ABIA STATE UNIVERSITY, UTURU

DEPARTMENT OF PHYSICS

2020/2021 SECOND SEMESTER EXAMINATION

PHY 102: GENERAL PHYSICS II

Use the following constants where necessary:

Planck's constant (h)	$= 6.63 \times 10^{-34}$ J.s
Speed of light (c)	$= 3.0 \times 10^{8}$ m/s
1 electron volt (eV)	$= 1.6 \times 10^{-19}$ J
1 Angström unit	$= 10^{-10}$ m
Electronic charge (e)	$= 1.6 \times 10^{-19}$ C
Permittivity of free space (ε_0)	$= 8.85 \times 10^{-12} C^2N^{-1}m^{-2}$
Mass of an electron (M_e)	$= 9.1 \times 10^{-31}$kg
Mass of an proton (M_p)	$= 1.7 \times 10^{-27}$kg
Gravitational constant (G)	$= 6.69 \times 10^{-11} Nm^2kg^{-2}$

INSTRUCTIONS: Answer any 7 Questions. **TIME: 2hrs**

1. a. i) Define electrostatics (ii) State the law of conservation of charge (iii) What are the two processes of charging an uncharged body (iv) Write down two properties of a charge. (6 marks)

b. What is the total charge of all the electrons in a gold plate with mass 5 grams? (Atomic number of gold, $Z_g = 79$, atomic mass = 196.97 and Avogadro's number = 6.02×10^{23} mole^{-1}) (4 marks)

2. a) State Coulomb's law and show that the ratio of the electrostatic force to the gravitational force is independent of the distance of separation between the particles. (4 marks)

b. (i) Find the magnitude of the electrostatic force between an alpha particle and an electron 20μm apart. (ii) Calculate ratio of the electrostatic force to the gravitational force between the alpha particle and the electron. (Use the following: Mass of an alpha particle, $M_\alpha = 6.64 \times 10^{-27}$kg, alpha particle has charge = 2e, electric constant, $k = 9.0 \times 10^{9} Nm^2C^{-2}$) (6 marks)

3. a) Define the following (i) electric field intensity (ii) electric potential (iii) electric potential energy (iv) Equipotential surface (v) Gaussian surface (5 marks)

b. Find the electric field at a point 50cm from a charge 30μC. Also find the electric potential in moving the charge from infinity to that point. (Take $k = 9.0 \times 10^{9} Nm^2C^{-2}$) (5 marks)

4 a. (i) State Gauss' law and its application. (2 marks)

(b) Write down the expression for electric flux when the electric field lines are (i) perpendicular to the surface of area A (ii) parallel to the surface and (iii) when the unit vector, n, perpendicular to the area makes an angle θ with the field. (3 marks)

(c) A flat rectangular surface of area $10^{-2}m^2$ has an electric field of magnitude $400NC^{-1}$ at each point on the surface. Calculate the electric flux for this surface when the electric field is (i) perpendicular to the surface (ii) parallel to the surface (iii) makes an angle 75° with the plane of the surface. (5 marks)

5 a) Define the following (i) excitation energy (ii) ionization energy (iii) isotope. (3 marks)

b. What are the means by which excitation or ionization of an electron may occur? (3 marks)

c. Arrange the following series in the order of increasing frequency and state the part of the electromagnetic spectrum they can be found: Balmer series, Paschen series and Lyman series. (4 marks)

6. (a) (i) Define a capacitor, draw its symbol and differentiate it from that of battery (ii) why are capacitors classified as passive devices? (iii) What is the net effect of combining capacitors in parallel? (5 marks)

(b) Two capacitors of 10μF and 15μF respectively connected to a 12V battery are connected in parallel; what is the potential difference across each plate and calculate charge on each capacitor. (5 marks)

C.A. E.A.W.A.E.Q.S.

