Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2026

Marking Scheme

Chemistry

Ordinary Level

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.

In considering this marking scheme for the written examination, the following points should be noted.

1. In many instances only key words are given – words that must appear in the correct context in the candidate's answer in order to merit the assigned marks.
Where incorrect terminology is used or where part of the candidate's answer contradicts another part, the marks may not be awarded. Cancellation may apply when a candidate gives more than the required number of responses, or a list of correct and incorrect answers.

2. Words, expressions or statements separated by a solidus, /, are alternatives which are equally acceptable.

3. A double solidus, //, separates answers which are mutually exclusive. A partial answer from one side of the // may not be taken in conjunction with a partial answer from the other side.

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

5. The detail required in any answer is determined by the context and manner in which the question is asked, and also by the number of marks assigned to the answer in the examination paper. Therefore, in any instance, it may vary from year to year.
Material that is bracketed is not required in that year.

6. When a candidate is asked to identify a chemical substance, either the name or formula is accepted, unless otherwise indicated. For *deionised water*, the term *distilled water* or *pure water* should also be accepted, unless otherwise indicated. For organic compounds the IUPAC name or traditional scientific name is acceptable, unless otherwise indicated. Inorganic compounds may be named using oxidation state or traditional naming convention – e.g. potassium manganate(VII) or potassium permanganate for $KMnO_4$.

7. Each time an arithmetical error occurs in a calculation, one mark is deducted; this also applies to inappropriate or incorrect rounding of numerical answers. This deduction applies to incorrect M_r values, but only if a candidate shows the addition of all the correct atomic masses and the error is clearly an arithmetical one. If the addition of atomic masses is not shown, the candidate loses the marks for an incorrect M_r.

8. For drawing the molecular structure of an organic compound, one mark is deducted if the H atoms are omitted in a systematic way and one mark is deducted if bonds to H atoms are omitted in a systematic way.

9. For omission of appropriate units (or for incorrect units) in final answers, one mark is deducted, unless otherwise indicated.

10. A zero should only be recorded when the candidate has attempted the question item but does not merit marks. If a candidate does not attempt a question item examiners should record NR.

11. Examiners are expected to annotate each part of the candidate's response as directed at the marking conference.

For a fully correct response, examiners may award one total mark (e.g. 6 marks) or a number of partial marks (e.g. 2 marks, 2 marks, 2 marks) that add to the same total.

For an incorrect or partially incorrect response examiners should place the appropriate annotations near the correct/incorrect elements of the response such that a total mark is generated for the response (e.g. 2 marks, 0 marks, 2 marks).

Symbol	Name	Use
	Cross	Incorrect element
	Tick	Correct element (0 marks)
	Tick_n	Correct element (n marks)
	Horizontal wavy line	To be noticed
	Vertical wavy line	Additional page
	Ellipse	Incorrect material
-1	−1	−1
0	0	0
^	^	Missing element
C	C	Cancellation
[	Square bracket	Surplus element

12. Bonus marks at the rate of 10% of the marks obtained will be given to a candidate who answers entirely through Irish and who obtains 75% or less of the total mark available (i.e. 300 marks or less). In calculating the bonus to be applied decimals are always rounded down, not up ¬ e.g., 4.5 becomes 4; 4.9 becomes 4, etc. See below for when a candidate is awarded more than 300 marks.

Marcanna Breise as ucht freagairt trí Ghaeilge

Léiríonn an tábla thíos an méid marcanna breise ba chóir a bhronnadh ar iarrthóirí a ghnóthaíonn níos mó ná 75% d'iomlán na marcanna.

N.B. Ba chóir marcanna de réir an ghnáthráta a bhronnadh ar iarrthóirí nach ngnóthaíonn níos mó ná 75% d'iomlán na marcanna don scrúdú. Ba chóir freisin an marc bónais sin **a shlánú síos**.

Tábla 400 @ 10%
Bain úsáid as an tábla seo i gcás na n-ábhar a bhfuil 400 marc san iomlán ag gabháil leo agus inarb é 10% gnáthráta an bhónais.

Bain úsáid as an ngnáthráta i gcás 300 marc agus faoina bhun sin. Os cionn an mharc sin, féach an tábla thíos.

