1 Complete **word** equations for each of the following reactions. Write **no reaction** if no reaction takes place.

a) methanol (CH_3OH) + oxygen → ....

b) silane (SiH_4) + oxygen → ....

c) hydrochloric acid + calcium oxide → ....

d) ammonia + nitric acid → ....

e) nitric acid + zinc → ....

f) lithium + water → ....

g) sodium carbonate + sulfuric acid → ....

2 Classify each of the following metals as having high / medium / low reactivity.

a) gold ....   b) calcium ....   c) iron ....

3 Complete the table about the following reactions by ticking the correct boxes.

equation	transfer of		type of reaction	
	protons	electrons	redox	acid-base
$Fe + Cu(NO_3)_2 \rightarrow Fe(NO_3)_2 + Cu$				
$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$				
$Br_2 + 2KI \rightarrow 2KBr + I_2$				

4 a) Complete the table to show the products of the electrolysis of the following compounds.

compound	state	product at positive electrode	product at negative electrode
sodium chloride	molten		
potassium bromide	aqueous		
silver nitrate	aqueous		

b) Write balanced half equations for the following electrolysis conversions.

i) $Al^{3+} \rightarrow Al$ ....

ii) $Br^- \rightarrow Br_2$ ....

iii) $H^+ \rightarrow H_2$ ....

iv) $OH^- \rightarrow O_2$ ....

5 When a aqueous solution of chlorine (Cl_2) is added dropwise to an aqueous solution of sodium bromide (NaBr), a displacement reaction takes place to form bromine (Br_2) and sodium chloride (NaCl) in the solution.

a) What colour change would you see in this reaction? ....

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b) Explain by reference to electrons why chlorine displaces bromine in this reaction.

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c) Write a balanced equation for this reaction.

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d) Write the simplest ionic equation for this reaction.

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e) Write two half equations to show what happens in this reaction.

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f) Explain clearly why this is a redox reaction. ....

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| Area	Strength	To develop	Area	Strength	To develop	Area	Strength	To develop
Done with care and thoroughness			Electron v proton transfer			Write half equations for displacement		
Good SPG			Identify electrolysis products			Know halogen reactivity trend		
Word equations for reaction with O_2			Write electrolysis half equations			Explain halogen reactivity trend		
Word equations for metal reactions			Write formulae			Give observations in halogen displacement		
Word equations for acid reactions			Write balanced equations			Explain redox in terms of electrons		
Metals as high/medium/low reactivity			Write ionic equations for displacement					

1 **a** Calculate the energy change in the following reaction using the bond energies given.
[C–C = 348,   C-H = 412,   C=C = 612,   H–H = 436 kJ/mol]
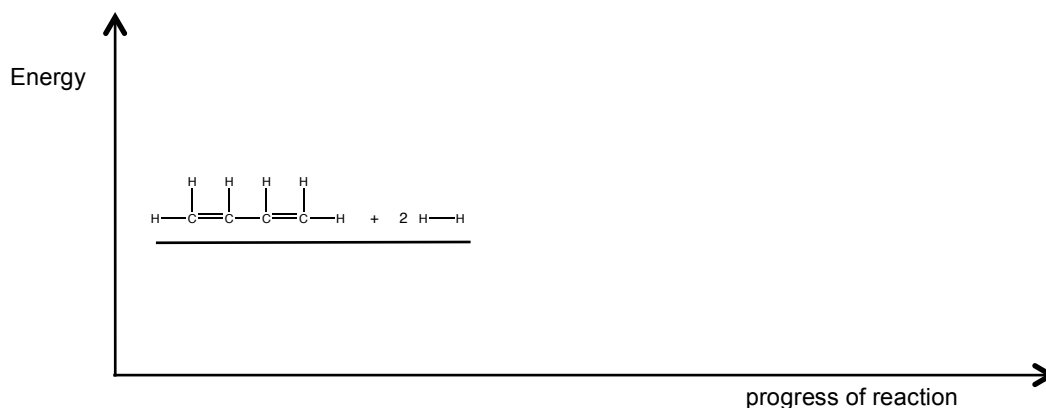

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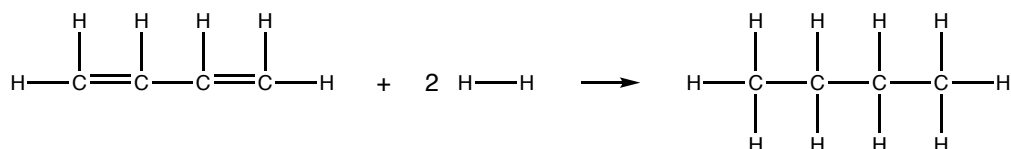
b Explain whether this reaction is exothermic or endothermic by discussing bond breaking and making.

