Christ Church Grammar School

Science Department
Year 11 2021

ATAR PHYSICS
UNIT 1: ELECTRICAL PHYSICS
TOPIC TEST 2021

Teacher: CJO JRM PCW
(Please circle)

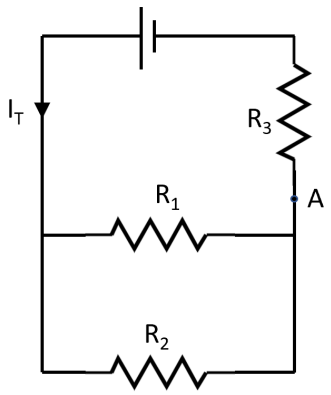
Time allowed for this paper
Working time for paper: 50 minutes.

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:	/ 52
=	%

Question 1 **(8 marks)**



(a) Describe what would happen to happen to the total current through the circuit I_T if the following changes were made to the circuit. Explain your reasoning.

(i) An additional resistor was placed in parallel with R_2

(2 marks)

Description	Marks
This provides an additional pathway for current to flow through, therefore decreasing the overall resistance of the circuit. (1/2 mark only for stating "resistance decreases"	1
I_T would therefore increase	1
Total	2

(ii) An additional resistor was placed at location A

(2 marks)

Description	Marks
A resistor added in series will add increase the overall resistance of the circuit, impeding current through all pathways	1
I_T would therefore decrease	1
Total	2

In a circuit, the total power supplied by the battery must equal the total power dissipated in the resistors. When resistors are connected in parallel across a battery, the full battery voltage is dropped across each. Voltage is proportional to electrical potential energy.

(b) Explain why the above statements can all be true but do not contradict the law of conservation of energy. (4 marks)

Description	Marks
V = W/q, voltage is defined as electrical potential energy (or work) per unit charge.	1
When a resistor is added in parallel, a separate path for charge to flow is added. The charge (or current) supplied by the cell splits between the available path.	1
The same work per unit charge is done across the resistor, but with less amounts of charge, hence power dissipated through each resistor is less than the total supplied	1
The total power that the battery supplied will match the total that is dissipated through all resistors, hence the law of conservation of energy is obeyed.	
Total	4

Question 2 **(4 marks)**

A cell has a potential difference between its two plates of 12.0 V and it is connected to a simple circuit containing a 20.0 Ω resistor and an open switch.

Calculate the work done by the cell if the switch is closed for a period of 4.00 minutes.

Description		Marks
$V = \frac{W}{q}$ $W = Vq$ $I = \frac{q}{t}$ and $V = IR$	OR P=VI V=IR and P= $\frac{W}{t}$	1
$W = \frac{V^2}{R}t$	(P = 7.20 W if calculated intermediately)	1
$W = \frac{12^2}{20}$ 4*60		1
1730 J		1
	Total	4

Question 3 **(6 marks)**

A hair dryer has a very high current draw compared to most handheld appliances. A hair dryer designed to operate in Australia, connected to a 240 V power supply, is rated at 2,400 W.

(a) Calculate the current draw that would be expected when the hair dryer is operated in Australia.

(2 marks)

Description	Marks
$P = VI$ $I = \frac{P}{V} = \frac{2400}{240}$	1
10.0 A	1
Total	2

(b) Calculate the current draw if the same hair dryer was taken to the USA and plugged in to a 110 V power supply.

(4 marks)

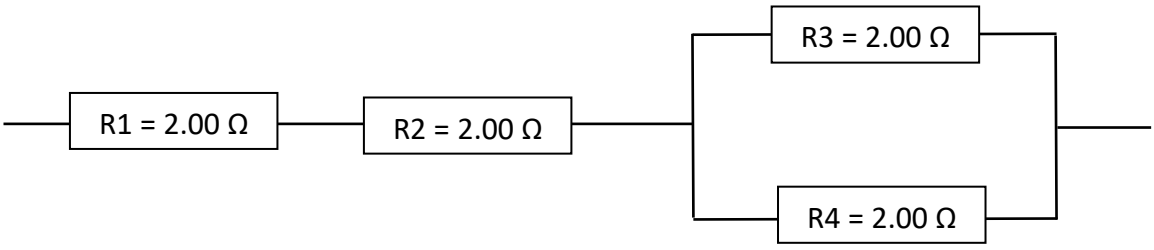
Description	Marks
Resistance is fixed. In Australia: $V = IR$ $R = \frac{V}{I} = \frac{240}{10} = 24.0\ \Omega$	2
In USA $I = \frac{V}{R} = \frac{110}{24}$	1
4.58 A (max 2 marks for stating P=2400, calculating I = 21.8 A)	1
Total	4

