E YOUNG MODULUS CONCEPT

PHY 106

GENERAL PHYSICS II

'AST QUESTIONS & SOLUTIONS WITH EXPLANATORY NOTES

can also request for CHS 122/Organic Chemistry, Biology, Use of English, Phy 106 Calculus/Engineering Matl

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Rivers State University

DEPARTMENT OF PHYSICS

PHY 106: GENERAL PHYSICS II FOR SCIENCES, FACULTIES OF AGRIC & ENVIRONMENT, AND TECH. & SCIENCE EDUCATION

TEST FOR SECOND SEMESTER **2019/2020 SESSION**

ANSWER ALL QUESTIONS **TIME: 1.5 HOURS**

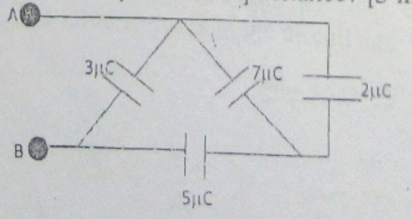
Some Physical Constants
Electronic charge, $e = 1.6 \times 10^{-19}$ C; Planck's constant, $h = 6.6 \times 10^{-34}$ J-sec; for H_2 atom $Z = 1$; $n = 1$; velocity of light (photon), $c = 3 \times 10^{8} ms^{-1}$; electronic mass, $m = 9.1 \times 10^{-31}$ kg; 1.6eV = 1J; Permittivity of free space, $\varepsilon_0 = 8.86 \times 10^{-12} C^2/N\text{-}m^2$.

1. (i) Why is ***light*** considered to be *electromagnetic* (EM) in nature. **[2 marks]**.
 (ii) Give 2 reasons why ***convex mirrors*** are used as driving mirrors in vehicles. **[2 marks]**.
 (iii) A lady 1.2m tall stands a distance of 3m in front of a large vertical plane mirror.
  (a) Determine the size of the image of the lady formed by the mirror. **[2 marks]**.
  (b) How far from the lady is the image? **[2 marks]**.
  (c) Determine the magnification of the image. **[2 marks]**.

2. (a) Copy the statement below and fill in the correct answer.
 "The source of the electric field is the .... while the source of the magnetic field is .... or ...." **[2 marks]**.
(b) State the Right Hand Rule for determining the direction of the magnetic field around a conductor carrying current. **[2 marks]**.
(c) (i) Write down the resonance equation for a cyclotron accelerating particles. **[1 mark]**.
 (ii) Show that the frequency of the cyclotron is independent of its radius. **[2 marks]**.
(d) (i)State what you understand by Hall effect as applied to a plate-conductor carrying current. **[2 marks]**
 (ii) Write down the Lorentz force for the electromagnetic field. **[1 mark]**.

3. (a) (i) What is a point charge? **[2 marks]**.
 (ii) Three point charges, $q_1 = 3C$, $q_2 = 5C$ and $q_3 = 6C$ located along a straight horizontal line, such that q_2 is 7cm and q_3 is 11cm, from q_1 (at the origin). Draw the charge system and Find the net force on q_2. **[3 marks]**.

 (b) (i) What device stores energy in its electrical field? **[2 marks]**.
 (ii) In the circuit below, find the equivalent capacitance; if a voltage source of 12V is applied across terminals A and B, what charge will be on the equivalent capacitance? **[3 marks]**.



RIVERS STATE UNIVERSITY OF SCIENCE & TECHNOLOGY

FACULTY OF SCIENCE

SEMESTER: SECOND

DEPT: PHYSICS

YEAR: ON

COURSE: PHY. 106. GENERAL PHYSICS II

DATE: 16-09-201

TIME: 2 HOUR

INSTRUCTIONS: ATTEMPT ONLY FOUR QUESTIONS, AT LEAST ONE QUESTIO FROM EACH SECTION AND ANY OTHER QUESTION.

SECTION A

1. (a) (i) The total force a moving charge in space is called?
   (ii) Write an expression for this force, defining the terms there-in.

(b) An electron experiences a force $F = (3.2i - 2.7j) \times 10^{-13} N$ when passing a magnetic field $B = (0.27K)T$. What is the velocity of the electron?

(c) Calculate the magnetic force on a 50m length of wire stretched between t when the current in the wire is 150A and the earth's magnetic field of $5 \times 10^{-}$ an angle of 30° with the wire.

(a) What is an electric motor?

(b) Describe schematically the operation of an electric motor

(c) What are the three magnetic elements known to you? Write brief notes on th

SECTION B

$F = q(E +$

3. (a) (i) What is meant by the term *Equivalent Resistance*?

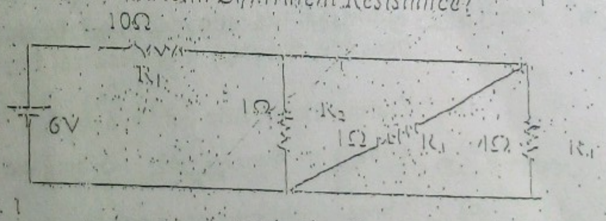


Fig. 1

(ii) Calculate the equivalent resistance of the network shown in Fig 1 ab
(iii) Calculate the current in the R_L resistor.

(b) State Kirchhoff's laws?

(c) In the circuit shown in Fig. 2 overleaf. Calculate:
(i) The three currents in the circuit and (ii) the potential V_{ab}.

$E = 0.5$

$I = \frac{V}{R} \rightarrow \frac{}{4}$

15

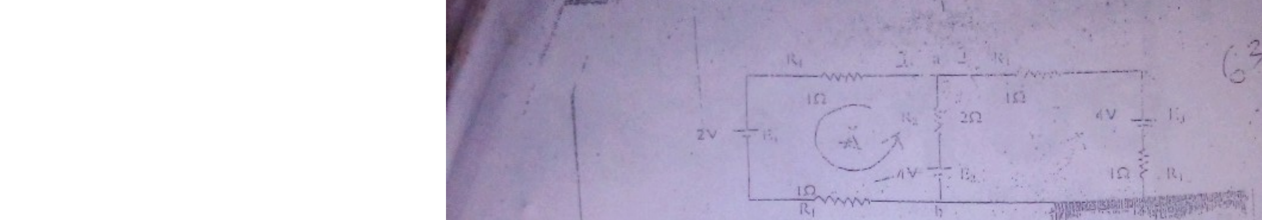


Fig. 2

(a) What is a Meter Bridge used for?

(b) In a meter bridge circuit it was found that null deflection was obtained in the galvanometer, when the sliding contact was at the 20cm mark. When an 11Ω resistor was connected in the left hand gap the balance point moved to 75cm mark. Calculate the value of the resistor originally in the bridge circuit.

(c) (i) Explain the term *Time Constant* of a capacitor?
(ii) How many time constants will elapse before the capacitor in an RC circuit is charged to within 10% of its equilibrium charge.

SECTION C

(a) State (i) the Coulombs law and (ii) Newton's law of gravitation.

(b) Compare the electric and gravitational force of attraction between the electron and proton in a hydrogen atom, assuming that their distances of separation is 5.3×10
$\{m_e = 9.1 \times 10^{-31} kg,\ m_p = 1.7 \times 10^{-27} kg,\ e = 1.6 \times 10^{-19} C\}$

(c) Show that the ratio in (5b) is independent of the distance of separation. Also give possible reason(s) why electrical forces are not as apparent as gravitational force

6 (a) Define the electric field in a region.

(b) Show that $E = \frac{Q}{4\pi\varepsilon_0 r^2}\hat{r}$ where the symbols used have their usual meaning. (

(c) Three charges are positioned as shown in Fig. 3 below. If $Q_1 = Q_2 = 8\mu C$ and d
Determine (i) q if the electric field ... is zero (ii) State any principle used in ar
at the value of q. (k ... $8.85 \times 10^{-12} C/N\,m^2$)

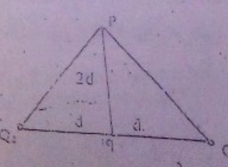


Fig.3

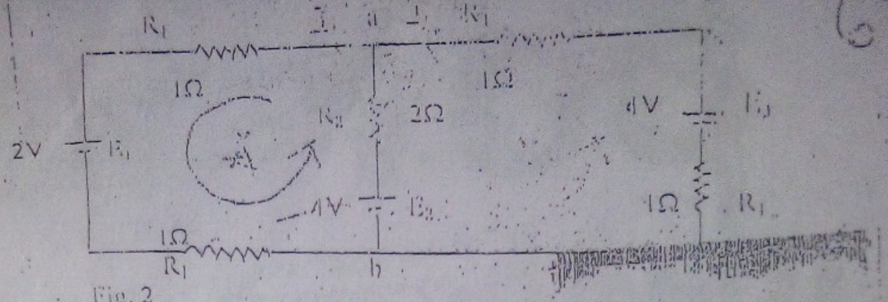


Fig. 2

4. (a) What is a Meter Bridge used for?

(b) In a meter bridge circuit it was found that null deflection was obtained in the galvanometer, when the sliding contact was at the 20cm mark. When an 11Ω resistor was connected in the left hand gap the balance point moved to 75cm mark. Calculate the value of the resistor originally in the bridge circuit.

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SECTION C

5. (a) State (i) the Coulombs law and (ii) Newton's law of gravitation.

(b) Compare the electric and gravitational force of attraction between the electron and proton in a hydrogen atom, assuming that their distances of separation is 5.3×10
$\{m_e = 9.1 \times 10^{-31} kg,\ m_p = 1.7 \times 10^{-27} kg,\ e = 1.6 \times 10^{-19} C\}$

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(c) Three charges are positioned as shown in Fig. 3 below. If $Q_1 = Q_2 = 8\mu C$ and d ... Determine (i) q if the electric field at P is zero (ii) State any principle used in ar at the value of q. [ε_0 = 8.85 × 10^{-12} $C/N\,m^2$]

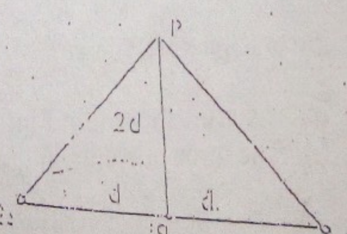

Fig.3

PHY 106.1 2011 SESSION.

