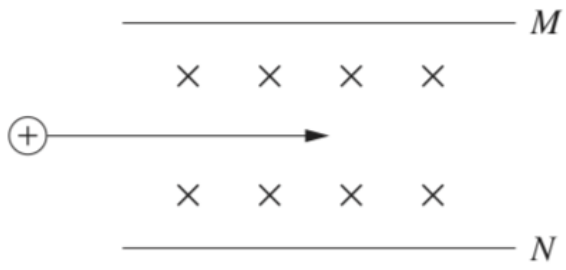
New Syllabus NESA Questions:

1)

A positively-charged ion travelling at 250 m s^{-1} is fired between two parallel charged plates, *M* and *N*. There is also a magnetic field present in the region between the two plates. The direction of the magnetic field is into the page as shown. The ion is travelling perpendicular to both the electric and the magnetic fields.



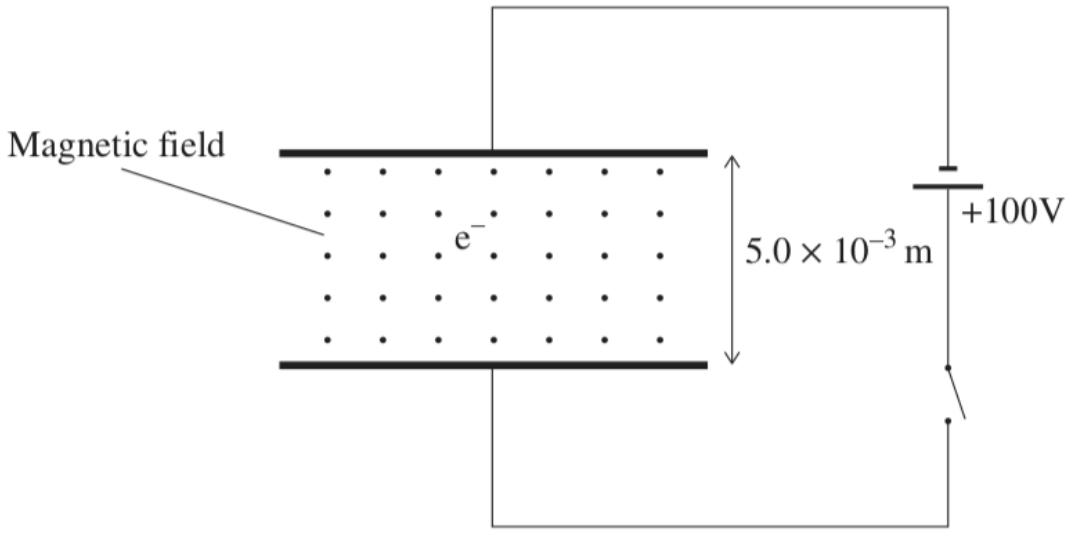
The electric field between the plates has a magnitude of 200 V m^{-1}. The magnetic field is adjusted so that the ion passes through undeflected.

What is the magnitude of the adjusted magnetic field, and the polarity of the *M* terminal relative to the *N* terminal?

	Magnitude of magnetic field (teslas)	*Polarity of M relative to N*
A.	0.8	positive
B.	0.8	negative
C.	1.25	positive
D.	1.25	negative

2)

The diagram shows a stationary electron in a magnetic field. The magnetic field is surrounded by two parallel plates separated by a distance of 5.0×10^{-3} m and connected to a power supply and a switch. **5**



The switch is initially open. At a later time the switch is closed.

Analyse the effects of the magnetic and electric fields on the acceleration of the electron both before and immediately after the switch is closed. In your answer, include calculation of the acceleration of the electron immediately after the switch is closed.

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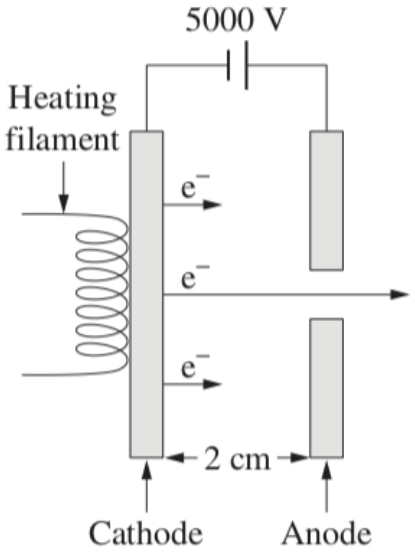
3)

An ‘electron gun’ like that used by JJ Thomson is shown.



Electrons leave the cathode and are accelerated towards the anode.

(a) Show that the acceleration of the electrons as they just leave the cathode is $4 \times 10^{16}\ \text{m s}^{-2}$. **2**

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(b) Calculate the velocity of an electron as it reaches the anode. **2**

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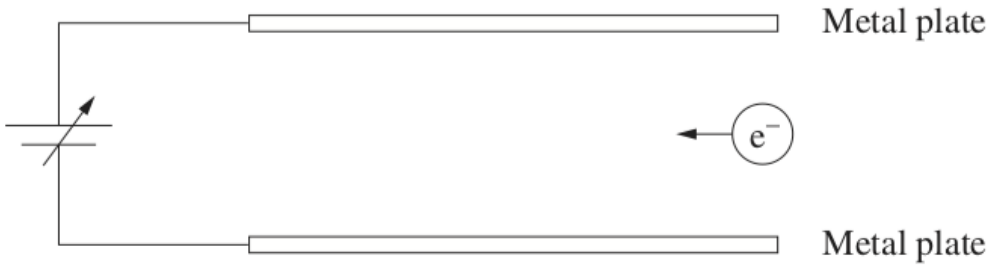
4)

