10: Electromagnetism – Topic questions

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
7	2017	June	41
8	2017	June	41
9	2017	June	41

The mark scheme for each question is provided at the end of the document.

7 An electron having charge $-q$ and mass m is accelerated from rest in a vacuum through a potential difference V.
The electron then enters a region of uniform magnetic field of magnetic flux density B, as shown in Fig. 7.1.

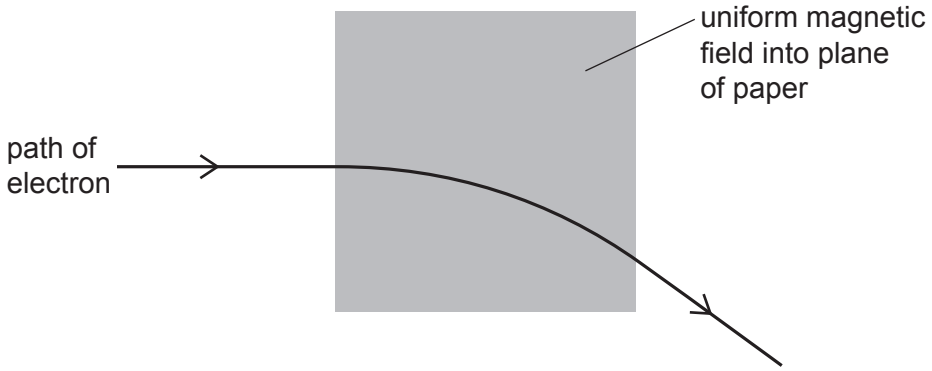

Fig. 7.1

The direction of the uniform magnetic field is into the plane of the paper.
The velocity of the electron as it enters the magnetic field is normal to the magnetic field.
The radius of the circular path of the electron in the magnetic field is r.

(a) Explain why the path of the electron in the magnetic field is the arc of a circle.

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.....[3]

(b) Show that the magnitude p of the momentum of the electron as it enters the magnetic field is given by

$$p = \sqrt{(2mqV)}.$$

[2]

(c) The potential difference V is 120 V. The radius r of the circular arc is 7.4 cm.

Determine the magnitude B of the magnetic flux density.

B = ... T [3]

(d) The potential difference V in **(c)** is increased. The magnetic flux density B remains unchanged.

By reference to the momentum of the electron, explain the effect of this increase on the radius r of the path of the electron in the magnetic field.

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[Total: 10]

8 Explain the main principles behind the use of nuclear magnetic resonance imaging (NMRI) to obtain information about internal body structures.

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.....[8]

[Total: 8]

9 A simple transformer is illustrated in Fig. 9.1.

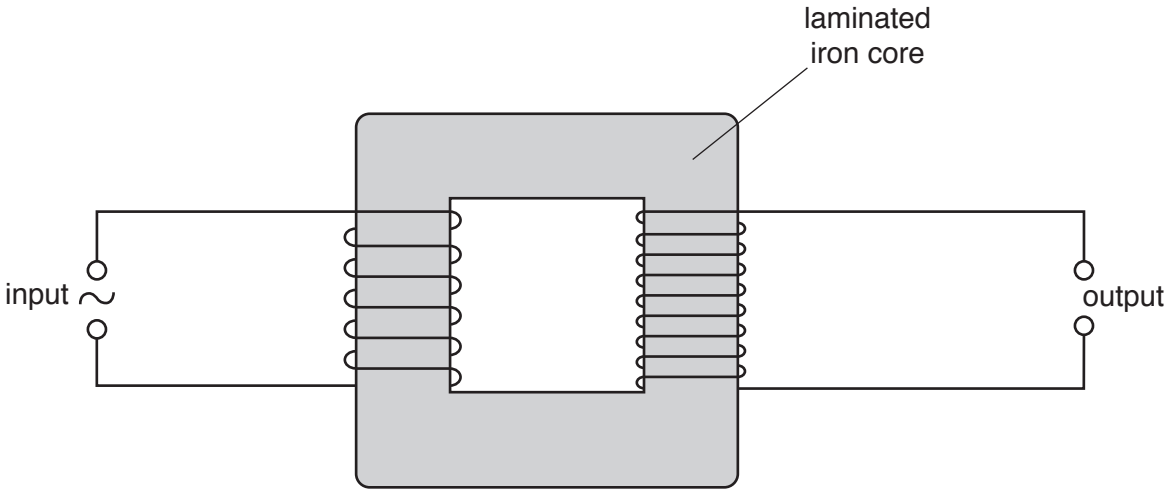

Fig. 9.1

(a) **(i)** State why the transformer has an iron core, rather than having no core.

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.....[1]

(ii) Explain why the core is laminated.

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.....[2]

(b) By reference to the action of a transformer, explain why the input to the transformer is an alternating voltage, rather than a constant voltage.

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.....[3]

[Total: 6]

Question	Answer	Marks
7 (a)	(magnetic) force (always) normal to velocity/direction of motion	**1**
	(magnitude of magnetic) force constant **or** speed is constant/kinetic energy is constant	**1**
	so provides the centripetal force	**1**
7 (b)	increase in KE = loss in PE **or** ½ $mv^2 = qV$	**1**
	$p = mv$ with algebra leading to $p = \sqrt{(2mqV)}$	**1**
7 (c)	$Bqv = mv^2 / r$ $mv = Bqr$ **or** $p = Bqr$	**1**
	$(2 \times 9.11 \times 10^{-31} \times 1.60 \times 10^{-19} \times 120)^{1/2} = B \times 1.60 \times 10^{-19} \times 0.074$	**1**
	$B = 5.0 \times 10^{-4}$ T	**1**
7 (d)	greater momentum	**1**
	($p = Bqr$ and) so r increased	**1**
		Total: 10
8	strong (uniform) magnetic field	**1**
	* <u>nuclei</u> precess/rotate about field (direction)	
	radio frequency pulse/RF pulse (applied)	**1**
	* RF or pulse is at Larmor frequency / frequency of precession	
	causes resonance / excitation (of nuclei)/nuclei to absorb energy	**1**
	on relaxation/de-excitation, nuclei emit RF/pulse	**1**
	* (emitted) RF/pulse detected and processed	
	non-uniform field (superposed on uniform field)	**1**
	allows positions of (resonating) nuclei to be determined	**1**
	* allows for position of detection to be changed/different slices to be studied	
	max. 2 of additional detail points marked *	**2**
		Total: 8

Question	Answer	Marks
9 (a) (i)	core reduces loss of (magnetic) flux linkage/improves flux linkage	**1**
9 (a) (ii)	reduces (size of eddy) currents in core	**1**
	(so that) heating of core is reduced	**1**
9 (b)	alternating voltage gives rise to changing magnetic flux in core	**1**
	(changing) flux links the secondary coil	**1**
	induced e.m.f. (in secondary) only when flux is changing/cut	**1**
		Total: 6

Notes about the mark scheme are available separately.