A-level
Applied Science
SC02 Energy Transfer Systems
Mark scheme

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Version/Stage: V1 Final Mark Scheme

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Question	Answers	Additional Comments/Guidance	Mark	ID details
1(a)(i)	(Respiration that) needs (requires) oxygen / (takes place) in the presence of oxygen	Accept 'O' or O_2 Accept 'with oxygen'	1 (AO1)	
1(a)(ii)	$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ (ignore any references to energy or ATP) correct inputs (correctly balanced) correct outputs (correctly balanced)		 1 (AO1) 1 (AO1)	
1(b)(i)	• measure the amount of oxygen consumed / volume of water (in pipette) • (measure the amount of oxygen consumed / volume of water) in a given time / time taken	Allow amount = volume Allow time taken for the pipette to fill with water	1 (AO1) 1 (AO1)	
1(b)(ii)	Any **3** of: • KOH absorbs carbon dioxide <u>produced by the peas</u> (from the respiration chamber) • oxygen (in the chamber) is consumed <u>by the peas</u> • volume of gas (inside the chamber) decreases • pressure inside chamber reduces • pressure of water outside the chamber forces water into the pipette	Allow 'pipette' for 'chamber'	 1 (AO1) 1 (AO1) 1 (AO1) 1 (AO1) 1 (AO1) Max 3	
1(b)(iii)	The volume of water (in the pipette) is equal to the volume of oxygen consumed by the peas OR draw a volume/time graph The volume of water/oxygen is divided by the time taken OR calculate the gradient (of volume/time graph)		1 (AO2)	

			1 (AO2)	
Total			**10**	

2(a)	**C**		1 (AO1)	Automatic
2(b)	Bicuspid valve: left atrium Tricuspid valve: right atrium		1 (AO1) 1 (AO1)	
2(c)(i)	Take pulse rate at rest / before exercise Measure pulse rate for a given time (minimum 30 seconds) Engage in exercise Take pulse rate again (after exercise) Time how long it takes for pulse rate to return to normal / resting rate / pulse rate before exercise began The time taken is an indication of the person's level of fitness / the shorter the time taken, the fitter the person	Allow converse for last mark point	1 (AO2) 1 (AO2) 1 (AO2) 1 (AO2) 1 (AO2) 1 (AO2) Max 4	
2(c)(ii)	Increased frequency of impulses (travel in) sympathetic nerve / accelerator nerve from cardiovascular centre (in) brain / medulla (oblongata) to S-A node in right atrium (of heart)	Ignore reference to blood CO_2 levels	1 (AO1) 1 (AO1) 1 (AO1) 1 (AO1) 1 (AO1) 1 (AO1) Max 4	
2(d)(i)	133 / 85 (mm Hg)	Do not accept 133 – 85 OR 85 – 133 OR 85 /133	1 (AO1)	General
2(d)(ii)	Systolic	Accept systole	1 (AO1)	
2(d)(iii)	(Blood pressure lowest) when resting / sleeping / relaxing		1 (AO1)	

2(d)(iv)	(More) active / (start to) exercise (Become) nervous / scared / fearful / panic (Become) excited (Become) stressed (Become) angry	Reject answers related to health-related issues	1 (AO1) 1 (AO1) 1 (AO1) 1 (AO1) 1 (AO1) Max 3	
Total			**17**	

3(a)(i)	The volume of <u>air</u> that is inhaled/exhaled in one breath	Accept amount = volume **Reject 'volume of air that is inhaled <u>and</u> exhaled'** Allow 'breathed in' = 'inhaled' Allow 'breathed out' = 'exhaled'	1 (AO1)	
3(a)(ii)	**F**		1 (AO1)	Automatic
3(a)(iii)	<u>Maximum</u> possible tidal volume / <u>Max</u>imum amount of air that can be breathed in after a <u>maximum</u> expiration / <u>Max</u>imum amount of air that can be breathed out after a <u>maximum</u> inspiration / <u>Maximum</u> amount of air you can breathe in <u>and</u> out	Accept: Inspiratory reserve volume + tidal volume + expiratory reserve volume	1 (AO1)	
3(a)(iv)	**E**		1 (AO1)	Automatic
3(b)(i)	The <u>maximum</u> volume of (additional) air that can be inspired (by determined effort) after a normal inspiration / The inspiratory capacity minus the tidal volume	N.B. Inspiratory capacity = the total amount of air that can be drawn into the lungs after normal expiration	1 (AO1)	
3(b)(ii)	**B**		1 (AO1)	Automatic
3(b)(iii)	**D**		1 (AO1)	Automatic

