Note to teachers and students on the use of published marking schemes

Marking schemes published by the State Examinations Commission are not intended to be standalone documents. They are an essential resource for examiners who receive training in the correct interpretation and application of the scheme. This training involves, among other things, marking samples of student work and discussing the marks awarded, so as to clarify the correct application of the scheme. The work of examiners is subsequently monitored by Advising Examiners to ensure consistent and accurate application of the marking scheme. This process is overseen by the Chief Examiner, usually assisted by a Chief Advising Examiner. The Chief Examiner is the final authority regarding whether or not the marking scheme has been correctly applied to any piece of candidate work.

Marking schemes are working documents. While a draft marking scheme is prepared in advance of the examination, the scheme is not finalised until examiners have applied it to candidates’ work and the feedback from all examiners has been collated and considered in light of the full range of responses of candidates, the overall level of difficulty of the examination and the need to maintain consistency in standards from year to year. This published document contains the finalised scheme, as it was applied to all candidates’ work.

In the case of marking schemes that include model solutions or answers, it should be noted that these are not intended to be exhaustive. Variations and alternatives may also be acceptable. Examiners must consider all answers on their merits, and will have consulted with their Advising Examiners when in doubt.

Future Marking Schemes

Assumptions about future marking schemes on the basis of past schemes should be avoided. While the underlying assessment principles remain the same, the details of the marking of a particular type of question may change in the context of the contribution of that question to the overall examination in a given year. The Chief Examiner in any given year has the responsibility to determine how best to ensure the fair and accurate assessment of candidates’ work and to ensure consistency in the standard of the assessment from year to year. Accordingly, aspects of the structure, detail and application of the marking scheme for a particular examination are subject to change from one year to the next without notice.
Introduction

In considering the marking scheme the following should be noted.

1. In many cases only key phrases are given which contain the information and ideas that must appear in the candidate’s answer in order to merit the assigned marks.

2. The descriptions, methods and definitions in the scheme are not exhaustive and alternative valid answers are acceptable.

3. The detail required in any answer is determined by the context and the manner in which the question is asked, and by the number of marks assigned to the answer in the examination paper and, in any instance, therefore, may vary from year to year.

4. The bold text indicates the essential points required in the candidate’s answer. A double solidus (//) separates points for which separate marks are allocated in a part of the question. Words, expressions or statements separated by a solidus (/) are alternatives which are equally acceptable for a particular point. A word or phrase in bold, given in brackets, is an acceptable alternative to the preceding word or phrase. Note, however, that words, expressions or phrases must be correctly used in context and not contradicted, and where there is evidence of incorrect use or contradiction, the marks may not be awarded. Cancellation may apply when a candidate gives a list of correct and incorrect answers.

5. In general, names and formulas of elements and compounds are equally acceptable except in cases where either the name or the formula is specifically asked for in the question. However, in some cases where the name is asked for, the formula may be accepted as an alternative.

6. There is a deduction of one mark for each arithmetical slip made by a candidate in a calculation.
SECTION A

QUESTION 1

(a) WHAT: cooking fat / lard / vegetable (olive, sunflower, rape seed) oil //
sodium (potassium) hydroxide (caustic soda, NaOH, caustic potash, KOH)

(b) COPY: diagram with two correct labels:

(c) WHAT: antibumping granules / glass beads (bits, pieces) / boiling chips
porcelain chips (bits, pieces) / pumice / any named inert material

(d) WHAT: the ethanol / C₂H₅OH / alcohol
[Accept water]

(e) BRINE: salt / NaCl //
water / solution / dissolved / in water //
HOW: filtration / decanting / pour off water

(f) WHY: to avoid burns to skin from /
to remove sodium hydroxide (name or formula: see (a) above) / to remove impurities
[Allow safety]

WARM: to avoid dissolving (wasting) much soap / more soluble in warm water
QUESTION 2