Bunmharc	Marc Bónais
301 - 303	29
304 - 306	28
307 - 310	27
311 - 313	26
314 - 316	25
317 - 320	24
321 - 323	23
324 - 326	22
327 - 330	21
331 - 333	20
334 - 336	19
337 - 340	18
341 - 343	17
344 - 346	16
347 – 350	15

Bunmharc	Marc Bónais
351 – 353	14
354 – 356	13
357 – 360	12
361 – 363	11
364 – 366	10
367 – 370	9
371 – 373	8
374 – 376	7
377 – 380	6
381 – 383	5
384 – 386	4
387 – 390	3
391 – 393	2
394 – 396	1
397 – 400	0

1. The apparatus shown in the diagram below can be used to prepare and collect the hydrocarbon ethene (C_2H_4) in the laboratory.

(*a*) (*i*) Identify solid A.

aluminium oxide / Al_2O_3

(*ii*) What colour is solid A?

white

(*iii*) Explain why the tube should be removed from the water before the Bunsen burner is removed.

to prevent suckback

(*iv*) State one other precaution that should be taken when carrying out this experiment.

one appropriate safety or procedural precaution

(*v*) State one property of ethene that allows it to be collected above water as shown.

insoluble in water / less dense than water / non polar

[12+3+2+2+2]

(*b*) (*i*) Ethene is an unsaturated hydrocarbon. Explain what is meant by the term unsaturated.

contains double or triple bonds

(*ii*) Identify a reagent that could be used to show that ethene is unsaturated.

bromine (water) // (acidified) potassium permanganate

(*iii*) State the colour change observed when ethene is bubbled through this reagent.

from yellow / orange / brown // purple / pink

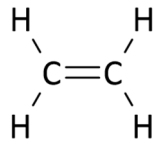
to colourless [*do not accept clear*]

[9+2+2+2]

(*c*) (*i*) Explain what is meant by the term hydrocarbon.

compound containing hydrogen and carbon (only)

(*ii*) Draw the molecular structure of ethene, including all atoms and bonds.



-1 if C–C double bond omitted

(*iii*) State one use for ethene.

e.g. as a fuel, ripening fruit etc.

[8+3+3]

2. A student filled the piece of apparatus labelled A, shown on the right, with a solution of 0.2 M hydrochloric acid (HCl) and titrated it against 25 cm^3 portions of a sodium hydroxide (NaOH) solution of unknown concentration. An approximate titration was carried out first and then two accurate titrations were carried out.

(*a*) (*i*) Identify the piece of apparatus labelled A.
burette

(*ii*) Describe how A was washed before use.
with deionised water
with solution / HCl

(*iii*) Name the piece of apparatus that was used to transfer exactly 25 cm^3 of the NaOH solution to a conical flask.
pipette / burette / graduated cylinder **[12+1+1+1]**

(*b*) (*i*) Name an indicator suitable for use in this titration.
methyl orange / phenolphthalein

(*ii*) State the colour change observed at the end point of this titration.
yellow / orange / pink
to pink / red / colourless **[7+1+1]**
[*award -1 marks if colours are reversed*]

The titration reaction is described by the following balanced chemical equation:

$$HCl + NaOH \rightarrow NaCl + H_2O$$

The results of the titration are shown in the table below.

Approximate titration	First accurate titration	Second accurate titration
27.2 cm^3	26.5 cm^3	26.6 cm^3

(*c*) (*i*) Calculate the average volume of **HCl** needed to neutralise the **NaOH**.
$\mathbf{26.5 + 26.6 = 53.1}$ **[3]**
$\mathbf{53.1 \div 2 = 26.55\ (cm^3)}$ **[3]**

(*ii*) Calculate the concentration of the **NaOH**, in moles per litre.
$\frac{M1V1}{n1} = \frac{M2V2}{n2}$ // $\frac{M}{1000} \times v$ **[2]**
$\frac{(0.2)(26.55)}{1}$ // $\frac{0.2}{1000} \times 26.55 = 5.31 \times 10^{-3}$ **[2]**
$\frac{(M)(25)}{1}$ // $\frac{5.31 \times 10^{-3}}{25} \times 1000$ **[2]**
= 0.21 (moles per litre) **[2]**

(*iii*) Calculate the concentration of the **NaOH**, in grams per litre.
Mr (NaOH) = 40 **[2]**
$\mathbf{0.21 \times 40 = 8.4 - 8.5\ (g)}$ **[2]**

