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June 2005

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CHEMISTRY 4335, MARK SCHEME

Paper 1F

1.	(a)		electron	1
	(b)		electron	1
	(c)		protons **and** neutrons	1
	(d)		protons **and** electrons	1
	(e)		neutron	1
				Total 5 marks
2.	(a)		atomic number / proton number	1
	(b)		(relative) atomic mass **NOT** mass number	1
	(c)		1 / alkali metals	1
	(d)		6	1
	(e)		4 / 5 / 6	1
				Total 5 marks
3.	(a)	(i)	5	1
		(ii)	carbon dioxide + water → carbonic acid	1
	(b)		fizzy drinks / carbonated drinks fire extinguishers dry ice (for refrigeration) } **any two** **Accept other correct uses**	2
	(c)		O=C=O **ALLOW** dot and cross diagram with/without non-bonding electrons	1
				Total 5 marks
4.	(a)		metals non-metals } these two can be in reverse order gained lost high high	1 1 1 1 1 1
	(b)	(i)	2.8.2 and 2.8.7 (either way round)	2
		(ii)	2.8 and 2.8.8 (either way round)	2
				Total 10 marks

5.	(a)		B A	May use 'solid' 'liquid' 'gas'	**1**
			B C	if suitable key given.	**1**
			A C		**1**
			C A		**1**
	(b)		B / liquid		**1**
	(c)		tick to show element		**1**
			tick to show mixture		**1**
			tick to show mixture		**1**
			tick to show compound		**1**
				Total 9 marks	
6.	(a)	(i)	s aq aq g *Five correct= (2); four or three correct= (1); two or fewer= (0)*		**2**
		(ii)	copper(II) carbonate - (light/dark/pale) green		**1**
			copper(II) sulphate - (light/dark/pale) blue **NOT** royal blue		**1**
		(iii)	effervescence / fizzing / bubbles **NOT** gas formed **ALLOW** solid disappears/dissolves		**1**
	(b)		a carbonate	these two can be in reverse order	**1**
			an acid		**1**
			a salt		**1**
			(*this sentence must make chemical sense*)		
			neutralisation		**1**
	(c)	(i)	to neutralise/react with **all** the acid / use up the acid		**1**
		(ii)	filtration / filtering		**1**
	(d)		crystallisation **ALLOW** leave in warm place		**1**
				Total 12 marks	
7.	(a)	(i)	heat **ALLOW** warm or reference to flame **NOT** burn / Bunsen		**1**
		(ii)	turns white / paler		**1**
			condensation / droplets / liquid / steam **NOT** water vapour		**1**
		(iii)	'hydration' box ticked		**1**
	(b)	(i)	measure the freezing / boiling point		**1**
		(ii)	0°C / 100°C		**1**
	(c)	(i)	acid rain		**1**
		(ii)	stonework/buildings eroded/eaten away **NOT** corroded trees/plants/ crops harmed/killed fish harmed / killed **NOT** animals	**any two**	**2**
				Total 9 marks	

8.

Material	Use	Property
aluminium	Overhead electricity cables / coins / window frames	Good conductor of electricity / resists corrosion
copper	Overhead electricity cables / coins	Good conductor of electricity / resists corrosion
poly(chloroethene)	Insulation on electrical wires / window frames	Does not conduct electricity / resists corrosion
poly(ethene)	Injection moulding	Low melting point

Total 5 marks

9. (a) (i) calcium **1**

(ii) limewater **1**
milky / cloudy / white ppt **1**

(iii) carbonate **1**

(b) (i) Fe^{2+} **1**

(ii) iron(II) hydroxide **1**

(iii) sulphate **1**

(iv) $BaSO_4$ **1**

(c) any two from chloride / bromide / iodide **2**

(d) (i) $CaCO_3$ **1**

(ii) $FeSO_4$ **1**

Total 12 marks

10. (a) (i) air **1**
natural gas / oil **NOT** methane **1**

(ii) 450°C (±50°C) **1**
200 atm (±50 atm) **1**
iron (catalyst) **1**

(iii) liquefied / cooled / condensed **1**

(iv) recycled / fed back into reactor **1**

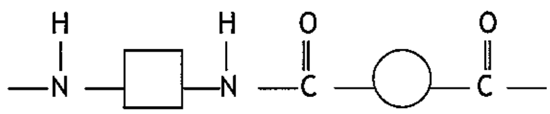
(b) $NH_3 + HNO_3 \rightarrow NH_4NO_3$ **or** $NH_4OH + HNO_3 \rightarrow NH_4NO_3 + H_2O$ **2**
formula of reactants (1 mark); formula of products (1 mark)
incorrect balance **maximum 1**

Total 9 marks

11.	(a)		BITUMEN: (waterproofing) roofs / roads / tarmac	**1**
			KEROSENE: (fuel for) aircraft/ stoves / lamps	**1**
	(b)	(i)	gasoline + oxygen → carbon dioxide + water **ALLOW** petrol / octane as reactant	**1**
		(ii)	insufficient/limited oxygen / air	**1**
		(iii)	carbon monoxide	**1**
			toxic / poisonous	**1**
			reduces ability of blood to carry oxygen / mention of (carb)oxyhaemoglobin	**1**
			OR	
			carbon / soot (1 mark) specified effect on lungs / respiratory system (1 mark)	
	(c)		heat / boil	**1**
			suitable apparatus (container to heat in; condenser; thermometer) - can be shown in diagram	**1**
			collect sample boiling between 80°C and 120°C (depends on apparatus)	**1**

Total 10 marks

12.	(a)		condensation	**1**
	(b)	(i)	(di)amine **ALLOW** amino	**1**
		(ii)	(di)carboxylic acid	**1**
		(iii)	alternating circle and square correct linkage between blocks (NH-CO- is minimum) two NH and CO groups in correct positions is minimum	**3**



must have 'continuation bonds' for 3rd mark
ALLOW terminal COOH or NH_2 if brackets used round repeat unit

	(c)		low	**1**
			weak	**1**
			molecules	**1**

Total 9 marks

Paper 2H

1.

