HOLY CROSS COLLEGE

Life to the Full

Western Australian Certificate of Education
ATAR course examination, 2017

Question/Answer Booklet

11 PHYSICS

Test 4 - Heating and Cooling

Name SOLUTIONS

Student Number: In figures

Mark: $\overline{}$ / 29 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.

1. Explain why a pump gets hot while you pump up a bicycle tyre or a football with it. [2 marks]

• Air particles are pushed closer together, so E_p decreases. (1)

• If E_p decreases, energy must leave the system, so it feels hot. (1)

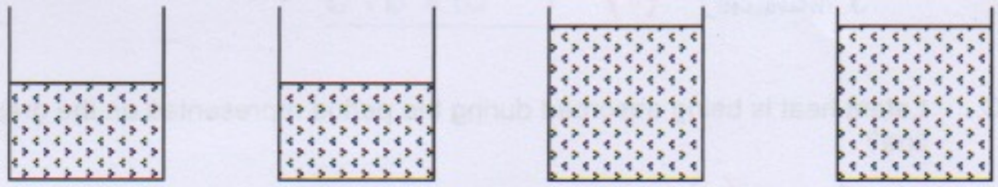
2. Which of the following statements are ***true***?

I A temperature of 50° C is the same as a temperature of 50 K.
II A temperature rise of 50° C is the same as a temperature rise of 50 kelvin.
III A temperature fall of 50° C is the same as a temperature fall of 50 kelvin.

A. I and II only
B. I and III only
C. II and III only (1)
D. I, II and III

[1 mark]

3. Four identical beakers **I, II, III and IV** are placed on a large electric hotplate. **I** and **II** are half-full and **II** and **IV** are full of tap water at the same initial temperature. **I** and **IV** are placed on the hotplate for 2.5 minutes, **III** is left on for 5 minutes and **II** is left on for 10 minutes. At the end of each of these periods, the particular beaker is removed from the hotplate. The water does not boil in any of the beakers.



I	II	III	IV
Half Full	*Half Full*	*Full*	*Full*
2.5 minutes	*10 minutes*	*5 minutes*	*2.5 minutes*

A. Which one of the beakers of water will absorb the greatest amount of heat in total? [1 mark]

II (1)

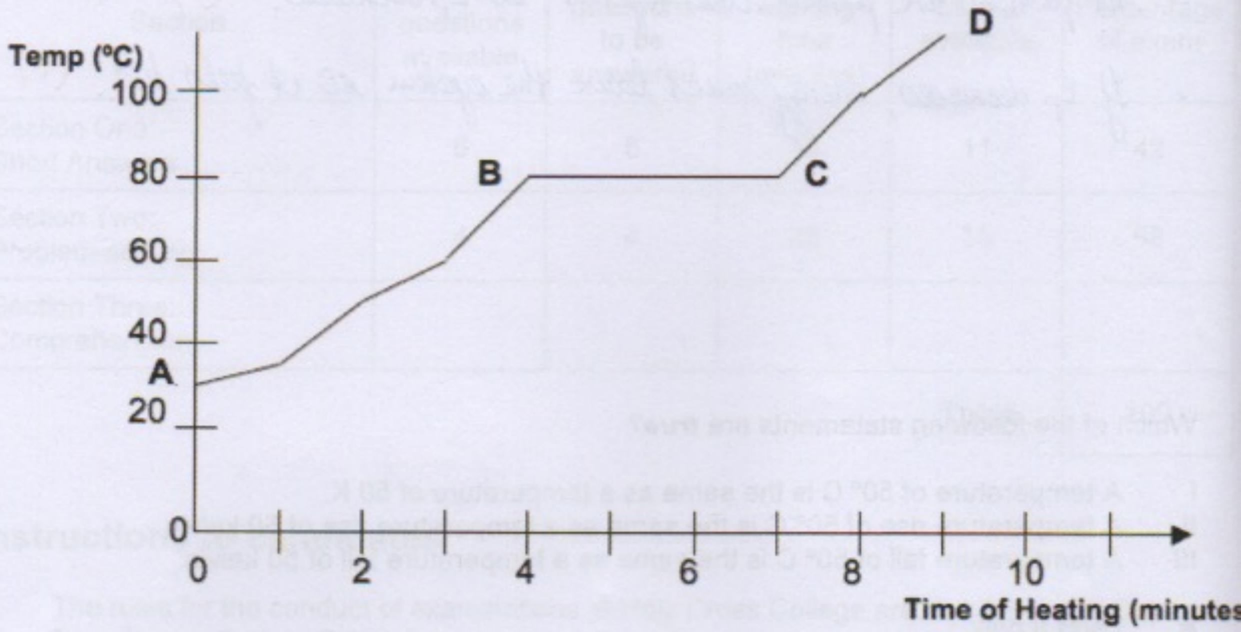
B. Which one of the beakers of water will have the lowest temperature immediately after being heated? [1 mark]

IV (1)

C. Which two beakers of water will have almost the same final temperature after being heated? [2 marks]

I and III (1 each)

4. An experiment was carried out in which some solid naphthalene crystals were warmed in a test tube. The graph below represents the results obtained.



