New Syllabus NESA Questions:

1) A

2)

Marking guidelines:

Criteria	Marks
• Analyses the effects of both the magnetic and electric fields on the electron before and after closing the switch • Correctly calculates the acceleration of the electron	5
• Describes some effects of both the magnetic and electric fields on the electron before and after closing the switch • Applies a correct process to calculate the acceleration of the electron	4
• Describes the effects of both the magnetic and electric fields on the electron OR • Applies a correct process to calculate the acceleration of the electron and describes some effects of the magnetic/electric field OR • Provides some correct steps in calculating the acceleration of the electron and describes some effects of both the magnetic and electric fields on the electron	3
• Provides correct steps in calculating the acceleration of the electron OR • Outlines some effects of the magnetic and/or electric fields on the electron	2
• Provides some relevant information	1

Sample answer:

Before the switch is closed, there is no electric field and the magnetic field has no effect on the electron due to it being stationary. After the switch is closed the electric field will accelerate the electron downwards (towards the positive plate).

The acceleration of the electron immediately after the switch is closed is given by a = F/m where F = Eq and E = V/d.

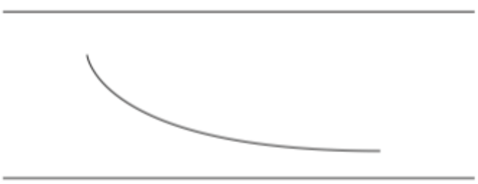
$E = 100 / 0.005 = 20\ 000\ \text{Vm}^{-1}$

$F = \text{Eq} = 20\ 000 \times 1.602 \times 10^{-19} = 3.2 \times 10^{-15}$ N

$a = \text{F/m} = 3.2 \times 10^{-19} / 9.109 \times 10^{-31}$

$\quad = 3.5 \times 10^{15}\ \text{ms}^{-2}$ downwards (towards the positive plate)

Now that the electron is moving, the magnetic field will force the electron towards the right. The exact direction and path it follows will depend on the strength of the magnetic field. However, the force due to the magnetic field will be increasing due to the increasing velocity of the electron. It will therefore travel in a curved path.



3)

Mapping grid (a):

Content	**Syllabus outcomes**	**Bands**
Mod 6 Charged Particles, Conductors and Electric and Magnetic Fields	PH12–4, PH12–6 PH12–13	3–5

Marking guidelines (a):

Criteria	**Marks**
• Applies a correct process to calculate acceleration • Includes correct units	2
• Shows some relevant calculations	1

Sample answer:

$$E = \frac{V}{d}, \quad \vec{F} = q\vec{E}, \quad \therefore F = \frac{Vq}{d}$$

$$\vec{F}_{\text{net}} = m\vec{a}, \quad \therefore a = \frac{Vq}{dm}$$

$$a = \frac{5000 \times 1.602 \times 10^{-19}}{0.02 \times 9.109 \times 10^{-31}}, \quad \therefore a = 4 \times 10^{16} \text{ m s}^{-2}$$

Mapping grid (b):

Content	**Syllabus outcomes**	**Bands**
Mod 6 Charged Particles, Conductors and Electric and Magnetic Fields	PH12–4, PH12–6 PH12–13	3–4

Marking guidelines (b):

Criteria	**Marks**
• Correctly calculates the velocity with correct units	2
• Provides some relevant information	1

Sample answer:

$$v^2 = u^2 + 2as$$

$$v = \sqrt{0 + 2 \times 4 \times 10^{16} \times 0.02}$$

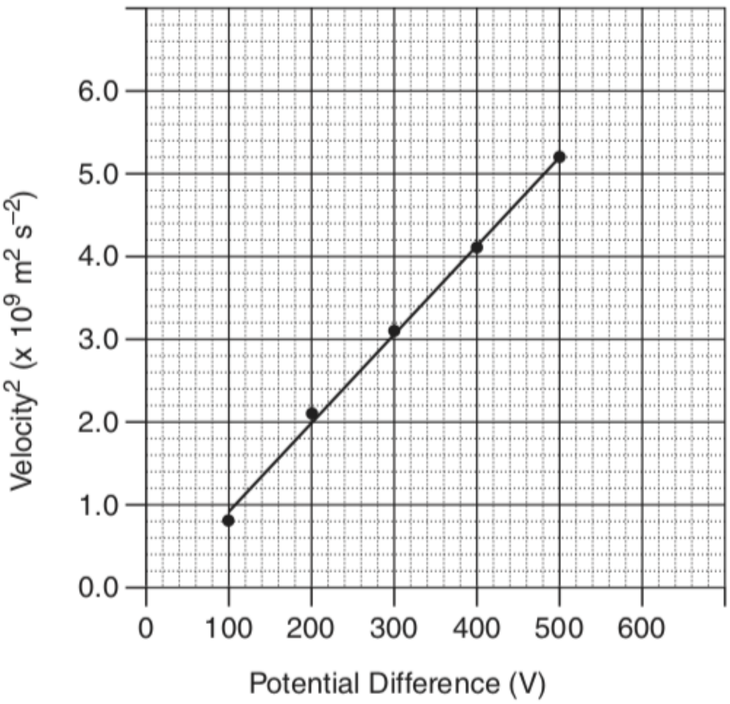
$$= 4 \times 10^7 \text{ m s}^{-1}$$

4)

