Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2025

Marking Scheme

Physics and 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, i.e. words that must appear in the correct context in the candidate's answer in order to merit the assigned marks.

2. 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.

3. Words, expressions or statements separated by a solidus, /, are alternatives which are equally acceptable. Answers that are separated by a double solidus, //, are 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 <u>alternative valid answers are acceptable</u>.

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. Each time an arithmetical slip occurs in a calculation, one mark is deducted ; this also applies to inappropriate or incorrect rounding of numerical answers.

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

8. 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. Answer eleven parts

(*a*) Calculate the weight of a small dog with a mass of 5 kg. (acceleration due to gravity, g = 9.8 m s^{-2})

5 × 9.8 = 49 (N) **(6)**

[*accept partial answer for 3*]

(*b*) Calculate the work done when a force of 150 N moves an object 3.5 m in the direction of the force.

150 × 3.5 = 525 (J) **(6)**

[*accept partial answer for 3*]

(*c*) The image shows a sign with a speed limit of 30 km/h. State the speed limit in metres per second.

30 × 1000 = 30000 m **(4)**

÷ 3600 = 8.3 (m s^{-1}) **(2)**

(*d*) State Newton's third law of motion.

for every action there is an equal and opposite reaction **(6)**

[*accept partial answer for 3*]

(*e*) State the lower fixed point on the Celsius temperature scale.

0 (°C) **(6)**

[*accept partial answer for 3*]

(*f*) What is meant by a thermometric property?

physical property that changes measurable with temperature **(6)**

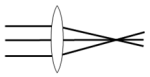
[*accept partial answer for 3*]

(*g*) What is meant by refraction?

bending of light as it travels from one medium to another **(6)**

[*accept partial answer for 3*]

(*h*) The image on the right shows parallel light rays passing through a glass lens. State the name of this type of lens.



convex / converging **(6)**

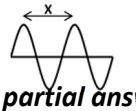
[*accept partial answer for 3*]

(*i*) State one application of total internal reflection.

fibre optics/ mirage etc. **(6)**

[*accept partial answer for 3*]

(*j*) What term is given to the distance marked X on the waveform shown?



wavelength / λ **(6)**

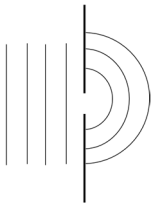
[*accept partial answer for 3*]

(*k*) State one difference between a transverse wave and a longitudinal wave.

direction of vibration perpendicular (parallel) to the direction of motion **(6)**

[*accept partial answer for 3*]

(*l*) Sketch a diagram to show the diffraction of plane waves after passing through a narrow gap.



(6)

[*accept partial answer for 3*]

(*m*) Name any two terminals found inside a three-pin plug.

live//neutral // earth **[*any two*]** **(4+2)**

(*n*) What is the purpose of a transformer?

change the voltage (of alternating current) **(6)**

[*accept partial answer for 3*]

(*o*) State one way to increase the capacitance of a parallel plate capacitor.

increase (common) area / decrease distance (between plates) / increase permittivity of material

(6)

(*p*) Two 16 µF capacitors connected in parallel are shown.
Calculate the effective capacitance of the combined capacitors.

16+16 = 32 (µF) **(6)**

[*accept partial answer for 3*]

(*q*) State what each letter in Einstein's equation $E = mc^2$ stands for.

E = energy

m = mass

c = speed of light **(4+1+1)**

(*r*) State one difference between nuclear *fission* and nuclear *fusion.*

fission: splitting of a large nucleus (to release energy) /

fusion: joining of two smaller nuclei (to release energy) **(6)**

[*accept partial answer for 3*]

2. (*a*) Define

(*i*) velocity

$\frac{s}{t}$ **/ change in displacement per unit time**

(*ii*) acceleration

$\frac{v-u}{t}$ **/ change in velocity per unit time**

(*iii*) What is meant by potential energy?

E_p = mgh

Kinetic energy (K.E.) can be calculated using the equation below:

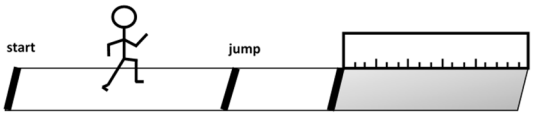
$$\text{K.E.} = \frac{1}{2}mv^2$$

(*iv*) Identify two factors (variables) which change the kinetic energy of a moving object.

mass / *m*

velocity / *v* **(8+8+4+2+2)**

(*b*) The diagram below shows an athlete of mass 68 kg taking part in a long jump. During the run towards the point labelled 'jump' the athlete accelerates from a constant velocity of 6.1 m s^{-1} to 7.3 m s^{-1} in 2.0 seconds.



