PEARSON EDEXCEL IGCSE PHYSICS · 4PH1

PHYSICS



MARK SCHEME

SECTION 4: ENERGY RESOURCES AND ENERGY TRANSFERS (PACK 2)

SCORE	PERCENTAGE
/180	%

STEMUP

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Mark Scheme

Q1.

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)	

Q2.

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

Q3.

<table>
<tr><th>Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>(a) (i)</td><td>each tick correctly placed in each row;;;;

<table><tr><th></th><th colspan="4">Energy store</th></tr><tr><th>Method of generating electricity</th><th>Thermal</th><th>Gravitational potential</th><th>Kinetic</th><th>Chemical</th></tr><tr><td>Geothermal power station</td><td>✓</td><td></td><td></td><td></td></tr><tr><td>Hydroelectric power station</td><td></td><td>✓</td><td></td><td></td></tr><tr><td>Petrol generator</td><td></td><td></td><td></td><td>✓</td></tr><tr><td>Wind turbine</td><td></td><td></td><td>✓</td><td></td></tr></table></td><td>more than one tick in a row negates the mark</td><td>4</td></tr>
<tr><td>(ii)</td><td>petrol generator;</td><td></td><td>1</td></tr>
<tr><td>(b)</td><td>any two from:

MP1. idea of noise pollution;
MP2. idea of visual pollution;
MP3. idea that turbine only generates electricity when the wind blows;
MP4. difficult for output to match demand;

MP5. wind is a dilute source of energy;

MP6. can cause harm to migrating flocks of birds;</td><td>ignore statements relating to cost
ignore bald ‘pollution’
ignore bald ‘pollution’

ignore ‘do not generate much electricity/energy’
allow idea that wind farms take up a lot of space</td><td>2</td></tr>
</table>

Q4.

Question number	Answer	Notes	Marks
(a) (i)	idea that it will run out / cannot be replaced;	ignore renewed/re-used	1
(ii)	any two correct readings taken from graph; evaluation of total; e.g. (proportion =) 27.5 + 35 + 19.5 (proportion =) 82 (%)	 allow 81-83 (%)	2
(b)	a named effect e.g. global warming, acid rain; a named pollutant e.g. carbon dioxide, sulphur dioxide, nitrogen (di)oxide;	 -1 for incorrectly linked effect and pollutant	2
(c) (i)	correct reading of solar from graph; evaluation; e.g. solar = 1.5% (solar output = $0.015 \times 4.76 \times 10^{11}$ =) $7.1(4) \times 10^{9}$ (W)	seen anywhere in working	2
(ii)	correct use of ratio; evaluation; e.g. land area = 4.76×10^{11} / 250 (land area =) 1.90×10^{9} (m^2)	 allow $1.904... \times 10^{9}$ (m^2)	2
(iii)	any three from: MP1. land area needed is much less than total land area of USA / there is enough space; MP2. land area needed is (much) less than 1% of total land area; MP3. idea that Sun doesn't shine all the time; MP4. idea that some areas of land may not be suitable for solar power;	no mark for simple yes/no for suitability allow ecf from (ii) also scores MP1 allow idea of competing land uses e.g. housing/agriculture	3

Q5.

Question number	Answer	Notes	Marks
(a)	GPE = mass × gravitational field strength × height;	Accept g for gravitational field strength allow standard symbols e.g. m for mass, h for height reject 'gravity' for g	1
(b)	substitution; conversion of mass to kg and height to m; correct evaluation to at least 2 sf; e.g. GPE = 0.014 × 10 × 0.29 = 0.041 (J)	allow use of 9.8, 9.81 0.0406 (J) to 3sf reject responses that do not use 'g' reject incorrect physics i.e. 14/29 = 0.48... which with a POT error gives 0.048 correct substitution with POT error scores 2 marks	3
(c)	recall of KE= 1/2 mv^2; substitution and rearrangement to v^2 as subject; evaluation; correct answer: 2.7 (m/s) e.g. KE= 1/2 mv^2 $5.1 \times 10^{-2} = ½ \times 0.014 \times v^2$ $v^2 = 2 \times 5.1 \times 10^{-2} \div 0.014 = 7.2857....$ $v = 2.6992....$ v = 2.7 (m/s)	 treat answer of $8.53.. \times 10^n$ as a POT error, 1 mark penalty	3
(d)	idea of conservation of energy; idea that KE lost = GPE gained + WD;	accept idea that without friction KE (lost) = GPE (gained) i.e. idea that KE lost is greater than GPE gained condone 'friction reduces KE as wasted heat'	2

Q6.

