# Physics ATAR - Year 11

# Electrical Physics
# Unit Test
# 2019

| Name: SOLUTIONS | Mark: / 56<br><br>= %|
|---|---|

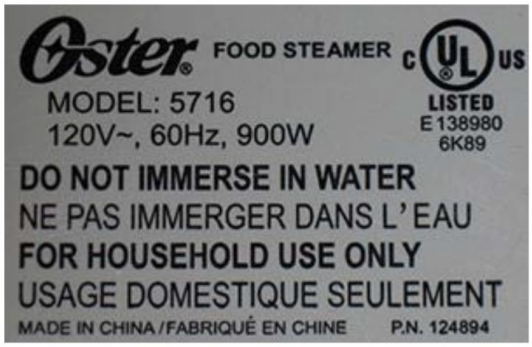
Time Allowed: 50 minutes

Notes to Students:

- You must include **all** working to be awarded full marks for a question.
- Marks will be deducted for incorrect or absent units and answers stated to an incorrect number of significant figures.
- **No** graphics calculators are permitted – scientific calculators only.

**Question 1** **(8 marks)**

A label from an electrical food steamer is shown to the right.




(a) Calculate the current that flows through the steamer when it is operating. Express your answer to 3 significant figures.

(2 marks)

$P = IV$ $I = P / V$ (1/2)

$= 900 / 120$ (1/2)

$= 7.50$ A (1/2)

(b) Calculate the number of electrons that move through a point in the steamer in a time period of 1.20 hours.

(3 marks)

$n = Q / e$ $=$ $I.t / e$ (1)

$=$ $(7.50)(1.20 \times 60 \times 60) / (1.60 \times 10^{-19})$ (1)

$=$ $2.03 \times 10^{23}$ electrons (1)

(c) If Synergy charges 26.0 cents per kWh, calculate the cost of operating the steamer for a time period of 1.20 hours.

(3 marks)

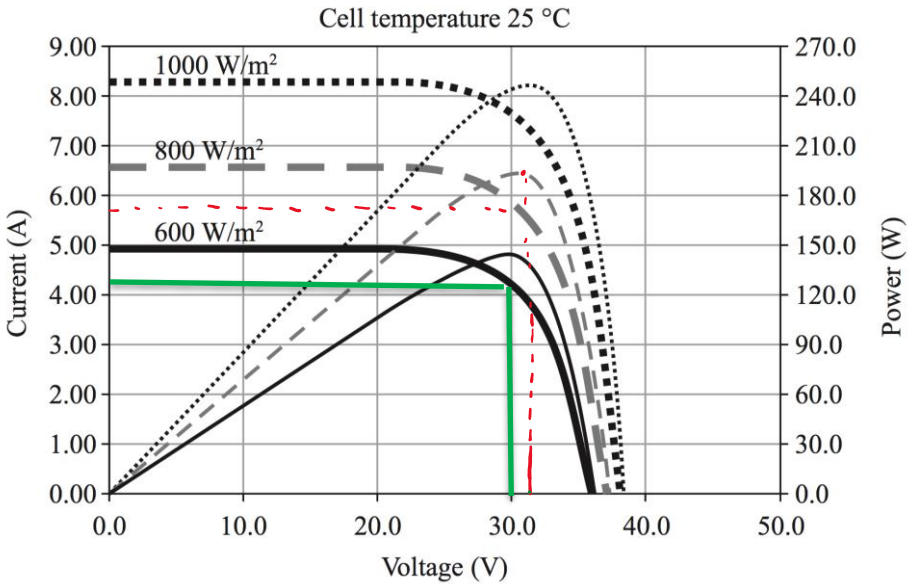
Cost = Power x time x rate (1)

= 0.900 x 1.2 x 26 (1)

= 28.1 cents (1)

**Question 2** **(7 marks)**

The diagram below shows the characteristic current, voltage and power curve for a solar cell at 25.0 °C with light of various intensities shining on it (measured in $Wm^{-2}$) The higher the light intensity, the higher the current produced. The thinner lines represent the power output of the cells for a given light intensity and relate to the right axis.




(a) State the approximate voltage and current of the cell under which maximum power production occurs for the 800 $Wm^{-2}$ light intensity.

(2 marks)

V ~ 32 V (1)

I ~ 5.8 A (1)

(b) Showing your working on the graph, determine the current that would be drawn when the light intensity is 600 $Wm^{-2}$ and the solar cell is generating a voltage of 30.0 V

(2 marks)

~ 4.2 A (1 mark for working out on graph)

(c) Is the increase in current of the cell directly proportional to the intensity of the light shining on it? Justify your response with a suitable calculation.

