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GCE O Level Chemistry (7081)

June 2005

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CHEMISTRY 7081, MARK SCHEME

Paper 1

1. (a) SO_2 **(1)**

(b) magnesium carbonate **(1)**

(c) CH_3OH **(1)**

(d) iron(II) oxide **(1)**

(e) ethene **(1)**

(f) K_2SO_4 **(1)**

Total 6 marks

2. (a) green **(1)**
red / pink **(1)**

(b) blue **(1)**
white / grey **(1)**

(c) green **(1)**
brown / yellow-brown / yellow **(1)**
NOT red / orange

Total 6 marks

3. (a) 17 **(1)**
2.8.1 **(1)**
manganese / Mn **(1)**

(b) (i) sodium (any answer / no answer scores) **(1)**
(ii) chlorine (any answer / no answer scores) **(1)**
(iii) manganese **(1)**

Total 6 marks

4. (a) 10 **(1)**

(b) 2 **(1)**

(c) 8 **(1)**

(d) 132g **(1)**

(e) 3 **(1)**

(f) 0.0125 **(1)**

Total 6 marks

5. (a) sodium **(1)**

(b) iron **(1)**

(c) copper **(1)**

(d) platinum **(1)**

(e) calcium **(1)**

(f) aluminium **(1)**

Total 6 marks

6. (a) flame test / put into Bunsen flame **(1)**

(b) yellow precipitate **(1)**
(**NOT** 'pale yellow' or 'cream')

(c) HCO_3^- / CO_3^{2-} **(1)**

(d) sodium hydroxide (solution) **or** (aqueous) ammonia **(1)**

(e) blue precipitate **(1)**
dissolves to give (deep) blue solution **(1)**

Total 6 marks

7. (a) neon / Ne **(1)**

two covalent bonds correctly shown **(1)**
remainder of electrons around each atom correct **(1)**
(**ACCEPT** all dots / crosses)

allotropes / polymorphs **(1)**

(i) isotopes **(1)**
(ii) it has two more neutrons **(1)**

Total 6 marks

8. (a) add manganese dioxide / other named catalyst / heat **(1)**
rekindles a glowing spill **(1)**

(b) electrolysis **(1)**
apply flame - pops / explodes when ignited **(1)**

(c) add named mineral acid **(1)**
(**NOT** concentrated sulphuric acid or concentrated nitric acid)
turns potassium dichromate solution from orange to green **(1)**
(**ACCEPT** potassium permanganate purple to colourless)

Total 6 marks

9. (a) C_2H_5 **(1)**

(b) (i) correct structural formula for 2-methylpropane **(1)**
(bonds must be between C and C)
(ii) methylpropane / isobutane **(1)**

(c) $C_4H_{10} \rightarrow C_3H_6 + CH_4$ / $C_4H_{10} \rightarrow C_2H_6 + C_2H_4$ **(1)**

(d) they contain a (carbon-carbon) double bond / unsaturated **(1)**

(e) 4 **(1)**

Total 6 marks

10. (a) manganate/manganate(VII) / MnO_4^- / permanganate **(1)**
(**NOT** manganese)

diffusion **(1)**

movement in straight lines only **(1)**
minimum three changes of direction (four lines) **(1)**

ion would spread more quickly / rate increases **(1)**
(no credit for reference to rate of reaction)
(no credit for reference to molecules)
moving more quickly / more (kinetic) energy **(1)**

Total 6 marks

11. (a) solid **(1)**

(b) (i) ionic **(1)**
(ii) covalent **(1)**

(c) calcium astatide **(1)**

(d) Relative Formula Mass of $CaAt_2$ = 460 seen or implied **(1)**

$$\% \text{ by mass} = \frac{420 \times 100}{460} = 91.3\%$$ **(1)**

Total 6 marks

12. (a) electrolysis **(1)**
(**NOT** reduction)

(b) air **(1)**

(c) salt **or** water **(1)**

(d) freezing / solidification **(1)**

(e) dissolving **(1)**
(**NOT** hydrolysis or hydration or dilution)

Total 5 marks

13. (a) A = iron **(1)**
B = hydrogen **(1)**
C = iron(II) sulphate **(1)**
D = iron(II) hydroxide **(1)**
E = iron(III) oxide **(1)**
(must have oxidation state of iron each time)
ACCEPT correct formulae

