HOLY CROSS COLLEGE

Life to the Full

Western Australian Certificate of Education
ATAR course examination, 2018

Question/Answer Booklet

11 PHYSICS

Test 4 - Electricity

Name SOLUTIONS

Student Number: In figures

Mark: ___/58 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	12	12	50	58	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.

Circle the correct answer in the following four questions. [4 marks]

1. The lower slot of any power point in your home will enable a connection to:

   (a) the active part of the supply circuit.
   (b) the neutral part of the supply circuit.
(1) (c) the earth wiring in your home.
   (d) a residual current device (RCD).

2. Which of the following is the correct definition for electrical current?

   (a) The charge per unit volume per unit time.
   (b) The charge per unit volume.
(1) (c) The charge per unit time.
   (d) The time per unit charge.

3. How does the total resistance of two identical resistors in parallel (R_{tot}) compare to the resistance of the individual resistors (R)?

   (a) $R_{tot} = R$
(1) (b) $R_{tot} < R$
   (c) $R_{tot} > R$
   (d) It depends on the resistance, R.

4. How much current is drawn by a 6.00 W torch globe that utilises two 1.50 V cells placed in series?

   (a) 0.500 A
   (b) 4.00 A
   (c) 9.00 A
(1) (d) 2.00 A

5. A battery in a circuit has current of 4.50 A passing through it.

   (a) How many coulombs of charge pass through the battery in 5.00 seconds? [2 marks]

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

$$\Rightarrow q = It$$

$$= (4.50)(5.00) \quad (1)$$

$$= \underline{22.5\ C} \quad (1)$$

(b) If the battery provides a potential difference of 9.00 V, how many joules of energy (work) does it provide to the circuit each second? (3 marks)

$W = Vq = VIt$ (1)

$= (9.00)(4.50)(1.00)$ (1)

$= \underline{40.5\ J}$ (1)

6. (a) How much energy (in ***kilowatt-hours*** and ***joules***) will a 2.00×10^2 W globe use in 4.00 hours of operation? [4 marks]

$P = \frac{E}{t}$

$\Rightarrow E = Pt$ (1)

$= (2.00 \times 10^2)(4.00 \times 3.60 \times 10^3)$ (1)

$= \underline{2.88 \times 10^6\ J}$ (1)

$= \underline{0.800\ kWh}$ (1)

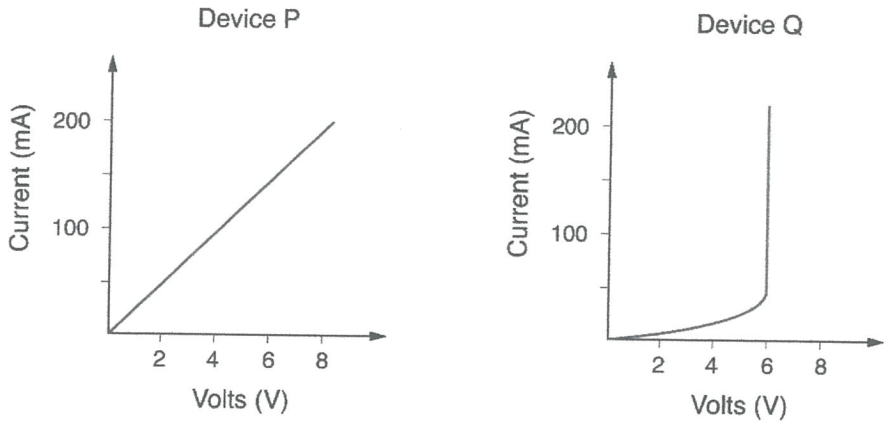
(b) An electricity company charges 30.0 cents per kilowatt hour (kWh) of electricity consumed. How much does it cost to use this 2.00×10^2 W globe for 2.50 hours? [3 marks]

$Cost = P \times t \times \$$ (1)

$= (0.200)(2.50)(30.0)$ (1)

$= 15.0$ cents (1)

7. Two electrical devices have current–voltage characteristics as shown below.



(a) Which of the two components obeys Ohm's law? [1 mark]

