SIR ARTHUR LEWIS COMMUNITY COLLEGE

ACADEMIC YEAR (2024/2025) – SEMESTER ONE

END OF SEMESTER EXAMINATION

COURSE CODE	:	**PHY212**
COURSE TITLE	:	**Electricity, Magnetism & Quantum Theory**
LECTURER(S)	:	**Ozzy King**
DATE	:	**19th December 2024**
TIME	:	**1 p.m. – 3 p.m.**
DURATION	:	**2 Hours**
STUDENT ID #	:	_____

GENERAL INFORMATION AND INSTRUCTIONS

- Students must sign **IN** and **OUT** on the examination class list.
- Write your ID number on the question paper.
- This exam consists of SIX questions. Candidates must attempt **ALL** questions.
- All working **MUST** be **CLEARLY** shown.
- The use of non-programmable calculators is permitted.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

List of Physical Constants

Speed of light in free space	c	=	3.00×10^{8} m s^{-1}
Permeability of free space	μ_0	=	$4\pi \times 10^{-7}$ H m^{-1}
Permittivity of free space	ε_0	=	8.85×10^{-12} F m^{-1}
Elementary charge	e	=	1.60×10^{-19} C
The Planck constant	h	=	6.63×10^{-34} J s
Unified atomic mass constant	u	=	1.66×10^{-27} kg
Rest mass of electron	m_e	=	9.11×10^{-31} kg
Rest mass of proton	m_p	=	1.67×10^{-27} kg
Acceleration of free fall	g	=	9.81 m s^{-2}
1 Atmosphere	Atm	=	1.00×10^{5} N m^{-2}
Avogadro's number	N_A	=	6.02×10^{23} per mole

This exam consists of **SIX** questions. Candidates must attempt **ALL** questions. All working **MUST** be **CLEARLY** shown. The use of non-programmable calculators is permitted.

1. a. i. What is the physical reason for copper being a better conductor than a material such as nichrome which is used to make resistors? [01]

ii. By redrawing the axes in Figure 1 on your answer sheet, sketch a graph to show how the resistance per unit length of a wire varies with the cross-sectional area of the wire. [01]

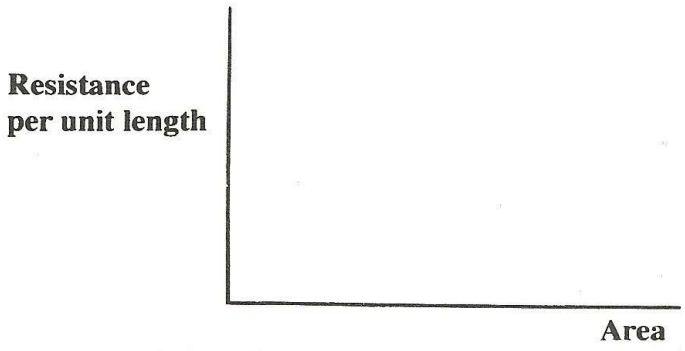


Figure 1

iii. Write an equation relating the resistance per unit length to the area of the wire. [01]

b. A small heater is constructed from nichrome wire with a diameter 0f 0.45 mm. The heater produces heat at a rate of 25 W from a 9 V supply.

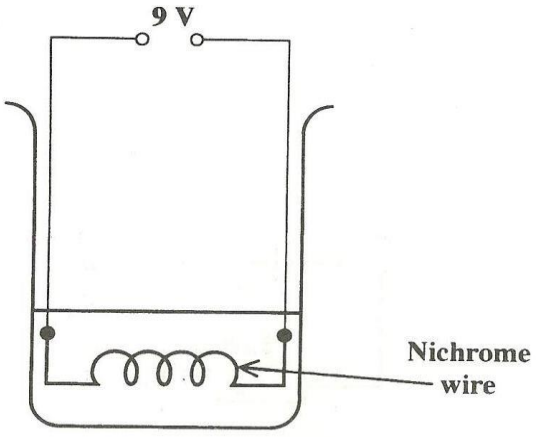


Figure 2

i. What is the resistance of the heater? [02]

ii. The length of nichrome wire required to make the heater is 42 cm. Calculate the resistivity of nichrome. [04]

TOTAL 09 marks

2. In the circuit shown in Figure 3, batteries A and B have negligible internal resistance. Battery C has an internal resistance of 3 Ω.

