HOLY CROSS COLLEGE
Life to the Full

Western Australian Certificate of Education
ATAR course examination, 2018

Question/Answer Booklet

11 PHYSICS

Test 3 - Heating and Cooling

Name SOLUTIONS

Student Number: In figures | | | | | | | | |

Mark: ___/25

In words

Time allowed for this paper
Reading time before commencing work: five minutes
Working time for paper: fifty minutes

Materials required/recommended for this paper
To be provided by the supervisor
This Question/Answer Booklet
Formulae and Data Booklet

To be provided by the candidate
Standard items: pens, (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters

Special items: non-programmable calculators satisfying the conditions set by the School Curriculum and Standards Authority for this course

Important note to candidates
No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of exam
Section One: Short Answers	4	4	15	11	44
Section Two: Problem-solving	3	3	35	14	56
Section Three: Comprehension					
				Total	100

Instructions to candidates

1. The rules for the conduct of examinations at Holy Cross College are detailed in the College Examination Policy. Sitting this examination implies that you agree to abide by these rules.

2. Write your answers in this Question/Answer Booklet.

3. Working or reasoning should be clearly shown when calculating or estimating answers.

4. You must be careful to confine your responses to the specific questions asked and to follow any instructions that are specific to a particular question.

5. Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

   - Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
   - Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

6. Answers to questions involving calculations should be ***evaluated and given in decimal form.*** It is suggested that you quote all answers to ***three significant figures***, with the exception of questions for which estimates are required. Despite an incorrect final result, credit may be obtained for method and working, providing these are ***clearly and legibly set out***.

7. Questions containing the instruction "estimate" may give insufficient numerical data for their solution. Students should provide appropriate figures to enable an approximate solution to be obtained. Give final answers to a maximum of two significant figures and include appropriate units where applicable.

8. Note that when an answer is a vector quantity, it must be given with magnitude and direction.

9. In all calculations, units must be consistent throughout your working.

DATA

Use the data sheet plus the following table.

Table of Specific Heats ($J\ kg^{-1}\ K^{-1}$)	
Water	4.18×10^3
Pewter	1.43×10^2
Steam	2.00×10^3
Glass	8.40×10^2
Ice	2.10×10^3
Aluminium	8.80×10^2
Ethylene Glycol	2.40×10^3
Air	1.00×10^3
Copper	3.90×10^2
Stainless Steel	4.45×10^2
Lead	1.30×10^2
Av. Human Body	3.50×10^3

1. Distinguish between the terms ***heat*** and ***temperature***. [2 marks]

HEAT: the flow of energy from one object to another due to a temperature difference. (1)

TEMPERATURE: a measure of the average E_K of the particles in an object. (1)

2. Liquid sodium metal is used to transfer heat in some nuclear reactors.

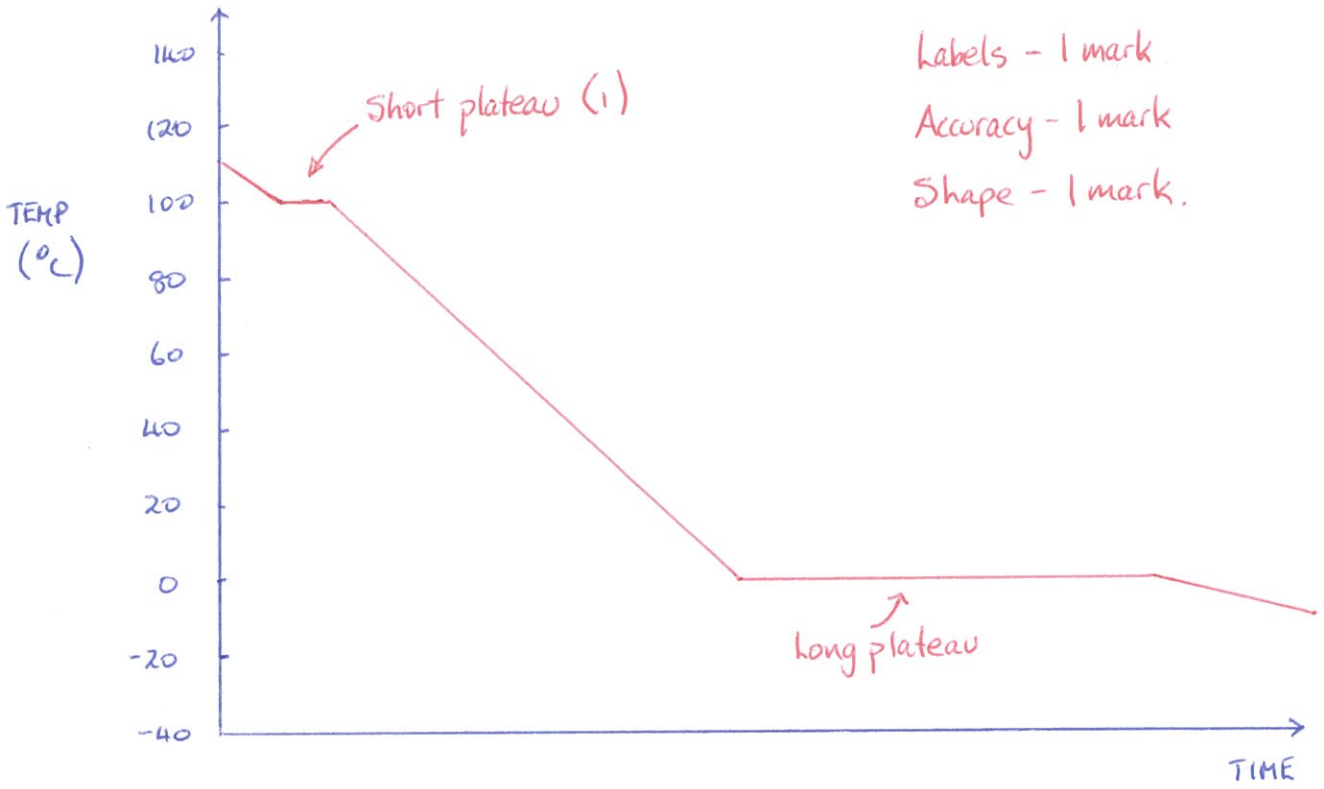
   (a) What is the main method of heat transfer in the reactor cooling system? [1 mark]

