PEARSON EDEXCEL IGCSE PHYSICS · 4PH1

PHYSICS



MARK SCHEME

SECTION 6: MAGNETISM AND ELECTROMAGNETISM (PACK 2)

SCORE	PERCENTAGE
/189	%

STEMUP

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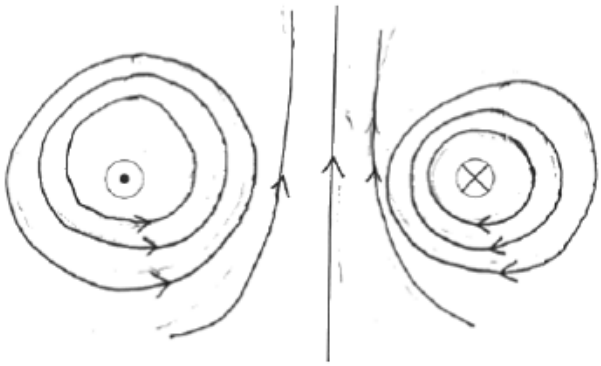
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Mark Scheme

Q1.

Question number	Answer	Notes	Marks
(a)	EITHER plotting compass; multiple compasses or repeated use of single compass; joining up of dots/idea of compasses forming continuous line(s); OR iron filings; sprinkled; card tapped;	all marks can be awarded for a correctly labelled diagram	3
(b)	one field line passing through middle from top to bottom; circular/elliptical field lines around wires; field line spacing increasing further from wires; arrows correct direction; 		4
(c) (i)	A; B is not right as the force cannot be generated by the LHR. C and D are not right as the force cannot be parallel to the magnetic field.		1
(ii)	current (in one wire) and field (from other wire) both reversed; the two effects cancel (so no change);	DOP allow relevant reference to (F)LHR	2
		Total for Question = 9 marks	

Q2.

Question number	Answer	Additional guidance	Mark
(a)(i)	Number of metal discs	allow load	1

Question number	Answer	Additional guidance	Mark
(a)(ii)	(Soft) iron is a magnetic material	easy to magnetise/demagnetise	1

Question number	Answer	Mark
(b)(i)	• Scale on the y-axis (1) • Both axes labelled with variable and unit (1) • Plotted (1) • Bars drawn (1)	4

Question number	Answer	Mark
(b)(ii)	To support the weight of the (soft iron) bar (1)	1

Question number	Answer	Additional guidance	Mark
(b)(iii)	An explanation that makes reference to three of the following points: • repeat and average (1) • repeat anomalous result (1) • use intermediate weights e.g. 1, 3, 5, 7, 9 (1) • extend the range of the results beyond 10 weights (1) • use standard masses (1)	however expressed	3

(Total for question = 10 marks)

Q3.

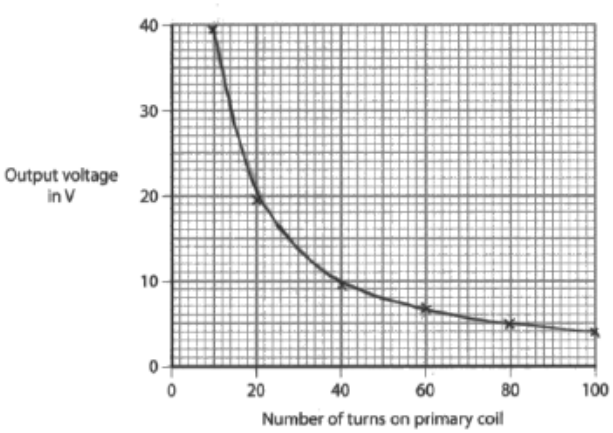
Question number	Answer	Notes	Marks
(a)	substitution into P = E / t; rearrangement; evaluation; e.g. $1.2 \times 10^5 = 4.0 \times 10^6$ / time (time =) $4.0 \times 10^6 / 1.2 \times 10^5$ (time =) 33 (s)	 -1 for POT error allow 33.3...	3
(b) (i)	idea that current only passes (a point) in one direction;	allow does not change direction	1
(ii)	any three from: MP1. provides a connection / current to the coil / commutator; MP2. idea of reverses the current in the coil; MP3. every half turn; MP4. reverses (coil) field / polarity / force (every half turn); MP5. so that force is always in the same direction; MP6. so that the motor keeps turning (the same way);	 allow idea of swapping the contacts allow moment for force	3
(c) (i)	chemical;	allow thermal / heat	1
(ii)	idea of conservation of energy; idea that energy is transferred (from kinetic store of car); to chemical store (of battery pack);	allow "energy can't be created or destroyed" / eq allow energy transferred electrically	3

