

Student: \_\_\_\_\_

Max. Marks : 18 Marks

Time : 18 Minutes

Q1.

The force between two identical point charges, X and Y, is  $F$ .

Charge X is doubled; charge Y remains the same.

Which row of the table gives the force on each charge?

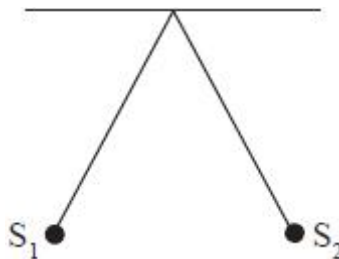
	X	Y
<input type="checkbox"/> A	$F$	$F$
<input type="checkbox"/> B	$F$	$2F$
<input type="checkbox"/> C	$2F$	$F$
<input type="checkbox"/> D	$2F$	$2F$

(Total for question = 1 mark)

Q2.

Answer the question with a cross in the box you think is correct  . If you change your mind about an answer, put a line through the box  and then mark your new answer with a cross  .

This question refers to two small positively charged spheres  $S_1$  and  $S_2$  suspended by threads, as shown.



The electrostatic force between the two charges is initially  $F$ .

The charge on  $S_1$  is doubled whilst the charge on  $S_2$  is unchanged. The distance between  $S_1$  and  $S_2$  doubles.

Which of the following is the new force on  $S_2$ ?

A  $\frac{F}{4}$

B  $\frac{F}{2}$

C  $F$

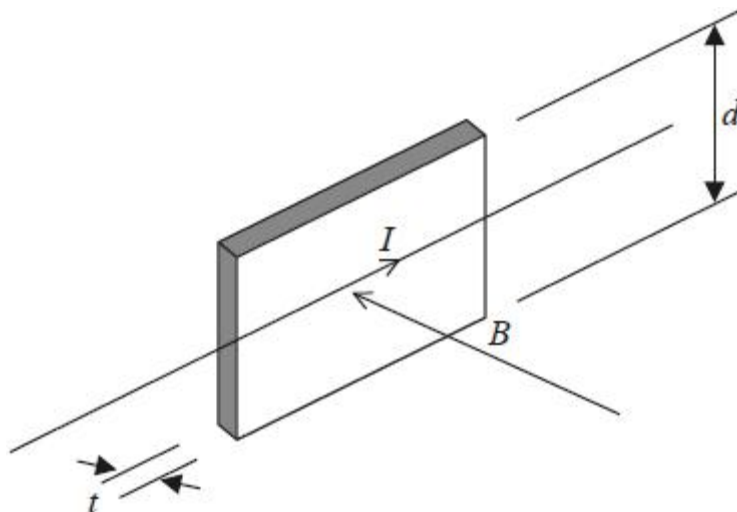
D  $2F$

(Total for question = 1 mark)

**Q3.**

Tiny sensors in smartphones could be used to determine the position of the phone on the Earth's surface by measuring the Earth's magnetic flux density.

A current  $I$  and a magnetic field of flux density  $B$  are applied to a slice of semiconductor as shown. The slice has thickness  $t$  and depth  $d$ .



Electrons collect at the top edge of the slice and the bottom edge becomes positively charged. As a result a potential difference known as a Hall voltage  $V_{\text{HALL}}$  develops.

Electrons continue to collect at the top edge of the slice, until the force on a moving electron due to the magnetic field is equal to the force on the electron due to the electric field.

Derive the following equation for  $V_{\text{HALL}}$ :

$$V_{\text{HALL}} = \frac{BI}{nte}$$

where  $n$  is the number of charge carriers per unit volume of the semiconductor.

(4)

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**(Total for question = 4 marks)**

**Q4.**

A simple model of the hydrogen atom consists of an electron moving in a circular path around a proton.

(i) In this simple model it is the electrostatic force, rather than the gravitational force, that is responsible for keeping the electron in a circular path.

By means of calculations justify this statement.

radius  $r$  of the hydrogen atom =  $5.3 \times 10^{-11}$  m

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(ii) Ignoring the gravitational force, calculate the velocity of the electron in this simple model of the hydrogen atom.

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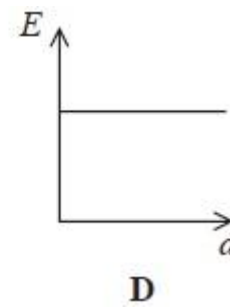
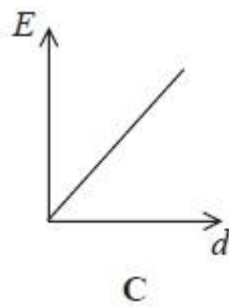
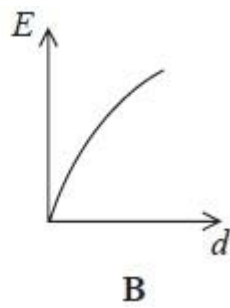
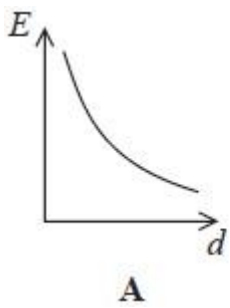
Velocity = .....

