edexcel
advancing learning, changing lives

ResultsPlus

Examiners' Report
January 2011

GCE Chemistry 6CH02 01

ResultsPlus
look forward to better exam results

A PEARSON COMPANY

Edexcel Limited. Registered in England and Wales No. 4496750
Registered Office: One90 High Holborn, London WC1V 7BH

Edexcel is one of the leading examining and awarding bodies in the UK and throughout the world. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers.

Through a network of UK and overseas offices, Edexcel's centres receive the support they need to help them deliver their education and training programmes to learners.

For further information, please call our GCE line on 0844 576 0025, our GCSE team on 0844 576 0027, or visit our website at www.edexcel.com.

If you have any subject specific questions about the content of this Examiners' Report that require the help of a subject specialist, you may find our **Ask The Expert** email service helpful.

Ask The Expert can be accessed online at the following link:
http://www.edexcel.com/Aboutus/contact-us/

Alternatively, you can contact our Science Subject Advisor directly by sending an email to Richard Hammond on ScienceSubjectAdvisor@EdexcelExperts.co.uk.
You can also telephone 0844 576 0037 to speak to a member of our subject advisor team.

ResultsPlus

ResultsPlus is Edexcel's free online tool that offers teachers unrivalled insight into exam performance.

You can use this valuable service to see how your students performed according to a range of criteria – at cohort, class or individual student level.

- Question-by-question exam analysis
- Skills maps linking exam performance back to areas of the specification
- Downloadable exam papers, mark schemes and examiner reports
- Comparisons to national performance

For more information on ResultsPlus, or to log in, visit www.edexcel.com/resultsplus.
To set up your ResultsPlus account, call 0844 576 0024

January 2011

Publications Code US026195

Introduction

It was pleasing to see some very good scripts from some well prepared candidates on this unit. In contrast there were many candidates who, while displaying good calculation and application skills in the last two questions, were lacking in knowledge of halogen and organic chemistry in questions 13 and 14. Careful study and learning of the chemical reactions is essential to success in this unit.

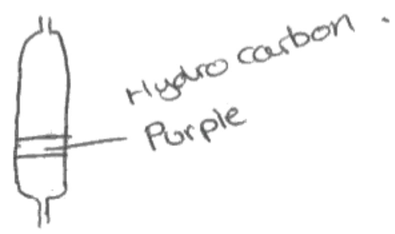
The multiple choice section seemed to give few problems to most candidates, except for the questions applying knowledge of intermolecular forces 6(a) and (b).

Question 13 (a) (i)

Many candidates seemed unfamiliar with separating flasks. The most commonly drawn container was a sealed test tube, which only lost the first mark. Ideally the separating flask should be drawn with a stopper. A tap is essential.

The less dense layer is the upper layer, and this is, of course, where the iodine is dissolved, though a number of candidates labelled the aqueous layer as containing the iodine.

Diagram



Colour of hydrocarbon layer .... Purple .

ResultsPlus
Examiner Comments

The drawn funnel has no tap.
The funnel has no stopper, but would not have been penalised.

ResultsPlus
Examiner Tip

Always check that apparatus drawings would work.

Question 13(a) (ii)

This question was an exercise in balancing redox equations. Many candidates had seen the reaction, which is in the specification (2.7 2 b i), though those who had not could still gain full credit if Fe^{3+} was reduced to Fe. Nearly all knew iodine was formed.

The common error was failure to balance for charge.

Write the ionic equation for this reaction. State symbols are **not** required.

(1)

$$2I^- + Fe^{3+} \rightarrow I_2 + Fe^{2+}$$

ResultsPlus

Examiner Comments

The candidate has the correct formulae, and has balanced for each element, but they have not balanced for charge.

ResultsPlus

Examiner Tip

Always check ionic equations by adding up the total charges on each side. As it is written this equation has a total of one positive charge on the left and two on the right.

Question 13(b) (i)

Good candidates realised that sulfuric acid oxidizes iodide to iodine, while phosphoric acid does not, or does so to a lesser extent.

A significant proportion of sulfuric acid candidates confused ioidide and iodine, suggesting sulfuric acid oxidizes iodine. Some even thought reduces iodide.

(i) Suggest why phosphoric(V) acid is used in this preparation rather than concentrated sulfuric acid.