Material	Use	Property
aluminium	Overhead electricity cables / coins / window frames	Good conductor of electricity / resists corrosion
copper	Overhead electricity cables / coins	Good conductor of electricity / resists corrosion
poly(chloroethene)	Insulation on electrical wires / window frames	Does not conduct electricity / resists corrosion
poly(ethene)	Injection moulding	Low melting point

Total 5 marks

2. (a) (i) calcium — **1**

(ii) limewater — **1**
milky / cloudy / white ppt — **1**

(iii) carbonate — **1**

(b) (i) Fe^{2+} — **1**

(ii) iron(II) hydroxide — **1**

(iii) sulphate — **1**

(iv) $BaSO_4$ — **1**

(c) any two from chloride / bromide / iodide — **2**

(d) (i) $CaCO_3$ — **1**

(ii) $FeSO_4$ — **1**

Total 12 marks

3. (a) (i) air — **1**
natural gas / oil **NOT** methane — **1**

(ii) 450°C (±50°C) — **1**
200 atm (±50 atm) — **1**
iron (catalyst) — **1**

(iii) liquefied / cooled / condensed — **1**

(iv) recycled / fed back into reactor — **1**

(b) $NH_3 + HNO_3 \rightarrow NH_4NO_3$ **or** $NH_4OH + HNO_3 \rightarrow NH_4NO_3 + H_2O$ — **2**
formula of reactants (1 mark); formula of products (1 mark)
incorrect balance **maximum 1**

Total 9 marks

4. (a) BITUMEN: (waterproofing) roofs / roads / tarmac — 1
KEROSENE: (fuel for) aircraft/ stoves / lamps — 1

(b) (i) gasoline + oxygen → carbon dioxide + water — 1
ALLOW petrol / octane as reactant

(ii) insufficient/limited oxygen / air — 1

(iii) carbon monoxide — 1
toxic / poisonous — 1
reduces ability of blood to carry oxygen / mention of (carb)oxyhaemoglobin — 1

OR

carbon / soot (1 mark)
specified effect on lungs / respiratory system (1 mark)

(c) heat / boil — 1
suitable apparatus (container to heat in; condenser; thermometer) - can be shown in diagram — 1
collect sample boiling between 80°C and 120°C (depends on apparatus) — 1

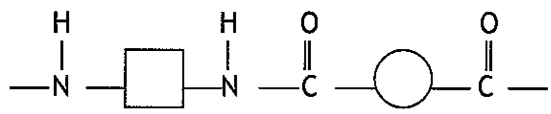
Total 10 marks

5. (a) condensation — 1

(b) (i) (di)amine **ALLOW** amino — 1

(ii) (di)carboxylic acid — 1

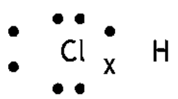
(iii) alternating circle and square — 3
correct linkage between blocks (NH-CO- is minimum)
two NH and CO groups in correct positions is minimum



must have 'continuation bonds' for 3rd mark
ALLOW terminal COOH or NH_2 if brackets used round repeat unit

(c) low — 1
weak — 1
molecules — 1

Total 9 marks

6.	(a)		**atoms** of the same element / with the same number of protons / same proton number / same atomic number	1
			but different numbers of neutrons / different mass numbers	1
	(b)	(i)	number of protons **and** atomic number = 37	1
			number of neutrons = 48	1
			mass number = 87	1
		(ii)	(85 x 0.72) + (87 x 0.28)	1
			= 85.6	1
	(c)		same number of electrons (in outer shell) / both have one electron in the outer shell / same electronic configuration (mention of protons or neutrons = 0)	1
	(d)	(i)	Rb_2O	1
			RbCl	1
		(ii)	**any two**: rubidium fizzes / bubbles / moves around (**NOT** gas given off); rubidium disappears / dissolves (**NOT** floats); rubidium melts / forms a ball or sphere; flames / catches fire / explodes	2
		(iii)	$2Rb + 2H_2O \rightarrow 2RbOH + H_2$	
			correct formulae of products	1
			balancing correct equation	1
				Total 14 marks
7.	(a)		potassium manganate(VII) / potassium permanganate	1
			oxidising agent / to remove hydrogen	1
	(b)	(i)	$Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$	1
		(ii)	brown / red / orange **NOT** yellow	1
		(iii)	chlorine more reactive than iodine / iodine less reactive than chlorine / chlorine a better oxidising agent than iodine / iodide better reducing agent than chloride (must have both species)	1
	(c)		(yellow-) green	1
			to colourless / misty/steamy fumes	1
	(d)		 shared pair of electrons between H and Cl	1
			total of 8 electrons in outer shell of Cl and 2 in H	1

(e) (i) (A) red / pink **1**
(hydrochloric) acid formed / solution contains H^+ ions **1**
NOT HCl is acidic

(ii) (B) blue / no change **1**
no acid formed / liquid neutral / no H^+ ions / **1**
HCl doesn't dissociate

Total 13 marks

8. (a) electrons free to move / flow / mobile **1**

(b) ions **1**
cannot move / in fixed positions (unless molten) **1**
*Any mention of free electrons / covalent bonds / ions **forming** = 0*

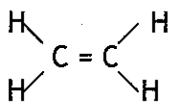
(c) B / – for first reaction and A / + for second reaction **1**
reduction for first reaction and oxidation for second reaction **1**