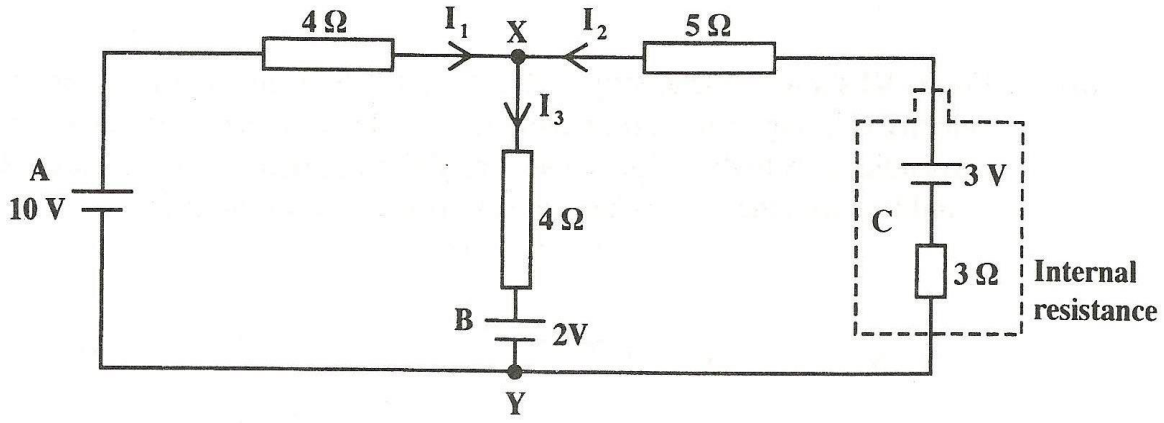


Figure 3

Use the circuit in Figure 3 to find:

a. The currents I1, I2 and I3 [10]
b. The potential difference between X and Y [02]

TOTAL 12 marks

3. The circuit diagram below shows a 6.0 V battery of negligible internal resistance connected in series to a light dependent resistor (LDR), a variable resistor and a fixed resistor, R.

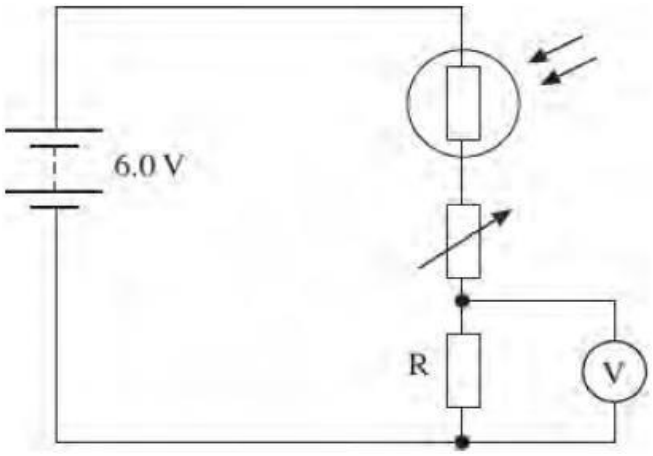


Figure 4

a. For a particular light intensity the resistance of the LDR is 50 kΩ. The resistance of R is 5.0 kΩ and the variable resistor is set to a value of 35 kΩ. Calculate the reading on the voltmeter

[02]

b. The resistance of an LDR decreases with increasing light intensity. State and explain what happens to the reading on the voltmeter if the intensity of the light incident on the LDR increases.

[02]

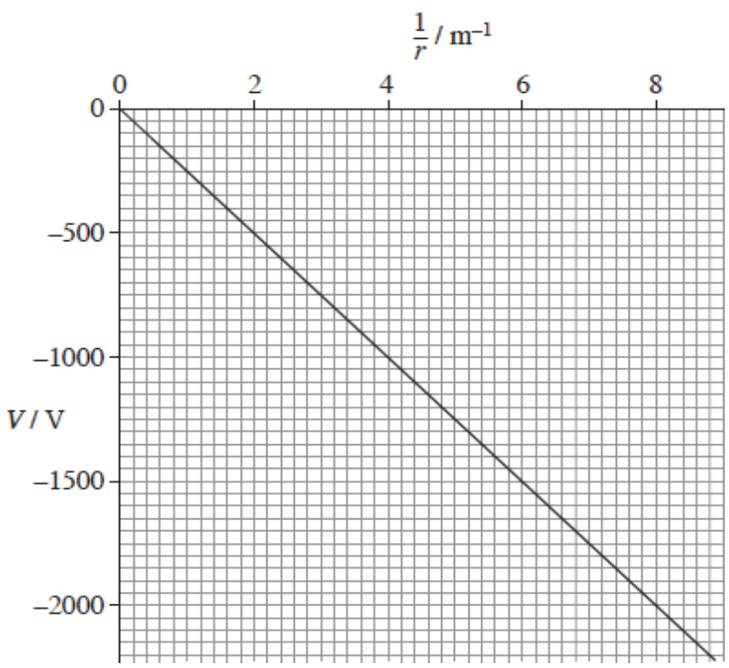
c. For a certain application at a particular light intensity the p.d. across R needs to be 0.75 V. The resistance of the LDR at this intensity is 5.0 kΩ. Calculate the required resistance of the variable resistor in this situation.

