Neap:

PHYSICS VCE UNITS 1&2
DIAGNOSTIC TOPIC TESTS 2016

TEST 4: HOW DO ELECTRIC CIRCUITS WORK? (II)

SUGGESTED SOLUTIONS AND MARKING SCHEME

Question 1 (16 marks)

a. Q — 1 mark

The graph of voltage versus current is linear for graph Q, hence this is ohmic. — 1 mark

b. 2 A — 1 mark

The two components P and Q are in a series circuit, therefore the current through both components has to be the same.

c. 5.0 V — 2 marks

The potential difference for device P is read from the voltage versus current graph when the current is 2.0 A.

d. 2.5 V — 2 marks

The potential difference for device Q is read from the voltage versus current graph when the current is 2.0 A.

e. 7.5 V

The variable voltage supplies the total potential difference across both components in series. — 1 mark

*Note: Consequential on answers to **Question 1c.** and **1d.***

f. $P = IV$

$= 2 \times 7.5$ — 1 mark

$= 15$ W — 1 mark

*Note: Consequential on answer to **Question 1e.***

g. 2.0 A — 2 marks

The current for device P is read from the voltage versus current graph when the potential difference is 5.0 V.

h. 4.0 A 2 marks

The current for device Q is read from the voltage versus current graph when the potential difference is 5.0 V.

i. Total power supplied to the circuit is given by $P = IV$, where the total current for these two devices in parallel is 6.0 A.

$P = IV$

$= 6.0 \times 5.0$ 1 mark

$= 30$ W 1 mark

Question 2 (2 marks)

V_{in} to the voltage divider circuit is 18.0 V DC. The output voltage V_{out} is 5.0 V. This means R_1 has 13.0 V across it while R_2 has 5.0 V across it. 1 mark

Therefore, the ratio of the two resistances, $R_1 : R_2$, must be 13 : 5. As R_1 is 26 kΩ, R_2 must be 10 kΩ. 1 mark

Question 3 (2 marks)

A current of 20 mA is dangerous for yourself because you cannot let go and therefore break the electrical connection as your muscles are paralysed. 1 mark

A member of your family who is watching this happen and tries to grab you to break the connection will also have their muscles paralysed. 1 mark

Question 4 (2 marks)

1 lux corresponds to an LDR resistance of 100 kΩ. 1 mark

$V_{DE} : V_{EF} = R_L : R$

$8 : 4 = 100\ \text{k}\Omega : R$

$R = 50\ \text{k}\Omega$ 1 mark

Question 5 (2 marks)

An LED is a light-emitting diode – it converts electrical energy to light energy and is therefore an electro-optical transducer. 1 mark

A photodiode converts light energy to electrical energy, therefore it is an optoelectrical transducer. 1 mark

Question 6 (6 marks)

a. $P = \dfrac{V^2}{R}$

$= \dfrac{12^2}{24}$ 1 mark

$= 6\ \Omega$ 1 mark

b. These two light globe resistances are in a parallel circuit. Using the parallel formula for resistors:

$$\frac{1}{R} = \frac{1}{6} + \frac{1}{6}$$ 1 mark

$$= \frac{1}{3}$$

$$R = 3\ \Omega$$ 1 mark

c. A 1 mark

Car headlights are wired in parallel. This means that if one headlight is broken the other will still work. This is a distinct advantage if you are driving at night and one of the headlights breaks. 1 mark

Question 7 (10 marks)

a. If there is a fault in the household lighting circuit that causes too much current to be drawn from the mains electricity, the circuit breaker will activate and turn the power off via the active side. 1 mark

This is important as if the circuit breaker was in the neutral side and activated due to an electrical fault, the active wire would still be connected to the fault. 1 mark

b. The function of the circuit breaker is to cut the power off quickly if there is an electrical fault. 2 marks

c. The five lights are wired in parallel so that if one light breaks, the others still can be used. 1 mark

It also ensures that each globe receives a standard 240 V supply. 1 mark

d. no 1 mark

In a parallel circuit like this, the light globes can be of variable wattage. While each globe still has the full 240 V voltage across it, it will only draw the current required to achieve the designated brightness. 1 mark

e. 5 globes = 5 × 120 W

$$P = IV$$

$$I = \frac{5 \times 120}{240}$$ 1 mark

$$= 2.5\ \text{A}$$ 1 mark

Question 8 (5 marks)

a. The total current drawn by the electric kettle (10 A) and the other light (0.5 A) is enough for the circuit breaker to trip, 1 mark

which means that both the light and the kettle will stop working. 1 mark

b. The metal-cased electric kettle needs to be earthed to be safe. 1 mark

The individual light sockets are not earthed, as light globes do not need an earth. 1 mark

This means that Jacque's illegal connection has created a situation that if the electric kettle was faulty, the case could become active and possibly lethal. 1 mark