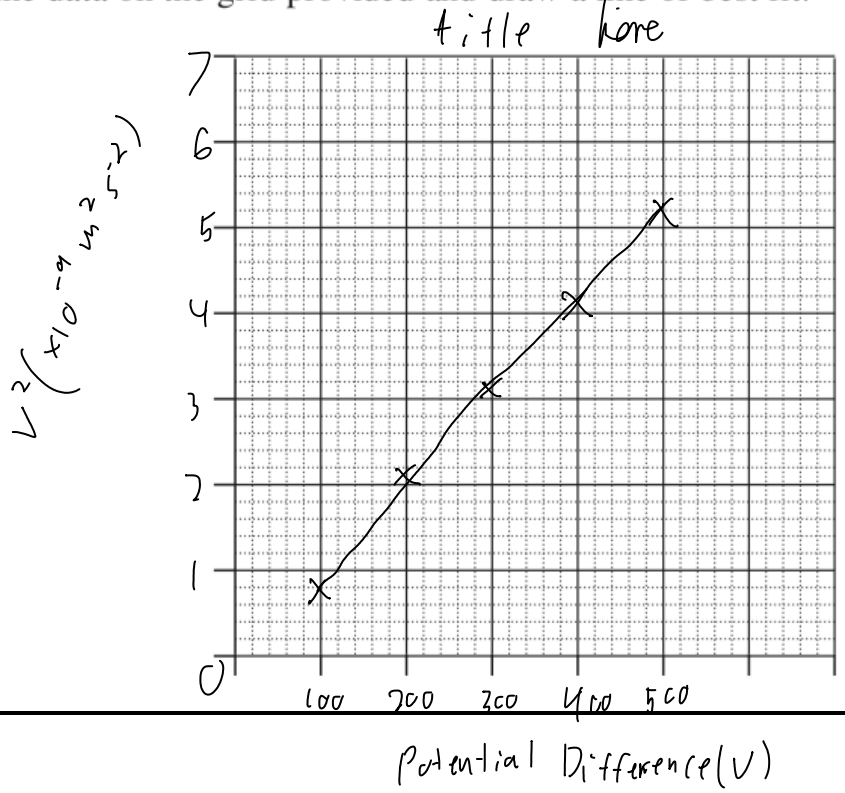
Negatively charged particles were accelerated from rest between a pair of parallel metal plates. The potential difference between the plates was varied, and the final velocity of the particles was measured for each variation.



The data in the table show the potential difference between the plates and the square of the corresponding final velocity of the particles.

Potential difference (V)	v^2 ($\times 10^9$ m^2 s^{-2})
100	0.8
200	2.1
300	3.1
400	4.1
500	5.2

(a) Plot the data on the grid provided and draw a line of best fit. **3**



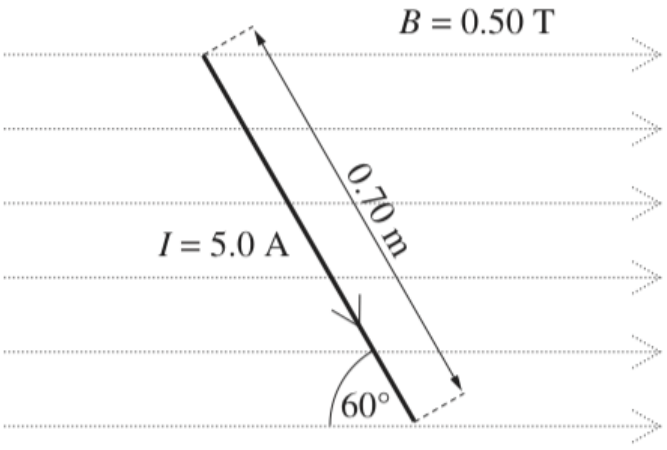
(b) A student hypothesised that the charged particles are electrons. Justify whether the student's hypothesis is correct or not. Support your answer using the data provided and relevant calculations. **3**

A

$\gamma_{avg} = \text{gradient}_{avg} = \frac{5.2 - 0.6}{500 - 100} = 0.011 = \frac{v^2}{V}$

5)

A current of 5.0 A flows in a wire that is placed in a magnetic field of 0.50 T. The wire is 0.70 m long and is at an angle of 60° to the field. **2**



Calculate the force on the wire.

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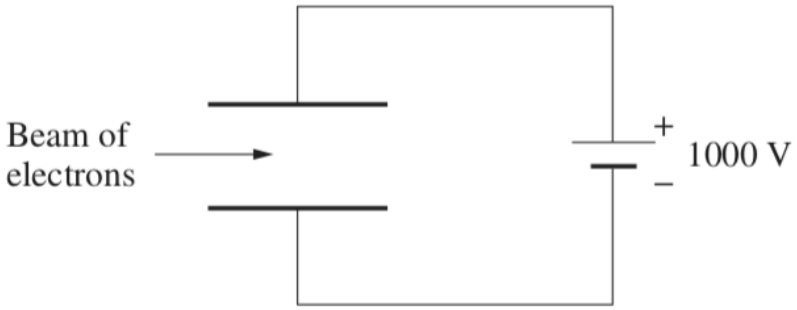
Past HSC Questions:

2018:

12 The diagram shows electrons travelling in a vacuum at 2×10^{6} m s^{-1} between two charged metal plates 1×10^{-3} m apart.



A magnetic field is to be applied to make the electrons continue to travel in a straight line.

What is the magnitude and direction of the magnetic field that is to be applied?

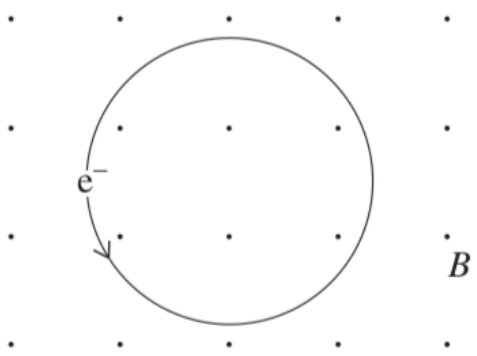
A. 5×10^{-1} T into the page

B. 5×10^{-1} T out of the page

C. 1×10^{6} T into the page

D. 1×10^{6} T out of the page

13 An electron moves in a circular path with radius r in a magnetic field as shown.



If the speed of the electron is increased, which row of the table correctly shows the effects of this change?