(*d*) Describe, with the aid of a labelled diagram, how a student could obtain a pure, dry sample of the sodium chloride (**NaCl**) produced during this reaction.
repeat without indicator
evaporate the solution suitable diagram (with at least 2 correct labels) **[6+2]**
[***max 6 marks if diagram not drawn***]

3. (*a*) What is meant by the term rate of reaction?

change in concentration

per unit time / with respect to time **[3+2]**

[*allow 3 marks for reference to speed*]

(*b*) A student measured the rate of production of oxygen gas (**O_2**) by the decomposition of a dilute solution of hydrogen peroxide (**H_2O_2**) in the presence of a suitable catalyst.

The reaction is described by the following balanced chemical equation:

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

(*i*) What is a catalyst?

(a substance that) speeds up a (chemical) reaction **[6]**

(*ii*) Identify a suitable catalyst for the decomposition of **H_2O_2**.

e.g. manganese dioxide / MnO_2 etc. **[3]**

(*iii*) Draw a labelled diagram of a suitable apparatus for carrying out this experiment.

catalyst and substrate in suitable container //

suitable apparatus measuring the volume of gas collected //

timer **[*any two*]** **[6+3]**

[*max 6 marks if labels omitted*]

The results are shown in the table below.

Time (seconds)	0	30	60	90	120	150
Volume of oxygen gas produced (cm^3)	0	24	36	42	47	47

(c) (*i*) Draw a graph on graph paper to show how the volume of oxygen gas produced varies with time.

labelled axis **[3]**

scaled axes **[3]**

points plotted accurately **[6×1]**

curve of good fit **[3]**

[max 12 marks if not on graph paper]

(*ii*) Use your graph to estimate the time taken for 30 cm^3 of oxygen to be produced.

read from graph ≈ 45 s **[4]**

(*iii*) Calculate the average rate of reaction during the first 90 seconds.

$42 \div 90 \approx 0.46$ ($cm^3\ s^{-1}$) **[4]**

(*iv*) How would you expect the initial rate of this reaction to be affected by using the same volume of a more concentrated **HCl** solution? Explain your answer. **[4]**

Due to a typographical error in Question 3(c)(iv) candidates who attempted Question 3 are to be awarded full marks [4] for part (iv).

4. (*a*) Name the scientist who is credited with the discovery of the nucleus.

Rutherford **[6]**

(*b*) The combustion of octane (C_8H_{18}) is described by the following balanced chemical equation:

$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O \qquad \Delta H = -10\,940 \text{ kJ mol}^{-1}$

Is this reaction exothermic or endothermic? Justify your answer.

exothermic

ΔH is negative / reference to combustion reaction **[5+1]**

(*c*) What is meant by chromatography?

separating a mixture

using a mobile and stationary phase **[5+1]**

(*d*) Why is fluoride added to water during the water treatment process?

prevent tooth decay **[6]**

(*e*) How many (*i*) protons, (*ii*) electrons, are there in the ion Be^{2+}?

4 protons

2 electrons **[5+1]**

(*f*) Explain why the relative atomic masses of most elements are not whole numbers.

average

of isotopes **[5+1]**

(*g*) Sulfur is in the same group of the periodic table as oxygen. Write down the formula for a compound formed between hydrogen (H) and sulfur (S).

H_2S **[6]**

(*h*) What is the name of the process used to extract eugenol (clove oil) from cloves?

steam // distillation **[5+1]**

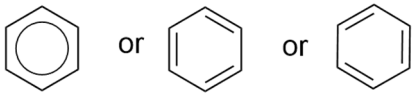
(*i*) Calculate the percentage by mass of aluminium in Al_2O_3.

Mr = 102 **[2]**

$\frac{\mathbf{54}}{\mathbf{102}}$ **[2]**

$\times \mathbf{100} \approx \mathbf{53}\ \%$ **[2]**

(*j*) Draw the molecular structure of the aromatic compound benzene (C_6H_6).



[6]

(*k*) Name two alkali metals from the following list of elements:

magnesium lithium iron oxygen sodium

lithium

sodium **[5+1]**

(*l*) Answer part A *or* part B.