7 (a) State Ohm's law and Kirchhoff's laws (3 marks)

(b)Define the following: Current, electric power, electromotive force and resistance. (4 marks)

(c) . If an AC draws a current of 10A from 220V source find (i) the power rating of the AC (ii) the electric resistance, R (3 marks)

.8 Write down (i) 4 properties of X-rays (ii) 3 properties of nuclear force and (iii) 3 properties Coulomb's force. (10 marks)

9. (a) State Bohr's theory of the hydrogen atom (3 marks)

b) The energy levels in eV of hydrogen are given by:

$$E = \frac{-13.0}{n^2}$$

,where n = 1, 2, 3, ...

(i) Compute the four lowest energy levels and construct the energy level diagram. (4 marks)

(ii) Calculate the excitation energy of an electron which jumps from the ground state to the second excited state, n = 3 ($1\frac{1}{2}$ marks)

(iii) What is the ionization energy of this electron? ($1\frac{1}{2}$ marks)

$12\frac{1}{A} = \frac{3\times10^{-6}}{4.26\times10^{-5}} = 2.38\times10^{-1}$

(b) $q = e = 1.6\times10^{-14}$

$v = J = 23.81 Am^{-2}$

$Ud =$

$n =$

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1 (a i) Pg 1

- Electrostatics Can be define d as an electrical Phenomenon associated with the study of charge and charge at rest

(ii)

The Law of Conservation of charge states that the total quantity of charge in any Process does not change rather transfered from one body to the other

(iii)

An Uncharged body Can be Charged by

- Conduction
- Induction

SIR JOHN (J.K)

(iv)

Properties of a charge (Any Two) Choose two (2) only.

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Like Charges repels each other, while unlike charges attracts each other

Charges are Conserved

A Charge can be Positively or negatively Charged

(4) Charges are Quantized.

(5) Charges are transferable.

(15)

Total Charge

Formulae: $Q = \pm ZNe$

Provided with; $M = 5g$

$e = 1.60 \times 10^{-19} C$

$Z = 79$ (electrons) / Atomic no

$A = 196.97 g$ (Atomic mass)

Avogadros $= 6.02 \times 10^{23} mol^{-1}$

Pls NOTE: $N = \frac{\text{Mass}}{\text{Atomic Mass}} \times \frac{\text{Avogadros}}{1}$

$\Rightarrow \frac{5}{196.97} \times \frac{6.02 \times 10^{23}}{1}$

$= 1.528 \times 10^{22}$

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Cont

So; Total Charge : Back to formula

$$Q = (-79)(1.528 \times 10^{22})(1.60 \times 10^{-19})$$

$$= -1.93 \times 10^{5} \text{ C electrons}$$

Ans

(2a)

Coulomb's Law states that the Magnitude of force of attraction between two Points Charges is directly Proportional to the two Charges and inversely Proportional to the square of the distance (r) b/w them

Mathematically;

$$F \propto \frac{Q_1 Q_2}{r^2} \quad \text{or} \quad F = \frac{e^2}{4\pi\varepsilon_0 r^2}$$

$$= F = \frac{kQ_1 Q_2}{r^2}$$

NOTE Pls: $k = \frac{1}{4\pi\varepsilon_0} = 9.0 \times 10^{9} \text{ Nm}^2\text{C}^{-2}$

$\varepsilon_0 = 8.85 \times 10^{-12}$

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ε_0 = Permittivity of free space

Showing that the Ratio of Electric force "f_e" and Gravitational force "f_g" is Independent of their distance "r"

$$\frac{f_e}{f_g} = \frac{\frac{e^2}{4\pi\varepsilon_0 r^2}}{\frac{GM_1M_2}{r^2}}$$

$$\Rightarrow \frac{e^2}{4\pi\varepsilon_0 r^2} \times \frac{r^2}{GM_1M_2}$$

$$\frac{f_e}{f_g} \Rightarrow \left[\frac{e^2}{4\pi\varepsilon_0 GM_1M_2}\right] \rightarrow \text{Ratio}$$ Ans

Because the distance "r" b/w the forces is cancelled out so the forces are Independent of distance b/w them. Ans

(25)