3(c)	The likelihood (OWTTE) of a negative reaction The nature (OWTTE) of the (negative) reaction The severity (OWTTE) of a negative reaction	Allow 'side effects' for 'negative reactions' Reject any unqualified reference to side effects	1 (AO1) 1 (AO1) 1 (AO1) Max 2	
Total			**9**	

4(a)	193.2 (W) (Accept 193) Correct answer = 2 marks 1 compensation mark for any of: 96.6 / 257.6 / 322.0 / 28 x 0.46 x 15	For information: *[R = A × U × T* = 28 × 0.46 × 15 = 193.2] Area of roof = 3.5 × 4 × 2 = 28 m^2 Temp difference = 20 – 5 = 15°C	1 (AO2) 1 (AO2)	
4(b)	(Fewer windows better for energy efficiency) Loss through windows > loss through insulated roof	Mark is for explanation of choice N.B. Comparison needed	1 (AO2)	
4(c)	Air is a good insulator/poor conductor Small pockets of air reduce convection	Allow less convection in smaller air gaps Allow 'prevent' = 'reduce'	1 (AO1) 1 (AO1)	
4(d)(i)	Black is a good radiator/emitter	Ignore black is a good absorber Accept 'to radiate more/lots of heat' OWTTE	1 (AO1)	
4(d)(ii)	Increase the surface area		1 (AO1)	
4(e)	Heat up the air / surroundings		1 (AO1)	

4(f)	Insulation reduces/prevents heat (from the room/surroundings) entering the fridge by <u>conduction</u>	Any reference to convection/radiation/evaporation negates mark for conduction	1 (AO1)	

4(g)	White surfaces <u>reflect</u> heat/radiation (and so prevent heat/radiation from the room/surroundings entering the fridge) OR White is a poor absorber (so reduces heat/radiation from the room entering the fridge)	Accept 'to reflect heat' Ignore white is a bad emitter / radiator	1 (AO1)	

Total			**10**

5ai	v = 4.24 m s^{-1} (accept 4.2) Correct answer scores 3 OR: For 2 marks any of the following: v^2 = 18 OR v^2 = 2 ×10 800 ÷ 1200 OR 0.5 x 1200 x v^2 = 10 800 OR: For 1 mark any of the following: ½mv^2 = 10 800 KE = ½mv^2 KE = 10 800 Stand-alone mark for correct unit: m s^{-1}		3 (AO2) 1 (AO1)	

5aii	All the GPE lost by the ball is transferred to KE / (Δ) GPE = (Δ) KE	Accept no energy lost / wasted from the system (as the ball falls) Accept no air resistance/no air friction 'No drag/no friction' is insufficient	1 (AO1)	

5b	• Same change in momentum/ impulse for the house wall and the garage wall • Ball in contact with house wall for longer time/energy of ball lost more slowly OR ball in contact with garage wall for shorter time • Force = rate of change of momentum • Rate of change of momentum is less • Smaller force acting on the house wall OR larger force acting on the garage wall Accept alternative answers that refers to acceleration: • force = mass × acceleration OR *F* = *ma* • acceleration of the ball is smaller when it hits the house wall (same change in speed / velocity over a longer time) OR acceleration of ball is larger when it hits the garage wall	• ball takes longer to stop with house wall • correct formula stated, e.g. $F = \frac{m\Delta v}{\Delta t}$ Allow for 1 mark: • house wall is thicker so the ball travels a longer distance (before it stops so acceleration is smaller) • house wall is thicker so more strikes are needed to demolish it	3 (AO1)	