A State one difference between a batch process and a continuous process in industrial chemistry.

reaction vessel cleaned / emptied out // after every batch / reaction etc. **[5+1]**

or

B State two differences between metals and non-metals.

metals: conduct heat // conduct electricity // lustrous// malleable // high melting point // high boiling point etc. **[ANY TWO]** **[5+1]**

5. (*a*) (*i*) Explain what is meant by the term electronegativity.

relative attraction of an atom

for shared electrons / single covalent bond

(*ii*) Write down the electronegativity values for boron (B) and chlorine (Cl) from page 81 of the *Formulae and Tables* booklet.

B = 2.04

Cl = 3.16

(*iii*) The bonding in BCl_3 is covalent. Use the electronegativity values you wrote down in (*ii*) to predict whether the bonding is *polar* covalent or *non-polar* covalent.
Justify your answer.

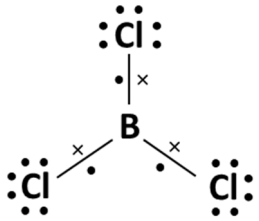
polar covalent / polar

any reference to difference in electronegativity ≈ 1.12

(*iv*) Draw a dot and cross diagram to show the arrangement of the valence electrons in a molecule of BCl_3.

correct valence electrons on boron //

correct valence electrons on chlorine atoms



(*v*) BCl_3 is an example of a molecule of general formula AX_3. Name two possible shapes of a molecule of general formula AX_3 from the following list of shapes:

v-shaped pyramidal linear triangular planar tetrahedral

triangular planer

pyramidal **[12+10+(8×1)]**

(*b*) (*i*) How do electronegativity values change across a period of the periodic table?
Explain this trend.

increase

increasing nuclear charge / decreasing atomic radius

(*ii*) How do electronegativity values change down a group of the periodic table?
Explain this trend.

decrease

increasing atomic radius / screening effect (of outer electrons) **[4+4+2+2]**

(*c*) (*i*) Another type of bonding is ionic bonding. What is ionic bonding?

transfer of electrons

(*ii*) Identify an ionic compound.

any correct ionic compound **[6+2]**

6. Answer the questions that follow with reference to compounds A to E in the table below:

A	CH_4
B	C_2H_2
C	C_3H_8
D	C_4H_{10}
E	$C_6H_5CH_3$

(*a*) (*i*) State the systematic IUPAC name of compound A.
methane

(*ii*) State the systematic IUPAC name of compound C.
propane

(*iii*) Identify a compound from the table that is an aromatic compound.
$C_6H_5CH_3$ / E

(*iv*) Identify two compounds from the table that are the main constituents of liquid petroleum gas (LPG).
C_3H_8 / C
C_4H_{10} / D **[7 + (4×2)]**

(*b*) (*i*) Name the homologous series to which compound A belongs.
alkanes

(*ii*) Name the homologous series to which compound B belongs.
alkynes **[4+2]**

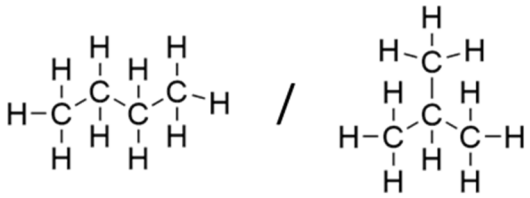
(*c*) (*i*) When compound B burns completely in oxygen, two other compounds are produced. Copy, complete and balance the following chemical equation for the complete combustion of compound B.

$C_2H_2 + \mathbf{2\frac{1}{2}}O_2 \rightarrow \mathbf{2CO_2 + H_2O}$ **[3×2]**

(*ii*) Describe the appearance of the flame of compound B when it burns in air.
yellow / bright / luminous /
sooty / smoky **[9]**

(*d*) (*i*) What is the name given to compounds that have the same chemical formula but different molecular structures?
(structural) isomers

(*ii*) C_4H_{10} has two possible molecular structures. Draw the molecular structure of either of these, including all the atoms and bonds.



(*iii*) State the systematic IUPAC name for the structure you have drawn.
butane / methylpropane **[6+6+2]**

7. (*a*) A sample of water was taken from a river and several tests were carried out on the water.