Magnitude of Electric force "f_e"

formula: $f_e = \frac{e^2}{4\pi\varepsilon_0 r^2}$ or $\frac{Q_1 Q_2}{4\pi\varepsilon_0 r^2}$

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We are Provided with;

$e = 1.60 \times 10^{-19} C$

Also $k = \frac{1}{4\pi\varepsilon_0} = 9.0 \times 10^9 Nm^2C^{-2}$

So Using the formulae;

$$f_e = \frac{k e^2}{r^2}$$

So Substituting;

$$f_e = \frac{(9.0 \times 10^9)(1.60 \times 10^{-19})^2}{(20 \times 10^{-6})}$$

$$= 1.15 \times 10^{-23} C \quad \text{Ans}$$

(25ii)

finding the Ratio of Electric & Gravitational force

formulae: $\frac{f_e}{f_g} = \left[\frac{e^2}{4\pi\varepsilon_0 G M_1 M_2}\right]$

OR $= \frac{k e^2}{G M_1 M_2}$

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Provided with:

$M_1 = M_\alpha$ (Mass of alpha Particle)

$M_2 = M_e$ (Mass of electron)

$M_1 = 6.64 \times 10^{-27}$ kg

$M_2 = 9.1 \times 10^{-31}$ kg $\quad G = 6.69 \times 10^{-11}$

and

$k = 9.0 \times 10^9 \, Nm^2 C^{-2}$

Since $\frac{F_e}{F_g} = \frac{k e^2}{G M_1 M_2}$

$= \frac{(9.0 \times 10^9)(1.60 \times 10^{-19})^2}{(6.69 \times 10^{-11})(6.64 \times 10^{-27})(9.1 \times 10^{-31})}$

Ans with Unit $= 5.7 \times 10^{38}$ No Unit

It has No Unit Ans

3a

- Electric field Intensity, Can be defined as the Ratio of Magnitude of Electric force Per Unit Charge

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acting on the Positive test Charge.

Mathematically;

$E = F/q$ Expressed in NC^{-1}

(ii)

Electric Potential Can be defined as the work done to move a Unit Positive Charge from Infinity to a Point in the Electric field. "V"

Mathematically;

$V = \frac{W}{q}$

(iii)

Electric Potential Energy. This Can be defined as the energy required to move a unit Charge from one Point to the other against it's electric field.

Cont Pg 8//

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(iv)

Equipotential Surface: This can be define as Points (Lines of forces) in the Surface of an electric field that have Same Potential.

(v)

Guassian Surface: This can be defined as a three dimensional Closed Gauss Surface at which the Unit Vector of the electric flux is calculated.

(3b)

finding Electric field

Provided that with:

$K = 9.0 \times 10^9 \, Nm^2 C^{-2}$

$r = 50cm = \left(\frac{50}{100}\right) = 0.5m$

$q = 30\mu m = \left(30 \times 10^{-6}\right) m$

formular, $E = \frac{Q}{4\pi\varepsilon_0 r^2} = \frac{kQ}{r^2}$

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$$E = \frac{(9.0\times10^{9})(30\times10^{-6})}{(0.5)^2}$$

$$= 1.0\times10^{6}\ NC^{-1}\ \text{Ans}$$

(ii) Electric Potential "V"

$$V = \frac{Q}{4\pi\varepsilon_0 r} = \frac{kQ}{r}$$

$$V = \frac{(9.0\times10^{9})(30\times10^{-6})}{(0.5)}$$

$$= 1.35\times10^{5}\ \text{Joule/C}\ \text{Ans}$$

* ENDING HERE FOR NOW *

MORE ARE COMING

JOHNKINGSLEY
(Group Admin)

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CONTINATION

(4a)

Gauss's law states that in an enclosed surface, the magnitude of the Electric flux is Proportional to the net quantity of Charge in the same enclosed surface.

Mathematically

$\Phi \propto q/\varepsilon_0$ where; Φ is = Electric flux

q = Charge

ε_0 = Permitivity of free space

(Pg I)

Applications of Gauss Law

⊛ Gauss Law law is Applied in

① Electric field due to a charge ∮ Parallel ∮ Plane

NOTE: Equations are not asked here, But may be Asked in our Set*

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Equation

N/B: $\phi = q/\varepsilon_0$ and $\phi = E \cdot A$ is the general formular for Electric flux "ϕ"

Where A = Area of the shape
E = Electric field.

