Physics ATAR - Year 11

Thermal Physics Test 2019

Name:	Mark: / 51 = % Teacher: CJO JRM PCW

Time Allowed: 50 Minutes

Notes to Students:

1. You must include **all** working to be awarded full marks for a question.
2. Marks will be deducted for incorrect or absent units and answers stated to an incorrect number of significant figures.
3. **No** graphics calculators are permitted – scientific calculators only.

ADDITIONAL FORMULAE AND DATA

First Law of Thermodynamics: $\boldsymbol{\Delta U = Q - W}$

Temperature Conversion: K = C + 273

Question 1 **(9 marks)**

During an exercise routine, a 65.0 kg person may give off 7.50×10^2 kJ of heat in 35.0 minutes by evaporation of sweat from the skin.

(a) Calculate the mass of water that has been lost by evaporation of sweat.

(3 marks)

(b) Although the energy removed draws heat from mass of the person, explain why their overall body temperature remains at a constant 37.0 °C.

(3 marks)

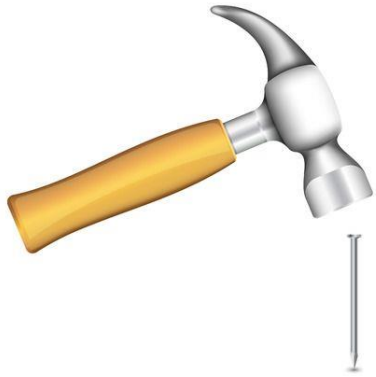
The person notices that on a particularly humid day, the same exercise routine is a lot more exhausting and uncomfortable than when it is a dry day.

(c) Explain, making reference to relevant modes of heat transfer why this is the case.

(3 marks)

Question 2 **(8 marks)**

A 1.40 kg hammer is travelling at a speed of 1.80 ms^{-1} as it strikes a nail at room temperature (25.0 °C) and is brought to rest.



(a) Calculate the temperature rise of a 8.00 g iron nail if the nail is struck 10 times in quick succession.

(4 marks)

(c_{Fe} = 4.50x10^2 $Jkg^{-1}K^{-1}$)

(b) State two assumptions made in the calculations for part (a)

(2 marks)

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(c) Sketch a labelled temperature time curve of the nail if it is allowed to sit for an indefinite period of time.

(2 marks)

Question 3 **(8 marks)**

A mass of ice at -15.0 °C is placed into an insulated copper calorimeter of mass 0.350 kg containing 0.240 kg of water, both initially at 28.0 °C. The resulting temperature is recorded to be 17.0 °C.

(a) Calculate the mass minimum mass of ice required to produce this temperature change. (5 marks)

(c_{cu} = 3.90×10^2 $Jkg^{-1}K^{-1}$)

(b) Explain why the mass of ice calculated in (a) is described as “minimum mass”. (3 marks)

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Question 4 **(8 marks)**

The equation for heat flow through a substance via conduction is given as: $\frac{Q}{t} = \frac{kA\Delta T}{L}$.

Where k = thermal conductivity
A = cross sectional area (m^2)
L = thickness of material (m)
ΔT = temperature difference (K)

(a) Using dimensional analysis, determine the units of thermal conductivity.

(2 marks)

A major source of heat loss from a house is through windows. Consider a glass window 5.00 mm thick and 2.50 m by 1.60 m in area. The inside temperature is 23.00 °C and the outside temperature is 22.60 °C.

(b) If the thermal conductivity of the glass is 0.820, calculate the rate of heat flow through the glass.

(3 marks)

(c) State and explain, making reference a relevant mode of heat transfer, one modification that can be made to the window that will reduce the rate of heat transfer.

(3 marks)

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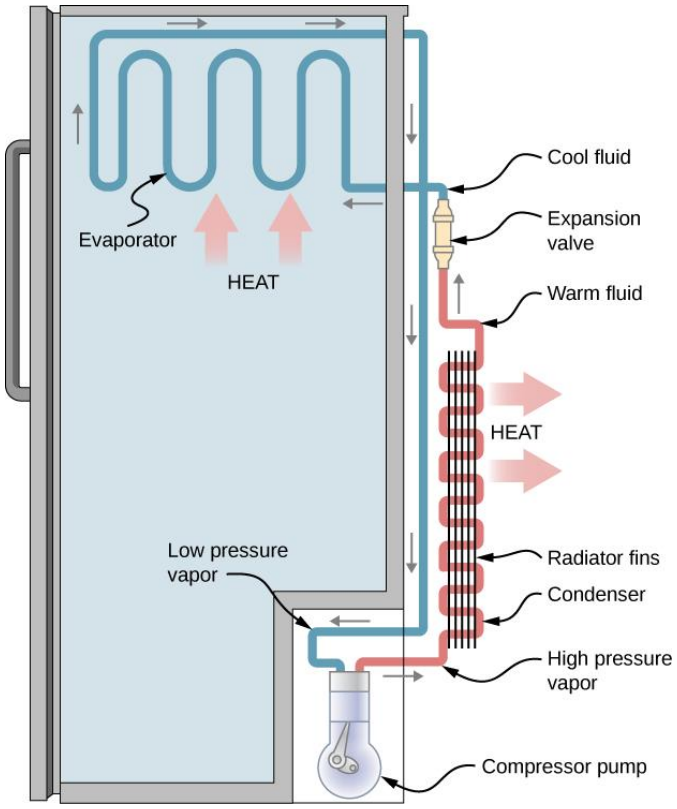
Question 5 **(12 marks)**

The diagram provided shows the movement of refrigerant through a refrigeration cycle. In order for heat to be successfully removed from the inside of the refrigerator, a compressor must do work on the system by compressing the vapour as it cycles to the rear of the refrigerator.



(a) Describe the effect that compressing the vapour has on its temperature, making reference to the kinetic theory of matter or relevant scientific laws.

(3 marks)

The compressor does 7550 J of work on 0.0550 kg of refrigerant vapour initially at 12.0 °C in a given time period.

(b) Providing there is no phase change at the location, calulate increase in internal energy of the refrigerant and the final temperature of the refrigerant.

(4 marks)

$C_{refrigerant}$ = 2740 $Jkg^{-1}K^{-1}$

(c) On the diagram of the refrigerator on the previous page:

i. circle the region where the refrigerant is drawing heat from its surroundings in order to evaporate.

(1 mark)

ii. the region where the refrigerant is doing work on its surroundings.

(1 mark)

The radiator fins at the rear of the refrigerator play an important role of removing heat at the greatest rate possible.

(e) State and explain one feature of the radiator fins that maximises this heat transfer.

(3 marks)

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Question 6 **(2 marks)**

Provide one similarity and difference between conduction and convection.

Similarity:_____

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Difference: _____

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Question 7 (4 marks)

A student wishes to determine the initial temperature of a 0.352 kg piece of copper. He heats the copper in an oven and then places the piece in an insulated foam container containing 0.750 kg of Water at 20.00 C. The final temperature of the mixture is measured to be 24.50 C. Calulate the initial temperature of the copper.

$C_{copper} = 3.90 \times 10^{2}\ Jkg^{-1}K^{-1}$

END OF TEST