Question 5 **(7 marks)**

You are provided with five resistors, each of 2.00 Ω. Show how to connect them to produce an effective resistance of 5.00 Ω, using five or fewer resistors.

(a) Draw in the space below, so that points A and B are at either end of the effective resistance. Label the resistors in your diagram R1, R2, R3 ….etc. If you used fewer resistors, use fewer labels.

(3 marks)

Description	Marks
	
2 in series and 1 in parallel	1
neat straight lines, drawn with ruler	1
appropriately labelled	1
Total	3

The resistor network you have drawn is now constructed and connected correctly to a 9.00 V power supply.

(b) Calculate the voltage drop across each of the resistors and write the value in the table below. If you used fewer than five resistors, leave the unused resistor box(es) blank.

(4 marks)

Description	Marks
$I_T = V_T / R_T$ $= 9.00 / 5.00$ $= 1.80$ A	1
$V_1 = V_2 = I_T.R$ $= 1.80 \times 2$ $= 3.60$ V	1
$V_T = V_P + V_{R1} + V_{R2}$ $9 = V_P + 3.6 + 3.6$	1
$V_P = 1.80$ V	1
Total	4

Resistor	Voltage drop (V)
R1	3.60
R2	3.60
R3	1.80
R4	1.80
~~R5~~	

Question 6 **(7 marks)**

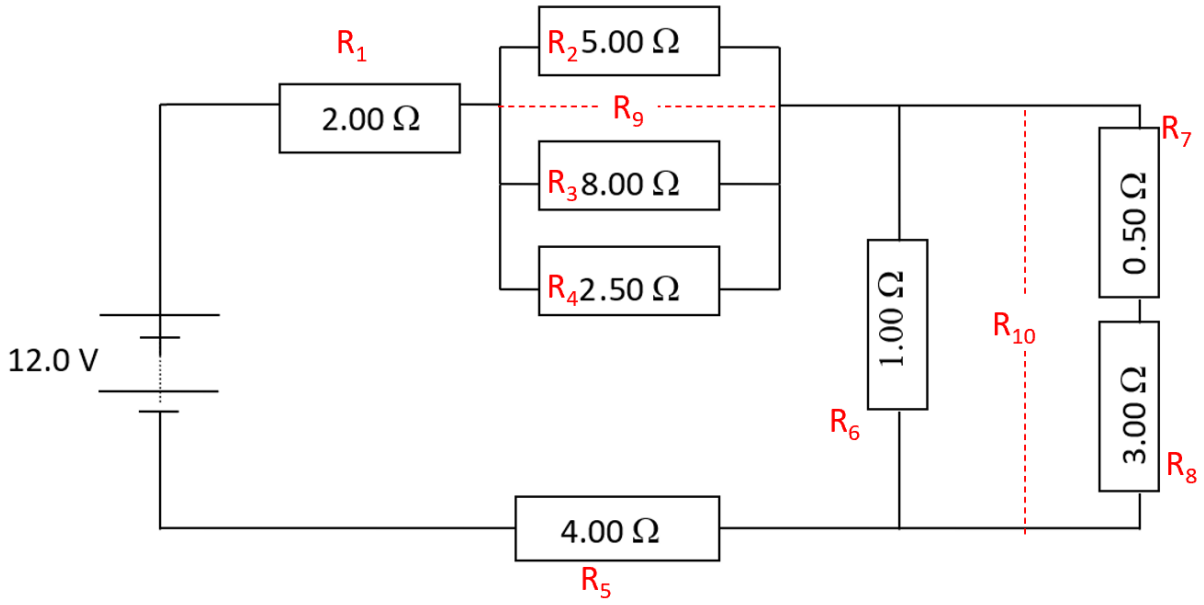
Narendra and Susan are discussing the best way to roast their chicken dinner. Narendra wants to eat as soon as possible and wants the quickest cooking time, and Susan wants to use the cheapest option that uses the least energy. The dinner will take approximately 4.60 x 10^5 J of energy to cook. The options are as follows:

Appliance	Power Rating (kW)	Efficiency
Oven	2.00	50.0 %
Electric Frying Pan	1.20	75.0 %

Justify through calculation, which option Narendra and Susan should each choose.

