



FOUNDATION PHASE TEST SPECIFICATION

Programme:	Foundation				
Unit:	Engineering Science : Electronics				
Phase Test No:	1	Lecturer:	Tim Tudor	Internal Verifier:	Abi Summerfield

Time and Date:	9.00am 23/3/2012	Duration:	1 Hour	Contribution to Overall Unit Assessment (%):	15%
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Outcomes being Assessed (from Unit Syllabus):	
Number	Description
1	Identify and apply appropriate physical principles and relationships in order to solve engineering problems.
2	Manipulate equations to produce numerical values in engineering units.

Instructions to candidates:

Write your name in the candidate name box below.

All working should be completed in this test booklet.

Answer ALL questions

Show all workings for calculations.

Formulae:

$$P = IV$$

$$E = \frac{CV^2}{2}$$

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

$$V = IR$$

$$I = \frac{Q}{t}$$

$$\Delta R = \alpha R_0 \Delta T$$

Candidate Name

Model Answers

Question 1

- a) Describe with reference to atomic structure how electricity flows through a conductor.

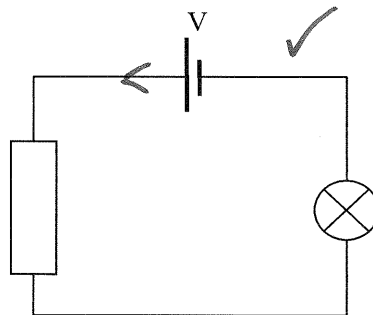
Mention - Electron movement

- Electrons carry negative charge
- Free electrons → Conductor
- No free electrons → Insulator
- Flow of electrons opposite to current
- Charge movement of energy

[3 mark]

- b) Draw and label an arrow to show the direction of conventional current flow on the circuit diagram below.

[1 mark]



- c) Give fluid and mechanical properties which are analogous to the following electrical terms :

Voltage : pressure, force

Current : Flow, movement

Resistance : valve, viscosity, Friction.

[3 marks]

d) State :

Kirchoff's Current Law:

The sum of the currents entering a junction is equal to the sum of the currents leaving $\sum_{k=1}^n I_k = 0$ ✓

[1 marks]

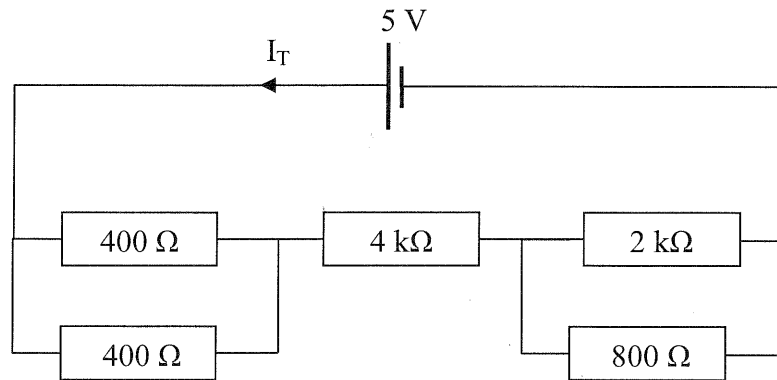
e) State :

Kirchoff's Voltage Law:

The sum of the ~~currents~~ voltages around a closed loop must equal 0. $\sum_{k=1}^n V_k = 0$ ✓✓

[2 marks]

Question 2



- a) Calculate the total resistance for the circuit above

$$R_T = \frac{1}{\frac{1}{400} + \frac{1}{400}} + 4000 + \frac{1}{\frac{1}{2000} + \frac{1}{800}}$$

$$R_T = 4.771 \text{ k}\Omega$$

[4 marks]

- b) Calculate the unknown current, I_T

$$V = IR \quad I = \frac{V}{R} = \frac{5}{4771} = 1.05 \text{ mA}$$

[2 marks]

- c) Calculate the total power dissipated by the circuit.

$$P = IV = \frac{V^2}{R} = \frac{5^2}{4771} = 5.24 \text{ mW}$$

✓ ✓

[2 marks]

- d) Calculate the current flowing through the 800 ohm resistor.

$$I_1 = \frac{R_2}{R_1 + R_2} \times I_T = \frac{2000 \times 1.05 \times 10^{-3}}{2800} = 0.75 \text{ mA.}$$