Q4.

Question number	Answer	Notes	Marks
(a) (i)	(soft) iron;		1
(ii)	pass a current in the coil / eq;	condone reference to 'electricity'	1

(b)	(i)	$N_p/N_s = V_p/V_s$;	allow any correct rearrangement allow "i(nput) and o(utput)" or "1 and 2" for "p(rimary) and s(econdary)" allow correct word equation ignore 'P' for 'N' condone 'T', 't' or 'n' for 'N' condone 'coils' for 'turns'	1
	(ii)	substitution; rearrangement; evaluation to 2s.f. or more; e.g. $1500/280 = 115/V_s$ $(V_s =)\ 115 \times 280 / 1500$ $(V_s =)$ 21 (V)	 allow 21.4666...(V)	3
	(iii)	use of transformer power formula; substitution OR rearrangement; evaluation; e.g. input power = output power OR $V_pI_p = V_sI_s$ $115 \times 1.2 = 20 \times I_s$ OR $I_s = V_pI_p/V_s$ $(I_s =)$ 6.9 (A)	 allow use of 20, 21, 21.5 etc. for output voltage allow use of turns ratio i.e. step-down voltage means step-up current allow 7 (A) allow range of 6.4-6.9	3
	(iv)	any two from: MP1. increase input voltage/current; MP2. decrease number of turns on secondary coil; MP3. increase number of turns on primary coil;	 condone "decrease number of secondary coils" condone "increase number of primary coils"	2
			Total for Question = 11 marks	

Q5.

Question number	Answer	Notes	Marks
(a) (i)	Points plotted to within half a small square; **Number of turns on primary coil** / **Output voltage in V** 10 / 39.6 20 / 19.7 40 / 9.9 60 / 6.6 80 / 5.0 100 / 4.0  	Points should lie on a very good curved line.	1
(ii)	Best fit line is smooth curve;	ECF their data points.	1
(iii)	As number of (primary) turns increases, (secondary) voltage decreases; At a decreasing rate/is non-linear;	Allow RA Allow unqualified 'inversely proportional' for 2 marks. Ignore: 'negative exponential'	2

(b)	(i)	$(N_p/N_s) = (V_p/V_s)$;	Allow any correct rearrangment. Allow "i(nput) and o(utput)" or "1 and 2"for "p(rimary) and s(econdary)". Allow correct word equation. Ignore 'P' for 'N' Condone 'T', 't' or 'n' for 'N' Condone 'coils' for 'turns'	1
	(ii)	Substitution of values for N_p, V_P and V_s ; Evaluation of N_s ; e.g. 40 / N_s = (6.8/9.9) = 0.686....; N_s = 40 /0.601.. = 58(.2....) ;	Allow any row of data from table or co-ordinates for a point on the line on the graph Accept answer in range 57-60. Accept non-integer number of turns.	2

Q6.

