HOLY CROSS COLLEGE

Life to the Full

Western Australian Certificate of Education
ATAR course examination, 2017

Question/Answer Booklet

11 PHYSICS

Test 5 - Electricity

Name SOLUTIONS

Student Number: In figures

Mark: 46/46 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	46	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.

1. A set of parallel plates has a voltage of 5.00×10^2 V applied across them. An electron is introduced next to the negative plate through a small hole and accelerates towards the opposite plate. Assume that the electron is stationary initially.

(a) Explain why the electron moves towards the opposite plate. (2 marks)

- An electric field exists between the plates. (1)
- The electron experiences a force due to the electric field that pushes it to the opposite plate. (1)

(b) Calculate the kinetic energy of the electron when it reaches the opposite plate. (3 marks)

$W = Vq = E_K$ (1)

$\Rightarrow E_K = (5.00 \times 10^2)(1.60 \times 10^{-19})$ (1)

$= \underline{8.00 \times 10^{-17}\ J}$ (1)

(c) What is the velocity of the electron when it reaches the opposite plate? (2 marks)

$E_K = \frac{1}{2}mv^2$

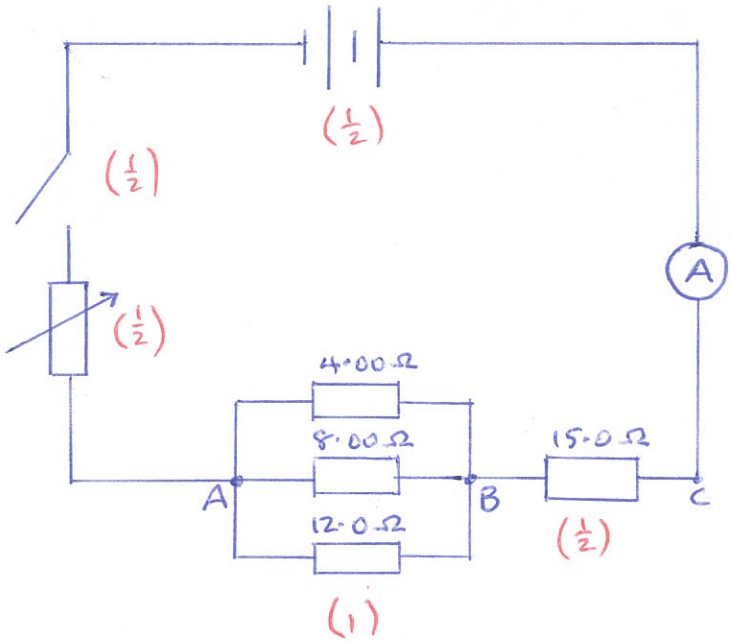
$\Rightarrow v = \sqrt{\frac{2E_K}{m}}$ (1)

$= \sqrt{\frac{2(8.00 \times 10^{-17})}{(9.11 \times 10^{-31})}}$

$= \underline{1.32 \times 10^7\ ms^{-1}}$ (1)

2. (a) Draw a circuit diagram to show the following. (4 marks)

- A battery of 2 cells.
- A switch.
- A rheostat (variable resistor).
- An ammeter measuring the total current flowing in the circuit.
- A 4.00 Ω resistor, 8.00 Ω and 12.0 Ω resistor, all in parallel with each other.
- A 15.0 Ω resistor in series with the parallel resistors.



(b) Calculate the effective resistance of the circuit. (3 marks)

$$\frac{1}{R_{AB}} = \frac{1}{4.00} + \frac{1}{8.00} + \frac{1}{12.0}$$

$$= \frac{6.00 + 3.00 + 2.00}{24.0} \quad (1)$$

$$= \frac{11.0}{24.0}$$

$$\Rightarrow R_{AB} = 2.18\ \Omega \quad (1)$$

$$R_T = R_{AB} + R_{BC}$$

$$= 2.18 + 15.0$$

$$= \underline{17.2\ \Omega} \quad (1)$$

3. The current cost of electricity in Western Australia is 26.474 cents per unit. (1.00 unit = 1.00 kWh = 3.60×10^6 J)

A solar hot water system that is electrically boosted to heat the water during winter. The booster is used for 3.00 hours each day for 75 days. If the booster is rated at 4.80kW, how much does it cost the household to heat the water? (3 marks)

Cost = P x t x rate (1)