Marking guidelines (a):

Criteria	Marks
• Uses appropriate scale • Labels axes correctly with units • Plots points accurately • Draws a line of best fit	3
• Provides a substantially correct graph	2
• Provides some basic features of the graph	1

Sample answer:



Marking guidelines (b):

Criteria	Marks
• Applies an appropriate method to determine if the charged particles could be electrons • Provides relevant data and calculations • Justifies their argument logically	3
• Applies an appropriate method to determine if the charged particles could be electrons • Provides some relevant data and/or calculations	2
• Provides some relevant information	1

Sample answer:

The change in kinetic energy is equal to the work done by the electric field:

$$W = \Delta K$$

$$qV = \frac{1}{2}mv^2$$

As $qV = \frac{1}{2}mv^2$, $\frac{v^2}{V} = \frac{2q}{m}$.

The gradient of the line of best fit is equal to the rise divided by the run:

gradient $\frac{v^2}{V} = \frac{2q}{m}$.

The gradient of the line of best fit $= \frac{(5.2 - 0.9) \times 10^9}{500 - 100}$

$= 1.1 \times 10^7 \text{ m}^2 \text{ s}^{-2} \text{ V}^{-1}$.

So, $\frac{q}{m} = \frac{\text{gradient}}{2}$

$= 5.4 \times 10^6 \text{ C kg}^{-1}$.

But, for an electron:

$$\frac{q}{m} = \frac{1.602 \times 10^{-19}}{9.11 \times 10^{-31}}$$

$$= 1.8 \times 10^{11} \text{ C kg}^{-1}$$

Therefore, the particles in this experiment cannot be electrons.

5)

Marking guidelines:

Criteria	Marks
• Correctly calculates the magnitude of the force and provides the direction	2
• Substitutes into a relevant formula OR • Provides the correct direction	1

Sample answer:

$F = lIB \sin\theta$

$= 0.7 \times 5.0 \times 0.5 \times \sin 60°$

$= 1.5$ N out of the page

Past HSC Questions:
2018:
12) A
13) B
26)

Question 26

Criteria	Marks
• Outlines similarities and differences between the effects of electric and gravitational fields • Refers to definitions of the fields	4
• Outlines similarities and/or differences between the effects of electric and gravitational fields	3
• Shows some understanding of the effects of electric fields and/or gravitational fields	2
• Provides some relevant information	1

Sample answer:

An electric field is a region in space where a force acts on a charged particle. A gravitational field is a region in space where an object with mass affects other objects with mass.

Electric field strength is given by $E = F/q$ (force per unit charge), whereas gravitational field strength is given by $g = F/m$ (force per unit mass).

Both fields produce forces of attraction, but only electric fields repel (due to like charges). Electric and gravitational fields vary in strength due to magnitudes of the charge or mass respectively.

Both fields decrease in strength with the square of the separation distance from a point charge or mass.

Answers could include

Gravity is a very weak fundamental force compared to the forces dependent on charge.

2017:
3) A
8) C
18) C

30)

Question 30

Criteria	Marks
• Provides an analysis of the motion of the proton	4
• Describes the path and/or direction of the proton	3
• Provides some characteristics of the path and/or direction of the proton	2
• Provides some relevant information	1

Sample answer:

The magnetic field will cause the proton to move in a circular path, initially moving out of the page, continuing in an anti-clockwise direction as viewed from the right. At the same time, the electric field will cause the proton to move to the left with increasing speed. The resultant motion of the proton is the vector sum of these two components, which will look like a helix that is getting stretched out towards the left. This helix will be decreasing in radius as the proton loses energy as it radiates electromagnetic radiation as it is an accelerating charge.

2016:
3) C
5) D
23) b)

Question 23 (b)

Criteria	Marks
• Provides correct substitution for the calculation of B with the correct direction	3
• Provides correct substitution to calculate *B* OR • Equates $F = qE$ and $F = qvB$ and states correct direction	2
• Provides correct direction OR • Provides partial substitution into a relevant equation	1

Sample answer:

$F_E = F_m$

$qE = qvB$

$B = \frac{E}{v}$

$B = \frac{10}{5.2 \times 10^4}$

$B = 0.0002T$ up the page

2015:

8) C

24)

Question 24 (a)

Criteria	Marks
• Correctly identifies inaccuracies in the path drawn and gives reasons	3
• Identifies inaccuracies in the diagram OR • Correctly identifies one inaccuracy and gives a reason	2
• Provides some relevant information relating to an inaccuracy in the diagram	1

Sample answer:

The electron is deflected in the wrong direction because it should be attracted towards the positive plate (or repelled by the negative plate).