(1)

As concentrated sulfuric acid will be reduced by the iodine (to SO_2 and then to H_2S) so hydrogen iodide would not be formed.

ResultsPlus
Examiner Comments

This would have beeen an excellent answer. It is fine to refer to iod**ide** reducing sulfuric acid. The candidate even knows the products of reduction. All this is spoiled by the iod**ine** doing the reducing.

ResultsPlus
Examiner Tip

Be very careful in using chemical terms, like iodide, the negative ion and iodine, the molecule.

Question 13(b) (ii)

Less than 10% of candidates answered this correctly, in spite of the rather generous marking, which allowed 'the hydrogen iodide dissolving'.

It was clear few candidates remembered doing this experiment, though 'describe and carry out the reactions of...hydrogen halides with water' is clearly in the specification (2.7 2 c iii).

(ii) Describe what you would see if a test tube of hydrogen iodide gas was inverted in a beaker of water.

(1)

The test tube would fill with water.

ResultsPlus
Examiner Comments

The fully correct answer.

ResultsPlus
Examiner Tip

If you miss an experiment, try and catch up with the lesson, or to see a video clip showing what happens.

Question 13(b) (iii)

Many candidates could not begin the equation because they are unfamiliar with the formula of ammonia and/or ammonium iodide, though ammonia and ammonium ions feature in the section on shapes of molecules.

The correct equation with states is given in all three text books recommended for the specification.

$$HI_{(g)} + NH_{3(g)} \rightarrow NH_4I_{(g)}$$

ResultsPlus

Examiner Comments

The formulae in the equation are correct but the states, which are difficult to read, are all gaseous.

ResultsPlus

Examiner Tip

Think of what you saw when you did this. Clouds of white smoke and remember smoke is tiny particles of solid in this reaction.

Question 13(c) (i)

This was one of the hardest questions. Though clearly in the specification, candidates only meet it once, and only the most able knew the products. It is a very important method of preparing iodoalkanes.

(i) Complete the following equation for the formation of 1-iodobutane. **(1)**

PI_3 + ...3...... $C_4H_9OH \rightarrow 3C_4H_9I + POH_3$

ResultsPlus
Examiner Comments

The candidate has done most of the work, recognising that three moles of iodine atoms are involved, and three moles of hydrogen atoms displaced, but they have forgotten the three moles of oxygen atoms.

ResultsPlus
Examiner Tip

Check equations for balancing of each element.

Question 13(c) (ii)

There were some good responses to this recognising that both London and permanent dipole-permanent dipole forces are present.

(ii) Identify the intermolecular forces present between molecules of 1-iodobutane. (1)

London forces

Permanent dipole -dipole interactions

ResultsPlus

Examiner Comments

A typical correct answer

A few very good candidates also recognised that the C-I bond is only very slightly polarised.

Question 13(c) (iii)

Most candidates knew that a yellow precipitate forms when an iodoalkane reacts with hot silver

(iii) 1-iodobutane reacts with hot aqueous silver nitrate solution. Describe what you would see when this reaction takes place.

(1)

light yellow

a ~~white~~ precipitate formed

ResultsPlus

Examiner Comments

The candidate has muddled the colours of silver bromide and silver iodide.

nit

ResultsPlus

Examiner Tip

It is useful to learn the sequence coming down Group 7 of the Periodic Table.
Siver halide precipitates are coloured as follows:
chloride is white; bromide is pale yellow; iodide is yellow.

Question 13(c) (iv)

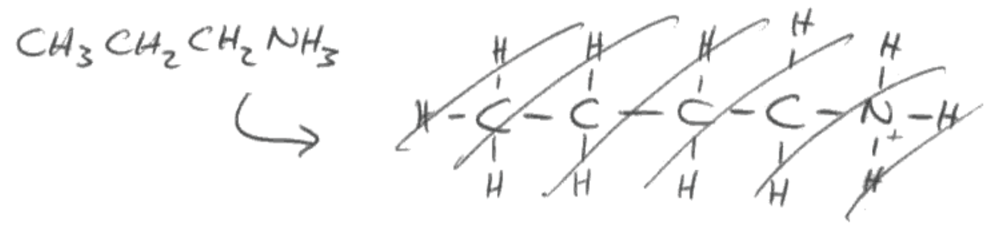
Only half the candidates answered this correctly.