Making E the subject of the Relation

$E = \phi/A = q/\varepsilon_0 A$ // Ans

② Electric field due to a Charged Spherical Surface

Equation (XLOTE)

$\phi = E \cdot A$

N/B: $\phi = q/\varepsilon_0$

And Area of the Sphere $= 4\pi r^2$

So; $E = \phi/A = q/4\pi r^2 \varepsilon_0$ // Ans

③ Electric field due to a Charged Cylindrical Surface

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Equation

$\Phi = E \cdot A$ ... AlSo $\Phi = q/\varepsilon_0$

A = Area of a cylinder

$A = 2\pi r L$

So Making E the Subject

$E = \Phi / A = q / 2\pi r L \varepsilon_0$ Ans

(4b)

Generally Electric flux "Φ" is Given By:

$\Phi = E \cdot A_n$

Now we have Various Equations Expressions for different forms of a Metallic Conductor Plate Placed on an enclosed Surface.

(i)

Perpendicular

$\Phi_\perp = E_\perp \cdot A$ NOTE "$\perp$" is a Sign of Perpendicular.

(ii)

Parallel

$\Phi = 0$ (zero)

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(iii)

When an angle is inclined ~~'θ'~~

$\phi = E \cdot A \cos\theta$

4C

Given us, that:

Area $= 10^{-2} m^2$

Electric field: $E = 400 N C^{-1}$

(i)

Calculating the Electric flux (ϕ) when Electric field lines is Perpendicular.

We have:

$\phi_\perp = E_\perp \cdot A$ (formula)

By Substitution

$\phi_\perp = (400)(10^{-2}) N m^2 C^{-1}$

$= 4 N m^2 C^{-1}$ Ans

(ii)

Parallel

$\phi = 0$

So Automatically Electric flux

$\phi = 0$ (zero)

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(iii)

Electric flux Inclined at an angle

$\theta = 75^\circ$

$\phi = E \cdot A \cos\theta$

$= (400)(10^{-2})(\cos 75^\circ)$ By Substt

$= 1.0 \times 10^{8} \, Nm^2 C^{-1}$ Ans

5c

Excitation Energy May be define as that amount of Energy which is Needed in order for an electron in it's ground state to attain an excitated state in an atom.

(ii)

Ionization Energy May be defined as the minimum quantity of energy in Joules needed for an atom to Loss an electron from it's ground State.

(iii)

Isotopes Can be defined as Nuclides which have Same Proton Number but different Neutron Number.

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Eg / For Instance:
Using Oxygen for Example.

$^{16}_{8}O$, $^{17}_{8}O$ Neutron No = 17 − 8
= 9 Ans

Neutron No = 16 − 8
= 8 Ans

(5b)

Excitation and Ionization may occur in the following ways.
NOTE BEFORE: I have Explained what Excitation & Ionization is all about in the Previous Pages.

① Bombardment of fast moving Electrons with those electrons at their ground state.

② Collision of Electrons with molecules in a flame of fire.

③ Collision of Electrons at ground state with Photons

NOTE: Photons are Produced when a U.V Ray strikes a metal.

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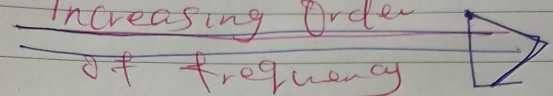
5C

Arranging in Order of Increasing Frequency

ANSWER

Paschen Series, Balmer Series, Lyman Series

Increasing Order of frequency



Spectrum Electromagnetism

1. Pasclen Series gives Infrared radiation
2. Balmer Series gives U.V and Visible Light
3. Lyman Series gives U.V only.

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NOTE:* I will EXPLAIN MORE BETTER IN CLASS *

Don't Miss His: ~~I thinking~~ today