Device P

(b) Determine the resistance of this device. [4 marks]

gradient $= \frac{\Delta I}{\Delta V}$

$= \frac{190 \times 10^{-3} - 0}{8.0 - 0}$ (1)

$= 2.37 \times 10^{-2}\ AV^{-1}$ (1)

$V = IR$

$\Rightarrow R = \frac{V}{I} = \frac{1}{\text{gradient}}$

$= \frac{1}{2.37 \times 10^{-2}}$ (1)

$= 42\ \Omega$ (1)

(c) (i) What is the effective resistance of the other device when a current of 2.00×10^2 mA flows through it? [2 marks]

$V = IR$

$\Rightarrow R = \frac{6.0}{0.200}$ (1)

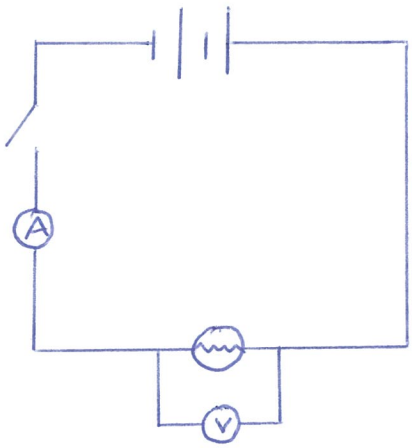
$= 30\ \Omega$ (1)

(ii) Would this value remain constant? Explain your answer. [2 marks]

- No. (1)
- For a potential difference of 6.0 V, the current varies from 50 mA upwards. (½)
- Hence, the effective resistance varies. (½)

8. A student set up an ammeter and a voltmeter in a simple circuit in order to measure the current and potential difference across her torch globe (light bulb) in the laboratory.

(a) Sketch a diagram to show how the student should place the ammeter and the voltmeter in her simple circuit. Include a switch and power source in your diagram. [3 marks]



Correct symbols - 2 marks
Position of meters - 1 mark

(b) Explain why ammeters and voltmeters must be placed in this way. [2 marks]

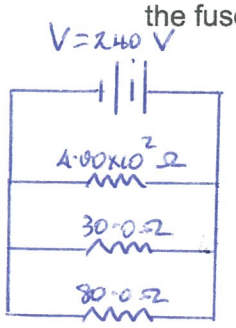
Ammeter
- Must be in series.
- Measures current without affecting its flow. (1)

Voltmeter
- Must be in parallel.
- Measures the potential difference without affecting current flow. (1)

9. If a person runs all of the following appliances at the same time, will the fuse blow (melt)?

A 4.00 x 10^2 Ω refrigerator, a 30.0 Ω heater and an 80.0 Ω microwave oven.

The appliances are all connected in ***parallel*** to a 2.40 x 10^2 V mains supply power point and the fuse in the circuit is rated at 10.0 amps. Explain your reasoning. [5 marks]



$\frac{1}{R_T} = \frac{1}{4.00\times10^2} + \frac{1}{30.0} + \frac{1}{80.0}$ (1)

$= 4.83\times10^{-2}\ \Omega^{-1}$

$\Rightarrow R_T = 20.7\ \Omega$ (1)

$V = I_T R_T$

$\Rightarrow I_T = \frac{2.40\times10^2}{20.7}$ (1)

$= 11.6$ A. (1)

∴ Fuse will blow. (1)

10. (a) Explain why it may be dangerous to operate a 240 V hair dryer in a bathroom.
[2 marks]

- Bathroom may have moisture in the air and on surfaces such as the floor. (✓)
- A person may be electrocuted if water gathers in the hairdryer circuitry or (✓)

(b) Describe ***two*** different safety features of our mains electricity supply system and how they act to protect us. [4 marks]

FUSE - melts if the current is too high.

CIRCUIT BREAKER - switches off if the current exceeds the maximum.

EARTH WIRE - acts as a conduit to earth if there is a short-circuit in an appliance.