(b) $Fe(s) + H_2SO_4(aq) \rightarrow FeSO_4(aq) + H_2(g)$
correct formulae and balance **(1)**
state symbols (formulae must be correct) **(1)**

Total 7 marks

14. (a) **concentrated** sulphuric acid **(1)**
heat (**NOT** high temperature) **(1)**

(b) add to water and decant or use a separating funnel / fractional distillation **(1)**

(c) sweet smell (ignore reference to pear drops etc) **(1)**

(d) methyl ethanoate **(1)**

(e) display formula of methyl ethanoate **(1)**
(**ALLOW** CH_3- in display formula)

Total 6 marks

15. (a) $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$ **(1)**

(b) (i) greatest number of reactant particles / highest concentration of acid **(1)**

(ii) fewer than 50 seconds **(1)**

(iii) moles of hydrogen = moles of magnesium = $\frac{120}{24000}$ (= 0.005) **(1)**

(iv) 0.005 x 24 = 0.12 g **(1)**
1000 x 0.005 = 5 cm^3 (**ACCEPT** 0.005 dm^3) **(1)**

Total 6 marks

16. (a) 1 mark each correct pair of plots **(3)**
line of best fit **(1)**

(b) 4100 - 4200 **(1)**

(c) (i) 670 **(1)**
(ii) 660 (ignore signs) **(1)**

(d) (i) n CO_2 **(1)**
n + 1 H_2O **(1)**
(ii) + n-1 x (660 to 670) **(1)**

Total 10 marks

Paper 2

Section A

1. (a) chemical change / decomposition **(1)**
brought about using an electric current / electricity **(1)**

(b) (i) soluble copper(II) compound e.g. sulphate/ nitrate **(1)**
(ii) Cu^{2+} and SO_4^{2-} / NO_3^- **(1)**
IGNORE H^+ and OH^-
(iii) $Cu \rightarrow Cu^{2+} + 2e^-$ **(1)**
oxidation **(1)**

(c) (i) 7 x 25 x 60 = 10500 (C) **(1)**
(ii) One mole Cu^{2+} requires 2 x 96 500 = 193 000 C **(1)**
Mass of copper = $\frac{64 \times 10,500}{193,000}$ **(1)**
= 3.4 - 3.5 g **(1)**

Total 10 marks

2. (a) - / negative **(1)**
in the nucleus **(1)**
1 **(1)**

(b) 56 protons **(1)**
81 neutrons **(1)**

(c) (i) $Ba^{2+} + CO_3^{2-} \rightarrow BaCO_3$ (**IGNORE** state symbols) **(1)**
50 cm^3 of 1 $moldm^{-3}$ contains $^1/_{20}$th mole **(1)**
$^1/_{20}{}^{th}$ mole of barium nitrate will produce $^1/_{20}{}^{th}$ mole of barium carbonate **(1)**
RFM of barium carbonate = 197 **(1)**
mass of barium carbonate = 197/20 = 9.85 g **(1)**

Total 10 marks

3. (a) 0.1 x 30 x 4.2 = 12.6 **(penalise if answer in J)** **(1)**

(b) (i) 72 **(1)**
(ii) 0.005 **(1)**
(iii) 12.6 / 0.005 = 2520 **(1)**

(c) (i) 4, 1384 **(1)**
10316 **(1)**
12956 **(1)**
10, 7400 **(1)**
(ii) 2640 **(1)**
(iii) e.g. heat lost (to the surroundings) / combustion of pentane incomplete **(1)**

Total 10 marks

4. (a) (i) a more reactive metal displaces a less reactive metal (from a solution of one of its salts) **(1)**

(ii) magnesium, chromium, cobalt, copper **(1)**

(iii) $Mg + Cu^{2+} \rightarrow Mg^{2+} + Cu$ **(1)**

(b) (i) remove layer of dirt/oxide **or** get good connection (**NOT** remove impurities / rust) **(1)**

(ii) magnesium **(1)**

(iii) magnesium **(1)**

(iv) electrons in wires **(1)**
(**IGNORE** comments on direction of flow)
ions in solution **(1)**

(c) zinc is more reactive than iron **(1)**
zinc oxidises/corrodes before iron **(1)**

