Name of the Program: B. Sc. in Civil Engineering
Semester: 2nd semester

Date: 04 July, 2025
Time: 10:00 am - 12:00 pm

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF NATURAL SCIENCES

Semester Mid Semester Examination
Course Number: PHY 4253
Course Title: Physics II

Summer Semester: 2023 - 2024
Full Marks: 120
Time: 2.0 Hours

There are **6 (Six)** questions. Answer any 4 **(Four)** questions. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets. Any other statements, if necessary.

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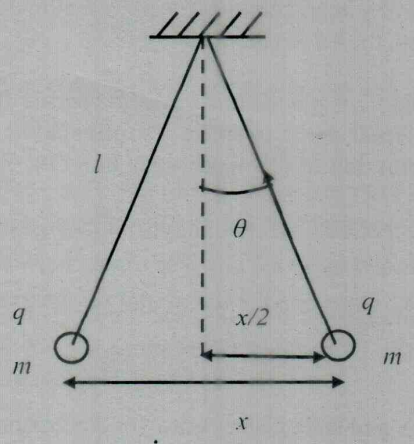
1. (a) State the hypothesis of "Conservation of Charge" and cite a relevant example, explaining how charge is conserved. (06) (CO1) (PO1)

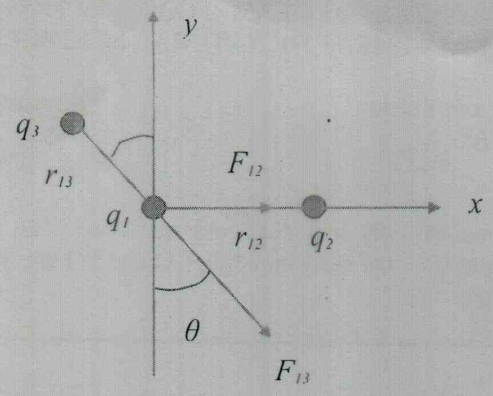
(b) (i) Two similar balls of mass m are hung from silk threads of length l and carry similar charges q (see the Figure shown below). Assume that θ is so small that $tan\theta$ can be replaced by its approximate equal $sin\theta$. To this approximation, relate that . (18) (CO2) (PO1)



(ii) Using appropriate formulae, demonstrate quantitatively that Coulomb force between an electron and a proton in a hydrogen atom is about 10^{39} times greater than the gravitational force between them.

(c) Figure below shows three charges q_1, q_2 and q_3. Assume that q_1=-1.0×10^{-6} (06)

C, q_2 =3.0×10^{-6} C, q_3=−2.0×10^{-6} C, r_{12}=15 cm, r_{13}=10cm, θ=30°. Calculate the resultant force on q_1. (CO3) (PO1)



2. (a) Describe the relationship between the electric lines of force and the electric field strength. (06) (CO1) (PO1)

(b) (i) If a particle of mass m and charge q is placed at rest in a uniform electric field E and released, then describe its motion. (18) (CO2) (PO1)

(ii) If an electric dipole is placed in a uniform electric field, then work must be done by an external agent to make the orientation of the dipole in the field. Find the expression of this work done in terms of dipole moment and electric field.

(c) An electric dipole consists of two opposite charges of magnitude $q=1.5\times10^{-6}$ C separated by $d=1.5$ cm. The dipole is placed in an external field of 1.5×10^{5} N/C. Calculate the maximum torque exerted by the field on the dipole. (06) (CO3) (PO1)

3. (a) Define electric flux and state Gauss's law for electrostatics.. (06) (CO1) (PO1)

(b) (i) Discuss how Coulomb's law can be deduced from Gauss's law. (18) (CO2) (PO1)
(ii) Consider a spherical distribution of charge of radius R. The charge distribution is spherically symmetric. Assuming the total amount of charge q uniformly distributed in the sphere, apply Gauss's law to find an expression for E for points (a) inside and (b) outside the sphere.

(c) Consider that positive charge in a gold atom (Z=79) is thought to be distributed uniformly throughout a sphere of radius 1.0×10^{-10} m. Calculate the electric field strength at the surface of the atom. Neglect the effect of the electrons. (06) (CO3) (PO1)

4. (a) State the concept of quantization of light and compare it with the classical concept. (06) (CO1) (PO1)

(b) Explain mathematically how the Plank's law completely support the experimental spectrum of black body radiation. (18) (CO2) (PO1)

(c) Calculate the de Broglie wavelength of (a) a golf ball of mass 48 g with a velocity of 30 m/s, and (b) proton with a velocity of 10^6 m/s. (06) (CO3) (PO1)

5. (a) Describe the quantum view of photoelectric effect, highlighting the role of photons and the concept of energy quantization. (06) (CO1) (PO1)

(b) Discuss the phenomena of the (i) photocurrent vs. plate potential by varying photon intensity and (ii) photocurrent vs. plate potential by varying photon frequency. Explain the Einstein's photoelectric equation. (18) (CO2) (PO1)

(c) Ultraviolet light of wavelength 360 nm and intensity 1.00 W/m^2 is directed at a potassium surface (work function 2.2 eV). i) Calculate the maximum kinetic energy of photoelectrons. ii) If 0.50% of the incident photons produce photoelectrons, determine how many electrons are emitted per second if the potassium surface has an area of 1.2 cm^2. (06) (CO3) (PO1)

6. (a) State Compton effect and define Compton wavelength. (06) (CO1) (PO1)

(b) In the Compton effect, an X-ray photon undergoes scattering by an electron while the latter remains stationary. Find an expression for the wavelength shift of the photon. (18) (CO2) (PO1)

(c) X-rays of wavelength 11.0 pm are scattered from a target. Calculate i) the wavelength of the X-rays scattered through 45°, and ii) the maximum kinetic energy of the recoil electrons. (06) (CO3) (PO1)