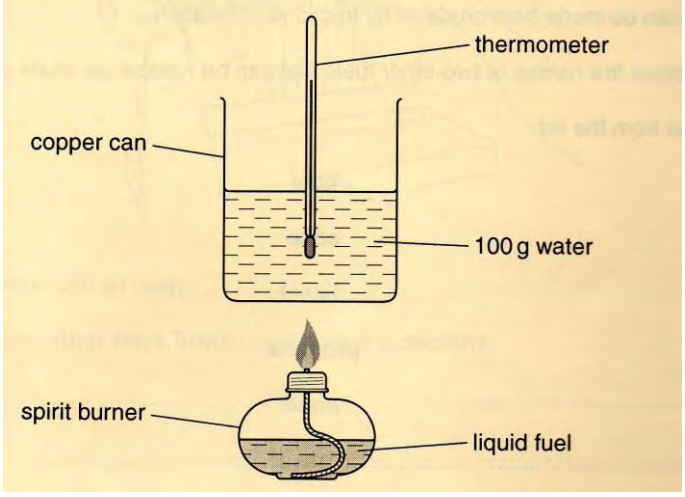
Question	Answer	Marks	Guidance
1 a	**LOOK FOR ANSWER FIRST OF ALL** **IF final temperature = 37.2 AWARD 3 MARKS** **IF final temperature = 37. 2380952380952 4 / 37 / or any value correctly rounded up to 2 or more decimal places AWARD 2 MARKS** $\Delta T = \frac{1600}{25 \times 4.2}$ (1) ΔT = 15.23809523809524 (1) Final temperature = 37.2 (1)	3	**allow** $\Delta T = \frac{q}{c \times m}$ (1) q = energy transferred c = specific heat capacity m = mass **allow** any answer correctly rounded up only **allow** this mark if quoted to one decimal place **allow** ecf from wrong temperature rise calculated
b	bond breaking absorbs or takes in energy **AND** bond making releases or gives out energy (1) idea that energy released is greater than energy absorbed (1)	2	**Second marking point is dependent on the first** **allow** bond breaking is endothermic **AND** bond making is exothermic (1) **allow** more energy associated with bond making than with bond breaking (1) **BUT** more energy released on forming bonds than absorbed in breaking bonds (2)
	Total	**5**	

Question	Answer	Marks	Guidance
2	**any four from:** correct use of a **spirit burner** (1) container of water above (spirit) burner (1) measures the change in temperature of the water (1) idea of measuring the mass of paraffin in the correct context (1) idea of repeating appropriate experiment (1)	4	**if experiment is unsafe, or incorrect experiment, max 1** **allow** paraffin burner **not** Bunsen burner **allow** reference to ΔT or change in temperature in equation (1) **allow** measure the temperature of the water at the start and at the end (1) **allow** marks from a **labelled** diagram 
	Total	**4**	

Question			Answer	Marks	Guidance
3	(a		bond making is exothermic / bond making gives out energy / bond making releases energy (1) more energy taken in than is released / more energy absorbed than given out (1) **but** it takes more energy to break the bonds than the energy released in making new bonds scores (2)	2	**allow** heat instead of energy **ignore** more bonds are broken than are made
	(b)	**(i)**	energy = 100 × 4.2 × 20 (1) **but** energy = 8400 (J) (2)	2	**allow** full marks for correct answer with no working out **allow** 2.2 x 4.2 x 20 or 184.8 (J) (1) **allow** 8.4 kJ (2)
		(ii)	highest temperature **change** (1) for least amount of fuel burnt (1)	2	**allow** calculation of energy change for each fuel showing that paraffin releases most energy (2) **allow** ecf from (b)(i) for energy calculations based on using the mass of fuel (instead of the mass of water) (2)
			Total	**6**	

Question			Answer	Marks	Guidance
4	(a)		bond breaking is endothermic / bond breaking takes in energy / bond breaking absorbs energy (1) bond making is exothermic / bond making gives out energy / bond making releases energy (1) more energy taken in than is released / more energy absorbed than given out (1)	3	**allow** heat instead of energy **ignore** more bonds are broken than are made

Question			Answer	Marks	Guidance
	(b)		**[Level 3]** Applies reacting particle model, including mention of collisions frequency and / or successful collisions, to explain the effect of temperature **AND** pressure on the rate of reaction. Quality of written communication does not impede communication of science at this level. **(5-6 marks)** **[Level 2]** Applies reacting particle theory, including mention of collisions, to explain the effect of temperature **OR** pressure on the rate of reaction. Quality of written communication partly impedes communication of science at this level. **(3–4 marks)** **[Level 1]** Applies reacting particle theory to explain the effect of temperature **OR** pressure on the rate of reaction. Quality of written communication impedes communication of science at this level. **(1–2 marks)** **[Level 0]** Insufficient or irrelevant science such as repeating the question. Answer not worthy of credit. **(0 marks)**	6	**This question is targeted at grades up to A.** **Indicative scientific points may include:** • Increasing pressure gives more crowded nitrogen and oxygen molecules / molecules are closer together / more nitrogen and oxygen molecules in the same volume so there is an increased number of collisions per second / collisions more often • Increasing temperature has nitrogen or oxygen molecules moving faster / molecules have more energy so more successful collisions per second / more energetic collisions. **Use the L1, L2, L3 annotations in scoris. Do not use ticks.**
			Total	**9**	