	Force on electron	*Radius of path*
A.	Increases	Decreases
B.	Increases	Increases
C.	Decreases	Decreases
D.	Decreases	Increases

Question 26 (4 marks)

Outline the similarities and differences between the effects of electric fields and gravitational fields on matter. In your answer, refer to the definitions of these fields. **4**

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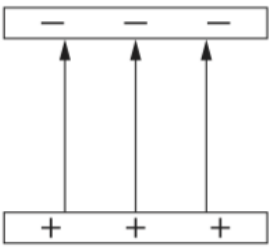
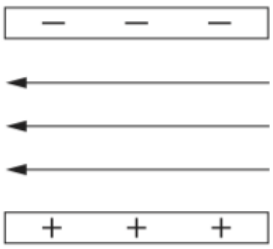
2017:

3 Which of the following correctly shows the electric field between two parallel, charged plates?

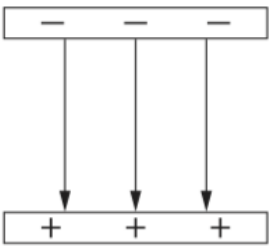
A.



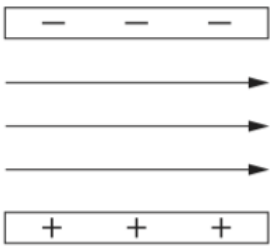
B.



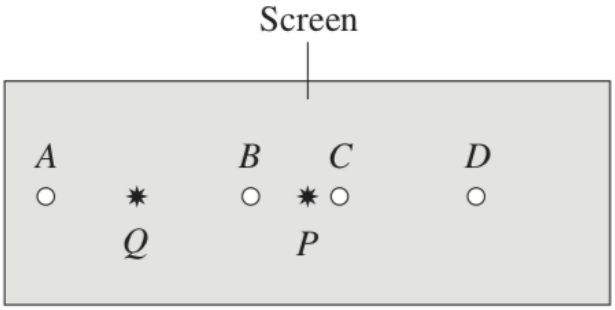
C.



D.



8 An electron is fired in a vacuum towards a screen. With no electric field being applied, the electron hits the screen at *P*. A uniform electric field is turned on and another electron is fired towards the screen from the same location, at the same velocity, striking the screen at point *Q*.



With the electric field still turned on, a proton is fired towards the screen from the same starting point as the electrons and with the same velocity.

At what point does the proton strike the screen?

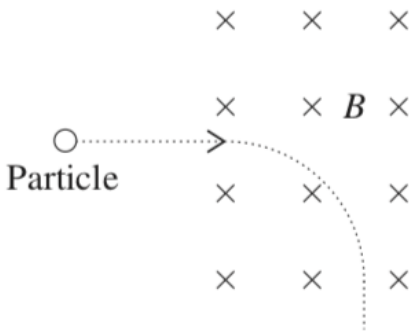
A. *A*

B. *B*

C. *C*

D. *D*

18 A particle of mass m and charge q travelling at velocity v enters a magnetic field of magnitude B and follows the path shown.



A second particle enters a magnetic field of magnitude $2B$ with a velocity of $\frac{1}{2}v$ and follows an identical path.

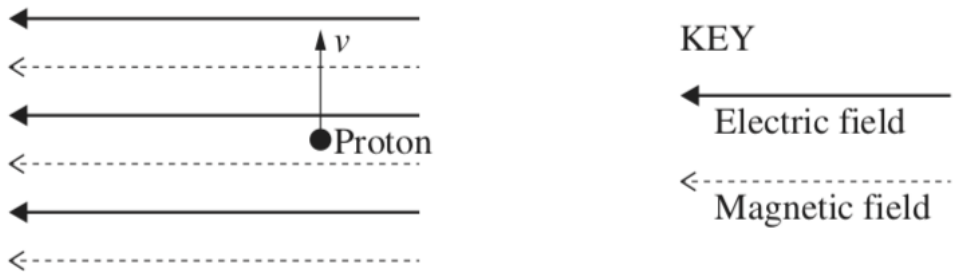
What is the mass and charge of the second particle?

	Mass	*Charge*
A.	m	q
B.	$\frac{1}{2}m$	$2q$
C.	$4m$	q
D.	m	$\frac{1}{2}q$

Question 30 (4 marks)

In a thought experiment, a proton is travelling at a constant velocity in a vacuum with no field present. An electric field and a magnetic field are then turned on at the same time. **4**

The fields are uniform in magnitude and direction and can be considered to extend infinitely. The velocity of the proton at the instant the fields were turned on is perpendicular to the fields.



Analyse the motion of the proton after the fields have been turned on.

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2016:

3 A region of space contains a constant magnetic field and a constant electric field.

How will these fields affect an electron that is stationary in this region?

(A) Both fields will exert a force.

(B) Neither field will exert a force.

(C) Only the electric field will exert a force.

(D) Only the magnetic field will exert a force.

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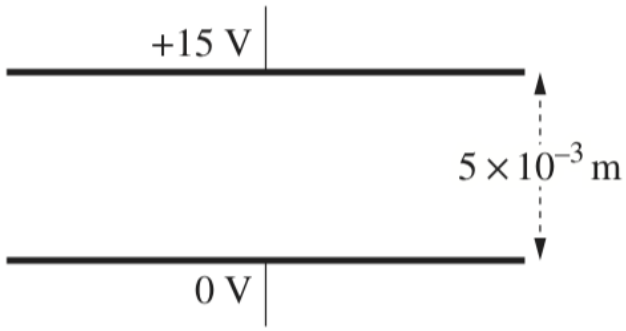
5 The diagram shows two parallel charged plates 5×10^{-3} m apart.



What is the magnitude of the electric field between the plates in V m^{-1}?

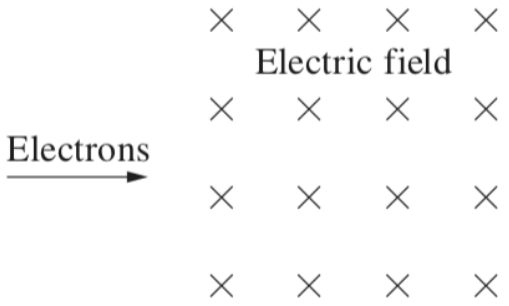
(A) 3.3×10^{-4}

(B) 0.33

(C) 3

(D) 3000

(b) The diagram shows electrons travelling in a vacuum at 5.2×10^4 m s^{-1} entering an electric field of 10 V m^{-1}. **3**



A magnetic field is applied so that the electrons continue undeflected.