1a. (i) The total force of a moving charge in space is called "Lorentz force".

(ii) The lorentz force: $\vec{f} = \vec{f_E} + \vec{f_M}$

$$\vec{f} = qE + q[\vec{V} + \vec{B}]$$

- $\vec{f_M}$ = force due to Magnetic field
- $\vec{F_E}$ = force due to electric field

q = charge Magnitude of the charge particle.

E = Electric field intensity

$\vec{V}$ = Velocity of moving particles

$\vec{B}$ = Magnetic field, Measured in Telsa

(1B) Given the force experienced by electron (e) equals: $f = (3.2i - 2.7j) \times 10^{-13} N$

$B = (0.27k) T$; but charge of electron;

$= -1.6 \times 10^{-19} C$

using; $\vec{F} = q(\vec{v} \times B) = e(\vec{v} \times B)$

Let $v = ai + bj + ck$

$$\vec{F} = e(ai + bj + ck) \times (0.27k) = e\begin{vmatrix} i & j & k \\ a & b & c \\ 0 & 0 & 0.27 \end{vmatrix}$$

$$= e[0.27] \begin{vmatrix} i \\ a \end{vmatrix}$$

$\vec{f} = e[0.27][bi - aj]$

$\Rightarrow (32i - 2.7j) \times 10^{-13} = 1.6 \times 10^{-19} (0.27)(bi - aj)$

$= 4.32 \times 10^{-29} bi - 4.32 \times 1$

Rivers State University

DEPARTMENT OF PHYSICS

PHY 106: GENERAL PHYSICS II FOR SCIENCES, FACULTIES OF AGRIC & ENVIRONMENT, AND TECH. & SCIENCE EDUCATION

TEST FOR SECOND SEMESTER 2019/2020 SESSION

ANSWER ALL QUESTIONS TIME: 1.5 HOURS

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(iii) A lady 1.2m tall stands a distance of 3m in front of a large vertical plane mirror.
(a) Determine the size of the image of the lady formed by the mirror. **[2 marks]**.
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(b) State the Right Hand Rule for determining the direction of the magnetic field around a conductor carrying current. **[2 marks]**.
(c) (i) Write down the resonance equation for a cyclotron accelerating particles. **[1 mark]**.
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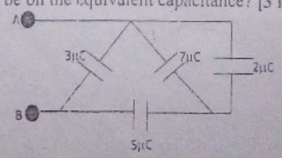
(ii) In the circuit below, find the equivalent capacitance;
if a voltage source of 12V is applied across terminals A and B, what charge will be on the equivalent capacitance? **[3 marks]**.



E YOUNG MODULUS CONCEPT

PHY 106

GENERAL PHYSICS II

PAST QUESTIONS & SOLUTIONS WITH EXPLANATORY NOTES

Can also request for CHS 122/Organic Chemistry, Biology, Use of English, Phy 106 Calculus/Engineering Math

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RIVERS STATE UNIVERSITY OF SCIENCE & TECHNOLOGY
FACULTY OF SCIENCE

SEMESTER: SECOND
DEPT: PHYSICS
COURSE: PHY. 106. GENERAL PHYSICS II

YEAR: ONE
DATE: 16-09-201
TIME: 2 HOUR

INSTRUCTIONS: ATTEMPT ONLY FOUR QUESTIONS, AT LEAST ONE QUESTIO FROM EACH SECTION AND ANY OTHER QUESTION.

SECTION A

1. (a) (i) The total force a moving charge in space is called?
(ii) Write an expression for this force, defining the terms there-in.

(b) An electron experiences a force $F = (3.2i - 2.7j) \times 10^{-13} N$ when passin a magnetic field $B = (0.27k)T$. What is the velocity of the electron? $-13 \cdot 7$

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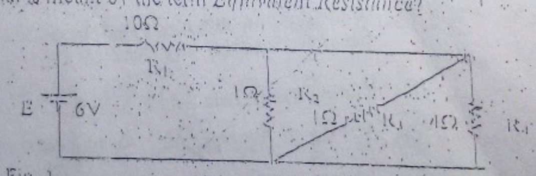

Fig. 1

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(ii) Calculate the equivalent resistance of the network shown in Fig 1 ab
(iii) Calculate the current in the R_4 resistor.

(b) State Kirchhoff's laws?

(c) In the circuit shown in Fig. 2 overleaf. Calculate;
(i) The three currents in the circuit and (ii) the potential V_{ab}.

$E = 10.5$

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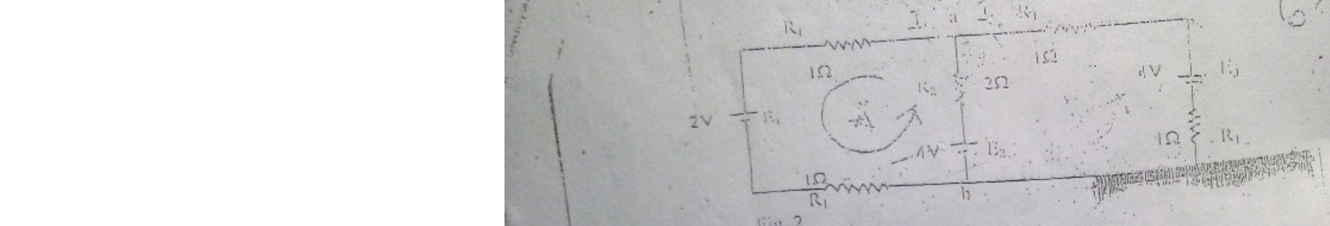

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(b) Compare the electric and gravitational force of attraction between the electron, and proton in a hydrogen atom, assuming that their distances of separation is 5.3×10
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6 (a) Define the electric field in a region.

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(c) Three charges are positioned as shown in Fig.3 below. If $Q_1 = Q_2 = 5\mu C$ and d Determine (i) q if the electric field ... is zero (ii) State any principle used in ar at the value of q. [... $8.85 \times 10^{-12} C/N m^2$]

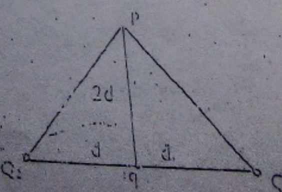

Fig.3

PHY 106.1 2011 SESSION.

1a. (i) The total force of a moving charge in space is called "Lorentz force".

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$$\vec{f} = qE + q[\vec{V} + \vec{B}]$$

$\vec{f_M}$ = force due to Magnetic field
$\vec{f_E}$ = force due to electric field
q = charge Magnitude of the charge particle.
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$B = (0.27k)$ T ; but charge of electron; $= -1.6 \times 10^{-19}$ C

using; $\vec{F} = q(\vec{v} \times B) = e(\vec{v} \times B)$

Let $v = ai + bj + ck$

$$\vec{F} = e(ai + bj + ck) \times (0.27k) = e\begin{vmatrix} i & j & k \\ a & b & c \\ 0 & 0 & 0.27 \end{vmatrix}$$

$$= e[0.27]\begin{vmatrix} i \\ a \end{vmatrix}$$

$\vec{f} = e[0.27][bi - aj]$

$\Rightarrow (32i - 2.7j) \times 10^{-13} = 1.6 \times 10^{-19} (0.27)(bi - aj)$

$= 4.32 \times 10^{-29}\ bi - 4.32 \times 1$

that region.

(b) The electric field is:

$\vec{E} = \frac{\vec{F}}{Q_2}$

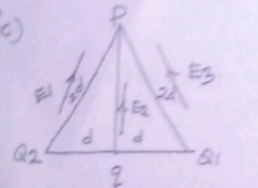
where, $\vec{F} = \frac{Q Q_2}{4\pi\epsilon_0 r^2}\cdot\hat{r}$

$\vec{E} = \frac{Q Q_2}{4\pi\epsilon_0 r^2}\cdot\hat{r} \times \frac{1}{Q_2}\ \frac{Q}{4\pi\epsilon_0 r^2}\hat{r}$

$\vec{E} = \frac{Q}{4\pi\epsilon_0 r^2}\cdot\hat{r}$

$\vec{E} = \frac{Q}{4\pi\epsilon_0 r^2}\cdot\hat{r}$

(c)



Let $\vec{E_1}, \vec{E_2}, \vec{E_3}$ be the electric field on p due to Q_2, q and Q_2 resp. as shown

where, $\vec{E} = \frac{Q}{4\pi\epsilon_0 d^2}\cdot\hat{r}$

Now $E_1 = \frac{Q_2}{4\pi\epsilon_0 r_1^2}\cdot\hat{r_1}$

where, $r_1 = di + \sqrt{(2d)^2 - d^2}$

$j = d_i + \sqrt{3d^2}\,j$

but $d = 0.5m$

$\vec{r_1} = 0.5i + 0.5\sqrt{3}j = 0.5i + 0.866j$

$|r_1| = \sqrt{0.5^2 + 0.866^2} = \sqrt{0.25 + 0.749}$

$= \sqrt{0.999956} = 0.99997$
$\simeq 1$

$\therefore \hat{r_1} = \frac{r}{|r|} = \frac{0.5i + 0.866j}{1}$

$= 0.5i + 0.866j$

$\vec{E_1} = \frac{8\times10^{-6}\times9\times10^{9}}{1}\cdot(0.5i + 0.866j)$

$= 72\times10^{3}(0.5i + 0.866j)$

$= (36i + 62.352j)\times10^{3}$

$E_2 = \frac{Q_1}{4\pi\epsilon_0 r_2^2}\hat{r}$

where: $\hat{r_2} = -di + d\sqrt{3}j$

$= -0.5i + 0.866j$

$\hat{r_2} = \frac{-0.5 + 0.866j}{1} = -0.5i + 0.866j$

$E_2 = [-36i + 62.352j]\times10^{3}$

Now $E_3 = \frac{q}{4\pi\epsilon_0 r_3^2}\hat{r} = \frac{9\times10^{9}}{0.866}j = 0.399\times q\,j$

but: $E_1 + E_2 + E_3 = 0$

$(36i + 62.352j) + 10^3\times(-36j + 62.352)$
$\times10^3 + 10.39q\times10^9 = 0$

$124.704j\times10^3 = -10.39q\times10^9 j$

$q = \frac{124.704\times10^3}{-10.39\times10^9}$ $\quad q = -12\times10^{-6}C$
$= -12$

(d) Superposition and

$= \frac{2-12}{3} = -10/3$ Volts.

p.d $= \frac{10}{3}$ Volts.

a.) A meter bridge is an instrument that Measures unknown resistance or to compare two resistance.

