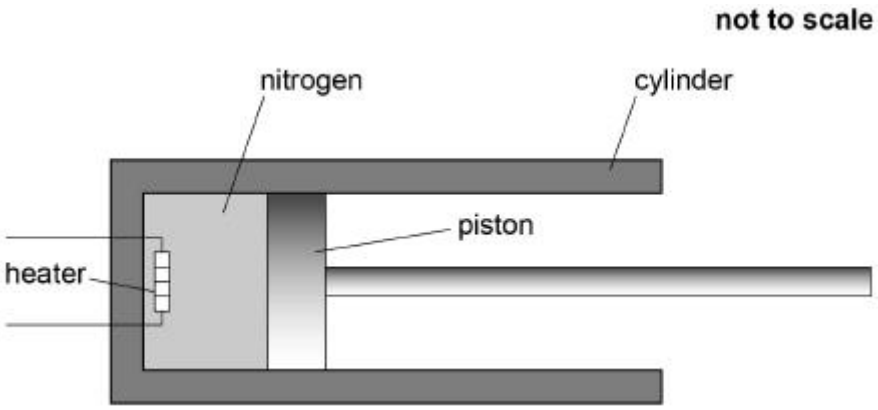
Name of the Student:_____
Max. Marks : 26 Marks **Time : 26 Minutes**

Q1.

The diagram shows a perfectly insulated cylinder containing 0.050 kg of liquid nitrogen at a temperature of 70 K.
A heater transfers energy at a constant rate of 12 W to the nitrogen.
A piston maintains the pressure at 1.0×10^5 Pa during the heating process.



(a) The nitrogen is heated from 70 K and is completely turned into a gas after 890 s.

Calculate the specific heat capacity of liquid nitrogen.
Give an appropriate unit for your answer.

specific latent heat of vaporisation of nitrogen = 2.0×10^5 J kg^{-1}

boiling point of nitrogen = 77 K

specific heat capacity = _____ unit = _____

(5)

(b) The work done by the nitrogen in the cylinder when expanding due to a change of state is **X**.
The energy required to change the state of the nitrogen from a liquid to a gas is **Y**.

Deduce which is greater, **X** or **Y**.

density of liquid nitrogen at its boiling temperature = 810 kg m^{-3}

density of nitrogen gas at its boiling temperature = 3.8 kg m^{-3}

(4)

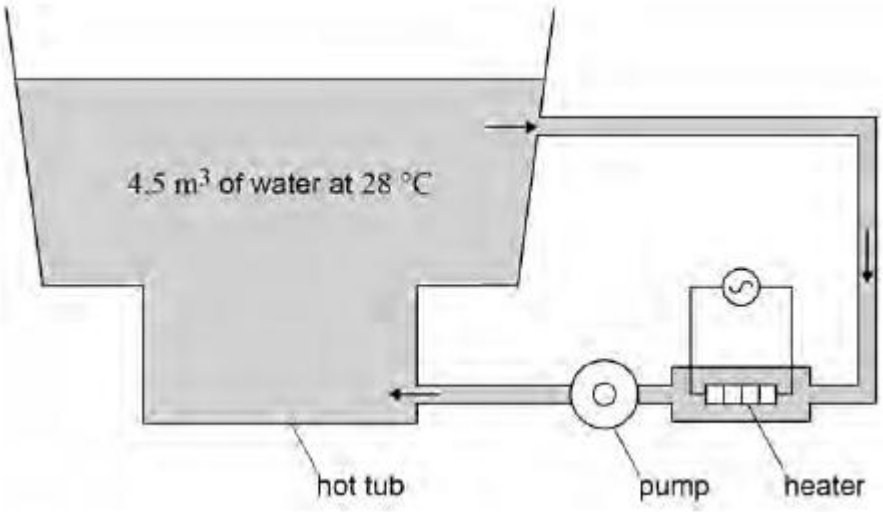
(Total 9 marks)

Q2.

(a) Explain what is meant by specific latent heat of fusion.

(2)

(b) The diagram shows how the temperature of the water is maintained in a hot tub.



