PEARSON EDEXCEL IGCSE PHYSICS · 4PH1

PHYSICS



MARK SCHEME

SECTION 2: ELECTRICITY (PACK 1)

SCORE	PERCENTAGE
/308	%

STEMUP

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Mark Scheme

Q1.

Question number	Answer	Notes	Marks
(a)	filament lamp / LED / ammeter; added in **series** with other components;	marks may be awarded if shown on circuit diagram allow other components that would give a visual indication e.g. buzzer, motor etc. DOP	2
(b) (i)	electron(s);		1
(ii)	substitution into charge = current × time; conversion of mA to A; evaluation of total charge; evaluation of number of charged particles; e.g. charge = 160 × 25 charge = 0.16 × 25 (charge =) 4.0 (C) number of particles = $(4.0/1.6\times10^{-19}) = 2.5\times10^{19}$	-1 for POT error 4000 scores 2 marks	4
(iii)	fewer charged particles / electrons (each second); with any **two** from: current (in circuit) is decreased; voltage is the same; current is rate of flow of charge;		3
		Total for question = 10 marks	

Q2.

Question number	Answer	Notes	Marks
(a)	any FOUR from: MP1. idea of magnetic field around coil (when current flows); MP2. idea of interaction between fields of magnet and coil; MP3. idea of force on coil from magnet; MP4. idea of alternating force on cone; MP5. cone vibrates; MP6. idea that cone forces air to vibrate; MP7. longitudinal wave formed;	ignore references to induction allow 'tube' for 'cone' allow idea of series of compressions and rarefactions	4
(b) (i)	substitution; evaluation; correct answer = 0.11 (W) e.g. power = current × voltage = 0.15 × 0.75 power = 0.1125 W	-1 for POT error	2
(ii)	suitable linear scale chosen (>50% of grid used); axes labelled with quantities and units; all plotting correct to nearest half square;	ignore orientation	3
(iii)	attempt at fitting first two points and fitting rest of points separately; single curve with a peak within one large square of third point;	ecf candidate's plotting max 1 mark for straight line consistent with candidate's plotting	2
(c)	any FOUR from: MP1. for diagram 4, cell voltage no longer shared; MP2. means current through each loudspeaker is doubled; MP3. so current from supply is four times higher; MP4. correct use of 'R = V/I'; MP5. (so) total resistance is a quarter of that from the series case;	accept voltages in parallel are the same accept voltage is shared in diagram 3 accept idea of current from each branch adds to give total current in cell accept higher order answers in terms of series and parallel equations accept calculation of both circuit's total resistance	4
			(Total for Question = 15 marks)

Q3.

Question number		Answer	Notes	Marks
(a)	(i)	voltmeter in parallel with component X;		1
	(ii)	light dependent resistor / LDR;		1
(b)	(i)	evidence of use of graph; 1700 (ohms);	 accept range 1650-1750 (ohms) allow full marks for 1700	2
	(ii)	evidence of use of voltage = current x resistance; substitution; evaluation; correct answer = 3.1 (V) e.g. V = IR V = 0.0018 × 1700 V = 3.06 (V)	allow use of standard symbols e.g. V = I × R accept v, V, i , I, r, R allow ECF from (i)	3
	(iii)	brightness decreases; plus ONE from: resistance (of circuit) increases; current in circuit decreases;	reject reference to covering the lamp reducing the brightness of the lamp	2
			(Total for Question = 9 marks)	

Q4.

Question number	Answer	Notes	Marks
(a)	D (the Sun); A is incorrect because a comet is the smallest object B is incorrect because the Earth is smaller than the Sun C is incorrect because the Earth and the Sun are larger than the Moon		1
(b)	A (alpha); B is incorrect because beta is less ionising than alpha C is incorrect because gamma is less ionising than alpha D is incorrect because gamma has a higher frequency than UV so is more ionising		1
(c)	B (ohm); A is incorrect because ampere is the unit for electric current C is incorrect because volt is the unit for voltage D is incorrect because watt is the unit for power		1
(d)	D (x-ray); A is incorrect because infrared has a longer wavelength than ultraviolet and x-ray B is incorrect because microwave has the longest wavelength C is incorrect because ultraviolet has a longer wavelength than x-ray		1
(e)	C (273 K); A is incorrect because this is subtracting 273, rather than adding 273 B is incorrect because this is adding 3, rather than adding 273 D is incorrect because this is adding 373, rather than adding 273		1
		Total for question	= 5 marks

Q5.

