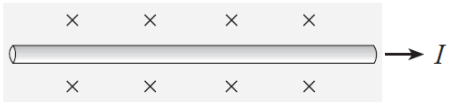
Magnetism Review

Multiple Choice

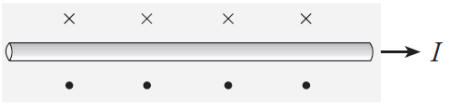
1. The direction of a magnetic field is determined to be the direction in which

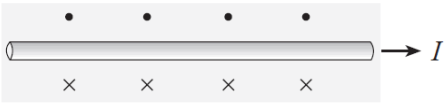
A. a positive charge would tend to move.
B. a negative charge would tend to move.
C. the north end of a compass needle would point.
D. the south end of a compass needle would point.

2. Which diagram shows the magnetic field created near a conductor carrying current towards the right?

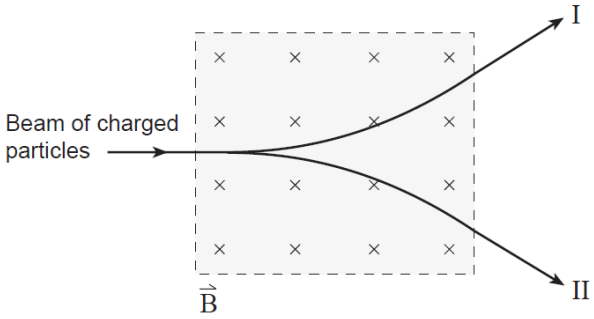
A. 

B. 

C. 

D. 

3. A beam of positively and negatively charged particles enters a magnetic field as shown. Which paths illustrate the positive and negative charges leaving the magnetic field region?

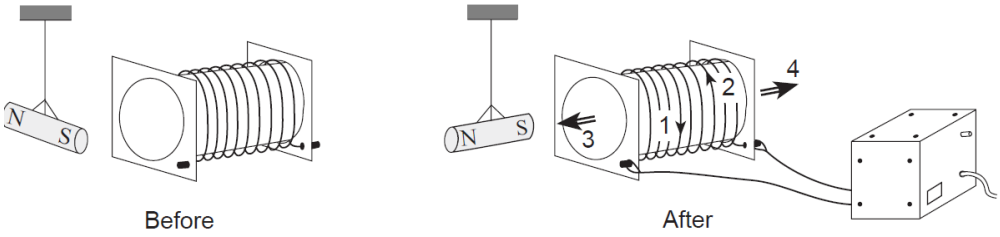


	PATH OF POSITIVE CHARGES	PATH OF NEGATIVE CHARGES
A.	I	I
B.	I	II
C.	II	I
D.	II	II

4. A solenoid has a length of 0.30 m, a diameter of 0.040 m and 500 windings. The magnetic field at its centre is 0.045 T. What is the current in the windings?

A. 2.9 A
B. 3.0 A
C. 21 A
D. 170 A

5. The diagram shows a magnet suspended near a solenoid. After the solenoid has been connected to a power supply, the magnet rotates to a new position with its south pole pointing towards the solenoid.



Which arrows show the direction of the current in the solenoid and the direction of the magnetic field caused by this current?

	DIRECTION OF CURRENT	DIRECTION OF MAGNETIC FIELD
A.	1	3
B.	1	4
C.	2	3
D.	2	4

6. The diagram shows a conductor between a pair of magnets. The current in the conductor flows out of the page.

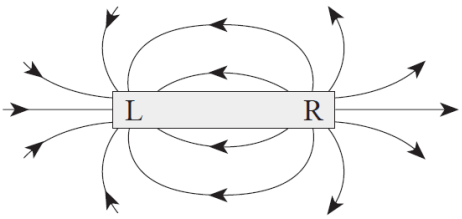
In what direction will the magnetic force act on the conductor?

A. up the page
B. down the page
C. towards the left
D. towards the right

7. A charged particle travels in a circular path in a magnetic field. What changes to the magnetic field and to the velocity of the particle would both cause the radius of its path to decrease?