(*i*) Calculate the average acceleration of the athlete.

7.6 - 6

÷ 2 s = 0.6 ms^{-1}

(*ii*) Calculate the force produced by the athlete during the acceleration.

68 × 0.6

40.8 N

(*iii*) Calculate the change in kinetic energy of the athlete during the acceleration.

KE(final) - KE(initial) / ½(68)(7.3)² - / ½(68)(6.1)²

546.72 J **(8+8+2+2+2+2)**

(*c*) (*i*) Describe an experiment to measure the acceleration due to gravity, *g*. You should include a labelled diagram in your answer.

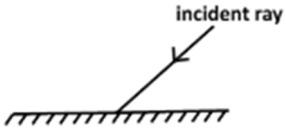
object/ball	**//**	**pendulum bob**		
timer	**//**	**stopwatch**		
measure s	**//**	**measure s**	**[any two]**	**(8+4)**

(*ii*) State one precaution to ensure an accurate result.

avoid parallax error //use accurate timer//smooth sphere etc. **[*any one*]** **(6)**

[*accept partial answer for 3*]

3. (*a*) The diagram shows an incident ray of light striking a plane mirror.



(*i*) What is meant by the underlined term?

(flat surface that) forms an upright image

(*ii*) State the laws of reflection of light.

angle of incidence equals angle of reflection

incident, reflected and normal ray all lie in the same plane

(*iii*) Copy and complete the diagram showing the location of the normal and the path of the reflected ray.

normal at correct location

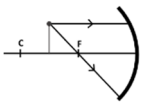
reflected ray (with $\theta_i \approx \theta_r$) **(8+8+4+2+2)**

(*b*) A pin placed in front of a concave mirror at a position between the focus, F, and the centre of curvature, C, forms a magnified image.

(*i*) What is meant by the underlined term?

bigger than object

(*ii*) Copy and complete the diagram to show how the two rays are reflected by the mirror forming an image of the head of the pin.



first reflected ray

second reflected ray

intersection of rays

(*iii*) Is the image formed *real* or *virtual*? State a reason for your answer.

real

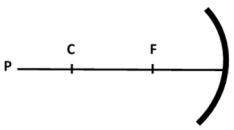
formed by the intersection of rays

(*iv*) Calculate the focal length of the mirror given that its radius of curvature is 15 cm.

$\frac{15}{2}$ = 7.5 (cm)

(8+8+6+2+2+2+2)

(*c*) The location of an object along the principal axis, P, affects the type of image formed. Copy the diagram below into your answerbook.



(*i*) Draw an X on the principal axis to show where the object must be placed to form an image of equal height.

X at C

(*ii*) Draw a Y on the principal axis to show where the object could be placed to form a virtual image.

any location inside F **(10+2)**

4. (*a*) (*i*) Name the Irish scientist who has a gas law named in recognition of his work on the relationship between the pressure and the volume of a gas.

Boyle

(*ii*) State the gas law associated with this work.

for a fixed mass of gas at constant temperature
pressure is inversely proportional
to volume

(*iii*) What term describes the gas which obeys the gas laws at all pressures and temperatures?

Ideal **(8+8+3+3+2)**

(*b*) The following data were recorded during an experiment to investigate the relationship between the pressure and the volume of the gas in an apparatus kept at 0 °C.

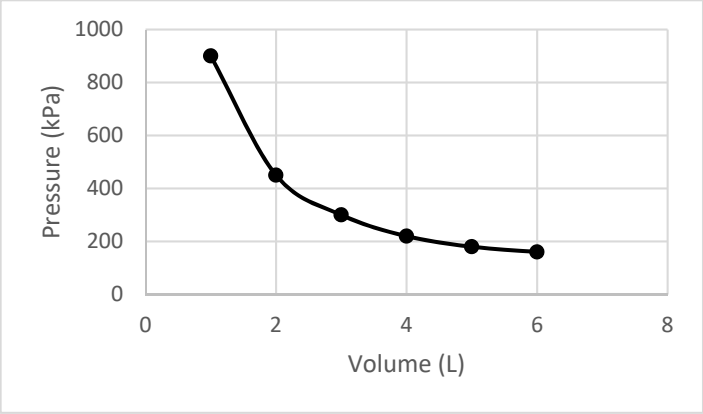
Volume (Litres)	1.0	2.0	3.0	4.0	5.0	6.0
Pressure (kPa)	900	450	300	220	180	160

(*i*) Convert 0 °C to its value on the Kelvin scale.