Question number	Answer	Notes	Marks
(a)	calculation of energy transferred by battery; efficiency formula stated; correct substitution; evaluation; e.g. energy supplied = VIt = 12 × 0.25 × 12 = 36 (J) efficiency = <u>useful energy output</u> total energy output efficiency = 25 / 36 (×100%) efficiency = 69 (%)	36 (J) seen seen or implied anywhere in working allow ecf from battery energy if clear 25/36 (×100) seen allow 70, 69.4...(%)	4
(b) (i)	current / coil has a magnetic field; interaction between fields; resulting in a force; forces on opposite sides of the coil are in opposite directions;	 ignore references to attraction / repulsion	4 1
(ii)	C - YZ; A is incorrect because WX moves downwards B is incorrect because part of XY moves downwards D is incorrect because part of ZW moves downwards		

Q6.

Question number	Answer	Notes	Marks
(a) (i)	idea that voltage across thermistor + voltage across fixed resistor = voltage across cell; 0.59 (V);	 allow 0.632 (V)	2
(ii)	voltage = current × resistance;	allow standard symbols and rearrangements e.g. V, I and R ignore c,C for current	1
(iii)	substitution; rearrangement; evaluation; e.g. 0.59 = 0.0062 × R R = 0.59 / 0.0062 (R =) 95 (Ω)	ecf answer from (i) -1 for POT error answers of R = 90.7... or R = 101.9...(Ω) gain full marks answer of 242 (Ω) gains 2 marks allow 95.2, 95.16... condone 95.1	3
(b) (i)	idea that resistance of thermistor decreases with an increase in temperature; idea of non-linear relationship;	 allow idea that rate of change is decreasing resistance inversely proportional to temperature scores both marks	2
(ii)	voltmeter reading decreases; (because) resistance **of thermistor** increases; idea that current in circuit/thermistor decreases;	allow voltage across resistor decreases	3

Q7.

Question number	Answer	Notes	Marks
(a) (i)	12 (V);		1
(ii)	voltage = current × resistance;	allow standard symbols and rearrangements e.g. R = V / I	1
(iii)	substitution; rearrangement; evaluation; e.g. 12 = 0.019 × R (R =) 12 / 0.019 (R =) 630 (Ω)	allow ecf from (i) -1 for POT error 0.631... scores 2 marks if 35mA used as the current (giving 342.8...) then award 2 marks max. allow 632, 631.6, 631.57...	3
(b) (i)	idea that current is conserved at a junction in a circuit;	e.g. current before and after junction must be the same, 16 + 19 = 35 etc. ignore "current is shared"	1
(ii)	use of voltage = current × resistance; calculation of total resistance of path (750 Ω); idea that resistances of two resistors in series adds up to total resistance; evaluation of resistance of Y; e.g. 12 = 0.016 × R_T R_T = 750 (Ω) 750 = 250 + R_Y R_Y = 500 (Ω)	must be more than just quoting the formula for the mark calculation of voltage across 250 Ω resistor (4.0 V) evaluation of voltage across R (8.0 V) evaluation of resistance of R (using V=IR) if mA not converted to A and 0.75 seen then award 2 marks max.	4

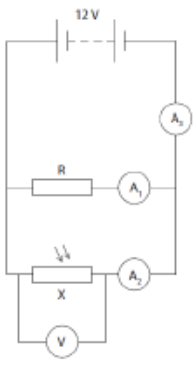
(c)	current decreases; with any one from: • (total) resistance of circuit has increased; • idea that there are now less paths for the current in the circuit;	DOP	2
		Total for Question = 12 marks	

Q8.

Question number	Answer	Notes	Marks
(a)	both symbols for voltmeter and ammeter drawn correctly; ammeter drawn in series with resistor; voltmeter drawn in parallel with resistor;	 allow if drawn in parallel with cell	3
(b) (i)	power = current × voltage;	allow standard symbols and rearrangements e.g. P = I × V ignore C, c for current	1
(ii)	substitution; evaluation; e.g. P = 0.00191 × 9.00 (P =) 0.0172 (W)	allow sub in A or mA -1 for POT error 17, 17.2, 17.19 = 1 mark allow 0.017, 0.01719 (W)	2
(c)	a current that only has one direction / eq;	allow current that flows in same direction	1
(d)	current would decrease; (because) resistance of circuit is greater than before;	allow current is now half / 0.955 (mA) / 0.000955 (A) allow resistance is double	2

Q9.

Question number	Answer	Mark
(a)(i)	An LDR (light-dependent resistor)	1

Question number	Answer	Mark
(a)(ii)	• correct symbol (1) • correct position in parallel with X (1) 	2

Question number	Answer	Additional guidance	Mark
(b)	rearrangement • $I = V/R$ (1) substitution • I = 12/840 (= 0.014 (A)) (1)	0.01429 (A) some evidence of working required for two marks	2

Question number	Answer	Additional guidance	Mark
(c)(i)	correct addition of current in A_1 with current in A_2 = 0.021 (A) (1)	ecf from 3(b) 0.025 (A) award full marks for correct numerical answer without working	1

Question number	Answer	Mark
(c)(ii)	An explanation that makes reference to the following points: • resistance of LDR increases (1) • hence current in A_2/A_3 decreases (1)	2

(Total for question = 8 marks)

Q10.