Total 10 marks

5. (a) (i) nitrogen - air **(1)**
hydrogen - (crude oil) / natural gas **NOT** methane **(1)**

(ii) iron **(1)**

(iii) oxidation / redox **(1)**

(iv) $NH_3 + HNO_3 \rightarrow NH_4NO_3$ **(1)**

(b) all plots correct **(1)**
smooth curve **(1)**

(c) (i) 520 - 540 (g per 100 g water) **(1)**

(ii) mass at 80°C = 580 and mass at 20°C = 192 **(1)**
mass obtained = 388 g **(1)**

Total 10 marks

SECTION A TOTAL 50 MARKS

Section B

6. (a) identify phenolphthalein / methyl orange as an indicator **(1)**
colour in sodium hydroxide solution - pink **or** purple / yellow **(1)**
colour in acid - colourless / red **(1)**
hydrochloric acid added until colour change **(1)**
colour change around neutral point / end point **(1)**

(5 marks)

(b) (i) burette and pipette **(1)**
any two from: **(1)**
- beaker
- conical flask / funnel
- white tile
- burette stand

(ii) diagram to show curved (down) meniscus (at ends) **(1)**
raise mark to eye level **(1)**
level taken at the bottom of the meniscus **(1)**

(5 marks)

(c) (i) 30.05 cm^3, 30.00 (cm^3) **(2)**

$$\frac{29.95 + 30.05 + 30.00}{3} = 30.00\ cm^3$$ **(1)**

(All volumes must be given to 2 d.p. - penalise once only)

(ii) $\frac{"30.00" \times 0.05}{1000}$ **(1)**

$= 0.0015$ (mol) **(1)**

(iii) 0.0015 mol **(1)**

(iv) $\frac{0.0015 \times 1000}{25}$ **(1)**

$= 0.06\ moldm^{-3}$ **(1)**

(8 marks)

(d) repeat experiment using same quantities **(1)**
but omitting indicator **(1)**
OR use:
- decolourising charcoal **(1)**, and filter**(1)**

heat in evaporating basin **(1)**
reduce volume of solution **(1)**
allow to cool and crystallise **(1)**
separate crystals from solution using filter funnel and filter paper **(1)**
dry in air **(1)**

(7 marks)

Total 25 marks

7. (a) bauxite identified as ore
reaction at anode: $2O^{2-} - 4e^- \rightarrow O_2$
(**ALLOW** pair of equations for 2 x O)
reaction at cathode : $Al^{3+} + 3e^- \rightarrow Al$ **(3)**
(If equations correct but at wrong electrodes, lose **(1)**)

Mark separately:

alumina identified as purified ore
on diagram labelled:
- lining carbon cathode
- carbon anode
- electrolyte molten
- cryolite + alumina/ore/Al_2O_3
- aluminium at bottom of tank
- mention of oxidation of anodes
- equation $C + O_2 \rightarrow CO_2$

maximum 7 **(7)**

(10 marks)

(b) (i) dissolve in water (**NOT** molten) **(1)**
connect into a circuit with bulb/meter **(1)**
bulb or meter shows a current is passing **(1)**
(ii) potassium - flame test **(1)**
lilac coloured flame **(1)**
sulphate - make solution **(1)**
addition of hydrochloric acid / nitric acid **(1)**
barium chloride/nitrate **solution** **(1)**
white **precipitate** **(1)**

(9 marks)

(c) (i) 516 **(1)**
(ii) 5.16 g = 0.01 mole anhydrous salt **(1)**
9.48 g = 0.01 mole hydrated salt **(1)**
Relative Formula Mass of hydrated salt = 948 **(1)**
mass due to water = 948 - 516 = 432 **(1)**
x = 432 / 18 = 24 **(1)**

(6 marks)

[alternative method for (c) (ii)]
mass of water : 4.32 **(1)**
moles $\frac{5.16}{516} : \frac{4.32}{18}$ **(1)**
$0.01 : 0.24$ **(1)**
$1 : 24$ **(1)**
$x = 24$ **(1)**

Total 25 marks

8. (a) suitable example e.g. salt and water **(1)**
(ethanol + water loses first mark **only**)
solution in flask **(1)**
heat flask **(1)**
condenser (**must** tilt down) **(1)**
some form of air-tight connection **(1)**
beaker/flask to collect distillate **(1)**
solvent evaporating in flask / condensing in condenser **(1)**
pure solvent in beaker **(1)**
(no diagram, **maximum 5 marks**)