(*i*) Describe how soap flakes could be used to test the hardness of the water.
add soap//
shake//
scum forms water is hard / lather forms if soft [any two]

(*ii*) A few drops of a solution of silver nitrate ($AgNO_3$) were added to a sample of the water to test for the presence of chloride (Cl^-) ions. What observation would confirm that chloride ions were present in the water?
white precipitate / cloudy solution [6+4+2]

(*b*) The water sample was determined to have high levels of both temporary hardness and permanent hardness.

(*i*) Identify a substance that causes temporary hardness in water.
calcium (magnesium) hydrogen carbonate

(*ii*) Explain the difference between temporary hardness and permanent hardness.
temporary hardness removed by boiling

(*iii*) Identify a method for removing permanent hardness from water.
addition of sodium carbonate (washing soda) / ion exchange / distillation

(*iv*) State one disadvantage of hard water.
eg. limescale, wastes soap *etc*. [6+5+2+2]

(*c*) The pH of the water was tested and it was determined that it was acidic.

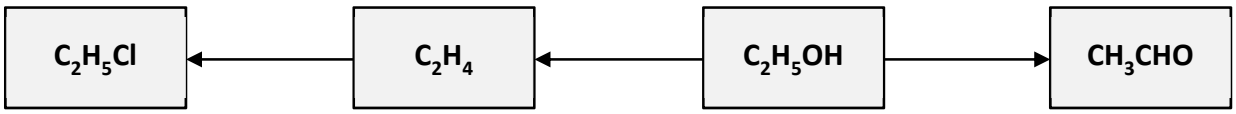
(*i*) What is an acid?
a substance that dissociates in water to form hydrogen ions / proton donor / turns blue litmus red / pH lower than 7

(*ii*) What is pH?
$-\log_{10}[H_3O^+]$ / measure of how acidic or basic a substance is

(*iii*) Describe how the pH of the water could be tested.
pH meter / universal indicator

(*iv*) Suggest a possible pH value for the acidic water.
any value less than 7 [8+6+6+3]

8. Study the series of reactions shown below and answer the questions that follow.

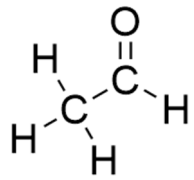


W **X** **Y** **Z**

(*a*) (*i*) State the systematic IUPAC name of compound Y.
Ethanol **[3]**

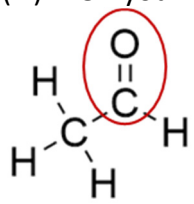
(*ii*) State the systematic IUPAC name of compound Z.
Ethanal **[3]**

(*iii*) Draw the molecular structure of compound Z, including all atoms and bonds.



[6]

(*iv*) On your diagram, draw a circle around the carbonyl group of compound Z.



[6]

(*v*) How many tetrahedral carbons are there in a molecule of compound Z?
one **[3]**

(*b*) Reactions may be classified using the following terms:

addition substitution elimination oxidation

(*i*) Use one of these terms to classify the conversion of compound X to compound W.
addition **[3]**

(*ii*) Use one of these terms to classify the conversion of compound Y to compound X.
elimination **[3]**

(*iii*) Use one of these terms to classify the conversion of compound Y to compound Z.
oxidation **[3]**

(*c*) (*i*) Identify reagents that could be used to convert compound Y to compound Z.
acidified potassium permanganate / Fehling's solution / Tollens reagent **[6]**

(*ii*) Compound Y is highly soluble in water. Explain why.
polar molecule / forms hydrogen bonds with water **[6]**

(*d*) (*i*) One of the four compounds W, X, Y and Z can be polymerised. Identify which one.
C_2H_4 / X **[4]**

(*ii*) One of the four compounds W, X, Y and Z can be formed by the halogenation of C_2H_6. Identify which one.
C_2H_5Cl / W **[4]**

9. (*a*) In the manufacture of sulfuric acid during the contact process, sulfur dioxide (SO_2) and oxygen (O_2) react in the presence of a catalyst to produce sulfur trioxide (SO_3).
An equilibrium is established.
The equilibrium is described by the following balanced chemical equation:

$$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)} \qquad \Delta H = -198 \text{ kJ mol}^{-1}$$

(*i*) Explain what is meant by the term chemical equilibrium.
rate of **[2]**
forward reaction equals reverse reaction **[3]**

(*ii*) Write an expression for the equilibrium constant K_c for this reaction.
$\frac{[SO_3]^2}{[SO_2]^2[O_2]}$ **[6]**
[award 3 marks if round brackets used]

According to Le Châtelier's principle, if certain conditions are changed in an equilibrium system, the system adjusts to relieve the stress applied.