Question number	Answer	Mark
(a)	• Axes shown with either voltage or current against time AND more than one wavelength shown (1) • Continuous curve drawn that alternates to + and −, and has approximately equal displacement on either side of x-axis (1)	2

Question number	Answer	Additional guidance	Mark
(b)	A diode only allows current in one direction	allow answers which describe what would happen to a battery with a.c.	1

Question number	Answer	Additional guidance	Mark
(c)(i)	• All circuit symbols correct (1) • Bulbs shown in series (1)	allow cell for battery reject power supply symbol	2

Question number	Answer	Additional guidance	Mark
(c)(ii)	Power = current × voltage	allow rearrangement and correct symbols, e.g. $P = I \times V$	1

Question number	Answer	Additional guidance	Mark
(c)(iii)	Process includes: • rearrangement • evaluation e.g. $I = P/V$ (1) = 0.33/6.0 = 0.055 (A) (1)	1 mark max if incorrect V is used	2

(Total for question = 8 marks)

Q11.

Question number	Answer	Additional guidance	Mark
(a)	In order to vary the current/voltage	allow because there is no variable voltage supply	1

Question number	Answer	Additional guidance	Mark
(b)(i)	A description that makes reference to the following three points: • a simple pattern statement e.g. as the voltage increases the current increases (1) • a statement about linearity e.g. gradient decreases with voltage (1) • reference to data from the graph e.g. at 0 V the current in 0 A, but at 10 V, the current is 0.16 A (1)	allow alternative statements the increase is greater at low voltages	3

Question number	Answer	Additional guidance	Mark
(b)(ii)	voltage = current × resistance	equation can be given in words or accepted symbols	1

Question number	Answer	Additional guidance	Mark
(b)(iii)	• Rearrangement • Substitution • Evaluation e.g. R = V/I (1) = 2.5/0.92 (1) 2.7 (Ω) (1)	seen anywhere allow a range of ±0.02 A for the reading of current from graph max two marks if current incorrect	3

Question number	Answer	Mark
(c)	Increases/equivalent	1

Q12.

Question number	Answer	Notes	Marks
(a)	correct voltmeter symbol drawn in parallel with any component; component is the resistor, X;		2
(b)	use of V = I × R; calculation of total R; sum of resistances = total R; evaluation of resistance of X; e.g. 9.0 = 0.012 × R_T R_T = 750 (Ω) 750 = R_x + 250 (R_x =) 500 (Ω)	seen anywhere correct calculation of voltage of 250Ω resistor evaluation of voltage of X e.g. V_{250} = 0.012 × 250 V_{250} = 3.0 (V) V_x = (9.0 - 3.0) = 6.0 (V) (R_x =) 500 (Ω)	4
		Total for question 7 = 6 marks	

Q13.

Question number	Answer	Notes	Marks
(a)	use of voltage = current × resistance; substitution and rearrangement of formula; evaluation of total circuit resistance; subtraction of thermistor resistance; correct evaluation of fixed resistor resistance; e.g. voltage = current × resistance R_{total} = 6.0 / 6.8 (mA) R_{total} = 882 (Ω) R_{fixed} = 882 - 490 R_{fixed} = 392(.35...) (Ω)	seen or implied allow current in mA or A allow ECF from POT error accept, for full marks, answers that calculate voltage of thermistor to find voltage of resistor voltage = current × resistance $V_{thermistor}$ = 6.8 (mA) × 490 (= 3.332) V V_{fixed} = (6.0 - 3.332 =) 2.668 V R_{fixed} = 2.668 / 6.8 × 10^{-3} R_{fixed} = 392(.35...) (Ω)	5
(b)	resistance of **thermistor** increases; current through circuit decreases; (so) voltage (across fixed resistor) decreases;	 dependent on scoring one of previous two marking points allow 2 max. as ECF for correct description with incorrect R_{therm} change allow correct potential divider argument for full marks	3
		Total for Question = 8 marks	

Q14.

Question number	Answer	Notes	Marks
(a)	LED drawn on branch of circuit containing only R_1; LED drawn in the correct orientation;		2
(b) (i)	correct ammeter symbol drawn on main branch of circuit and in series with cell;		1
(ii)	voltage across R_2 is the same / 4.5 V; (because) they are in parallel;	allow higher level answers in terms of energy transferred per unit charge	2
(c) (i)	energy (transferred) = charge × voltage;	allow standard symbols and rearrangements e.g. Q = E / V reject C for charge	1
(ii)	substitution; rearrangement; evaluation; e.g. 4.1 = charge × 4.5 (charge =) 4.1 / 4.5 (charge =) 0.91 (C)	 allow 0.911...(C)	3
(iii)	idea that a voltmeter is needed; voltmeter should be connected across / in parallel (with R_2); suitable means of varying circuit current described;	 e.g. changing number of cells, using a variable power supply, adding variable resistor to the circuit	3

Q15.

