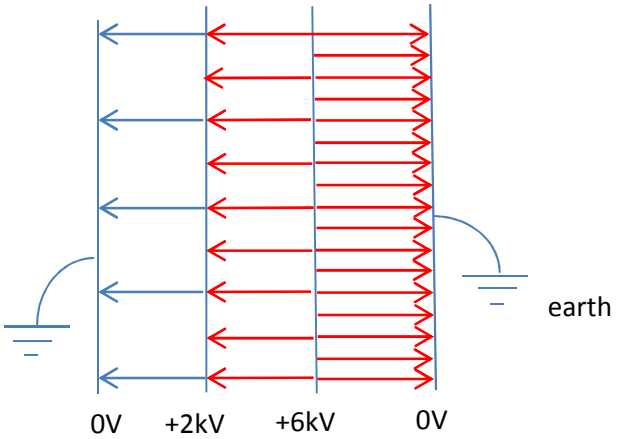
ELECTRIC FIELD TUTORIAL

Question 1

Figure shows an arrangement of parallel plates, each at a different voltage. The electric field lines are shown between the 1st pair. Copy and complete the diagram.



Question 2

Air is usually a good insulator. However, a spark can jump through dry air when the electric field strength is greater than about 40 000 Vcm^{-1}. This is called electrical breakdown. The spark shows that electrical charge is passing through the air- a current is flowing.

a. A Van de Graaff generator is found to be able to make sparks jump across a 4 cm gap. What is the voltage produced by the generator? **$V = Ed = (4x10^6) \times 0.04 = 160\ 000V$**

b. The highest voltage reached by the live wire of a conventional mains supply is 325 V. In theory how close would you have to get to a live wire to get a shock from it? **$d = V/E = (325) \times 4x10^6 = 0.08$ mm**

c. Estimate the voltage of a thunder-cloud from which lightning strikes the ground 100m below. **$V = Ed = 4x10^6 \times 100 = 400$ MV**

Question 3

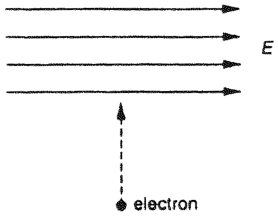
A particle of charge +2 µC is placed between 2 parallel plates, 10 cm apart, and with a potential difference of 5 kV between them. Calculate the field strength between the plates, and the force exerted on the charge. **$E = V/d = 50\ 000\ Vm^{-1}$; $F = qE = 0.1$ N**

Question 4

Calculate the acceleration of an electron in a television tube where the electric field strength is 50 000 V cm^{-1}. **$a = qE/m = 8.78 \times 10^{17}\ ms^{-2}$**

Question 5

An electron is projected at right angles to a uniform electric field E.

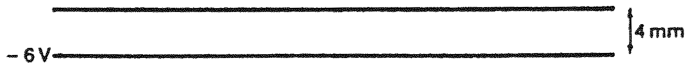


In the absence of other fields, in which direction is the electron deflected?

A.) To the right B.) To the left C.) Into the plane of paper D.) Out of the plane of paper

Question 6

2 large horizontal metal plates are separated by 4mm. The lower plate is at a potential of -6 V.



What potential should be applied to the upper plate to create an electric field of strength 5000 V/m upwards in the space between the plates?

A.) +20V B.) -20V C.) +26V D.) -26 V

Question 7

A constant potential difference is maintained between two parallel metal plates in an evacuated tube; their separation *d* can be varied. An electron in the space between the plates experiences a force *F*.

Which of the following shows how *F* depends on *d*?