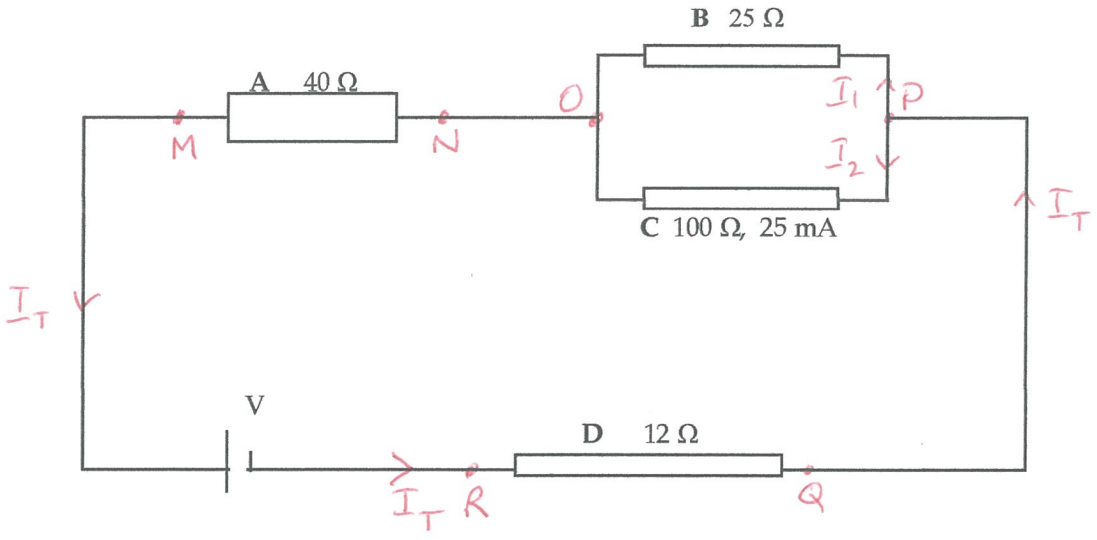
DOUBLE INSULATION - active and neutral wires are double wrapped in plastic.

RCD - detects a change in current between the active and neutral and switches off.

DOUBLE-POLE SWITCHES - disconnect active and neutral wires.

[Safety feature - 1 mark
Description - 1 mark]

11. In the circuit below, there is a 25.0 mA current in the 1.00 x 10^2 Ω resistor.



(a) Determine the potential difference across the 1.00 x 10^2 Ω resistor. [2 marks]

$V_{OP} = I_2 R_{100}$

$= (0.025)(1.00 \times 10^2)$ (1)

$= 2.50\ V$ (1)

(b) Calculate the total current that flows in the circuit. [4 marks]

$V_{OP} = I_1 R_{25}$

$\Rightarrow I_1 = \frac{2.50}{25.0}$ (1)

$= 0.100\ A$ (1)

$I_T = I_1 + I_2$

$= 0.100 + 0.025$ (1)

$= 0.125\ A$ (1)

(c) What voltage must be supplied by the source? [5 marks]

$$\frac{1}{R_{OP}} = \frac{1}{25.0} + \frac{1}{1.00\times10^{2}}$$

$$= 0.0500\ \Omega^{-1} \quad (1)$$

$$\Rightarrow R_{OP} = 20.0\ \Omega \quad (1)$$

$$R_T = 40.0 + 20.0 + 12.0$$

$$= 72.0\ \Omega \quad (1)$$

$$V_T = I_T R_T$$

$$= (0.125)(72.0) \quad (1)$$

$$= \underline{9.00\ V} \quad (1)$$

(d) Calculate the power dissipated in the 12.0 Ω resistor as heat. [3 marks]

$$P = I_T^{2} R_{12} \quad (1)$$

$$= (0.125)^{2}(12.0) \quad (1)$$

$$= \underline{0.187\ W} \quad (1)$$

12. In the electron gun in an old colour TV tube, the potential difference used to accelerate electrons is 1.50 kV. Calculate the speed at which electrons leave the gun, assuming that they have no speed as they leave the cathode (negative electrode) inside the gun. [3 marks]

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

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

$$= \sqrt{\frac{2(1.50\times10^{3})(1.60\times10^{-19})}{(9.11\times10^{-31})}} \quad (1)$$

$$= \underline{2.29\times10^{7}\ ms^{-1}} \quad (1)$$