(d) (i) (amount of Pb =) 0.05 (moles) **1**
(amount of Br_2 =) 0.05 (moles) **1**

(ii) M_r of bromine = 160 **1**
mass = 8 <u>g</u> **1**

Total 9 marks

9. (a) **1**



(b) water / steam **1**
heat (300°C ± 50°C) **1**
phosphoric acid (catalyst) **1**
IGNORE references to pressure

(c) (i) sugar / carbohydrate **ALLOW** sucrose **1**

(ii) fermentation **1**

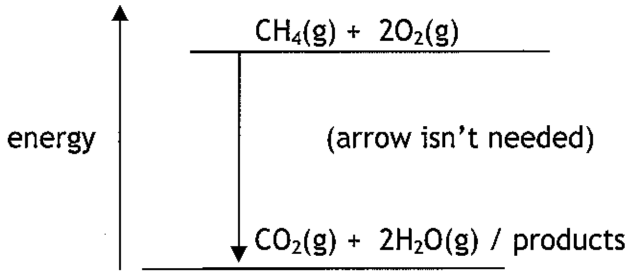
(d) oxidation **NOT** redox **1**
potassium dichromate(VI) **ACCEPT** manganate } or correct formulae **1**
sulphuric / phosphoric / hydrochloric acid } or correct formulae **1**

(e) (i) ester **1**

(ii) compounds with the same general formula / formula (of neighbouring members) differ by $-CH_2-$ **1**
similar (**ALLOW** same) chemical properties **1**

Total 12 marks

10. (a) products shown at lower energy **1**



(b) bonds broken = (4 x 412) + (2 x 496) / 2640 **1**
bonds formed = (2 x 743) + (4 x 463) / (-)3338 **1**
energy change = -698 (kJ/mol) **1**

(c) increase temperature **1**
increase pressure / concentration **1**
add (named metal) catalyst **1**

(d) (i) ($\rightleftharpoons$) reversible reaction **1**
(ΔH) enthalpy / heat (energy) change **NOT** 'energy change' **1**

(ii) (pressure increased) amounts reduced **1**
(temperature decreased) amounts reduced **1**
ALLOW 'decreases yield' but **NOT** 'equilibrium shifts to left'

Total 11 marks

11. (a) (i) 56 **1**

(ii) 0.25 **1**

(iii) $0.25 \div \frac{250}{1000}$ **1**

1.0 / 1 **1**

(b) (i) 0.4 **1**

(ii) 0.2 **1**

(iii) 4.8 dm^3 **1**

Total 7 marks

12.	(a)	allotropes	1
	(b)	covalent **NOT** 'giant covalent' without mention of bonding	1
		shared **pair** of electrons	1
		attraction between nuclei and (bonding) electrons	1
	(c)	cutting / drilling / grinding	1
	(d)	(diagram showing)	
		(three) fused hexagonal rings	1
		all carbon atoms shown	1
	(e)	many / strong (covalent) bonds (between atoms)	1
		much heat / energy needed to break them **NOT** hard to break	1
		any mention of 'ionic' = 0	

Total 9 marks

Paper 3

1.	(a)	A = measuring/graduated cylinder		1
		C = conical flask		1
		F = beaker		1
	(b)	A / measuring cylinder		1
		E / pipette	NB answers may be other way round	1
	(c)	B / (filter) funnel		1
			Total 6 marks	

2.	(a)		diagram shows suitable method of gas collection e.g. gas syringe	1
			apparatus chosen allows volume measurement	1
	(b)		table has columns: volume (of gas), mass (of solid), time	1
			units given (column headings or **all** data in table)	1
			all data recorded	1
	(c)	(i)	y axis: suitable scale (1cm = $10cm^3$), labelled as volume of gas **in** $\mathbf{cm^3}$	1
			6 or 7 points plotted correctly (4 or 5 points = 1)	2
			STRAIGHT line of best fit (through 0,0)	1
		(ii)	as mass increases rate increases (may be implied in 2^{nd} statement)	1
			directly proportional/doubling one doubles the other	1
		(iii)	greater mass has a bigger surface area	1
			doubling the mass doubles the surface area / more frequent collisions	1
			directly proportional mark from (ii) can be given in this section	
	(d)		collect same volume of gas (and measure time taken)	1
			Total 14 marks	

3.	(a)	(i)	temperature before: 27.0°C	1
			temperature after: 67.5°C	1
			temperature change: 40.5°C	1
		(ii)	mass of fuel / burner before **AND** after (burning)	1
		(iii)	67.3; 67.2; 66.9	
			all three correct (two correct = 1)	2
			all shown to 3 sf	1
		(iv)	48.5; 67.1; 70.4; 82.3	
			all four correct (any three correct =1)	2

(b) (i) yes
(temperature change **per gram of fuel** gives) similar results when repeated — 1

(ii) repeats give non-agreeing results / 81.6 not close to other results — 1

(iii) repeat experiment — 1
discard results which do not agree — 1

(c) no
only tested alcohols / only tested up to 4 carbon atoms — 1
there are other types of fuel / need to test bigger range / ones with more carbon atoms — 1

Total 15 marks

4. (a) (i) correct point indicated — 1

(ii) must explain why point too high

any **two** pairs from:

not left long enough
so precipitate not fully settled
OR
too much potassium iodide added
so more precipitate made
OR
tube not vertical while precipitate was settling
precipitate not uniform — 4

(iii) no precipitate can be made if no lead nitrate added — 1

(b) all potassium iodide used up / lead(II) nitrate in excess — 1

(c) (i) 1.5 cm (OR 1.2 cm if measured using candidate's own ruler) — 1

(ii) 3.7 / 3.8 cm^3 (OR 3.0 cm^3 if 1.2 cm above) — 1

(d) (i) indication of extra results between 6 and 10 cm^3 — 1

(ii) reference to turning point in graph (such as 'to be certain when height stops increasing') — 1

(e) filter — 1
wash — 1
dry — 1
weigh — 1

full marks must be given for any alternative method that works.