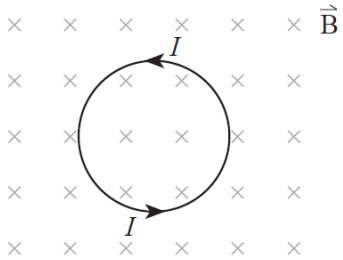
	CHANGE TO THE MAGNETIC FIELD	CHANGE TO THE VELOCITY
A.	increase	increase
B.	increase	decrease
C.	decrease	increase
D.	decrease	decrease

8. Identify the magnetic poles labelled L and R in the diagram shown.



	POLE L	POLE R
A.	North	North
B.	North	South
C.	South	North
D.	South	South

9. The diagram shows current I flowing in a circular coil located in a magnetic field.



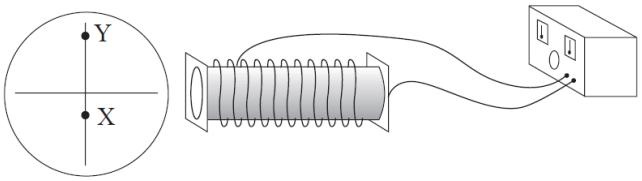
The magnetic force acting on the coil will tend to cause it to

A. expand.
B. contract.
C. move up the page.
D. move down the page.

10. An aircraft whose wingspan is 15 m carries a static charge of 0.60 C. It travels at 240 m/s perpendicular to a 1.5×10^{-4} T magnetic field. What magnetic force does the aircraft experience?

A. 0.022 N
B. 0.060 N
C. 0.54 N
D. 9.6×10^{5} N

11. An undeflected electron beam strikes the centre of a cathode ray tube. A solenoid placed beside a cathode ray tube causes the electron beam to strike the screen at position X.

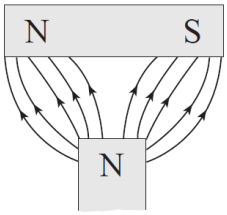


What changes to the magnitude and direction of the current in the solenoid would cause the electron beam to strike the screen at Y?

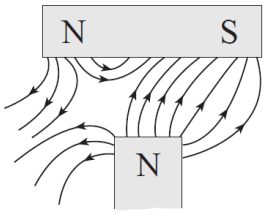
	CHANGE TO CURRENT MAGNITUDE	CHANGE TO CURRENT DIRECTION
A.	Increases	Remains the same
B.	Increases	Reverses
C.	Decreases	Remains the same
D.	Decreases	Reverses

12. Which of the following diagrams best represents the magnetic field in the region between the two permanent magnets?

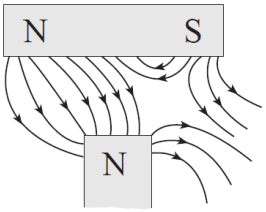
A.



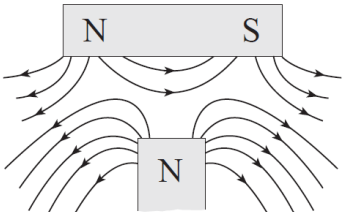
B.



C.



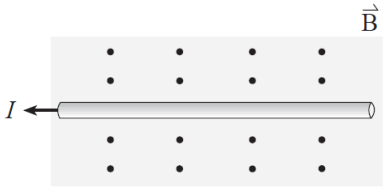
D.



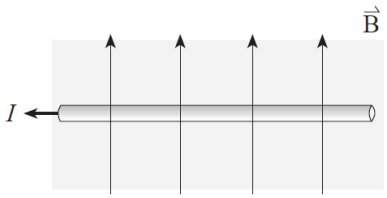
13. In which diagram would the current-carrying conductor experience a magnetic force out of the page?

A.

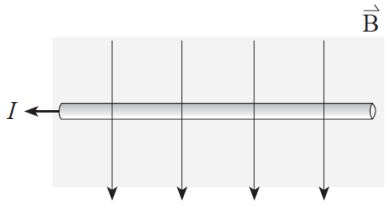
B.