The hot tub system has a volume of 4.5 m^3 and is filled with water at a temperature of 28 °C

The heater transfers thermal energy to the water at a rate of 2.7 kW while a pump circulates the water.

Assume that no heat is transferred to the surroundings.

Calculate the rise in water temperature that the heater could produce in 1.0 hour.

density of water = 1000 kg m^{-3}
specific heat capacity of water = 4200 J kg^{-1} K^{-1}

temperature rise = _____ K

(3)

(c) The pump can circulate the water at different speeds.
When working at higher speeds the rise in temperature is greater.

Explain why.
Again assume that no heat is transferred to the surroundings.

_____

_____

_____

_____

_____

(2)

(Total 7 marks)

Q3.

(a) A number of assumptions are made when explaining the behaviour of a gas using the molecular kinetic theory model.

State **one** assumption about the size of molecules.

_____

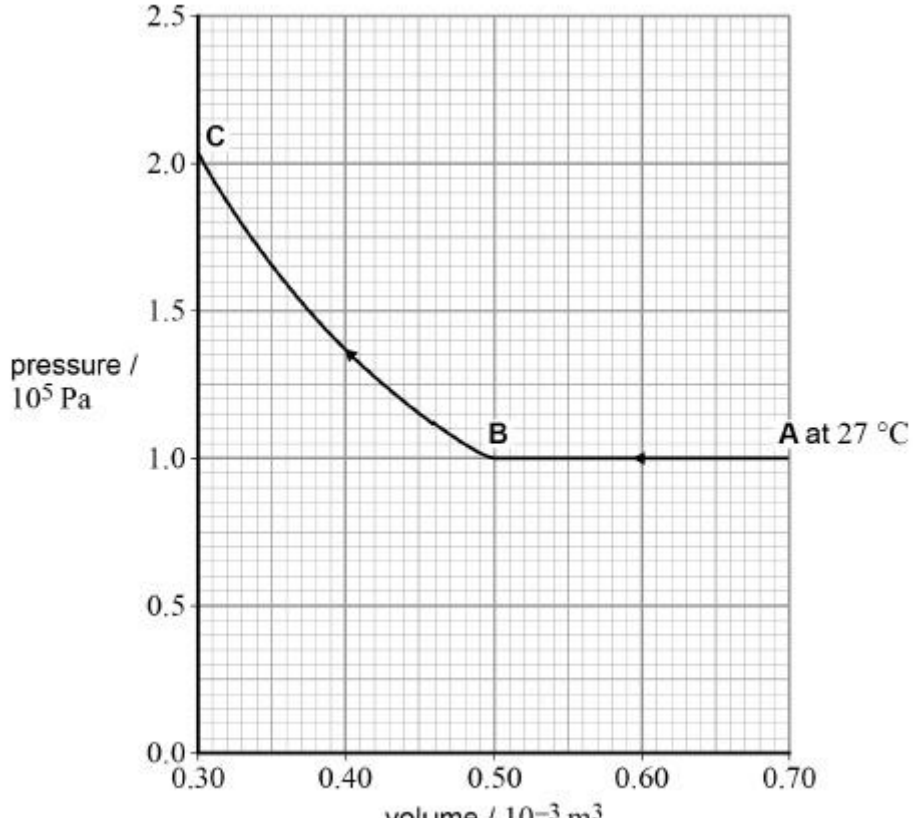
_____

_____

(1)

The graph shows how the pressure changes with volume for a fixed mass of an ideal gas.

At **A** the temperature of the gas is 27 °C. The gas then undergoes two changes, one from **A** to **B** and then one from **B** to **C**.



(b) Calculate the number of gas molecules trapped in the cylinder using information from the initial situation at **A**.

number of molecules = _____

(2)

(c) Calculate, in K, the change in temperature of the gas during the compression that occurs between **A** and **B**.

change in temperature = _____ K

(2)

(d) Deduce whether the temperature of the gas changes during the compression from **B** to **C**.

_____

_____

(2)

(e) Compare the work done on the gas during the change from **A** to **B** with that from **B** to **C** on the graph.

(3)

(Total 10 marks)