Electric Fields – 2020 A2

1. Nov/2020/Paper_41/No.5

(a) Define *electric potential* at a point.

.....

.....

..... [2]

(b) Two point charges A and B are separated by a distance of 12.0 cm in a vacuum, as illustrated in Fig. 5.1.

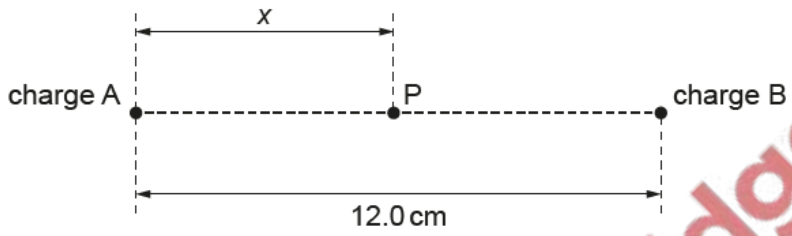

Fig. 5.1

The charge of A is $+2.0 \times 10^{-9}$ C.

A point P lies on the line joining charges A and B. Its distance from charge A is x.

The variation with distance x of the electric potential V at point P is shown in Fig. 5.2.

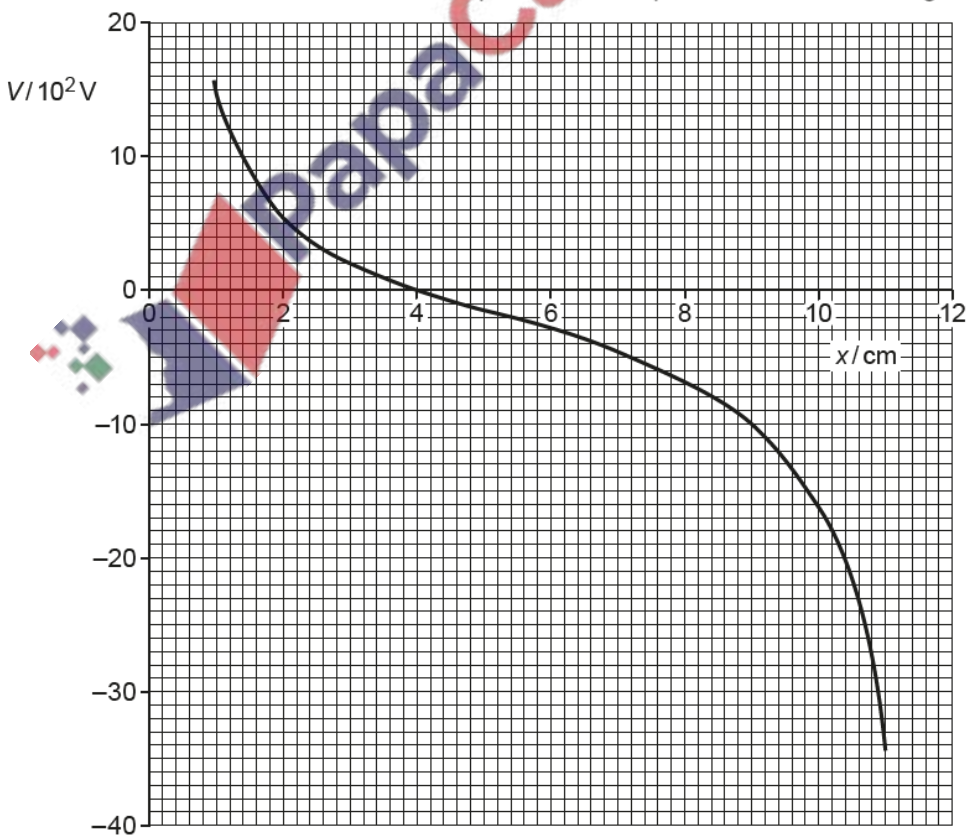

Fig. 5.2

Use Fig. 5.2 to determine:

(i) the charge of B

charge = ... C [3]

(ii) the change in electric potential when point P moves from the position where $x = 9.0\,\text{cm}$ to the position where $x = 3.0\,\text{cm}$.

change = ... V [1]

(c) An α-particle moves along the line joining point charges A and B in Fig. 5.1.