Total 15 marks

TOTAL FOR PAPER: 50 MARKS

CHEMISTRY 4335, CHIEF EXAMINER'S REPORT

Paper 1F Section A

Questions in this section are targeted at grades G, F and E.

Question 1

This question was designed to test candidates' knowledge of atomic structure. Most scored 3 or 4 marks, with none of the five parts proving noticeably more difficult than the others. Scores of 5 were rare.

Question 2

This question was designed to test candidates' knowledge of the Periodic Table and the information that can be obtained from it. All parts required candidates to identify a Group or Period, or to identify one of the two numbers given for each element. Very few candidates scored full marks. Common errors included the confusion of atomic number and mass number, and referring to mass number instead of relative atomic mass. Although a copy of the Periodic Table is provided as part of the question paper, it seemed that many candidates were not familiar with it. Several different types of Periodic Table are in common use, so it is recommended that teachers make sure that their candidates are familiar with the version that is used in these question papers.

Question 3

This question was about different features of carbon dioxide. It was poorly answered, with scores of zero being common.
The most frequent incorrect choice of pH value for rainwater was 1 or 7, with a few choosing 9 or 13.
Few correct word equations for the formation of carbonic acid were seen. A minority attempted a chemical equation, usually with incorrect formulae, but most could not write the names of the reactants - carbon, hydrogen and hydroxide all appeared, and even the carbonic acid product was often missing.
Uses of carbon dioxide were rarely correct. Answers included water, rain, breath and balloons, with a small minority quoting its correct use as a fire extinguisher.
Diagrams to show the bonds in a carbon dioxide molecule were disappointing. Many attempts did not include bonds, few had one carbon and two oxygen atoms, and many of those with three or more atoms were not linear (although this was stated in the question).

Question 4

Part (a) of this question was a sentence completion exercise, involving the selection of six words from the eight offered. Almost all candidates attempted this part and chose words from the ones offered. High scores were common, with very few candidates choosing grammatically impossible words (such as "gained" for "metals").
Part (b) was often attempted sensibly, with many candidates writing electronic configurations, although not always correctly. Some attempted chemical equations or left blanks.

Question 5
In part (a), the majority of candidates realised that they should write one of the letters A, B or C in each of the eight boxes provided, although some wrote only one letter for each change. The most common error was the use of the correct letters but in the wrong order. In part (b), the least common state of matter was often given as solid or gas.
In part (c), few candidates did not understand that they were to place ticks in selected boxes. Scores of 3 or 4 (out of 4) were quite common. Most realised that sulphur was an element, although there was evidence of confusion between mixtures and compounds.

Question 6
Most candidates were familiar with state symbols and thus scored 1 or 2 marks in this part. There was evidence of confusion between the liquid and aqueous states. Many candidates lose marks in this type of question through not clearly showing "s" and "g" differently, and teachers are advised to emphasise the importance of writing these letters in distinctly different ways.
A considerable variety of colours was seen in part (a)(ii). Some clearly remembered the use of copper(II) sulphate in the test for water and quoted blue and white (in both orders), while others seemed to be thinking of indicators and quoted red and green.
Part (b) was another sentence completion exercise, involving the selection of four words from the seven offered. Almost all candidates attempted this part and chose words from the ones offered. High scores were common, with very few candidates choosing grammatically impossible words (such as "neutralisation" for "an acid"). By far the commonest errors were to use "alkali" and "salt" as reagents.
In part (c)(i), the commonest wrong answer was the use of excess copper(II) carbonate as a catalyst, while in part (c)(ii), "distillation" and "heating" were almost as common as "filtration".
"Crystallisation" was rarely seen as the answer to part (d), with "heating" and "evaporation" being common.

Question 7
The theme of this question was a reversible reaction - something many candidates did not seem familiar with - and there were many blanks in the scripts of weaker candidates. Answers to part (a)(i) included "reversible reaction", "increase the pressure"; all the options in part (a)(iii) were popular choices.
The use of copper(II) sulphate in the chemical test for water in part (b) was not well known.
Acid rain and its effects, tested in part (c), were also not well known; but even for those who wrote about an environmental problem there was confusion with global warming, and stated effects were vague (e.g. "damages buildings" or "contaminates rivers").

Paper 1F Section B / Paper 2H Section A

Questions in this section are targeted at grades D and C.

Paper 1F Question 8 / Paper 2H Question 1

This question was designed to test candidates' knowledge of how the uses of materials are determined by their properties. Generally it was poorly answered by many candidates. Some chose uses and properties that did not appear in the lists provided, but the most disappointing feature of many answers was the choice of completely unsuitable uses, such as one of the polymers for railway tracks. Contradictory properties appeared such as "good conductor of electricity" linked with "insulation on electrical wires". Others gave two contradictory properties such as "strong" and "brittle" for steel railway lines. The most common error of better candidates was to give the correctly linked uses and properties the wrong way round for the two polymers.

Paper 1F Question 9 / Paper 2H Question 2

This question was designed to test candidates' understanding of chemical tests. Weaker candidates usually managed to score the two marks available for the carbon dioxide test, but little more, and often with several blanks. In spite of the use of bold type to emphasise when names or formulae were required, several candidates lost marks by not doing this.

In part (a), some candidates confused cations and anions and wrote the correct answers in the wrong places; more common was to identify the anion as calcium carbonate rather than just carbonate.