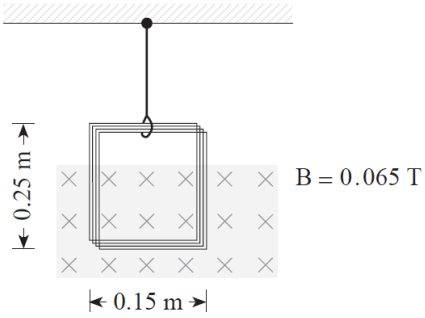
C.



D.



14. A coil of 25 turns of wire is suspended by a thread. When a current flows through the coil, the tension in the thread is reduced by 4.0×10^{-2} N.



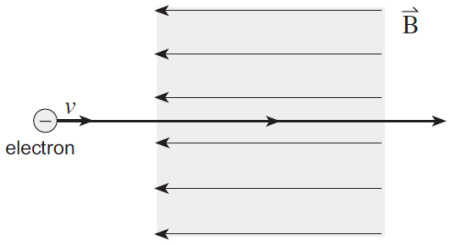
What are the magnitude and direction of the current?

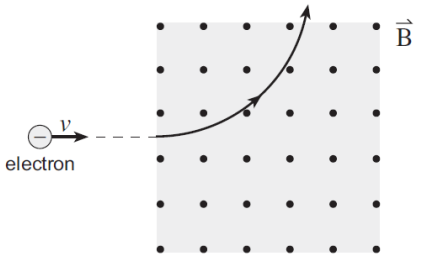
	MAGNITUDE OF CURRENT	DIRECTION OF CURRENT
A.	0.16 A	clockwise
B.	0.16 A	counter-clockwise
C.	4.1 A	clockwise
D.	4.1 A	counter-clockwise

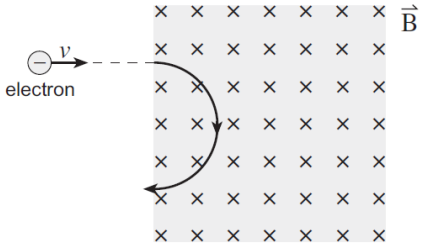
15. Which of the following devices commonly uses a solenoid?

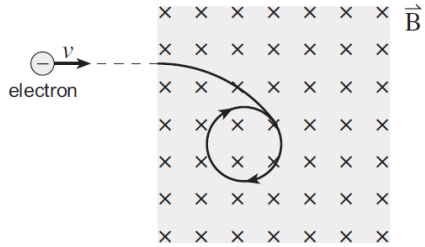
A. kettle
B. battery
C. television set
D. incandescent bulb

16. An electron, travelling with a constant velocity, enters a region of uniform magnetic field. Which of the following is **not** a possible pathway?

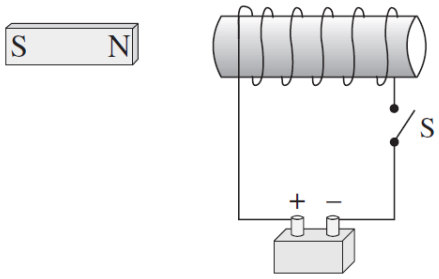
A.


B.


C.


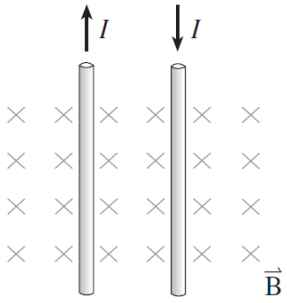
D.


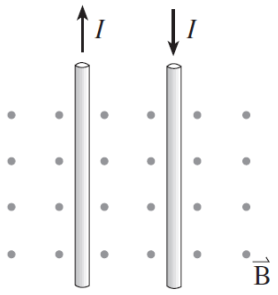
17. A bar magnet is at rest, next to a fixed coil. When switch S is closed, the bar magnet will move

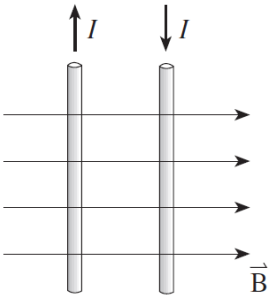


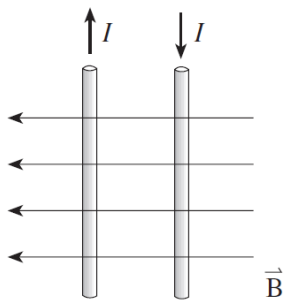
A. to the left.
B. to the right.
C. up the page.
D. down the page.

