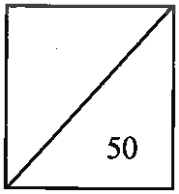
ELECTRICITY TEST – 2014



TIME: **55 minutes**

NOTE:

1. Calculations must show clear working with answers stated to **three significant figures.**
2. **Marks will be allocated for clear and logical setting out.**
3. State assumptions if working on open ended type questions.

Multiple choice: /6 marks. **Circle the correct response.**

1. The electrical resistance of a metal wire is increased by increasing its:
I temperature
II length
III cross-sectional area

(a) I only
(b) III only
(c) I and II only
(d) II and III only
(e) I, II and III

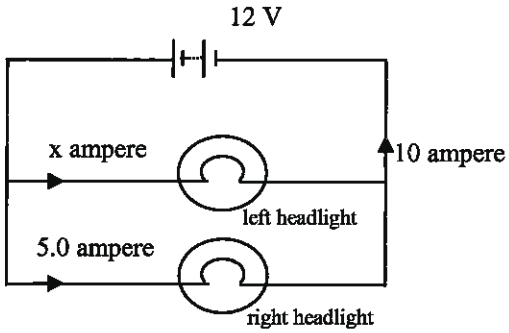
2. The open-circuit voltage of a 6-V battery is measured as 5 V. When the battery is short-circuited with an ammeter, the ammeter reads 4 A. What is the internal resistance of the battery?

(a) Not enough information
(b) 1.5 Ω
(c) 1.25 Ω
(d) 1.2 Ω
(e) 1 Ω

3. How much does it cost to run a 1500 W oven for 3 hours if electricity is charged at 20 c per kW h ?

(a) $9.00
(b) $1.00
(c) $0.90
(d) $0.60
(e) $0.10

4. The right and left headlights of a car are connected to the battery as shown below. Which headlight gets more voltage?



(a) not enough information
(b) same
(c) right headlight
(d) left headlight

5. What is the power dissipated by an electric light filament of resistance 1.54 ohms if a potential of 10.0 volts DC is maintained across the terminals?

(a) 23.7 watts
(b) 15.4 watts
(c) 64.9 watts
(d) 154 watts

6. Which statement about meters and their correct connection into circuits is TRUE?

(a) A voltmeter should have a low resistance and be connected in series with a component
(b) An ammeter should have a high resistance and be connected in parallel with a component
(c) A voltmeter should have a high resistance and be connected in series with a circuit
(d) An ammeter should have a low resistance and be connected in series with a component

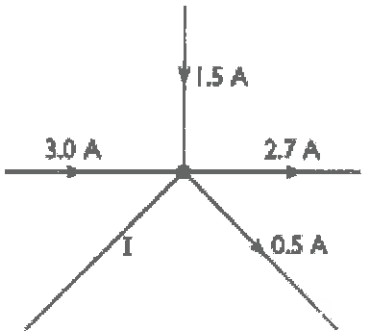
Short answer questions: **44 marks**

1. A camera flash gun passes 6 x 10^{12} electrons between its electrodes in a time of 1.6 ms. What is the average current flowing during the flash discharge? (2 marks)

$I = \frac{q}{t} = \frac{6\times10^{12} \times 1.6\times10^{-19}}{1.6\times10^{-3}} = 6\times10^{-4}\ A$

$= 6.00\times10^{-4}\ A$ ✓✓

2. Calculate the magnitude and direction (in or out) of the unknown current in the figure below (2 marks).



$\Sigma I_{in} = \Sigma I_{out}$

$\Sigma I_{in} = 4.5A$

$\Sigma I_{out} = 3.2A + I$

ie $I = 4.5 - 3.2 = 1.30\ A$ out ✓✓

3. The resistance of a wire is given by the equation $R = \frac{\rho l}{A}$ where, R = resistance (Ω), l = length of wire, A = cross sectional area of wire and ρ = the *resistivity* of the particular material used in the wire.

An electrician uses a particular copper wire in a household circuit which has a resistance of 0.1 Ω. If he exchanges this for another copper with double the length and 4× the cross-sectional area, what will be the resistance of the new wire? (2 marks)

$R = \frac{\rho l}{A}$

$R' = \frac{\rho \times 2l}{4A}$

$= \frac{1}{2}\frac{\rho l}{A}$

$= \frac{1}{2}R$ ✓

$R' = \frac{1}{2}\times 0.1$

$= 0.0500\ \Omega$ ✓

4. An electric kettle is connected to a 240 V supply that draws a current of 8.50 A. Show your working and calculate:

a) The **power** rating of the kettle.
(2 marks)

$P = VI = 240 \times 8.5$

$= 2040$ W ✓✓

b) The **heat energy** produced in 2 ½ minutes.
(2 marks)