Question number	Answer	Notes	Marks
(a)	correct voltmeter symbol; voltmeter connected in parallel with resistor;		2
(b)	light dependent resistor;	allow LDR	1
(c) (i)	9(.0) (V);		1
(ii)	substitution OR rearrangement; evaluation; e.g. 9.0 = current × 4500 OR current = voltage / resistance (current =) 0.0020 (A)	allow ecf from (i) allow 0.002 (A)	2
(iii)	substitution OR rearrangement; evaluation in Ω; conversion to kΩ; e.g. 3.0 = 0.0020 × resistance OR resistance = voltage / current (resistance =) 1500 (Ω) (resistance =) 1.5 (kΩ)	allow ecf from (ii)	3
(d)	lamp should be connected in parallel with component X / LDR; resistance of component X increases when it gets dark; voltage across component X increases / becomes greater than 10V when it gets dark;		3

Q16.

Question number	Answer	Notes	Marks
(a) (i)	voltage = current × resistance;	allow standard symbols and rearrangements e.g. I = V / R CONDONE "i" for "I" REJECT "c" or "C" for current	1
(a) (ii)	rearrangement; substitution; evaluation; correct answer: 0.084 A e.g. current = voltage/resistance current = 1.6/19 current = 0.084(2) (A)	ALLOW re-arrange and substitution in either order ACCEPT 84 mA	3
(b) (i)	correct symbol for voltmeter in parallel with any component; across resistor X;		2
(b) (ii)	evidence of idea that V_x is difference between cell voltage and voltage across 16 ohm resistor; 0.69 (V);		2

Q17.

Question number	Answer	Notes	Marks
(a)	A (current); B is incorrect because power is the rate of energy transferred C is incorrect because resistance is the ratio of voltage and current D is incorrect because voltage is the energy transferred per unit charge passed		1
(b)	D (voltage); A is incorrect because current is the rate of flow of charge B is incorrect because power is the rate of energy transferred C is incorrect because resistance is the ratio of voltage and current		1
(c) (i)	correct voltmeter symbol used; voltmeter drawn in parallel with S;	 condone drawn in parallel with R or the battery	2
(ii)	0.20 (A); 0.60 (A);	this order only allow 0.2 (A) this order only allow 0.6 (A)	2
(iii)	voltage = current × resistance; substitution; evaluation; e.g. V = I × R (V =) 0.40 × 11 (V =) 4.4 (V)	formula should be seen or implied by calculation allow standard symbols and rearrangements ignore C, c for current	3
(iv)	idea that voltage across battery is the same as voltage across R; (because) battery and R are connected in parallel / no other resistive components on loop with battery and R;	allow numerical value given e.g. 'voltage of battery = 4.4V'	2

(d)	idea that resistance (of thermistor) changes; when temperature increases, resistance decreases; (therefore) current increases when temperature increases;	allow even if relationship is the wrong way round ORA ORA	3

Q18.

Question number	Answer	Notes	Marks
(a)	wires have a higher current / voltage;	allow idea that if one breaks the rest will keep working / some can be on but not others / eq	1
(b) (i)	power = current × voltage;	allow standard symbols and rearrangements e.g. P = I × V reject C for current, W for power	1
(ii)	substitution; rearrangement; evaluation; e.g. 2800 = current × 230 (current =) 2800 / 230 (current =) 12 (A)	in either order -1 for POT error allow 12.17...(A)	3
(iii)	(current = 12 / 48 =) 0.25 (A)	allow ecf from (ii)	1

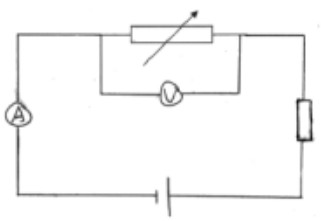
Q19.

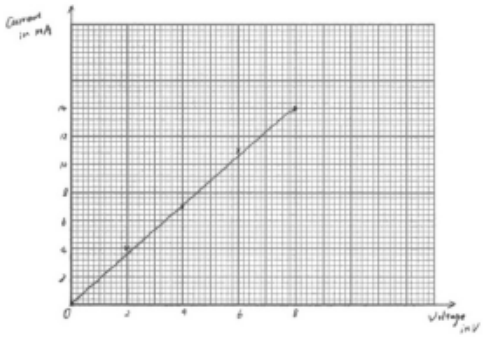
Question number	Answer	Notes	Marks
(a)	the **rate** of flow of charge/electrons;	allow amount of charge per second, amount of charge per unit time	1
(b)	electron(s);	ignore words written in addition to electron(s)	1
(c) (i)	power = current × voltage;	allow standard symbols and rearrangements e.g. I = P / V	1
(ii)	substitution; rearrangement; evaluation; e.g. 1400 = current × 230 (current =) 1400 / 230 (current =) 6.1 (A)	 -1 for POT error allow 6, 6.09, 6.086...	3
(iii)	any two from: MP1. idea that wire has resistance; MP2. electrons collide with lattice ions; MP3. idea of transferring energy (from electrons to wire/eq); MP4. increasing vibrations of lattice ions;	 ignore friction allow sensible alternatives for lattice ions e.g. atoms in the wire etc. ignore generic references to "heat" allow sensible alternatives for lattice ions e.g. atoms in the wire etc.	2
		Total for Question = 8 marks	

Q20.