18. In which diagram would an **external** magnetic field, $\vec{B}$, cause two current-carrying wires to move towards one another?

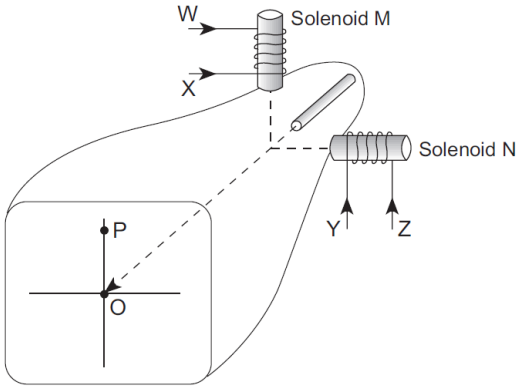
A.


B.


C.


D.


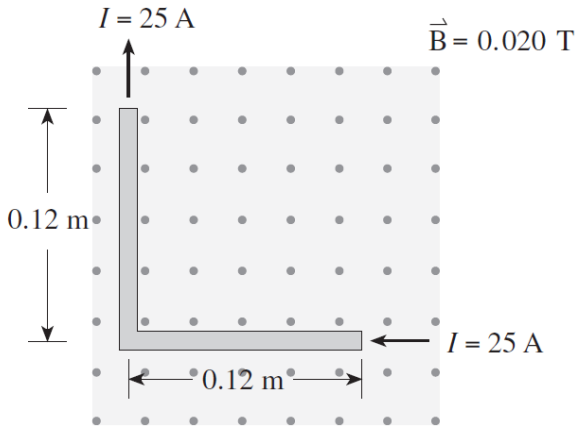
19. When there is no current in the solenoids, the electron beam in the cathode ray tube strikes the screen at the origin O.



In order to move the beam to position P, which solenoid is used and what is the direction of the current applied?

	SOLENOID	CURRENT DIRECTION
A.	M	W
B.	M	X
C.	N	Y
D.	N	Z

20. What is the magnitude of the magnetic force on the L-shaped conductor?

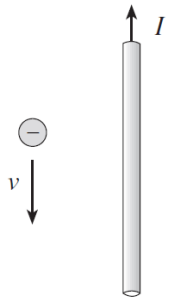


A. 0 N
B. 6.0×10^{-2} N
C. 8.5×10^{-2} N
D. 1.2×10^{-1} N

21. The direction of the magnetic field is the direction of force on a

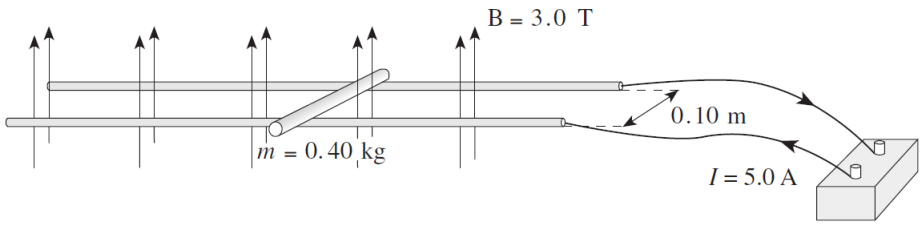
A. north magnetic pole.
B. south magnetic pole.
C. positively charged particle.
D. negatively charged particle.

22. What is the direction of the magnetic force on an electron moving near a current-carrying wire as shown?



A. left
B. right
C. into the page
D. out of the page

23. A 0.40 kg metal slider is sitting on smooth conducting rails as shown below.



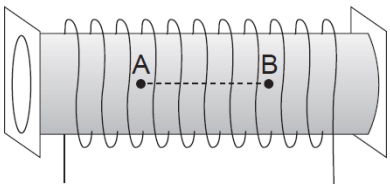
What is the magnitude and direction of the acceleration of the slider? (Ignore friction.)