(a) EXPL: solution of known // concentration

(b) GIVE: pure / not deliquescent (or not hygroscopic, doesn’t absorb moisture) / reasonably high relative formula (molar, accept molecular) mass ($M_r$) / stable / not efflorescent (doesn’t lose moisture) / solid / soluble

(c) NAME: volumetric flask

(d) HOW: add rinsings of beaker // use of funnel // use of glass rod // rinse funnel into flask and remove / rinse glass rod into flask ANY ONE: (9)

(e) OUTL: flask on level surface // [Accept “flat” for “level.”] mark at eye-level // using wash bottle // add dropwise (with dropper, with pipette) // until bottom of meniscus on (level with) mark (ANY ONE)

WHAT: invert (shake) several times / ensure thorough mixing (uniform concentration)

FIND: 

(i) 0.14 moles per litre

\[
\frac{17.85 \times M}{2} = \frac{25.0 \times 0.05}{1} \quad (6)
\]

\[
M = 0.14 \quad (3)
\]

(ii) 5.11 grams per litre

\[
0.14 \times 36.5 = 5.11 \quad (3)
\]

[Formula alone 3 marks]
[3 marks for each correct side of the expression. If both sides are incorrect then allow 3 marks for correct formula.]

[If answers are not given to two decimal places, deduct one mark. Make this deduction once only.] [3 marks for writing answer (i) × 36.5 or for correctly multiplying it out. Where $M_r$ is given as 36 treat as slip.]
QUESTION 3

(a) DESC: using clean / description of cleaning //
platinum (nichrome) / soaked (dipped) //
wire (probe) / splint (lollipop stick) //
dip wire (splint) into salt //
place salt in (into, on, at edge of, at top of) flame //
note (observe) colour ANY TWO: (8 + 3)

STATE: sodium: yellow / orange //
potassium: lilac / violet / purple //
copper: blue-green / green (6 + 2 + 1)

(b) (i) WHAT: copper deposited / brown (red-brown, red, black) deposit on rod (zinc) /
bubbles / lighter blue / lighter colour / paler / colourless solution / zinc corroding
[Accept zinc wearing away or acquiring ‘rusty’ appearance; Cu precipitate; plating]
(ii) EXPL: electron transfer from zinc (Zn) / zinc (Zn) lost electrons /
to copper ions / copper ions gained electrons (9 + 3)
[Accept zinc oxidised OR copper reduced]

(c) (i) HOW: add solution of silver nitrate //
white / precipitate formed (9 + 3)
[Allow 3 marks for mention of NH₃]
(ii) HOW: add freshly prepared iron(II) sulfate (ferrous sulfate, FeSO₄) solution //
concentrated (conc) sulfuric acid / H₂SO₄ //
poured carefully down inside of slanting test tube //
two layers formed //
brown ring at junction of liquids ANY TWO (2 × 3)
SECTION B

QUESTION 4

Eight items to be answered. Six marks to be allocated to each item and one additional mark to be added to each of the first two items for which the highest marks are awarded.

(a) WHICH: solid
    [Accept liquid or gas for 3 marks] (6)

(b) TERM: atomic radius / covalent radius
    [Accept radius for 3 marks] (6)

(c) WHAT: reaction in which heat (energy) // is gained (taken in) (2 × 3)

(d) WRITE: CH₂O (6)

(e) TYPE: substitution / free radical / halogenation (chlorination) (6)

(f) IDENTIFY: liquid A: water (H₂O) //
    solid B: calcium(II) dicarbide / calcium dicarbide / calcium carbide / CaC₂ [Accept “carbide.”] (5 + 1)
    [Allow 5 marks for reversed correct answers]

(g) STATE: (i) linear / straight / H – Cl //
    (ii) v-shaped / bent / angular O
        H        H (5 + 1)

(h) DIST: temporary: removed by boiling / permanent: not removed by boiling (6)

(i) WRITE: \[
\frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3} \]
    [3 for numerator correct, 3 for denominator correct, 3 if both correct but inverted] (6)

(j) NAME: diffusion (6)