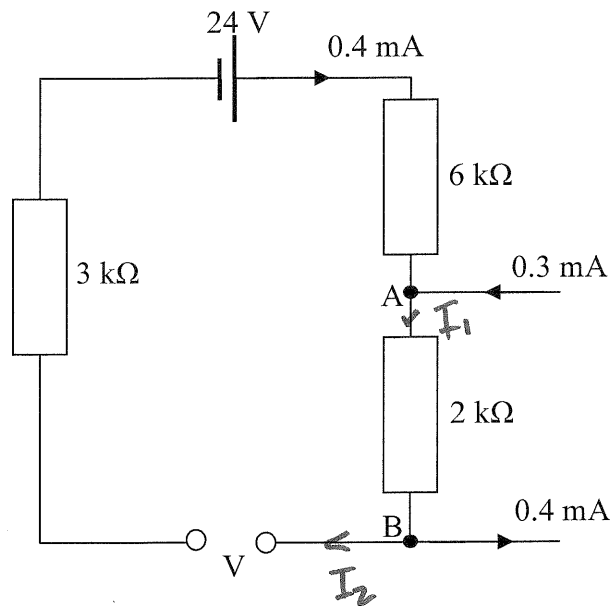
OR.

$$V_{800} = 1.05 \times 10^{-3} \times 571.43 = 0.6 \text{ V}$$
$$\therefore I_{800} = \frac{V}{R} = \frac{0.6}{800} = 0.75 \text{ mA.}$$

✓✓

[2 marks]

Question 3



- a) Label and calculate the unknown currents in the circuit above.

Set A: $I_1 + I_2 + I_3 = 0$

$$I_1 + (0.4 \times 10^{-3}) + (0.3 \times 10^{-3}) = 0$$

$$I_1 = -0.7 \text{ mA}$$

Away from A

Set B: $I_1 + I_2 + I_3 = 0$

$$I_2 + (0.7 \times 10^{-3}) - (0.4 \times 10^{-3}) = 0$$

$$I_2 = -0.3 \text{ mA}$$

Away from B

[4 marks]

- b) Calculate the unknown voltage, V.

$$V_1 = 24V$$

✓

$$V_2 = 0.4 \times 10^{-3} \times 6 \times 10^3 = 2.4V$$

$$V_3 = 0.7 \times 10^{-3} \times 2 \times 10^3 = 1.4V$$

✓

$$V_4 = V$$

$$V_5 = 0.3 \times 10^{-3} \times 3 \times 10^3 = 0.9V$$

✓

$$V_1 + V_2 + V_3 + V_4 + V_5 = 0$$

$$V_4 = -24 + 2.4 + 1.4 + 0.9$$

✓

$$V_4 = -19.3V$$

✓

[5 marks]

- c) Indicate the direction of this voltage on the circuit diagram by symbolising the unknown voltage as a battery



✓

[1 marks]

Question 4

- a) A long thin aluminium wire has a resistance of 0.33Ω at a temperature of 0 degrees Celsius. Calculate the resistance of the wire if it is heated to a temperature of 120 degrees Celsius, given that the temperature co-efficient of the material is $4 \times 10^{-3} \text{ K}^{-1}$

$$R_0 = 0.33 \Omega$$

$$\alpha = 4 \times 10^{-3} \text{ K}^{-1}$$

$$T_0 = 0^\circ \text{C}$$

$$\Delta R = \alpha R_0 \Delta T \quad \checkmark$$

$$T_1 = 120^\circ \text{C}$$

$$\Delta R = 4 \times 10^{-3} \times 0.33 \times (120 - 0) \quad \checkmark$$

$$\Delta R = 0.1584 \Omega$$

$$R_1 = R_0 + \Delta R = 0.33 + 0.1584 \quad \checkmark$$

$$R_1 = 0.488 \Omega$$

[5 marks]

- b) A certain wire is made from a material with a resistivity of $2.65 \times 10^{-8} \Omega\text{-m}$. Calculate the length of a wire if it has a diameter of 0.16 mm and a resistance of 80 Ω .

