Generating Electricity Mark Scheme

Q1.

Question Number	Acceptable answers	Additional guidance	Mark
*	This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning. Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning. The following table shows how the marks should be awarded for indicative content. Indicative content: Generator: • coil has to be rotated • cuts magnetic flux **Or** rate of change of flux linkage • induces an emf Motor: • current provided to coil • Force on sides of coil that are perpendicular to magnetic field • rotate coil as forces provide a moment	IC points / IC mark / Max linkage mark available / Max final mark **6** / 4 / 2 / **6** **5** / 3 / 2 / **5** **4** / 3 / 1 / **4** **3** / 2 / 1 / **3** **2** / 2 / 0 / **2** **1** / 1 / 0 / **1** **0** / 0 / 0 / **0**	**6**

Q2.

<table>
<tr><th>Question Number</th><th>Acceptable Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>*</td>
<td>This question assesses a student's ability to show a coherent and logical structured answer with linkage and fully-sustained reasoning

Indicative content:

IC1 As the magnet moves through the coil there is a change in magnetic flux linkage (with coil)
Or as the magnet moves through the coil the coil cuts (lines of) magnetic flux
Or as the magnet moves through the coil the coil cuts magnetic field lines

IC2 An e.m.f. is induced across the coil

IC3 This generates a current in the (capacitor) circuit

IC4 The diode only allows current in one direction

IC5 So capacitor is charged (repeatedly)

IC6 When switch is closed capacitor discharges through the LED</td>
<td>Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.
The following table shows how the marks should be awarded for indicative content.

<table>
<tr><th>Number of indicative marking points seen in answer</th><th>Number of marks awarded for indicative marking points</th></tr>
<tr><td>6</td><td>4</td></tr>
<tr><td>5–4</td><td>3</td></tr>
<tr><td>3–2</td><td>2</td></tr>
<tr><td>1</td><td>1</td></tr>
<tr><td>0</td><td>0</td></tr>
</table>

<table>
<tr><th></th><th>Number of marks awarded for structure of answer and sustained line of reasoning</th></tr>
<tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout</td><td>2</td></tr>
<tr><td>Answer is partially structured with some linkages and lines of reasoning</td><td>1</td></tr>
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Total marks awarded is the sum of marks for indicative content and the marks for structure and lines of reasoning

<table>
<tr><th>IC points</th><th>IC mark</th><th>Max linkage mark</th><th>Max final mark</th></tr>
<tr><td>6</td><td>4</td><td>2</td><td>6</td></tr>
<tr><td>5</td><td>3</td><td>2</td><td>5</td></tr>
<tr><td>4</td><td>3</td><td>1</td><td>4</td></tr>
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</table>
</td>
<td>6</td>
</tr>
</table>

Q3.

Question Number	Acceptable answers	Additional guidance	Mark
(a)	An explanation that makes reference to the following points: • current (in coil) produces a magnetic field/flux (1) • (a.c.) leads to changing (magnetic) field/flux through pan (1) • induces an emf in pan (1) • leads to current (in pan because it is an electrical conductor) (1) MP4 dependent on MP2	MP2 – 4 must relate to the pan	4

Question Number	Acceptable answers	Additional guidance	Mark
(b)	An explanation that makes reference to the following points: • high frequency means that flux/field is changing quickly **Or** increases rate of change of flux/field (1) • leads to increased (induced) emf (in pan) **Or** leads to increase in (induced) current (in pan) MP2 dependent on MP1 (1)		2

Q4.