The α-particle moves from the position where $x = 9.0\,\text{cm}$ and just reaches the position where $x = 3.0\,\text{cm}$.

Use your answer in **(b)(ii)** to calculate the speed v of the α-particle at the position where $x = 9.0\,\text{cm}$.

v = ... m s^{-1} [3]

[Total: 9]

2. Nov/2020/Paper_42/No.5

(a) **(i)** State what is meant by a *field of force*.

.....

.....

..... [2]

(ii) State **one** similarity and **one** difference between the electric field due to a point charge and the gravitational field due to a point mass.

similarity: .....

.....

.....

difference: .....

.....

.....

[2]

(b) An isolated solid metal sphere of radius 0.15 m is situated in a vacuum, as illustrated in Fig. 5.1.

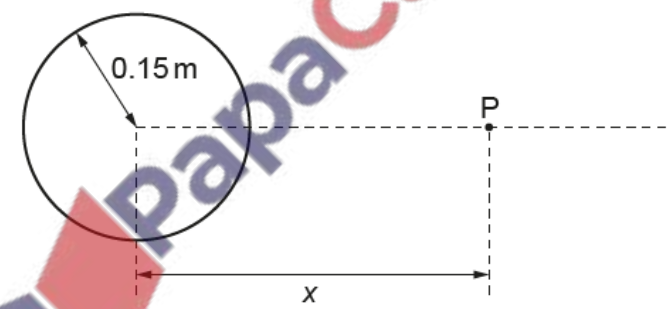

Fig. 5.1

The electric field strength at the surface of the sphere is 84 V m^{-1}.

Determine:

(i) the charge Q on the sphere

Q = ... C [2]

(ii) the electric field strength at point P, a distance $x = 0.45\,\text{m}$ from the centre of the sphere.

electric field strength = ... V m^{-1} [2]

(c) Use information from **(b)** to show, on the axes of Fig. 5.2, the variation of the electric field strength E with distance x from the centre of the sphere for values of x from $x = 0$ to $x = 0.45\,\text{m}$.