Though amines are only met once in AS, they are very important in A2, so candidate must spend time to carefully study names and formula of the simpler compounds.

It is helpful for candidates to remember the similarities between reactions of halogenoalkanes with

(iv) Give the structural formula for the organic product of the reaction between 1-iodobutane and ammonia.

(1)



(Total for Question 13 = 12 marks)

ResultsPlus

Examiner Comments

There are a number of instructive errors in this answer.
The candidate begins by drawing a displayed formula - for many, part of the thinking process. At this stage there is just one error, the protonated form of the amine was allowed, providing the charge was shown but the iodide ion, I^-, was needed as well. Unfortunately, even the charge was lost in the final structural formula, when the candidate decided to reduce the length of the carbon chain as well.

wat

ResultsPlus

Examiner Tip

Check the detail of formulae of products of organic reactions.
Learn ‘to count’ in organic chemistry:
meth, eth, prop, but etc.

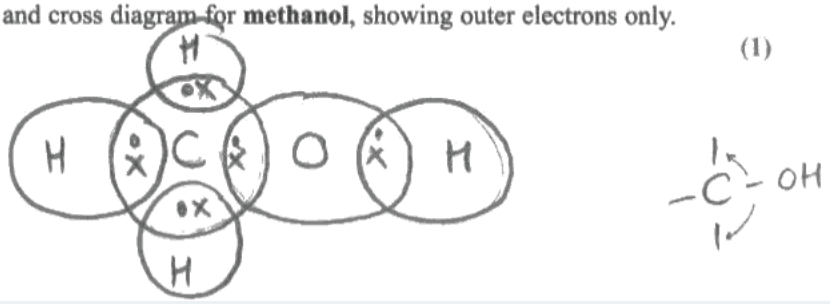
Question 14(a) (i)

About three quarters of candidates got this right. The commonest error was to omit the non-bonding

14 This question is about methanol, CH_3OH, and ethanol, CH_3CH_2OH.

(a) (i) Draw a dot and cross diagram for **methanol**, showing outer electrons only.

(1)



ResultsPlus

Examiner Comments

Both pairs of non bonding electrons are missing.

el

So lectrons. Though this was not penalised on this

oc enalised in future.

ResultsPlus

Examiner Tip

It is a good idea to first write the outer electron arrangements for all the atoms involved, here C, O, and H, with four, six and one electron respectively. Then it is less likely that the non- bonding electrons will be forgotten.

Question 14(a) (ii)

The first problem here was remembering the values for the bond angles. Many were successful in this. The justifications proved more demanding.

For the HCH angle, many described the shape correctly, but failed to explain why the tetrahedral shape was adopted. The key point is that bonding pairs of electrons repel each other and try to get as far apart as possible to adopt the position of minimum repulsion.

For the COH angle, the key point is that non-bonding pairs of electrons repel more than the bonding pairs.

(ii) Give the approximate values for the HCH and COH bond angles in methanol. Justify your answers.

(4)

HCH angle 109.5°

Justification Tetrahedral shaped, carbon has 4 bonding pairs of electrons, and no lone pairs of electrons.

COH angle 104°

Justification The COH is bent, the oxygen has two bonding pairs and two lone pairs of electrons.

ResultsPlus

Examiner Comments

Both bond angles are correct.
The first justification is all true, but misses the key point.
The same is true of the second.

ResultsPlus

Examiner Tip

When a justification is asked for, always give all the relevant information.

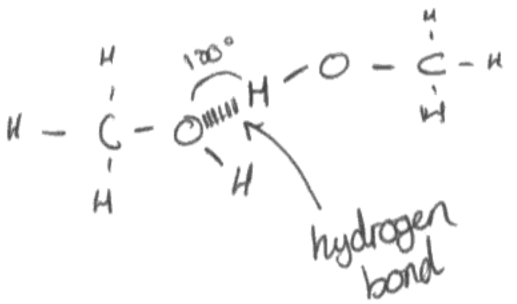
Question 14(a) (iii)

Very weak candidates attempted hydrogen bonds involving one or more methyl hydrogens or formed them between two OH hydrogens. Nearly half the candidates used a correct hydrogen atom with oxygen, and clearly identified the hydrogen bond.

Though the angle of 180° was often given, the problem was where to put it, and to ensure that the O-H...O were in a straight line.

