Christ Church Grammar School

Science Department
Year 11 2020

ATAR PHYSICS
UNIT 1: ELECTRICAL PHYSICS
TOPIC TEST 2020

Teacher: JRM SGA PCW CJO
(Please circle)

NAME: _____

Time allowed for this paper
Working time for paper: 50 minutes.

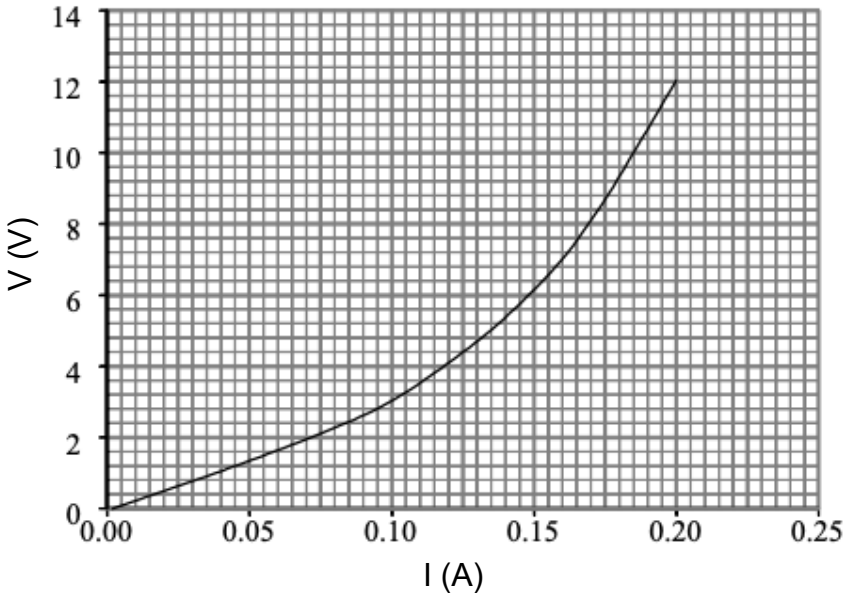
Instructions to candidates:

- You must include **all** working to be awarded full marks for a question. Answers should be expressed to 3 significant figures unless otherwise indicated.
- Marks may be deducted if diagrams are not drawn neatly with a ruler and to scale (if specified).
- Marks will be deducted for incorrect or absent units.
- **No** graphics calculators are permitted – scientific calculators only.

Mark:	/ 57
=	%

Question 1 **(6 marks)**

The graph below shows the relationship between the current "I" through a particular filament lamp and the potential difference "V" across it.



(a) Calculate the resistance of the lamp when the potential difference across it is 12.0 V. Express your answer to 3 significant figures.

(2 mark)

Description	Marks
R = V / I = 12.0 / 0.20	1
= 60.0 Ω	1
Total	2

(b) Calculate the resistance when the potential difference across it is varied from 0 V to 2.00 V. Express your answer to 3 significant figures.

(2 marks)

Description	Marks
R = V / I = 2 / 0.7	1
= 28.6 Ω	1
Total	2

(c) Calculate the power of the lamp when the potential difference across it is 12.0 V. Express your answer to 3 significant figures.

(2 marks)

Description	Marks
P = I V = 0.2 x 12	1
= 2.40 W	1
Total	2

Question 2 **(10 marks)**

Different countries have different values of mains voltage. In the USA a certain filament lamp is marked “110 V 60 W”. In Australia a certain filament lamp is marked “240 V 0.40 A”.

(a) Which bulb has the greatest resistance. Support your answer with an appropriate calculation. Express your answer to 3 significant figures.

