PEARSON EDEXCEL IGCSE PHYSICS · 4PH1

PHYSICS



MARK SCHEME

SECTION 2: ELECTRICITY (PACK 2)

SCORE	PERCENTAGE
/183	%

STEMUP

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Mark Scheme

Q1.

Question number	Answer	Notes	Marks
(a)	plate loses negatively charged particles; (loses) electrons;	reject response that infers positive electrons 'plate loses electrons' scores 2 marks.	2
(b) (i)	plate and ball have same (sign) charge; (so there is a) repulsive force on the ball (from that plate);	accept 'attractive force from other plate' / 'like charges repel' / 'plate X is negative and opposite charges attract' for 2 marks	2
(ii)	metal is a conductor;	allow 'it conducts'	1
(c) (i)	charge (transferred) = current x time;	allow standard symbols and rearrangements e.g. I = Q / t reject C or c for current	1
(ii)	substitution and rearrangement; evaluation; correct answer: 1.1 x 10^{-5} (A) e.g. charge = current x time current = charge / time = 5.1 x 10^{-6} / 0.45 current = 1.1(3) x 10^{-5} A	 allow factor of 2 either way i.e. {2.2 / 0.55} x 10^{-5} POT error scores -1	2
(iii)	any ONE of: • larger charge transfer (per trip); • ball gains more kinetic energy; • more trips per second;	 ignore 'V=IR' argument	1
(iv)	ammeter;		1
		Total for Question	= 10 marks

Q2.

Question number	Answer	Notes	Marks
(a)	A helium **nucleus** / 2 protons and 2 neutrons/ 4 nucleons, 2 protons;	Ignore chemical symbol	1
(b) (i)	Arrow labelled Y, through X away from nucleus; Line of action of force would pass through centre of nucleus by eye;		2
(ii)	Arrow labelled Z, opposite direction to their answer from b) (i) by eye; Same size as their answer from b) (i) by eye;	If no arrow Y, condone correct direction for arrow Z, i.e. force arrow pointing away from point X.	2
(iii)	MP1 Force on alpha is repulsive; MP2 Alpha and nucleus must be same (type of) charge; MP3 Alpha is positive **therefore** nucleus is positive;	Allow 'like charges repel' for MP1 and MP2	3
(c)	Selection of F = ma; Substitution or re-arrangement; Evaluation; e.g. a = 3.6 / 6.6 x 10^{-27} = 5.5 x 10^{26} m/s^2	Can be implied from working -1 for PoT error Allow 5.45 x 10^{26}, 5.454 x 10^{26}, 5.4545... x 10^{26} etc Condone 5.4 x 10^{26}	3

Q3.

Question number	Answer	Notes	Marks
(a)	movement of electrons; bucket gains electrons;	scores both marks	2
(b)	(droplets in each stream are) like/same charge; (like charges) repel;	ignore attraction to bucket	2

(c)	(i)	use of KE = ½mv^2; substitution; evaluation; e.g. KE = ½mv^2 KE = ½ × 6.2 × 10^{-9} × 3.8^2 (KE =) 4.5 × 10^{-8} (J)	stated or implied by working -1 for POT error allow 4.4 × 10^{-8}, 4.47 × 10^{-8} = 2 marks allow 4.4764 × 10^{-8} (J)	3
	(ii)	substitution into Q = It; rearrangement; evaluation; e.g. 1.1 × 10^{-10} = current × 9.2 × 10^{-3} current = 1.1 × 10^{-10} / 9.2 × 10^{-3} current = 1.2 × 10^{-8} (A)	stated or implied by working -1 for POT error allow 1.195... × 10^{-8} (A)	3
	(iii)	substitution into E = QV; conversion of kV to V; evaluation; e.g. E = 1.1 × 10^{-10} × 1.7 1.7 kV = 1700 V (E =) 1.9 × 10^{-7} (J)	allow **valid** substitution into E=VIt ignore units allow 1700 or ×1000 seen anywhere in working -1 for POT error allow 1.87 × 10^{-7} (J), 1.88 × 10^{-7} (J), 1.8768 × 10^{-7} (J)	3
			(Total for Question = 13 marks)	

Q4.