(3 marks)

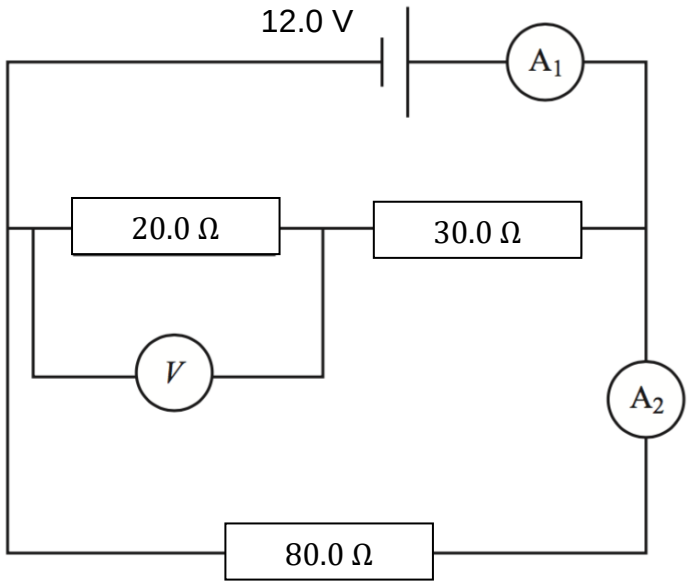
$\frac{P}{I}: \frac{1000}{8.2}: \frac{800}{6.6}: \frac{600}{4.9}$ (1)

: 122 : 122 : 122 (1)

Yes, increase is proportional (to a limit of 20V) (1)

**Question 3** **(7 marks)**

Consider the circuit shown. Calculate the readings on all of the meters.




$R_E = 20 + 30 = 50\ \Omega$ (1)

$\frac{1}{R_E} = \frac{1}{80} + \frac{1}{50} = \frac{8}{400} + \frac{5}{400} = \frac{13}{400}$ (1)

$R_E = \frac{400}{13} = 30.8\ \Omega$ (1)

$I = \varepsilon / R_T \quad = 12/30.8$

$= 0.390\ A \quad = A_1$ (1)

$I_2 = V_p / R \quad = 12/80$

$= 0.150\ A \quad = A_2$ (1)

$I_T = I_1 + I_2$

$0.390 = I_1 + 0.150$

$I_1 = 0.240\ A$ (1)

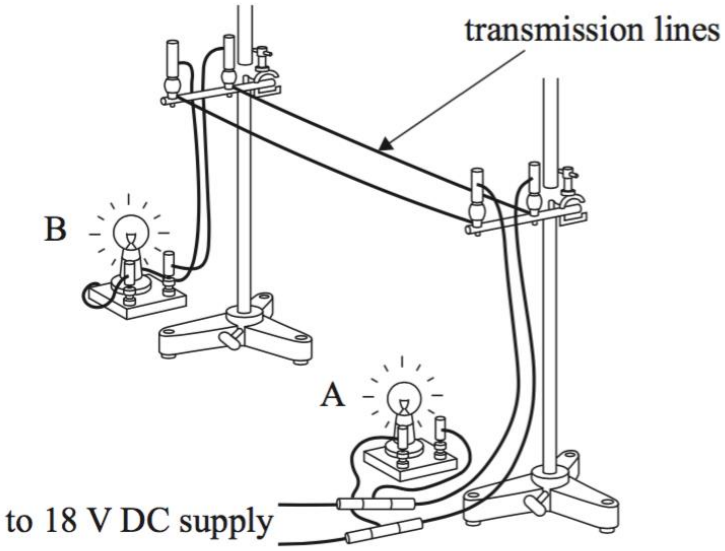
$V_{20} = I_1 R$

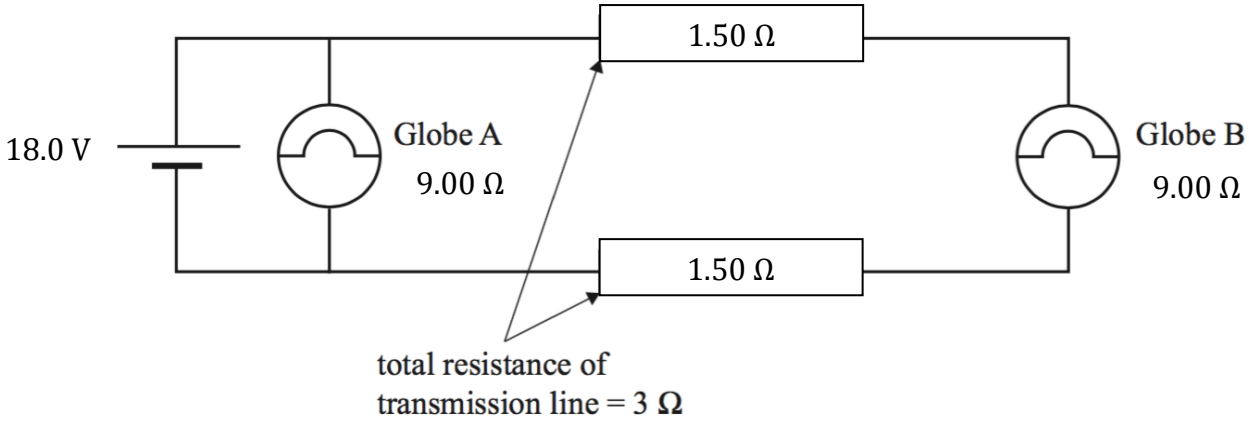
$= 0.240\ (20)$

$= 4.80\ V$ (1)