(8 marks)

(b) suitable example e.g. salt and sand **(1)**
add water to mixture / make **or** take solution **(1)**
heat / stir to ensure all of the solute dissolves **(1)**
filter funnel and paper **(1)**
beaker to collect filtrate **(1)**
pour mixture into filter paper / filter solution **(1)**
insoluble solid identified as residue **(1)**
soluble solid identified as in filtrate **(1)**
evaporate water from filtrate to obtain soluble solid **(1)**
(no diagram, **maximum 6 marks**)

(9 marks)

(c) suitable example e.g. dyes in coloured ink **(1)**
use of absorbent/filter paper **(1)**
need to use pencil / not pen to mark paper **(1)**
spot mixture near one end of paper **(1)**
suitable solvent e.g. water **(1)**
stand paper in solvent so spot just above surface **(1)**
leave until solvent has risen to the top of the paper **(1)**
various spots corresponding to different dyes **(1)**
(no diagram, **maximum 5 marks**)

(8 marks)

Total 25 marks

9. (a) suitable reaction vessel **(1)**
reactant **concentrated** sulphuric acid **IGNORE** heating **(1)**
suitable drying agent e.g. anhydrous calcium chloride **(1)**
collection by upward displacement **(1)**
apparatus airtight **(1)**
$NaCl(s) + H_2SO_4(l) \rightarrow NaHSO_4(s) + HCl(g)$
$2NaCl(s) + H_2SO_4(l) \rightarrow Na_2SO_4(s) + 2HCl(g)$
balanced equation **(1)**
state symbols **(1)**
(if reagent wrong can still score 4 marks for apparatus)
(no diagram, **maximum 5 marks**)

(7 marks)

(b) diagram to show:
- source of hydrogen chloride
- passing into an inverted funnel
- standing in beaker of water
- end of funnel just below surface of water

(4 marks)

(c) (i) any three of these observations:
- effervescence / bubbles of gas
- solution turns from colourless
- to green
- heat given off **(3)**

$Fe + 2HCl \rightarrow FeCl_2 + H_2$ **(1)**

(ii) white precipitate **only** **(1)**
$AgNO_3 + HCl \rightarrow AgCl + HNO_3$ **(1)**

(6 marks)

(d) (i) large surface area **(1)**
more collisions **(1)**

(ii) particles move more slowly / have less **kinetic** energy **(1)**
collisions less energetic / fewer effective collisions **(1)**

(iii) more particles **(1)**
more frequent collisions **(1)**

(iv) particles helped to mix / exposes more iron to acid **(1)**
more frequent collisions (between reactants) **(1)**
(second mark dependent on first mark)
(any mention of molecules - **penalise once**)

(8 marks)

Total 25 marks

CHEMISTRY 7081, CHIEF EXAMINER'S REPORT

Paper 1

Question 1
This was a high scoring question, the main errors being in the formulae of methanol and potassium sulphate.

Question 2
The colour of Universal Indicator in water was not well known and the appearance of oxidised iron(II) sulphate was often described as 'red-brown', probably a confusion with iron(III) hydroxide.

Question 3
(a) Full marks were usually scored.

(b) As the terms 's block' and 'p block' were likely to be unfamiliar to many candidates, two marks were awarded to everyone regardless of the answer given.

Question 4
The main errors were to include the faraday constant in part (e) and to place the decimal point incorrectly in part (f).

Question 5
Many candidates scored full marks but some thought that sodium burns with an orange-red flame.

Question 6
(a) Some answers included a full description of the flame test, which was unnecessary.

(b) Incorrect answers included 'pale yellow' rather than just 'yellow' and 'solution' rather than 'precipitate'.

(c) 'CO_3^-' and 'CO_2' were common incorrect responses.

(d) Satisfactory.

(e) Two answers were required: 'blue precipitate' followed by '(deep) blue solution' but these were rarely seen; often 'precipitate' and 'solution' were missing.

Question 7
(a) 'Argon' was the most common incorrect answer.

(b) Some diagrams had only one bonding pair and there were a few covalent molecules.

(c) 'Isomers' and 'isotopes' were sometimes offered.

(d) Marks were lost in part (ii) because some candidates did not give any numbers in their answers.

