1 **(a) (i)** correct structure **[1]**
$CH_2=CCl_2$

(ii) because it has a lower M_r **or** density **or** its molecules move faster **[2]**
it is lighter ONLY [1]
only comment - smaller molecules [0]
answer implies or states sieve idea then [0]

(b) (i) ester linkage **[1]**
COND polymer chain showing different monomers and continuation **[1]**
$-OOC-C_6H_4-COOCH_2CH_2O-$

(ii) fats **or** lipids **[1]**

(iii) does not decompose easily when heated **[1]**
accept similar statements

(c) (i) does not decompose **or** non-biodegradable shortage of landfill sites **or** of space visual pollution
poisonous/toxic/harmful gases when burnt
NOT carbon monoxide, sulphur dioxide. If gas named has to be a correct one eg HCl, HCN
dangerous to animals
Any **TWO** **[2]**

(ii) conserve petroleum or save energy **[1]**
NOT cheaper

TOTAL = 10

Question	Answer	Marks
2(a)	fast(reaction; large(r) surface area;	1 1
(b)	(dm^3);	1
(c)	moves equilibrium to right; increases yield (of sulfur trioxide) / uses up more sulfur dioxide;	1 1
(d)(i)	moves equilibrium to left; (forward reaction) exothermic;	1 1
(d)(ii)	d rate; molecules have less energy / move slower; fewer collisions (per second) / fewer particles have the activation energy / fewer collisions have the activation energy;	1 1 1
(e)(i)	moves to right;	1
(e)(ii)	high yield at 2 atm;	1
(f)	vanadium(V) oxide / vanadium pentoxide;	1
(g)	**M1** dissolve / react sulfur trioxide in (concentrated) sulfuric acid; add water to product of **M1**;	1 1

3(a)	M1 add chlori**n**e to (potassium) iodi**d**e solution; M2 red / brown / yellow / orange (solution) is formed; M3 Cl_2 + 2KI → 2KCl + I_2 Cl_2 + 2I → 2Cl + I_2 ;	3	Solution must be implied for M1 **A** any soluble iodide solution **A** black (ppt or solid) **A** multiples **I** state symbols but KI(aq) would allow the solution aspect of mark in M1
5(b)	M1 (0.013 moles of I and 0.065 moles of F atoms gives a) ratio 1:5; Formula = IF_5 ;	2	Award 2 marks for IF_5 **A** one mark for I_5F (as ratio is inverted) **A** one mark for IFl_5 or I_5Fl

Question	Answer	Marks	Guidance
3(c)(i)	example of a reversible reaction including attempts at removing / adding waters of crystallisation **OR** example of a reaction which under closed conditions would be reversible;	**1**	**A** written description of the reaction e.g. 'Haber process' unless equation is attempted in which case ignore written description **A** word equations / unbalanced equations **A** equations without equilibrium arrows **I** descriptions of physical changes
(c)(ii)	*Any **two** from:* (a reaction) M1 which can take place in both directions **OR** which can be approached from both directions; M2 in which concentrations / macroscopic properties do not change (with time); M3 the two reaction rates are equal;	**2**	**I** reference to 'closed system' **A** 'a reaction which can go forwards and backwards' for M1 **I** 'a reaction with an equilibrium arrow' or with '$\rightleftharpoons$' for M1 **R** concentrations (of reactants and products) are the same
(d)	M1 equilibrium goes to LHS **OR** equilibrium goes to reactants side; M2 because the concentration of chlorine decreases;	**2**	**A** reaction goes to LHS but **R** 'equilibrium goes to LHS and to products side' **A** backward reaction is favoured **I** less yield or less products **A** 'reactant' for 'chlorine' but not reactants **A** to replace missing chlorine

Question	Answer	Marks	Guidance
3(e)	M1 equilibrium goes to RHS **OR** equilibrium goes to products side; M2 exothermic reactions are favoured by low temperatures; M3 the forward reaction is exothermic;	**3**	**A** reaction goes to RHS but **R** 'equilibrium goes to RHS and to reactants side' **A** forward reaction is favoured **I** more yield or more products **A** for M1 and M2 'decreasing temperature makes the equilibrium go to RHS' **A** backward reaction is endothermic

4 (a (i) **first reaction**
volume / moles / molecules of reactants and products are different [1]

second reaction
volume / moles / molecules of reactants and products are the same [1]

(ii) first reaction (forward) reaction is endothermic [1]
second reaction (forward) reaction is exothermic [1]

(b) $C_8H_{18} \rightarrow 2C_4H_8 + H_2$ [1]

(ii) $2H^+ + 2e \rightarrow H_2$ [2]

or $2H_3O^+ + 2e \rightarrow H_2 + 2H_2O$
accept: –2e on right hand side accept: e
note: not balanced = 1

(iii) chlorine / Cl_2 / [1]
cond: water treatment / solvents / plastics / PVC / bleach / disinfectants / HC*l* / kill bacteria / sterilising water / chlorination <u>of water</u> / swimming pools / pesticides / herbicides / insecticides / germicides / pharmaceuticals [1]

sodium hydroxide/NaOH [1]

cond: making soap / degreasing / making paper / detergents / bio-diesel / paint stripper / clearing drains / alumina from bauxite / oven cleaner / bleach [1]

5 **(a (i)** burn sulfur in air **or** oxygen [1]
or heat a metal sulfide in air

(ii) bleach for wood pulp/cloth/straw **or** preserve food **or** sterilising
or making wine **or** fumigant **or** refrigerant [1]
Accept making paper

(iii) vanadium(V) oxide **accept** vanadium oxide **or** V_2O_5
or vanadium pentoxide [1]
oxidation state not essential but if given it has to be (V)

(iv) rate too slow **or** rate not economic [1]

(v) reaction too violent **or** forms a mist [1]

(b) (i) add water to yellow powder **or** to anhydrous salt [1]
it would go green [1]

(ii) change from purple **or** pink [1]
to colourless **NOT** clear [1]

(iii) reacts with oxygen in air [1]

(c) number of moles of $FeSO_4$ used = 9.12/152 = 0.06 [1]
number of moles of Fe_2O_3 formed = 0.03* [1]
mass of one mole of Fe_2O_3 = 160 g [1
mass of iron(III) oxide formed = 0.03 × 160 = 4.8 g [1
number of moles of SO_3 formed = 0.03 [1]
volume of sulfur trioxide formed = 0.03 × 24 = 0.72 dm^3 [1]
If mass of iron(III) oxide greater than 9.12 g, then only marks 1 and 2 available

Apply **ecf** to number of moles of Fe_2O_3* when calculating volume of sulfur trioxide.
Do not apply **ecf** to integers

[Total: 16]