Question number	Answer	Notes	Marks
(a)	any two from: MP1. water is renewable/eq; MP2. no fuel / transportation cost; MP3. no air pollution / greenhouse gases; MP4. always available (vs wind/solar);	 allow "water is free"/eq allow named pollutant e.g. CO_2 etc. allow "reliable" allow "respond quickly to demand"	2
(b) (i)	gravitational (potential energy);		1
(ii)	C (electrically); A is incorrect because there is no temperature difference B is incorrect because there are no light or sound waves emitted D is incorrect because the transfer does not involve forces		1
(c) (i)	rate of {energy transfer / doing work};	allow alternatives to rate e.g. per second, per unit time etc.	1
(ii)	evaluation of number of seconds in a day; substitution into P = W ÷ t; evaluation; e.g. 1 day = (24 × 60 × 60 =) 86 400 seconds (P =) $9.7 \times 10^{14} \div 86\,400$ (P =) 1.1×10^{10} (W)	seen anywhere in working -1 for POT error allow $1.1226... \times 10^{10}$ (W) allow 6.7×10^{11} J/min or 4.04×10^{13} J/hr if given unit changed. 2 marks max. if time unit conversion attempted but incorrect unit e.g. 6.7×10^{11} (J/min) or 4.04×10^{13} (J/hr)	3 1
(iii)	D (22 500 000 000 J/s); A is incorrect because joules is not the unit for power and mega has not been dealt with correctly B is incorrect because mega has not been dealt with correctly C is incorrect because joules is not the unit for power		
(iv)	any one from: • idea that electricity demand varies; • idea that water level in reservoir varies; • idea that water may not be available as readily at certain times of the year;	ignore idea of efficiency	1
			Total for Question 2 = 10 marks

Q7.

Question number	Answer	Notes	Marks
(a)	any FOUR from: Advantages: MP1: can respond to changes in demand; MP2: larger output for installation; MP3: less space required (for same output); MP4: not weather dependent; Disadvantages: MP5: may require a mountainous region; MP6: may require a large dam; MP7: installations are permanent;	accept RA where clear accept idea of continuity accept idea of flooding large areas ignore cost of installation ignore maintenance ignore global warming /greenhouse effect	4
(b)	any THREE from: MP1. reduction in GPE store of water; MP2. mechanical work done on turbine; MP3. increase in KE store of turbine; MP4. mechanical work done on generator; MP5. increase in KE store of generator; MP6. idea of electrical work done on grid;	 accept GPE of water converted to KE accept KE of water converted to KE of turbine accept KE of turbine converted to KE of generator accept KE of generator converted to electrical energy	3

Q8.

Question number	Answer	Notes	Marks
(a) (i)	Substitution (including conversion of time to seconds); Re-arrangement of given equation P = W/t; Evaluation; e.g. Energy = 75 x (22 x 60) = 99 000 (J)	 Allow W or E for energy or work. Can be implied from their working. Accept 1650 or 5.9 million for 2 marks.	3
(ii)	Any ONE assumption from • dog does not change temperature • dog does not change power output • rate of transfer is constant (despite increase in temp of water) • no heating of outside world/surroundings/material of bag • no heating from the surroundings	 Ignore unqualified '100% efficient' or 'no energy lost'	1
(iii)	Use of Q = m x c x $\Delta\theta$; Substitution of their energy, mass, c; Evaluation of temp change; Calculation of final temp = temp change + 16; e.g. 99 000 = 8.7 x 4200 x $\Delta\theta$ temp rise = 99 000/(8.7 x 4200) = 2.7 final temp = 19 (°C);	 Allow ECF from (a)(i) Allow ECF from evaluation of temp change. Accept 16.04... for all marks (ecf E without min->s conversion) Accept answer to 3 or more sf i.e 18.7	4

(b)	Any THREE from MP1 Dog and water are at different temperatures; MP2 Dog and water in physical contact so likely to be conduction; MP3 No movement of particles from dog to water, so not convection / EQ; MP4 Dog and bag are both solids, so convection impossible; MP5 Not much radiation as dog and water similar temperatures;	 Allow "no gap between dog and bag so no convection"	3

Q9.