In part (b), "Fe(II)" often appeared instead of "Fe^{2+}". Teachers are asked to emphasise to candidates the importance of using upper and lower case letters correctly in chemical formulae - "FE" and "So_4" are not acceptable - and errors of this sort were penalised once in a paper.

There was confusion in part (c) between halogen and halide, and neither "chlorine" nor "chlorine ions" were accepted for "chloride".

Paper 1F Question 10 / Paper 2H Question 3

This question was about the Haber Process, and most candidates were able to score some marks here.

In part (a)(i), air was usually given as the raw material for nitrogen, but methane for hydrogen was not accepted as it is not a raw material. Most candidates had a good idea of the temperature and pressure values used, although not all appeared with units: "a temperature of 450" was seen in several scripts. Teachers are advised to tell candidates to quote a precise value rather than a wide range. Although there is some variation throughout the world, the specification quotes a temperature of 450°C. Candidates who quoted a value in the range 400 to 500°C, or a narrow range lying within this (such as 400 to 450°C) scored, while those who gave "200 - 500°C" did not.

The separation of ammonia from the reactants was a problem for many candidates, and most laboratory separations were seen such as filtration and distillation. For the unused reactants, "recycled" was the expected answer. Those who gave alternative answers needed to make it clear that there was no time delay, so "fed back into the reactor" scored, but "used later to make more ammonia" did not.

The equation in part (b) was well attempted, although a common error was the confusion between ammonia and ammonium, while some gave the equation for the formation of ammonia.

Paper 1F Question 11 / Paper 2H Question 4

This question was about the oil industry.

In part (a), scores of 1 or 2 were common. Road-making was usually given as a use of bitumen; those who chose waterproofing needed to be specific and include "roofs" in their answer. Answers given for a use of kerosene were more variable: "fuel for aircraft" was acceptable, but "used in factories" and "fuel for cars" were not.

In part (b), the word equation was often incorrect, the commonest error being the omission of oxygen. A surprising number gave a chemical equation for the combustion of methane. The problem of incomplete combustion was well known, and some candidates gave accurate descriptions of the role of haemoglobin. The recognition of carbon monoxide as toxic or poisonous was accepted, while "dangerous" and "harmful" were not. Thankfully, not many candidates strayed into mentions of acid rain and global warming.

Part (c) was poorly done, with a score of 1 being common. Most candidates gained the easy mark for heating the crude oil, but few could name the minimum acceptable apparatus (flask, condenser and thermometer) and almost none stated how a sample with the given boiling range could be obtained.

Paper 1F Question 12 / Paper 2H Question 5

This question was about polymers.

In part (a), most recognised that nylon was a condensation polymer.

Part (b) was not well answered: many candidates could not identify the monomer types. For the amine, answers included "amide", "alkali", "ammonia" and "nitrous", while "carboxylic" was often omitted from "acid". Many candidates seemed unfamiliar with polymer structure diagrams, and not all attempted to show a link between the two monomer structures. Others did not use the square and circle symbols provided, or came unstuck in trying to show the amide link. Ideally the N-H and C=O should include these bonds, although NH and CO correctly linked was accepted. The use of C-O lost the mark, as did versions such as "-N-H-C=O-". The repeat unit was often unclear: dimers involving one of each monomer were common, with no continuation bonds to indicate that this was part of a larger structure.

Paper 2H Section B

Questions in this section are targeted at grades A*, A and B.

Question 6

The theme of this question was rubidium, and most candidates attempted most parts, with varying degrees of success.

The explanation of isotopes in part (a) was well done, with little confusion between the two relevant nucleons. However, several answers failed to mention atoms, or referred to molecules or substances instead.

The table and calculation in part (b) were often well done: few candidates scored zero here. Common errors included failing to quote the answer to one decimal place, and using the wrong figures from the table, such as 48×72 instead of 85×72.

Part (c) was less well done, with many candidates quoting both protons and electrons being responsible for chemical properties, or referring to Periodic Table position ("they are both in Group 1").

The formulae in part (d) were often incorrect; RbO, RbO_2 and $RbCl_2$ appeared frequently. Candidates could score the observation marks in several ways, but common unacceptable answers included "floats" and "hydrogen gas given off". Teachers are advised to emphasise the subtle differences between **observations** such as "effervescence / fizzing / bubbles" and **interpretations** such as "hydrogen produced", and also between "rubidium melts" and "exothermic reaction occurs". The final equation was well attempted, with some lack of balancing and species such as "RbO" and "$Rb(OH)_2$".

Question 7

This question was designed to test candidates' understanding of the chemistry of halogens and halides.

Quite a number of candidates failed to score either mark in part (a). At this level an accurate name for what should be a familiar compound is expected, ideally potassium manganate(VII). The correct oxidation number should appear, although (IV) was often seen. "Potassium permanganate" was accepted. Its role as an oxidising agent was not well known; "reducing agent" and, more often, "catalyst" were seen.

Correct ionic equations were few and far between in part (b)(i) - some were correct but not ionic, and many were ionic but not balanced. The final iodine colour was not well known - colourless, white and green were given. The range of colours accepted included orange and brown, but not yellow (could be bromine) or black (this would be accepted for solid iodine but not for its aqueous solution). The explanation for the lack of a reaction between iodine and potassium chloride was usually attempted in terms of reactivity, but many answers failed to score. "Chlorine is less reactive than iodine" is fine, but "chloride is less reactive than iodine" or just "chlorine is less reactive" (than what?) were not accepted.

The colour change in part (c) often scored 1 or 2 marks. Some answers had green and colourless the wrong way round, but the commonest error was the mention of a solution, in spite of the state symbols in the given equation. There were many full, correct dot-and-cross diagrams in part (d), although some were spoiled by the inclusion of a lone electron in the outer shell of hydrogen in addition to the bonding pair. A surprising number of H-Cl-H molecules appeared.

