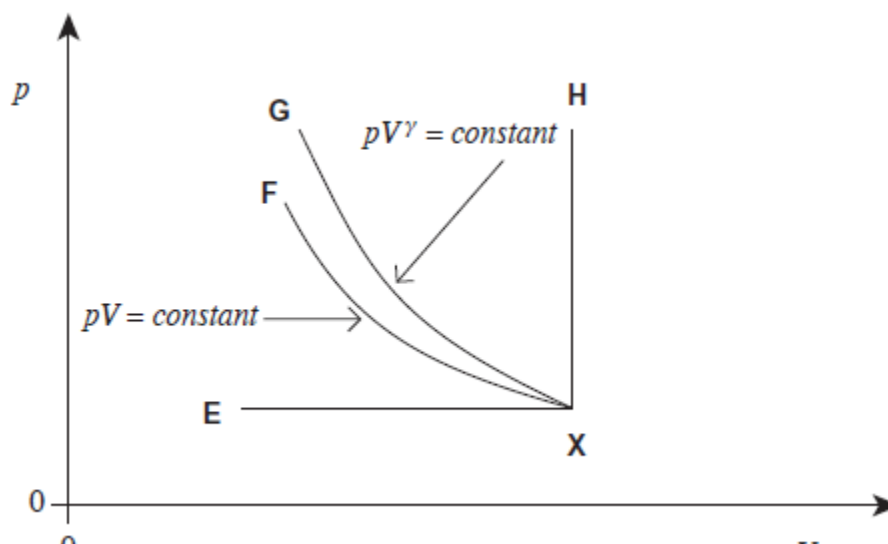
(1)

(Total 9 marks)

Q2.

- (a) A fixed mass of gas undergoes a change from one of states **E**, **F**, **G**, **H** to state **X** as shown on the pressure–volume (p – V) diagram in **Figure 1**.

Figure 1



Which change gives an increase in internal energy of the gas?
Tick (✓) the correct answer.

E to X	
F to X	
G to X	
H to X	

(1)

- (b) **Figure 2** shows a cross-section through the cylinder of a compressor used to supply air at high pressure to an air tank. The air tank is not shown. The high-pressure air in the tank is used to release and apply the brakes on a lorry.

On the outward stroke of the piston, air is drawn into the cylinder at atmospheric pressure through the inlet valve. The outlet valve remains closed. On the inward stroke, the inlet valve closes and the increasing pressure in the cylinder causes the outlet valve to open, forcing air into the tank. A small clearance volume exists when the piston is at the end of its inward stroke. The crankshaft of the pump is driven by the lorry engine by a gear wheel which acts as a flywheel.

Air is pumped into the air tank until the pressure reaches 8.0×10^5 Pa.

Figure 3 shows the idealised $p-V$ diagram for one cycle in the initial stages of pumping, when the pressure in the air tank has reached approximately 4.5×10^5 Pa. The compressed air in the clearance volume at **C** must expand to point **D** before the inlet valve will open.

- (i) The temperature of the air in the cylinder at the start of compression (point **A** on **Figure 3**) is 310 K.
Determine the temperature of the air at the point when the outlet valve is about to open. This is at point **B** on **Figure 3**.

temperature _____ K

(2)

(ii) Determine the net work done **on** the air during the cycle shown in **Figure 3**.

work done _____ J

(3)

