Question			Answer	Marks	Guidance
1	(a)		32 (g) of methanol makes 60 (g) of ethanoic acid / 10 moles of methanol is used / 32 x 10 = 320 (1) So 320 (g) makes 600 (g) of ethanoic acid (1)	2	**allow** two marks for the correct answer of 600g even if no working out
	(b)		atom economy = $\frac{60}{60+18}$ / $\frac{60}{46+32}$ / $\frac{60}{78}$ (1) **but** atom economy = $\frac{60}{60+18} \times 100$ / $\frac{60}{46+32} \times 100$ / $\frac{60}{78} \times 100$ (2)	2	**allow** atom economy formula in words for one mark i.e. atom economy = <u>total Mr of desired products</u> x 100 (1) total Mr of all products
	(c)		percentage yield = $\frac{9.5}{9.8}$ (1) **but** percentage yield = $\frac{9.5}{9.8} \times 100$ (2)	2	**allow** percentage yield formula in words for one mark e.g. percentage yield = <u>actual yield</u> x 100 predicted yield or percentage yield = <u>am</u> x 100 pm
	(d)	(i)	more sustainable / makes less or no **waste** products (1)	1	makes less waste is **not** sufficient **ignore** makes less products **ignore** it wastes less resources
		(ii)	less waste of reactants (1)	1	**allow** no need to recycle unreacted reactants **ignore** less waste / waste products **ignore** able to make more / more products made
			Total	**8**	

Question			Answer	Marks	Guidance
2	(a)		oil because • oil is easy to use / coal is not easy to use (1) • oil is available / natural gas is not available (1)	2	**marks are for explanation** **not** oil is the cheapest but **allow** oil is the cheapest fuel that is available **ignore** oil is cheap / oil is cheaper
	(b)		$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$ correct reactants and products (1) correct balancing (1)	2	**allow** any correct multiple, including fractions **allow** = / ⇌ instead of → **not** and / & / '+ energy' if included award 0 marks for the question balancing mark is dependent on the correct formulae but **allow** 1 mark for a balanced equation with a minor error in subscripts / formulae eg $C_3H_8 + 5O2 \rightarrow 3CO2 + 4H_2O$
			Total	**4**	

Question			Answer	Marks	Guidance
3	(a)		$2SO_2 + O_2 \rightarrow 2SO_3$ formulae correct (1) balancing (1) balancing mark is conditional on correct formulae	2	**allow** = instead of → **not** and / & / instead of + **allow** any correct multiples, including fractions **allow** one mark for correct balanced equation with minor errors of case, subscript and superscript eg 2SO2 + O_2 → 2SO3
	(b)	(i)	(increasing the temperature) reduces the yield of sulfur trioxide (1)	1	
		(ii)	catalyst increases rate of reaction (1) a lower temperature would give a better yield but would slow the reaction (1) a higher pressure would increase the yield but a higher pressure would increase plant cost / higher pressure would increase the yield but increase energy cost / higher pressure increases the yield but increases the safety risks (1)	3	 **allow** ora must specify the actual cost involved **allow** ora
			Total	**6**	