Question number	Answer	Notes	Marks
(a)	correct substitution KE = ½ (mass) × (speed)²; re-arrangement to give v; evaluation to show 5.8(4...) (m/s); e.g. KE = ½ m v² 0.29 = 0.5 × 0.017 × v² v² = 0.29 ÷ (0.5 × 0.017) = 34.1176471.. v = √34.1176471 = 5.8(4...) (m/s)	allow use of standard symbols e.g. KE = ½ m v² allow mass = 17 at this point	3
(b)	idea of conservation of momentum; idea that momentum before release was zero; evidence of re-arrangement; evaluation of large block speed giving 1.3 m/s; e.g. momentum of small block = 17 × 6 = 102 g m/s therefore momentum of large block = 102 g m/s momentum = mass × velocity = 75 v so v = 102/75 = 1.36 m/s	however expressed allow idea that momenta of two blocks is equal in magnitude allow 1.4 if v_{small} = 6 m/s ignore mass unit provided both masses consistent v=1.31 if v_{small} = 5.8 m/s v=1.32 if v_{small} = 5.84 m/s	4
(c)	substitution into given equation; idea of initial momentum = 0; evaluation; correct answer = 0.93 (N) e.g. force = change in momentum ÷ time taken force = ((0.017 × 6) - 0) ÷ 0.11 force = 0.102 ÷ 0.11 force = 0.9272... (N)	 allow use of init velocity = 0	3
(d)	substitution and re-arrangement of given equation; conversion of 17.6 cm to 0.176 m; evaluation; correct answer = 0.18(41...) (s) e.g. orbital speed=(2π × orbital radius)÷time period 6 = (2π × 0.176)÷T T = (2π × 0.176) ÷ 6 T = 0.1843... (s)	 accept 0.2 (s) accept use of v=5.84...(m/s) -1 POT error 0.092.. (s) for using 17.6 cm as a diameter scores 2 marks	3
		Total for Question : 13 marks	

Q10.

<table>
<tr><th>Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>(a)</td><td>1 mark for each correct tick;;;

<table>
<tr><th>Methods of generating electricity</th><th>Uses a renewable energy resource</th></tr>
<tr><td>coal power station</td><td></td></tr>
<tr><td>diesel generator</td><td></td></tr>
<tr><td>geothermal power station</td><td>✓</td></tr>
<tr><td>hydroelectric power station</td><td>✓</td></tr>
<tr><td>natural gas turbine</td><td></td></tr>
<tr><td>nuclear power station</td><td></td></tr>
<tr><td>solar cell</td><td>(✓)</td></tr>
<tr><td>wind turbine</td><td>✓</td></tr>
</table></td><td>4 candidate ticks = 2 marks max.
5-6 candidate ticks = 1 mark max.
7 candidate ticks = 0 marks</td><td>3</td></tr>
<tr><td>(b) (i)</td><td>B (by radiation);

A is incorrect because transfers by heating cannot take place through space
C is incorrect because there are no electrical conductors between the Sun and the panel
D is incorrect because it requires particles that are not present in the vacuum of space</td><td></td><td>1</td></tr>
<tr><td>(ii)</td><td>any 1 of:
MP1. only generates electricity when it is sunny / eq;

MP2. idea of visual pollution;

MP3. idea that solar panels take up a lot of space;</td><td>allow not generating electricity at night
ignore ‘depends on the weather’

Condone ‘ugly’</td><td>1</td></tr>
</table>

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) (i)	C (nuclear); A is incorrect because chemical reactions do not happen in the Sun B is incorrect because the kinetic store of particles increases during nuclear fusion D is incorrect because the thermal store of the Sun remains constant whilst fusion is taking place		1
(ii)	B (by radiation); A is incorrect because transfers by heating cannot happen in a vacuum C is incorrect because there is no electrical circuit or flow of ions D is incorrect because the transfer does not happen due to forces		1
(b) (i)	evaluation of total power / conversion of hours to seconds; evaluation of energy in J; evaluation of energy in MJ; e.g. power = (1000 × 15 =) 15 000 (m^2) OR time = (2 × 60 × 60 =) 7200 (s) energy = (15 000 × 7200 =) 108 000 000 (J) energy = (108 000 000 ÷ 1 000 000 =) 108 (MJ)	allow ×3600 seen anywhere in working	3
(ii)	substitution into $\Delta Q = m \times c \times \Delta T$; rearrangement; evaluation of ΔT; evaluation of final temperature; e.g. 100 000 000 = 1100 × 4200 × ΔT ΔT = 100 000 000 / (1100 × 4200) (ΔT =) 22 (°C) T = (20 + 22 =) 42 (°C)	 -1 for POT error allow ECF from incorrect ΔT allow 23.3..., 21.6... allow 41.6-43.8 (°C)	4
(iii)	any sensible suggestion; e.g. • heating process is not 100% efficient • energy also heats up pipes / not all energy is transferred to water • some energy is transferred to the surroundings • power of Sun may change	 allow energy transferred to (solar) panel ignore 'heat is lost'	1

Q13.