   - convection currents (1)

   (b) Give ***one*** reason why liquid sodium is used in preference to water. [2 marks]

   - Sodium has a much higher boiling point than H_2O. (1)
   - Remains liquid and can transfer heat quickly. (1)

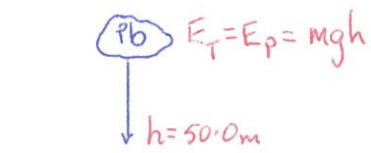
3. Draw a labelled graph showing the cooling curve for steam at 110 °C being turned into ice at -10 °C in a closed system. [4 marks]



4. A person spends 30 minutes swimming in a pool with the water heated to 32 °C. The air temperature is 34 °C and there is a warm easterly wind blowing at 10 kmh^{-1}. When the person emerges from the pool, she immediately feels cold. Give reasons why this occurs. [2 marks]

- Wind blows evaporated particles from above the skin. (1)
- More H_2O can evaporate, drawing heat from the skin and making her feel cold. (1)

5. A 3.00 kg lump of lead is dropped from a height of 50.0 m and lands on a hard surface. If 35.0% of the energy on impact is absorbed by the lead as heat, calculate the change in temperature of the metal. [4 marks]



35.0% of E_p (top) is absorbed.

ie. $Q = 0.350 \times mgh$

$= (0.350)(3.00)(9.80)(50.0)$ (1)

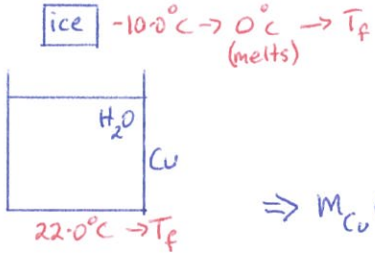
$= 5.145 \times 10^2\ J$ (1)

$Q = m_{Pb} c_{Pb} \Delta T$

$\Rightarrow \Delta T = \dfrac{5.145 \times 10^2}{(3.00)(1.30 \times 10^2)}$ (1)

$= \underline{1.32\ ^\circ C}$ (1)

6. A 50.0 g copper calorimeter contains 85.0 g of water at 22.0 °C. 5.00 g of ice at -10.0 °C is added carefully and the contents gently stirred until all of the ice has melted. Calculate the final temperature of the mixture. [5 marks]



$Q_{lost} = Q_{gained}$

$\Rightarrow m_{Cu} c_{Cu} \Delta T + m_w c_w \Delta T = m_i c_i \Delta T + m_i L_f + m_i c_w \Delta T$ (2)

$\Rightarrow (0.0500)(3.90 \times 10^2)(22.0 - T_f) + (0.0850)(4.18 \times 10^3)(22.0 - T_f) = (0.00500)(2.10 \times 10^3)(0.0 - (-10.0))$

$+ (0.00500)(3.34 \times 10^5) + (0.00500)(4.18 \times 10^3)(T_f - 0.0)$ (2)

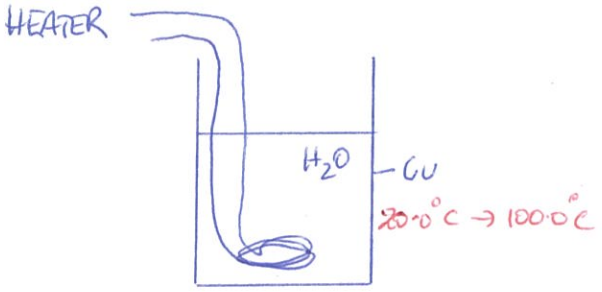
$\Rightarrow 429.0 - 19.50\,T_f + 7.817 \times 10^3 - 355.3\,T_f = 105.0 + 1.670 \times 10^3 + 20.90\,T_f$

$\Rightarrow 6.471 \times 10^3 = 395.7\,T_f$

$\Rightarrow \underline{T_f = 16.3^\circ C}$ (1)

7. A 1.20 kW electrical heater is placed into 2.50 x 10^2 g of water in a 1.30 x 10^2 g copper calorimeter. If the heater is 70.0 % efficient, how long does it take to bring the water to the boil, given it is initially at 20.0 °C? [5 marks]

$P = 1.20 \times 10^3$ W



$Q_{needed} = m_w C_w \Delta T + m_{Cu} C_{Cu} \Delta T$ (1)

$= (0.250)(4.18 \times 10^3)(80.0) + (0.130)(3.90 \times 10^2)(80.0)$

$= 8.766 \times 10^4$ J (1)

$0.700\,P = \frac{Q}{t}$

$\Rightarrow t = \frac{8.766 \times 10^4}{(0.700)(1.20 \times 10^3)}$ (1)

(1)

$= \underline{104\ s}$ (1)