A. Referring to the graph, what phase/s would be present between C and D? [1 mark]

liquid (1)

B. How long did it take the naphthalene to melt? [1 mark]

3 minutes (1)

C. Latent heat is being absorbed during the period represented on the graph by which line? [1 mark]

BC (1)

5. Use the Kinetic Theory to explain the difference between ***heat*** and ***temperature***. [2 marks]

HEAT: total of the E_p and E_k of the particles. (1)

TEMPERATURE: measure of the average E_k of the particles. (1)

6. Explain why a person standing in a breeze is more likely to feel cold if their clothes are wet rather than dry.

[2 marks]

• Breeze blows evaporated particles away from the surface of the clothes. (1)

• More H_2O particles can now evaporate, carrying heat away and decreasing the temperature of the clothes. (1)

7. At the end of a marathon run, an athlete's body temperature may be 3.2 ºC above normal body temperature.

If the mass of the athlete is 55.0 kg, how much energy is required to produce this change in temperature?

(Assume the average specific heat of the athlete is 3.50×10^3 $Jkg^{-1}C^{-1}$)

[3 marks]

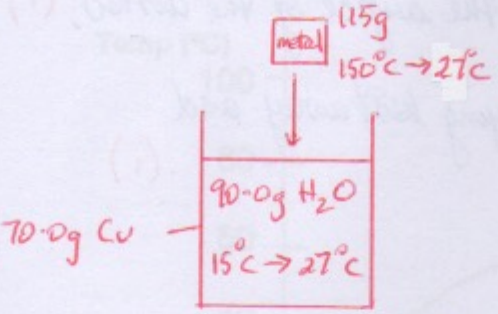
$$Q = mc\Delta T \quad (1)$$

$$= (55.0)(3.50 \times 10^3)(3.2) \quad (1)$$

$$= \underline{6.16 \times 10^5 \text{ J}} \quad (1)$$

8. In an experiment to determine the specific heat of an unknown metal, a 1.15×10^2 g sample at 1.50×10^2 °C is placed carefully into a 70.0 g copper calorimeter containing 90.0 g of water, initially at 15.0 °C. If the final temperature reached is 27.0 °C, determine the specific heat of the metal.

[4 marks]



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

$$\Rightarrow m_m c_m \Delta T = m_w c_w \Delta T + m_{Cu} c_{Cu} \Delta T \quad (2)$$

$$\Rightarrow (0.115)\, c_m (1.50\times10^2 - 27.0) = (0.0900)(4.18\times10^3)(27.0-15.0) + (0.0700)(3.90\times10^2)(27.0-15.0) \quad (1)$$

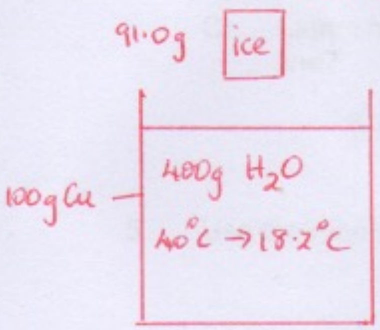
$$\Rightarrow \underline{c_m = 3.42\times10^2\ \mathrm{J\,kg^{-1}\,K^{-1}}}. \quad (1)$$

9. A copper calorimeter of mass 1.00×10^2 g contains 4.00×10^2 g of water at 40.0 ° C. When 91.0 g of ice at 0.00° C is added, the final temperature of the water is 18.2° C.

Use this information to determine the latent heat of fusion of water. ***Assume that there is no heat loss to the environment.***

[4 marks]

0°c → melts → 18.2°c,



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

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

$$\Rightarrow (0.0910)\, L_f + (0.0910)(4.18\times10^3)(18.2-0) = (0.400)(4.18\times10^3)(40.0-18.2) + (0.100)(3.90\times10^2)(40.0-18.2) \quad (1)$$

$$\Rightarrow \underline{L_f = 3.34\times10^5\ \mathrm{J\,kg^{-1}}} \quad (1)$$

10. An electric kettle's heating element has a power rating of 2.10 kW. If its transfer of energy to the water is 60.0% efficient, calculate how long it would take to boil away 1.10 kg of water initially at 20.0 °C.
(Assume the heat absorbed by the kettle is negligible.)

[4 marks]

$$Q_{needed} = m_w c_w \Delta T + m_w L_v$$
$$= (1.10)(4.18\times10^3)(100.0-20.0) + (1.10)(2.26\times10^6) \quad (1)$$
$$= 2.854\times10^6 \text{ J} \quad (1)$$

$$P = \frac{Q}{t}$$
$$\Rightarrow (0.600)(2.10\times10^3) = \frac{2.854\times10^6}{t} \quad (1)$$
$$\Rightarrow \underline{t = 2.26\times10^3 \text{ s}} \quad (1)$$