(k) A STATE: lightning / bacteria (micro-organisms) / volcano
    [Accept legumes or clover, etc] (6)
    or

B NAME: sodium / aluminium / lithium / magnesium / calcium / other correct answer
    [Accept potassium] [Accept copper for 3 marks] (6)
QUESTION 5

(a) DIST: mass no: number of protons and neutrons / number of nucleons / mass of nucleus / mass of particular isotope

rel at mass: average mass of atom(s) of an element / average of isotopes taking abundance into account //

based on (relative to, compared with) \( \frac{1}{12} \) mass of carbon-12 atom

GIVE: they are mixtures of isotopes / average masses of isotopes

(b) (i) WHO: Mendeleev //

(ii) WHAT: order of increasing atomic number (Z)

(c) (i) EXPL: spontaneous //

[Allow random]

decay (disintegration, decomposition, breakdown) // of unstable / nuclei (atoms) //

with emission of radiation (particles, rays)

ANY TWO: (5 + 1)

(ii) WHAT: a high-speed electron (\( e^- \)) [Accept “e” ]

[Allow any valid property as a way of identifying a beta particle: negatively charged or charge of \(-1\); high speed particles; moderately (medium) penetrating; moderately (medium) ionising; deflected in an electric field; negligible or very small mass (1/1840 amu); speeds of 30 – 70 % of light)]

(iii) EXPL: time taken //

for half the radioactive atoms to decay /

for half the mass (amount) (sample) of the element to decay

for activity to decrease by a half

(5 + 1)

(iv) GIVE: radiocarbon dating of ancient artefacts / tracer in studying reactions

[Accept mention of archaeology]

(d) DRAW:

[Allow 3 marks for showing 2 electrons in inner shell. Allow 3 marks for showing 4 electrons in the outer shell. Where 14 e correctly arranged 2, 8, 4 allow 5.]
QUESTION 6

(a) NAME: crude oil (petroleum) // coal // natural gas // biogas
   [Accept fossil fuel(s) for 5 marks if it is the only answer; otherwise allow 3 marks]

   ANY TWO: (5 + 3)

(b) (i) WHAT: liquefied (liquid) petroleum gas
   [Not “bottled gas”. Award max 3 for ‘gas’ if ‘(liquefied) liquid’ and ‘petroleum’ are incorrect]

   (ii) NAME: propane

   (iii) WHAT: mercaptans / sulfur compounds //
         HOW: give the gas a noticeable odour (smell)

   (iv) GIVE: cooking / heating / camping stoves / lighter / tarring roofs

   (6 + 6 + 3 × 3)

(c) NAME: propene / propylene

   DRAW: \[ \begin{array}{c}
   - C - C = C \end{array} / \begin{array}{c}
   CH_3CH=CH_2 \end{array} / \begin{array}{c}
   \text{structure} \end{array} \] (6 + 3)

(d) NAME: methylbenzene / toluene

   WOULD: high //
   GIVE: presence of aromatic / ring / cyclic

   (6 + 3 + 3)
QUESTION 7

(a) DEFINE: (i) acid: dissociates to give hydrogen ions (H\(^+\)) in aqueous solution (water) //

(ii) base: dissociates to give hydroxyl (hydroxide) ions (OH\(^-\)) in aqueous solution (water)

[Accept BL definitions for full marks] (5 + 3)

EXPLAIN: reaction between acid and base //
giving salt and water only (5 + 1)

GIVE: name: hydrochloric acid //
formula: HCl (5 + 1)

(b) DESCRIBE: (i) find mass of (weigh) filter paper //
filter // known volume of water through weighed filter paper //
dry and // reweigh filter paper // subtract weighings

(ii) find mass of (weigh) evaporating dish (beaker, other) //
evaporate to dryness // known volume // of filtered water //
cool and reweigh dish // subtract weighings ANY THREE from (i) or (ii): (3 × 6)