(*iii*) Predict the effect on the concentration of SO_3 if the pressure is increased.
Justify your answer.
increase **[4]**
reaction with fewer moles/molecules (of gas) favoured **[2]**

(*iv*) Predict the effect on the concentration of SO_3 if the temperature is increased.
Justify your answer.
decrease **[4]**
endothermic reaction favoured **[2]**

(*v*) Predict the effect on the concentration of SO_3 if the catalyst is removed.
Justify your answer.
no effect **[4]**
catalyst does not change position of equilibrium **[2]**

(*b*) SO_2 is a colourless gas, with a pungent smell, similar to the smell of a just-struck match. If SO_2 is released from its container, the room fills up with its smell.

(*i*) Name the process that is responsible for the spreading of gas particles to fill a room.
diffusion **[3]**

(*ii*) In which state of matter (solid, liquid or gas) do particles move around fastest?
gas **[3]**

(*c*) Charles's law and Boyle's law are two of the gas laws that can be combined to make what is known as the combined gas law:

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

(*i*) State Charles's law.
(at constant pressure) temperature and volume **[3]**
are directly proportional **[3]**

(*ii*) A sample of SO_2 at a temperature of 298 K and a pressure of 2×10^5 Pa has a volume of 6.1 litres. Using the combined gas law shown above, calculate the volume occupied by the SO_2 at standard temperature (273 K) and standard pressure (1×10^5 Pa).
$\frac{(2\times10^5)(6.1)}{298}$ **[3]**
$\frac{(1\times10^5)(V_2)}{273}$ **[3]**
$V_2 \approx 11.2$ **L** **[3]**

10. Answer any two of the parts (*a*), (*b*) and (*c*). (2 × 25)

(*a*) When chlorine gas is bubbled through a solution of iron(II) sulfate, the reaction that occurs may be described by the following balanced chemical equation:

$$Cl_2 + 2Fe^{2+} \rightarrow 2Fe^{3+} + 2Cl^-$$

Oxidation and reduction occur during this reaction.

(*i*) In terms of electrons, explain what is meant by oxidation.
loss of electrons

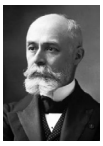
(*ii*) In terms of electrons, explain what is meant by reduction.
gain of electrons

(*iii*) Identify the substance oxidised in this reaction.
iron(II) sulphate / Fe^{2+}

(*iv*) Identify the oxidising agent.
Cl_2 / chlorine

(*v*) How many electrons are transferred when this chemical reaction occurs as described by the balanced equation?
two **[12+10+1+1+1]**

(*b*) Radioactivity is observed when the nucleus of a radioisotope decays to emit one or more types of radiation.



(*i*) The French scientist shown on the right discovered radioactivity while carrying out experiments on uranium salts in 1896. Name this scientist.
Becquerel

(*ii*) Identify the three types of nuclear radiation.
alpha
beta
gamma

(*iii*) Which of these types of nuclear radiation is most penetrating?
gamma

(*iv*) Uranium was the first radioactive element to be discovered.
Identify one other example of a radioactive element.
any correct example

(*v*) State two uses of radioisotopes.
food irradiation / cancer treatment / archaeological dating *etc*.

(*vi*) What is meant by the term half-life of a radioactive sample?
time taken for half the nuclei (in a sample) to decay **[9+9+(7×1)]**

(*c*) When 3.6 g of magnesium (Mg) metal reacts with hydrochloric acid (HCl), hydrogen (H_2) gas is produced. This reaction is described by the following balanced chemical equation:

$$2HCl + Mg \rightarrow MgCl_2 + H_2$$

(*i*) Calculate how many moles are in 3.6 g of Mg.

$\frac{3.6}{24}$ **[3]**

0.15 (moles) **[2]**

(*ii*) How many moles of HCl react with the Mg?

× 2 **[3]**

0.30 (moles) **[2]**

(*iii*) Calculate how many molecules of HCl react.

$0.30 \times 6 \times 10^{23} = 1.8 \times 10^{23}$ (molecules) **[5]**

(*iv*) Calculate the mass of $MgCl_2$ produced.

