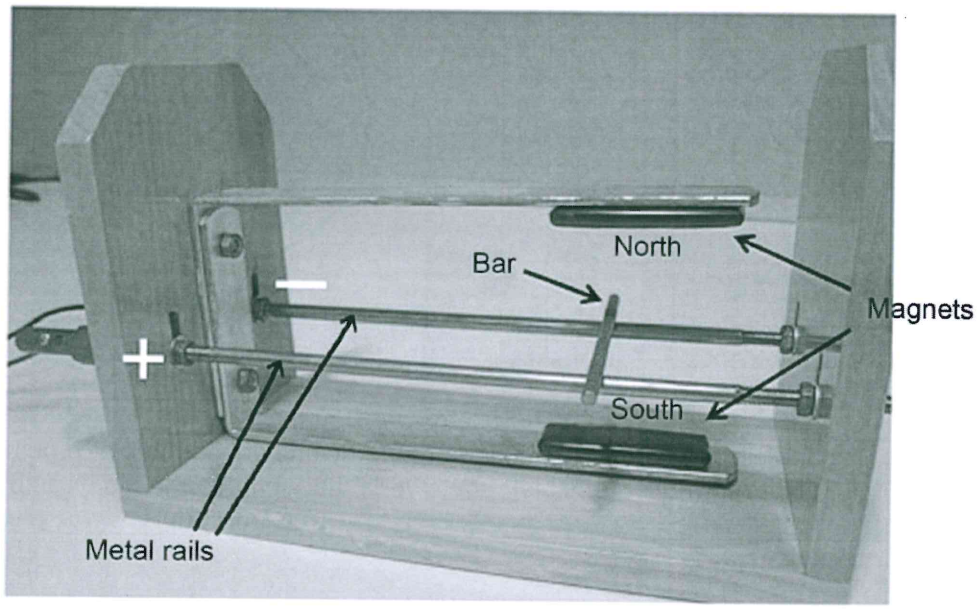
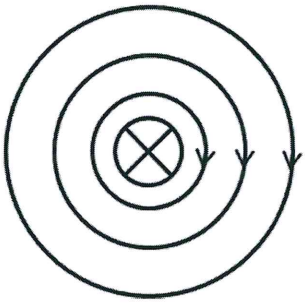
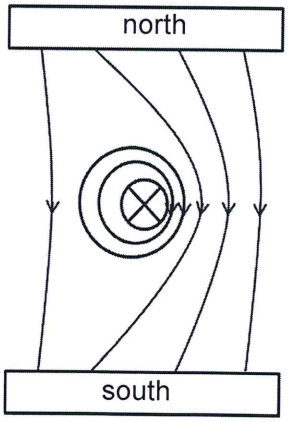
Exam Answers
Chapter 4.1 - Magnetic Fields
Answer 1 2011:2:16

(10 marks)

An apparatus that demonstrates the interactions between a current and a magnetic field is shown below. There are two metal rails on which a metal bar is free to roll. Contact between the rails and bar allows a current to flow through them from the power pack attached to the metal rails. Two magnets provide a uniform magnetic field around the bar.



(a) Draw the magnetic fields associated with the following situations. (4 marks)

The bar carrying current into the page		The current carrying bar in a uniform magnetic field
		

Description	Marks
LH diag. Field directions shown and magnitude changes with distance	1–2
RH diag. Field direction of both shown and field interaction with a higher density on the right	1–2
	Total 4

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Chapter 4.1 - Magnetic Fields
Answer 1 continued

(b) The rails are 8.50 cm apart and the magnetic field strength due to the magnets is $B = 1.50 \times 10^{-3}$ T.

Calculate the magnitude of the force acting on the bar when an electric current of 5.00 A is passed through the bar.

Draw and label on the photograph on page 18 the direction of the force and current. (4 marks)

Description	Marks
$F = BI\ell$ $F = 1.5 \times 10^{-3} \times 15 \times 10.085$	1
$F = 6.375 \times 10^{-4}$ N	1
Current direction chosen correctly (into page)	1
Direction shown on the diagram correctly (to the left)	1
	Total 4

(c) The apparatus in the photograph is then tilted at a small angle to the horizontal by lifting the left side when the current is flowing. The bar rolls toward the right-hand side, away from where the power supply is connected, due to the effects of gravity acting on the bar.

