Chapter 2·1 WACE Q

Question 1

Geologists collect samples from active volcanoes as shown in the following pictures. The samples are taken, when the molten rock is about 1150°C, with a metal hammer that has a pointed side. The sample is then cooled quickly by placing it and the hammer into a bucket of water.

A geologist takes a 1.78 kg rock sample back to a laboratory and uses an oven that can measure the amount of heat transfer in order to make an accurate measurement of the rock's specific heat capacity.

(a) Calculate the specific heat capacity (including the units) of the rock sample, given the rock absorbs 1.57×10^6 J of energy to increase its temperature by 1050°C. (3 marks)

(b) The geologist could have estimated the specific heat capacity of the rock by measuring the temperature of the water in the bucket before and after adding the hot solidified rock and hammer to it. Give a reason why this method would not give an accurate result. (1 mark)

Question 2

(3 marks)

When we go to bed on a winter's night we usually cover ourselves with a blanket, doona or quilt to keep warm. Explain briefly how this keeps us warm by referring to the three methods of heat transfer listed below.

Conduction: _____

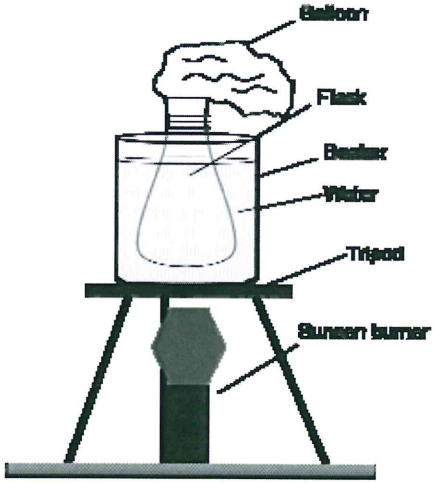
Convection: _____

Radiation: _____

Question 3

(12 marks)

An empty, clean and clear flask was put into a refrigerator for one hour. The flask was then taken from the refrigerator and a balloon was placed on the open end of the flask. The flask was then placed into a beaker with hot water, as shown below.



(a) Explain what was seen to happen to the balloon as the gas in the flask absorbed the thermal energy from the hot water. (2 marks)

_____

_____

_____

(b) Indicate the form of energy transfer (conduction, convection or radiation) that occurred in the following situations: (3 marks)

(i) between the Bunsen burner flames and the tripod: _____

(ii) between the tripod and the beaker: _____

(iii) between the water and the flask: _____

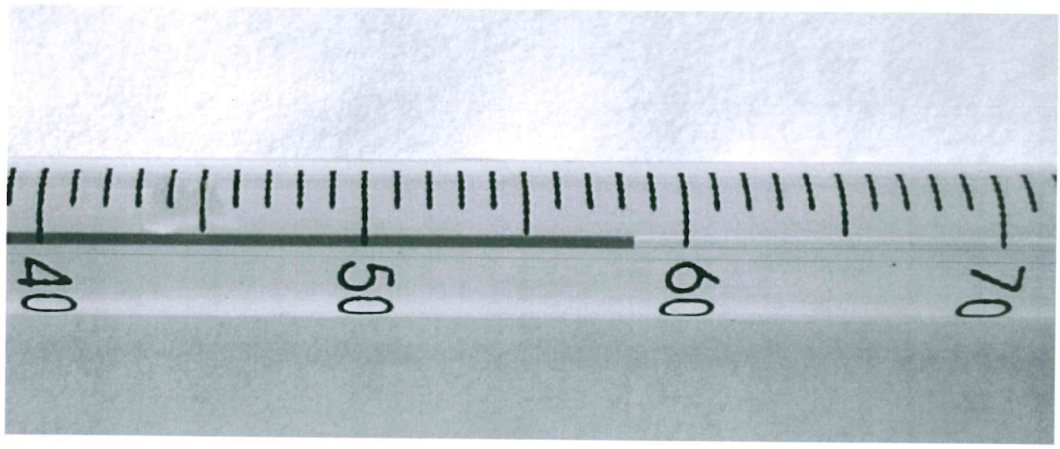
(c) Consider the following statements describing what happens when the water and the gas in the balloon are at the same temperature. (2 marks)

A The water has more internal energy overall than the gas.
B The average energy of the water's molecules is greater than the average energy of the gas molecules.
C The heat will flow from the water to the gas.