(c) EXPRESS: (i) 0.15 g/l // 1.7 g/l (2 × 3)

\[
\frac{0.015 \times 1000}{100} = 0.15 \text{ g/l} \quad (3)
\]
\[
\frac{0.17 \times 1000}{100} = 1.7 \text{ g/l} \quad (3)
\]

[Treat as a –1 slip a correct expression with incorrect answer or no answer]

(ii) 150 parts per million // 1700 parts per million (2 × 3)

\[
0.15 \times 1000 = 150 \text{ ppm} \quad (3)
\]
\[
1.7 \times 1000 = 1700 \text{ ppm} \quad (3)
\]

[Accept answer to (i) × 1000 for 3 marks, but –1 slip if incorrect answer or no answer given]
QUESTION 8

(a) NAME: X ethanol / ethyl alcohol // [Accept alcohol]
Y ethanal / acetaldehyde //
Z ethene / ethylene (6 + 4 + 1)

(b) WHICH: Y / CH₃CHO / ethanal / acetaldehyde / the aldehyde

DRAW: \[ -\text{C} - \text{C}^* = \text{O} \]
[Allow correct structure of X, Y or Z]

PLANAR: planar carbon correctly identified e.g. with asterisk (6 + 2 × 3)

(c) WHAT: oxidation (dehydrogenation) (3)

DESCRIBE: add a little Y to Fehling’s solution in a test tube //
heat (warm) gently //
red precipitate \{ppt of copper(I) oxide (cuprous oxide, Cu₂O)\} formed
ANY TWO: (6 + 3)

(d) DRAW:

ANY TWO CORRECT LABELS: (6 + 3)

Give (2 × 3) for left assembly and right assembly
QUESTION 9

(a) DEFINE:  
(i) change in concentration // per (in) unit time  
[Accept speed of reaction for 3 marks]  
(ii) alters (speeds up, increases) rate of reaction //  
but chemically unchanged at the end  (3 + 2)

(b) GIVE: manganese(IV) oxide / manganese dioxide / MnO₂ / liver / celery  (6)

(c) WHAT: enzyme(s) //  
EXAMPLE: amylase (ptyalin) / lipase / pepsin / catalase / other correct example  (6 + 3)

(d) (i) DIFF: rate slower in A / rate faster in B  
WHAT: different surface area(s) // particle size  (6 + 3)

(ii) HOW: increase in rate  (6)

(e) NAME: platinum // palladium // rhodium  
ANY TWO: (5 + 1)  
[Accept symbols]

GIVE: harmful gases converted to harmless gases / nitrogen oxide(s) converted to nitrogen / carbon monoxide converted to carbon dioxide / unburned hydrocarbons converted to carbon dioxide and water  (3)
QUESTION 10

(a) DEFINE: relative attraction (affinity) / measure of attraction / number expressing attraction // for shared electrons / for electrons in a covalent bond / shared pair (4 + 3)

EXPLAIN: (i) increase in nuclear charge / decrease in atomic radius
[Allow increase in atomic number or increasing number of protons]

(ii) increase in atomic radius / increase in size of atom / increase in number of shells / shielding (screening) effect increased (6 + 3)

USE: HCl: polar // [Accept covalent]
NaCl: ionic //
H₂: covalent (5 + 2 + 2)

(b) (i) HOW MANY: 0.1 moles (7)

\[
\begin{align*}
M_r &= 84 \\
8.4 \div 84 &= 0.1
\end{align*}
\]
[Treat \(M_r = 83\) as slip] (4)

(ii) WHAT: 0.9 grams (6)

\[
0.1 \text{ mol NaHCO}_3 \equiv 0.05 \text{ mol H}_2\text{O} \\
0.05 \times 18 &= 0.9 \text{ g}
\]
[Award 3 marks if 18 used in calculation attempt] (3)

(iii) VOLUME: 1.12 litres (6)

\[
0.1 \text{ mol NaHCO}_3 \equiv 0.05 \text{ mol CO}_2 \\
0.05 \times 22.4 &= 1.12 \text{ litres}
\]
[Award 3 marks if 22.4 used in calculation attempt] (3)