Question number	Answer	Notes	Marks
(a) (i)	recall of equation: speed = frequency × wavelength; substitution or re-arrangement; correct evaluation; correct answer = 0.013 (m) e.g. speed = frequency × wavelength wavelength = speed ÷ frequency wavelength = 330 ÷ 25000 wavelength = 0.0132... (m)	allow use of standard symbols e.g. $v = f \times \lambda$ condone s for speed reject w for wavelength answer to 3sf is 0.0132 (m)	3
(ii)	amplitude corresponds to 2 squares; 2 squares gives 10 V for amplitude;	ecf incorrect number of squares for amplitude e.g. 4 squares giving 20V scores 1 mark	2
(b) (i)	field lines outside of coil appear to loop from end to end; arrow directions self-consistent; no overlapping field lines;	allow field lines approximately uniform through solenoid condone incorrect poles	3
(ii)	any THREE from: MP1. idea of force on coil from magnet; MP2. idea of alternating force on card; MP3. card vibrates; MP4. idea that card forces air to vibrate; MP5. longitudinal wave formed;	allow idea of interaction between fields of bar magnet and coil allow idea of series of compressions and rarefactions	3
(iii)	idea that 25 kHz is outside the range of human hearing; upper limit of human hearing is 20 kHz;	ignore reference to 20Hz or lower limit	2
(iv)	increase current (amplitude)/ increase strength of (bar) magnet/ increase number of turns on coil;	allow increase density of turns on coil condone change card for a different material allow change size or shape of card allow moving magnet closer to the coil allow higher order answers in terms of resonance	1
		Total for Question: 14 marks	

Q7.

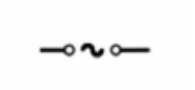
Question number	Answer	Notes	Marks
(a)	coil of wire; current in the wire; iron core;	 current may be inferred from diagram	3
(b)	down;	allow force arrow drawn pointing down on diagram	1
(c) (i)	time taken; for {activity / number of (radioactive) nuclei / amount of isotope / count rate} to halve;	 allow atoms for nuclei	2
(ii)	any two from: MP1. radiation unlikely to penetrate out of walls; MP2. (more than) two half-lives have passed; MP3. amount of barium-133 remaining is less (than 25%); MP4. visitors exposed to radiation for very short time;	 allow idea that activity / amount of radiation is (much) less than before	2

Q8.

Question number	Answer	Notes	Marks
(a)	(to the) left; (because) repulsion (due to like magnetic poles);	allow towards A, away from B ignore backwards reject if mention of charge	2
(b) (i)	0.045 (kg m/s);	allow 'the same'	1
(ii)	momentum of B after collision = 0.045 – (-0.021); evaluation; e.g. 0.045 - −0.021 (momentum =) 0.066 (kg m/s)	 allow 0.024 for 1 mark allow 0.045 + 0.021	2
(iii)	substitution into F = change in momentum / time taken; evaluation; e.g. F = 0.066 / 0.19 (F =) 0.35 (N)	allow ECF from (ii) use of 0.024 from (ii) gives 0.126... (N) allow 0.347... (N)	2
(iv)	(to the) right;	allow towards B, away from A	1
		(Total for Question = 8 marks)	

Q9.

Question number	Answer	Notes	Marks
(a)	reference to a coil or solenoid; reference to a core; reference to a current; reference to a named magnetic material; i.e. (soft) iron or steel	all marks can be scored by a labelled diagram(s) allow reference to 'material that magnetises and demagnetises easily'	4

(b)	(i)	period given as 4 squares; correct use of *x* scale; subsequent correct evaluation of period; correct answer: 0.002 (s) e.g. period is 4 squares period = 4 x (0.50 ÷ 1000) = 2(.0) × 10^{-3} (s)	ECF candidate's reading of period in squares -1 for POT error Accept 2(.0) ms	3
	(ii)	substitution into given equation; evaluation; correct answer: 500 Hz e.g. frequency = 1/0.002 frequency = 500 (Hz)	allow ECF from (i) -1 for POT error from candidate's answer from (i)	2
	(iii)	statement of at least one frequency boundary of human hearing; valid comparison of answer to (ii) with relevant frequency boundary;	condone 25 Hz for lower boundary	2
	(iv)	(trace) goes both positive and negative/eq; frequently/continuously/eq;		2
	(v)	symbol with two clear terminals and (sine) wave; 		1

Q10.

