

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

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- (b) Two long parallel positively charged plates are placed a distance 5.0 cm apart. A conducting plate of width 1.5 cm is placed a distance 1.0 cm from the left plate as shown in Fig. 3.1.

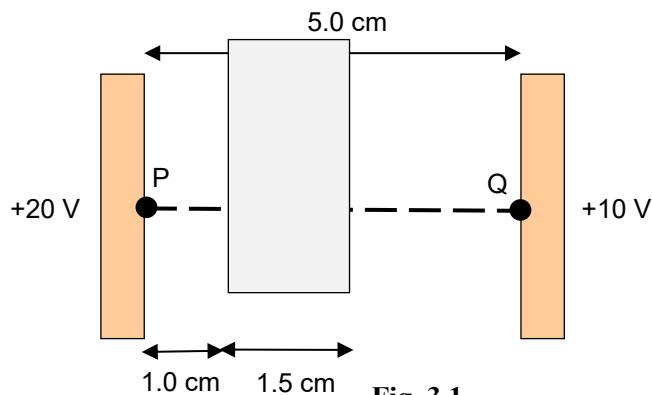


Fig. 3.1

- (i) Sketch a fully labelled graph on the axes provided to show the variation with distance x of the electric potential V from P to Q.



[2]

- (ii) Hence, sketch a fully labelled graph on the axes provided to show the variation with distance x of the electric field strength E from P to Q



[2]

- (c) A charged conducting spherical balloon is attached to a valve and is connected to the Earth through a resistor as shown in Fig. 3.2. The balloon is discharging through the resistor and losing gas through the valve. The valve is continuously adjusted so that the current in the resistor is kept constant.

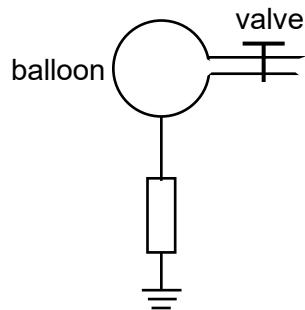


Fig. 3.2

The resistor has a value of 5.0Ω and the balloon has an initial charge of $1.5 \times 10^{-11} \text{ C}$ on its surface and a radius of 2.5 cm.

1.5

- (i) Show that the constant current I through the resistor is 1.08 A.

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- (ii) Explain why the rate of decrease of the balloon's radius is directly proportional to the rate of decrease in the balloon's charge for a constant current to flow through the resistor.

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- (iii) Show that the rate of decrease of the balloon's radius R_{radius} and constant current I is given by the following expression,

$$R_{radius} = 1.7 \times 10^9 I.$$

[1]

- (iv) Determine the time taken for the balloon to lose all its charge.

time taken = s [1]

- (v) The balloon can be considered to be fully deflated when its radius is 0.5 cm.

By calculating the time it takes for the radius of the balloon to reach 0.5 cm, determine if the balloon would lose all its charge first or be fully deflated first.

[2]