$t = 2\frac{1}{2}$ min

$= 2.5 \times 60$

$= 150$ s

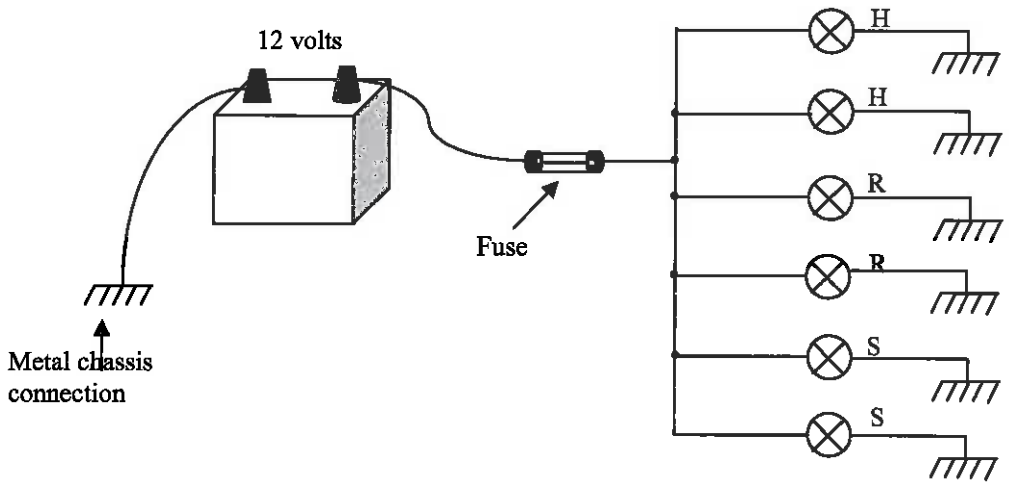
$E = Pt$

$= VIt$

$= 2040 \times 150$

$= 306000$ J ✓✓

5. A car 12 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 W each; 2 x rear-lights at 21 W each (R); 2 stoplights at 36 W each (S).



The owner of the car put a 15 A fuse in the circuit. Is this fuse likely to be appropriate? Show your working and explain your answer. (3 marks)

Total power dissipated $= 2 \times 42 + 2 \times 21 + 2 \times 36$

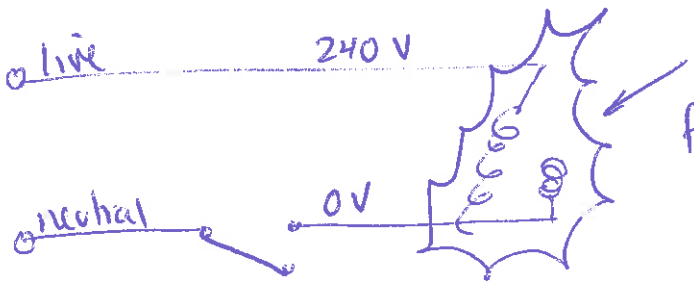
$= 198$ W

All components are running on 12 V

$I_{Tot} = \frac{P}{V} = \frac{198}{12} = 16.5$ A ✓✓

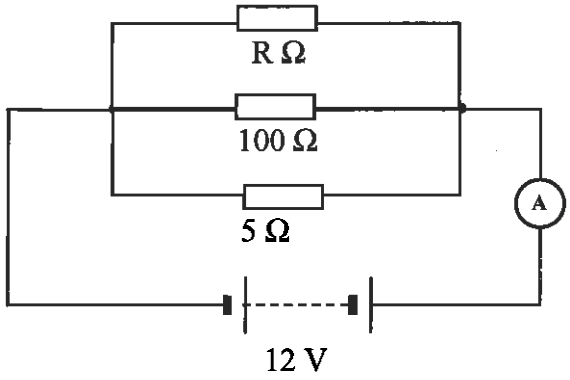
No. This fuse is too low in current rating. It will blow at the design current ✓

6. If a switch is placed on the neutral wire rather than the active wire in a household electrical circuit the switch is still able to turn devices on and off. However, a switch is placed on the neutral wire is potentially hazardous. Explain why. You may wish to use a diagram. (3 marks)



The diagram shows a switch incorrectly placed on the neutral line. If a component is faulty & becomes 'live', a switch on the neutral line will not isolate it from the supply voltage & so it will still be dangerous to touch even though it is switched off.

7. The current in the ammeter below is measured as 3 A. Determine the value of the unknown resistance. (4 marks)



$R_T = \frac{V_T}{I_T} = \frac{12}{3} = 4\ \Omega$ ✓

$\frac{1}{R_T} = \frac{1}{R} + \frac{1}{100} + \frac{1}{5} = \frac{1}{4}$ ✓

ie $\frac{1}{R} = \frac{1}{4} - \frac{1}{100} - \frac{1}{5}$

$= \frac{25}{100} - \frac{1}{100} - \frac{20}{100} = \frac{4}{100}$

ie $R = \frac{100}{4} = 25\ \Omega$ ✓✓

8. A 12.0 volt battery from a certain car has a capacity of 140 Ah, which means that it can supply a current of 140 A for 1.00 hour, a current of 70.0 A for 2.00 hour, and so forth.

