

**NAMIBIA UNIVERSITY  
OF SCIENCE AND TECHNOLOGY**

**FACULTY OF HEALTH, NATURAL RESOURCES AND APPLIED SCIENCES**

**SCHOOL OF HEALTH AND APPLIED SCIENCES**

**DEPARTMENT OF BIOLOGY, CHEMISTRY AND PHYSICS**

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**QUALIFICATION: BACHELOR OF SCIENCE**

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**QUALIFICATION CODE: 07BOSC**

**LEVEL: 6**

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**COURSE CODE: EAM601S**

**COURSE NAME: ELECTRICITY AND MAGNETISM**

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**SESSION: JUNE 2023**

**PAPER: THEORY**

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**DURATION: 3 HOURS**

**MARKS: 100**

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**FIRST OPPORTUNITY EXAMINATION PAPER**

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**EXAMINER (S)**

**PROF MUNAWAR KARIM**

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**MODERATOR:**

**DR VAINO INDONGO**

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**INSTRUCTIONS**

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1. Write all your answers in the answer booklet provided.
  2. Read the whole question before answering.
  3. Begin each question on a new page.
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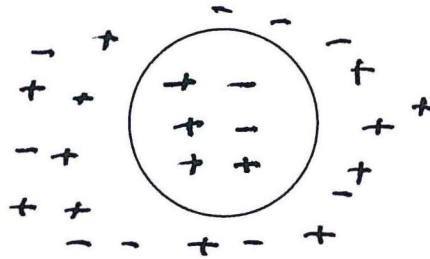
**PERMISSIBLE MATERIALS**

Scientific Calculator

THIS PAPER CONSISTS OF 3 PAGES

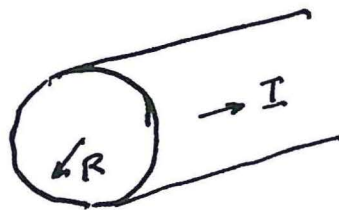
Electricity and Magnetism Final Examination June 2023

- 1) In the diagram below there is a collection of charges. + means +q and - means -q. What is the flux through the surface of the sphere? Recall flux  $\Phi_E = \oint \vec{E} \cdot \vec{da}$ . (20 points)



- 2) Given a uniformly charged sphere of radius  $R$  and charge  $Q$ : (10 points)
- Calculate the  $E$ -field inside the sphere (3 points)
  - Calculate the  $E$ -field outside the sphere (3 points)
  - Draw a graph of the  $E$ -field both inside and outside the sphere (2 points)
  - Identify points where the field is maximum and minimum. There is more than one point where the field is minimum. (2 points)
- 3) Two point-charges  $Q_1$  and  $Q_2$  are separated by a distance  $r$ . (10 points)
- What is the effect on the force between the charges if  $Q_1$  is changed to  $2Q_1$ ? (4 points)
  - What is the effect on the force between the charges if  $r$  is changed to  $2r$ ? (4 points)
  - What is the force as  $r \rightarrow \infty$ ? (2 points)
- 4) You are required to measure an unknown charge  $Q$ . (20 points)
- Set up a force balance with two identically charged spheres each carrying a charge  $Q$  and of mass  $m$  suspended from two light strings of length  $l$ . (5 points)

- b) Draw a free-body diagram depicting equilibrium between the tension on the string  $\vec{T}$ , weight  $m\vec{g}$  and the Coulomb force  $\vec{F}$ . Using Newton's Second law write a vector equation depicting equilibrium. (5 points)
- c) Equate vertical and horizontal components of the three forces. (5 points)
- d) Solve the equations for the force in terms of  $l, m$  and  $g$ . (2 points)
- e) From the force calculate the unknown charge in terms of  $l, m$  and  $g$ . Let  $a = 0.2m, l = 1.0m, m = 0.005 \text{ kg}, k = 9 \times 10^9, g = 9.80 \text{ m/s}^2$ . (3 points)
- 5) Two charges  $q_1 = 2nC$  and  $q_2 = +0.25nC$  are located on the x-axis separated by  $0.3m$ . A third charge  $q_3 = -0.5nC$  is also placed on the x-axis. (20 points)
- a) Set up the equation for the forces acting on  $q_3$  due to  $q_1$  and  $q_2$ . (10 points)
- b) Find the locations (two solutions) on the x-axis where the force on  $q_3 = 0$ . (10 points)
- 6) A solid conductor of radius  $R$  carries a current  $I$  along its axis.
- a) Using Ampere's law calculate the B-field inside the conductor. Show the direction of the B-field. (10 points)
- b) The B-field outside the conductor. Show the direction of the B-field. (5 POINTS)
- c) For values of  $R = 0.01m, I = 10A$ , locate and calculate the maximum B-field. Use  $\mu_0 = 4\pi \times 10^{-7} \text{ H/m}$ . (5 POINTS)



(3)