United International University

School of Science and Engineering

Final Examination; Year 2023; Trimester: Summer
Course: PHY 2105; Title: Physics; Sec: A-H
Full Marks: 40, Time: 2 Hours

Any examinee found adopting unfair means will be expelled from the trimester/program as per UIU disciplinary rules.

Questions no 1, 2, 3,4 are mandatory to answer. Answer any one from question no 5 and 6.

1. (a) When you twist a metal door lock to open or close a wooden door, a tiny imbalance in either positive or negative charge on the door lock is the cause of static electricity. (i) Which type of force is produced here? (ii) Is there any conductor and insulator here? Identify it, if any, and distinguish (at least two) between conductor and insulator from the above example, if any. — 2 CO1

(b) All four charges are equally spaced from center point O in Figure 01. Draw a diagram with electric field lines. What will be the electric field at the center point O? — 2 CO1

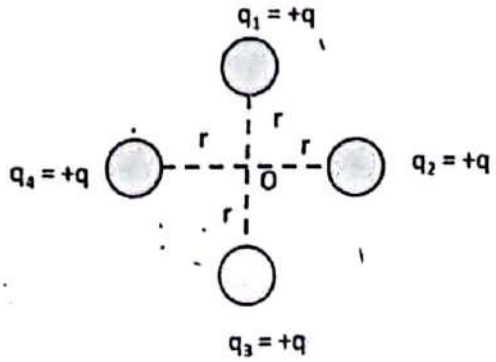

Figure 01

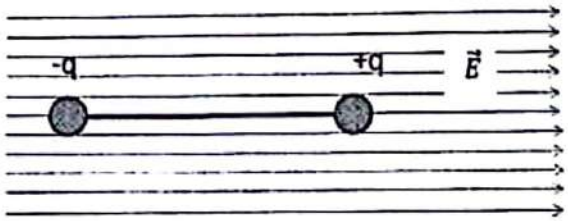

Figure 02

(c) What will be the torque of a dipole if it is placed according to Figure 02? Draw the direction of the dipole moment to analyze the torque. — 2 CO1

2. (a) A charged object has -160 nC of charge. Find out the number of electrons in that object. — 2 CO3

(b) Compare the electrostatic force and gravitational force between two electrons when they are separated at a distance 100 nm from each other. The gravitational constant is $G = 6.67 \times 10^{-11}\ m^3\ kg^{-1}s^{-2}$, the mass of each proton is 1.67×10^{-27} kg, and the mass of the electron is 9.1×10^{-31} kg. Here, $e = -1.6\times10^{-19}$ C. — 3 CO3

(c) Calculate the magnitude and direction of the force experienced by q_0 from Figure 03. Given, $q_0 = 1\times10^{-19}$ C. — 3 CO3

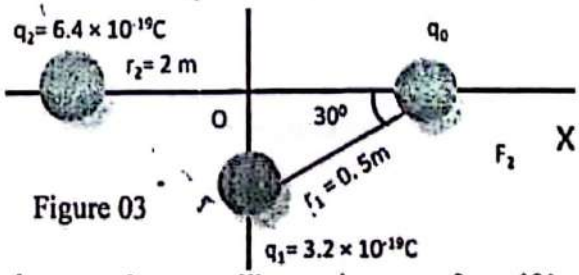

Figure 03

3. (a) Calculate the position between q_1 and q_2 where an electron will experience no force if it is placed. (Figure 04). Here, $e = -1.6\times10^{-19}$ C. — 3 CO3

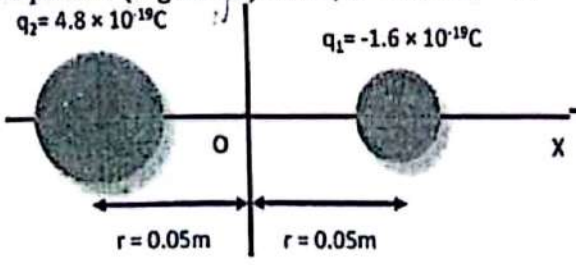

Figure 04

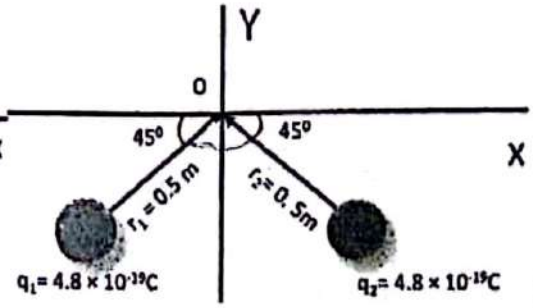

Figure 05

(b) Calculate the magnitude and direction of the net electric field at point O. (Figure 05) 3 CO3

(c) An electric dipole consists of charge + 7e and -7e separated by 0.20 μm. It is placed in an electric field of strength 6.1×10^{-8} N/C. Calculate the magnitude of the torque and the potential energy on the dipole when the dipole moment is 38° to the electric field. 3 CO3

4. (a) What is the electric potential at the center of the square of charged particles shown in Figure 06? The distance, a = 1.3 m, and the charge q = 10 nC. 3 CO3

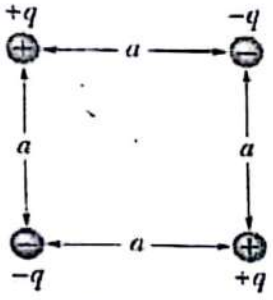

Figure 06

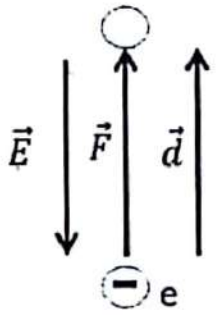

Figure 07

(b) Electrons are continually being knocked out of air molecules in the atmosphere by cosmic-ray particles coming in from space. Once released, an electron, moving upward from the Earth, experiences an electric force due to the electric field that is produced in the atmosphere by charged particles. Near Earth's surface the electric field has the magnitude E =150 N/C and is directed downward. What is the change ΔU in the electric potential energy of a released electron when the electric force causes it to move vertically upward through a distance d = 340 m (Figure 07)? Through what potential change ΔV does the electron move? 3 CO3

(c) How much work is required to turn an electric dipole 120^0 in a uniform electric field of magnitude E = 150 N/C if the dipole moment has a magnitude of $p = 3.6\times10^{-24}$ Cm and the initial angle is 30^0? 3 CO3

5. (a) Show that, electric field, $E= \frac{2kp}{z^3}$, k = coulomb constant and the symbols have their usual meanings. Here, p = dipole moment = qd. 4 CO2

(b) If two charges behave like a dipole, then show that the moment of force is, $\vec{\tau} = \vec{P} \times \vec{E}$. Calculate the value of angles between the electric field and dipole moment for maximum and minimum torque. 4 CO2

6. (a) Derive the equation of electric field at a certain distance from a point charge. Write vector form of your derived equation. 4 CO2

(b) Find out the electric potential due to a single charge. Modify your derived equation for n number of charges. 4 CO2

CO1: Define different physical quantities with examples. **CO2:** Derive/Show the various equations of electric field, electric potential, electric dipole, dipole moment, electrostatic force, etc. **CO3:** Evaluate different numerical problems based on the basic characteristics of electric charge, electric field, electric potential, electric dipole moment, and electrostatic force.