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c Complete the energy profile for this reaction. Draw arrows to show the overall energy chance (label "OEC") and the activation energy (label "AE")

Energy

progress of reaction

2 Tick the correct box to show whether each of the following relates to an exothermic or an endothermic reaction.

	exothermic	endothermic
energy change is +72 kJ		
products have more energy than reactants		
neutralisation of hydrochloric acid by sodium hydroxide		
thermal decomposition of copper carbonate		

3 Fuel cells have a number of advantages over non-rechargeable and rechargeable cells. The hydrogen fuel cell is the most common fuel cell.

    a Give one advantage and one disadvantage of hydrogen fuel cells compared to rechargeable cells.

       advantage ....

       disadvantage ....

    b Give the half equations for the reactions that take place at the electrodes in hydrogen fuel cells.

       anode .... cathode ....

4 A simple cell can be made by placing two different metals (as electrodes) in a salt solution (as electrolyte). A student made some cells in this way and measured the voltage (potential difference) in each case. The table shows which electrode was connected to which terminal of the voltmeter.

positive electrode	negative electrode	voltage (V)
nickel	iron	+0.19
iron	zinc	+0.32
iron	cobalt	+0.16

    a What is an electrolyte? ....…....................

       ....

    b Place the four metals in order of reactivity, with the most reactive first.

       most .... least

    c What would the voltage be if a cell was made using cobalt and nickel, with nickel connected to the negative terminal of the voltmeter.   ....

    d To create the cell the greatest voltage with a positive voltage when connected to a voltmeter:

       i) which two metals would you use? ....…....

       ii) what would the voltage be? ....…....…...

   iii) which metal would be the positive electrode? ....

Area	Strength	To develop	Area	Strength	To develop	Area	Strength	To develop
Done with care and thoroughness			Can draw energy profiles			Use voltage to order metal reactivity		
Shows suitable working			Can label activation / energy change			Work out voltage in cells		
Calculate energy change using bonds			Pros and cons of fuel cells			Use voltage data to solve problems		
Deduce if exo/endothermic			Fuel cell electrode equations					
Explain if exo/endothermic using bonds			Knows what an electrolyte is					

1 An experiment was carried out to see how the rate of a reaction changes during the reaction. A piece of magnesium was reacted with hydrochloric acid and the volume of hydrogen gas collected recorded. A graph was plotted of the results.
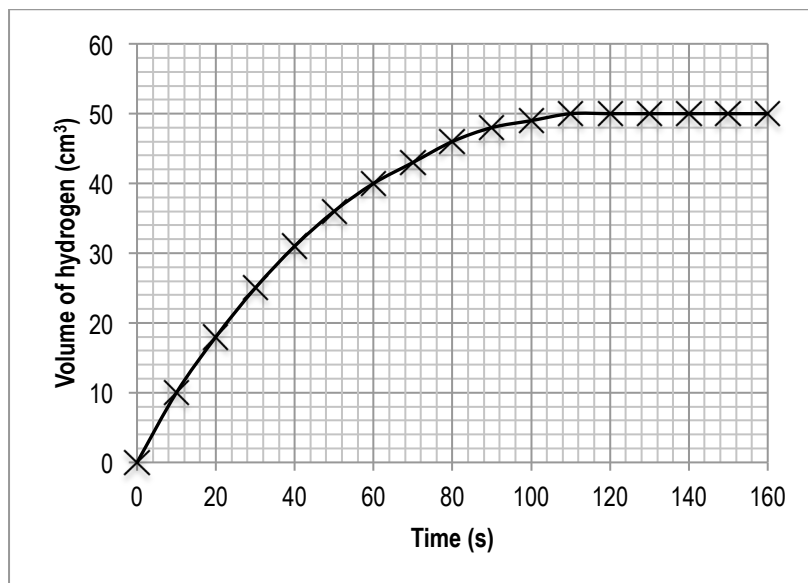
a Draw a tangent to the line to find the rate at 40 seconds.

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b Explain why the reaction slows down. ....

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2 Hydrochloric acid reacts with sodium thiosulfate in a flask to form a precipitate that increases the turbidity of the mixture. The time taken for the mixture to become too cloudy to see a cross on a piece under the flask can be used to investigate factors that affect the reaction rate.

a A student carried out an experiment to see how changing the concentration of the acid affects the reaction rate. List four key control variables in this experiment.

1 .... 3 ....

2 .... 4 ....

b Explain why increasing the concentration of the acid would increase the rate of reaction.

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3 Catalysts increase the rate of chemical reactions. Explain, in simple terms, how they work.

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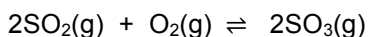
4 Sulfur dioxide reacts with oxygen to form sulfur trioxide in a reaction that reaches a state of dynamic equilibrium in a closed system. The forward reaction is exothermic.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

a What is happening when a reaction is in dynamic equilibrium?