Question number	Answer	Mark
(a)	A description that makes reference to three of the following points. For a liquid: • molecules closely spaced (1) • molecules slide over one another (1) For a gas: • molecules spread out (1) • molecules move with random motion (1)	3

Question number	Answer	Additional guidance	Mark
(b)(i)	Process includes: • Conversion of time into seconds substitution into or rearrangement of • $P = W/t$ • Evaluation e.g. time = 120 seconds (1) 2200 = W/120 (1) W = 260 000 (joules) (1)	seen anywhere in working allow 264 000 answer of 4400 (joules) gains 2 marks max	3

Question number	Answer	Additional guidance	Mark
(b)(ii)	Energy transferred = mass × specific heat capacity × change in temperature	equation can be given in words or symbols e.g. $\Delta Q = m \times c \times \Delta\theta$ allow E for Q, T for θ	1

Question number	Answer	Additional guidance	Mark
(b)(iii)	Process includes: • rearrangement of equation (1) • substitution into correct equation (1) • evaluation of temperature difference (1) • calculation of final temperature (1) e.g. 264 000 = 1.1 × 4200 × $\Delta\theta$ (1) $\Delta\theta = \frac{264\,000}{1.1 \times 4200}$ (1) ($\Delta\theta$ =) 57 (°C) (1) final temperature = 77 (°C) (1)	allow ecf from (b)(i)	4

Question number	Answer	Additional guidance	Mark
(c)(i)	Thermometer	allow temperature sensor AND data logger	1

Question number	Answer	Mark
(c)(ii)	An explanation that makes reference to the following points: • actual temperature lower than calculated (1) • energy is lost to the surroundings not all the energy is transferred to the water (1)	2

(Total for question = 14 marks)

Q14.

Question number	Answer	Notes	Marks
(a)	rate of doing work / rate of energy transfer;	condone "amount of energy transferred each second" accept "energy transferred per second" allow correct formula allow correct word equation reject idea of P = IV reject "amount of energy in a given time"	1
(b)	results table constructed with appliance column and power column; power column heading to include correct unit;	allow alternative orientation with two rows condone power in 1st column ignore names given to non-power heading reject if units given with raw data	2
(c) (i)	213 W identified;		1
(ii)	omission of anomalous result; mean calculated; candidate's mean correctly rounded and expressed to 3 significant figures; e.g. mean power = [199 + 202 + 200 + 201 + 201] ÷ 5 mean power = 200.6 (W) mean power = 201 (W)	allow ECF from (c)(i) 203 (W) scores 2 marks 202.667...(W) scores 1 mark	3
		Total for Question = 7 marks	

Q15.

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	

Q16.

Question number	Answer	Notes	Marks
(a) (i)	(in solids) particles vibrate only; (in liquids) particles slide over each other; (in gases) particles move freely / randomly;		3
(b) (i)	energy starts in a chemical store (in the fuel); energy is transferred by heating; to a thermal store (in the water);	 allow transfer by convection / radiation allow kinetic store of water allow heat energy for thermal energy	3
(ii)	horizontal line shows the change of state; (because) temperature remains constant during change of state;	can be shown on graph	2

Q17.

Question number	Answer	Notes	Marks
(a)	temperature difference calculated; substitution into given formula; correct evaluation; e.g. $\Delta T = 100 - 16 = 84$ (°C) energy supplied = $0.45 \times 4200 \times 84$ (energy supplied =) 160 000 (J)	e.g. 84 seen or 100 - 16 seen allow ecf for incorrect temperature <u>difference</u> 158 000 (J) scores 2 marks only allow 159 000, 158 760 (J)	3
(b) (i)	(7.4 - 3.0) = 4.4 (minutes);	allow 4 minutes and 24 seconds, 4 and $^{4}/_{10}$ minutes	1
(ii)	conversion of time into seconds; substitution into P = W/t OR rearrangement; correct evaluation; e.g. time = 264 (s) 2200 = W / 264 OR W = P × t energy supplied = 580 000 (J)	allow ECF from (i) allow ECF from (i) allow substitution in minutes 9700, 9680 (J) scores 2 marks allow 581 000, 580 800 (J)	3
(c)	idea of all water being the same temperature;	allow idea of distributing thermal/heat (energy) evenly throughout water	1
(d)	**arrangement** idea that liquid has molecules that are close together; idea that gas has (widely) spaced molecules; **motion** idea that liquid has molecules that move/slide past each other; idea that gas has molecules that move {faster/freely/randomly/straight lines};	allow marks if seen on diagrams allow particles for molecules ignore random/irregular arrangement for liquid and gas	4
		Total for Question = 12 marks	

Q18.

Question number	Answer	Notes	Marks
(a) (i)	reference to reflection or absorption; white is a good reflector/poor absorber;	ignore reference to emission	2
(ii)	any TWO from: air is a (good) insulator / poor conductor; reduction in convection; idea that trapped air cannot circulate;		2
(b)	substitution into given equation (energy = $mc\Delta\theta$); rearrangement; evaluation of temperature change; evaluation of final temperature; e.g. 210 000 = 4.5 x 4200 x ΔT ΔT = 210 000/(4.5 x 4200) ΔT = 11 (°C) final temperature = 46 (°C)	ecf incorrect temp change accept 35(°C) for 3 marks if supported with working that shows evidence of a temperature change of 11 x 10^{-3} (°C)	4
		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)