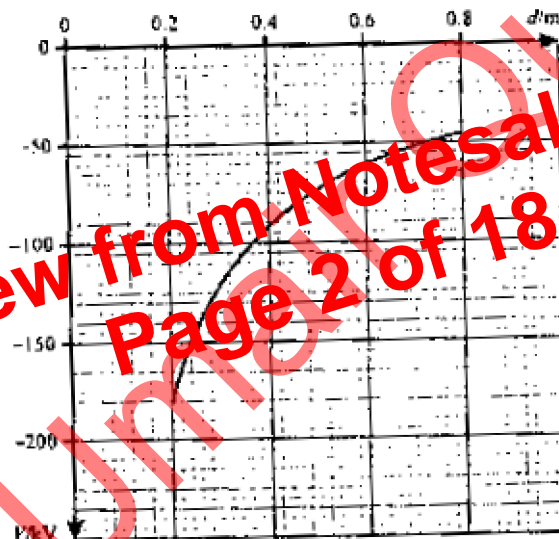


Assume  $\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$

1. Two point charges  $X = +5 \text{ nC}$  and  $Y = -3 \text{ nC}$  are placed  $40.0 \text{ mm}$  apart. Calculate
  - (a) the force between the charges
  - (b) the combined electric field strength and potential at
    - (i) their mid point
    - (ii) the point that is  $100 \text{ mm}$  from  $X$  and  $60 \text{ mm}$  from  $Y$ .
  
2. (a) State what is meant by the potential at a point in an electric field.  
 (b) A Van de Graff generator is a machine which is used to produce very high potential differences. When in use, charge builds up on a hollow spherical conducting dome until the dome achieves the required potential difference between it and the earth. The Electric potential of the earth is assumed to be zero volt.

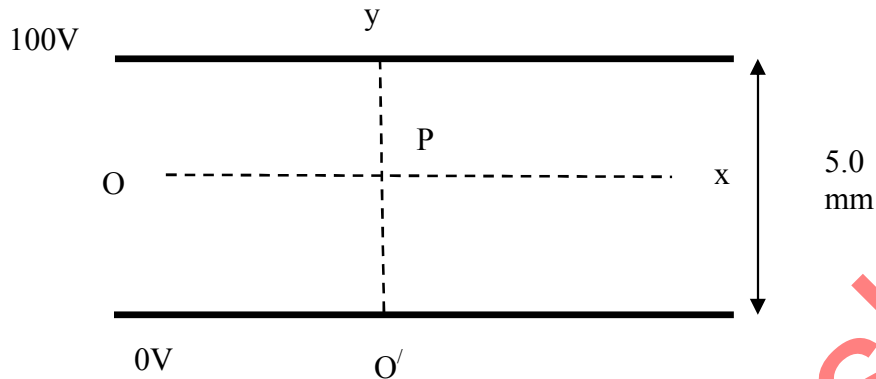


The figure above shows how the potential  $V$  varies with distance  $d$  from the center of the charged spherical dome of a Van de Graff generator, for values of  $d > 0.2 \text{ m}$ . The spherical dome of radius  $0.15 \text{ m}$  is also shown.

- (i) use the figure to determine the potential at a distance of  $0.30 \text{ m}$  from the center of the dome of Van de Graff generator.
- (ii) Determine the potential at the surface of the dome of the Van de Graff generator. Show your reasoning.
- (iii) Draw lines to represent the electric field near the surface of the dome.
- (iv) Determine the electric field strength at a distance of  $0.30 \text{ m}$  from the center of the dome.
- (v) Calculate the force exerted on an electron when it is  $0.30 \text{ m}$  from the center of the dome. Charge on an electron =  $-1.6 \times 10^{-19} \text{ C}$ .

(vi)

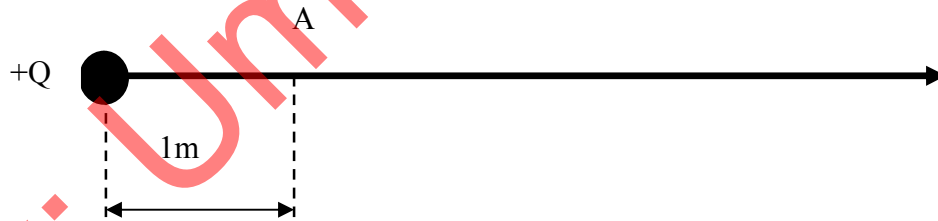
3. The figure below shows a pair of parallel plates separated by a distance of 5.0mm



A potential difference of 100V is applied between the plates.

- (i) The dashed lines Ox and O'y define directions parallel and perpendicular to the plates respectively. Sketch graphs to show the variation of electric field strength (intensity) E at different points along Ox and O'y respectively.
- (ii) Point P is midway between the plates.
  1. Calculate the magnitude of the electric field strength (intensity) at P.
  2. Calculate the magnitude of the force on a point charge of  $+1\mu\text{C}$  placed at P. State the direction of this force.

(v) The diagram shows a isolated point charge  $+Q$ . The point A is unit distance (1m) from the charge.



- (i) On a copy of the axis below sketch a graph to show how the electric field strength (intensity) E varies with distance x from the charge  $+Q$ . Start the graph at a point marked B, corresponding to the point A at  $x=1\text{m}$ , and continue it in the direction of increasing x. Label this graph E.
- (ii) Also on your axis sketch a graph to show how the electric potential V varies with x. Again start the graph at point B. label this graph V.

Fig. 5.2. shows the variation with distance  $x$  from the centre of the sphere of the potential  $V$  due to the charge  $+Q$ .

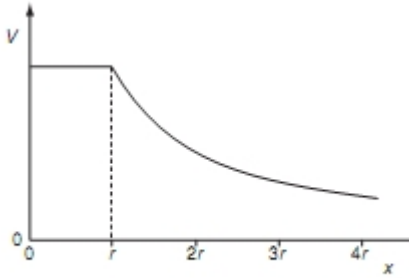


Fig. 5.2

- (a) State the relation between electric field and potential.
- (b) Using the relation in (a), on Fig. 5.3 sketch a graph to show the variation with distance  $x$  of the electric field  $E$  due to the charge  $+Q$ .

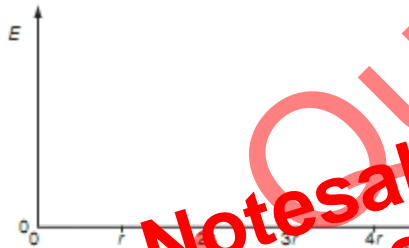


Fig. 5.3

23. An isolated conducting sphere of radius  $r$  is placed in air. It is given a charge  $+Q$ . This charge may be assumed to act as a point charge situated at the centre of the sphere. (june 2005)

- (a) (i) Define electric field strength.  
 (ii) State a formula for the electric field strength  $E$  at the surface of the sphere. Also, state the meaning of any other symbols used. (b) The maximum field strength at the surface of the sphere before electrical breakdown (sparking) occurs is  $2.0 \times 10^6 \text{ Vm}^{-1}$ .

Calculate the maximum values of

- . The sphere has a radius  $r$  of  $0.35\text{m}$ .  
 (i) the charge that can be stored on the sphere,  
 (ii) the potential at the surface of the sphere.  
 (c) Suggest the effect of the electric field on a single atom near the sphere's surface as electrical breakdown of the air occurs.

(june 2006)