AQA, Edexcel, OCR

A Level

A Level Physics

Electric Fields 1 (Answers)

Name:

M M E

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Total Marks: /30

1. Total for Question 1: 13

(a) Define the electric field strength at a point in space. [1]

Solution: The force experienced per unit positive charge at that point.

(b) State one similarity and one difference between the electric fields produced by charges and the gravitational fields produced by masses. [2]

Solution:
Similarities: both have dependence on product of two charges/masses; both have inverse square law dependence on distance; point charges/masses produce radial fields.
Differences: whilst gravitational fields are always attractive, electric fields can also be repulsive.

(c) Which two of the following statements are true? [2]

i. The direction of an electric field is that in which a negative charge would move.
ii. Electric field lines are always perpendicular to the surface of a conductor.
iii. The spacing of electric field lines is directly proportional to the field's strength.
iv. The direction of an electric field is that in which a positive charge would move.

Solution: 2 and 4.

(d) Sketch the electric fields produced by the following:

Solution: All sketches below should adhere to the simple rules of field lines: perpendicular to conductors' surfaces; arrows from + to -; uniformity indicated by equal spacing; greater strength represented by more closely spaced lines.

i. A negative point charge. [1]

Solution: Radial field with arrows pointing inwards. Lines should be straight.

ii. A positively charged sphere. [1]

Solution: Radial field with arrows pointing outwards. Lines should be straight.

iii. Two parallel plates with opposite charges. [2]

Solution: Uniform field in the middle region of the plates; towards the ends the field lines should bow out.

iv. Two spheres with opposite charges. [2]

Solution: Densely spaced lines where the surfaces are closest together; more widely spaced lines fanning out elsewhere. Lines from outside edges need not be joined up to each other.

v. A positively charged sphere and a negatively charged plate. [2]

Solution: Strongest field where surface separations are smallest.

2. A metal sphere has a radius, r, of 1.0 m and a positive charge of 5.0×10^{-7} C.

Total for Question 2: 9

(a) Calculate the electric field strength at a distance, d, of 1.0 m from the surface of the sphere. [3]

Solution: 1100 NC^{-1}

(b) Without repeating the full calculations you performed in the previous part, determine how the calculated field strength would change in the following circumstances.

i. The charge doubles. [1]

Solution: $\times 2$

ii. r triples. [2]

Solution: $\times \frac{1}{4}$

iii. d is five times larger. [3]

Solution: $\times \frac{1}{9}$

3. An electron is accelerated from rest by a uniform electric field. Given that the field strength is 1.2×10^5 NC^{-1}, calculate the following:

Total for Question 3: 8

(a) The force experienced by the electron. [2]

Solution: 1.9×10^{-14} N

(b) Its speed after 4 ns. [3]

Solution: 8.4×10^7 ms^{-1}

(c) Its displacement after 8 ns. [3]

Solution: 0.67 m