Question number	Answer	Notes	Marks
(a)	(current is the) rate of flow of charge;	allow amount of charge passing per unit time/second ignore rate of flow of electrons	1
(b) (i)	idea that LED shows that current is present / fuse is still working;	allow idea that it shows when the fuse has blown	1
(ii)	correct symbol for ammeter placed in series with fuse;		1
(c) (i)	0.1 (A);		1
(ii)	0.6 (A);		1
(iii)	lamp 3; any two from: • (because) power = current × voltage; • voltage is the same for all lamps; • current is greatest;	allow ECF from (c)(i) if I_1 given as greater than 0.3(A) leading to lamp 2 being brightest allow $P = V^2 / R$ allow resistance is lowest	3
		Total for Question = 8 marks	

Q21.

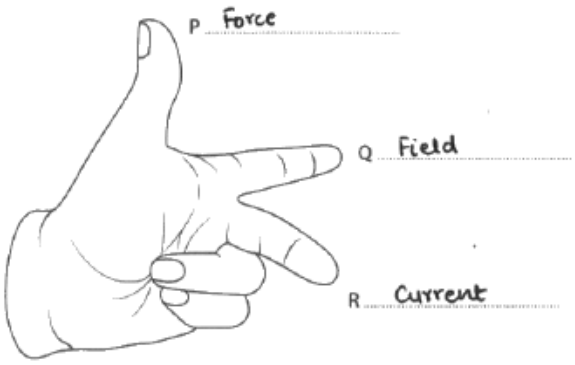
Question number	Answer	Notes	Marks
(a) (i)	correct symbol for resistor; correct symbol for cell; correct symbol for ammeter; circuit is complete series circuit; 	reject extra components allow ECF for missing/incorrect symbols	4
(ii)	voltmeter symbol is correct and in parallel with any component; voltmeter is in parallel with variable resistor;		2

(b)		any FOUR from: stretchy resistor increases in resistance (when mass increased); total resistance increases; I = V/R; current in circuit less; voltage across fixed resistor decreases; so voltage across stretchy resistor increases; as total voltage is constant/voltage of cell constant;	reject V=IR or I=V/R with assumption of constant current	4
(c)	(i)	voltage;	allow 'V'	1
	(ii)	suitable linear scale chosen (>50% of grid used); axes labelled with quantities and unit; all plotting correct to nearest half square; 	ignore orientation	3
	(iii)	correct best fit line judged by eye;		1
			(Total for Question = 15 marks)	

Q22.

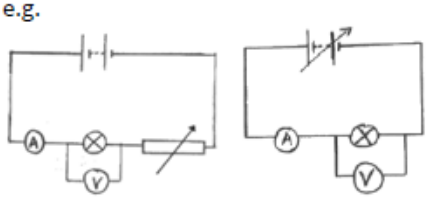
Question number	Answer	Notes	Marks
(a)	live / L;	allow red / brown wire	1
(b)	any two from: MP1. earth wire; MP2. circuit breaker; MP3. double insulation; MP4. insulated cables;	 allow RCD, trip switch, surge protector allow any mention of insulated wires	2
(c) (i)	power = current × voltage;	allow standard symbols e.g. P = I × V ignore C, c for current	1
(ii)	substitution; evaluation; unit; e.g. (P =) 9.6 × 230 (P =) 2200 watts / W	 mark independently 2.2 kW = full marks allow 2208, 2210 allow J/s	3
(iii)	 coil has resistance; electrons transfer/lose energy (as they flow through coil); (due to) electron collisions with (lattice) ions in the coil;	allow wire for coil throughout allow atoms, particles for ions	3
(d)	idea of excessive current; melts the fuse (wire); breaking the **circuit**;	e.g. "current becomes too high" allow breaking the fuse condone "blows the fuse" allow "stops the current" / eq	3

Q23.

Question number	Answer	Notes	Marks
(a)	thumb: (magnetic) force; index finger: (magnetic) field; middle finger: current; e.g.  	CONDONE "motion" ALLOW correct symbols eg I for current	3
(b)	3 field lines with arrow from North to South; field lines parallel and evenly spaced;	IGNORE any lines drawn outside of the space between the poles	2

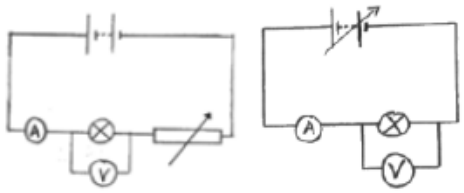
Question number		Answer	Notes	Marks
(c)	(i)	a.c. current changes direction frequently/continuously/repeatedly/50 Hz; d.c. current is in one direction only;		2
	(ii)	(to / towards) right;	ALLOW in	1
	(iii)	battery supplies constant current; idea of no vibration;	ALLOW idea that battery provides a direct current	2

Q24.