Mr = 95 **[3]**

$0.15 \times 95 = 14.25$ (g) **[2]**

(*v*) Calculate the volume of H_2 gas produced under conditions of s.t.p.

$0.15 \times 22.4 = 3.36$ (L) **[5]**

11. Answer any two of the parts (*a*), (*b*), (*c*) and (*d*). (2 × 25)

(*a*) A flame test was carried out on a sample of potassium chloride (KCl).

(*i*) State two safety precautions that should be taken when carrying out a flame test.
any two relevant safety precautions

(*ii*) Describe the steps involved in carrying out a flame test.
dip pre-soaked (wet) wooden splint (platinum wire) //
into a sample of salt //
hold over a blue Bunsen flame [ANY TWO]

(*iii*) Name the colour of the flame for KCl.
violet / purple

A sample of sodium chloride (NaCl) was tested in a similar manner.

(*iv*) How could cross-contamination between the two salts be avoided?
use a new wooden splint each time / clean platinum wire with concentrated HCl

(*v*) Name the colour of the flame for NaCl.
Yellow / orange

[12+8+(5×1)]

(*b*) Lead was first added to petrol in the 1920s to improve the efficiency of vehicles and raise the octane number of the fuel.

(*i*) What is meant by the term octane number?
measure (of the tendency) of a fuel to resist knocking

(*ii*) Explain why the use of lead was discontinued.
toxic etc.

(*iii*) Apart from using lead, state one other way of increasing the octane number of a fuel.
isomerisation / catalytic cracking / dehydrocyclization / adding oxygenates

(*iv*) Petrol is one of the fractions separated from crude oil during fractional distillation in an oil refinery. Name two other fractions and state a use for each one.
Fraction // Fraction
Corresponding use // Corresponding use [12+8+(5×1)]

(*c*) The following terms are omitted from the passage below which describes the stages of sewage treatment.

bacteria nitrogen polluted phosphorus
screening settlement oxygen

In your answerbook, write the term corresponding to each of the letters A to G.

Before sewage can be released into rivers, lakes or seas, it is treated in three separate processes. If untreated sewage was released into water, there would be a high demand for dissolved ___A___ and as a result the water would become ___B___. The first process in sewage treatment is called primary treatment. It is a mechanical process, where large solids are removed by ___C___ and suspended solids are removed by ___D___. Secondary treatment is where suspended and dissolved organic material is decomposed by ___E___ that use oxygen from the air. Tertiary treatment involves the removal of compounds of ___F___ and ___G___ from the sewage.

A = oxygen
B = polluted
C = screening
D = settlement
E = bacteria
F = nitrogen / phosphorus
G = nitrogen / phosphorus **[10+10+(5×1)]**

(*d*) Answer part **A** *or* part **B**.

A Choose <u>one</u> of the following chemical industries and answer the questions that follow:

- the manufacture of ammonia from natural gas, water vapour and air
- the manufacture of nitric acid from ammonia
- the manufacture of magnesium oxide from sea water

(*i*) State the chemical formula of a product in the industry you have chosen.
formula **[5]**

(*ii*) State where the manufacturing process happens or used to happen.
location **[5]**

(*iii*) State two reasons why this location was chosen.
e.g. transportation, workforce **[5]**

(*iv*) Explain how waste effluent is managed in the industry you have chosen.
explanation **[5]**

(*v*) Describe how safety is promoted in the industry you have chosen.
explanation **[5]**

or

B The addition polymer poly(chloroethene), also known as polyvinyl chloride or PVC, is widely used to manufacture window frames, drainpipes, credit cards, and many other plastic objects.

(*i*) State one property of PVC that makes it suitable for manufacturing these objects.
e.g. flexibility / waterproof/ light weight **[3]**

Chloroethene monomers react to form the polymer PVC.

(*ii*) What is a monomer?
small molecule (that may undergo polymerisation) **[3]**

(*iii*) What is a polymer?
chain of monomers **[6]**

(*iv*) Name one other addition polymer.
e.g. poly(ethene) **[3]**

(*v*) Outline the importance of recycling plastics.
so that oil is not used to make new plastics / plastic don't degrade **[4]**

(*vi*) Name any two of the five stages involved in the recycling of plastics.
sorting, shredding, washing, drying and re-extrusion [any two] **[6]**