) Given that without the unknown resistor, balance point is 20cm Mark, and that with an unknown resistor balance point is at the 75cm Mark, using the ratio.

$$\frac{11}{5-20} = \frac{\text{unknown}}{100-(75-20)}$$

$$= \frac{11}{55} = \frac{x}{45} \quad ; x = 9\Omega$$

) It states that the force that exist between two charged particles is proportional to the product of their charges and inversely proportional to the Square of their distance apart.

i.e $f = \frac{kQ_1 Q_2}{d^2}$

Where: f = force that exist

Q_1, Q_2 = Magnitude of charge particles.

k = Constant of proportionality

d = distance between them.

(ii) Newtons law of gravitation states that the force of attraction between any two bodies in the universe is directly proportional to the product of their Masses and inversely proportional to their distance of Separation.

(5b) Same as Question 26. 2012/13

(5c) From the solution in (5b)

Ratio = $\frac{KQ_eQ_p}{GM_eM_p}$

∴ Ratio is not dependent on the distance of separation.

(6) The electric field in a region is the effect of the presence of a given charge, called the POINT CHARGE; It is defined as force per unit charge.

RIVERS STATE UNIVERSITY OF SCIENCE & TECHNOLOGY,
PORT HARCOURT
FACULTY OF SCIENCE

PHY 106: GENERAL PHYSICS II EXAMINATION FOR YEAR I SCIENCES AND OTHER STUDENTS

SECOND SEMESTER 2011/2012 SESSION. 28th September, 2012. TIME ALLOWED: 2 HRS

INSTRUCTIONS: Answer question one (1) and two (2) other questions, making a total of three (3) questions.

1. (a) With large labelled diagrams, discuss the key contributions of the under listed Scientists to the understanding of atomic structure:
   (i) J. J. Thompson
   (ii) Rutherford
   (iii) Bohr

   (b) (i) What is a DC Circuit?
   (ii) List four examples of a DC Voltage source.
   (iii) A galvanometer has an internal resistance of 30Ω and a full-scale deflection of 50mA. Describe how this galvanometer can be used as a voltmeter measuring up to 3000V.

2. (a) How much energy is required to remove an electron in the hydrogen (H_1) atom?

   (b) If the binding energy of H_1 atom is E = - 13.6eV (= 2.2×10^{-18}J), find the orbit radius of the electron in the H_1 atom.

3. (a) State two conditions under which an electron would remain in its orbit without spiralling into an atomic nucleus.
   (b) Prove that the:
   (i) Potential energy of an electron moving around nucleus at a radius r given by:

$$E_p = -\frac{Ze^2}{4\pi\varepsilon_0 r}$$

   (ii) Kinetic energy of an electron moving around nucleus at a radius r given by:

$I_2 = I + I_1$ $\quad$ $V = \varepsilon c l$

$\frac{1.88}{3\times10^5}$ $\quad$ $\frac{1.65}{0.00003}$

$$E_k = \frac{Ze^2}{8\pi\varepsilon_o r}$$

(iii) Total energy of an electron moving around nucleus at a radius given by:

$$E_{total} = -\frac{Ze^2}{8\pi\varepsilon_o r}$$

where Z = number of proton; +e = proton charged; -e = electron cha ε_o = permittivity of vacuum.

4 (a). What is meant by the term *Equivalent Resistance*?

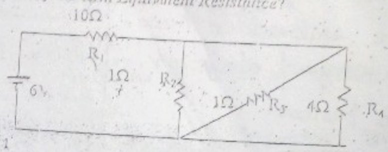


Fig. 1

(b) (i) Calculate the equivalent resistance of the network shown in Fig. 1 above.

(ii) Calculate the current in the R_3 resistor.

5(a) State Kirchhoff's Second Rule?

(b) In the circuit shown in Fig. 2 below Calculate;
(i) The three currents in the circuit and
(ii) the potential V_{ab}.

$V_a - V_b$ $\quad$ 0.1x $\quad$ 1.Y

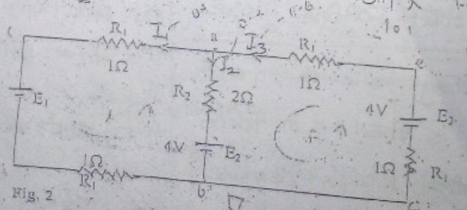


Fig. 2

$2x^2 + 5 + 3x^2$

$5x^2 + 2$

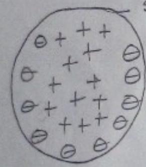
$F = \frac{q_1 q_2}{r^2}$

$E_2 - I_2 R_2$ $\quad$ $I_2 - E_1$

MB

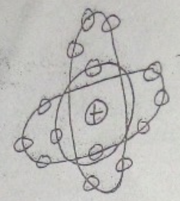
2011/2012 SESSION.

) J. J Thompson's Model of the atom: According to J.J thompson, an atom is viewed as a homogenous Sphere of positive charge inside of which are embedded negatively charged electrons is shown below.



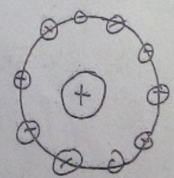
i) RUTHERFORD'S MODEL

According to Rutherford, an atom is viewed in form of a planet which consist of Positively charged heavy are called the nucleus where most of the atom was Concentrated. Around this nucleus, negatively charged electrons Circle in orbits much as planets move around the sun.



(III) BOHR'S MODEL OF THE ATOM.

Niel Bohr viewed atom; hydrogen as a Case Study, as a circle in which electrons move around the nucleus in certain Specific circular orbits also called energy levels) and that the centrifugal Force due to this Motion Counter-balance the electrostatic attraction between the electron and the nucleus. These electrons Can move without losing energy. He called the possible orbital stationary states.



(1B) A. D.C circuit is one which Consist of any of Constant Voltage Sources, Constant current Sources and resistors.

6. (ii) Four examples of a D.C voltage sources are:

a) Batteries
b) Thermo Couple
c) Solar cells
d) Electric Dynamo.

(iii) Refer to question (6b) 2012/2013.

3bi) The potential energy of an electron equals the centripetal energy of the circle of the orbit.

$\frac{mv^2}{r} \cdot r$ = potential energy

$= \frac{-e.e}{4\pi \varepsilon r_0^2} \cdot r$

mv^2 = potential energy

$= -e^2/4\pi\varepsilon r$

for Z protons: $E_p = \frac{-Ze^2}{4\pi\varepsilon_0 r}$

(ii) Kinetic energy $= \frac{1}{2}mv^2$, but

$mv^2 = \frac{Ze^2}{4\pi\varepsilon_0 r}$

$E_K = \frac{1}{2}\left[\frac{Ze^2}{4\pi\varepsilon_0 r}\right] = \frac{Ze^2}{8\pi\varepsilon_0 r}$

(ii) Total energy

$E_{total} = E_p + E_K$

$E_{total} = \frac{-Ze^2}{4\pi\varepsilon_0 r} + \frac{Ze^2}{8\pi\varepsilon_0 r}$

$= \frac{-2Ze^2 + Ze^2}{8\pi\varepsilon_0 r}$

$= \frac{-Ze^2}{8\pi\varepsilon_0 r}$

4a. Same with question 3a(i) 2011.

4bi. Refer to question 3a ii 2011

NOTE: please Continue from 3aiii 2011.

where: $I_5 = \frac{-6}{94}$ Amps

$I_4 = 4I_5 = 4\left[\frac{-6}{94}\right] = \frac{-24}{94}$ Amps.

$\therefore I_5 = 24/94$ Amps.

Negative Sign shows opposite direction.

(5a.) Kirchoff's Rule states that within any closed circuit or loop, the Sum of voltage drop equals the Sum of voltage rise.

(5b.)i. Refer to question (3c i) 2011

(ii) Refer to Question (3c ii 2011).

PTO

2013

RIVERS STATE UNIVERSITY OF SCIENCE & TECHNOLOGY
NKPOLU – OROWORUKWO, PORT HARCOURT
DEPARTMENT OF PHYSICS
SECOND SEMESTER EXAMINATIONS [illegible] SESSION
PHY 106 : GENERAL PHYSICS II (ELECTRICITY, MAGNETISM, OPTICS & NUCLEAR PHYSICS)

TIME: 2 ½ HOURS

INSTRUCTIONS

ANSWER FOUR (4) QUESTIONS IN ALL. YOU SHOULD ANSWER AT LEAST ONE FROM EACH SECTION. QUESTIONS CARRY EQUAL MARKS.

Use the underlisted values where necessary. All symbols have their usual meanings.

$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2\ N^{-1}\ m^{-2}$

$\mu_0 = 4\pi \times 10^{-7}\ H.m^{-1}$

$1/4\pi\varepsilon_0 = 9 \times 10^9\ N.m^2.C^{-1}$

SECTION A

1(a) Define the following terms and indicate the S.I. units where necessary
(i) Electric field lines (ii) electric potential at a point (iii) electric Dipole. (3 marks)

(b) State the following laws (i) law of conservation of electric charge (ii) Coulomb's law (iii) Gauss' law (3 marks)

(c) (i) Three point charges are held at the corners of an isosceles triangle as shown in the Figure 1. If $q = 3\mu C$, $L = 5$ cm and $M = 6$ cm. What is the resultant force on the +2q.