Total			**8**

6ai	• No fuel costs after installation • Produces no/less CO_2/nitrous oxide/sulfur dioxide • Produces no/less particulate pollution/smoke • No by-products such as ash, or warm water from fossil fuel stations • Renewable / no danger of 'running out'	Allow does not rely on a (fossil) fuel source Allow produces no/less of named pollutants produced by fossil fuels 'Less greenhouse gas' insufficient Do not accept reference to impact on environment without justification	1 (AO1)	

6aii	Advantages of solar cells: any 2 of: • low <u>maintenance</u> (costs) / inexpensive running costs • no moving parts • gives example of location suitable for solar but not suitable for wind turbines • not dangerous to birds • create no noise pollution • no or reduced visual pollution Disadvantages of solar: any 1 of: • lower energy production (per unit area) • much less effective in countries receiving little/variable sunlight • only work during daylight • produces direct current so no use in National Grid or transport system	Accept converse arguments Accept other reasonable answers provided they compare solar and wind (e.g. 'renewable' is not acceptable) Under 'advantages': ignore reference to area Do not accept 'does not require windy conditions' unless justified with reference to requiring sunny conditions	2 (AO1) 1 (AO1)	
6b	• They have no moving parts • There is no energy loss through friction (heat) / there is a lower chance of break down		1 (AO2) 1 (AO2)	
6ci	• A suitable steady or controlled light source • Method of measuring output • Diagram shows meter attached to solar cell facing the light source	Light source must be constant / controllable e.g. a lamp but **not** a window	1 (AO3) 1 (AO3) 1 (AO3)	
6cii	IV: (type of) solar cell (tested) DV: cell output voltage/ potential difference/ current/power/energy	Ignore reference to light intensity	2 (AO3)	
6ciii	The solar cell with the highest (average) reading (will be the most effective)	Reject references to electricity	1 (AO3)	
6civ	• Ensure constant light intensity • Solar cells placed at a constant distance from the light source • Cells should be at the same angle to the source (preferably perpendicular)	Ignore reference to time	2 (AO3)	

	• Cells to have the same area of exposure/same size • Ensure cells are clean/free from dust • Repeat the tests or collect data for extended periods (and average)		Max 2	

Total			**14**	
7ai	450 (W) Correct answer scores 3 marks For 2 marks: $P = \frac{750 \times 0.60}{(1)}$ OR P = 750 x 0.6 For 1 mark: P = E/T Allow power = work done/time taken	Attempt to use kinetic energy scores 0 Students using P = Fv can be fully credited	1 (AO2) 1 (AO2) 1 (AO1)	
7aii	Chemical energy Converts to/changed into gravitational potential energy/kinetic energy	Correct answer only Ignore reference to 'thermal energy'	1 (AO1) 1 (AO1)	

7aiii	529.4 (W) (allow 529) Correct answer gains 3 marks One compensation mark for correct equation: efficiency = useful (power) output / total (power) input OR any correct re-arrangement of the above. One additional compensation mark for correct substitution: (must be clear they are substituting 85% and not just 85) • 85% = 450 / total energy input • OR 85/100 = 450 / total energy input • OR (total energy input =) 450 x 100 / 85 • OR (total energy input =) 450 / 85% OR 450 / 0.85 Allow ecf from (a)(i)	Allow: efficiency = useful (energy) output / total (energy) input	1 (AO2) 1 (AO2) 1 (AO1)	
7aiv	(529.4 − 450) = 79.4 (W) Accept 79 (W) ECF answer = a(iii) – a(i)		1 (AO2)	

7b	Any **3** of: • work (energy) is done (used) to accelerate the climber and so will transfer to kinetic rather than GPE • any horizontal motion requires work/energy without increasing GPE • energy (not work) is used holding muscles tense without increasing height or GPE • not all the energy from respiration has been used to increase GPE • Actual muscle efficiency is less than 85% • So more chemical energy is required for the same (useful) output	Accept other specific responses that demonstrate additional energy being required from respiration that is not directly used to increase GPE Allow 1 mark for reference to specific bodily functions	3 (AO1)	

Total			**12**