(5 marks)

Description	Marks
USA $P = I V$, $I = P/V$, $V = IR$, $R = V / I$ $R = V^2 / P = 110^2/60$	1
$= 202\ \Omega$	1
AUS $R = V / I = 240 / 0.4$	1
$= 600\ \Omega$	1
Hence, Australian globe has the greater resistance.	1
Total	5

(b) If the USA bulb was used in Australia, calculate the current it would draw. Express your answer to 3 significant figures. (If you could not complete part (a), use R = 150 Ω)

(2 marks)

Description	Marks
$I = V / R = 240 / 202$	1
$= 1.19$ A	1
Total	2

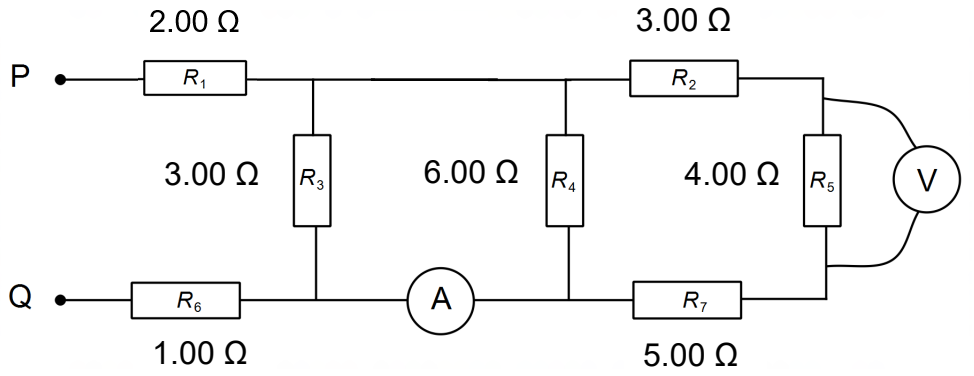
(c) If each bulb is used in their correct country (with correct mains voltage), explain whether the bulbs have the same brightness. Justify your response with an appropriate calculation.

(3 marks)

Description	Marks
Since $P = IV$, $P_{AUS} = 240 \times 0.40 = 96$ W	1
Therefore the Australian globe’s power is greater than the USA globe	1
Since $P = E / t$, more energy is converted to light per unit time.	1
Total	3

Question 3 **(14 marks)**

Consider the circuit shown below, containing seven resistors, an ammeter and a voltmeter.



(a) Re-draw a simplified circuit to show the channel with the voltmeter as one equivalent resistor.

(3 marks)

(Must show working out for 12 Ω) – ½ mark.

(b) Show via calculation the total resistance between terminals P and Q is 4.71 Ω.

(3 marks)

Description	Marks
$\frac{1}{R_E} = \frac{1}{3} + \frac{1}{6} + \frac{1}{3+4+5} = \frac{7}{12}$	1
$\therefore R_E = \frac{12}{7} = 1.71\ \Omega$	1
RT = 2.00 + 1.00 + 1.71 = 4.71 Ω	1
Total	3

Question 3 Continued.

A voltage source of 9.00 volts is then placed across the terminals P and Q

(c) Calculate the total current drawn by the circuit.

(2 marks)

Description	Marks
$I = V / R = 9.00 / 4.71$	1
$= 1.91$ A	1
Total	2

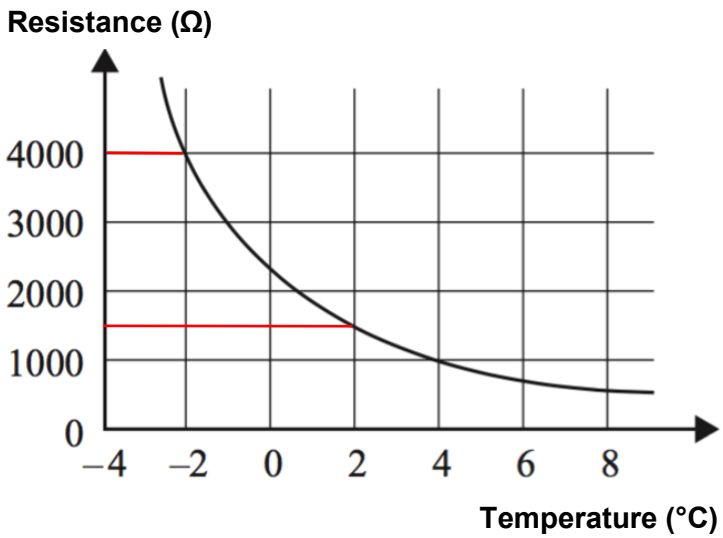
(d) Calculate the voltage measured by the voltmeter.