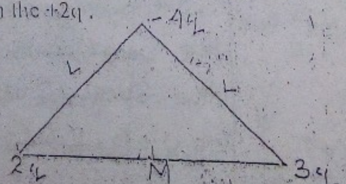


Figure 1

(7 marks)

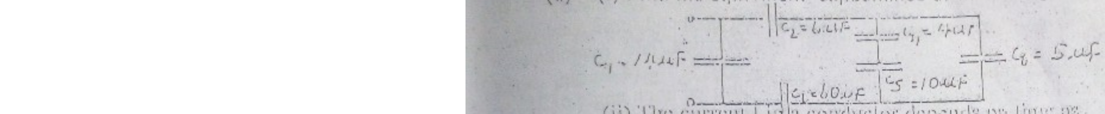
(ii) The electric field everywhere on the surface of a hollow sphere of radius 15 cm is measured to be equal to $4.5 \times 10^4\ N.C^{-1}$ and point radially outward from the centre of the sphere. What is the electric flux through this surface? Hence calculate the amount of charge enclosed. (3 marks)

(iii) A charge $q_1 = 10\mu C$ is located at the origin, and a second charge $q_2 = -2\mu C$ is located on the axis at $x = 0.6$ m, calculate the electric potential energy at this pair of charges. (1 ½ marks)

2(a) Define the following: (i) capacitor (ii) dielectric (iii) resistor (3 marks)

(b) State (i) Kirchhoff's rules (ii) Ohm's law (2 marks)

(c) (i) Find the equivalent capacitance of the arrangement in Figure 2.



(3 marks)

(ii) The current I in a conductor depends on time as

$I(t) = 5t^2 - 3t + 10$

Where t is in seconds. What quantity of charge moves across a section through the conductor during the interval $t = 2$ s and $t = 5$ s? (2 marks)

(iii) If $I = 12$ A and $R = 14\ \Omega$. Calculate the equivalent resistance and the voltage across AB in Figure 3. (3 marks)

(iv) Determine the three currents shown in Figure 4. (4 ½ marks)

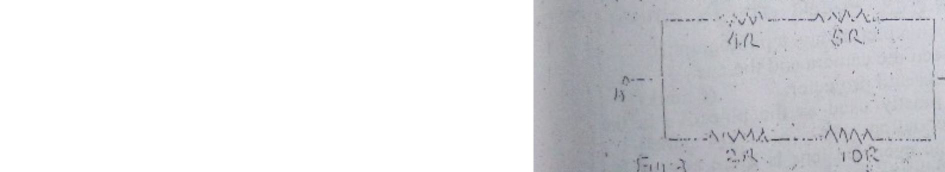
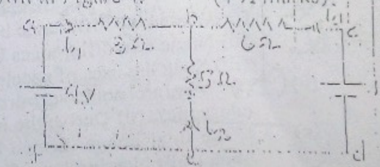


Fig 3



SECTION B

3(a) Draw diagrams, with clear indications of current and flux directions to show the magnetic flux pattern associated with an electric current flowing in (i) a straight wire (ii) plane circular coil (iii) a solenoid (4 marks)

(b) State a rule, which gives the relation between

(i) the direction of the current and that of the field in a long straight wire in a plane at right angles to the wire.

(ii) the direction of deflection of a compass needle with respect to a straight wire carrying a current over the compass needle.

(iii) the direction of deflection of a compass needle with respect to a straight wire carrying a current under the compass needle.

(iv) Draw diagrams to illustrate (ii) and (iii). (5 marks)

(c) Sketch the magnetic field resulting from the interaction between the magnetic fields from two wires with two currents of same magnitude in opposite direction. What would it look like if the currents were not of the same magnitude? (8 ½ marks)

4(a) Explain the terms: electromagnetic induction and induced electromagnetic force. (4 marks)

(b) Describe an experiment to show how an induced emf can be produced and the factors on which its direction and magnitude depend. (5 marks)

(c) A uniform magnetic field of strength 1T is directed at an angle of 25^0 to the normal to the plane of a 1 000 turn rectangular copper coil of length 0.05 m and width 0.04 m. The diameter of the copper wire, which makes up the coil, is 1.00 mm and the resistivity of copper is $1.7 \times 10^{-8} \Omega$ m. The magnetic field through the loop decreases to zero in 0.3 s. Determine (i) the initial flux through the coil (ii) the average induced emf in the coil as the field decreases and (iii) the amount of charge that passes through the coil as the field decreases. (8 ½ marks)

SECTION C

5(a) (i) What is the difference between a picture and a photograph?
(ii) Name two differences between the camera and the eye.
(iii) State the uses of spectrometer and projector. (6 marks)

(b) (i) Why are concave mirrors mostly used as the objective in the telescope? (ii) Derive the lens equation. (4 marks)

(c) If the final image formed by the eyepiece lens is 2 cm beyond the object of objective lens. Calculate the focal lengths of the objective and eyepiece lenses, assuming that the magnification power of the instrument is 12.5, and the object position from the eyepiece lens is 6 cm while the image position of the objective lens is 8.5 cm. (Note that the final image is virtual) (7 ½ marks)

6(a) Define the following terms: decay constant, binding energy, mass defect and natural radioactivity. (4 marks)

(b) Compare alpha and gamma radiation in terms of their speed, charge, mass and ionisation of gases. Show that $N = N_o e^{-\lambda t}$. (5 marks)

(c) The half life of a radioactive material is three months. If the material contains 10 tera atoms, calculate (i) the number of disintegration in the first second (ii) how long will elapse before 10 milli atoms remain (in days) (iii) the count rate at this time in hours.

SOLUTIONS TO PHY 106

SECTION A.

1a. ELECTRIC FIELD LINES.

Electric field lines are imaginary lines drawn in such a way that the direction of any point is the same as the direction of the motion. field at that point. It is Measured in NC^{-1} (Newton per coulomb)

ii) ELECTRIC POTENTIAL AT A POINT:

Is defined as the negative of the work per unit charge done by the electric field when a test charge Move from point A to point B. Given as; $V = V_A - V_B - \int_A^B E \cdot dc$

$$= \frac{W(A \to C)}{q_o}$$

It is Measured in Volt (V)

(III) ELECTRIC DIPOLE: Is simply a Combination of two equal charges of opposite Sign seperated by a distance of 2a.

1B. (ii) COULOMB'S LAW: states that the force of attraction or repulsion between charges is directly propotional to the product of their charges and inversely propotional to the square of their distances apart

$+q \overset{r}{\text{———}} -q$

$f = \frac{kq_1q_2}{r^2}$; $k = \frac{1}{4\pi\varepsilon_0}$; $f = \frac{q_1q_2}{4\pi\varepsilon_0 r^2}$

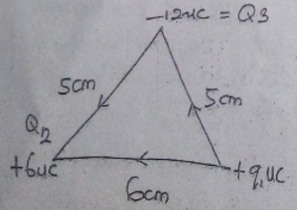
(III) GAUSS' LAW; states that the electric flux for any enclosed surface is proportional to the charge enclosed by the surface. Mathematically:

$$\Phi = Q/\varepsilon_0 \Rightarrow \oint (\vec{E}.n)ds = Q/\varepsilon_0$$

where; ε_0 = Permitivity of free space,
ds = element of area of surface.
Q = charge enclosed.

(c)

if $q = 3uC$, $L = 5cm$, $m = 6cm$. The diagram now becomes;



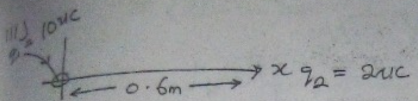
The arrow in fig a show the force each of charge $-4q$ and $+3q$ exert on a single force $+2q$. Let the force on Q_2 due to Q_1 be f_{21}, seperate by a distance of 6cm

$6cm = 0.06m$

By Newton Law; $f = \frac{Q_1Q_2}{4\pi\varepsilon_0 r^2}$

$Q_1 = 9\times10^{-6}C$, $Q_2 = 6\times10^{-6}C$

$F = \frac{9\times6\times10^{-6}\times10^{-6}}{4\pi\varepsilon_0 r^2} = 9\times10^{9}\times6\times10^{-6}\times9\times10^{-6}$



The electric potential energy is given by;

$$u = \frac{1}{4\pi\varepsilon_0}\left[\frac{Q_1 Q_2}{r}\right] \Rightarrow r = 0.6m = \frac{9\times10^{9}\times10\times10^{-6}\times2\times10^{-6}}{0.6}$$

$$= \frac{180\times10^{-3}}{6\times10^{-1}} = 30\times10^{-2}J \text{ or } = 0.3J.$$

2a. CAPACITOR; This is an electric device used in storing electrical energy.

RESISTOR: It is an electrical device that opposes or that alters the flow of current (electron).

DIELECTRIC : These are two conducting Materials (an insulator) inserted between the plates of a practical capacitor.

2b. KIRCHOFF'S RULES. There are two of them. The first rule called "junction rule" states that at any junction point, the algebraic sum of the current leaving the junction must equal the algebraic current entering the junction. Hence the algebraic sum of the current at a junction is equal to zero. $\Sigma I = 0$

KIRCHOFF'S 2^{ND} RULE; or loop rule states that the algebraic sum of the charges in potential differences around any closed path of the circuit must be equal

$$= \frac{9\times6\times9\times10^{9}\times10^{-6}\times10^{-6}}{0.0036} = \frac{9\times6\times9\times10^{9-12}}{36\times10^{-4}}$$

$$= \frac{3\times9\times10^{-3}\times10^{4}}{2}$$

$$= \frac{27}{2}\times10 = 27\times5 = \underline{\underline{135N}}$$

Also let the force on Q_2 due to Q_3 be $F_{2,3}$

$Q_3 = -12\times10^{-6}C$; Hence $f_{2,3} = \frac{Q_2 Q_3}{4\pi\varepsilon_0 r^2}$

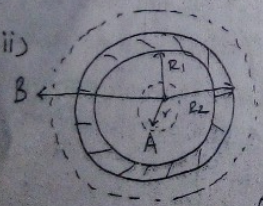
$r = 5cm = 0.0025m$; $f_{2,3} = \frac{9\times10^{9}\times6\times10^{-6}\times(-12\times10^{-6})}{(0.005)^2}$

$$= \frac{9\times6\times(-12)\times10^{-3}\times10^{4}}{25}$$

Hence the resultant force on Q_2 i.e charge $+2\mu$

$F_R = f_{2,1} + f_{2,3} =$

(ii)