A. $F \propto 1 / d^2$ **B. $F \propto 1 / d$** **C. $F \propto d$** **D. $F \propto d^2$**

Question 8

The electric potentials V are measured at distances x from P along the line PQ. The results are:

V/V	13	15	18	21	23
x/m	0.020	0.030	0.040	0.050	0.060

The component along PQ of the electric field for x = 0.040 m is approximately

A. 300 Vm^{-1} towards Q

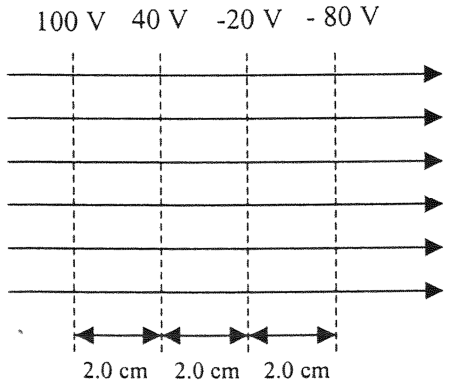
B. 300 Vm^{-1} towards P

C. 450 Vm^{-1} towards Q

D. 450 Vm^{-1} towards P

Question 9

The diagram shows a uniform electric field in which the lines of equal potential are spaced 2.0 cm apart.



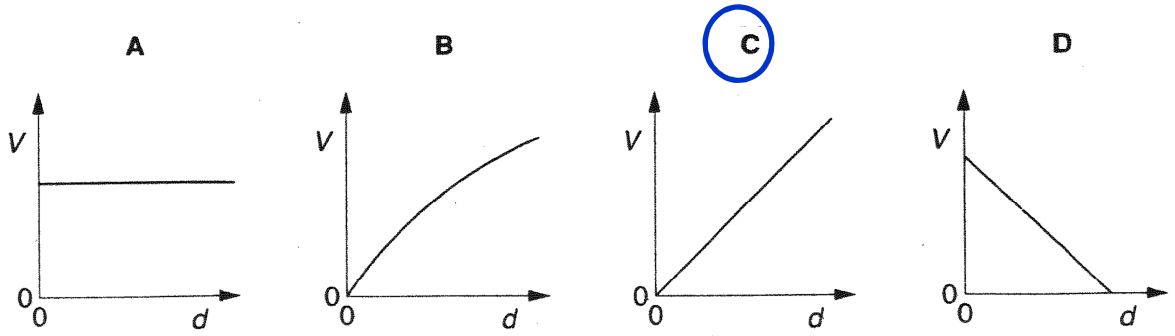
What is the value of the electric force which is exerted on a charge $+6.0 \times 10^{-6}$ C when place in the field?

A.) 1.8×10^{-2} N B.) 2.8×10^{-2} N C.) 3.8×10^{-2} N D.) 4.8×10^{-2} N

Question 10

A constant electric field is to be maintained between two large parallel plates for which the separation *d* can be varied.

Which graph shows how the potential difference *V* between the plates must be adjusted to keep the field strength at a constant value?



Question 11

The potential difference between a pair of similar, parallel, conducting plates is known. What additional information is needed in order to find the electric field strength between the plates?

A. separation of the plates and density of the medium.

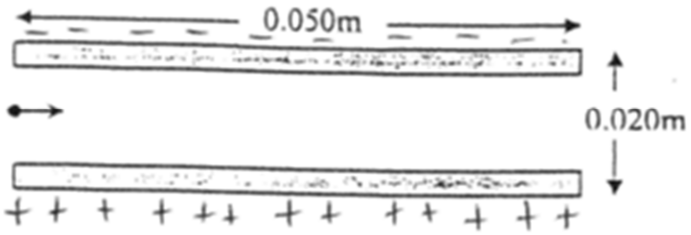
B. separation and area of the plates.

C. density of the medium.

D. separation of the plates.

Question 12

A uniform electric field of strength 500 NC^{-1} is set up between two parallel horizontal plates of length 0.050 m and separation 0.020 m in a vacuum. An electron travelling with a velocity of 4.0 x 10^6 ms^{-1} parallel to the plates enters the field at a point midway between the plates, as shown in the diagram below.



Calculate

i.) The magnitude and direction of force on the electron due to the electric field only.