Better candidates often scored all four marks in part (d); others scored zero. Common errors were 'white' instead of 'red' (with reference to the bleaching effect of chlorine) in part (d)(i), while in part (d)(ii) many explanations were in terms of the alkaline nature of methylbenzene or of a neutralisation reaction taking place.

Question 8

The theme of this question was electrolysis, although the introductory part (a) asked about electronic conduction. Although most answers referred to electrons they failed to score through not mentioning their movement - just to mention delocalised or free electrons was not sufficient.

To score both marks in part (b), candidates needed to express the idea that ions could not move in the solid, or could move in the molten state. Most scored 1 or 2 marks here: the most serious error was to state that lead(II) bromide "formed ions" when melted.

In part (c), many candidates chose not to use the letters A and B to identify the electrodes and lost the mark. Some wrote "cathode" and "anode", while others wrote the names of the substances formed.

Full marks for part (d) proved impossible for all but the best candidates. It was sometimes not possible to understand how some candidates had seemingly plucked numbers out of the air, although many had a good idea of how to go about the calculation. The final mass of bromine was 8g, although candidates should realise that a correct final answer does not always score full marks. The reason the instruction "show all the steps in any calculations" appears is well-illustrated by this question. The amount of Br_2 in part (d)(i) was often given as 0.10 mol instead of 0.05 mol; then in part (d)(ii), the A_r of 80 was used instead of the M_r of 160. The combination of these two errors also gave 8g! In calculations of this type, with more than one step, examiners often to award marks consequentially e.g. in part (d)(ii):

$0.05 \times 160 = 8$ g scores 2 (completely correct)

$0.05 \times 80 = 4$ g scores 1 (quotes wrong M_r but uses it correctly)

$0.10 \times 160 = 16$ g scores 2 (quotes correct M_r and uses it correctly, and has already been penalised for 0.10 in part (d)(i))

Question 9

This question was about some organic reactions.

The ethene formula in part (a) was usually correct.

Full marks in part (b) were rare. Some candidates wrote about the fermentation reaction, while those who knew the pressure and temperature values often failed to mention the other reagent.

Part (c) was generally poorly attempted. A variety of unacceptable answers appeared for sucrose's type of substance, including "solid", "alcohol", "acid" and "large alkane". Similarly, for the type of reaction, answers such as "cracking", "decomposition", "hydrolysis" and "hydration" appeared.

Few candidates appreciated that the reaction in part (d) was an oxidation, and most of those who did suggested oxygen as the reagent.

In part (e), the homologous series was often recognised as ester, although fewer candidates could explain accurately what the term meant. Some answers read like descriptions of isotopes, while those who were nearer the mark gave "empirical" instead of "general" formula.

Question 10

The theme of this question was energetics and equilibrium.

The energy level diagram in part (a) was frequently blank.

A very small number of candidates was able successfully to complete the calculation in part (b), and many were unable to start. Some averaged the four bond energy values, others failed to use the coefficients in the equation, and some failed to give a negative sign to the final answer. A disappointing feature of many attempts was the untidy way in which the calculation was set out; the worst examples had several numbers written all over the place and no indication of what might be a final answer. Teachers are advised to encourage candidates to include some words (such as "bonds broken = ...") as well as showing working, which often allows examiners to award

some credit for partially correct attempts. For example, in this question, 1 mark was awarded for a correct calculation of the energy given out when the bonds were formed (3338 kJ), and any different answer without any working did not earn the mark. However, the same mark could be gained by showing the working as $(2 \times 743) + (4 \times 463)$ without writing down 3338. Some candidates are more likely to score marks in this way, as they often make calculator errors (such as entering 436 instead of 463).
The changes in conditions in part (c) were often correct, although candidates should realise that "pressure" does not mean the same as "increase the pressure", and that "adding more oxygen" with no reference to pressure or concentration is not precise enough.

In part (d), most knew that $\rightleftharpoons$ referred to a reversible reaction, but ΔH was less well described as "delta heat" or just "heat" or "energy". Most realised that the last part required them to apply Le Chatelier's Principle: few answered in terms of changes in rate of reaction. Some answered in terms of the direction of the shift in equilibrium position (such as "shifts to the left") but did not go on to refer to the amounts of products. A minority gave different answers for the two products (more CO / less H_2).

Question 11
This question consisted entirely of calculations, and it was pleasing to see many candidates scoring full marks. Common errors were the use of atomic numbers instead of atomic masses in part (a)(i), not converting 250 cm^3 to 0.25 dm^3 in part (a)(iii), and ignoring the 2:1 mole ratio in part (b)(ii). Teachers are advised to train candidates to give units for numerical answers, even if their omission is not always penalised. For example, in this question, the units were specified in the first five parts of the question, so their omission was not penalised, but in part (b)(iii) the correct value of 4.8 did not score without the unit dm^3.