Question number	Answer	Notes	Marks
(a)	any four of: MP1. idea of friction/rubbing (between powder and funnel/plastic tubing); MP2. powder becomes charged; MP3. metals are conductors; MP4. charge is transferred to/from metal rod and thin piece of metal; MP5. metal rod and thin piece of metal have the same charge; MP6. therefore they repel / eq;	 ignore whether positive or negative charge allow electrons transferred	4
(b) (i)	A (gains negatively charged electrons); B is incorrect because it would leave the metal can positively charged C is incorrect because electrons are not positively charged D is incorrect because electrons are not positively charged		1
(ii)	charge = current × time;	allow standard symbols and rearrangements e.g. $Q = I \times t$ reject use of C/c for charge or current	1
(iii)	substitution; rearrangement; evaluation; e.g. (-) 9.4×10^{-9} = current × 12 (current =) (-) 9.4×10^{-9} / 12 (current =) (-) 7.8×10^{-10} (A)	 -1 for POT error $7.83... \times 10^{-10}$ (A)	3
(c)	any three of: MP1. any relevant danger; MP2. idea that metal can/aircraft should be earthed; MP3. charge will flow to/from ground; MP4. idea that no charge will build up on metal can/aircraft;	 e.g. spark, explosion, fire allow description of earthing e.g. 'connect metal can to ground with a wire' allow addition of earth path to diagram allow idea that 'charge is neutralised'	3

Q5.

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

Q6.

Question number	Answer	Additional guidance	Mark
(a)	Idea of friction (between particles)	allow rubbing	1

Question number	Answer	Additional guidance	Mark
(b)	An explanation linking: • electrons in the ground (1) • are repelled from the surface layers (1)	 reject for one mark movement of positive charges	2

Question number	Answer	Additional guidance	Mark
(c)(i)	To remove (or add) electrons from the outer shells/levels of an atom	allow turning (atoms) into ions	1

Question number	Answer	Additional guidance	Mark
(c)(ii)	Charge = current × time	allow in words or any rearranged form e.g. $Q = I \times t$	1

Question number	Answer	Additional guidance	Mark
(c)(iii)	• Rearrangement • Substitution and evaluation $t = Q/I$ (1) = 15/32 000 = 0.00047 (s) (1)	POT error = −1 award full marks for correct numerical answer without working	2

Question number	Answer	Additional guidance	Mark
(c)(iv)	Process includes: • substitution of V (= IR) into energy equation • substitution • rearrangement • evaluation $E = QIR$ (1) $510 \times 10^6 = 15 \times 32 \times 10^3 \times R$ (1) $(R =) \frac{510 \times 10^6}{15 \times 32 \times 10^3}$ (1) 1060 (Ω) (1)	allow calculation of V from $E = QV$ or $E = VIt$ allow substitution into $V = IR$ allow rearrangement of $V = IR$ 1062.5 must see answer to at least 2 significant figures in order to determine that evaluation is correct some supporting working must be seen with correct answer to receive full marks	4

(Total for question = 11 marks)

Q7.

Question number	Answer	Notes	Marks
(a)	(force to the) right; (because) opposite charges attract / like charges repel;	allow 'towards the positive plate" or "away from the negative plate"	2
(b)	line drawn showing the ink drop deflecting to the right of the centre and hitting paper below; line drawn starts vertical and becomes increasingly more curved as the ink drop moves towards paper;	allow ECF from (a) if direction of force to the left DOP	2
(c) (i)	substitution into force = mass × acceleration; rearrangement; evaluation; e.g. $8.5 \times 10^{-7} = 1.1 \times 10^{-10} \times a$ (a =) $8.5 \times 10^{-7} / 1.1 \times 10^{-10}$ (a =) 7700 (m/s^2)	 -1 for POT error allow 7727.27...	3
(ii)	use of $v^2 = u^2 + (2 \times a \times s)$; substitution OR rearrangement; evaluation in metres; conversion to mm; e.g. $v^2 = u^2 + (2 \times a \times s)$ $3.9^2 = 0 + (2 \times 7700 \times s)$ OR $s = (v^2 - u^2) / 2a$ (s =) 9.9×10^{-4} (m) (s =) 0.99 (mm)	can be implied from substitution allow ECF from (i) independent mark award if correct conversion attempted on incorrect answer allow 9.8×10^{-4} - 9.9×10^{-4} allow 0.98 - 0.99	4

(d)	idea of swapping polarities of plates; idea of increasing the amount of charge on plates;	allow positively charging ink drop allow increasing amount of charge on ink drop allow decreasing {mass or volume} of the ink drop	2

Q8.

Question number	Answer	Notes	Marks
(a)		ignore statements relating to paint as a whole being attracted to the object	3
	paint particles are positively charged;	allow idea of particles being given same charge condone particles being negatively charged	
	paint particles repel/like charges repel;	Allow idea that paint particles are attracted to the electrons in the (metal) object	
	producing a thin / even coat of paint;	allow idea that paint finish is improved allow idea that paint reaches parts that would otherwise be difficult	
(b)	any three from: MP1. object becomes charged when paint particles land on it; MP2. (without earthing) further paint particles would be repelled by the object as they have the same charge; MP3. earthing discharges object; MP4. electrons transferred between Earth and object; MP5. (earthing means) paint continues to reach object/ giving thicker coat/give even coverage;	allow 'neutralises object' or 'object becomes neutral'	3
		Total for question = 6 marks	

Q9.

