Western Australian Certificate of Education
ATAR course examination, 2018

Question/Answer Booklet

11 PHYSICS

Test 4 - Electricity

Name SOLUTIONS

Student Number: In figures

Mark: $\overline{}$ 36

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	8	8	50	36	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 party balloon was charged in the laboratory to +3.50 nC. It was then moved near a student and the charge was discharged to her arm in 3.20 ms.

(a) How many electrons were removed from the balloon during the charging process? (2 marks)

$$\# \text{ electrons} = \frac{3.50 \times 10^{-9}}{1.60 \times 10^{-19}} \quad (1)$$

$$= \underline{2.19 \times 10^{10}} \quad (1)$$

(b) What current flowed when the charge on the balloon was discharged? (2 marks)

$$\underline{I} = \frac{q}{t}$$

$$= \frac{3.50 \times 10^{-9}}{3.20 \times 10^{-3}} \quad (1)$$

$$= \underline{1.09 \times 10^{-6} \text{ A}} \quad (1)$$

2. During an experiment in a linear particle accelerator, a proton was accelerated from rest to a speed of 2.75 x 10^{6} ms^{-1}. What potential difference was required to achieve this? (3 marks)

$$W = Vq = \frac{1}{2}mv^2$$

$$\Rightarrow \quad V = \frac{mv^2}{2q} \quad (1)$$

$$= \frac{(1.67 \times 10^{-27})(2.75 \times 10^{6})^2}{2(1.60 \times 10^{-19})} \quad (1)$$

$$= \underline{3.95 \times 10^{4} \text{ V}} \quad (1)$$

3. In a typical household in Perth, the following appliances were used in one day.

- Refrigerator rated at 2.00×10^2 W ran for a total of 5.00 hours.
- Electric oven rated at 3.60 kW was used for 90.0 minutes.
- Air conditioner rated at 5.80 kW was used for 2.50 hours.

Given the cost of electricity is 28.8 cents per unit, how much did it cost to run these appliances? (3 marks)

$$\text{Cost} = P \times t \times r \quad (1)$$
$$= [(0.200)(5.00) + (3.60)(1.50) + (5.80)(2.50)](28.8) \quad (1)$$
$$= \underline{602\text{¢}} \quad (1)$$

4. What current flows through a 12.0 MΩ resistor with a potential difference of 75.0 V across it? (2 marks)

$$V = IR$$
$$\Rightarrow I = \frac{V}{R}$$
$$= \frac{75.0}{12.0 \times 10^6} \quad (1)$$
$$= \underline{6.25 \times 10^{-6} \text{ A}} \quad (1)$$

5. Find the equivalent resistance when resistors of 8.00 Ω, 12.0 Ω and 16.0 Ω are arranged in:

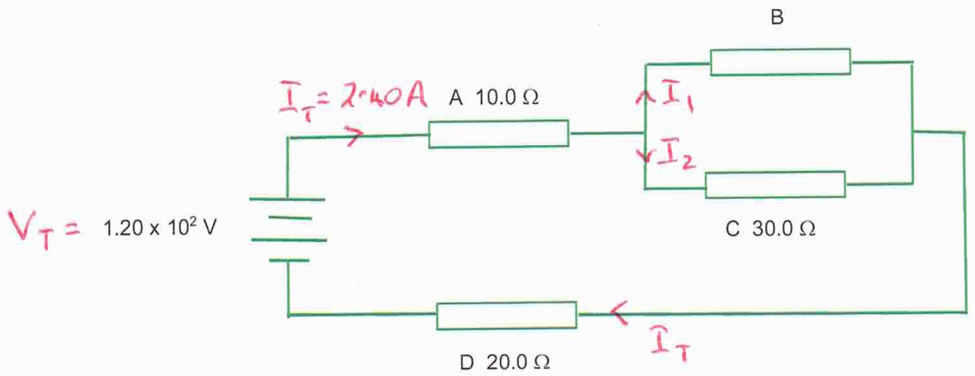
(a) series. (2 marks)

$$R_T = 8.00 + 12.0 + 16.0 \quad (1)$$
$$= \underline{36.0\ \Omega} \quad (1)$$

(b) parallel (3 marks)

$$\frac{1}{R_T} = \frac{1}{8.00} + \frac{1}{12.0} + \frac{1}{16.0} \quad (1)$$
$$= 0.2708\ \Omega^{-1} \quad (1)$$
$$\Rightarrow \underline{R_T = 3.69\ \Omega} \quad (1)$$

6. A current of 2.40 A flows into resistor A in the following circuit.



(a) What is the potential difference across resistor A? (2 marks)

$$V_A = I_T R_A$$
$$= (2{\cdot}40)(10{\cdot}0) \quad (1)$$
$$= \underline{24{\cdot}0\ V} \quad (1)$$

(b) Calculate the potential difference across resistor D? (2 marks)

$$V_D = I_T R_D$$
$$= (2{\cdot}40)(20{\cdot}0) \quad (1)$$
$$= \underline{48{\cdot}0\,V} \quad (1)$$

(c) Use the information in part (a) and (b) to determine the current flowing in resistor C. (3 marks)

$$V_T = V_A + V_{BC} + V_D$$
$$\Rightarrow V_{BC} = 1{\cdot}20 \times 10^2 - 24{\cdot}0 - 48{\cdot}0 \quad (1)$$
$$= 48{\cdot}0\,V \quad (1)$$

$$V_{BC} = I_2 R_c$$
$$\Rightarrow I_2 = \frac{48{\cdot}0}{30{\cdot}0}$$
$$= \underline{1{\cdot}60\ A} \quad (1)$$

(d) Determine the value of the unknown resistor B. (3 marks)

$I_T = I_1 + I_2$

$\Rightarrow I_1 = 2.40 - 1.60$ (1)

$= 0.800\ A$ (1)

$V_{BC} = I_1 R_B$

$\Rightarrow R_B = \frac{48.0}{0.800}$

$= \underline{60.0\ \Omega}$ (1)

(e) What is the total power used in this circuit? (2 marks)

$P = V_T I_T$

$= (1.20 \times 10^2)(2.40)$ (1)

$= \underline{288\ W}$ (1)

7. Why is overloading a power board with no reset button dangerous? (2 marks)

- The current drawn by each appliance adds up to a large current. (1)
- If this current exceeds the maximum rating for the wiring leading to the power board, it will heat up and could catch fire. (1)

8. A plastic electric kettle rated at 2.20 kW is used to bring 1.60 L of water at 16.0 °C to the boil to make a cup of tea. Assuming 75.0% of the heat produced by the heating element is absorbed by the water, calculate how long it takes for the water to boil. (5 marks)

$$Q_{needed} = m_w c_w \Delta T$$
$$= (1.60)(4.18 \times 10^3)(84.0) \quad (1)$$
$$= 5.62 \times 10^5 \text{ J} \quad (1)$$

$$0.750\,P = \frac{Q}{t}$$

$$\Rightarrow \quad t = \frac{Q}{0.750\,P} \quad (1)$$
$$= \frac{5.62 \times 10^5}{(0.750)(2.20 \times 10^3)} \quad (1)$$
$$= \underline{3.40 \times 10^2 \text{ s}} \quad (1)$$