$$\rho = 2.65 \times 10^{-8} \Omega\text{-m} \quad \checkmark$$

$$d = 0.16 \text{ mm}$$

$$R = \frac{\rho L}{A} \Rightarrow L = \frac{RA}{\rho} \quad \checkmark$$

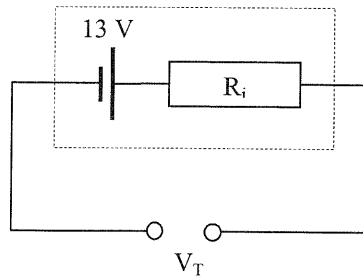
$$R = 80 \Omega$$

$$A = \pi r^2 = \pi (0.08 \times 10^{-3})^2 \quad \checkmark \quad \text{or} \quad \frac{\pi d^2}{4} = 2.011 \times 10^{-8} \text{ m}^2 \quad \checkmark$$

$$L = \frac{80 \times 2.011 \times 10^{-8}}{2.65 \times 10^{-8}} = 60.71 \text{ m.}$$

[5 marks]

Question 5



- a) A certain battery has an EMF of 13.1 V. Calculate the terminal voltage V_T when a current of 9A is drawn, if the battery has an internal resistance of 0.225 Ω .

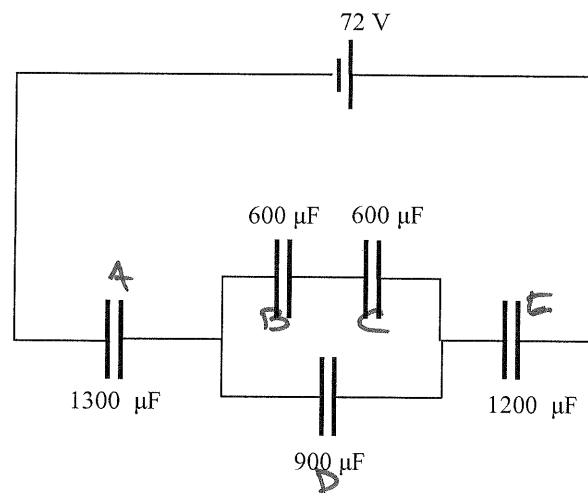
$$\text{Emf} = V + IR_i$$

$$V = \text{Emf} - IR_i \quad \checkmark$$

$$V = 13.1 - (9 \times 0.225) \quad \checkmark$$

$$V = 11.075 \text{ V} \quad \checkmark$$

[3 marks]



- b) Calculate the total capacitance of the circuit shown above.

$$C_{BC} = \frac{1}{\frac{1}{600} + \frac{1}{600}} = 300 \mu\text{F} \quad \checkmark$$

$$C_{BCD} = 300 + 900 = 1200 \mu\text{F} \quad \checkmark$$

$$C_{ABED} = \frac{1}{\frac{1}{1300} + \frac{1}{1200} + \frac{1}{1200}} = 40.5 \mu\text{F} \quad \checkmark$$

[4 marks]

- c) Explain how a capacitor stores energy and describe its construction.

Mention

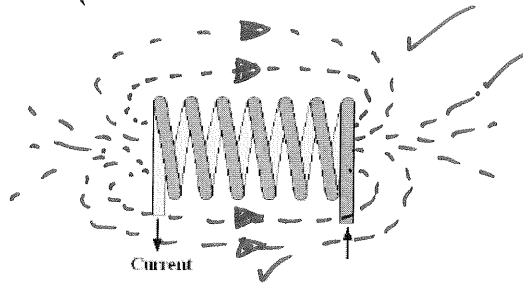
- 2 plates
- dielectric insulator
- electrons forced from one plate to the other
- Differential in charges make electrons want to flow back to balance charge

[3 marks]

Question 6

- a) Draw lines around the coil below to indicate the magnetic field lines which would be produced when a current is passed through the coil.

[3 marks]



- b) Explain the principles of how an alternator produces electrical current in a vehicle to charge a battery.

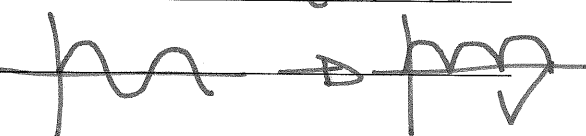
[4 marks]

Mention

- Conductor moves in magnetic field ✓
- Induced current in conductor ✓
- A.C current due to rotation ✓
- Magnetic flux produced by ✓
Lenz's law

- c) Explain what is meant by the term rectification

[3 marks]

Converting AC current to DC (all in ✓
same direction). 

|||| ||| || | | || | |

16. Scripts

END OF TEST

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ac → d.c
= 2 marks.