(6 marks)

Description	Marks
$V_E = I_T R_E = 1.91 \times 1.71$	1
$= 3.27$ V	1
$I_E = V_E / R_E = 3.27 / 12$	1
$= 0.273$ A	1
$V_4 = I_E . R_4 = 0.23 \times 4.00$	1
$= 1.09$ V	1
Total	6
Note: alternative methods (Voltage drop, Kirchoff's law exist.	

Question 4 **(10 marks)**

A thermistor is a device in which resistance varies with temperature. The characteristics of a particular thermistor are shown in the diagram.

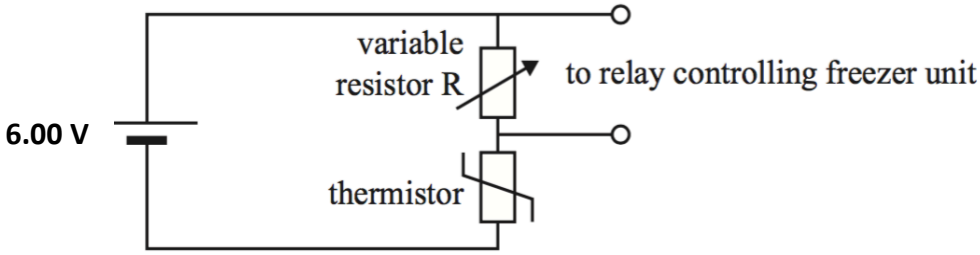


(a) Calculate the current in mA that would flow through the thermistor at 2.00 °C if the voltage across it were 2.50 V. Express your answer to 3 significant figures.

(3 marks)

Description	Marks
Resistance determine on graph = 1.4 kΩ or 1.5 kΩ	1
I = V / R = 2.50 / 1400	1
= 1.79 mA	1
Total	3

This thermistor is now used to control the temperature of a freezer unit of a refrigerator. The circuit is shown below. The switch controlling the freezer switches it on when the voltage across the variable resistor R is equal to (or greater than) 2.00 V. The freezer unit must turn on when the temperature is -2.00 °C or higher.



(b) Calculate the total current in mA required to flow through the circuit when the temperature is -2.00 °C in order to meet the required voltage across the resistor.

(4 marks)

Description	Marks
Resistance determine on graph = 4 kΩ	1
$V_T = V_{thermistor} + V_{resistor}$ $V_{thermistor} = 6.00 - 2.00 = 4.00$ V	1
I = V / R = 4.00 / 4000	1
= 1.00 mA	1
Total	4

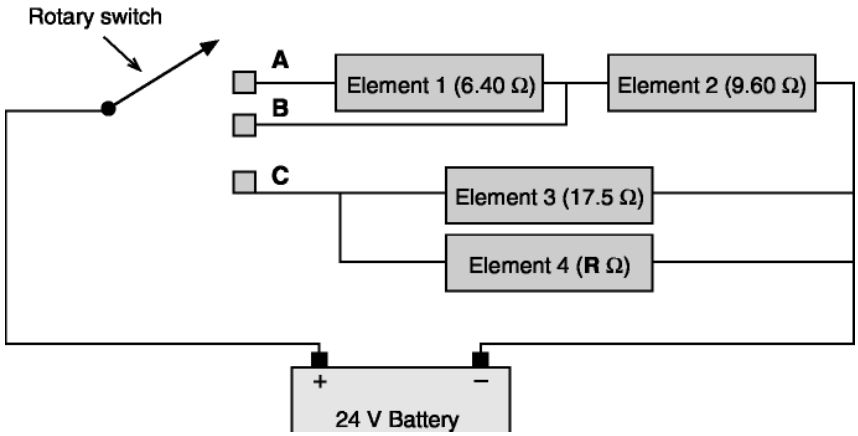
(c) Hence, calculate the resistance that the variable resistor needs to have in order achieve this current. (If you could not complete part (b), use I_T = 1.10 mA)

(3 marks)

Description	Marks
$R_T = V_T / I_T = 6.00 / 0.001$	1
$= 6000\ \Omega$	1
$R_{Resistor} = R_T - R_{Thermistor}$ $= 6000 – 4000 = 2.00\ k\Omega$	1
Total	3

Question 5 **(10 marks)**

Electric blankets are sometimes used to warm beds in camper vans. An electric blanket in a camper van bed has four heating elements. It is connected to a 24.0 V battery. A switch allows the user to select one of three heat settings by connecting it to either position A, B or C. The resistance of the elements is shown in the diagram below.