$r = 15cm$, $E = 4.5\times10^{4}NC^{-1} = 0.15m$

from Gaussian law;

$$\Phi = \oint(\vec{E}\cdot\hat{n})ds = Q/\varepsilon_0$$

$\Phi = E\times A = Q/\varepsilon_0$; $A = 4\pi r^2$

$\Phi = E\times4\pi r^2 = 4.5\times10^{4}\times4\pi r^2$

$= 18\times10^{4}\times3.142\times(0.15)^2$

$\therefore \Phi = Q/\varepsilon_0$ where $\varepsilon_0 = 8.85\times10^{-12}C^2N^{-1}m^{-2}$

$\therefore$ The amount of charge enclosed:

$Q = \varepsilon_0\times\Phi = 8.85\times10^{-2}\times\Phi$

$$= \frac{9\times6\times9\times10^{9}\times10^{-6}\times10^{-6}}{0.0036} = \frac{9\times6\times9\times10^{9-12}}{36\times10^{-4}}$$

$$= \frac{3\times9\times10^{-3}\times10^{4}}{2}$$

$$= \frac{27}{2}\times10 = 27\times5 = \underline{\underline{135N}}$$

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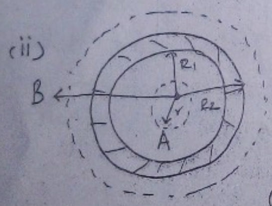
$$= \frac{9\times6\times(-12)\times10^{-3}\times10^{4}}{25}$$

Hence the resultant force on Q_2 i.e charge $+2\mu$

$F_R = f_{2,1} + f_{2,3} =$

(ii)



$r = 15cm$, $E = 4.5\times10^{4}NC^{-1} = 0.15m$

from Gaussian law;

$\Phi = \oint(\vec{E}\cdot\hat{n})ds = Q/\varepsilon_0$

$\Phi = E\times A = Q/\varepsilon_0$; $A = 4\pi r^2$

$\Phi = E\times4\pi r^2 = 4.5\times10^{4}\times4\pi r^2$

$= 18\times10^{4}\times3.142\times(0.15)^2$

$\therefore \Phi = Q/\varepsilon_0$ where $\varepsilon_0 = 8.85\times10^{-12}C^2N^{-1}m^{-2}$

$\therefore$ The amount of charge enclosed:

$Q = \varepsilon_0\times\Phi = 8.85\times10^{-2}\times\Phi$

zero. $\Sigma(E+IR)=0$

ii) OHM'S LAW; states that the current on a metallic conductor is directly proportional to the potential difference across it's end provided every other physical factors remain constant. $V \propto I \Leftrightarrow I \propto V$

$V = IR$ where $R =$ Resistor.

) Given that $I(t) = 5t^2 - 3t + 10$; differentiating

$\frac{dI}{dt} = 10t - 3$ hence; $I(t) = 10t - 3$

at $t = 2$ sec.

$I(2) = 2(10) - 3 = 20 - 3 = 17A$

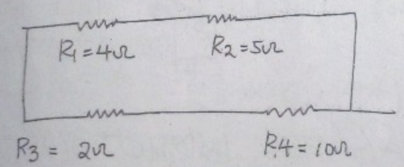
also; at $t = 5$ Sec.; $I(5) = 5(10) - 3 = 50 - 3 = 47A$.

hence: Recall; $I = Q/t$; Total current $= 47 - 17 = 30A$

total time $= 5 - 2 = 3$ sec. $\therefore 30 = Q/3$; $Q = 3 \times 30 = 90C$

ii) Given $I = 2A$ $R = 14\Omega$

Let;

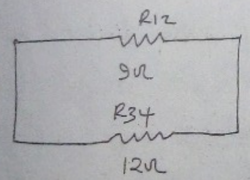


R_1 & R_2 // (i.e in Series)

$R = 4 + 5 = 9\Omega$

R_3 & R_4 = (Series Connection)

$R_{eq} = 2 + 10 = 12\Omega$



Now we have // connection.

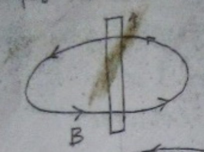
$\frac{1}{R_{eq}} = \frac{1}{9} + \frac{1}{12} = \frac{4+3}{36} = \frac{7}{36}$

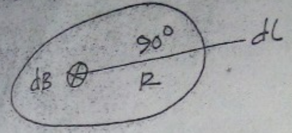
$R_{eq} = 36/7 = 5.14\Omega$

If $I = 12A$ $V = IR = 12 \times 5.14 = 61.7V$

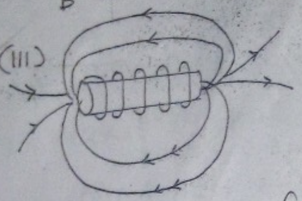
18

3a. for straight wire : (ii) plane circular coil.



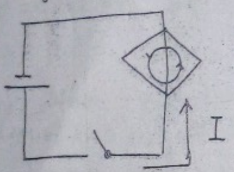


(iii)

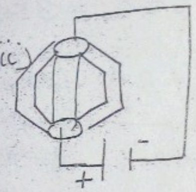


(3b.) i – iii Right hand rule.

(iv) Diagram for (ii) above;

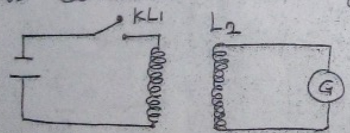


(iii)



4a. ELECTROMAGNETIC INDUCTION.

Lets Consider the two coil of wire L_1 and L_2 below



If the coil at L_1 was connected to a battery and to a switch K and the second connected to a galvanometer at oppositive end. Now if the switch at L_1 was closed, a steady current will set-up which will produce a negative field hence the second coil. C_2 is seen to be inside the magnetic field. If these persist, it will ...

…bserved that the current on L_2 due to L_1 will be detected by the galvanometer, hence, the galvanometer will always deflect in opposite direction the switch (K) is closed or open as the case may be, due to the action of L_1. This is called electromagnetic induction. The action on L_2 due to L_1 is known as induced electromagnetic force on L_2 due to L_1.

4b.) (a) Number of Magnetic field — N

(b) Relative Motion of the coil and the bar Magnet.

4c. Given that $B = 1T$; $\theta = 25°$; $N = 100$ turns $L = 0.05m$

$W = 0.04m$; $\rho = 1.7 \times 10^{-8} \Omega m$; $d = 1 \times 10^{-3} m$

From Magnetic flux definition, we have ;

$$\Phi = BA\cos\theta = 1(L \times W) \times \cos 25$$

$$= 1 \times (0.05 \times 0.04) \times \cos.25 = 1.81 \times 10^{-3} wb.$$

substitute into;

$$E = \frac{-N\Delta\Phi B}{\Delta t} = -N\left(\frac{d\Phi B}{dt}\right) ; E = \frac{-(1000)(1.81 \times 10^{-3})wb}{0.3}$$

(ii) $= -0.60V$

(iii) Recall that $\rho = R^{A}/_{L}$ or $R = \rho^{L}/_{A}$

relating the induced E.m.f with ohm's Law.

$E = IR = I\rho^{L}/_{A} = Q/t\,(\rho^{L}/_{A})$ $\therefore d = \frac{ELA}{\rho L}$

By substitution and simplification we have;

20 ~~3~~

$$\frac{0.6\times 0.3\times \pi/4\times(1\times 10^{-3})}{(1.7\times 10^{-8})\times 0.05} = \frac{18\times 10^{-2}\times 1\times 10^{-6}\times \pi/4}{5\times 1.7\times 10^{-10}}$$

$$= \frac{18\times 10^{-8}\times 10^{-10}}{8.5} = \frac{18\times 10^{-8}\times 10^{10}}{8.5} = \frac{18\times 10^{2}}{8.5} = 1.7\times 10^{2}$$

6a. (i) DECAY CONSTANT: is defined as the instateneons rate ~~of~~ ~~decay~~ per unit atom of a Substance. Given as; $\lambda = \frac{0.693}{t\frac{1}{2}}$ where $t\frac{1}{2}$ = half-life.

(ii) BINDING ENERGY: This is the mechanical energy often needed to seporate a whole into different parts. or it is the Mechanical Work which must be done against forces which hold an object to it's constituent part

	Speed	charge	Mass	Ionization of gases.
Alpha.	5-7% of Light's speed.	+2e	Very Massive	Large ionization
Gamma.	Travel at a Speed of Light.	Neutral.	Negligible Mass.	Small.

6B. Supposing there are N atoms of a radioactive element present at a time, then the number per unit time can be expressed as $-\frac{dN}{dt}$ since: N is decreasing with time we have; $-\frac{dN}{dt} \times N$

$\frac{dN}{dt} = -\lambda N$ where λ = decay constant

$\lambda = 1/N\,(dN/dt)$ integrating above;

$N = N_0 e^{-\lambda t}$

$dN/dt = -\lambda N$

Q-E-D

RIVERS STATE UNIVERSITY OF SCIENCE AND TECHNOLOGY
NKPOLU-OROWORUKWO, PORT HARCOURT

DEPARTMENT OF PHYSICS

PHY 106: GENERAL PHYSICS II EXAMINATION FOR YEAR 1 ~~STUDENTS~~

SECOND SEMESTER 2014/2015 SESSION. TIME ALLOWED: 2 HRS

INSTRUCTIONS: Answer ALL Questions in Section A, one (1) question from each of the Sections, making a total of four (4) Questions.

Some Physical Constants: Acceleration due to gravity, $g = 10ms^{-2}$; Permittivity of free space, $K = 9.0x10^9Nm^2C^{-2}$; Magnitude of charge of electron, $Q = 1.6x10^{-19}C$; Mass of electron, $m_e = 9.1x10^{-31}kg$; Mass of proton, $m_p = 1.67x10^{-27}kg$; Atomic number and mass of Copper = 29 and 63.5g/mol respectively.

