Saigon International College

SCIENCE DEPARTMENT
Physics ATAR YEAR 11
Semester 1

AEPHY

TEST # 3

Electrical Physics

Task Weighting: 5% of the school mark for this pair of units

Time: 70 minutes

Student Name: Chu Minh Đăng

Score: 45/58 Great

ANSWER ALL QUESTIONS IN THE SPACES PROVIDED ON THIS PAPER.

Full working must be shown to obtain full marks. Should show answers in 3 s.f. and scientific notation.
NOTE: Where necessary use the constants supplied on the SCASA formula sheet. Non-programmable calculators are permitted. Use a blue or black pen. Pencil is allowed only for diagrams and graphs.
Number of Questions: 10

Question 1 (2 marks)

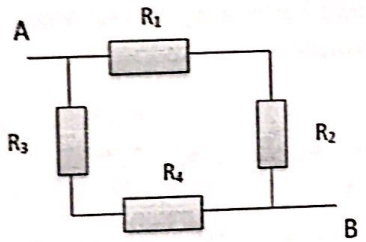
If a neutral atom gains two electrons, what is the charge, in coulombs, of the resulting ion? Explain your reasoning.

The charge will be negative because the electrons have negative charge, and the central atom is neutral. So it make the neutral atom become negative ~~$(1.6 \times 10^{-19} \times 2 = 3.2 \times 10^{-19}$ C~~

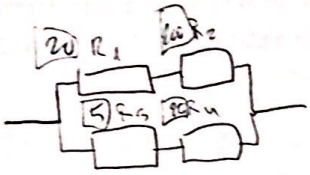
-12C ✗ 3.2×10^{-9} C

Question 2 (5 marks)

An electric circuit is shown I the diagram below. A DC voltage of 10 V is applied between A and B. The values of the resistors are $R_1 = 20\ \Omega$, $R_2 = 100\ \Omega$, $R_3 = 5\ \Omega$ and $R_4 = 25\ \Omega$.



a) Calculate the total resistance, R_T. [3]



$20 + 100 = 120$ $\quad \frac{1}{R_T} = \frac{1}{120} + \frac{1}{29}$

$5 + 25 = 30$ $\quad 5 + 25 = 29$ use a calculator.

(-1) $\quad R_T = 23.4\ \Omega$

b) Determine the current (I_T) between A and B. [2]

$V = IR$

$10 = I \times 23.4$

$\frac{10}{23.4} = I$

$I = 0.428$ A OK

1

3

Question 3 (3 marks)

A graph of a ____________________ resistor is shown below.

a) Circle the correct word to go in the space above to complete the sentence. [1]

i. ohmic   ii. Obama (Barack)   iii. omega   iv. non-ohmic

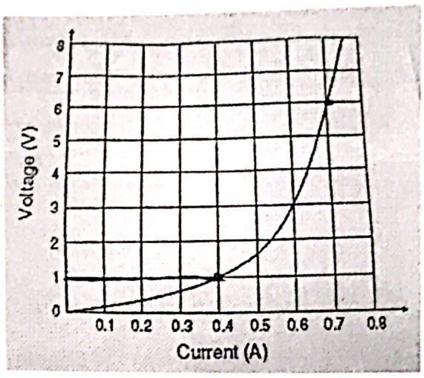
b) Calculate the resistance when there is 0.40A of current flowing through the resistor. [2]

$V = IR$

$1 = 0.4R$

$R = \frac{1}{0.4}$

$R = 2.50\Omega$



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Question 4 (4 marks)

A household electrical circuit includes components that protect people when using electrical devices. The fuse has now been replaced by circuit breakers. Explain how circuit breakers work and their advantages of over fuses.

Circuit breakers are reuseable where as fuse are not reusable (you have to replace a fuse if it blow. Fuse are not as reliable as circuit breaker. A circuit breaker work by allowing the user to turn on or off, by creating a gap in the circuit. Because circuits only work if it is all connected, when there is a high enough voltage through the circuit breaker, it will automatically shut off and create a gap in the circuit.

4

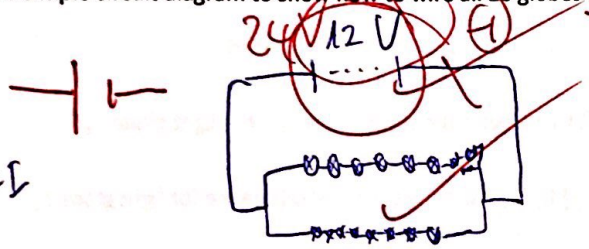
Question 5 (8 marks)

A set of 16 party lights (globes) is purchased to decorate the backyard patio for a party. When all the lights are functioning, they draw a current of 3.20A from a power supply of 24V. When one of the globes is removed, half of the lights go out, leaving the other half working. When one of the remaining globes is removed, the remaining seven working lights go out too.