Describe two changes that could be made, either to the circuit or apparatus, to enable the force due to the current's interaction with the magnetic field to hold the bar stationary.

(2 marks)

Description	Marks
Any two of the following Increase potential difference across the circuit (to increase current) Get bigger/stronger magnets Move magnets closer to bar	1–2
	Total 2

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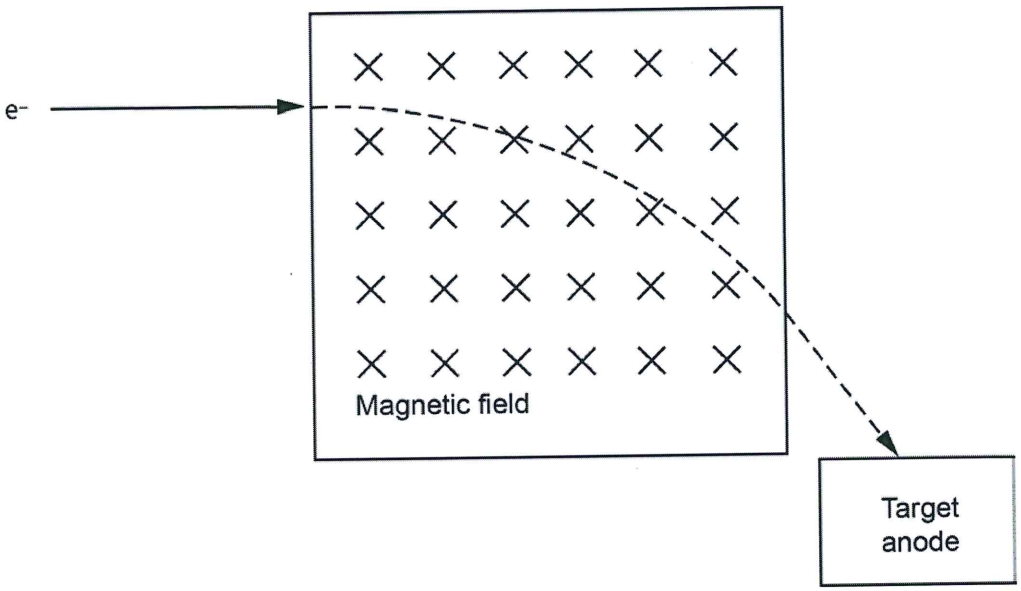
Answer 2 2013:2:18

(14 marks)

An electron moving at 0.9c enters a region of space and follows a path that has a constant radius of 0.348 m while in the magnetic field shown on the diagram, before striking a target anode.



(a) Draw the magnetic field enclosed in the indicated space. (2 marks)

Description	Marks
Uniform magnetic field	1
Into the page	1
Total	**2**

(b) (i) Derive the formula $B = \frac{mv}{qr}$. (2 marks)

Description	Marks
$F_c = F_B$	1
$mv^2/r = qvB$ (must show some progression to arrive at the answer)	1
$B = mv/qr$	
Total	**2**

(ii) Use this formula to calculate the field strength needed to direct an electron along this path. Include units in your answer. (4 marks)

Description	Marks
$v = 0.9 \times 3 \times 10^8$	1
$B = mv/qr = (9.11 \times 10^{-31} \times 0.9 \times 3 \times 10^8) / (1.6 \times 10^{-19} \times 0.348)$	1
$B = 4.42 \times 10^{-3}$	1
T (unit)	1
Total	**4**

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Answer 2 continued

(iii) Describe how each of the changes below affect the charged particle's path in the magnetic field. (4 marks)

Property changed	Effect on radius
Particle's charge is reversed	
Particle's charge is increased	
Particle's velocity is increased	
Magnetic field is increased	

Description	Marks
Bends up instead of down and/or unchanged radius	1
Radius decreases	1
Radius increased	1
Radius decreased	1
Total	**4**

(c) Relativistic effects were not considered when calculating the electron's path. Outline briefly the effects that special relativity predicts about the radius of the electron's motion. (2 marks)

Description	Marks
Increasing the speed of a particle increases its mass	1
The more massive a particle (with everything else constant) the larger the radius	1
Total	**2**