

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

Question		Answer	Marks	Guidance
2	(a)	oil because <ul style="list-style-type: none"> <li>oil is easy to use / coal is not easy to use (1)</li> <li>oil is available / natural gas is not available (1)</li> </ul>	2	<b>marks are for explanation</b>  <b>not</b> oil is the cheapest but <b>allow</b> oil is the cheapest fuel that is available  <b>ignore</b> 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	<b>allow</b> any correct multiple, including fractions <b>allow</b> = / $\rightleftharpoons$ instead of $\rightarrow$ <b>not</b> and / & / '+ energy' if included award 0 marks for the question  balancing mark is dependent on the correct formulae but <b>allow</b> 1 mark for a balanced equation with a minor error in subscripts / formulae eg $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$
<b>Total</b>			<b>4</b>	

Question		Answer	Marks	Guidance	
3	(a)	$2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3$ formulae correct (1) balancing (1) balancing mark is conditional on correct formulae	2	<b>allow</b> = instead of $\rightarrow$ <b>not</b> and / & / instead of + <b>allow</b> any correct multiples, including fractions <b>allow</b> one mark for correct balanced equation with minor errors of case, subscript and superscript eg $2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3$	
	(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	<b>allow</b> ora must specify the actual cost involved <b>allow</b> ora
			<b>Total</b>	<b>6</b>	