Question			Answer	Marks	Guidance
5	(a)		energy = 100 × 4.2 × 9 (1) energy = 3780 (J) (1)	2	**allow** full marks for correct answer with no working out
	(b)		no energy released calculated for other value(s) / idea that temperature increase relates to the energy released (1) because the one with most atoms or pentanol the temperature increase is not the highest / with most atoms does not release the most energy (1)	2	**allow** yes with energy calculated for the other value(s) / idea that the temperature increase is related to the energy released (1) and the last result is an anomaly (1) **allow** energy calculations based on using the mass of fuel (1.0g)
			Total	**4**	

Question			Answer	Marks	Guidance
6	(a)	(i)	same mass or volume or amount of water (in copper can) / same distance between burner and copper can / use same burner each time / same copper can / same size flame or wick (1)	1	**ignore** same mass of fuel **ignore** use the same equipment **ignore** using the same starting temperature
		(ii)	repeat experiment / AW (1)	1	**allow** compare with results from other students
	(b)		energy released = 100 x 4.2 x 25 / 10 500 (1) 10 500 ÷ 0.6g = 17500 / energy per gram = 17 500 (1)	2	**units not needed** 17 500 on its own scores (2) if answer not to 3 sig figs, eg 17 500.00, then one mark only **allow** ecf from wrong energy released to include 3 sig figs ie energy released ÷ 0.6
	(c)		evidence of calculation of energy per gram for ethanol and/or petrol (1) idea that paraffin transfers more than twice the energy transferred by petrol/ethanol, but is only slightly more expensive (1)	2	**allow** evidence of using temperature change per gram instead
			Total	**6**	

Question	Answer	Marks	Guidance
7 a	$2H_2 + O_2 \rightarrow 2H_2O$ correct formulae (1) balancing (1) balancing mark is conditional on correct formulae	2	**allow** any correct multiple e.g. $4H_2 + 2O_2 \rightarrow 4H_2O$ (2) **allow** = or ⇌for arrow **not** 'and' or & for + **allow** one mark for correct balanced equation with minor errors in case, subscript and superscript e.g. $2h_2 + O^2 \rightarrow 2H_2o$ (1)
b	horizontal line on the LHS is above the horizontal line on RHS (1) reactants i.e. hydrogen and oxygen and products i.e. water correctly labelled (1) (2)$H_2 + O_2$ (2)H_2O	2	**ignore** any labelling on the lines **ignore** any lines linking the reactants and products **ignore** transition states or free atoms in the middle of the diagram – focus on reactants and products only **this mark is independent of the first marking point** **allow** words instead of formulae / reactant and product **allow** H—H and O–O
c	provides water that astronauts can use / light / lightweight / low density / compact / no moving parts (1)	1	**allow** idea that makes a usable product i.e. water (for astronauts) / can be used as drinking water **ignore** efficient / reliable

Question	Answer	Marks	Guidance
d	idea that fuel cells contain poisonous catalysts (which need to be disposed of) (1) (idea of pollution) from the **burning** of fossil fuels associated with fuel cell production or manufacture of raw materials (1)	2	**allow** catalyst could be pollutants (when disposed of) / contain harmful catalysts **ignore** dangerous catalysts **allow** makes waste when they are thrown away **allow** mining for some of the materials used in a fuel cell (will cause pollution)
	Total	**7**	

Question			Answer	Marks	Guidance
8	(a)		energy released = 100 × 4.2 × 20 **or** 8400 (1) energy per gram = 16800 (1)	2	**allow** 8400 on answer line (1) 16800 on its own scores **two** marks **allow** ecf from wrong energy released i.e. energy released ÷ 0.5 (1) e.g. 0.5 X 4.2 X 20 / 0.5 or 84 on answer line (1)
	(b)		Yes, because as the molecular size increases the temperature change increases (1) and result for decane is anomalous (1) **or** no, because although as the molecular size increases the temperature change increases (1) but result for decane does not fit the pattern / there is a bigger change in temperature for nonane than for decane / there is a bigger energy change for nonane than for decane (1)	2	no mark for yes or no, it is for the explanation answer must refer to the temperature change and not temperature at the end
			Total	**4**	