SECTIONA

(a) A TV antenna contains a capacitor of 10μF charged to a potential difference of 20KV. Calculate:
 (i) The charge, Q [2 marks]
 (ii) The Potential energy stored in the capacitor [3 marks]
 (iii) Obtain an expression for the capacitance of a parallel plate capacitor [5 marks]

(b) A circular plate with radius 7cm is rotated in a uniform electrical field of 7.4×10^5 N/C. Calculate the electrical flux through this area when the electric field is:
 (i) Perpendicular to the surface of the plate. [2 marks]
 (ii) Parallel to the surface. [3 marks]
 (iii) Makes an angle of 60° with the plane of the surface. [5 marks]

(c) (i) Compare briefly real image and a virtual image [4 marks]
(ii) A refrigerator (object) of height 1.8m, width 0.8m and mass 60kg is placed 2m in front of a plane mirror. Calculate (1) image height (2) distance of image from the Object (3) Magnification. [6 marks]

SECTION B

1. When a circuit cannot be further reduced by the method of simple series and parallel connections of resistors:
 a. State the rules that can be used to deal with such circuits. [10 marks]
 b. Find the currents in the circuit (Fig. 1)below (Where $R_1 = 3\Omega$, $R_2 = 2\Omega$, $R_3 = 4\Omega$):[15 marks]

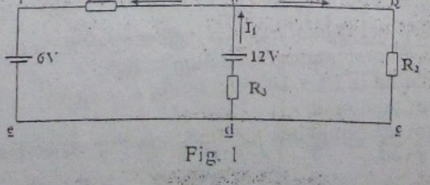


Fig. 1

22

(a) Deduce expressions for the combined Resistance of two Resistors

i. Connected in series [5 marks]

ii. Connected in parallel [5 marks]

(b) Calculate the equivalent resistance of the network as shown in Fig. 2. Each resistor has 2Ω. [15 marks]

Fig. 2

SECTION C

(a) If the electric flux that leaves the spherical surface is given as: $\varphi = \oint E \cdot \hat{n}\, ds$. Show that $\varphi = \frac{Q}{\varepsilon_o}$. [7 marks]

(b) What is *electric flux density*? [3 marks]

(c) Determine the velocity of a proton that travels 5cm in a system with an electric field 2×10^{-3} C/ [7 marks]

(d) State the law of conservation of electric charge. [3 marks]

(a) Four charges $Q_1 = 5\mu C$, $Q_2 = 2.1\mu C$, $Q_3 = 4\mu C$ and $Q_4 = 3.5\mu C$ are placed at the four corners of ~~square 5cm~~ on a side. Find the potential at the centre of the square. [7 marks]

(b) What is an *electric potential*? [3 marks]

(c) What are *electric field lines*? [3 marks]

(d) Two charges $Q_1 = 50\mu C$ and $Q_2 = 100\mu C$ are located on the xy plane at a position $r_1 = 8\hat{i}$ m and $r_2 = 6\hat{j}$ m. Find the force exerted on Q_1. [7 marks]

SECTION D

(a) With diagram, give 2 reasons why a Convex Mirror is used as a driving mirror. [10 marks]

(b) With diagrams, give 1 reason why a Concave Mirror is used in the design, and construction of torchlight. [6 marks]

(c) An object is placed in front of s concave mirrorwhose radius of curvature is 12cm. If the height of the real image formed is three times that of the object, calculate the the distance of the object from the mirror. [9 marks]

(a) State Snell's law of refraction of light. [3 marks]

(b) State briefly 2 conditions under which *total internal reflection of light* occurs. [6 marks]

(c) Name 2 practical applications of total internal reflection of light. [4 marks]

(d) Velocity of light in a certain liquid is 1.5×10^8 m/s, and in air velocity is 3×10^8 m/s.

(i) Find the refractive Index of the liquid. [5 marks]

(ii) If a ray of light passes from the liquid into air, find the value of the critical angle. [7 marks]

2. (a) Deduce expressions for the combined Resistance of two Resistors
    i. Connected in series [5 marks]
    ii. Connected in parallel [5 marks]

(b) Calculate the equivalent resistance of the network as shown in Fig. 2. Each resistor has 2Ω. [15 marks]

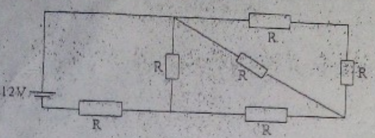


Fig. 2

SECTION B

3. (a) If the electric flux that leaves the spherical surface is given as: $\varphi = \oint E \cdot \hat{n}\, ds$. Show that $\varphi = \frac{Q}{\varepsilon_o}$. [7 marks]

(b) What is *electric flux density*? [3 marks]

(c) Determine the velocity of a proton that travels 5cm in a system with an electric field 2×10^{-3} C/N [7 marks]

(d) State the law of conservation of electric charge. [3 marks]

4. (a) Four charges $Q_1 = 5\mu C$, $Q_2 = 2.1\mu C$, $Q_3 = 4\mu C$ and $Q_4 = 3.5\mu C$ are placed at the four corners of ~~square 5cm on~~ a side. Find the potential at the centre of the square. [7 marks]

(b) What is an *electric potential*? [3 marks]

(c) What are *electric field lines*? [3 marks]

(d) Two charges $Q_1 = 50\mu C$ and $Q_2 = 100\mu C$ are located on the xy plane at a position $r_1 = 8\hat{i}$ m and $r_2 = 6\hat{j}$ m. Find the force exerted on Q_1. [7 marks]

SECTION C

5. (a) With diagram, give 2 reasons why a Convex Mirror is used as a driving mirror. [10 marks]

(b) With diagrams, give 1 reason why a Concave Mirror is used in the design, and construction of torchlight. [6 marks]

(c) An object is placed in front of s concave mirrorwhose radius of curvature is 12cm. If the height of the real image formed is three times that of the object, calculate the the distance of the object from the mirror. [9 marks]

6. (a) State Snell's law of refraction of light. [3 marks]

(b) State briefly 2 conditions under which *total internal reflection of light* occurs. [6 marks]

(c) Name 2 practical applications of total internal reflection of light. [4 marks]

(d) Velocity of light in a certain liquid is 1.5×10^8 m/s, and in air velocity is 3×10^8 m/s.
  (i) Find the refractive Index of the liquid. [5 marks]
  (ii) If a ray of light passes from the liquid into air, find the value of the critical angle. [7 marks]

2014/2015 SESSION

SOLUTIONS PHY106

SECTION A

1 (a) Given: $C = 10\mu f = 10^{-6}F$

$V = 20kV = 20\times10^{3}V$

$Q = ?\ ;\ U = ?$

(i) From $Q = CV = 10^{-6}\times 20\times10^{3}$

$= 10^{-6}\times 20\times 10^{4}$

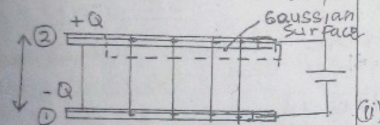
$= 2\times10^{-2} = 0.02C$

(From textbook Ex. 4.23)

(ii) $U = \frac{1}{2}CV^2 = \frac{1}{2}\times10^{-6}\times(20\times10^3)^2$

$= 200J = \underline{\underline{0.2kJ}}$

(iii) check exercise 4.14



From the above figure, the flux of E through the upper plate Gaussian surface is zero, since it lies inside. Through the lower wall which lie between the capacitor plate. Hence From Gauss Law

$\Phi = EA = \frac{Q}{\varepsilon_0}$

$E = \frac{Q}{A\varepsilon_0}$

The pd across plate is

$V = E\times d\ \therefore V = \frac{Qd}{A\varepsilon_0}$

but $Q = CV$; $Q = C\frac{Qd}{A\varepsilon_0}$

$1 = \frac{Cd}{A\varepsilon_0}$; $\frac{A\varepsilon_0}{d} = C$

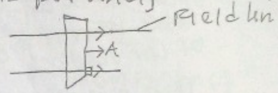
$\therefore \boxed{C = \frac{A\varepsilon_0}{d}}$

1(b) Given $r = 7cm$; $\Phi = ?$

$E = 7.4\times10^5 N/C$

(i) $\Phi = EA\cos\theta$

When perpendicular $\hat{n} = \theta = 0$ [the unit vector is parallel]



$\Phi = 7.4\times10^5\times\pi r^2$

$7.4\times10^5\times\pi\left(\frac{7\times10^{-2}}{2}\right)^2$

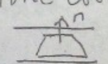
$\underline{2.847\times10^3 Nm^2/C}$

(ii) When the electric field is parallel to the surface it implies that the unit vector $\hat{n}$ is perpendicular

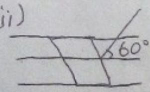
$\hat{n} = \theta = 90^\circ$

$\Phi = EA\cos 90^\circ = 0$

No field line crosses the surface



(iii)



when it is oblique

$\Phi = EA\cos 60$

$= 7.4\times10^5\times\pi\left(\frac{7\times10^{-2}}{2}\right)^2\cos 1$

$2847.85\cos 60 = 1423.92$

$= \underline{1.423\times10^3 Nm^2/C}$

Fewer field lines crosses

(See page 53, Ex 2.10 of your text book)

1(c)(i)

REAL IMAGE	VIRTUAL IMAGE
(1) There are produced by concave mirror or convex lens	There are produced by convex mirror or concave lense
(2) There ~~are~~ is actual intersection of rays	There is no actual intersection of rays
(3) The ray that produces real image actually pass through the principal focus	The rays only appear to form from the focus but do not actually do so
(4) Real image can be captured or casted on a screen	They cannot be captured or casted on a screen.