Question number	Answer	Notes	Marks
(a) (i)	neutron / n;		1
(ii)	correct evaluation; given to 1s.f.; e.g. (number =) $3.3... \times 10^{11}$ (number =) 3×10^{11}	 independent mark	2
(iii)	any three from: MP1. nuclei move (too) slowly at low temperature; MP2. nuclei interact/collide less often at low temperature; MP3. nuclei repel each other; MP4. nuclei cannot get close enough / don't have chance to undergo fusion;	allow RA in terms of high temperature/pressure allow atoms/particles/hydrogen for nuclei allow nuclei not having enough KE allow less chance of collisions	3
(b) (i)	nucleus must be moving; downwards;	allow travelling for moving reject if implication that movement is caused by the force	2
(ii)	increase magnetic field strength / increase speed of nucleus / increase temperature of reactor;	allow use stronger magnets	1

Q11.

Question number	Answer	Notes	Marks
(a)	creation of a (large) nucleus from small **nuclei**; resulting in a loss of mass; and the release of energy;	condone "fusing of two nuclei" accept reference to $E=mc^2$ condone "converted to energy"	3
(b) (i)	electrical working;	condone 'electrically'	1
(ii)	substitution in $V_{in}I_{in} = V_{out}I_{out}$; re-arrangement; evaluation; correct answer = 1.8 (kA) e.g. input power = output power $V_{in}I_{in} = V_{out}I_{out}$ $28 \times 21 = 330 \times I_{out}$ $I_{out} = (28 \times 21) \div 330$ $I_{out} = 1.7818...$	-1 POT error	3
		Total for Question: 7 marks	

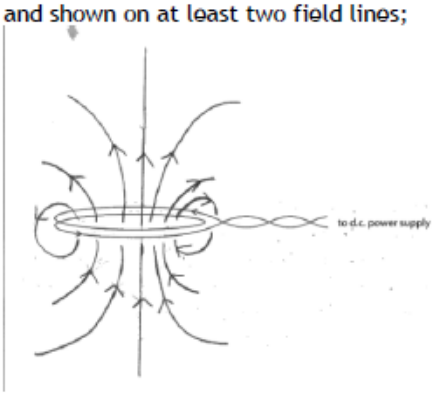
Q12.

Question number	Answer	Notes	Marks
(a)	any four from: MP1. idea that step-down means secondary voltage is less than primary voltage; MP2. current in (primary) coil produces magnetic field; MP3. the current is changing / has frequency of 50 Hz; MP4. causing a (changing) magnetic field in the core; MP5. the core strengthens the magnetic field; MP6. the secondary coil experiences a changing magnetic field; MP7. which induces a voltage in the secondary coil;	allow RA allow recognition that alternating current is used allow 'secondary is cut by (changing) field lines' allow current for voltage	4
(b) (i)	$(N_p/N_s) = (V_p/V_s)$;	allow any correct rearrangement allow "i(nput) and o(utput)" or "1 and 2"for "p(rimary) and s(econdary)" allow correct word equation ignore 'P' for 'N' condone 'T', 't' or 'n' for 'N' condone 'coils' for 'turns'	1
(ii)	substitution; rearrangement; evaluation; e.g. $(160/45) = 12/V_s$ $V_s = 12 / (160/45)$ $(V_s =) 3.4$ (V)	 allow 3.375 (V)	3
		Total for Question = 8 marks)	

Q13.

