Life to the Full

Western Australian Certificate of Education
ATAR course examination, 2019

Question/Answer Booklet

11 PHYSICS

Test 3 - Heating and Cooling

Name SOLUTIONS

Student Number: In figures

Mark: $\frac{}{28}$

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					
Section Two: Problem-solving	7	7	50	28	100
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. Karen wants to cool a glass of Coke at room temperature down to a reasonable drinking temperature. She is not worried about diluting the drink. She is deciding between adding 50 g of ice at 0 °C or 50 g of water at 0 °C. Which would be better and why? Justify your answer without calculation. Equations will be useful. (3 marks)

- 50 g of ice. (1)
- $Q_{ice} = m_i L_f + m_i c_w \Delta T$ $\quad Q_{water} = m_w c_w \Delta T$ (1)
- The ice needs to melt first, so it absorbs more heat from the Coke. (1)

2. After running hard during a game of soccer on a warm autumn day, Steven was covered in sweat as he walked to the huddle at half-time. A gentle breeze was blowing, making him feel cold and he shivered a little. Explain, using Physics principles, how the sweat and wind is helping cool Steven's body. (4 marks)

- Sweat (water) sits on the skin and evaporates. (1)
- To do this, it absorbs heat from the skin, making it cooler. (1)
- The wind blows evaporated water molecules away from above the skin. (1)
- This allows more water molecules evaporate from the skin, cooling it further. (1)

3. This is a photo of a lawn mower engine. It does not use a cooling system involving a coolant circulating around the engine. Label any features that allow it to cool and explain how they achieve this. (3 marks)

COOLING FINS (1)

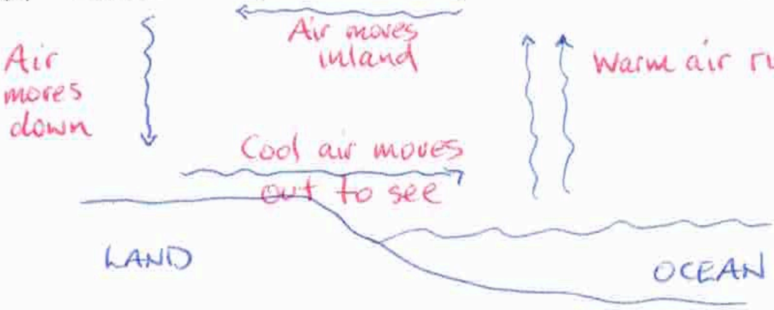
- The fins increase the surface area of the motor. (1)
- This allows heat to be radiated at a faster rate. (1)

4. During summer, Perth experiences strong easterly winds (winds from over the land).

(a) Draw a simple labelled diagram to show how the air moves. (2 marks)

(b) Explain the Physics behind why the air moves this way. (2 marks)

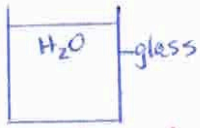
(a)



Correct direction (1)
Labels (1)

(b)
- Ocean is warmer than the land. ($\frac{1}{2}$)
- Warm air over the ocean becomes less dense and rises. (1)
- Cool air moves out to sea to take its place. ($\frac{1}{2}$)

5. In the laboratory, a 245 g glass beaker containing 195 g of water at 19.0 °C is placed above a Bunsen burner. How much heat energy needs to be supplied to raise the water to boiling point? (4 marks)



$\Delta T = 19°C \rightarrow 100°C$

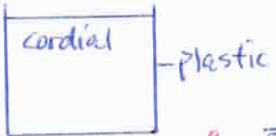
$$Q = m_w C_w \Delta T + m_g C_g \Delta T \quad (1)$$
$$= (0.195)(4.18\times10^3)(81.0) + (0.245)(8.40\times10^2)(81.0) \quad (1)$$
$$= \underline{8.27\times10^4\ J} \quad (1)$$

↑ Conversions (1)

6. How much ice at -5.00 °C needs to be added to a 75.0 g plastic cup holding 275 g of orange cordial at 18.0 °C to cool it to 9.00 °C? Assume the specific heat of the cordial is the same as water. ($c_{plastic}$ = 1.67 x 10^3 $Jkg^{-1}K^{-1}$) (5 marks)

$\boxed{\text{ice}}$ $-5°C \rightarrow 0°C \rightarrow$ melts $\rightarrow 9°C$
$\Delta T \quad L_f \quad \Delta T$

$$Q_{lost} = Q_{gained}$$



$\Delta T = 18°C \rightarrow 9°C$

$$\Rightarrow m_c C_c \Delta T + m_p C_p \Delta T = m_i C_i \Delta T + m_i L_f + m_i C_w \Delta T \quad (2)$$
$$\Rightarrow (0.275)(4.18\times10^3)(9.00) + (0.0750)(1.67\times10^3)(9.00) =$$
$$m_i(2.10\times10^3)(5.00) + m_i(3.34\times10^5) + m_i(4.18\times10^3)(9.00) \quad (2)$$
$$\Rightarrow 1.147\times10^4 = 3.821\times10^5\, m_i$$
$$\Rightarrow \underline{m_i = 3.00\times10^{-2}\ kg} \quad (1)$$

7. A stainless-steel kettle of mass 1.10 kg holds 1.30 L of water at 21.0 °C. The heating element is rated at 2.40 kW and is 65.0 % efficient in transferring heat to the water and steel. How long will it take for the water to start boiling? (5 marks)

$$Q_{needed} = m_w c_w \Delta T + m_c c_s \Delta T$$

$$= (1.30)(4.18\times10^3)(79.0) + (1.10)(4.45\times10^2)(79.0) \quad (1)$$

$$= 4.68\times10^5 \text{ J} \quad (1)$$

(1) $0.650\,P = \frac{Q}{t}$

$$\Rightarrow \quad t = \frac{4.68\times10^5}{(0.650)(2.40\times10^3)} \quad (1)$$

$$= \underline{3.00\times10^2 \text{ s}} \quad (1)$$