Question 8

(a) The catalyst was incorrectly identified by many candidates; a more common answer was 'apply heat', which was accepted. There were frequent references to 'burning splints'.

(b) Very few offered 'electrolysis' but the test was well known.

(c) 'Heating' was often suggested rather than adding a named acid. The test was often correct in essence but 'yellow to green' rather than 'orange to green' for potassium dichromate(VI) was a common error. Similarly, those who used potassium manganate(VII) often said it was 'decolourised' rather than giving the colour change from purple to colourless.

Question 9

(a) This was usually correct but 'CH_2' and 'C_nH_{2n+2}' were also seen.

(b) The diagram was often correct but an extra carbon atom sometimes appeared. A number was not required before 'methylpropane' but it had to be correct if given.

(c), (d) and (e) were well answered.

Question 10

(a) 'Manganese', 'Mn^{2+}' and 'K^{+}' were common incorrect answers.

(b) 'Brownian motion' was offered by a minority.

(c) Random movement in straight lines was required, and careless diagrams incurred some penalty. A central point with lines radiating from it occurred quite frequently.

(d) There was confusion between rate of spreading and rate of reaction. Loose terminology was also rife with 'atoms', 'molecules' and 'ions' being used quite indiscriminately. Many candidates seemed to think that only the water molecules would gain energy and move faster; the spreading was said to result from collisions between the water molecules and the manganate(VII) ions. This will, of course, occur but the ions also gain energy and move faster.

Question 11

There were numerous variations on 'astatide' that were not accepted. In the calculation, weaker candidates did not take into account that there are two astatide ions in $CaAt_2$.

Question 12

Common incorrect answers were 'reduction' in part (a), 'condensation' in part (d) and 'dilution' or 'hydration' in part (e).

Question 13

Those who recognised that the element was iron scored high marks, although some oxidation states were missing or incorrect; the state symbols were sometimes missing in the equation. The answer to part (a) was occasionally given as 'iron(II)' which was not accepted. If the incorrect element was chosen in part (a), some credit was given in other parts.

Question 14

(a) The commonest mistakes were to omit 'concentrated' (H_2SO_4) and to give a temperature of 180°C.

(b) Few candidates realised that the components of the reaction mixture are miscible and that it is necessary to add water before using a separating funnel. Those who chose 'fractional distillation' were the most successful.

(c) 'A pleasant smell' was considered to be too vague and many candidates insisted that there would be a smell of 'pear drops'.

(d) There was some confusion over the name, 'ethyl methanoate' being the most popular incorrect answer.

(e) The ester linkage was usually correct but an extra CH_2 was sometimes included.

Question 15

(a) Usually correct, but some used HCl.

(b)(i) This part was poorly done as many vaguely referred to frequency of collisions or stated that the acid was in excess (which was given in the question).

(ii) Often correct although the second option was quite popular.

(iii) A common error was to divide 120 by 1000 rather than by 24000 when finding the number of moles of hydrogen and hence magnesium; consequential marking was then applied to the rest of the question. It was often difficult to follow the method amidst a mass of numbers as little explanation was provided.

Question 16

(a) Many good graphs were seen but double lines, freehand lines and lines bent to fit all the points were also noted.

(b) Well answered.

(c) Most candidates calculated these values correctly.

(d)(i) Some candidates used numbers instead of 'n' and 'n+1'.

(ii) This part was answered correctly by very few students.

This was a high scoring question for most candidates.

Paper 2

General comments

Calculations were generally very well done.

Ionic equations and the balancing of equations were often weak.

There were too many examples of diagrams which were badly drawn and did not show necessary detail with sufficient clarity to score the marks available.

Section A

Question 1
Electrolysis was reasonably well understood, but too many answers were directed towards specific examples rather than a general definition.

A high proportion of candidates were able to identify the ions in copper(II) sulphate solution and provide a suitable equation for the reaction at the anode. There was considerable confusion between oxidation and reduction in terms of electron transfer.

The calculation was generally well done. A common error was to respond in terms of 1 mole of electrons rather than 2 moles.

Question 2
Atomic structure was well known although a surprising number of candidates did not know the relative mass of the proton.

The information provided by the mass number and atomic number of an isotope was well understood.

