JC 2 Term 1 Physics Topical Quiz 3
Gravitational field, Electric field and Magnetic field
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Total Marks: 11 / 20

Time: 25 mins

Charge of electron, e = 1.6×10^{-19} C; Mass of electron, m = 9.1×10^{-31}kg
The universal gravitational constant, G = 6.7×10^{-11} N m^2 kg^{-2}.

1(a) Figure 1 below shows a small area of the surface of the Earth, assumed to be flat and a conductor of electricity. There is a uniform electric field of 500 Vm^{-1} near the surface and it is directed away from the surface.

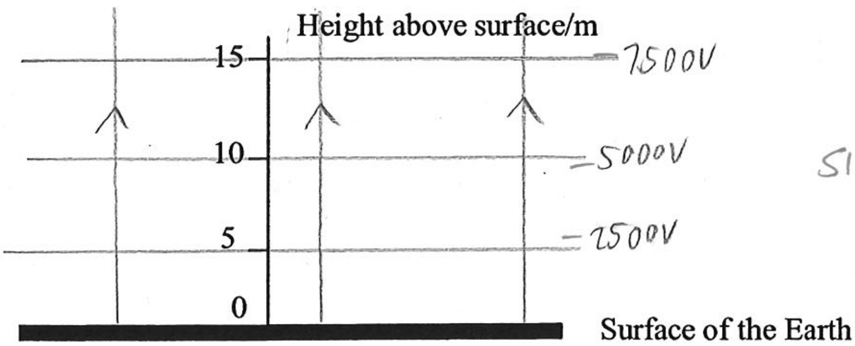


Figure 1

sign. −1

2

(i) Draw on the diagram three electric field lines and three equipotential lines. Label the equipotential lines with their potential values, taking the potential of the Earth as zero. [3]

(ii) A charge of + 5.0 μC is positioned at a height of 5.0 m above the Earth's surface.

Calculate the work done by an external agent in moving this charge of + 5.0 μC

1 through a distance of 2.0 m parallel to the Earth's surface, at height 5.0 m above Earth's surface, and

1

Work done = 0 J ~~5.0 × 500 × 5.0 2.0~~

2 from this height down to the surface of the Earth. [3]

Work done = Fs
= $5.0 \times 10^{-6} \times 500 \times 5.0$
= 0.0125J

2

3 An electron describes a circular path of radius 4.0 cm in a uniform Earth's magnetic field of flux density 100 μT. Find the speed of the electron. [2]

$r = \frac{mv}{Bq}$

$v = \frac{Bqr}{m}$

$= \frac{(100 \times 10^{-6})(1.6 \times 10^{-19})(0.04)}{9.1 \times 10^{-31}}$

$= 7.03 \times 10^{5}$ ms^{-1} (3s.f)

2

7

2 The electrostatic potential difference between the underside of a large thundercloud and the earth's surface is 5.0 MV. The underside of this thundercloud is at a height of 500 m from the earth's surface.

(i) Estimate the electric field strength between earth and cloud. What assumption have you made? [2]

$$E = \frac{\Delta V}{d} = \frac{5.0 \times 10^{6}}{500} = 10000\ \mathrm{Vm^{-1}}$$

Assumption: Charge distribution on cloud and ground are uniform. X

(ii) What is the smallest charge a raindrop of diameter 4.0 mm must have in order not to fall under gravity? State any additional assumption made.
Assume the density of water is 1000 kgm^{-3}. [4]

$F_G = F_E$

$$1000 \times \frac{4}{3}\pi\left(\frac{4}{1000}\right)^3 \times 9.81 = q(10000)$$

$q = 2.62 \times 10^{-9}\ \mathrm{C}$ (3s.f) X

Assumption: Gravitational field strength is 9.81 N kg^{-1} at all heights. X

3 The gravitational field strength of the Earth (of radius 6.38 x 10^6 m) at its surface is 9.81 N kg^{-1}. Calculate the gain in the potential energy of a satellite of mass 3000 kg between its launch and when it is at a height of 0.12 x 10^6 m above the Earth's surface. [4]

Gain in P.E = work done by satellite

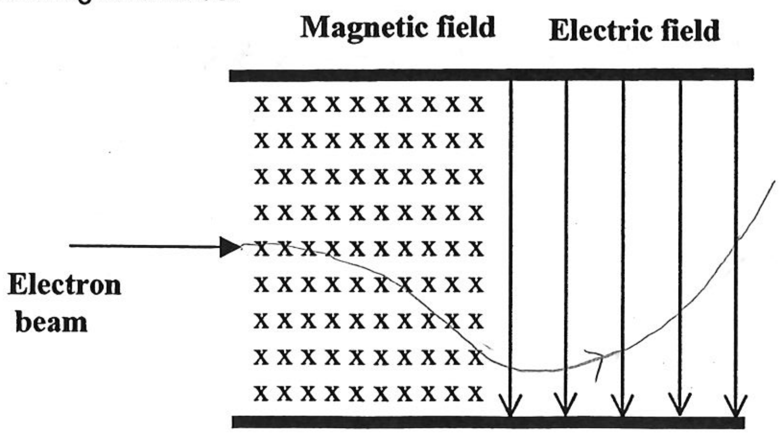
$= mg\Delta h$

$= 3000 \times 9.81 \times 0.12 \times 10^{6}$

$= 3.53 \times 10^{9}\ \mathrm{J}$ (3s.f) X

0

4 On the figure below, sketch a possible path of an electron **through** adjacent electric and magnetic fields. [2]



Magnetic field down into plane of paper

Electric field in the direction of the arrows

2

4