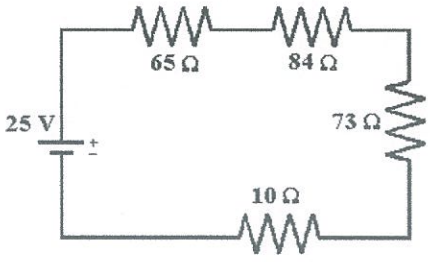
$= (4.80)(75 \times 3.00)(26.474)$ (1)

$= 2.859 \times 10^4$ cents

$= \underline{\$285.90}$ (1)

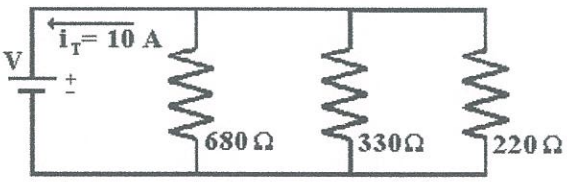
4. Determine the resistance of the following circuits. (3 marks)

(a)



$\underline{R_T = 2.32 \times 10^2\ \Omega}$ (1)

(b)



$\frac{1}{R_T} = \frac{1}{680} + \frac{1}{330} + \frac{1}{220}$

$= 9.046 \times 10^{-3}$ (1)

$\Rightarrow \underline{R_T = 1.10 \times 10^2\ \Omega}$ (1)

5. A set of Christmas tree lights operates from a 2.40×10^2 V supply. The set of lights has twelve similar 10.0 W globes in series.

(a) What is the potential drop across each globe? (2 marks)

$V_{globe} = \frac{2.40 \times 10^2}{12}$ (1)

$= 20.0$ V (1)

(b) What is the current through each globe? (2 marks)

$P_{globe} = V_{globe} I$ (1)

$\Rightarrow I = \frac{10.0}{20.0}$

$= 0.500$ A (1)

(c) What is the resistance of each globe? (2 marks)

$V_{globe} = I R_{globe}$ (1)

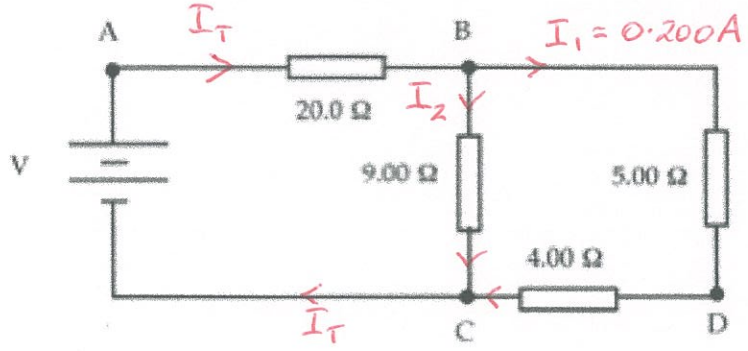
$\Rightarrow R_{globe} = \frac{20.0}{0.500}$

$= 40.0\ \Omega$ (1)

(d) How can you prove that the globes are in series and not in parallel? (1 mark)

- Remove 1 globe – the rest should go out. (1)

6. Four resistors are connected to a power supply of negligible internal resistance as shown. A current of 0.200 A flows in the 4.00 Ω resistor.



(a) Determine the voltage across BDC. (3 marks)

$V_{BDC} = I_1 R_{BDC}$ (1)

$= (0.200)(9.00)$ (1)

$= \underline{1.80\ V}$ (1)

(b) What current flows in the 9.00 Ω resistor? (2 marks)

$V_{BC} = I_2 R_{BC}$

$\Rightarrow I_2 = \frac{1.80}{9.00}$ (1)

$= \underline{0.200A}$ (1)

(c) What current flows in the 20.0 Ω resistor? (2 marks)

$I_T = I_1 + I_2$ (1)

$= 0.200 + 0.200$

$= \underline{0.400\ A}$ (1)

(d) What voltage would be measured across the terminals of the power supply?

(4 marks)

$\frac{1}{R_{BCD}} = \frac{1}{9.00} + \frac{1}{9.00}$

$= \frac{2.00}{9.00}$ (1)

$\Rightarrow R_{BCD} = 4.50\,\Omega$ (1)

$R_T = R_{AB} + R_{BCD}$

$= 20.0 + 4.50$

$= 24.5\,\Omega$ (1)

$V_T = I_T R_T$

$= (0.400)(24.5)$

$= \underline{9.80\,V}$ (1)

7. A group of students were given the task of determining the value of an unknown ceramic resistor. Their results were as follows.