(iii) Using displayed formulae, draw a diagram to show a hydrogen bond between two methanol molecules. On your diagram, show the bond angle around the hydrogen atom of the hydrogen bond and give its value.

(2)



ResultsPlus
Examiner Comments

The displayed formulae are fine, the correct atoms are involved and the hydrogen bond is clear - the label is a good idea.
The bond angle is known but it is in the wrong place - straight lines, like bonds are at 180° - the angle must be around the central hydrogen.

ResultsPlus
Examiner Tip

Hydrogen bonds are to a hydrogen directly attached to, and formed from, a fluorine, nitrogen or oxygen.
Bond angles are always around a particular atom in a molecule.

Question 14(b) (i)

Many candidates confused the reaction of an alcohol with sodium with the corresponding reaction of water. The examiners were generous this time and did not deduct marks, but they may not be so generous in future.

Similarly a white precipitate, for a white solid, forming was allowed, though this is not really correct.

(b) Methanol reacts with sodium.

(i) State what you would observe in this reaction.

(2)

A violent reaction with fizzing and gas being given off.

ResultsPlus

Examiner Comments

The mark was awarded for fizzing, even though the reaction is not violent.

ResultsPlus

Examiner Tip

In revision, try to recall what was seen when experiments were carried out.

Question 14(b) (ii)

The problem for many here was the formula of the organic product. It is like the reaction of sodium with water, in that an O-H bond is broken. The convention in organic chemistry is to give the organic part of the formula first.

Some candidates, on finding that the equation did not balance when hydrogen, H_2, formed, attempted to change the organic formula.

(ii) Write the equation for this reaction. State symbols are **not** required. (1)

$CH_3OH + Na \longrightarrow CH_3O^-Na^+ + H_2$

ResultsPlus

Examiner Comments

All formulae are correct, but no attempt has been made to balance for hydrogen.

ResultsPlus

Examiner Tip

Always check that equations balance for elements, if they do not it is often simplest, as it is here to use a half instead of doubling everything else.

Question 14(c) (i)

Many candidates were aware of the chemicals needed and gave either their correct names or formulae.

Some lost marks by giving both names and formulae and getting one wrong.

(c) **Ethanol** can be used to make ethanal.

(i) Identify, by name or formula, the two chemicals you would use to make ethanal from ethanol in the laboratory.

(2)

Potassium dichromate (VI) acidified with dilute sulphuric acid.

ResultsPlus
Examiner Comments

The fully correct answer, with the oxidation number of chromium specified, and the appropriate acid strength for favouring aldehyde formation.

ResultsPlus
Examiner Tip

Learn names and formulae of chemicals used in organic reactions and the conditions for reactions.

Question 14(c) (ii)

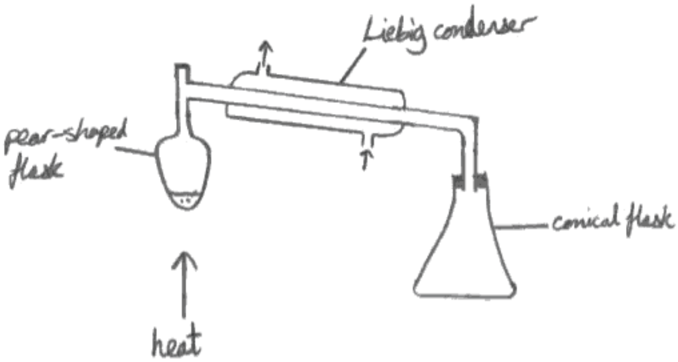
Weak candidates drew a reflux set up, confusing this with carboxylic acid preparation. It was common to omit a source of heat (a labelled arrow was sufficient) or to leave the still head open at the top, allowing the vapours to escape rather than pass through to the collecting vessel.

Some sealed the collection, so the apparatus would explode, while others did not place the collecting vessel under the delivery tube.

(ii) Draw a diagram of the apparatus you would use to prepare ethanal from ethanol in the laboratory and collect the product.