a) Explain why the second set of seven lights went out when the second globe was removed, but not when the first globe was removed. [2]

Because the party lights were set up in 2 parallel lines. In each of the branch, 8 light bulbs are set in series. The two branches are set in parallel so when one light of the first branch was removed, it created a gap in the circuit, making half of the lights go out, creating a gap in that branch. The second set of light went out because that set branch was set on a another branch in parallel to the first. when a gap in the first branch happen, there is still a complete circuit flowing through the second branch, so it still continue to work

b) Draw a simple circuit diagram to show how to wire all 16 globes to the 24V power supply. [2]



Series $I = I = I$
$V = V + V$

Parallel $I = I + I + I$
$V = V = V = V$

c) Determine the voltage across each globe. [2]

12V 24V $I = 3.2\ A$
16 8 $V = 12\ V$

$\frac{12}{16} = \frac{3}{4} V = 0.75V$

d) Determine the current through each globe. [2]

$\frac{3.2}{2} = 1.6\ A$ on each branch

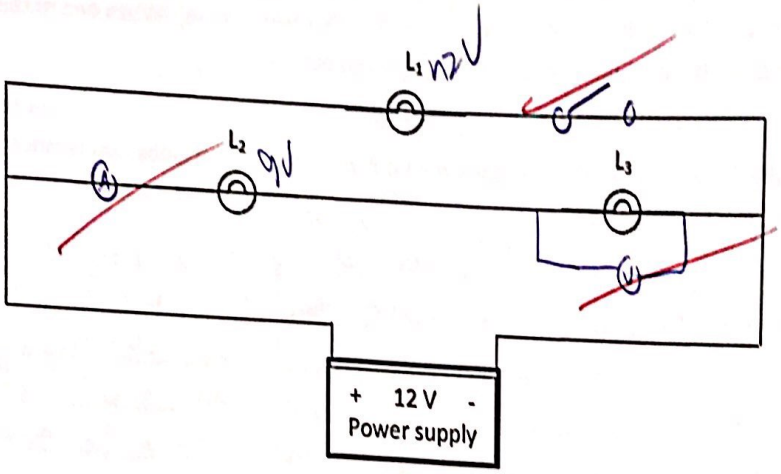
$\frac{1.6}{16} = 0.10A$ Why? 3

in series I stays the same.

10

Question 6 (11 marks)

A physics student wanted to create a circuit using three light globes. She did not have three globes that were the same, and she made the circuit below.



a) On the diagram above, draw in the following:

i. A switch (—o o—) so that only light globe L_1 is affected. [1]

ii. Ammeter (—(A)—) to measure the current through the light globe L_2. [1]

iii. A voltmeter (—(V)—) to measure the potential difference for light globe L_3. [1]

b) Which way does conventional current flow? Circle the correct answer. [1]

L_2 to L_3 L_3 to L_2 L_1 to L_2

c) Explain why changes to the brightness of L1 and L3 that occurs if L2 blows (breaks). [2]

If L_2 blew, that branch of the circuit will have a gap so L_2 will not produce any light as well. If L_2 blew, L_1 is set in parallel with L_3 so L_1 will become brighter as it does not have to share current with the other branch

d) Light globe L_1 is 12.0V and light globe L_2 is 3.00V. What should light globe L_1's voltage be to maintain 3.00V across light globe L_2? [1]

12 - 9 = 3V

e) Both L_1 and L_2 have a power rating of 100 watts.

i. Calculate the resistance of L_1. [4]

V = IR

P = VI

L_1 V = 12V

100 = 12 I

$\frac{100}{12}$ = I of L_1

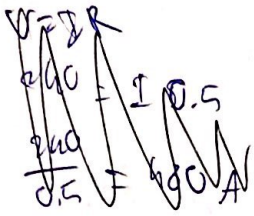
12 = $\frac{100}{12}$ R

R = 1.44 Ω

3 **Question 7** (8 marks)

The 240V supply cable to a certain house has a total resistance of 0.5 Ω. The maximum power likely to be used at any one time is estimated to be 10kW, while the normal load is estimated at 120W. Note, that the supply cables are in series with the loads in the house and there will be a potential drop (voltage drop) along the supply cable due to their resistance.

a) What is the **maximum** current likely to be used by the household? [2]



$P = VI$

$10000 = 240 \times I$

$\frac{10000}{240} = 41.6\,A$

b) What will the voltage drop along the supply cables be under minimum load of 120W? [3]
Hint: first find the **minimum** current when voltage coming into the home is 240V.