Question number	Answer	Notes	Marks
(a)	neutral particle has same number of protons and electrons; positive particle has more protons than electrons;	ignore neutral particle has no charge allow positive particle has lost electrons reject positive particle has gained protons	2
(b)	(sulfur particles are) attracted to negative plate/repelled by positive plate; (sulfur) particles experiences a (resultant) force (to the right);	accept correct use of "like charges repel" or "unlike charges attract"	2
(c) (i)	D - (into the page); A is incorrect because the force, direction of travel and magnetic field must be at right angles to each other B is incorrect because the force, direction of travel and magnetic field must be at right angles to each other C is incorrect because this would result in a force in the opposite direction to that shown		1
(ii)	substitution into given formula; rearrangement; evaluation; e.g. $2.9 \times 10^8 = (2 \times \pi \times 1.1(\times 10^3)) \div$ orbital period orbital period = $(2 \times \pi \times 1.1(\times 10^3)) \div 2.9 \times 10^8$ (orbital period =) 2.4×10^{-5} (s)	-1 for POT error allow $2.383... \times 10^{-5}$ (s)	3
		Total for Question = 8 marks	

Q14.

Question number	Answer	Notes	Marks
(a)	A (into the page); B is incorrect because this field would produce a force into the page C is incorrect because this field would produce a force to the left D is incorrect because this field would not produce a force at all		1
(b)	at least one straight, vertical central field line; at least one field line drawn circling the wire / at least one peripheral field loop; field direction correct and consistent throughout and shown on at least two field lines;  	ignore breaking of field lines as they pass through the centre of the coil judge by eye condone spiral drawn around wire DOP	3
(c) (i)	any three of: MP1. (current produces) alternating magnetic field (in charging base coil); MP2. idea that field is cut by coil in phone; MP3. voltage induced (across coil in phone); MP4. therefore current in battery (from coil in phone);	allow equivalent words for alternating e.g. variable, changing etc. allow higher level responses in terms of flux linkage	3
(ii)	any **one** advantage; e.g. battery will charge faster / stronger magnetic field any **one** disadvantage; e.g. causes a great(er) heating effect	condone 'greater risk of electric shock'	2

Q15.

Question number	Answer	Notes	Marks
(a)	step-up transformer increases voltage OR step-down transformer decreases voltage; step-up transformer reduces current; (lower current means) lower heating/energy losses; (town) requires low voltage {for safety / to reduce chance of electrocution / so appliances operate correctly};		4
(b) (i)	$N_p/N_s = V_p/V_s$;	allow any correct rearrangement or word formula allow n, T for turns allow 1, in for p allow 2, out for s	1
(ii)	substitution; rearrangement; evaluation; e.g. $3300/N_s = 15/340$ $N_s = (3300 \times 340) \div 15$ (N_s =) 75 000	 -1 for POT error allow 74 800	3
(c) (i)	thermal (store);	condone heat	1
(ii)	any three from: MP1. field lines cut by core; MP2. idea of an induced voltage; MP3. conductors have **free** electron(s); MP4. idea that there is a force on the electron(s); MP5. idea that the movement of electrons is the current;		3
		Total for Question = 12 marks	

Q16.

Question number	Answer	Notes	Marks
(a) (i)	(soft) iron;	accept other suitable ferromagnetic materials	1
(ii)	input power = output power; OR primary voltage × primary current = secondary voltage × secondary current;	allow • formula in words or symbols • standard abbreviations: i.e. s, p, in, out, 1, 2	1
(iii)	substitution; rearrangement; evaluation; e.g. $275\,000 \times I_p = 230 \times 95$ $(I_p =) \; 230 \times 95 \; / \; 275\,000$ $(I_p =) \; 0.079$ (A)	 -1 for POT error 79.45...(A) scores 2 marks allow 0.07945...	3
(b)	any five from: MP1. step-up transformer used before transmission; MP2. voltage is increased before transmission; MP3. current is reduced before transmission; MP4. less heating in transmission cables; MP5. less energy wasted in transmission cables; MP6. step-down transformer used after transmission; MP7. voltage is decreased after transmission **for safety**;	allow any mark if clear from diagram	5

Q17.