$F = qE = (1.6 \times 10^{-19}) \times (500)$

$F = 8.0 \times 10^{-17}$ N (perpendicularly towards the positive plate)

ii.) The time taken for the electron to emerge from the plates at the other end.

t = distance / speed = $(5.0 \times 10^{-2}) / (4.0 \times 10^{6})$

$t = 1.25 \times 10^{-8}$ s

iii.) The distance of the electron from the positive plate as it emerges.

$s = ut + \frac{1}{2} at^2 = \frac{1}{2} at^2$; initial vertical velocity is zero

$s = \frac{1}{2} (F/m)t^2$; F = ma -> a = F/m

$s = \frac{1}{2} (8.0 \times 10^{-17} / 9.11 \times 10^{-31})(1.25 \times 10^{-8})^2$

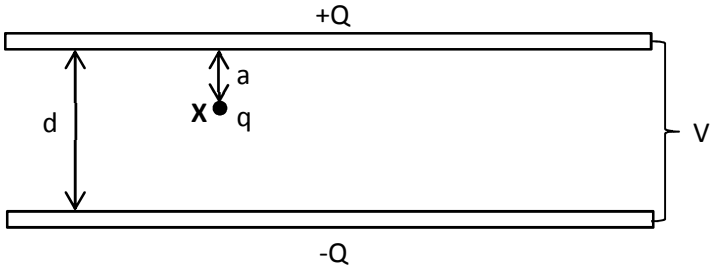
$s = 0.0069$ m or 6.9×10^{-3}m

Thus, distance from positive plate = 0.01 – 0.0069

= 0.0031 m or 3.1×10^{-3}m

Question 13

A point charge q is situated at **X** between two parallel plates which have a potential difference V and carry charges +Q and –Q.

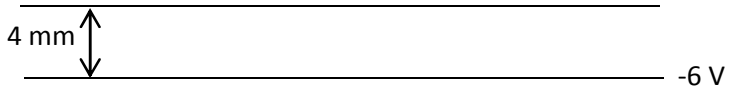


What is the electric field strength at **X**?

A. V/d B. Vq/d C. V/a D. V/d – V/a

Question 14

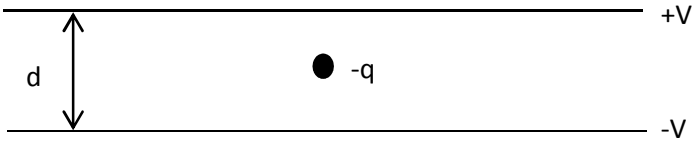
Two horizontal metal plates are separated by 4mm. The lower plate is at a potential of -6 V. What potential should be applied to the upper plate to create an electric field of strength 4000 Vm^{-1} upwards in the space between the plates?



A. + 22 V B. + 10 V C. – 10 V D. – 22 V

Question 15

An oil droplet has a charge –q and is situated between two parallel horizontal metal plates as shown below.

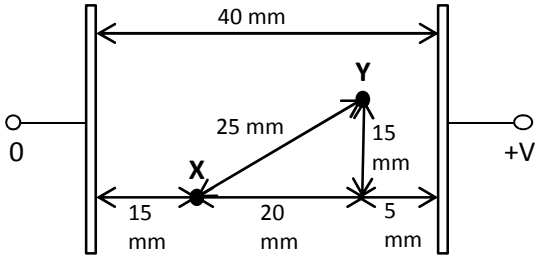


The separation of the plates is d. The droplet is observed to be stationary when the upper plate is at potential +V and the lower at potential –V.
For this to occur, the weight of the droplet is equal in magnitude to

A. Vq/d B. 2Vq/d C. Vd/q D. – 2Vd/q

Question 16

Two large plane parallel conducting plates are situated 40 mm apart as shown. The potential difference between the plates is V.



What is the potential difference between point **X** and point **Y** ?

A. 15/40 V B. 20/40 V C. 25/40 V D. 40/40 V