Question number	Answer	Notes	Marks
(a) (i)	circuit with symbols for ammeter, voltmeter, lamp, any power supply all correct;	variable power supplies or variable number of cells can be shown using labelled standard symbols	4
	voltmeter in parallel with lamp; ammeter in series with lamp;	if no lamp in circuit, allow ammeter drawn in series with power supply	
	correct means of varying voltage of lamp i.e. variable power supply/rheostat/potentiometer;	allow variable resistor in series with lamp	
	e.g. 		
(ii)	any four from: MP1. record ammeter and voltmeter reading;	allow 'measure voltage and current'	4
	MP2. repeat readings (for each voltage) and find average;	allow repeating experiment to find average	
	MP3. idea of changing the voltage / current;	allow described method that would change voltage or current e.g. adding more cells, changing circuit resistance etc.	
	MP4. plot a graph of voltage and current; MP5. switch off current/circuit between readings;	ignore "let lamp cool between readings"	

(b)	(i)	ampere / amp / A / mA;	reject I	1
	(ii)	correctly evaluated energy; given to 2 significant figures; e.g. 162 (J) gets 1 mark 160 (J) gets 2 marks	DOP	2
	(iii)	red or orange;		1

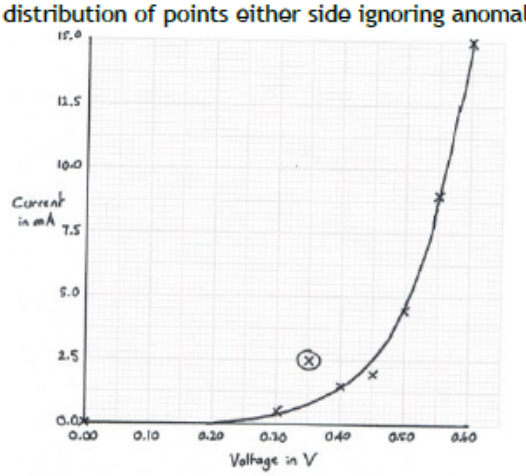
Q25.

Question number	Answer	Notes	Marks
(a)	circuit with symbols for ammeter, voltmeter, lamp, any power supply all correct; voltmeter in parallel with lamp; ammeter in series with lamp; correct means of varying voltage of lamp i.e. variable power supply/rheostat/potentiometer; e.g. 	variable power supplies or variable number of cells can be shown using labelled standard symbols allow if voltmeter in parallel with lamp and ammeter if no lamp in circuit, allow ammeter drawn in series with power supply allow variable resistor in series with lamp	4

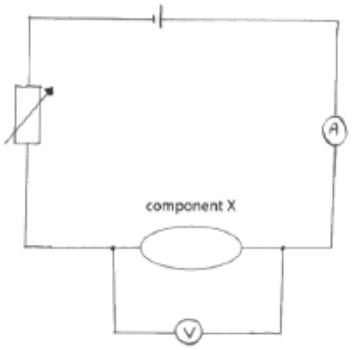
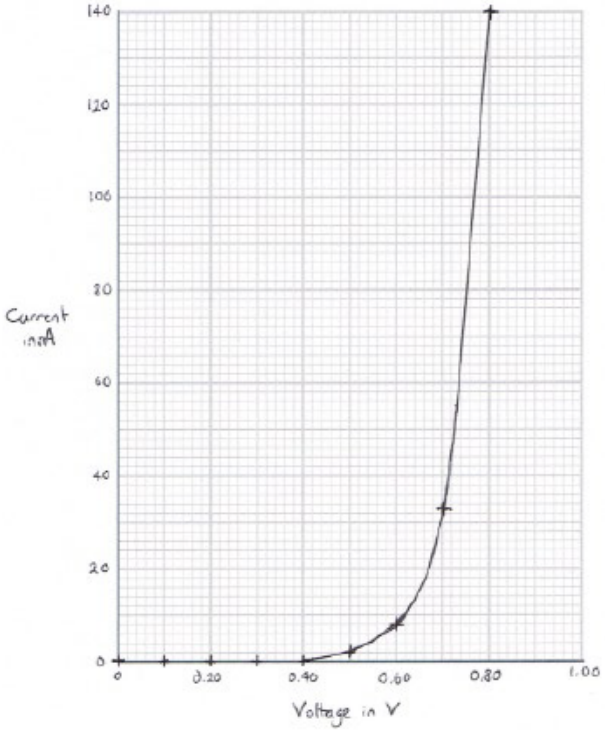
(b)	(i)	smooth curve drawn within one small square of each data point;	curve must pass within one small square of point at (0,0)	1
	(ii)	correct reading of current from graph; use of R = V / I; evaluation of resistance; e.g. current = 0.016 A R = 2.0 / 0.016 (R =) 130 (Ω)	allow ecf from line drawn in (i) allow ecf from incorrect current reading allow 125 (Ω)	3
	(iii)	resistance increases (as voltage increases); with either; • (because) temperature (of filament) increases OR • (because) interactions between electrons and lattice increases	allow electrons collide with ions/atoms more	2
			Total for question = 10 marks	

Q26.