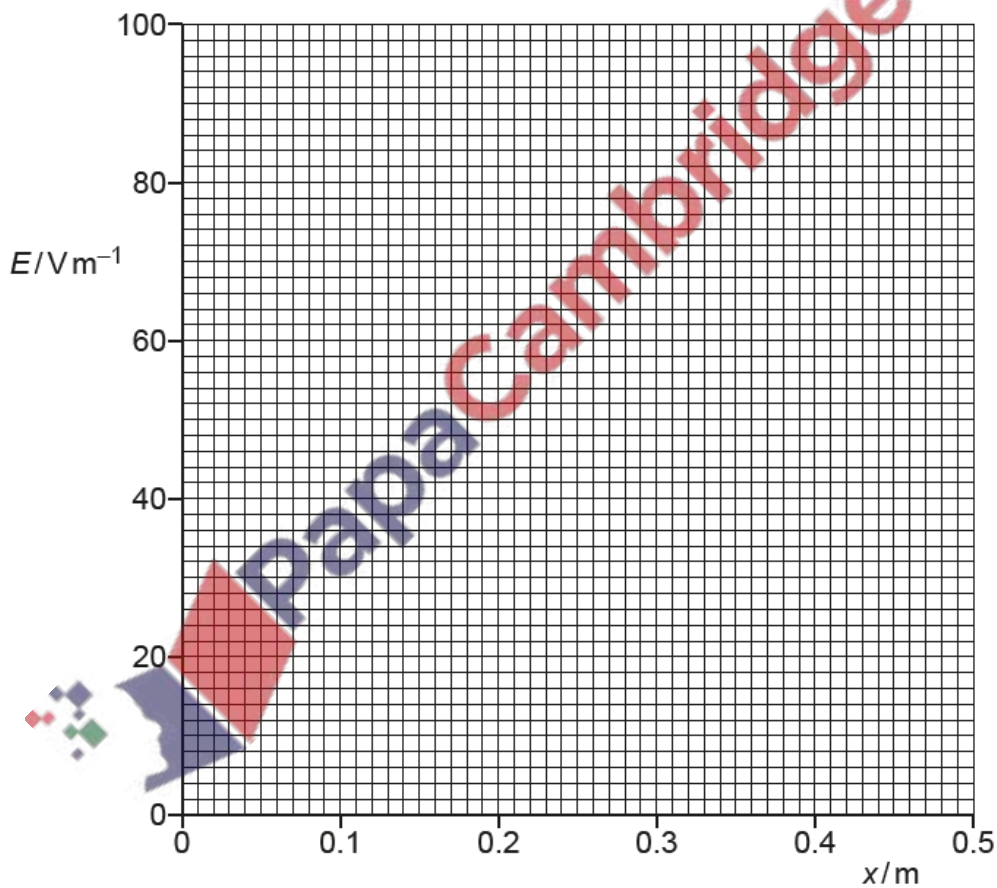

Fig. 5.2

[3]

[Total: 11]

3. June/2020/Paper_41/No.5

(a) State **one** similarity and **one** difference between the fields of force produced by an isolated point charge and by an isolated point mass.

similarity: .....

.....

difference: .....

.....

[2]

(b) An isolated solid metal sphere A of radius R has charge $+Q$, as illustrated in Fig. 5.1.

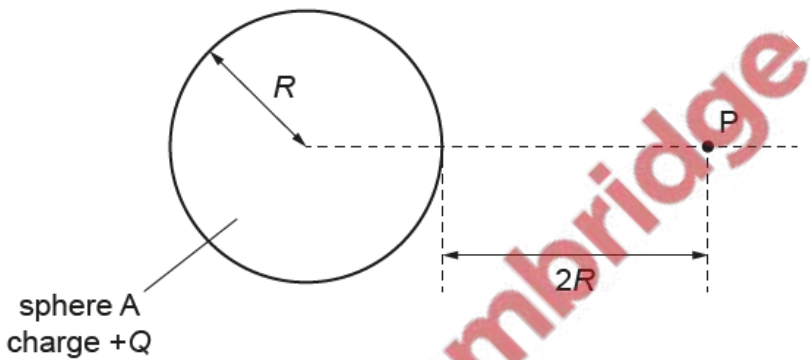

Fig. 5.1

A point P is distance $2R$ from the surface of the sphere.

Determine an expression that includes the terms R and Q for the electric field strength E at point P.

E = ... [2]

(c) A second identical solid metal sphere B is now placed near sphere A. The centres of the spheres are separated by a distance 6*R*, as shown in Fig. 5.2.

Fig. 5.2

Point P lies midway between spheres A and B.

Sphere B has charge –*Q*.

Explain why:

(i) the magnitude of the electric field strength at P is given by the sum of the magnitudes of the field strengths due to each sphere

.....

..... [1]

(ii) the electric field strength at point P due to the charged metal spheres is not, in practice, equal to 2*E*, where *E* is the electric field strength determined in **(b)**.

.....

.....

..... [2]

[Total: 7]

4. June/2020/Paper_42/No.7

A metal sphere of radius R is isolated in space.

Point P is a distance x from the centre of the sphere, as illustrated in Fig. 7.1.

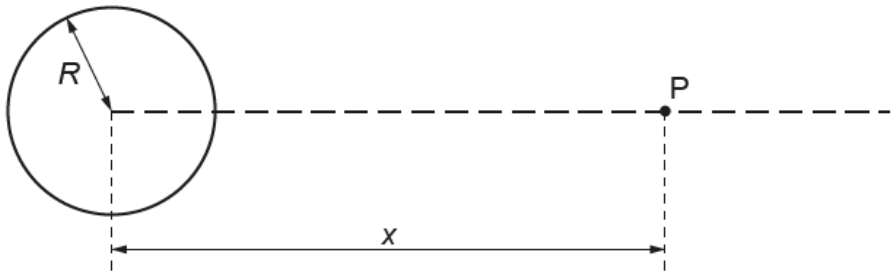

Fig. 7.1

The variation with distance x of the electric field strength E due to the charge on the sphere is shown in Fig. 7.2.