**(Total for question = 7 marks)**

**Q5.**

Two parallel, conducting plates are connected to a battery. One plate is connected to the positive terminal and the other plate to the negative terminal. The plate separation  $d$  is gradually increased while the plates stay connected to the battery.

Select the graph that shows how the electric field strength  $E$  between the plates varies with separation  $d$ .



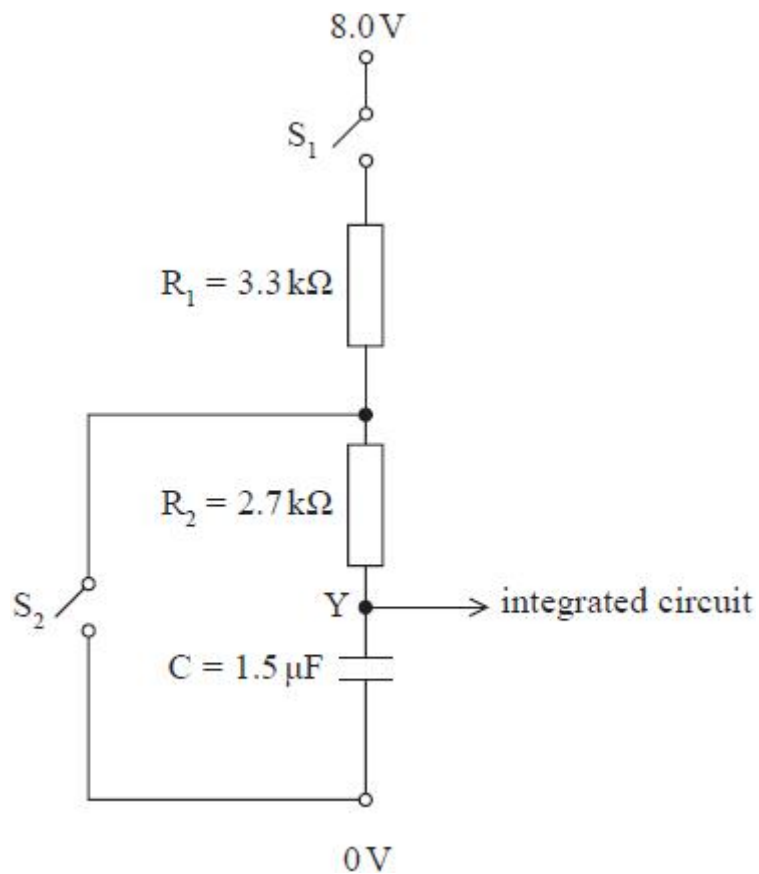
- A
- B
- C
- D

(Total for Question = 1 mark)

**Q6.**

The properties of capacitors make them useful in timing circuits.

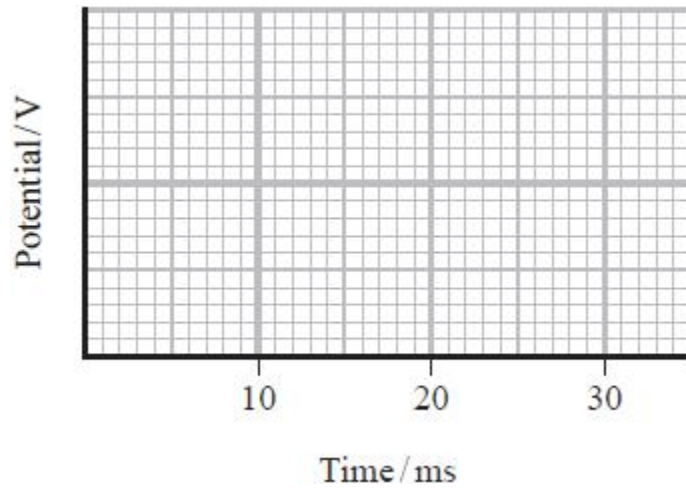
The following circuit is used to provide an input Y to an integrated circuit.



Initially the capacitor is uncharged. The switch  $S_1$  is closed.

Sketch a graph to show how the potential at point Y varies with time.

(3)



**(Total for question = 3 marks)**

**Q7.**

Some flowers are negatively charged and surrounded by an electric field. This helps to attract bees.

A bee has short hairs which are thought to carry charge.

State how the bee might use this to detect the electric field of a flower.

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**(Total for question = 1 mark)**