What is the magnitude and direction of the magnetic field?

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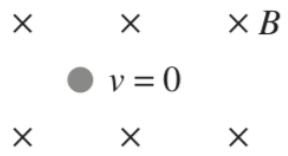
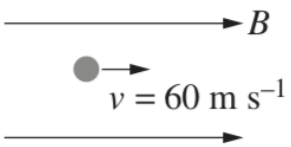
2015:

8 In which of the following situations does the magnetic field exert the greatest force on the proton (●), given that all of the fields are of equal magnitude?

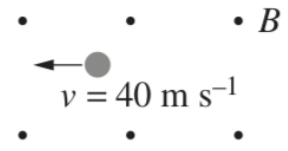
(A)



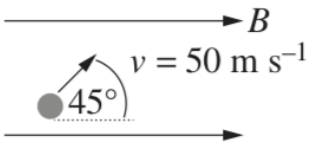
(B)



(C)

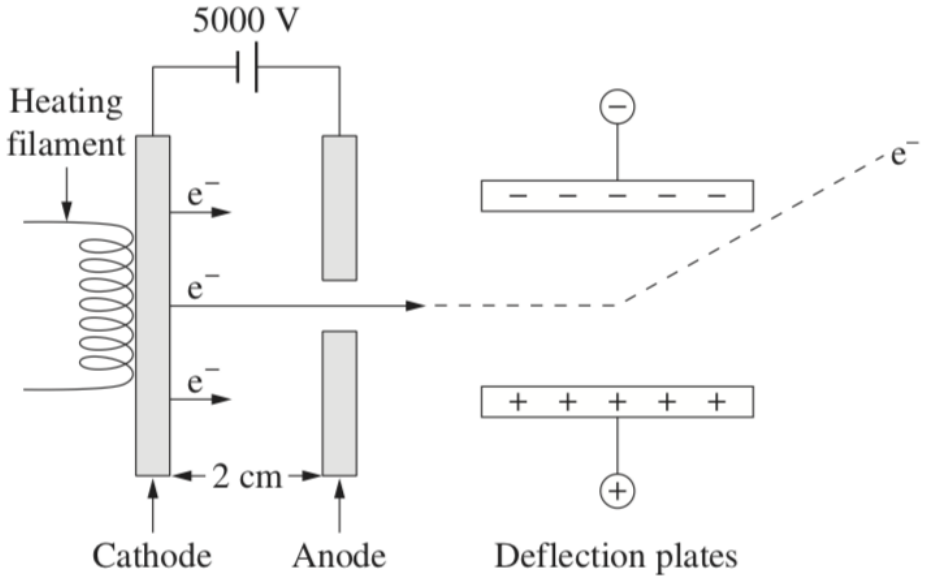


(D)



Question 24 (7 marks)

A part of a cathode ray oscilloscope was represented on a website as shown.



Electrons leave the cathode and are accelerated towards the anode.

(a) Explain why the representation of the path of the electron between the deflection plates is inaccurate. **3**

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(b) Calculate the force on an electron due to the electric field between the cathode and the anode. **2**

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(c) Calculate the velocity of an electron as it reaches the anode. **2**

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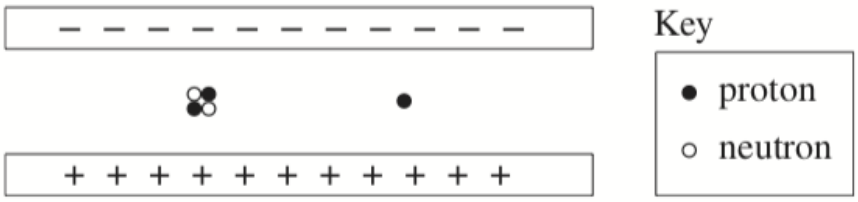
2014:

17 The diagram shows an alpha particle (⁘) and a proton (•), placed at equal distances from two large charged metal plates.



Which of the following best describes the motion of the particles?

(A) Both particles move with the same acceleration.

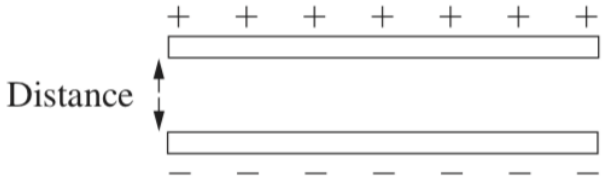
(B) The alpha particle moves with half the acceleration of the proton.

(C) The alpha particle moves with twice the acceleration of the proton.

(D) The alpha particle moves with a quarter of the acceleration of the proton.

2013:

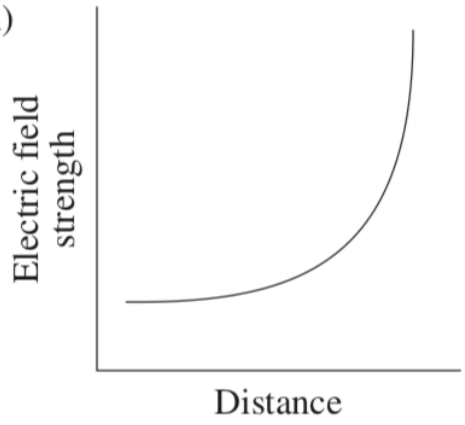
14 Two charged plates are initially separated by a distance as shown in the diagram.



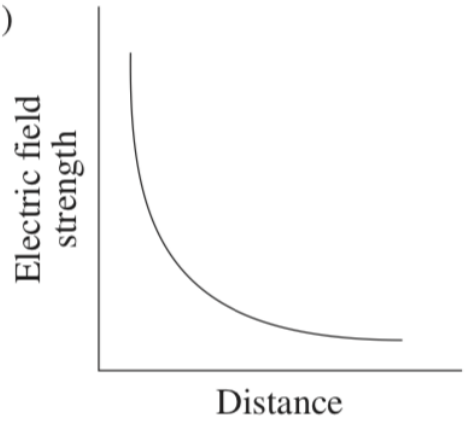
The potential difference between the plates remains constant.

