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 | |
| **QUALIFICATION CODE:** 07BOSC | **LEVEL:** 6 |
| **COURSE CODE:** EAM601S | **COURSE NAME:** ELECTRICITY AND MAGNETISM |
| **SESSION:** JULY 2023 | **PAPER:** THEORY |
| **DURATION:** 3 HOURS | **MARKS:** 100 |

| **SECOND OPPORTUNITY /SUPPLEMENTARY EXAMINATION PAPER** | |
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| **EXAMINER (S)** | PROF MUNAWAR KARIM |
| **MODERATOR:** | DR VAINO INDONGO |

| **INSTRUCTIONS** |
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| 1. Write all your answers in the answer booklet provided.<br>2. Read the whole question before answering.<br>3. Begin each question on a new page. |

**PERMISSIBLE MATERIALS**

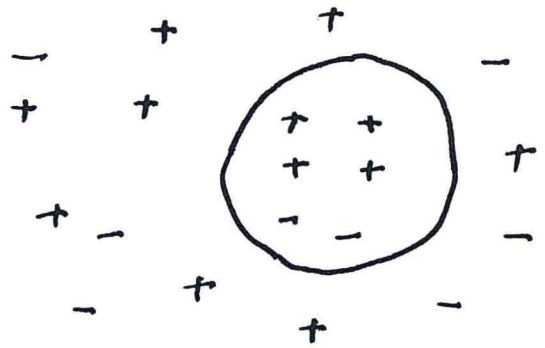
Scientific Calculator

THIS PAPER CONSISTS OF 4 PAGES INCLUDING THIS FRONT PAGE.

Electricity and Magnetism Final Examination June 2023

Supplemental examination

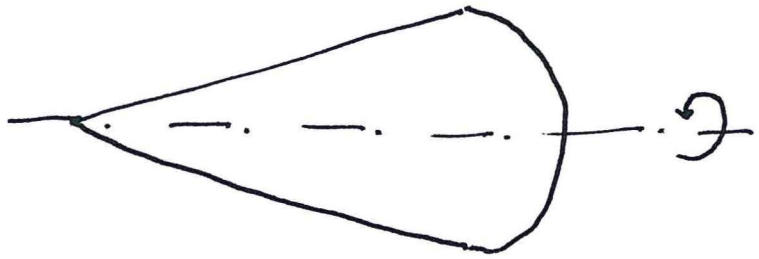
1) In the diagram below there is a collection of charges. + means +q and – means -q. What is the flux through the surface of the sphere? Recall flux $\Phi_E = \oint \vec{E}.\overrightarrow{da}$. (20 points)



2) Given a uniformly charged cylinder of radius *R*, length $l$ and charge *Q*: (10 points)
   a) Calculate the *E*-field inside the cylinder (3 points)
   b) Calculate the *E*-field outside the cylinder (3 points)
   c) Draw a graph of the E-field both inside and outside the cylinder (2 points)
   d) Identify points where the field is maximum and minimum. There is more than one point where the field is minimum. (2 points)

3) Electric potential and electric field are related by $E = -dV/dr$. The field is strongest where the potential changes most rapidly. In the diagram below the metal object is charged to a potential $V$. Identify the point (10 points)

(2)



3-D OBJECT

a) Where the field is maximum. (4 points)

b) Where the field is minimum. (4 points)

c) Where the field has an intermediate value. (2 points0

3) You are required to measure an unknown current $I$. (20 points)

a) Set up a force balance with two anti-parallel currents each carrying a current $I$ and of length $l$. A mass $m$ is placed on the top current carrying conductor so that its weight balances the repulsive force between the currents. (10 points)

b) Draw a free-body diagram depicting equilibrium between the weight of the mass and the force between the two currents. Using Newton's Second law write a vector equation depicting equilibrium. At equilibrium the center-to-center distance is $r = 5mm.$ (5 points)

c) From the force calculate the unknown current $I$ in terms of $l, m$ and $g$. Let $l = 0.1m, m = 1.63 \times 10^{-3}\ kg, \mu_0 = 4\pi \times 10^{-7} H/m, g = 9.80\ m/s^2.$

Use $F = (\mu_0/4\pi) I^2 l^2/(r)^2.$ (5 points)

(3)

4) 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)

5) A hollow cylindrical conductor of inner radius $r_1 = 0.03m$ and outer radius $r_2 = 0.05m$ carries a current $I = 10A$ along its axis. (20 points)

   a) Using Ampere's law calculate the B-field in the hollow part of the conductor.(5 points)

   b) The B-field outside the conductor. Show the direction of the B-field. (5 points)

   c) The B-field in the solid part of the conductor. Use $\mu_0 = 4\pi \times 10^{-7} H/m$. (10 points)