# United International University

## School of Science and Engineering

Final Examination; Year 2023; Trimester: Fall
Course: PHY 2105; Title: Physics; Sec: A-O
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.***

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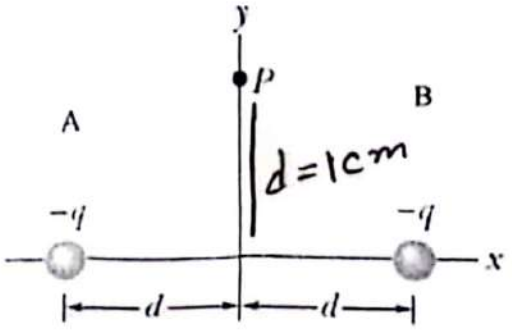
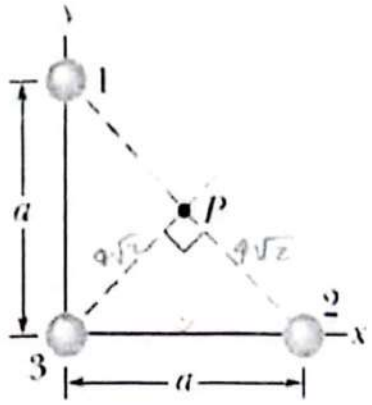
| 1. | (a) If two opposite charges (one positive and one negative) are placed on the same axis, it is possible to get a point on the axis between the charges where there is no electric field? Do they construct electric dipole? Justify your answer. | 2 | CO1 |
| | (b) Does the electric potential of a point in an electric field increase or decrease If the magnitude of the electric field increases? Justify your answer with proper reason. | 2 | CO1 |
| | (c) When does a dipole experiences no torque in an electric field? Explain briefly. | 2 | CO1 |
| 2. | (a) Robert has pulled out some electron from a ball making a net charge of $+1.6\times10^{-17}$ C. How much electrons have been pulled out by him? | 2 | CO3 |
| | (b) Three charges lie on the x axis: $q_1 = +30\ \mu C$ at the origin, $q_2 = -18\ \mu C$ at x =5 m, $q_3 = +20\ \mu C$ at x=8 m. Calculate (i) magnitude of net force on $q_2$, and (ii) direction of net force on $q_2$ | 3 | CO3 |
| | (c) Charges of magnitude 18 nC each are located in vacuum at the corners A, B and C of a right angle triangle measuring 8 m in height and 6 m base BC. If the charge at A and C are positive and the charge B is negative, what is the magnitude and direction of the total force on the charge at A? | 3 | CO3 |
| 3. | (a) An electric dipole consists of charge + 3e and -3e separated by 0.2 nm. It is in an electric field of strength $6.8\times10^{-9}$ N/C. Calculate the magnitude of the torque on the dipole when the dipole moment is (i) parallel to, (ii) perpendicular to, and (iii) half of right angle to the electric field. | 3 | CO3 |
| | (b) Ammonium hydroxide ($NH_4OH$) is a molecule that has a permanent dipole moment is $5.98\times10^{-30}$ Cm. (i) What is the dipole distance of ammonia base molecule? and (ii) If the molecule is placed in an electric field of $1.5\times10^{-4}$ N/C, what maximum and minimum torque can the field exert on it? | 3 | CO3 |
| | (c) Four charges +3q, +5q, +3q and –3q are placed at the corners of a square. (i) Draw the arrangement of the charges, and (ii) Calculate the magnitude and direction of electric field at the intersection of the diagonals of the square of side 5 cm if q = 6 nC. | 3 | CO3 |
| 4. | (a) Two equal charges of $10\times10^{-5}$ C are shown in figure below. Each produces an electric field at point *P* on Y axis.<br>(i) What is the magnitude of the electric potential at point *P*?<br>(ii) If we replace the -q charge at position A with a charge *Q* of unknown value such that the net potential at point *P* will be zero, what will be the value of Q? Calculate the value. | 3 | CO3 |



(b) The three particles are fixed in place and have charges $q_1 = q_2 = +2e$ and $q_3 = -2e$. Distance $a = 8$ μm. Here, the distance of point P from charge 3 is $4\sqrt{2}$ μm. 3 CO3

(i) What is the magnitude of the net electric potential at point $P$ due to the particles?

(ii) What will be the potential at $P$ if we place $q_1 = q_2 = +e$ and $q_3 = -2e$?

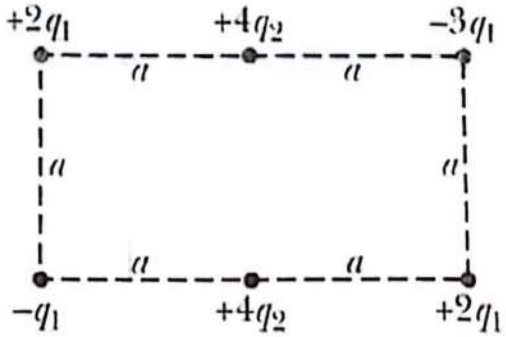



(c) The ammonia molecule $NH_3$ has a permanent electric dipole moment equal to 2 D, where 1D = 1 Debye unit = $3.34 \times 10^{-30}$ Cm. Calculate the electric potential due to an ammonia molecule at a point 60.0 nm away along the axis of the dipole. (Set V= 0 at infinity) 3 CO3

5. (a) Two charges $q_1 = 5q$ and $q_2 = 3q$ are separated at a distance $r$ in vacuum. If the distance between them is increased 5 times and the charge $q_1$ is decreased $\frac{1}{2}$ times compare the initial and final electrostatic force on $q_1$ from $q_2$. Discuss if there is any change in the direction of the electrostatic force. 4 CO2

(b) Show that, a potential energy U is associated with the orientation of the dipole moment in the field such that, $U = -\vec{P}.\vec{E}$. Calculate the condition for maximum and zero potential energy. Here $\vec{P}$ is the dipole moment and $\vec{E}$ is the electric field. 4 CO2

6. (a) Figure below shows a rectangular array of charged particles fixed in place, with distance $a$ and the charges shown as integer multiples of $q_1 = q$ and $q_2 = 2q$. With $V = 0$ at infinity, calculate the net electric potential at the rectangle's center. 4 CO2




(b) Show that, the electric potential difference between two points i and f is 4 CO2

$$V_f - V_i = -\int_i^f \vec{E}.\overrightarrow{ds} = -Ed$$

where the integral is taken over any path connecting the points and the symbols have their usual meanings.

**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, etc.