Which of the graphs best represents the change in electric field strength as the distance between the two plates is increased?

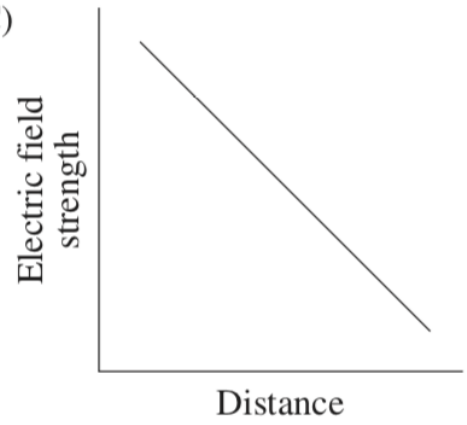
(A)



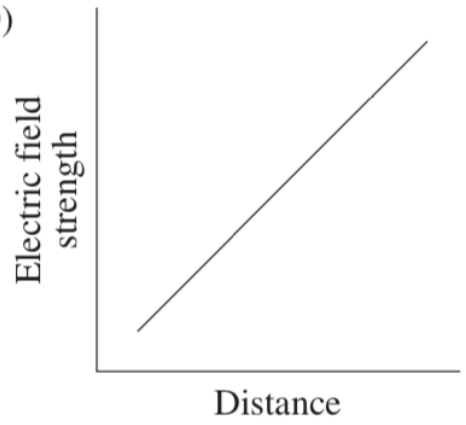
(B)



(C)

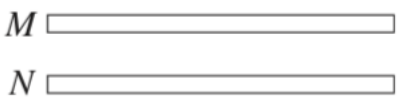


(D)



Question 26 (5 marks)

An electric field is produced between two charged parallel plates, *M* and *N*.



(a) The plates, *M* and *N*, are 1.0 cm apart and have an electric field of 15 V m^{-1}. **2**

Calculate the potential difference between the plates.

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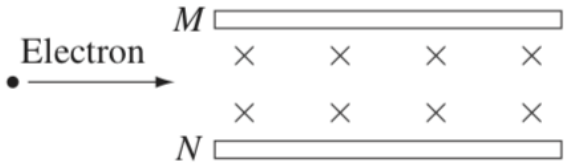
(b) The potential difference is now changed and a magnetic field of 0.5 T is placed perpendicular to the plates, as shown in the diagram below. **3**



Determine the magnitude and direction of the electric field required to allow the electron to travel through undeflected, if the electron is moving at 1×10^4 m s^{-1}.

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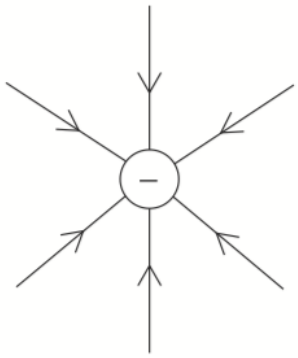
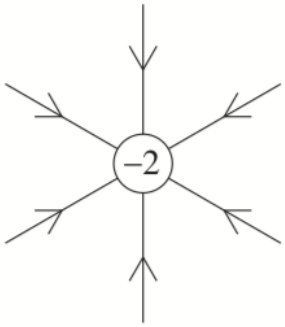
2012:

6 The diagram represents the electric field around a negative charge.

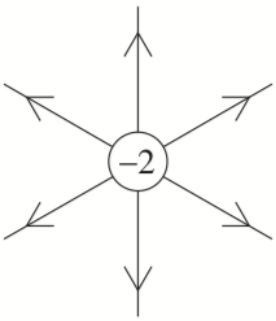


If the magnitude of the charge were doubled, which diagram would best represent the new electric field?

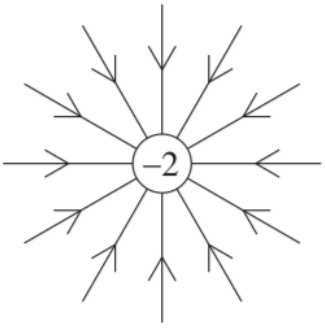
(A)



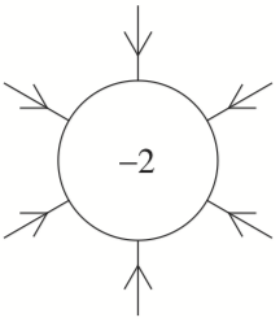
(B)



(C)

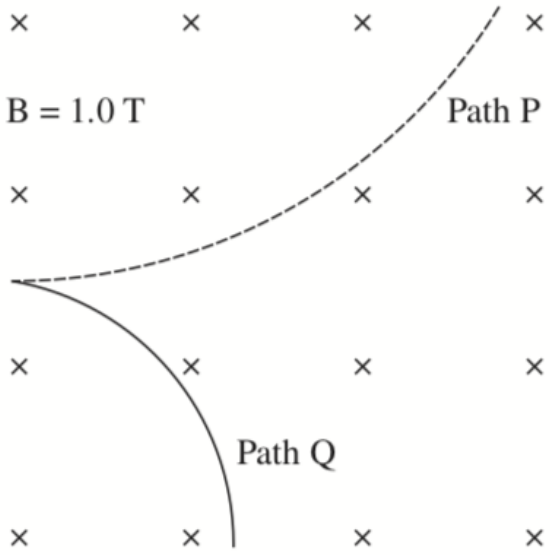


(D)



Question 30 (5 marks)

The diagram shows the paths taken by two moving charged particles when they enter a region of uniform magnetic field.



(a) Why do the paths curve in different directions? **1**

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(b) Why are the paths circular? **2**

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(c) How do the properties of a particle affect the radius of curvature of its path in a uniform magnetic field? **2**

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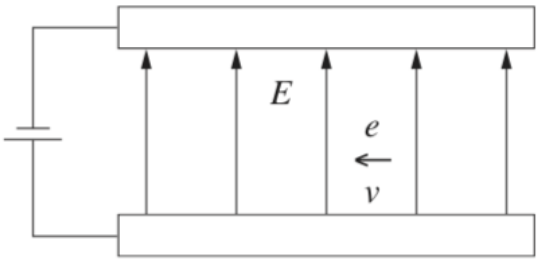
2011:

19 An electron, e, travelling with a velocity, v, passes through an electric field, E, between two parallel plates.



What is the direction of the force that this electric field exerts on the electron?