Question number	Answer	Notes	Marks
(a)	both ammeter and voltmeter symbols correct; ammeter drawn in series with LED; voltmeter drawn in parallel with LED;		3

(b)	(i)	axes scales cover 50% of the grid in both directions and have a sensible, continuous scale; both axes labelled with quantities and units; all data plotted correctly;	reject if either scale uses multiples of 3, 7 or 9 or if discontinuous ignore orientation reject if either scale is discontinuous data should be plotted to within half a small square	3
	(ii)	(0.35,2.5) circled;		1
	(iii)	smooth curve drawn with approximately even distribution of points either side ignoring anomaly;  	allow ecf from (i) so judge curve for the student's plotting	1
	(iv)	(data are) continuous/not discrete;		1
	(v)	voltage = current × resistance;	allow standard symbols and rearrangements reject C, c for current	1
	(vi)	MP1. voltage across resistor = 0.015 × 270; MP2. voltage across resistor is 4.05 (V); MP3. voltage across power supply = voltage across LED + voltage across resistor; MP4. voltage across power supply is (4.05 + 0.60 =) 4.7 (V);	allow 15 × 270 for this mark allow 4.0, 4.1 (V) scores MP1 and MP2 allow 4.65, 4.6 (V) V = 4050.6 (V) = 3 marks allow alternative method of calculating resistance of LED to find total resistance of circuit	4
			Total for Question = 14 marks	

Q27.

Question number	Answer	Notes	Marks
(a)	symbols for cell, variable resistor, ammeter and voltmeter all correct; cell and variable resistor in series with component X; ammeter in series with component X; voltmeter in parallel with component X only; e.g.  	allow higher level potential divider type circuits condone symbols for more than one cell or battery allow voltmeter in parallel with component X and ammeter	4
(b) (i)	sensible linear scales; axes labelled with units; all points plotted correctly within ½ a small square; e.g.  	must have voltage on x-axis e.g. occupy >50% of the grid and not multiples of 3 etc. Voltage in V / Current in mA: 0.00 / 0 0.10 / 0 0.20 / 0 0.30 / 0 0.40 / 0 0.50 / 2 0.60 / 8 0.70 / 33 0.80 / 140	3
(ii)	smooth curve with increasing gradient that passes through all data points;	allow if within ½ a small square of each data point	1
(iii)	diode / light emitting diode;	allow LED	1
		Total for Question = 9 marks	

Q28.

Question number	Answer	Notes	Marks
(a)	idea that if one bulb fails all bulbs turn off;	allow idea that bulbs cannot be controlled individually	1
(b)	any one from: • less likely to overheat; • idea that the circuit is simpler; • lower voltage bulbs; • all bulbs controlled with one switch;	accept uses fewer wires	1
(c) (i)	voltage = current × resistance;	allow standard symbols and rearrangements e.g. I = V / R	1
(ii)	substitution; rearrangement; evaluation; e.g. 33 = I × 390 (I =) 33 / 390 (I =) 0.085 (A)	 allow 0.08, 0.0846... condone 0.084	3
(iii)	dimensionally correct substitution into E = V × I × t; conversion of hours to seconds; use of 7 bulbs; evaluation; e.g. E = 33 × 0.085 × 2.5 2.5 hours = 9000 seconds voltage used = 231 OR ×7 used in working (E =) 180 000 (J)	allow ECF from (ii) allow 60 × 60 or 9000 seen anywhere in working 23 760-25 245 = 3 marks (x7 not used) 6.60-7.01 = 2 marks allow answer between 165000 to 180000	4

(d)	brightness is greater in lamp Y; with any **two** from: more energy transferred to each bulb in lamp Y; bulbs in lamp Y have a larger voltage / 46 V; resistance of (circuit in) lamp Y is less; current in bulb / circuit in lamp Y is greater;	allow RA	3

Q29.