	MAGNITUDE	DIRECTION
A.	0.42 m/s^2	left
B.	0.42 m/s^2	right
C.	3.8 m/s^2	left
D.	3.8 m/s^2	right

24. A 0.20 m long solenoid has 750 turns of copper wire and the magnetic field near its centre is measured to be 3.0×10^{-2} T. What is the current flowing through the solenoid?

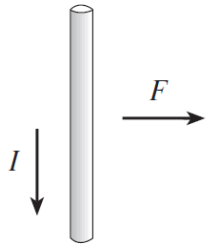
A. 1.6 A
B. 6.4 A
C. 32 A
D. 160 A

25. Which of the following best describes the magnetic field inside a current-carrying solenoid as you move from A to B.



	DIRECTION	MAGNITUDE
A.	constant	constant
B.	constant	changing
C.	changing	constant
D.	changing	changing

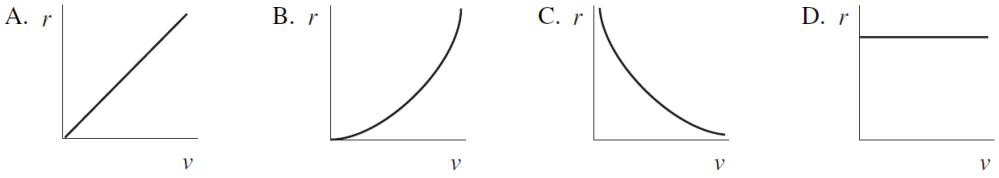
26. A section of conductor is carrying a current due south, as shown below.



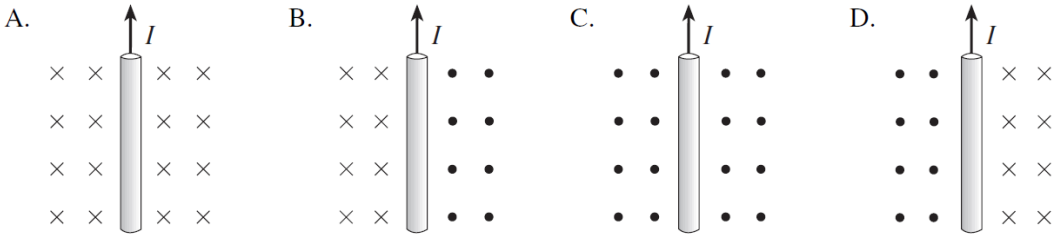
Due to the presence of a magnetic field, the conductor experiences a magnetic force to the right. What is the direction of the magnetic field?

A. left
B. right
C. into the page
D. out of the page

27. A charged mass is accelerated to various speeds and then passed through a perpendicular magnetic field. Which of the graphs below is the best representation of how the radius of its circular path through the magnetic field varies with speed?



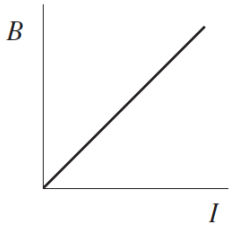
28. Which of the four diagrams below correctly depicts the magnetic field found on either side of a current carrying wire?



29. Charged particles having momentum p_1, pass perpendicularly through a magnetic field and their circular path has a radius of r. What would the radius be for particles with the same charge having momentum $p_2 = 2p_1$?

A. $2r$
B. $\frac{1}{2}r$
C. $\sqrt{2}r$
D. $\frac{r}{\sqrt{2}}$

30. The current through a solenoid is varied and the resulting magnetic field at its centre is recorded in each case. A graph of the magnetic field versus the current is produced.



Which of the following represents the slope of this graph?

A. $\frac{\mu_0 N}{l}$
B. $\frac{Nl}{\mu_0}$
C. $\frac{\mu_0 B}{N}$
D. $\frac{Il}{N}$

Answers

MC

1. C	11. B	21. A
2. D	12. B	22. B
3. B	13. C	23. D
4. C	14. B	24. B
5. C	15. C	25. A
6. C	16. D	26. C
7. B	17. A	27. A
8. C	18. B	28. D
9. B	19. C	29. A
10. A	20. C	30. A

Written Response

1.

a) A proton moves with a speed of 3.6×10^5 m/s at right angles to a uniform 5.0×10^{-5} T magnetic field. What is the radius of curvature for the motion of the proton? **(5 marks)**