(a) Calculate the total resistance of the circuit when the switch is in position A.

(2 marks)

Description	Marks
$R_T = R_1 + R_2$ $= 6.40 + 9.60$	1
$= 16.0\ \Omega$	1
Total	2

(b) When the switch is in position A, calculate the current in the circuit.

(2 marks)

Description	Marks
$I = V / R = 24 / 16$	1
$= 1.50$ A	1
Total	2

(c) When the switch is in position C, the total resistance of the circuit is 5.72 Ω. Calculate the resistance R of Element 4.

(3 marks)

Description	Marks
$\frac{1}{R_T} = \frac{1}{R3} + \frac{1}{R4}$ $\frac{1}{5.72} = \frac{1}{R4} + \frac{1}{17.5}$	1
$\frac{1}{R4} = \frac{1}{5.72} - \frac{1}{17.5} = \frac{589}{5005}$	1
$\therefore R_4 = \frac{5005}{589} = 8.50\ \Omega$	1
Total	3

Question 5 Continued.

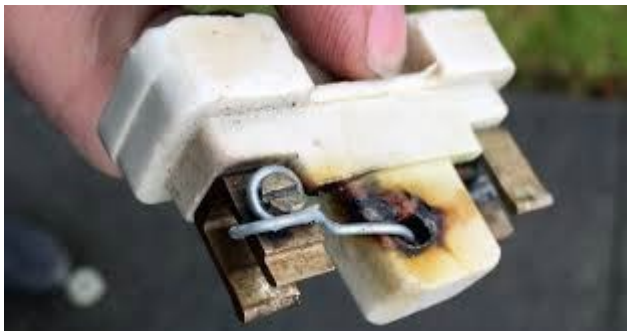
(d) Calculate the power output of the blanket when the switch is in position B.

(3 marks)

Description	Marks
I = V / R = 24.0 / 9.60 = 2.50 A	1
P = I V = 2.5 (24.0)	1
= 60.0 W	1
Total	3

Question 6 **(7 marks)**

While investigating an electricity supply failure in a workshop it becomes apparent that a fuse has melted within the main electrical panel, leaving an open circuit and preventing charge from flowing. In order to restore the electricity, a worker places a large iron nail between the two open terminals in order to allow the flow of charge. This enables the workshop to keep operating as per normal.



(a) Explain why this was not an appropriate fix for this problem and justify your response.

(3 marks)

Description	Marks
If the fuse has melted, there must be some fault in the system which remains unrectified (short or overloading)	1
By replacing with a conductor potentially excessive charge will be able to flow (or fuse is overrated)	1
Causing damage to the circuits / potential for fire	1
Total	3

(b) Fuses are being phased out of household use and being replaced by circuit breakers that perform the same function. Explain one of the benefits of a circuit breaker over a fuse.

(1 marks)

Description	Marks
Can be reset instead of needing replacement OR Cheaper than replacing fuses OR Can trip the circuit much faster OR Cannot be tampered with as per part (a)	1
Total	1

The electrical panel in the workshop also has an earth wire leading from all circuits to a long metal rod that is inserted deep into the ground outside the building.

(c) State which hazard this protects the consumer from and explain why a fuse or a circuit breaker cannot protect from this hazard.

(3 marks)

Description	Marks
Shock hazard	1
Fuse or Circuit Breaker only prevents excess current flow through a circuit.	1
As a shock hazard can exist under the fuse/circuit current rating, they do not always protect the consumer from current leakage.	1
Total	3

END OF TEST