Question 12
Answers to this question were very disappointing, with high scores almost unknown.
Most candidates gave allotropy in part (a), although some quoted isotopes.
In part (b), in spite of "bonding" in the question being in bold type, most candidates wrote about structures instead. Most earned the mark for "covalent", although for some this was later cancelled because it was contradicted by "intermolecular forces". Candidates should realise that writing acceptable and contradictory answers in the same question part can result in the loss of marks. Especially in questions of this type, there is a tendency for candidates to include several answers that cannot all be correct (some even included ionic and metallic bonding). The more difficult mark, for a shared pair of electrons, was usually not scored through omitting to mention a **pair** of electrons. Answers to a question that is targeted at grade A* should be correct and complete to earn credit. Almost no candidates scored the most difficult mark for realising that the bond was the result of "attraction between the bonding pair of electrons and the nuclei of the atoms involved in the bond" (this is a direct quote from the specification).
In part (c), many candidates mentioned drilling, but some of those who wanted to give "cutting" actually wrote "cutlery". Although examiners are sympathetic towards words that are not spelled correctly, a line is drawn for spellings that are those of, or close to, unacceptable answers. So, for example, "girnding" is likely to be accepted as meaning "grinding" in this question part, but in an organic question "ethane" will never be accepted as meaning "ethene".
Answers to part (d) were disappointing, with many candidates drawing only hexagons, even though the question specifically asked for the atoms to be shown (this could have been done by C symbols or by large dots). At least two hexagons were needed in one layer, to show that each carbon atom in graphite formed three covalent bonds.

Very few candidates scored both marks in part (e), which required them to indicate that the covalent bonds were strong (or that there were very many of them), and also that a lot of heat energy was needed to break them.

Paper 3

This paper is designed to assess the investigative skills detailed in the specification. The skills assessed are split into three areas (P - planning; O - obtaining and recording; A - analysing and E - evaluating). To obtain a high mark candidates must show that they can match the level 8 (or level 6 in the case of skill E) descriptors. It was noted that the higher levels of evaluations proved difficult for a number of students.

Question 1

Most students scored well on this question. Students are expected to be familiar with the names, diagrammatic representations and uses of common laboratory apparatus. There are a number of different types of 'flask' used in laboratories, and so the full name (not just 'flask') was required.

Question 2

The diagram completion in part (a) required the candidate to know how to collect a gas and also how to measure the volume of a gas in a suitable graduated container (such as a measuring cylinder or gas syringe). The quality of diagrams was not being assessed, but apparatus needs to be recognisable - candidates are recommended to label their diagrams so that there is no doubt as to what they are trying to show. A number of candidates tried to collect a gas over water without the water being present.

In part (b), students had to put data represented in prose into a table. Tables of data must always make it clear what the units of measurement are. These can be shown (preferably) in the column or row headings, or after each figure. Many candidates scored full marks, but a common error was to record only four of the five sets of results. Candidates are expected to be able to convert common units such as, in this question, minutes into seconds.

Graph plotting is an important technique for representing data. Most candidates chose suitable scales and plotted the points correctly. However, the y-axis label (which also required units) was often missing. Most lines seen were 'dot to dot' rather than best fit. If a candidate tries to draw a straight line, this should be done with the aid of a ruler rather than freehand. Graph points and lines are best done in pencil so that errors may be erased.

Part (c)(ii) required the pattern shown in the results to be described. Most candidates could state that increasing the mass increased the rate; some gave incomplete statements such as 'mass increases the rate' - the direction of change of both quantities is required when describing a relationship. Since this was a two-mark question, candidates should have been aware that there were two things required in the answer - very few went on to say that the relationship was directly proportional. Candidates who ignored the question and talked about the volume of oxygen rather than the rate could not score the marks.

Many candidates had difficulty in part (c) when asked to explain the pattern in the results. A number of candidates became confused by not carefully reading the introduction to the question which stated '...they used different masses of the same sized marble chips'. A common error was to think that as the mass of the marble chips got bigger, the chips got bigger, and so the surface area got less (and so the reaction slower) rather than the correct idea that an increasing mass meant more chips and so a bigger surface area. To gain both marks the students were expected to explain why rate increases and why the relationship is directly proportional.

In part (d), many candidates failed to read the question. A common error was to state 'use the same mass of marble chips' while the investigation was using this as the independent variable.

Question 3

Most candidates could successfully read the thermometers, but it should be noted that since the thermometers were graduated to 0.5°C, the readings should be given to 1 decimal place. Some candidates tried to read the scales too accurately: they will not normally be expected to read anything more accurately than halfway between shown divisions. In part (a)(ii), candidates were given a strong clue in the stem of the question by being told that the temperature had to be measured both before and after heating (the table just gave the temperature change). To measure the mass of the fuel used both the start and the end mass would be required. A number of candidates focused of measuring the mass of the water.

In part (a)(iii), candidates were expected to use the equation provided to work out the temperature change per gram of fuel. Since all other data in this column of the table was given to 3 significant figures, the same degree of accuracy was expected. A minority of candidates gave answers to 4 significant figures, but a common error was to truncate numbers rather than to round them. Candidates are expected to be able to calculate arithmetical means from numerical data and this was tested in part (a)(iv). Since the data were given to 3 significant figures, arithmetical means were expected to the same degree of accuracy. While the majority of candidates could do this, some came up with values that seemed unrelated to the data provided.

Part (b) required candidates to evaluate the data obtained. If data are reliable then repeat values will be similar to each other; unreliable data can be identified by the fact that the repeats do not agree with each other. In part (b)(ii), candidates were told that the results were unreliable. A common error was for answers to focus on the mass of fuel or the temperature change data rather than look at the wide spread in the 'temperature change per gram of fuel' data. Few candidates gained both marks in part (b)(iii). It is not sufficient just to repeat the experiment, since data that we know to be unreliable will still be used. It should be made clear that either the existing results for propanol are discarded or only concordant results should be used.

In part (c), a sweeping conclusion was given. Most candidates thought that the statement was justified; only a small minority could identify the flaw in that the results only apply to alcohols with up to 4 carbon atoms.

Question 4

The identification of the anomalous point should have been straightforward, but a significant number of candidates circled all points that were not on the line. An anomalous point is one that falls outside of the expected range. Due to experimental error, perfectly acceptable datum points may not fall on the line, but will be near to it. An anomalous point will fall outside the range allowed by experimental error. Experimental error is caused by the limitations of the accuracy of the apparatus and is outside the control of the experimenter. In part (a)(ii), candidates found it very difficult to explain what may have happened to cause the anomalous point. Explanations had to take into account the fact that the depth of precipitate was too great. Vague answers such as 'volumes measured wrongly' were not credited. Only the very best candidates could offer reasonable reasons why more precipitate than expected had been obtained.