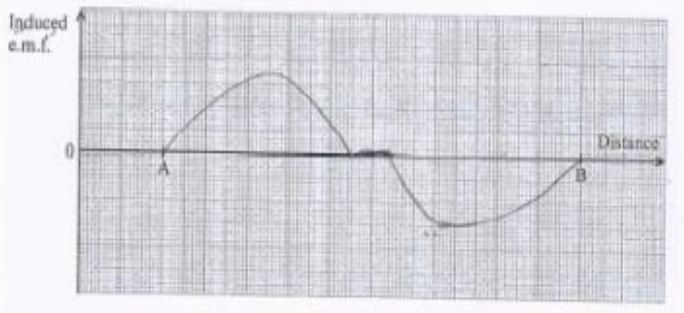
Question Number	Answer		Mark
*(a)	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) A clear statement that an alternating/changing current produces an alternating/changing magnetic field/flux	(1)	
	Reference to the iron core becomes magnetised **Or** increases magnetic field	(1)	
	the idea that the field produced in the core/wire is linked to the coil	(1)	
	(e.m.f. produced) due to EM induction **Or** reference to induced e.m.f. **Or** Faraday's law in words (do not accept induced current/voltage on its own) [be careful not to credit the random use of words/phrases like, there is flux linkage, flux cutting takes place or the field lines are cut by the coil. Also watch out for candidates who think there is a current in the coil creating the flux linkage]	(1)	4
(b)	(Constant current means) no change of flux (linkage) **Or** no changing (magnetic) field **Or** flux/ field is constant [do not credit 'flux won't be changing direction' or 'no flux linkage being cut' or alternating]	(1)	1
(c)	More than one wire in cable	(1)	
	Cable carries current in both directions **Or** Magnetic fields will cancel	(1)	2
(d)(i)	The larger the current the greater the (magnetic) flux/field (produced) **Or** the larger the change in current the larger the change in the (magnetic) flux/field	(1)	
	gives a greater rate of change of flux **Or** bigger change in flux in the same time **Or** a greater (induced) e.m.f./voltage/reading	(1)	2
(d)(ii)	the idea that frequency changes the value of (induced) e.m.f/voltage/reading **Or** the idea that the frequency changes the rate of change of (magnetic)flux	(1)	
	An understanding that there are now two factors (current and frequency) altering (induced) e.m.f/voltage/reading.	(1)	2
	Total for question		11

Q5.

Question Number	Answer	Mark
(a)	The induced e.m.f. (1) Is equal/proportional to the rate of change of (magnetic) flux (linkage) **Or** $\varepsilon = (-)\, d(N\Phi)/\Delta t$ with symbols defined (1)	2

Question Number	Answer	Mark
*(b)	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) the idea that due to the magnet moving there is a changing field around the ring (1) An e.m.f. induced (in a closed circuit hence a current flows) (1) Change in direction of magnet, changes the direction of e.m.f./current (1) Magnitude of e.m.f. (and current) depends on the rate of change of flux linkage **Or** magnitude of e.m.f. (and current) depends on position/ speed of magnet (1)	4

Q6.

Question Number	Answer		Mark
*(a)	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) **Max 6 from**		
	Reference to changing/cutting of field/flux	(1)	
	Induced e.m.f. proportional to rate of change/cutting of flux (linkage) (accept equation)	(1)	
	Initial increase in e.m.f. as the magnet gets closer to the coil	(1)	
	Identifies region of negative gradient with magnet going through the coil	(1)	
	Indication that magnet's speed increases as it falls	(1)	
	Negative (max) value › positive (max) value (this mark is dependent on awarding marking point 5)	(1)	
	Time for second pulse shorter (this mark is dependent on awarding marking point 5)	(1)	
	The areas of the two parts of the graph will be the same (since $N\varphi$ constant)	(1)	6
(b)	Two sequential pulses (if **not** two sequential pulses, scores zero)	(1)	
	Pulses same height (+/- 3 mm squares) and width (by eye)	(1)	
	Pulses in opposite directions	(1)	
	Region of zero e.m.f. in the middle	(1)	4
	Example (peaks could be in opposite directions) 		

Q7.

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Indicative content:

As magnet A moves, its coil experiences a change of magnetic flux (linkage)
The change in magnetic flux linkage induces an emf in the coil
The (induced) emf causes a current in both coils
The current in the second coil causes a force to act on magnet B, driving magnet B into oscillation
Because both mass-spring systems have the same period/frequency
Resonance occurs (and magnet B oscillates with increasing amplitude)

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Linkage Marks

IC points 1 – 4
Three of these points could score one linkage mark

IC points 5 & 6 could score one linkage mark</td>
<td>6</td>
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</table>