(2)

'Heat and distill off'



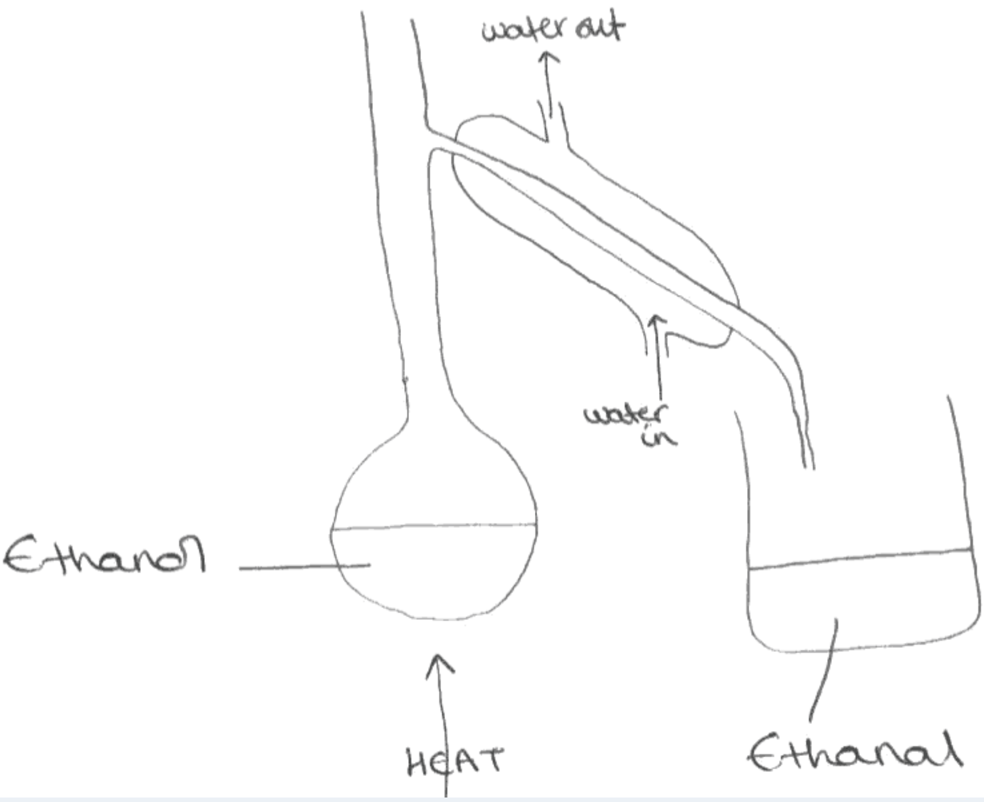
ResultsPlus

Examiner Comments

An example of sealed apparatus, that would explode.

(ii) Draw a diagram of the apparatus you would use to prepare ethanal from ethanol in the laboratory and collect the product.

(2)



ResultsPlus

Examiner Comments

The still head is open, so the vapours would escape.

ResultsPlus

Examiner Tip

Always check a diagram to see if the set up would work.

Question 14(c) (iii)

It was best to begin by answering the question, with a clear statement that ethanal has the higher boiling temperature. Good candidates went on to recognise that this was due to additional permanent dipole-permanent dipole forces in ethanal, and both had London (or dispersion) forces.

(iii) Both ethanal and propane have a molar mass of 44 g mol^{-1}, but their boiling temperatures are different.

Suggest which substance has the higher boiling temperature. Justify your answer by comparing the intermolecular forces in each compound.

(2)

Ethanal has a higher boiling point as it can form hydrogen bond whereas propane can only form instataneous dipole - dipole force.

(Total for Question 14 = 16 marks)

ResultsPlus

Examiner Comments

This here is the most common error for this question. Ethanal is correctly identified as having the highest boiling temperature, and the intermolecular force in propane is given correctly. Ethanol cannot form hydrogen bonds to itself.

ResultsPlus

Examiner Tip

Hydrogen bonds can only form when a hydrogen atom is directly attached to fluorine, oxygen or nitrogen.

Question 15(a) (i)

Use of a pestle and mortar was not remembered very well.

(a) (i) What should be used to crush the tablet? (1)

pestle and mortar

(ii) Name a suitable indicator for the titration. State the colour change you would

ResultsPlus
Examiner Comments

The correct answer with correct spelling.

ResultsPlus
Examiner Tip

It is a good idea to note names and spelling of apparatus especially when used for the first time.

Question 15(a) (ii)

Only weak candidates used inappropriate chemicals like litmus and universal indicator which do not give sharp end points.

Most used methyl orange or phenolphthalein. Some spellings were very poor. Candidates should be encouraged to learn correct spellings of important chemical names.