[04]

TOTAL 08 marks

4. a. State, in words, Coulomb's Law [02]

b. The graph shows how the electric potential, V, varies with 1/r , where r is the distance from a point charge Q.



State what can be deduced from the graph about how V depends on r and explain why all the values of V are negative.

[02]

c. Use data from the graph to show that the magnitude of Q is about 30 nC. [02]

d. i. A +60 nC charge is moved from a point where r = 0.20 m to a point where r = 0.50 m in the field of point charge Q.

Calculate the work done in moving the +60 nC charge. [02]

ii. Calculate the electric field strength due to Q at the point where r = 0.40 m. [02]

TOTAL 10 marks

5. a. Determine the effective capacitance of the network of capacitors in the circuit shown Below [03]

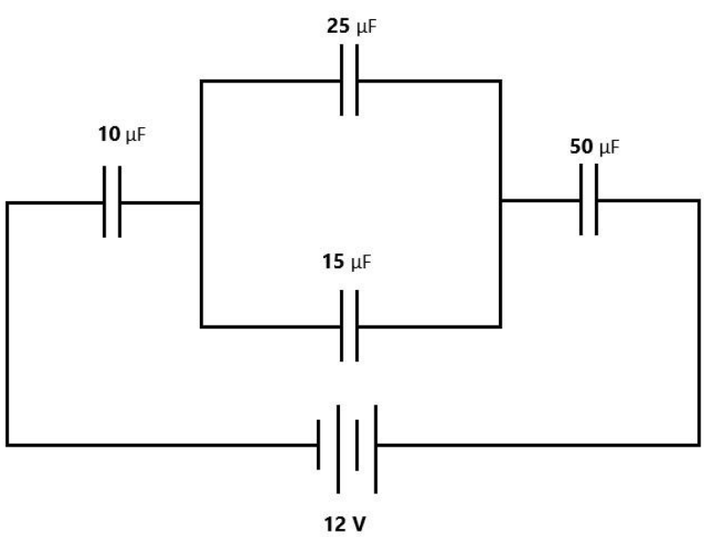


Figure 5

b. What is the total charge stored by the network of capacitors? [02]

c. What is the charge stored in the 10 µF capacitor? [01]

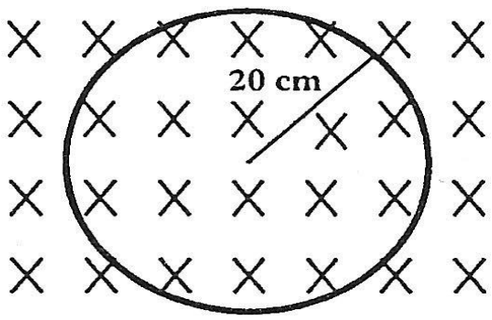
d. What is the potential difference across the 10 µF capacitor [02]

e. What is the charge stored in the 25 µF capacitor [04]

TOTAL 12 marks

6. a. State, in words, Faraday's Law of electromagnetic induction [02]

b. A wire loop of radius 20 cm has a resistance of 2.0 Ω. The plane of the loop is at right angles to a uniform magnetic field as shown in Figure 6. The magnetic field strength is increasing at a rate of 0.010 T s^{-1}.



Calculate:

i. the induced emf in the loop [03]

ii. the current in the loop [01]

c. The magnetic field is now set at a constant value, B, and the loop is rotated through an angle of 90° in a time of 0.15 s (so that the plane of the coil is now parallel to the
direction of the field). During this motion, a voltmeter connected to the loop reads a peak value of 13.0 mV. Calculate the magnetic field strength B. [03]

TOTAL 09 marks