The electron does not suddenly get deflected at the midpoint as shown because the plate's field deflects the electron from the point it enters the region between the plates on the left.

Answers could include:

The electron does not follow a straight path anywhere between the plates because its acceleration is uniform towards the positive plate.

[Accurate drawing with annotations is also acceptable.]

Question 24 (b)

Criteria	Marks
• Applies a correct method to calculate force	2
• Substitutes into a relevant formula	1

Sample answer:

$$E = \frac{F}{q} \qquad \text{and} \qquad E = \frac{v}{d}$$

$$\therefore \frac{F}{q} = \frac{v}{d} \qquad\qquad F = \frac{Vq}{d}$$

$$= \frac{5000 \times 1.6 \times 10^{-19}}{0.02}$$

$$= 4 \times 10^{-14}\, N$$

Question 24 (c)

Criteria	Marks
• Applies a correct method to calculate velocity	2
• Substitutes into a relevant formula	1

Sample answer:

$$a = \frac{F}{m}$$
$$= \frac{4 \times 10^{-14}}{9.1 \times 10^{-31}}$$
$$= 4.4 \times 10^{16} ms^{-2}$$

$$v^2 = u^2 + 2ay$$
$$v = \sqrt{2 \times 4.4 \times 10^{16} \times 0.02}$$
$$= 4.19 \times 10^7 ms^{-1}$$

Answers could include:

Other methods, eg using electrical energy $\rightarrow$ kinetic energy also possible.

2014:

17) B

2013:

14) B

Question 26 (a)

Criteria	Marks
• Substitutes into correct equation to calculate the potential difference between the plates	2
• Partial substitution into a relevant equation	1

Sample answer:

$$E = \frac{V}{d}$$
$$\therefore V = Ed = 15 \times 1.0 \times 10^{-2} = 0.15\ V$$

Question 26 (b)

Criteria	Marks
• Demonstrates correct process to determine the magnitude of the electric field AND • Identifies the correct direction of the electric field	3
• Demonstrates correct process to determine the magnitude of the electric field OR • Correctly substitutes into a relevant equation and identifies the correct direction of the electric field	2
• Identifies ONE relevant piece of data	1

Sample answer:

$$F = qvB = qE$$

$$\therefore E = vB = 1 \times 10^4 \times 0.5$$

$$= 5000 \ V\,m^{-1} \text{ from } M \text{ to } N$$

2012:

6) C

Question 30 (a)

Sample answer:

The two charged particles have opposite charges.

Question 30 (b)

Sample answer:

The paths are circular because the force produced by the magnetic field on the moving charge is constant in magnitude and always perpendicular to the particles' velocities, and these are the conditions necessary for circular motion to be produced by a force.

Question 30 (c)

Sample answer:

The greater the mass of a particle travelling through a magnetic field, the greater the radius of curvature of its path, other variables being unchanged. The greater the charge of the particle, the smaller the radius of curvature of its path.

2011:
19) D

2010:
15) B

2009:
15) A

Question 19 (a)

Answers could include:

Two equations are necessary.

$E = V/d$ and $F = qE$

These are combined to obtain

$$F = qV/d$$

$$F = 1.602 \times 10^{-19} \frac{100}{0.10}$$

$$= 1.6 \times 10^{-16} \text{ N}$$

Direction: Towards the 0V plate.

Question 19 (b)

Answers could include:

Will need to determine the value of the constant acceleration

$$F = ma$$

$$\therefore a = \frac{F}{m} = \frac{1.602 \times 10^{-16}}{9.109 \times 10^{-31}}$$

$$= 1.759 \times 10^{14} \text{ m s}^{-2}$$

Will need the perpendicular component of the velocity as the acceleration influences this component of the velocity only

$$v_h = 6.0 \times 10^6 \sin 60°$$

$$= 5.196 \times 10^6 \text{ m s}^{-1}$$

Determine time using

$$v = u + at$$

$$0 = 5.196 \times 10^6 - 1.759 \times 10^{14} t$$

$$t = \frac{5.196 \times 10^6}{1.759 \times 10^{14}}$$

$$= 2.9 \times 10^{-8} \text{ s}$$

$$= 2 \times 2.9 \times 10^{-8} \text{ s}$$

$$= 5.9 \times 10^{-8} \text{ s}$$

2008:
11) D

Before 2009 there were no answers given for short answer please use a book like Excel Physics

2007:
11) D
13) C

2006:
12) C

2004:
10) A

2001:
2) A