1c(ii) $h_o = 1.8cm$; $h_i = ?$
$u = 2m$; $v = ?$

From practical it is a fact that one of the properties of a plane mirror is that the image size & object size are always the same. i.e $h_i = h_o = 1.8m$. Again object distance from the mirror is the same with image distance from the mirror $u = v = 2m$

Finally the magnification is always one (1)

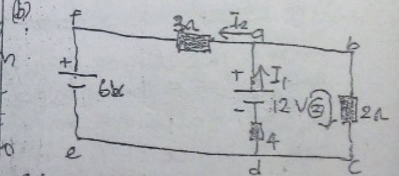
From the foregoing analysis $m = \frac{v}{u} = \frac{2}{2} = 1$

$h_i = 1.8m$, $v = 2m$, $m = 1$

SECTION B

1(a) The rules that could be used is the Kirchoff's rules

(b)

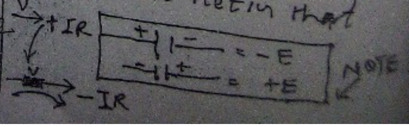


Step 1: Locate your Junction (i.e where more than 2 current leave or enters) that is at a, then establish KCL – Law where $\sum I = 0$

$I_1 = I_2 + I_3$ ——— (1)

entering current → leaving current

Step 2: Take 2 loops and move round noting that



Taking loop I :

$-12 + 6 + 3I_2 = 0$

$-6 = -3I_2$

$I_2 = 6/3 = 2A$

Again at loop 2

$+12 - 2I_3 - 4I_1 = 0$

$-2I_3 - 4I_1 = -12$

$I_3 + 2I_1 = 6$ ——— (2)

From equ. (1)

$I_1 = I_2 + I_3$ put into eqn. (2)

$I_3 + 2(I_2 + I_3) = 6$

$I_3 + 2I_2 + 2I_3 = 6$

But $I_2 = 2A$

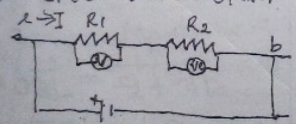
$I_3 + 2(2) + 2I_3 = 6$

$3I_3 = 6 - 4$; $3I_3 = -2$

$I_3 = -2/3 = -0.667A$

The negative (-) sign in the current indicates that the true direction are opposite ones assumed. The magnitude are however correct.

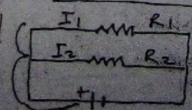
2(a)(i) Series connection



When connected in series the same current flows through them but different voltages: hence the equivalent voltages across $V = V_1 + V_2$

$IR = IR_1 + IR_2$ $\boxed{R_{eq} = R_1 + R_2}$

(ii) In parallel

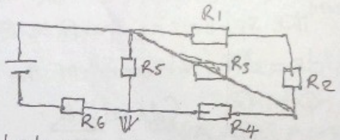


In this case the same voltage drops but different current branches each case, hence we wish to compute the equivalent current From $V = IR$; $I = V/R$; $I = I_1 + I_2$

$V/R = V/R_1 + V/R_2$ $\boxed{1/R_{eq} = \frac{1}{R_1} + 1/R_2}$

(2b) see Ex 6.18

Lets see the reduction step-by-step.



Lets number them for easy explanation

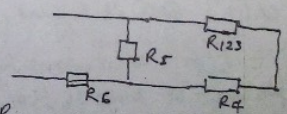
R_1 and R_2 are in series

$R_{12} = R_1 + R_2 = R + R = 2R$

Next: we remove R_3 by combining it in parallel with R_{12}

$\frac{1}{R_{eq}} = \frac{1}{R_3} + \frac{1}{R_{12}} = \frac{1}{R} + \frac{1}{2R} = \frac{2+1}{2R}$

$R_{eq} = R_{R3} = 2R/3$



R_4 and R_{123} are in series

$R_{1234} = R_{1-4} = \frac{2R}{3} + R = 5R/3$

which will be in parallel with R_5

$1/R_{1-5} = 3/5R + \frac{1}{R} = \frac{3+5}{5R} = 8/5R$

$R_{1-5} = 5R/8$

Finally this will be series with R_6

$R_{1-6} = \frac{5R}{8} + R = \frac{5R+8R}{8} = \frac{13}{8}(2) =$

$= \frac{13}{4} = \underline{\underline{3.25\Omega}}$

SECTION C

3(a) $\phi = \oint E.\hat{n}\,ds$

E if the electric field about the spherical surface $E = \frac{Q}{4\pi\varepsilon_0 r^2}$

$ds = dA$ (element of the area)

$\phi = \frac{Q}{4\pi\varepsilon_0 r^2}\int dA = \frac{QA}{4\pi\varepsilon_0 r^2}$

but area of sphere $= 4\pi r^2$

$\phi = \left[\frac{A}{4\pi r^2}\right] \cdot \left[\frac{Q}{\varepsilon_0}\right]$

$\phi = \left[\frac{4\pi r^2}{4\pi r^2}\right] \cdot \frac{Q}{\varepsilon_0} = \frac{Q}{\varepsilon_0}$

provided

$\hat{n}$ parallel to the surface area with $\cos\theta = 1$. This is called Gauss Law

(3b) Electric flux density is the product of electric field intensity and the area perpendicular to the field $\phi = EA\cos\theta$

(3c) $E = 2 \times 10^{-3}\ \mu/c$

$s = x = 5cm = 0.05m$

$e = 1.6 \times 10^{-19}\ C$

From $E = F/e$

$Ee = ma \therefore a = \frac{Ee}{m}$

but $v^2 = u^2 + 2as$

$v^2 = 2\left(\frac{Ee}{m}\right)s$

$V = \sqrt{2\left(\frac{Ee}{m_p}\right)s}$

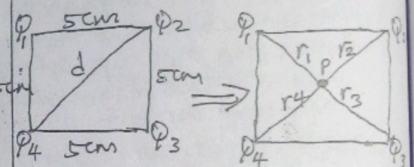
$V = \sqrt{\frac{2 \times 2 \times 10^{-3} \times 1.6 \times 10^{-19} \times 0.05}{1.67 \times 10^{-27}}}$

$= \sqrt{\frac{3.2 \times 10^{-23}}{1.67 \times 10^{-27}}}$

$= \underline{\underline{138.43 m/s}}$

(3d) The Law of conservation of electric charge states that in any process the net amount of charge produced is zero

(4a)



From pythagoras

$d = \sqrt{5^2 + 5^2} = \sqrt{50} = 5\sqrt{2}\ cm$

$r_1 = r_2 = r_3 = r_4 = \frac{5\sqrt{2}}{2} = 2.5\sqrt{2}\ cm$

$0.025\sqrt{2}\ m$

but $V_P = \frac{Q_1}{4\pi\varepsilon_0 r_1} + \frac{Q_2}{4\pi\varepsilon_0 r_2} + \frac{Q_3}{4\pi\varepsilon_0 r_3} + \frac{Q_4}{4\pi\varepsilon_0 r_4}$

$= \frac{1}{4\pi\varepsilon_0 r}\left[Q_1 + Q_2 + Q_3 + Q_4\right]$

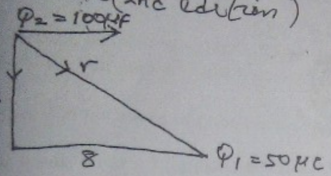
$= \frac{k}{r}\left(5 + 2.1 + 4 + 3.5\right]$

$= \frac{9 \times 10^9}{0.025\sqrt{2}}\left[14.6\right] = \underline{\underline{3.72 \times 10^{12} V}}$

(see similar problem in e.g. 5 of your text page 78-79

(4b) – 4c see other session solutions (repeated)

(4d) From the old text book (2nd edition)

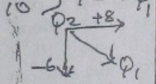


$r = \sqrt{6^2 + 8^2} = \sqrt{36+64} = \sqrt{100} = 10m$

Force on Q_1 due to $Q_2 = F_{1,2}$

$\vec{F}_{1,2} = \frac{K Q_1 Q_2}{r_{1,2}^2} \hat{r}_{2,1}$

$\vec{r} = 6\hat{j} + 8\hat{i} = \frac{8\hat{i}}{10} - \frac{6\hat{j}}{10}$] From $Q_2 \rightarrow Q_1$



$\hat{r} = \frac{-6\hat{j} + 8\hat{i}}{10} = 0.6\hat{j} + 0.8\hat{i}$

$$\vec{F}_{1,2} = \frac{9\times10^9 \times 50\times10^{-6} \times 100\times10^{-6} \times (0.8\hat{i} - 0.6\hat{j})}{10^2}$$

$\frac{45}{100}(0.8\hat{i} - 0.6\hat{j}) = (0.36\hat{i} - 0.27\hat{j})$

(5c) $r = 12cm$; $h_i = 3h_o$

$u = ?$; $f = r/2 = 12/2 = 6cm$

From $m = v/u = \frac{h_i}{h_o}$

$v/u = \frac{3h_o}{h_o}$

$v = 3u$

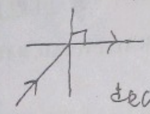
hence from $1/f = \frac{1}{u} + \frac{1}{v}$

$1/6 = \frac{1}{u} + \frac{1}{3u}$; $1/6 = \frac{3+1}{3u}$

$1/6 = 4/3u$; $3u = 24$; $u = 24/3 = 8cm$

6(a) Snell's Law of Refraction states that the ratio of the sine of angle of incidence to the sine of angle of refraction is constant for a given medium $\eta = \frac{\sin i}{\sin r}$

(6b)



The index of refraction mes- decreases across boundary in the direction of light refraction

(ii) The angle of incidence of light ray must exceed the critical angle of the interference

(6c) Application of total internal reflection.

(i) Fibre-optic cables

(ii) Diamond cutters (iii) periscope

(6d)

$V_a = C = 3\times10^8 m/s$

$V_m = 1.5\times10^8$; $n = ?$

refractive index $=$

$\frac{V_{air}}{V_{md}} = c/V_m = \frac{3\times10^8}{1.5\times10^8} = 2 \therefore n = 2$

(ii) $\eta = 1/\sin C$

$\sin C = 1/n = 1/2$

$C = \sin^{-1}(1/2) = \sin^{-1}(0.5)$

$= \underline{30°}$

29

RIVERS STATE UNIVERSITY
NKPOLU-OROWORUKWO, PORT HARCOURT

DEPARTMENT OF PHYSICS

PHY 106: GENERAL PHYSICS II FOR FACULTIES OF SCIENCE,

SECOND SEMESTER 2016/2017 SESSION. TIME ALLOWED: 2 HRS

INSTRUCTIONS: Answer ALL Questions in Section A, one (1) Question from each of the Sections, making a total of four (4) Questions.