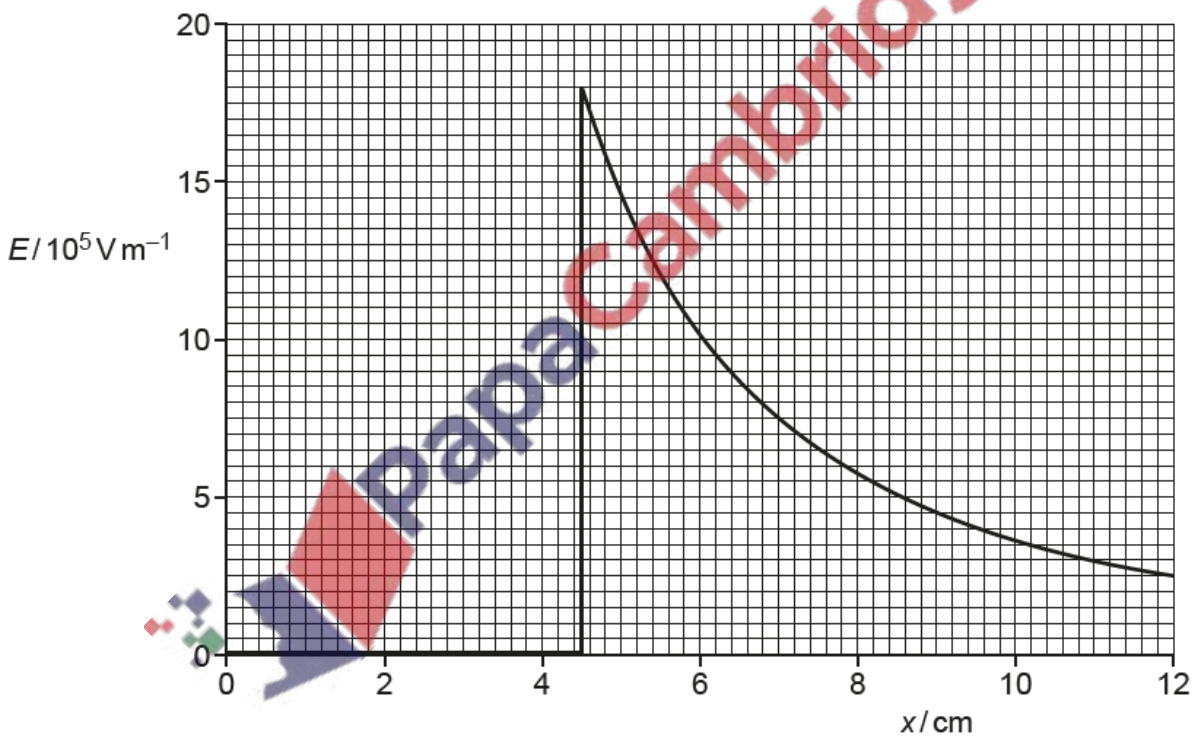

Fig. 7.2

(a) State what is meant by *electric field strength*.

.....

.....

..... [2]

(b) **(i)** Use Fig. 7.2 to determine the radius R of the sphere. Explain your working.

R = ... cm [2]

(ii) Use Fig. 7.2 to determine the charge Q on the sphere.

Q = ... C [3]

(c) An α-particle is situated a distance 8.0 cm from the centre of the sphere.

Calculate the acceleration of the α-particle.

acceleration = ... $m\,s^{-2}$ [3]

[Total: 10]

5. March/2020/Paper_42/No.6

Two positively charged identical metal spheres A and B have their centres separated by a distance of 24 cm, as shown in Fig. 6.1.

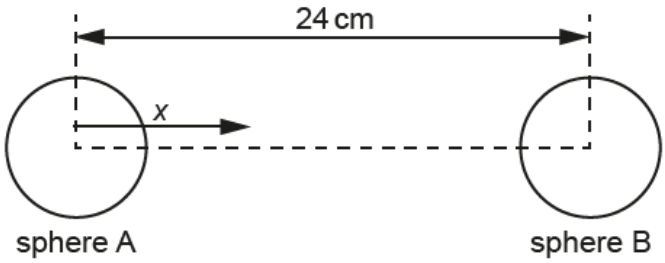

Fig. 6.1 (not to scale)

The variation with distance x from the centre of A of the electric field strength E due to the two spheres, along the line joining their centres, is represented in Fig. 6.2.