The ionic equation for the reaction between solutions of barium nitrate and sodium carbonate caused problems for a surprising proportion of candidates. Common errors included selecting incorrect ions and placing incorrect charges on the correct ions. The final calculation was very well done.

Question 3
Calculations on the heat released by burning ethanol were generally very good, but candidates need to take more care with units.

Calculations using bond dissociation energies were generally very good with most errors resulting from using incorrect numbers of bonds.

Explanations of why the actual and theoretical values for the combustion of ethanol are different were surprisingly poor with many candidates being unable to offer any sensible comment.

Question 4
Explanations of reactivity using the information from the table were reasonable but too often comments were about specific reactions rather than of a general nature. Most candidates were able to order the metals in terms of reactivity.

The ionic equation for the reaction between magnesium and copper(II) ions was not well done. Far too often incorrect ions were given or spectator ions were included.

Comments on the simple cell and the action of the metals were reasonable although explanations of the flow of electricity through the cell and the external circuit were often confused and appeared to be based on little more than guesswork.

A surprisingly high proportion of candidates were unable to explain how zinc is able to protect iron from rusting sufficiently well to score the two marks available.

Question 5
The industrial production of ammonium nitrate was generally well known. The commonest mistake was to identify water as the source of hydrogen.

Most candidates were able to plot and draw the graph with sufficient accuracy; however there is room for improvement in this area. Too often marks are being thrown away due to lack of accuracy and/or an inability to draw an acceptable curve of best fit.

Section B

Question 6
The question was generally well answered.

Many candidates failed to identify phenolphthalein and methyl orange as indicators and there was some confusion over colour changes.

Most candidates appeared reasonably familiar with the apparatus used for titration and the procedure for reading the level on a liquid in a pipette or burette.

One the whole the calculations were very well done. A common error was to give the volume used in Experiment 3 and the average volume as a whole number rather than to two decimal places.

The last part of the question was often badly done. Many candidates appeared to be oblivious to the fact that the titration mixture would be impure due to the presence of the indicator, and this had to be removed using charcoal, or the titration repeated using the same volumes of acid and alkali but without indicator.

Question 7
This question was frequently very well done.

Knowledge of the extraction of aluminium was very good. Common errors included confusion between bauxite and alumina, and between anode and cathode.

A surprisingly high proportion of candidates were unable to suggest a sensible test to demonstrate that aluminium potassium sulphate is ionic. Solubility in water was insufficient. What was required was inclusion in a simple circuit including a bulb.
Tests for K^+ and SO_4^{2-} were generally well known however marks were lost by candidates failing to state that solutions of reagents were used.

The calculation was extremely well done with the vast majority of candidates obtaining full marks.

Question 8
A very popular question generally providing candidates with high marks.

Marks were most often lost by candidates failing to provide sufficient information.

The quality of diagrams was too often no better than borderline. Candidates should be advised that marks are not awarded for diagrams that bear little resemblance to the pieces of apparatus they are supposed to represent, or where important detail cannot be clearly seen.

Accounts of chromatography were significantly less well written and detailed than those of the other two separation techniques in this question.

Question 9
This question was generally not well done.

Accounts of the preparation of dry hydrogen chloride ranged from excellent to extremely poor. Candidates who suggest collecting the dry gas over water cannot seriously expect to obtain many marks. Once again diagrams were often poor.

The majority of candidates were aware of the need to use an inverted funnel to dissolve hydrogen chloride in water.

Most candidates had some knowledge of what happens when dilute hydrochloric acid is added to iron and to silver nitrate solution. However, all too frequently, marks were thrown away because candidates failed to state what observations would be seen. Some of the reactions suggested with silver nitrate, involving the evolution of nitrogen dioxide, were fanciful in the extreme.

Discussion of the effects of different factors on the rate of reaction was very varied in quality. Candidates were told to address their answers in terms of particles and collisions but accounts were often confused leaving the examiners with the impression that answers owed more to guesswork than to understanding.

CHEMISTRY 7081, GRADE BOUNDARIES

Grade	A	B	C	D	E
Lowest mark for award of grade	77	66	56	51	39

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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Edexcel International Publications, Adamsway, Mansfield, Notts, NG18 4FN, UK
Telephone: +44 (0) 1623 450 781
Fax: +44 (0) 1623 450 481
Email: intpublications@linneydirect.com

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