Some Physical Constants: Planck's constant, h = 6.6×10^{-34} J-sec; for H_2 atom ... velocity of light (photon), c = $3 \times 10^8 ms^{-1}$; electronic mass, m = 9.1×10^{-31} kg; ... Permittivity of free space, $\varepsilon_o = 8.86 \times 10^{-12} C^2/N\text{-}m^2$; Acceleration due to gravity, g = 10m... Magnitude of charge of electron, Q = 1.6×10^{-19} C; Mass of electron, $m_e = 9.1 \times 10^{-31}$ kg; Mass of proton, $m_p = 1.67 \times 10^{-27}$ kg.

SECTION A

1. (a) Three charges $Q_1 = 6\mu C$, $Q_2 = -6\ \mu C$ and $Q_3 = 4\mu C$ are located at ... 0.6im, 0.0im and 0.8jm respectively. Find the net force on charge Q_3. [10 marks]

(b) A 240m-length of wire stretched between two towers is at 60^o to the magnetic field of 5×10^{-3}T. If the wire of 10mm radius has a resistance of 5Ω in an electric field of $100NC^{-1}$, determine the magnitude of the magnetic Force. [10 marks]

2. (a) State the full name for the acronym *LASER*. List five (5) applications of Laser. [10 marks]

(b) A photon or light is considered to have dual character as *wave* and as a *particle*. Write for each five (5) attributes of a (i) wave and (ii) particle. [10 marks]

30.

SECTION B

(a) With a large labelled schematic diagram, describe briefly how photoelectrons can be produced in the laboratory. State reasoned precautions taken to ensure the experiment is successful. [7 marks]

(b) Mention 4 applications of photoelectric emission. [8 marks]

4. (a) State briefly Bohr's 3 fundamental postulates for atomic structure. [6 marks]

(b) A photon of green light has a wavelength of 5200Å. Calculate the photon's

(i) Frequency (f), (ii) magnitude of momentum (p), (iii) energy (E) leaving answers in both Joules and eV. [9 marks]

SECTION C

5. (a) Find the equivalent capacitance of the combination and the potential difference on the 2μF capacitor (Figure 1). [10 marks]

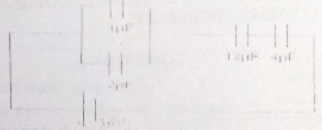


Figure 1

(b) Explain what is a *Semi-Conductor* with three (3) examples. [5 marks]

6. (a) What is the velocity of a proton particle that covers 2mm in an electric field of $100NC^{-1}$? [9 marks]

(b) Discuss the two (2) phenomena of induced charges. [6 marks]

RIVERS STATE UNIVERSITY,
NKPOLU-OROWORUKWO, PORT HARCOURT, NIGERIA
DEPARTMENT OF PHYSICS
Second Semester Examinations (Undergraduate)
2018/2019 Academic Session

PHY 105: GENERAL PHYSICS II:
(ELECTRICITY, MAGNETISM AND MODERN PHYSICS) (SCIENCE GROUP)

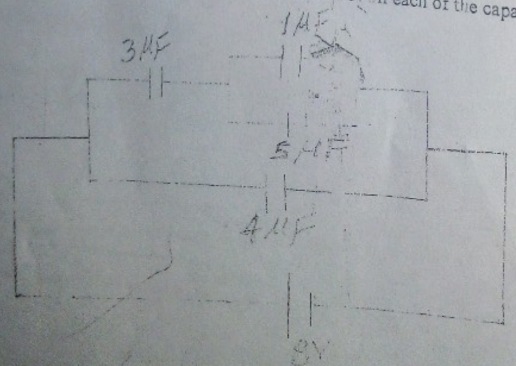
Time: 2 Hours

INSTRUCTIONS:
- ATTEMPT FOUR (4) QUESTIONS IN ALL: AT LEAST ONE (1) FROM EACH SECTION.
- SYMBOLS HAVE THEIR USUAL MEANINGS EXCEPT OTHERWISE STATED.
- INDICATE UNITS (S.I.) WHERE NECESSARY.

SECTION A

1. (a). What is a field point? (2½ mks)
   (b). State Coulomb's Law. (5 mks)
   (c). Three point charges positioned in space such that $q_1 = -3q$ at $4i$ cm, $q_2 = +2q$ at $3j$ cm and $q_3 = +4q$ at the origin. If $q = 1\mu C$.
      (i). draw the resulting charge system.
      (ii). evaluate the resultant force on the q_2 charge. (10 mks)

2. (a). What is a capacitor? (2½ mks)
   (b). Calculate the capacitance and energy stored on a capacitor with 250 μC charge on it, with a potential difference of 1000 V across it. (5 mks)
   (c). In the capacitive circuit below:
      (i). find the equivalent capacitance and charge on it.
      (ii). Find the charge and potential difference in each of the capacitors. (10 mks)



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SECTION B

3 (a). (i). State the Biot-Savart law for the magnetic field of a conductor carrying current. (2 mks)

(ii) Name two sources of magnetic field you know. (2 mks)

(iii) Give the statement of Ampere's law. (2 mks)

(b). Starting from Biot-Savart law, derive the magnetic field B at a direct distance 'a' meters near an infinitely long straight conductor carrying current. (8 mks)

(c). A long straight wire of diameter 2 millimetres is carrying a current of 5 Amperes. Calculate the magnetic field at a direct distance 40 centimetres from the wire. (3 ½ mks)

4. (a). Define an alternating current signal, and hence write down the equations expressing the instantaneous values of (i). current, (ii). voltage of an alternating current. (4 mks)

(b). (i). What do you understand by the term 'Root Mean Square' value of an alternating Current. (2 mks)

(ii). Write down the expressions for the reactances of a capacitor and an inductor in the circuit of an alternating current, and explain the symbols. (4 mks)

(c). If an alternating current source has a root mean square voltage of 240 volts, and delivers a power of 300 Watts to a resistor, calculate (i). the peak voltage, (ii). the resistance of the hot resistor. (7 ½ mks)

SECTION C

5 (a). (i). What causes presbyopia and astigmatism?

(ii). How can each of the eye defects above be corrected?

(iii). Describe the term "eye-ring". (5 mks)

(b). With the aid of a simple diagram briefly describe how the image in formed in an astronomical telescope. (5 mks)

(c). An object is placed 15cm from the objective lens of a compound microscope. If the focal length of the objective is 10cm and the first image forms 5cm from the eye-piece lens, calculate the separation of the two lenses (no need for a diagram). (7 ½ mks)

$f = 10$ $v = 5$ $f_p = \frac{5\,(f_o + f_e)}{f_e}$ $f_p = \frac{10(5+15)}{15}$ $\frac{2250}{5} =$

6. (a). According to Bohr's Theory of the hydrogen atom, an electron in the ground state may be boosted to one of its many other allowed stable energy levels in several ways. Name three (3) of these ways. (3 mks)

(b).(i). What does the term "wave-particle duality" mean?

(ii). What are line spectra?

(iii). How do semi-conductors behave and give three (3) examples of pure (intrinsic) semi-conductors? (7 mks)

(c). Calculate the frequency of the third (3^{rd}) line in the Lyman Series. (Use Planck's constant, $h = 4.136 \times 10^{-15}$ eV.s). (7 ½ mks)

SECTION B

(a) With a large labelled schematic diagram, describe briefly how photoelectrons can be produced in the laboratory. State reasoned precautions taken to ensure the experiment is successful. [7 marks]

(b) Mention 4 applications of photoelectric emission. [8 marks]

4. (a) State briefly Bohr's 3 fundamental postulates for atomic structure. [6 marks]

(b) A photon of green light has a wavelength of 5200Å. Calculate the photon's (i) Frequency (f), (ii) magnitude of momentum (p), (iii) energy (E). [illegible] answers in both Joules and eV. [9 marks]

SECTION C

5. (a) Find the equivalent capacitance of the combination and the potential difference on the 2μF capacitor (Figure 1). [10 marks]

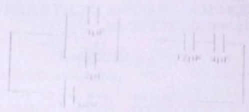

Figure 1

(b) Explain what is a *Semi-Conductor* with three (3) examples. [5 marks]

6. (a) What is the velocity of a proton particle that covers 2mm in an electric field of $100NC^{-1}$? [9 marks]

(b) Discuss the two (2) phenomena of induced charges. [6 marks]

RIVERS STATE UNIVERSITY
NKPOLU-OROWORUKWO, PORT HARCOURT

DEPARTMENT OF PHYSICS

PHY 106: GENERAL PHYSICS II FOR FACULTIES OF SCIENCE,

SECOND SEMESTER 2016/2017 SESSION.   TIME ALLOWED: 2 HRS

INSTRUCTIONS: Answer ALL Questions in Section A, one (1) Question from each of the Sections, making a total of four (4) Questions.

Some Physical Constants: Planck's constant, h = 6.6×10^{-34} J-sec; for H_2 atom ... velocity of light (photon), c = 3×10^{8} ms^{-1}; electronic mass, m = 9.1×10^{-31} kg; ... Permittivity of free space, $\varepsilon_o = 8.86 \times 10^{-12} C^2/N\text{-}m^2$. Acceleration due to gravity, g ... Magnitude of charge of electron, Q = 1.6×10^{-19} C; Mass of electron, $m_e = 9.1 \times 10^{-31}$ kg; Mass of proton, $m_p = 1.67 \times 10^{-27}$ kg.

SECTION A

1. (a) Three charges $Q_1 = 6\mu C$, $Q_2 = -6\mu C$ and $Q_3 = 4\mu C$ are located at ... 0.6im, 0 ... 0.8jm respectively. Find the net force on charge Q_3. [10 marks]

   (b) A 240m-length of wire stretched between two towers is at 60^o to the magnetic field of 5×10^{-5} T. If the wire of 10mm radius has a resistance of 5Ω in an electric field of $100NC^{-1}$, determine the magnitude of the magnetic Force. [10 marks]

2. (a) State the full name for the acronym *LASER*. List five (5) applications of Laser. [10 marks]

   (b) A photon or light is considered to have dual character as *wave* and as a *particle*. W... for each five (5) attributes of a (i) wave and (ii) particle. [10 marks]

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SECTION B

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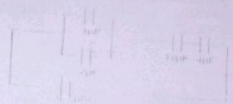

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