Question number	Answer	Notes	Marks
(a)	40 000 {waves / vibrations / oscillations}; in 1 second / unit time;	allow 40 000 wavelengths / wavefronts allow per second	2
(b) (i)	(wave) speed = frequency × wavelength;	allow standard symbols and rearrangements e.g. $\lambda = v / f$ condone s for speed ignore incorrect symbols e.g wl for wavelength, ws for wave speed	1
(ii)	substitution; rearrangement; evaluation; e.g. $345 = 40\,(000) \times \lambda$ $\lambda = 345/40\,(000)$ $(\lambda =)\ 8.6 \times 10^{-3}$ (m)	 POT error = -1 correct answer with no working gains full marks 8.6, 8.62, 8.63, 8.625 = 2 marks allow 9×10^{-3}, 8.62×10^{-3}, 8.63×10^{-3}, 8.625×10^{-3} (m)	3
(iii)	use of speed = distance/time seen or implied; factor of 2 seen; substitution; evaluation; e.g. speed = distance/time distance should be doubled $345 = 4.70 \div$ time (time =) 0.0136 (s)	allow any rearrangement or in correct symbols allow d, s, x for distance allow v for speed condone s for speed 0.007, 0.0068... scores 3 marks (no factor of 2 used) allow 0.01, 0.014, 0.01362... (s)	4

(c)	idea that the person can see/know what (distance) they are measuring/eq;	e.g. marks the position that (distance) is being measured to	1
(d)	any three from: MP1. sound is longitudinal light is transverse; MP2. sound vibrations are in the direction of travel, light vibrations are perpendicular to the direction of travel; MP3. light is electromagnetic, sound is not; MP4. light can travel through a vacuum/space, sound cannot; MP5. light travels (much) faster (in air) than sound; MP6. light slows down in denser medium but sound speeds up;	allow points shown on a labelled diagram allow higher level ideas i.e. light can be polarised but sound can't allow reverse argument (RA) for all marking points can be given from diagram showing longitudinal and transverse waves allow oscillations, displacements for vibrations allow direction of energy transfer for direction of travel allow sound is mechanical, light is not allow sound needs a medium but light does not allow quoted speeds for comparison	3
		Total for Question = 14 marks	

Q30.

Question number	Answer	Notes	Marks
(a)	use of voltage = current × resistance; calculation of voltage across 240 ohm resistor (2.88 V); idea that voltages of two resistors in series adds up to supply voltage; evaluation of voltage across R; e.g. $V = I \times R$ $V_{240} = (0.012 \times 240 =) 2.88$ (V) $V_R + V_{240} = 9.2$ (V_R =) 6.3 (V)	allow rearrangements and standard symbols calculate total resistance of circuit (767 Ω) evaluation of resistance of R (527 Ω) evaluation of voltage across R (using V = IR) allow 2.9 (V) allow 9.2 – 2.88 or V + 2.88 = 9.2 allow 6.32 (V) if mA not converted to A and 2880 seen then award 2 marks max.	4

(b)	(i)	any three from: MP1. coil produces a magnetic field; MP2. (which) interacts with the magnetic field of the (permanent) magnet; MP3. producing a force acting on the coil; MP4. opposite forces on either side of coil; MP5. coil rotates / turns;	 allow coil becomes an electromagnet allow one side is pushed up and the other is pushed down allow coil spins, pointer moves (to the left)	3
	(ii)	vertical arrow UP (on wire CD);		1
	(iii)	any three from: MP1. more turns on the coil; MP2. stronger (permanent) magnet; MP3. add an iron core; MP4. producing a larger force (for the same current); MP5. use of a longer pointer; MP6. use of a weaker return spring; MP7. producing a greater movement at the end of the pointer (for the same current);	 allow "more coils" allow method to increase field strength e.g. moving magnets closer together allow producing the same force for a smaller current allow same movement for a smaller current	3

Q31.

Question number	Answer	Notes	Marks
(a) (i)	any THREE from: trolley changes direction; induction depends on direction of relative motion; idea that voltage has changed directon (as sign of voltmeter reading depends on direction of voltage); idea that at ends of motion, voltage is zero;	condone current for voltage ignore idea induction depending on speed	3
(ii)	speed may change/ magnetic field may not be uniform;	accept idea that magnetic field may change allow idea of entering or leaving field	1
(b) (i)	substitution; re-arrangement; evaluation; correct answer: 1.8×10^{-4} (A) e.g. charge = current × time 1.4×10^{-4} = current × 0.78 current = $(1.4 \times 10^{-4}) \div 0.78 = 1.79 \times 10^{-4}$ (A)	substitution and rearrangement in either order -1 POT error	3
(ii)	substitution; re-arrangement; evaluation; correct answer: 1.6×10^{-2} (V) e.g. energy = charge × voltage $2.3 \times 10^{-6} = 1.4 \times 10^{-4} \times$ voltage voltage = $(2.3 \times 10^{-6}) \div (1.4 \times 10^{-4}) = 1.64 \times 10^{-2}$ (V)	allow use of standard symbols e.g. $E = Q \times V$ allow v,V for voltage reject C,c for charge substitution and rearrangement in either order -1 POT error	3
			(Total for Question = 10 marks)