WJEC EDUQAS A-LEVEL PHYSICS · COMPONENT 3

PHYSICS



EXAM QUESTION PACK

3.9 MAGNETIC FIELDS

SCORE	PERCENTAGE
/44	%

STEMUP

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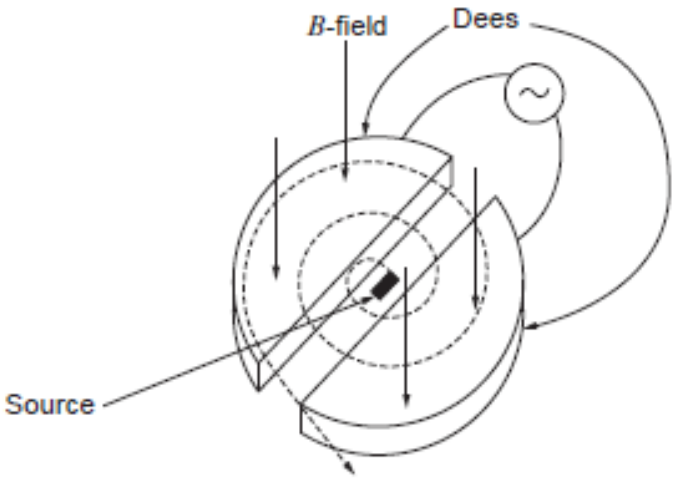
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#1

9. A cyclotron is shown and it is used to accelerate helium-4 nuclei from rest. After completing 12 cycles of the cyclotron, a helium nucleus has a kinetic energy of 4.32 MeV.



(a) Calculate the final velocity of a helium-4 nucleus (the mass of a helium-4 nucleus is 4u). [3]

(b) Calculate the pd between the dees. [3]

(c) The uniform magnetic flux density is 0.47 T. Calculate the frequency of the alternating pd applied to the dees. [3]

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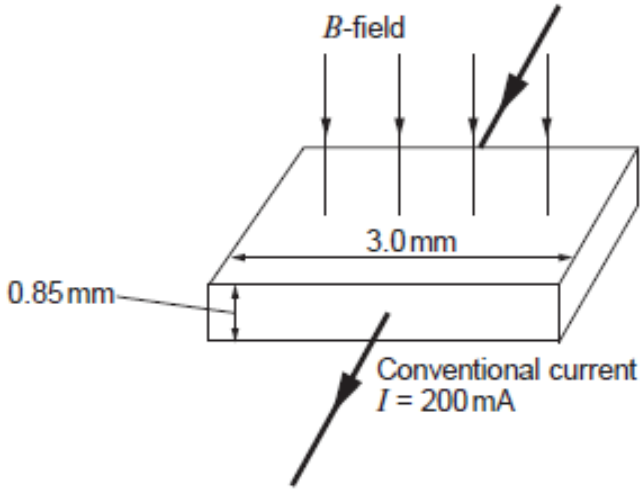
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Question taken from Eduqas examination paper 842103, June 2018

#2

9. *(a)* The silicon chip shown in the diagram is used as a Hall probe with electrons as the charge carriers. Explain how the Hall voltage arises and which face of the chip becomes positively charged. [4]



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(b) The concentration of conduction electrons is $2.4 \times 10^{24}\,m^{-3}$. Calculate the mean drift velocity of the electrons. [2]

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(c) The Hall voltage, V_H, for this chip can be expressed as:

$$V_H = kB$$

where k is a constant and B is the magnetic flux density. Calculate a value for k and **state its unit.** [3]

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Question taken from Eduqas examination paper 842103, June 2019

#3

An insulated wire is made into a long solenoid of length 4.00 m by winding it around a pipe of diameter 3.00 cm. The wire is 0.25 mm thick and is wound so that each loop just touches the next.

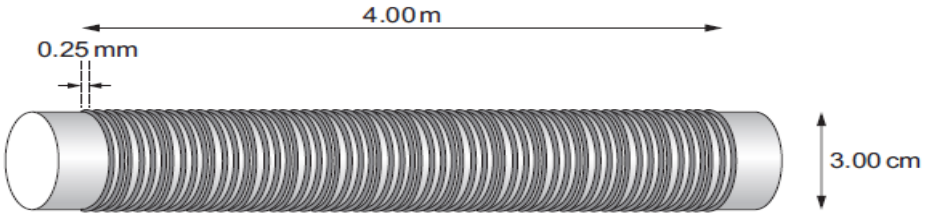


Diagram not to scale

(a) Show that the length of the wire is approximately 1.5 km. *You may assume that the insulation thickness is negligible.* [3]

(b) Show that a steady current of approximately 25 mA is carried in the wire when a pd of 12.0 V is applied across its ends. The resistivity of the wire is $1.59 \times 10^{-8}\ \Omega\,m$. [3]

(c) Calculate the magnetic field strength, B, inside the solenoid. [2]

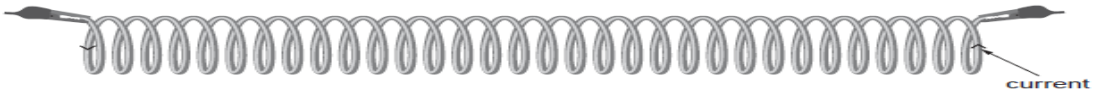
(d) Explain whether or not the solenoid could produce a magnetic field of 2 T. You should include a calculation to reinforce your answer. [3]

Question taken from Eduqas examination paper 842103, June 2017

#4

(a) (i) A long solenoid has 12 000 turns per metre and carries a current of 3.8 A. Calculate the magnetic flux density at its centre. [1]

(ii) **Sketch the magnetic field lines** due to this long solenoid. [2]



(iii) State how the strength of the magnetic field produced by **this solenoid** can be increased greatly without increasing the current or changing the dimensions of the solenoid. [1]

(b) Maria carries out an experiment inside an extremely large magnetic field of uniform density 1.76 T. She uses a copper wire and deforms it from shape 1 to shape 2 in a time of 42 ms.