Question number	Answer	Notes	Marks
(a) (i)	substitution; evaluation; e.g. (P =) 1.2 × 5.0 (P =) 6.0 (W)	 allow 6 (W)	2
(ii)	substitution using same power as (a)(ii); rearrangement; evaluation; e.g. 6.0 = I × 230 (I =) 6.0 / 230 (I =) 0.026 (A)	allow ECF from (a)(i) allow 0.03 (A)	3
(b) (i)	charge = current × time;	allow rearrangements and standard symbols e.g. Q = I × t reject c, C for current, charge	1
(ii)	substitution of 1.2 A for current; correct evaluation in seconds; evaluation in minutes; e.g. 10500 = 1.2 × time OR t = 10 500 / 1.2 (t =) 8750 (s) (t =) 150 minutes	 -1 POT error mark independently allow 146, 145.83... 145 minutes gets 2 marks only condone fractional minutes i.e. 145 5/6 min)or combined minutes & seconds i.e. 145:50	3
(iii)	time will be less / eq; (because) current is greater;	 allow numerical statement e.g. "current is now 2.1A" reject reference to input current	2

(c)	any four from: MP1. (step-down) transformer decreases voltage; MP2. current in (primary) coil produces magnetic field; MP3. current is changing / alternating; MP4. causing a (changing) magnetic field in the core; MP5. the core strengthens the field (at the secondary coil) /eq; MP6. field lines interact with secondary coil; MP7. which **induces** a voltage in the secondary coil; MP8. transformers won't work with (constant) d.c.;	accept input/output for primary/secondary allow idea of fewer turns on secondary (than primary) including on the diagram (e.g. clearly more turns drawn and P/S coils labelled) allow (primary) coil becomes an electromagnet allow 'current is a.c.' allow reference to magnetise and demagnetise allow field lines cutting secondary coil allow **induces** a current in the secondary coil	4
		Total for Question = 15 marks	

Q18.

Question number	Answer	Notes	Marks
(a)	step-down;		1
(b)	$\frac{\text{input (primary) voltage}}{\text{output (secondary) voltage}} = \frac{\text{primary turns}}{\text{secondary turns}}$;	allow V for voltage, n or N or t or T for turns, allow subscripts 'i' and 'o' or 'p' and 's' or '1' and '2'	1
(c) (i)	substitution into correct turns ratio equation; rearrangement to find V_s; substitution into $V_pI_p=V_sI_s$; rearrangement to give I_s; evaluation; e.g. $230/V_s = 16/4$ $V_s = 230 / 4 = 57.5$ (V) $230 \times 11 = 57.5 \times I_s$ $I_s = 230 \times 11 / 57.5$ $I_s = 44$ (A)	ecf from incorrect V_s	5
(ii)	D; A, B and C are all rated below the nominal current of the input coil, so would all 'blow' instantly.		1
		Total for Question = 8 marks	

Q19.

Question number	Answer	Additional guidance	Mark
(a)(i)	Advantage: any suitable (1) e.g. • does not contribute to global warming • wind available in all parts of Earth • can be used on a large or small scale Disadvantage: any suitable (1) e.g. • noisy • visual pollution • harm to (migratory flocks of) birds	ignore renewable as given in the stem	2

Question number	Answer	Additional guidance	Mark
(a)(ii)	A description that makes reference to the following three points: • no output until 5 m/s (1) • linear increase of output from 5 m/s to 15 m/s (1) • output constant at 0.6 MW for speeds over 15 m/s (1)	data points must be referenced allow 1 mark for correct trend without any data references.	3

Question number	Answer	Additional guidance	Mark
(b)	A description that includes reference to five of the following points: construction: • soft iron core (1) • primary coils (1) • secondary coils (1) operation: • lower voltage applied to the primary coils/RA (1) • must be a.c. (1) • number of primary coils< secondary coils (1) • turns ratio of 220 (1)	may be shown on a labelled diagram	5

(Total for question = 10 marks)