Question number	Answer	Notes	Marks
(a) (i)	idea that the dome loses electrons;	however expressed reject if idea that positive charge has been transferred	1
(ii)	substitution into $E = V \times I \times t$; rearrangement; evaluation; e.g. $0.50 = 120\,000 \times I \times 15$ $I = 0.50 / [120\,000 \times 15]$ $(I =) 2.8 \times 10^{-7}$ (A)	ignore units -1 for POT error allow 0.000 000 277...(A) condone 2.7×10^{-7} (A)	3
(b) (i)	any three from: MP1. metal case loses electrons; MP2. (because) metal case is a conductor; MP3. dome and metal case have the same charge; MP4. repulsion between dome and metal case;	 allow metal case becomes (positively) charged	3
(ii)	any four from: MP1. repulsive force from dome decreases as separation increases; MP2. named downward force e.g. weight, air resistance acts on the case; MP3. (eventually, resultant) downwards force acts on case; MP4. causing the case to slow down; MP5. kinetic energy decreases; MP6. gravitational potential energy increases; MP7. kinetic energy becomes zero (at maximum height);	 allow speed becomes zero	4

Q10.

Question number	Answer	Notes	Marks
(a) (i)	idea of rubbing / friction; with another insulator;	allow **suitable** named insulator e.g. duster, cloth, hair etc.	2
(ii)	C (-0.0052 C); A is incorrect because this is equivalent to -520 mC B is incorrect because this is equivalent to -52 mC D is incorrect because this is equivalent to -0.52 mC		1
(iii)	A (the rod has gained negatively charged electrons); B is incorrect because electrons are not positively charged C is incorrect because this would make the rod positively charged D is incorrect because electrons are not positively charged		1
(iv)	suitable method of demonstrating; correct observation;	e.g. • place rod on electroscope • place rod near stream of water from a tap • place rod near hair • place rod above small pieces of paper • place rod near another (charged) rod e.g. • leaf on electroscope deflects • water moves towards rod • hair moves towards rod • paper moves towards rod • rods move towards/away from each other	2
(b) (i)	photocopiers / inkjet printers / smoke precipitators / (electrostatic) spray painting;	allow any correct use	1
(ii)	risk of a spark; (causing) explosion / fire;		2

Q11.

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

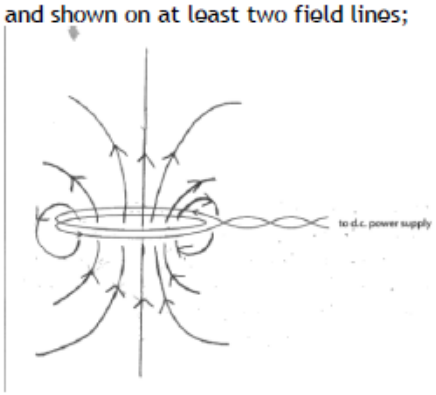
Q12.

Question number	Answer	Notes	Marks
(a)	D; A cannot be correct as this is a description of fission B cannot be correct as this is a description of gamma decay C cannot be correct as this is a description of beta decay		1
(b)	(nuclei are) positively charged; like charges repel;	reject idea of charged atoms	2
(c)	high temperature; high pressure;	'high temperature and pressure' scores 2 marks	2

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)	insulator;	Allow 'non/not conductive'	1
(b)	any reference to electron transfer; loss (of electrons);	idea of 'loss of electrons (from tube)' scores 2. reject any reference to movement of positive charges	2
(c)	electrons move through wire; as they are attracted by or to the metal mast; idea that this makes metal mast neutral (again);	allow idea of 'opposite charges attracting' allow idea of 'to earth/earthing the mast' if no other mark scored	3
(d)	recall of **equation energy = charge × voltage**; substitution or re-arrangement; evaluation; correct answer = 860 (V) e.g. energy = charge × voltage voltage = energy/charge = 3.7/0.0043 voltage = 860.465... (V) voltage = 860 (V)	allow use of standard symbols e.g. E = Q × V reject C,c for charge -1 for PoT error	3
(e)	spark/discharge; damage/harm/injury/electrocution (of engineer);		2
		Total for Question : 11 marks	

Q16.

Question number	Answer	Notes	Marks
(a)	any FOUR from: advantages: MP1 no carbon (dioxide) emissions; MP2 no contribution to { global warming / greenhouse effect / acid rain }; MP3 is renewable; MP4 low maintenance/no moving parts; disadvantages: MP5 needs a favourable climate; MP6 needs long days /doesn't work at night; MP7 needs a lot of space; MP8 cannot respond to rapid changes in demand;	ignore unnamed 'greenhouse gases'	4
(b)	d.c. travels in one direction only; a.c. changes direction **frequently/continuously**;		2
		Total for Question = 6 marks	

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	