Figure 2

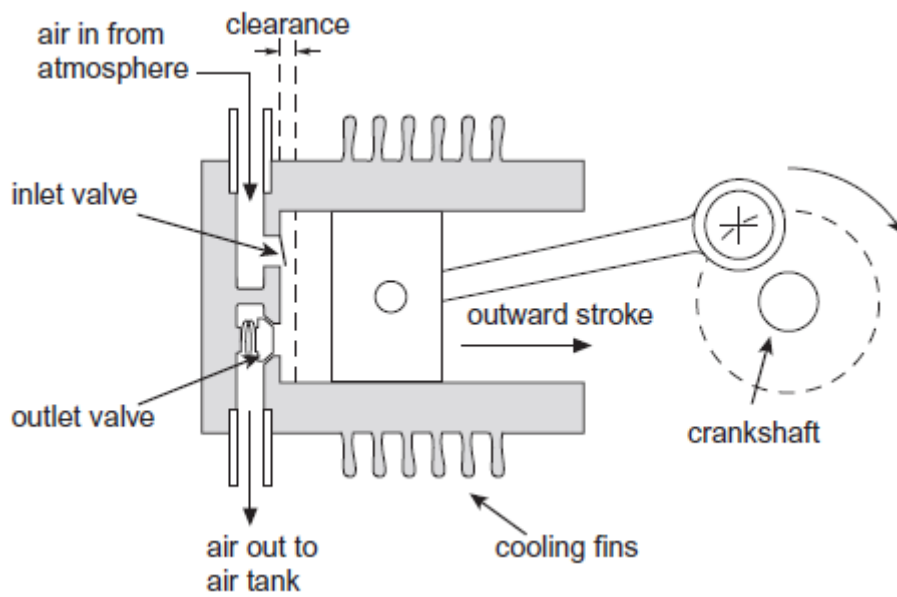
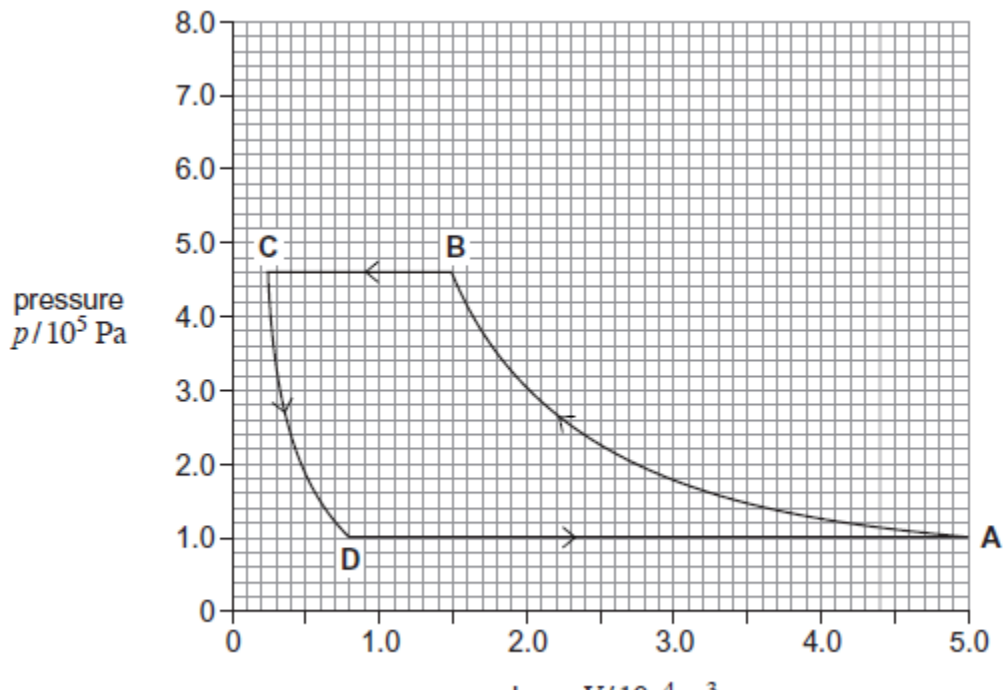


Figure 3



(iii) Determine the power input to the compressor when it runs at 420 revolutions per minute.

power _____ W

(1)

(iv) Explain how the performance of the air compressor changes as the pressure in the tank **increases**. Calculations are not expected.

In your answer you should consider:

- how and why the $p-V$ diagram will change as the pressure in the tank increases
- how the temperature of the air in the cylinder changes
- the power input to the compressor, assuming it runs at constant speed
- the part played by the flywheel on the crankshaft.

The quality of your written communication will be assessed in your answer.

(6)
(Total 13 marks)