Part (a)(iii) required students to explain why the graph line should go through the origin. Some candidates implied that all graph lines had to start there. This is clearly not the case and when drawing graphs they should be encouraged to consider whether or not (0,0) is a valid point. In this case it is, since with no lead(II) nitrate there can be no precipitate, while in others (such as solubility curves) it is not.

Part (b) was answered too vaguely by many. Statements such as 'the reagents are used up' were not sufficient. Since the experiment used an increasing amount of lead(II) nitrate, it had to be the potassium iodide that ran out.

Most students could correctly read the height of the precipitate in the tube, although some clearly did not read the labels on the diagram and gave the depth of the solution. A significant number of candidates read the value from the graph incorrectly by starting on the wrong axis. Using graphs in this way should be something which is fairly routine for students.

Part (d) required students to realise that the graph had a turning point. Where a graph has a turning point it should be normal procedure to obtain more readings at smaller incremental values of the independent variable so that the exact location of the turning point can be found.

Part (e) was generally well answered and the majority of candidates were able to gain one mark for an indication that they could weigh the precipitate. The remaining three marks were for detail on how the mass could be found. Only the best candidates could give the full detail including the all-important stages of washing and drying the precipitate once it had been obtained by filtration.

CHEMISTRY 4335 COURSEWORK, PRINCIPAL MODERATOR'S REPORT

Science Coursework General Comments

The number of students entered for this component of the IGCSE examination was as follows:

Spec Code	Subject	Number entered
4335	Chemistry	79

All centres that entered students for this component of the examination had their science coursework moderated by Edexcel's Co-ordinating Principal Moderator. The moderating instrument used was the Sc1 criteria as used by Home centres, using exemplars provided by the JCQ (Joint Council for Qualifications) as a guide.
Centres entering students for the coursework component of the IGCSE examinations in 2005 therefore had their coursework moderated to the same standards as for all Home centres.

Chemistry 4335

The tasks chosen for the coursework assessment were of variable quality. Rate tasks are normally seen in chemistry investigations and, with some reservations (see later), are perfectly acceptable. However, tasks such as "finding the percentage of water of crystallisation", "order of reactivity of three metals", and "percentage mass in seashells" are **not** appropriate. The first and third are not true investigations (and therefore do not easily match the mark criteria) and the second suffers from having a range of only three metals. In addition, a task on "rusting of metals" was seen this year, which is more appropriate for students aged 14, than those of 16.

Several centres did a rates task on varying the concentration of sodium thiosulphate when reacting with hydrochloric acid. This is fine for students of average ability, but does have some problems for the most able students, especially in skills P, O, and A (please see later for details).

Several of the scripts had no teacher annotation on them, with marks recorded only on the FIMAS (Final Mark Aggregation) form. Teachers are respectfully reminded that when scripts are marked, they should use the printed coursework mark criteria as a guide, putting minimal annotation such as P6b, P8a, and P8b alongside the point in the script where the student achieves the mark description.

Skill Area Comments
Skill P: P8a. The planning of reliable data is a key feature at this mark. Students must know that reliable data is that which is concordant, and therefore they must **plan to obtain** some results for the same data point (or data set) which shows the same (or very similar) result. In some cases, it is difficult for students to incorporate sufficient scientific knowledge into their planning to obtain P8a. In the case of the sodium thiosulphate/hydrochloric acid task, students who are studying concentration effects as the variable are a good example. It is more appropriate to study temperature as the variable, so that students can discuss exo- and endothermic steps, as well as the concept of activation energy.

Skill O: O8a. Centres who awarded full marks for the visual disappearance of a cross in the thiosulphate/acid task were too generous. The observation of a cross disappearing as the precipitate of sulphur forms is a subjective matter, and therefore lacks **precision**. (Precision is a key factor in the award of O8a). Please note also that the requirements of O6a and O6b should be fully met before O8a is considered.
Skill A: A6a. The description for this mark clearly states that, where appropriate, graphs should have lines of best fit (ie **not** dot-to-dot graphs) where the variables are continuous. Several such graphs were seen this year.
A6b. At this mark description, students are not merely required to discuss the shape of the graph, but also need to explain what it shows using some scientific knowledge and understanding.
A8a. The scientific knowledge and understanding must be at grade A/A* level.
A8b. Students normally discuss **in detail** (ie about half of one page) how their results match their prediction.
Skill E: centres were frequently too generous in the award of six marks in this skill area. This mark is normally commensurate with grade A/A* performance, and some **detail** is expected when students discuss the range of evidence obtained, the closeness of repeat readings (ie reliability of the data), as well as providing reasonable explanations for any anomalous data.
Where further work is proposed, similar considerations apply: students are expected to give about half of one page of detail, either discussing areas of the graph which need more attention (perhaps at a peak or a trough), **or** they give procedural details for the proposed investigation of a second, **linked** variable.

CHEMISTRY 4335, GRADE BOUNDARIES

Option 1 : with Written Alternative to Coursework (Paper 3)

	A*	A	B	C	D	E	F	G
Foundation Tier				45	38	31	24	17
Higher Tier	79	64	49	35	29	26		

Option 2 : with Coursework

	A*	A	B	C	D	E	F	G
Foundation Tier	No candidates this session							
Higher Tier	81	67	53	40	33	29		

Note: Grade boundaries may vary from year to year and from subject to subject, depending on the demands of the question paper.

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