(A) ↑

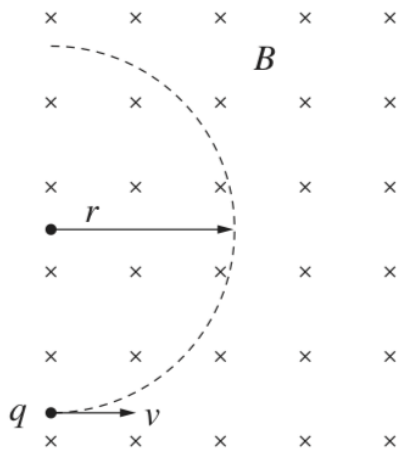
(B) ↖

(C) ↙

(D) ↓

2010:

15 A charged particle, q, enters a uniform magnetic field B at velocity v. The particle follows a circular path of radius r as shown.



If the magnitude of the magnetic field were doubled and the other variables were kept constant, what would the new radius be?

(A) $\frac{r}{4}$

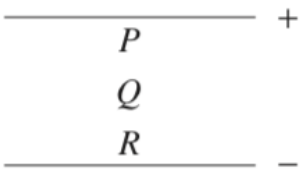
(B) $\frac{r}{2}$

(C) $2r$

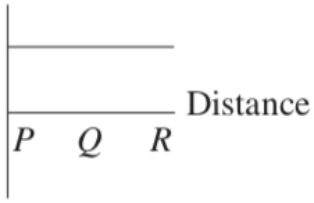
(D) $4r$

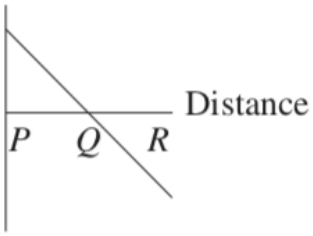
2009:

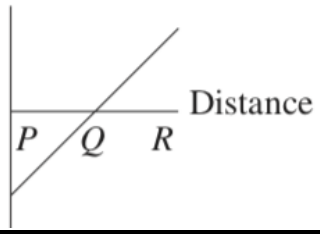
15 The diagram shows two parallel plates with opposite charges. P, Q and R represent distances from the positive plate.

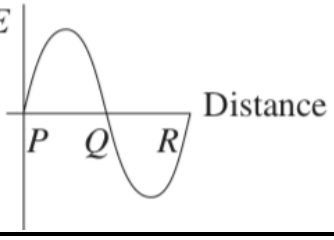


Which of the following graphs describes the electric field strength, E, between the plates?

(A)


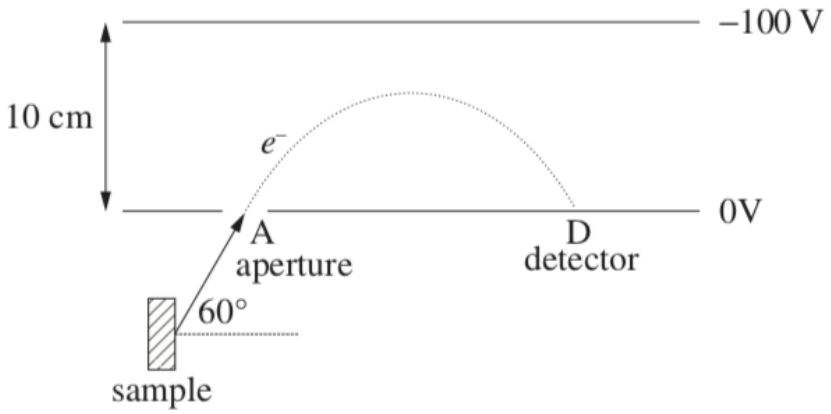
(B)


(C)


(D)


Question 19 (6 marks)

An electron is emitted from a mineral sample, and travels through aperture A into a spectrometer at an angle of 60° with a speed of 6.0×10^6 m s^{-1}.



NOT TO SCALE

(a) Calculate the magnitude and direction of the force experienced by the electron inside the spectrometer. **3**

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(b) The electron experiences constant acceleration and eventually strikes the detector, D. **3**

What is the time taken for the electron to travel from A to D?

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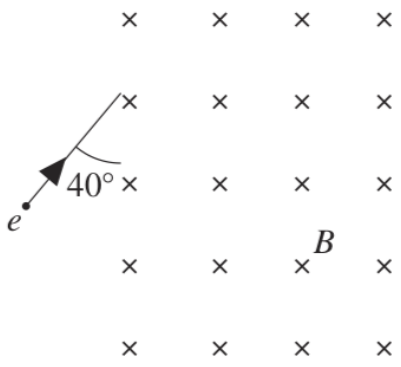
2008:

11 An electron, e, moving with a velocity of 8.0×10^6 m s^{-1} enters a uniform magnetic field, B, of strength 2.1×10^{-2} T as shown.



The electron experiences a force which causes it to move along a circular path.

What is the radius of the path followed by the electron?

(A) 1.1×10^{-3} m

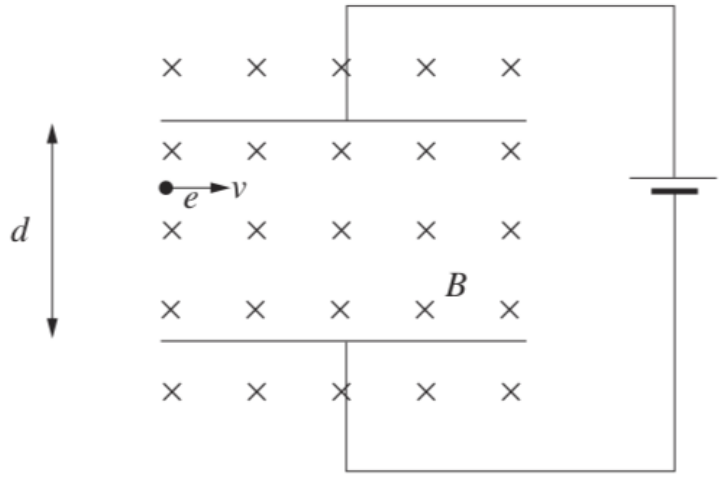
(B) 1.4×10^{-3} m

(C) 1.7×10^{-3} m

(D) 2.2×10^{-3} m

Question 23 (7 marks)

Two parallel metal plates in a magnetic field are separated by a distance d, as shown. An electron enters the space between the plates.