MOLECULES: \(3 \times 10^{22}\) (6)

\[
1.12 \text{ litres CO}_2 &= 0.05 \text{ mol} \\
0.05 \times 6 \times 10^{23} &= 3 \times 10^{22}
\]
[Award 3 marks if \(6 \times 10^{23}\) used in calculation attempt] (3)
Question 10 continued

(c) (i) **STATE:** separation //

mixture of components (parts) //
as a mobile phase (named solvent) //
passes through a stationary phases (named stationary phase) //

(ii) **WHICH:** gas chromatography / GC //

[Accept HPLC or high performance liquid chromatography or TLC or thin layer chromatography for 6 marks] //

(iii) DESC: Paper chromatography

apply mixture using dropper (capillary tube) / spotting on paper //
about 2 cm (slightly, just) above (below*) eluent** //
place in tank (beaker, other suitable container) //
the indicators separate as they move up (down) with eluent**

ANY THREE: (6 + 3 + 3)

* The eluent** can be at the top of the tank and move down the paper.

or

Thin layer chromatography

apply mixture using dropper (capillary tube) / spotting on plate //
about 2 cm (slightly, just) above eluent** //
place plate in tank (beaker, other suitable container) //
the indicators separate as they move up with eluent**

ANY THREE: (6 + 3 + 3)

or

Column chromatography

dissolve mixture in eluent** // add to column //
add mixture to column // add eluent**
continue to add eluent** so that it flows through column //
separation occurs into bands

ANY THREE: (6 + 3 + 3)

** For eluent accept mobile phase or solvent or named solvent, e.g. water.

[Marks can be awarded for labelled diagram, and least one label being present.]
QUESTION 11

(a) WRITE: 1: Dalton  //  
2: Thomson  //  
3: Rutherford  //  
4: Bohr  //  
5: Moseley  //  

\[(12 + 6 + (2 \times 3) + 1)\]

(b) STATE:  
(i) clumping (removing) suspended particles  //  
(ii) raising the pH  // [Accept making less acid or neutralising or prevention of damage to pipes (teeth)]  
(iii) lowering the pH  // [Accept making less basic (alkaline) or neutralising or improving taste]  
(iv) killing harmful bacteria / sterilizing  //  
(v) preventing tooth decay  //  

\[(5 + 5 + 2 + 2 + 1)\]

NAME: sand / gravel / aggregate  //  

SUGGEST: sewage / fertilisers / silage  // ANY TWO: (6 + 1)  
[Accept run off for either fertilisers or silage but not for both; accept flooding or heavy rain]

(c) A  
(i) GIVE: purify / remove carbon dioxide / remove water vapour  //  
liquefy  //  
by lowering temperature / increasing pressure (compressing)  //  
separate oxygen by fractional distillation  //  

\[(7 + 3)\]

(ii) WHAT: CFCs: chlorofluorocarbon(s)  //  
HCFCs: hydrochlorofluorocarbons(s)  //  

\[(5 + 1)\]

GIVE: refrigerants / air-conditioning gases / aerosol propellants / fire extinguishers  //  

\[(3)\]

(iii) WHAT: ultra-violet (uv) barrier / prevents skin cancer  //  

\[(6)\]

or  

B  
(i) EXPL: list of elements (metals) arranged in order  //  
of tendency to lose electrons (order of tendency to be oxidised) / of their standard electrode potentials / of decreasing reactivity  //  

\[(4 + 3)\]

(ii) GIVE: variable valency (valence) / coloured ions (compounds) / ability to act as catalysts  //  

\[(2 \times 3)\]

(iii) WHICH: iron  //  

\[(3)\]

GIVE: higher in electrochemical series / loses electrons more easily / more easily oxidised  //  

\[(3)\]

(iv) METH: painting // electroplating // galvanising (coating with zinc) // tin coating // use of sacrificial metal // greasing  //  

\[(2 \times 3)\]