Voltage (V)	Current (A)
2.1	0.10
4.4	0.21
6.3	0.28
7.9	0.37
10.2	0.49
12.1	0.55

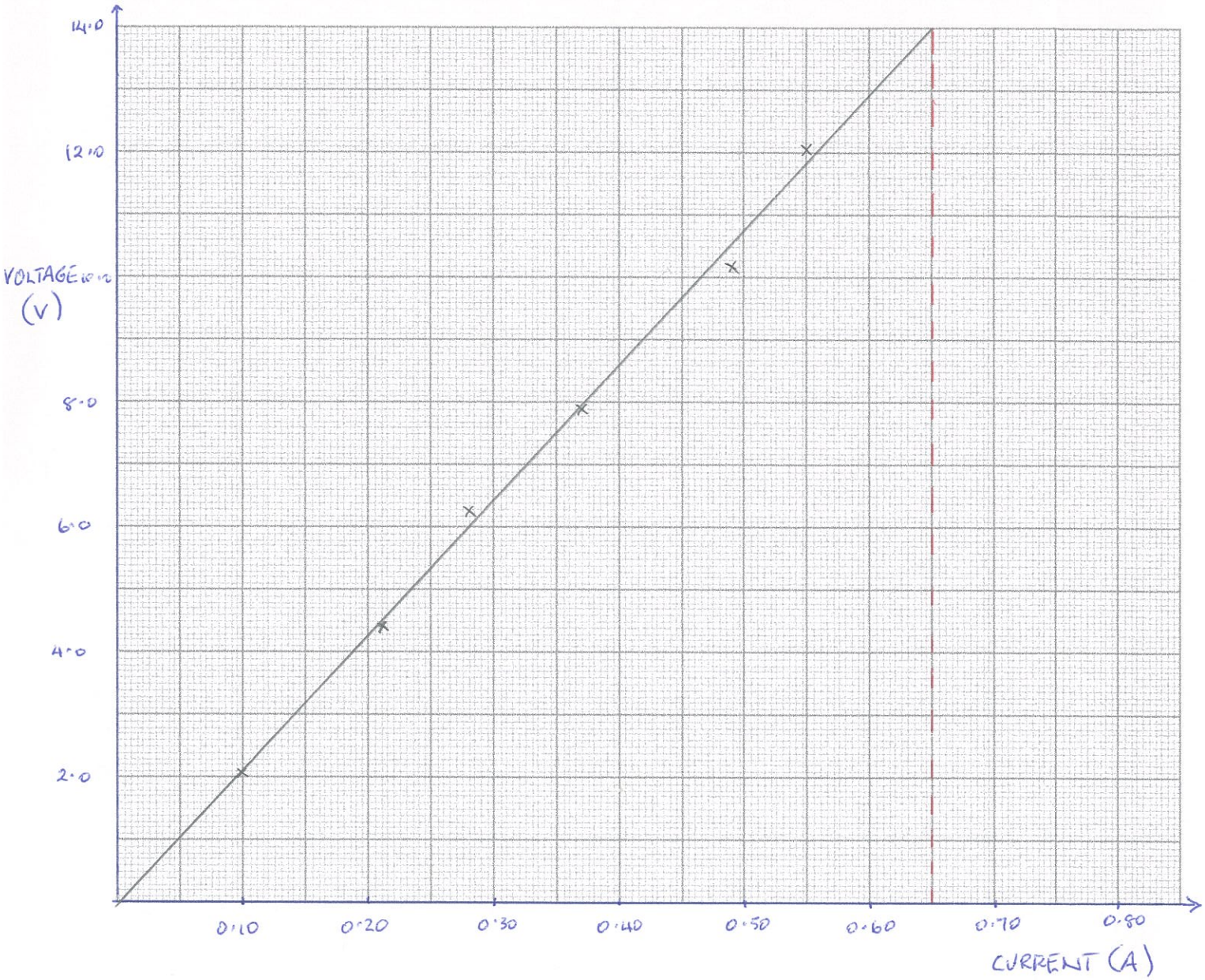
(a) Graph these results on the grid provided. (4 marks)

(b) Determine the gradient of the graph and hence the value of the resistance. (4 marks)

$\text{gradient} = \frac{(14.0 - 0.0)}{(0.65 - 0.0)}$ (1)

$= \underline{21\,\Omega}$ (1)

[2 points used - 1 mark
Sig. fig. - 1 mark]



[Labels + units - 2 marks
Plotting - 1 mark
Line of best fit - 1 mark.]