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b What would happen to the yield of sulfur trioxide if the temperature was increased? Explain your answer.

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c What would happen to the yield of sulfur trioxide if the pressure was increased? Explain your answer.

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Area	Strength	To develop	Area	Strength	To develop	Area	Strength	To develop
Done with care and thoroughness			Calculate gradient			How T affects equilibrium position		
Shows suitable working			Explain why reactions slow down			Why T affects equilibrium position		
Can draw tangents to curves			Explain how catalysts work			How P affects equilibrium position		
Choose points for gradient			Explain dynamic equilibrium			Why P affects equilibrium position		

1 Draw the displayed structure of each of the following molecules in the boxes.

methanol	butane
propene	ethyl ethanoate

2 Hexane is an alkane. Hexene is an alkene. They both contain six carbon atoms.

a) What is the molecular formula of hexane? ....

b) Alkanes are saturated hydrocarbons. Explain these terms.

hydrocarbon ....

saturated ....

c) Describe a test what you could use to distinguish hexane from hexene. Give the result for each compound.

test ....

hexane result ....

hexene result ....

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3 a) Ethanoic acid is a weak acid. Draw it structure.

b) What are weak acids? ....

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4 Ethene can be made by cracking of long alkanes. Describe **why** this is done and **one way** in which this is done.

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5 Name the monomers that these polymers are made from.

polymer	starch	proteins	poly(ethene)	DNA
monomer				

6 Draw the structure of the polymers formed from these monomers:, and state whether they are addition or condensation polymers.

monomer structure(s)	polymer structure	polymer type
(monomer: $C=C$ with H, F, H, F groups)		
(monomer: $H-N-C-C-O-H$ amino acid structure)		
(monomers: diol and dicarboxylic acid structures)		

Area	Strength	To develop	Area	Strength	To develop	Area	Strength	To develop
Done with care and thoroughness			Test for C=C with Br_2(aq)			Draw addition polymers		
Good SPG			Understands strong and weak acids			Draw condensation polymers		
Can draw organic molecules			Knows how cracking is done			Identify addition/condensation polymers		
Knows organic definitions			Knows why cracking is done					
Write molecular formula of alkanes			Identify monomers for natural polymers					

1) a) How many moles in 33.0 kg of ammonium sulfate $(NH_4)_2SO_4$. ....

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b) What is the mass of 0.040 moles of oxygen, O_2? ....

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2) a) What maximum mass of methanol that can be made when 12 g of hydrogen reacts with an excess of carbon monoxide? $CO + 2H_2 \rightarrow CH_3OH$

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b) In a reaction, 60 g of methanol was formed from 12 g of hydrogen. Calculate the percentage yield.

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3) Calculate the percentage atom economy to make iron from iron(III) oxide by reaction with carbon monoxide. $Fe_2O_3 + 3CO \rightarrow 2Fe + 2CO_2$

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4) What volume of hydrogen gas is formed, measured at room temperature and pressure, when 0.65 g of zinc reacts with sulfuric acid? $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

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5) What volume of carbon dioxide gas is formed when 100 cm^3 of propane gas burns (both gases are at room temperature and pressure)? $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

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6) 0.595 g of tin (Sn) reacts with 0.71 g of chlorine (Cl_2) to form tin chloride. Find the simplest molar ratio in which tin reacts with chlorine and use it to find the formula of the tin chloride. Finally, write a balanced equation for the reaction.

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7) Lead reacts with chlorine to form lead(II) chloride. When 6.21 g of lead reacts with 2.84 g of chlorine, which is the limiting reagent and what mass of lead(II) chloride is formed?

$Pb + Cl_2 \rightarrow PbCl_2$

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8) Find the concentration of oxalic acid ($H_2C_2O_4$) in mol/dm^3 and g/dm^3 given that 25.0 cm^3 of this solution reacts with 22.8 cm^3 0.100 mol/dm^3 sodium hydroxide solution in a titration.

$H_2C_2O_4 + 2NaOH \rightarrow Na_2C_2O_4 + 2H_2O$

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Area	Strength	To develop	Area	Strength	To develop	Area	Strength	To develop
Done with care and thoroughness			Can work out % atom economy			Understands limiting reagents		
Shows suitable working			Can work out % yield			Work out moles for solutions		
Can work out M_r			Understands why yield < 100%			Convert mol/dm^3 to g/dm^3		
Work out moles from mass			Work out gas volume from mass or mol			Does not round too much		
Can work out mass from moles			Understands reacting gas volumes			Gives units		
Use equation to find reacting moles			Deduce molar reacting ratio from mass					