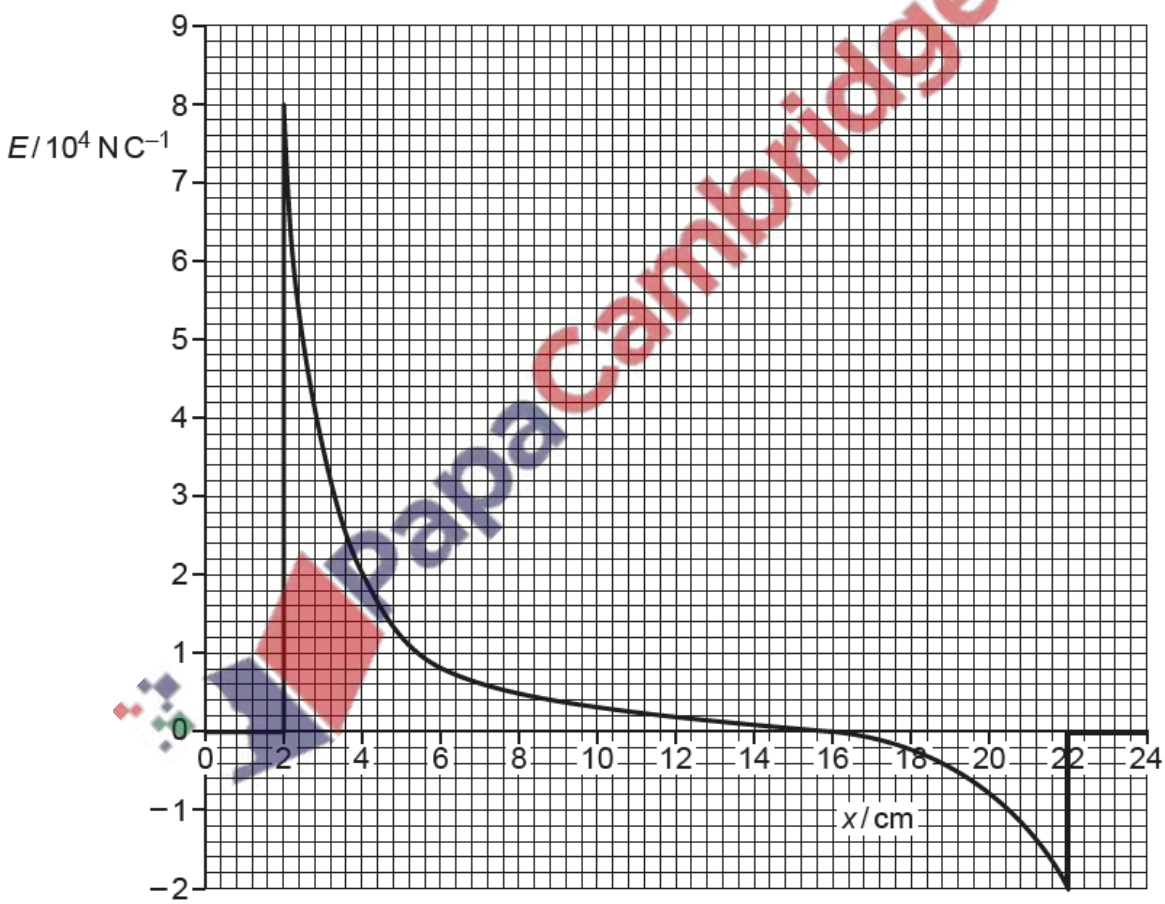

Fig. 6.2

(a) State the radius of the two spheres.

radius = ... cm [1]

(b) The charge on sphere A is 3.6×10^{-9} C. Determine the charge Q_B on sphere B.

Assume that spheres A and B can be treated as point charges at their centres.

Explain your working.

Q_B = ... C [3]

(c) **(i)** Sphere B is removed.

Use information from **(b)** to determine the electric potential on the surface of sphere A.

electric potential = ... V [2]

(ii) Calculate the capacitance of sphere A.

capacitance = ... F [2]

[Total: 8]