The acid colour of the indicator needed to be given first, as acid is in the titration flask.

(ii) Name a suitable indicator for the titration. State the colour change you would expect to see.

(2)

Indicator phenophaline

Colour change from pink to colorless

ResultsPlus
Examiner Comments

The spelling of phenolphthalein is just about recognisable. The candidate has failed to understand that the acid is in the titration flask.

ResultsPlus
Examiner Tip

When asked for an indicator, check the solutions in the flask and in the burette.

Question 15(b) (i)-(viii)

The structured titration calculation on a less familiar 'back titration' did not trouble good candidates with most achieving full marks.

Those who kept going, despite errors could still gain most of the marks.

(b) (i) Select appropriate readings and calculate the mean titre.

(1)

$$\frac{11.40 + 11.20}{2} = 11.30\ cm^3$$

(ii) Calculate the number of moles of sodium hydroxide used.

(1)

moles = vol x conc

$$= \left(\frac{11.30}{1000}\right) \times 0.3$$

$$= 0.00339 \text{ moles}$$

(iii) Use your answer to (ii) to write down the number of moles of hydrochloric acid left in 10.0 cm^3 of the solution used in the titration.

(1)

moles = vol x conc

$$= \frac{5}{1000} \times 1 = 0.005$$

$$0.005 - 0.00339 = 0.0011$$

(iv) Calculate the number of moles of hydrochloric acid left in 100 cm^3 of solution.

(1)

$$0.0011 \times 10 = 0.011$$

(v) 50.0 cm^3 of 1.00 mol dm^{-3} hydrochloric acid contains 0.0500 mol of hydrochloric acid.

Use this and your answer to (iv) to calculate the number of moles of hydrochloric acid that reacted with the indigestion tablet. **(1)**

0.05 × 2 = 0.1

0.1 − 0.011 = 0.089

(vi) The equation for the reaction between hydrochloric acid and calcium carbonate is:

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

Use this, and your answer to (v), to calculate the number of moles of calcium carbonate in one tablet. **(1)**

$$\frac{0.089}{2} = 0.0445$$

(vii) Calculate the mass of calcium carbonate in one tablet.

[Assume that the molar mass of $CaCO_3$ is 100 g mol^{-1}] **(1)**

mass = moles × M_R

= 0.0445 × 100

= 4.45g

ResultsPlus
Examiner Comments

This a typical moderate answer. The mean titre and the amount of sodium hydroxide are correctly calculated.
The first error comes in (iii), but this is correctly transferred to (iv).
Though the value in (iv) is used in (v) the value of 0.05 mol of HCl is strangely doubled.
However, the candidate perseveres, and correctly transfers the error to (v) and (vi).

ResultsPlus
Examiner Tip

In a calculation like this check each step, to try to avoid errors.
If you think you have made a mistake and can't see it, carry on.

Question 16(a)

Many candidates were comfortable in applying rules for assigning oxidation numbers, but some did not know the rules sufficiently, and thought oxygen changed oxidation number.

(a) For each of the first three reactions, state the initial and final oxidation numbers of any elements that change their oxidation numbers. Hence decide which are redox reactions.

(5)

Reaction 1 Initial oxidation number of O = -1

Final oxidation number of O = -2.

Oxidation. ⟶ REDOX

Reaction 2 Initial oxidation number of C = +2

Final oxidation number of C = +4.

Reduction ⟶ REDOX.

Reaction 3 No change in oxidation numbers.

ResultsPlus

Examiner Comments

A number of common errors are shown here.
Oxygen only changes in oxidation number if the element itself, peroxides, or oxyfluorides are invoved in a reaction.
Only one oxidation number change is given for each reaction.
The statement for reaction 3 should have continued with ‘this is not redox reaction’.

ResultsPlus

Examiner Tip

In redox reactions something is oxidised and something else must be reduced.

Question 16(b)

In part (i), many good candidates scored full marks, giving the effect of each condition on both yield and rate with appropriate explanations.

Common omissions were some of the reasons, and occasionally, the effect of conditions on rate.

Weaker candidates wrote contradictions late in their answer.

In part (ii) it was important to focus on the percentage conversion of methane. The ready availability of water was more often recognised.

*(b) (i) Discuss, with reasons, the conditions of temperature and pressure that would favour the production of hydrogen in **reaction 1**. You should consider the effect of the conditions on both yield and rate.