$V = 240$

$R = 0.5$

$P = 120$

$I = 41.6$

$41.6 - 0.5\,A = 41.1\,A$

$V = IR$

$V = 41 \times 0.5$

$V = 20.5\,V$

$P = VI$

$120 = 240 \times I$

$0.5\,A = I$

$V_{drop} = I \cdot R$

$= 0.5 \times 0.5$

$= 0.25\,V.$

c) What will the voltage at the household switch be under maximum load? [3]

3

Question 8 (4 marks)

The label on a rechargeable Lithium-Polymer (LiPo) battery reads: "11.1 volt, 1800 mAh". The battery is being used to operate a remote-control vehicle.

a) The term "1800 mAh" refers to which quantity below? Circle your answer. [1]

Current Time Energy Charge

b) Given that the electric motor of the vehicle draws a constant 12 A from the battery during an operating time of 9.0 minutes, calculate the efficiency of the motor, if the motor produces 5.8×10^4 J of useful energy. [3]

$P = VI$

11.1×12

$P = 11.1 \times$

$P = 133.2\ W$

9 min = 60×9 = 540 seconds

$\frac{5.8 \times 10^4}{540} = W$

2900 W

÷ 27

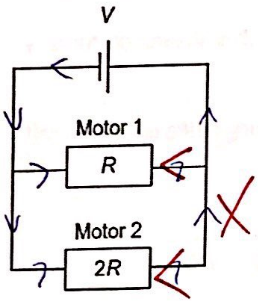
$P = 107.407\ W$

$\frac{107.407}{133.2} \times 100 = 80.62$

Question 9 (4 marks)

3

Two different motors with resistances of R and $2R$ are running in parallel with each other, powered by the same voltage source V.



a) On the diagram above indicate, with an arrow, the direction of conventional current through one of the motors. [1]

b) Due to unusual heating of the wires of Motor 2 its resistance halves from $2R$ to R. If all other factors stay the same, describe the change that occurs in the overall current drawn by the circuit, due to this unusual heating. Use relevant physics concepts to justify your answer. [3]

$I \propto \frac{1}{R}$

There must have been a cooling of the wire because the resistance of 2R decrease (halve) to R. We know that if temperature increases, R decreases, so a decrease in R means that the wire was cooled / decrease in temperature. When the resistance is less, the current increase because current and resistance are inverse to one another.

9

Question 10: (9 marks)

Read the following and answer the questions related to the article.

A forty-three tonne glider

Thunderstorms can produce lightning bolts with an average of 1.00×10^9 V and carrying a current of 1.00×10^5 A. Most pilots are not seriously concerned about lightning, as the outer skin of most aircraft is made primarily of aluminium. When lightning strikes the skin, charge flows from the contact point to the back of the aircraft, where it is discharged into the air.

In 1988, a new Boeing 737 aircraft with 45 people on board was coming in to land at New Orleans when it passed through a thunderstorm. At an altitude of about 5000 m, the aircraft suddenly lost thrust in both engines and all electrical power. The aircraft was now a 43-tonne glider.

With only three minutes to find a place to land, the pilot had the choice of a crowded freeway or a waterway. New Orleans is surrounded by waterways enclosed in levees (permanent grass covered banks), which are designed to prevent the water from flooding the city. If he landed the aircraft on the freeway, many more people could die. The pilot then spotted a grass-covered levee to the right of a waterway. While the levee was shorter and narrower than a runway, it was solid, and safer than the water.

Lining up with the levee was difficult, but was successfully achieved. Despite having neither engine thrust nor brakes, a successful landing was made on the levee. The landing was hard and, as one passenger described, their seatbelts prevented them from shooting forward and crashing into the seat in front of them.

(a) Lightning can be five times hotter than the surface of the Sun, but as it strikes an aircraft for only about 4.00×10^{-7} s, this is not usually a problem.

Using the data given in the article, calculate the average energy of one lightning strike on an aircraft. [3]

$P = VI$

$P = 1.00 \times 10^9 \times 1.00 \times 10^5$

$P = 1 \times 10^{14}$ W

$P = \frac{W}{t}$

$1 \times 10^{14} = \frac{W}{4.00 \times 10^{-7}}$

$W = 4 \times 10^7$ J

b) Calculate the total charge in coulombs involved in one average lightning strike. [2]

$1 \times 10^9 = \frac{4 \times 10^7}{q}$

$q = \frac{1}{25}\,C$

$q = 0.04\,C$

c) Using the charge on one electron from the Formulae and Data Booklet, calculate the number of electrons that would enter the aircraft during a 4.00×10^{-7} s strike. Assume that all the charge in the lightning strike is carried by electrons. [2]

$\frac{0.04}{1.60 \times 10^{-19}}$

$4 \cdot 00 \times 10^{-7} =$

2.5×10^{17} electrons

d) How are the pilots and passengers inside the plane protected from the lightning strike? [2]

Because when the lightning strikes the plane, the plane is made out of aluminium, which conducts and transfers the electrons to the back of the aircraft where it will be discharged into the air

END OF TEST