**Question 4** **(7 marks)**

Roger and Mark are investigating the transmission of electric power using a model system, as shown below. Each globe has a resistance of 9.00 V and is connected to an 18.0 V power supply. Each transmission line has a resistance of 1.50 Ohm. Assume that the other connecting wires have negligible resistance.




(a) Calculate the power produced by globe A.

(3 marks)

$P = IV$ $I = V/R$ $P = V^2/R$ (1)

$= 18^2/9$ (1)

$= 36.0$ W (1)

(b) Calculate the total voltage drop over the transmission lines.

(4 marks)

$R_E = 1.5 + 1.5 + 9 = 12\ \Omega$ (1/2)

$I = V / R$ (1/2)

$= 18/12$ (1/2)

$= 1.50$ A (1/2)

$V_{drop} = IR$ (1/2)

$= 1.50(3)$ (1/2)

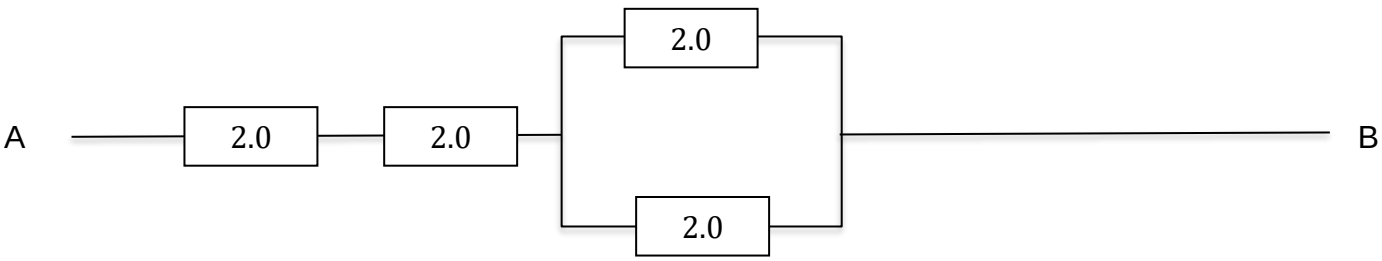
$= 4.50$ V (1)

**Question 5** **(3 marks)**

You are provided with five resistors, each of 2.0 Ω. Show how to connect them to produce an effective resistance of 5.00 Ω, using five or fewer resistors.

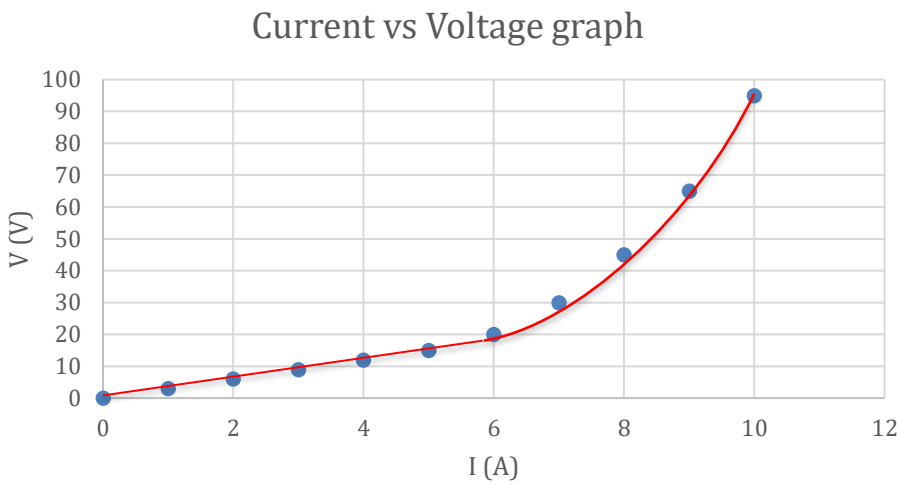
(a) Draw in the space below, so that points A and B are at either end of the effective resistance. Label the resistors in your diagram R1, R2, R3 ….etc. If you used fewer resistors, use fewer labels.

1 mark for neatness: strait lines, right angle junctions, symbols



**Question 6** **(9 marks)**

A voltage source is connected across a light bulb and the current is recorded for different voltages. The graph is shown to the right.