Description	Marks
OVEN ELECTRIC FRYING PAN Determines useful power output $P_{OUT} = P_{IN} \times \frac{\varepsilon}{100}$ $P_{OUT} = 2000 \times \frac{50}{100} = 1000\ W$ $P_{OUT} = 1200 \times \frac{75}{100} = 900\ W$	2
Determines cooking time $t = \frac{E}{P_{OUT}} = \frac{460{,}000}{1000} = 460\ s$ $t = \frac{E}{P_{OUT}} = \frac{460{,}000}{900} = 511\ s$	2
Determines total energy used $E_{IN} = P_{IN} \times t$ $= 2000\ (460) = 920{,}000\ J$ $1200\ (511) = 613{,}000\ J$	2
Narendra would choose Oven, Susan would choose Electric Frying Pan	1
Total	7

Question 7 **(14 marks)**



(a) Show that that the total resistance of the circuit is 8.16 Ω.

(4 marks)

Description	Marks
$\frac{1}{R_9} = \frac{1}{5} + \frac{1}{8} + \frac{1}{2.5}$ $R_9 = 1.38\ \Omega$	1.5
$\frac{1}{R_{10}} = \frac{1}{1} + \frac{1}{(3+0.5)}$, $R_{10} = 0.777\ \Omega$	1.5
R_{EQ} = 2.00 + 1.38 + 0.777 + 4.00 = 8.16 Ω	1
Total	4

(b) Calculate the current that flows through the 8.00 Ω resistor.

(4 marks)

Description	Marks
$V_{R9} = I_T R_9$ = (1.47)(1.38) = 2.03 V	2
$I_{R3} = V_{R9} / R_3$ = 2.03 / 8 = 0.254 A	2
Total	4

(c) Calculate the voltage drop across the 0.50 Ω resistor.

(6 marks)

Description	Marks
$I_T = V / R_{EQ}$ $= 12.0 / 8.16$ $= 1.47$ A	1.5
Find voltage across R_{10} $V_{R10} = I_T R_{10}$ $= (1.47)(0.777)$ $= 1.14$ V	1.5
Find current through R_7 and R_8 $I_{R7} = V_{R10} / (R_7 + R_8)$ $= 1.14 / (3.00+0.50)$ $= 0.326$ A	1.5
Find voltage across R_7 $V_{R7} = I_{R7} R_7$ $= (0.326)(0.50)$ $= 0.163$ V	1.5
Total	6

Question 4 **(6 marks)**

Many workplaces do not allow the use of power boards as they can introduce an electrical hazard.

(a) Explain why this is the case and what hazard these workplaces are trying to avoid.

(2 marks)

Description	Marks
A power board allows multiple devices to draw current through a circuit that was designed for one device *OR* By adding appliances in parallel, the overall resistance of the circuit decreases.	1
This can result in too large a current flowing through wires, which is a thermal hazard and can damage the circuit or cause a fuse to blow / circuit breaker to activate.	1
Total	2

Power boards designed for interior use can also become an electrical hazard if used outside, particularly during wet weather.

(b) On a rainy day, Tom left a live power board outside and noticed that all his appliances suddenly stopped working. Explain what has likely occurred with reference to your knowledge of household safety devices.

(4 marks)

Description	Marks
Water is a conductor, and when it comes into contact with a live circuit, it provides a pathway of low resistance for the charge to ground.	1
This allows a very large current to flow, known as a short circuit.	1
A fuse or circuit breaker is a safety device installed in household circuits that will open the circuit when excess current is detected	1
This causes all the appliances to lose power and protects the circuit from damage or causing fires.	1
(also accept current leakage detected and RCD activated if suitably justified)	
Total	4

END OF TEST