(7)

A lower pressure would increase the yield of H_2 as the equilibrium would shift to the right hand side. However, a ~~big~~ decrease in pressure would decrease the rate of reaction. So a relatively low pressure is favorable, but still high enough for an acceptable rate of reaction. An increase in temperature would also favour hydrogen production as the reaction is endothermic so equilibrium would shift to the right hand side. The increase in temperature would also increase the rate of reaction. So overall a high temperature and relatively low pressure favours the production of hydrogen.

(ii) Excess steam is used in reaction 1. State why an excess of a reagent is used

ResultsPlus

Examiner Comments

All the conditions are correctly given, but only one reason is given - for the increased yield at higher temperature.

ResultsPlus

Examiner Tip

Check that each part of a question is answered fully.

(ii) Excess steam is used in **reaction 1**. State why an excess of a reagent is used and suggest why steam, rather than methane, is chosen.

(2)

Steam is a lot cheaper and easier to produce than methane. There ~~greate~~ would be a proportion of the excess reagent wasted so it better to waste the cheaper reagent. Furthermore it is safer as an excess of methane could result in flammable gas being released which would pose a safety hazard.

ResultsPlus

Examiner Comments

The candidate has given the reason why steam is used, but failed to answer the first question.

ResultsPlus

Examiner Tip

After writing the answer check to ensure that all parts of the question have been answered.

Question 16(c)

This question was well answered with about three quarters of candidates gaining both marks. Some only mentioned alternative route, while others only mentioned lowering activation energy.

(c) Copper is a catalyst in **reaction 2**. Explain how a catalyst increases the rate of a reaction.

(2)

By providing a site ~~of~~ for the reaction to take place on it, the catalyst lowers the activation energy of a reaction. This means that, under the same conditions, more molecules have enough energy to react, and so rate of reaction is increased.

ResultsPlus
Examiner Comments

This is a good answer but it only refers to lowering activation energy, there is no specific mention of providing an alternative route for the reaction.

Question 16(d)

Most good candidates correctly recognised the regeneration of potassium carbonate as the economic advantage in part (i).

Nearly all realised carbon dioxide in global warming but there was a serious lack of understanding of the greenhouse effect, often confusing it with ozone layer depletion.

In environmental effects, it was important to focus on the effect of rising temperature, like melting polar ice caps, and the resulting rising sea levels.

(d) (i) State **one** economic advantage of **reaction 4**.

(1)

The potassium carbonate is regenerated which means will cost less money to produce new potassium carbonate.

*(ii) **Reaction 4** contributes to global warming. Identify the substance formed in this reaction which is likely to be responsible and explain the processes that lead to an increase in global temperatures.

Suggest **two** effects an increase in global temperatures might have on the environment.

(4)

CO_2 is a greenhouse gas which persists in the atmosphere and absorbs infrared radiations. This causes a depletion of the ozone layer which in turn allows harmful rays from the sun to reach the skin which could cause cancer, also it causes the polar ice caps to melt causing a rise in sea levels.

ResultsPlus
Examiner Comments

Part (i) is fine.
CO_2 is correct in (ii) but there is confusion in its role. It does absorb infrared, but this does not affect the ozone layer so the second mark is lost. Though two correct effects of global warming are given, one wrong effect is also given -there is no evidence that global warming causes skin cancer.

ResultsPlus
Examiner Tip

Do not muddle the two environmental issues; global warming and ozone layer depletion.

Advice to candidates

1 Learn the work on intermolecular forces thoroughly, and practice applying it each time you meet a new functional group in organic chemistry.

2 Learn the work on Groups 2 and 7.

3 Learn the organic chemistry, including reagents and conditions, names and formulae of reactants and products for each reaction.

4 Include experimental details in revision.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx

Further copies of this publication are available from
Edexcel Publications, Adamsway, Mansfield, Notts, NG18 4FN

Telephone 01623 467467
Fax 01623 450481
Email publications@linneydirect.com
Order Code -US026195 January 2011

For more information on Edexcel qualifications, please visit
www.edexcel.com/quals

Edexcel Limited. Registered in England and Wales no.4496750
Registered Office: One90 High Holborn, London, WC1V 7BH

Llywodraeth Cynulliad Cymru
Welsh Assembly Government

Rewarding Learning