(a) Draw a line of best fit for the data shown in the graph above.

(1 mark)

(b) State the range of **voltages** where the light bulb is ohmic.

(1 mark)

Range: 0 – **20** V

(c) Using the gradient, calculate the resistance of the light bulb when it is ohmic.

(3 marks)

$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{20 - 0}{6 - 0} = 3.33$ (1)

$V = R.I$

$y = m.x$ (1)

$R = 3.3\ \Omega$ (allow 1.s.f) (1)

Must show full working for gradient

Must show linearization logic

(d) Calculate the resistance of the light bulb when the current drawn is 8 amps.

(2 marks)

$R = V / I$ (1/2)

$= 45 / 8$ (1/2)

$= 5.6\ \Omega$ (1) (allow 1.s.f = 6 Ω)

(e) Explain why the resistances calculated in part (c) and (d) different, making reference to the kinetic theory of matter.

(3 marks)

- As current flows through the globe it heats up and the particles increase their Ek
- This additional Ek further impedes the motion of charge through the filament
- Leading to an increase in resistance.

**Question 7** **(7 marks)**

There are a variety of devices installed in household appliances and circuits that protect the consumer from electrical hazards.

(a) State the two types of hazards present in electrical circuits.

(1 marks)

Thermal and Shock

If a person comes into contact with a live wire with a potential difference of 240 V, serious injury can occur.

(b) Explain why a 10.0 A rated fuse in the circuit **will not** protect the person from this hazard.

(3 marks)

- Person places themselves in parallel with the appliance
- The person's resistance is high enough, the current will not exceed the fuse rating
- And so the fuse will not melt/break and create an open circuit.

(c) State which device protects the person from this hazard and explain how it functions.

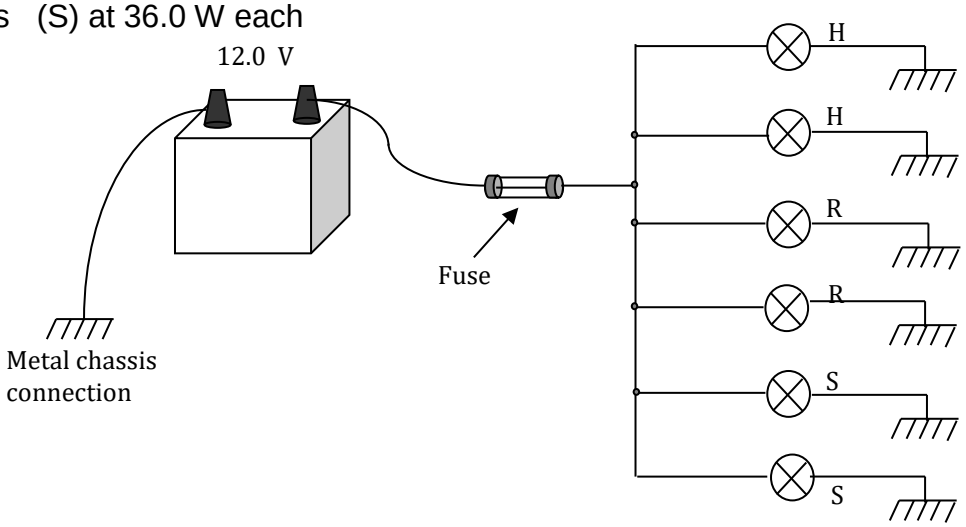
(3 marks)

- Residual Current Device (RCD)
- Monitors current travelling in both live and neutral wire.
- In the event of leakage, these values are different and it opens the circuit.

**Question 8** **(7 marks)**

A car 12.0 V lighting diagram shows 6 lamps connected to a common fuse. The lamps, all running from the battery are:

2 x headlights (H) at 42.0 W each
2 x rear-lights (R) at 21.0 W each
2 x stoplights (S) at 36.0 W each




(a) Determine the current that would flow through the fuse when all lamps are operating.
(4 marks)

$P_T = (2 \times 42) + (2 \times 21) + (2 \times 36)$

$= 198$ W (1)

$P = I V$ $I = P / V$ (1)

$= 198 / 12$ (1)

$= 16.5$ A (1)

(b) A mechanic has three fuses rated 10 A, 15 A and 20 A in his toolbox. State which of the 3 fuses he should use in the lighting circuit to allow it to operate properly.
(1 marks)

20 A fuse

(c) Explain why the globes are placed in parallel and not series.
(2 marks)

- So that the voltage **across** each globe is the same.
- And if one globe breaks, the others can still operate / globes can operate independently of one another.

(If student says voltage "through" each globe; maximum ½ mark for first point)
(If student says all globes have the same power/current/brightness; maximum ½ mark for first point)

**END OF TEST**