(a) On the diagram indicate with an arrow the direction of the force on the electron due to the magnetic field. **1**

(b) The strength of the magnetic field is $B = 0.001$ T and the electron's velocity is $v = 2 \times 10^6$ m s^{-1}. Calculate the magnitude of the magnetic force on the electron. **2**

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(c) If $d = 10$ mm, calculate the voltage required for the electron to continue on a straight path parallel to the plates. **2**

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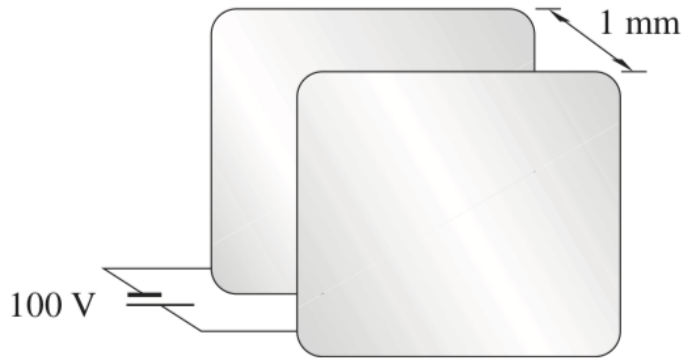
2007:

11 Two parallel metal plates are 1 mm apart. A potential difference of 100 V is applied as shown.



What is the magnitude of the uniform electric field between the plates?

(A) 10^{-3} V m^{-1}

(B) 10^{-1} V m^{-1}

(C) 10^{2} V m^{-1}

(D) 10^{5} V m^{-1}

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13 An electron is moving near a long straight wire. When a current is applied to the wire the electron experiences a force in the same direction as the current flow in the wire.

What was the electron's initial direction of motion?

(A) Parallel to the current direction

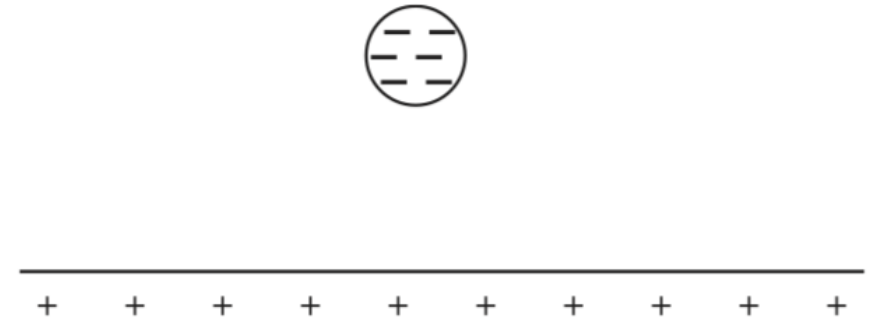
(B) Opposite to the current direction

(C) Towards the wire and perpendicular to it

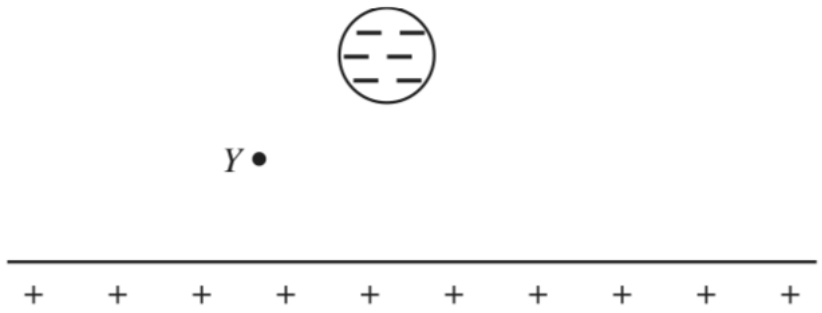
(D) Away from the wire and perpendicular to it

(a) A negatively charged cylinder is fixed in position near a positively charged plate as shown in the cross-section. **1**

Sketch the electric field lines between the cylinder and the plate on the cross-section diagram.



(b) A tiny particle of mass 10^{-30} kg and charge $+6 \times 10^{-12}$ C is released at point Y as shown on the diagram. The particle initially accelerates at 7.0×10^{21} m s^{-2}. **2**



Calculate the electric field intensity at Y.

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2006:

12 A charged non-magnetic particle is moving in a magnetic field.

What would NOT affect the magnetic force on the particle?