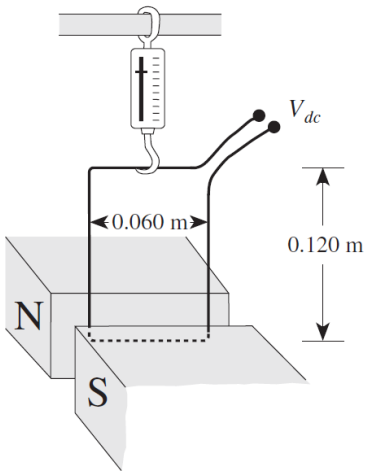
b) Describe the path of the proton in the magnetic field and use principles of physics to explain the proton's motion. **(4 marks)**

2. Protons travelling at 2.2×10^5 m/s enter at right angles to a magnetic field. The field is produced by a 0.16 m long solenoid. A current of 5.3 A flows through the 820 turns of wire of the solenoid.

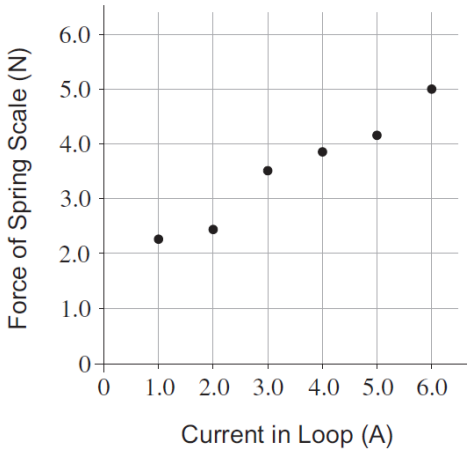
a) What is the magnetic field in the solenoid? **(3 marks)**

b) What is the radius of curvature of the proton beam in the magnetic field of the solenoid? **4 marks)**

3. A rectangular loop is suspended by a spring scale between magnetic poles. The loop is 0.60 m wide by 0.120 m high.



As the current in the loop is varied, the readings of the spring scale and current are plotted on a graph.



a) What is the weight, in newtons, of the loop? **(1 mark)**

b) What is the slope of the best fit line? **(2 marks)**

c) What is the magnitude of the magnetic field? **(2 marks)**

4. An electron travelling at 7.7×10^6 m/s enters at right angles into a uniform magnetic field. Inside the field the path of the electron has a radius of 3.5×10^{-2} m.

a) What is the magnitude of the magnetic field? **(4 marks)**

b) If the magnetic field is produced at the centre of a solenoid by a current of 0.62 A, what is the number of turns per unit length of the solenoid? **(3 marks)**

5. A proton travelling at 2200 m/s enters a 0.15 T magnetic field perpendicularly.

a) What is the magnitude of the proton's acceleration while travelling through the magnetic field? **(4 marks)**

b) What is the radius of the proton's circular path while travelling through the magnetic field? **(3 marks)**

Answers

1. a) A proton moves with a speed of 3.6×10^5 m/s at right angles to a uniform 5.0×10^{-5} T magnetic field. What is the radius of curvature for the motion of the proton? **(5 marks)**

$F_c = \dfrac{mv^2}{R}$ ← **1 mark**

$F_B = qvB$ ← **1 mark**

$F_c = F_B$ ← **1 mark**

$R = \dfrac{mv}{Bq} = \dfrac{\left(1.67 \times 10^{-27}\right)\left(3.6 \times 10^5\right)}{\left(5.0 \times 10^{-5}\right)\left(1.6 \times 10^{-19}\right)}$ ← **1 mark**

$R = 75$ m ← **1 mark**

b) Describe the path of the proton in the magnetic field and use principles of physics to explain the proton's motion. **(4 marks)**

The path is circular. ← **1 mark**

Moving charge in magnetic field produces a magnetic force. ← **1 mark**

Force ⊥ velocity. ← **1 mark**

This perpendicular force (acting on proton) produces circular motion. ← **1 mark**

2. a) What is the magnetic field in the solenoid?