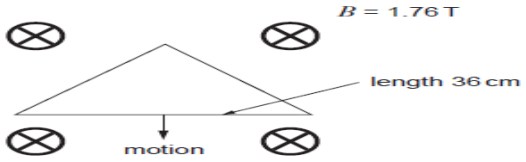


(i) Explain why a large current flows in the copper wire during this deformation. [3]

(ii) Explain how you can deduce that this current flows anticlockwise. [2]

(iii) Calculate the mean current flowing in the copper wire given that its resistance is $6.75 \times 10^{-3}\,\Omega$. [3]

(iv) Halfway through the deformation of the copper wire it is in the position shown below. Maria claims that in this position, a "motor effect" force of approximately 200 N will act upwards on the length of copper wire shown. Determine whether or not Maria is correct. [3]



Question taken from Eduqas examination paper 842103, November 2020

Marking Scheme

#1

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
9	(a)		Conversion $4.32 \times 10^6 \times 1.6 \times 10^{-19}$ i.e. 6.912×10^{-13} [J] (1) Rearrangement for v i.e. $v = \sqrt{\frac{2E}{m}}$ (1) Answer = 1.44×10^7 m s^{-1} (1)		3		3	2	
	(b)		24 total energy 'kicks' (or 2 per revolution) (1) 4.32 MeV divided by 24 (=180 000) (1) Also need to divide by 2e, Answer = 90 000 V (1) (2 marks for 180 kV, 1 mark for 360 kV, 2.16 MV →1 mark)		3		3	2	
	(c)		Equating: $m\omega^2 r = Bqv$ (1) or $\omega = \frac{Bq}{m}$ Rearrangement: $f = \frac{Bq}{2\pi m}$ (1) By implication can give 2 marks for this Answer = 3.6 MHz (ecf on part (b) i.e. using 1e instead of 2e 1.8 MHz) (1)		3		3	2	
			Question 9 total	**0**	**9**	**0**	**9**	**6**	**0**

#2

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
9	(a)		Force on charge carriers/electrons in mag field [1] [Force right] so left face becomes +ve [1] Electric field/voltage linked to charge movement [1] Electric force balances magnetic force / $V_H \propto B$ also constant I [1]	4			4		
	(b)		Correct application/substitution into equation $I = nAve$ [1] Answer = 0.204 [m s^{-1}] [1]		2		2	2	
	(c)		$eE = Bev$ used or equivalent e.g. $V = Bvd$ or $V = \frac{BI}{nte}$ [1] Correct comparison to get k e.g. $k = vd$ or $\frac{I}{nte}$ etc. [1] Correct answer = 6.13×10^{-4} V T^{-1} or m^2 s^{-1} or A m^2 C^{-1} unit mark, ecf on v [1]		3		3	3	
			Question 9 total	**4**	**5**	**0**	**9**	**5**	**0**

#3

Question	Marking details	Marks available					
		AO1	AO2	AO3	Total	Maths	Prac
(a)	Method for obtaining N e.g. $\frac{4\,000}{0.25 \times 10^{-3}}$ (1) Use of πd or $2\pi r$ (1) 1 508 m or $16\,000 \times \pi \times 0.03$ seen or equivalent (1)	1	1 1		3	3	
(b)	$R = \frac{\rho l}{A}$ used and $I = \frac{V}{R}$ used (1) 0.25 mm used as diameter for area or (0.125 mm as radius) (1) 24.6 mA seen or $\frac{12}{488}$ or $\frac{12}{486}$ seen or equivalent evidence (1)	1	1 1		3	3	
(c)	$n = \frac{N}{\text{length}}$ (1) Answer = 1.23×10^{-4} [T] (1) Award 1 mark only for answer of 3.35×10^{-7} [T]	1	1		2	2	
(d)	$B = \mu_0 nI$ used to calculate I **ecf** (1) Correct conclusion stated and consistent with calculation (1) Wires would melt / damaged / burnt / become hot / use superconductor / use cooling (1)			3	3	1	
	Question total	**3**	**5**	**3**	**11**	**9**	**0**

#4

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(a)	(i)	Answer = 57.3 m[T]	1			1	1	
		(ii)	Shape correct (minimum 3 lines) (1) Direction correct (no contradicting arrows) (1)	2			2		
		(iii)	Iron core	1			1		
	(b)	(i)	Change in flux (1) Complete circuit **OR** low resistance (1) Large rate of change of flux **OR** large flux & small t (1)		3		3		
		(ii)	Use FRHR **OR** use FLHR on electrons **OR** RH grip (1) on bottom part **OR** in bottom part **OR** induced field opposes (1)	1	1		2		
		(iii)	Faraday's law used e.g. 2.18 V **OR** $\frac{BA}{t}$ seen (1) $I = \frac{V}{R}$ used (1) Answer = 323 [A] (1)	1 1	 1		3	2	
		(iv)	Use of $F = BIL$ **ecf** (1) Answer = 205 [N] (1) Opposes motion (1)			3	3	2	
			Question total	**7**	**5**	**3**	**15**	**5**	**0**