(A) The strength of the magnetic field

(B) The magnitude of the charge on the particle

(C) The velocity component parallel to the magnetic field direction

(D) The velocity component perpendicular to the magnetic field direction

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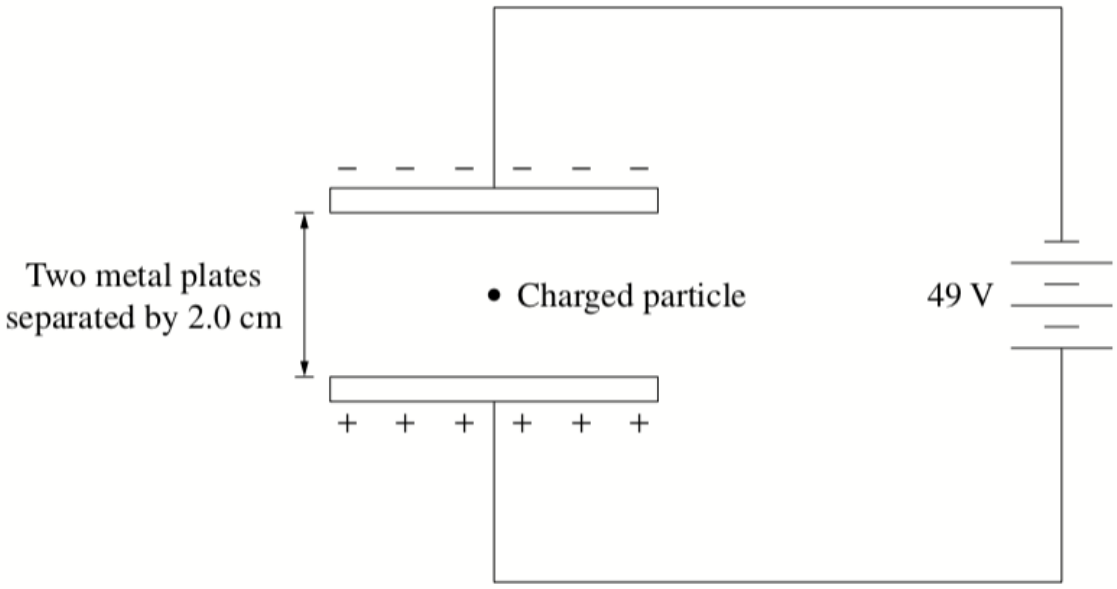
2005:

Question 26 (5 marks)

The diagram shows two parallel horizontal metal plates connected to a DC source of electricity. Suspended between the plates is a charged particle of mass 9.6×10^{-6} kg.



(a) Using conventional symbols, draw the electric field between the metal plates on the diagram above. **1**

(b) Determine the magnitude of the electric field between the plates. **1**

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(c) Determine the sign and magnitude of the charge on the particle if it is suspended motionless between the plates. **3**

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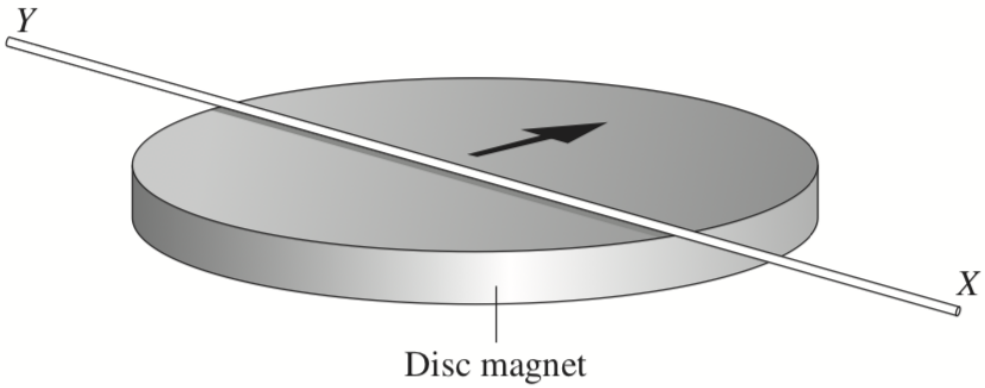
2004:

10 A disc magnet has its poles on its opposing flat surfaces. An insulated copper wire was placed on the disc magnet as shown in the diagram.



The instant the wire was connected to a DC battery, the wire was observed to move in the direction of the arrow.

Which statement describes the direction of the magnet's field and the direction of the current in the wire, consistent with this observation?

(A) The field was vertically upward and the current was from *X* to *Y*.

(B) The field was vertically upward and the current was from *Y* to *X*.

(C) The field was in the direction of the arrow and the current was from *X* to *Y*.

(D) The field was in the direction of the arrow and the current was from *Y* to *X*.

2002:

Question 25 (6 marks)

A pair of parallel metal plates, placed in a vacuum, are separated by a distance of 5.00×10^{-3} m and have a potential difference of 1000 V applied to them.

(a) Calculate the magnitude of the electric field strength between the plates. **1**

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(b) Calculate the magnitude of the electrostatic force acting on an electron between the plates. **1**

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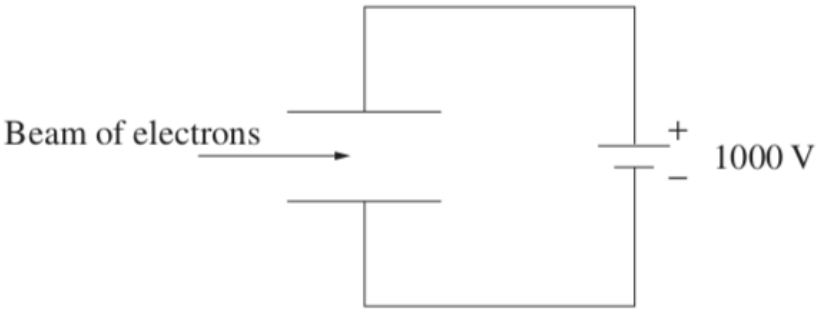
(c) A beam of electrons is fired with a velocity of 3.00×10^{6} m s^{-1} between the plates as shown. A magnetic field is applied between the plates, sufficient to cancel the force on the electron beam due to the electric field. **4**



Calculate the magnitude and direction of the magnetic field required between the plates to stop the deflection of the electron beam.

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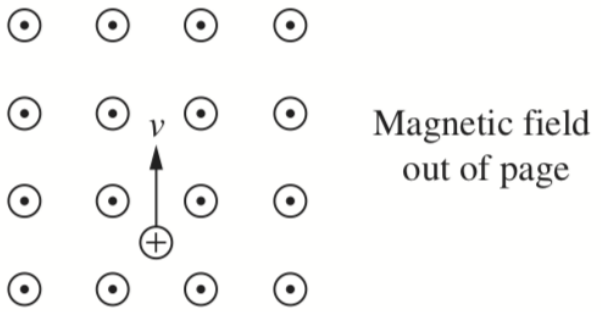
2001:

2 At a particular moment, a positively charged particle is moving with velocity v in a magnetic field as shown.



At this moment, what is the direction of the force on the positively charged particle?

(A) To the right

(B) To the left

(C) Into the page

(D) Out of the page