$$B = \mu_0 \frac{N}{\ell} I \qquad \leftarrow \textbf{1 mark}$$

$$B = \frac{\left(4\pi \times 10^{-7}\right)(820)(5.3)}{(0.16)} \qquad \leftarrow \textbf{1 mark}$$

$$B = 3.4 \times 10^{-2}\ \text{T} \qquad \leftarrow \textbf{1 mark}$$

b) What is the radius of curvature of the proton beam in the magnetic field of the solenoid? **(4 marks)**

$$F_c = \frac{mv^2}{r} \qquad \leftarrow \tfrac{1}{2}\ \textbf{mark}$$

$$F_E = Bqv \qquad \leftarrow \tfrac{1}{2}\ \textbf{mark}$$

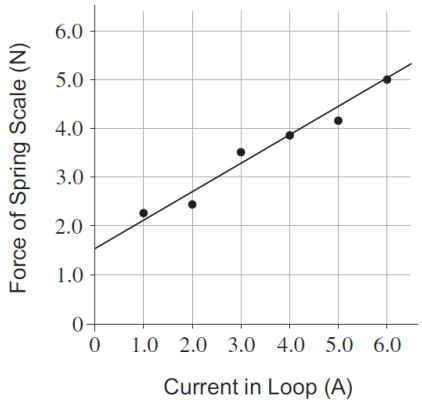
$$Bqv = \frac{mv^2}{r}$$

$$r = \frac{mv}{Bq} \qquad \leftarrow \textbf{1 mark}$$

$$r = \frac{\left(1.67 \times 10^{-27}\right)\left(2.2 \times 10^{5}\right)}{\left(3.4 \times 10^{-2}\right)\left(1.6 \times 10^{-19}\right)} \qquad \leftarrow \textbf{1 mark}$$

$$r = 6.8 \times 10^{-2}\ \text{m} \qquad \leftarrow \textbf{1 mark}$$

3. As the current in the loop is varied, the readings of the spring scale and current are plotted on a graph.



a) What is the weight, in newtons, of the loop?

≈ 1.5 N

b) What is the slope of the best fit line?

drawing a reasonable line through y-axis and to, or beyond, last point **(1 mark)**

$\frac{\Delta F}{\Delta I} \approx 0.58\ \frac{\text{N}}{\text{A}}$ or $0.58\ \text{T} \cdot \text{m}$ **(1 mark)**

4.

a) What is the magnitude of the magnetic field?

$$F_C = F_B$$

$$\frac{mv^2}{r} = Bqv$$

$$B = \frac{mv}{qR}$$

$$= \frac{\left(9.11\times10^{-31}\right)\left(7.7\times10^{6}\right)}{\left(1.6\times10^{-19}\right)\left(3.5\times10^{-2}\right)}$$

← **3 marks**

$$B = 1.3\times10^{-3}\ \text{T}$$ ← **1 mark**

b) If the magnetic field is produced at the c
the number of turns per unit length of th

$$B = \mu_0 \frac{N}{\ell} I$$

$$\frac{N}{\ell} = \frac{B}{\mu_0 I}$$

$$= \frac{1.3\times10^{-3}}{\left(4\pi\times10^{-7}\right)(0.62)}$$

← **2 marks**

$$\frac{N}{\ell} = 1.6\times10^{3}\ \text{turns/m}$$ ← **1 mark**

5.

a) What is the magnitude of the proton's acceleratic
magnetic field?

$$F_B = QvB$$ ← **1 mark**

$$F = ma$$ ← **1 mark**

$$a = \frac{QvB}{m}$$ ← **1 mark**

$$= \frac{\left(1.6\times10^{9}\right)(2\,200)(15)}{1.67\times10^{-27}}\ \text{m/s}^2$$ ← **½ mark**

$$= 3.2\times10^{10}\ \text{m/s}^2$$ ← **½ mark**

b) What is the radius of the proton's

$$a = \frac{v^2}{r}$$ ← **1 mark**

$$r = \frac{v^2}{a}$$ ← **1 mark**

$$= \frac{(2\,200)^2}{3.2\times10^{10}}\ \text{m}$$ ← **½ mark**

$$= 1.5\times10^{-4}\ \text{m}$$ ← **½ mark**