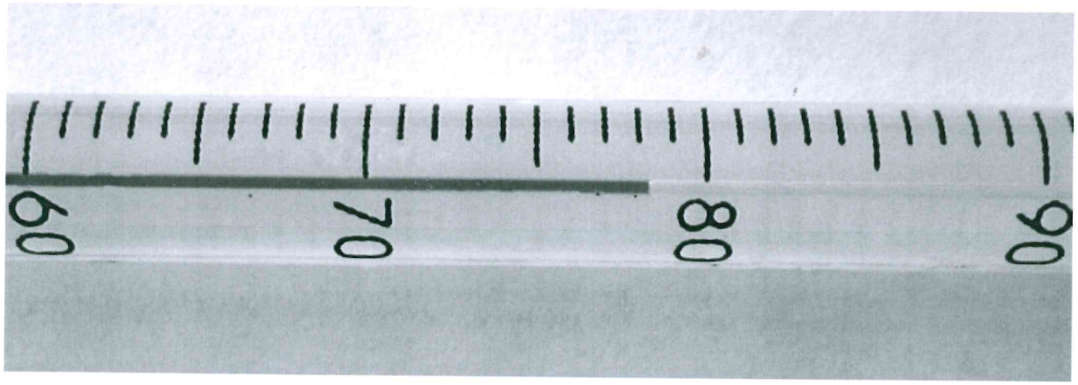
Which of the above statements is or are true? _____

Question 3 cont

(d) A thermometer was used to measure the temperature of the water in degrees Celsius at two different times, labelled 'before' and 'after'. Determine the readings, then calculate the temperature change and the absolute uncertainty of the temperature difference. Use significant figures appropriately. (5 marks)



Temperature before: _____



Temperature after: _____

Temperature difference: _____

Absolute uncertainty: _____

Question 4

(11 marks)

An experiment completed by Jess and Ben in a Stage 2 Physics class is outlined below.

7.87×10^{-2} kg of an unknown metal is heated in an oven until it reaches 95.0°C. It is then transferred to an insulated copper calorimeter containing 7.50×10^{-2} kg water, both of which are at 18.0°C. The copper that makes up the calorimeter has a mass of 4.43×10^{-2} kg with a specific heat capacity of 440 J kg^{-1} K^{-1}. The final temperature of 25.0°C is recorded after equilibrium is achieved.

Jess and Ben are able to derive formulae for the changes that are occurring:

$$\text{Metal's energy change} = m_{metal} \times c_{metal} \times (T_f - T_i)_{metal}$$

$$\text{Calorimeter's energy change} = \left[m_{copper} \times c_{copper} \times (T_f - T_i)_{copper}\right] + \left[m_{water} \times c_{water} \times (T_f - T_i)_{water}\right]$$

They know that energy should be conserved, so the magnitude of the two energy changes should be equal.

(a) Calculate the specific heat capacity of the unknown metal given the above information.
(4 marks)

(b) It is difficult to determine the exact value of the specific heat due to laboratory conditions.

(i) What is one possible source of error that Jess and Ben might have encountered?
(1 mark)

(ii) How would you expect the students' calculated specific heat capacity value to compare to the known value?
(2 marks)

(iii) What could they do to improve their results?
(1 mark)

(c) Jess and Ben had to write a conclusion to their experiment, but found it difficult to distinguish between heat and temperature. Write a simple definition for the terms 'heat' and 'temperature' as they would apply to the experiment above.

(i) Heat
(2 marks)

(ii) Temperature
(1 mark)