(a) How much energy is stored in the battery? (3 marks)

$E = VIt$

$= 12 \times 140 \times 60 \times 60$

$= 6048000$

$= 6.05 \times 10^6 \text{ J}$

(b) If the car's lights require 60.0 W of power, how long (in hours) can the battery keep them lighted when the engine (and hence its generator) is not running? (2 marks)

$I = P/V = \frac{60}{12} = 5 \text{ A}$

$\frac{140}{5} = 28.0 \text{ h}$

9. The element of an electric jug has a resistance of 50.0 Ω and draws a current of 4 A. 1.3 kg of water at a temperature of 25^{0}C is in the jug. How long will it take to bring the water to the boil (100^{0}C)? (3 marks)

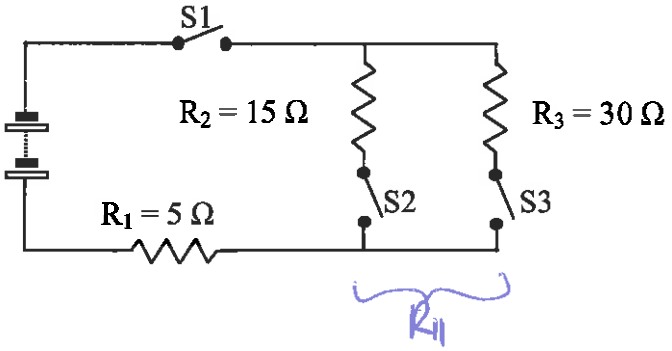
$E = VIt = I^2Rt = mc\Delta T$

$\therefore \quad t = \quad t = \frac{mc\Delta T}{I^2R}$

$= \frac{1.3 \times 4180 \times 75}{4^2 \times 50}$

$= 509 \text{ s}$

10. Three resistors are connected to a DC power supply as shown. When all switches are closed, it is found that the current in the 5.00 Ω resistor is 500 mA.



(a) With switches S1, S2 and S3 closed, calculate the total resistance of the circuit. (2 marks)

$R_{11} = (R_2^{-1} + R_3^{-1})^{-1}$
$= (15^{-1} + 30^{-1})^{-1}$
$= 10\ \Omega$

$R_T = R_{11} + R_1$
$= 10 + 5$
$= 15.0\ \Omega$

(b) With switches S1, S2 and S3 closed, determine the potential difference across resistors R_1 and R_2 and the battery terminal voltage. (3 marks)

$V_T = I_T R_T$
$= 0.5 \times 15$
$= 7.5\ V$

$V_{R1} = IR$
$= 0.5 \times 5$
$= 2.5\ V$

Thus $V_{11} = V_{R2} = 7.5 - 2.5$
$= 5\ V$

Answer $V_{R1} =$	2.50 V
Answer $V_{R2} =$	5.00 V
Answer $V_{Batt} =$	7.50 V

(c) With switches S1, S2 and S3 closed;

i) Determine the current flowing in the 15.0 Ω resistor. (2 marks)

$I_{15} = V/R = \frac{5}{15} = 0.333$ A

ii) Determine the current flowing in the 30.0 Ω resistor. (1 mark)

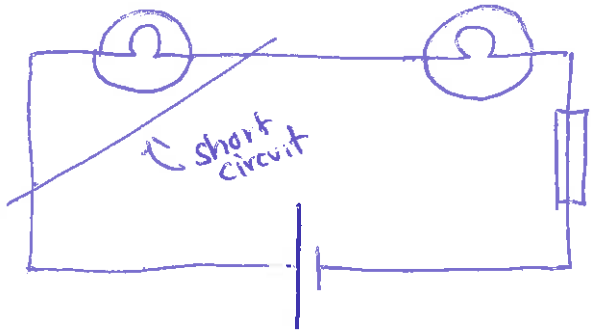
$I_{30} = 0.5 - 0.333 = 0.167$ A

(d) With switches S1, S2 and S3 OPEN, what voltage would be measured across R_1? (1 mark)

0

11. An electric circuit which is part of the lighting for a ~~house~~ car consists of a battery with 2 identical lamps *in series*. There is also a fuse in the circuit to protect it. Due to a fault, there is a short circuit (fault) ***across one of the lamps***.

(i) Draw the circuit described above, including the short circuit. **Clearly label the short circuit**: (2 marks)



Circuit ✓
short circuit ✓

(ii) Prior to the short circuit, both lamps were glowing with the same brightness. Circle one option for each lamp which describes any likely change to its brightness when the short circuit occurs: (2 marks)

a) Short circuited lamp will be: brighter / same brightness / duller / (no glow)

b) Other lamp will be: (brighter) / same brightness / duller / no glow

(iii) State one potential danger or negative effect of the short circuit in this situation (1 mark)

+ wires burn out/melt
+ fire

(iv) Explain with bullet points how the fuse functions to protect the circuit (2 marks)

+ The fuse is designed to break the circuit ✓ if the current exceeds a safe level ✓

☺ CONGRATULATIONS: ☺

YOU HAVE COMPLETED THE FINAL Y11 PHYSICS TEST