273.15 **(6)**

(*ii*) Draw a graph, on graph paper, of pressure (y-axis) against volume (x-axis).

label axis **(3)**
six points plotted correctly **(6 × 1)**
line of best fit **(6)**
(*max 9 marks to be awarded if graph paper not used*)



(*iii*) Use your graph to estimate the pressure of this gas when it occupies a volume of 3.5 litres.

value from graph ≈ 260 kPa **(9)**
(*max 3 marks awarded if graph not used*)

(*c*) In 1827 Robert Brown observed that pollen grains suspended in water moved in rapid random motion.

(*i*) State one assumption of the kinetic theory of gases.

molecules small and far apart /in constant random motion /collide with each other and with walls of container / collisions perfectly elastic / not attractive or repulsive forces between molecules **(any one)**

(*ii*) How do Robert Brown's observations provide evidence for the kinetic theory?

large particles moved around by smaller particles **(8+4)**

5. (*a*) The image shows a pair of point charges.

(*i*) Is the force between the charges *attractive* or *repulsive*? State a reason for your answer.

attractive **(3)**

opposite charges **(3)**

(*ii*) Copy the diagram and show the electric field pattern around the charges.

shape

direction **(6 + 3)**

The force between the two-point charges is 0.40 N.

(*iii*) What will happen to the size of the force if the size of both charges is doubled?

increase **(6)**

(*iv*) What will happen to the size of the force if the distance between the charges is doubled?

decrease **(6)**

(*b*) The following terms are used in stating Ohm's law:

potential difference (voltage) constant conductor current

(*i*) Copy and complete the following statement of Ohm's law in your answerbook:

"The . . . . . in a . . . . . is directly proportional to the . . . . . between its ends at a . . . . . temperature."

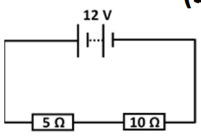
potential difference / current **(3)**

conductor **(3)**

current / potential difference **(3)**

constant **(3)**

The diagram shows a 5 Ω and a 10 Ω resistor in a circuit with a 12 V supply.



(*ii*) What term describes this arrangement of resistors?

series **(3)**

(*iii*) How could the current in the circuit be measured?

ammeter **(3)**

(*iv*) State the SI unit of electrical current.

amp / A **(3)**

(*v*) Calculate the combined resistance of the two resistors.

5 + 10 = 15 Ω **(6)**

[*accept partial answer for 3*]

(*vi*) Calculate the current in the circuit.

$\frac{12}{15}$ **= 0.8 A** **(6)**

[*accept partial answer for 3*]

(*vii*) Calculate the power generated in the circuit.

12 × 0.8 = 9.6 W **(6)**

[*accept partial answer for 3*]

6. Answer any two of the parts (a), (b), (c), (d). Each part carries 33 marks.

(*a*) (*i*) What is meant by momentum?

mass × velocity / mv

(*ii*) State the principle of conservation of momentum.

(in a closed system) the momentum before an interaction = the total momentum after / m1u1 + m2u2 = m1v1 + m2v2

Paint can A of mass 9.0 kg slides towards paint can B of mass 6.0 kg. Both cans are moving in the same direction along a smooth floor. A has an initial velocity of 0.55 m s^{-1} and B has an initial velocity of 0.35 m s^{-1}. The velocity of A after the collision is 0.45 m s^{-1}.

(*iii*) Calculate the momentum of can A before the cans collide.

9.0 × 0.55 = 4.95 kg ms^{-1}

(*iv*) Calculate the momentum of can B before the cans collide.

6.0 × 0.35 = 2.1 kg ms^{-1}

After the cans collide they continue to move in the same direction.

(*v*) Calculate the momentum of can A after the collision.

9.0 × 0.45 = 4.05 kg ms^{-1}

(*vi*) Calculate the velocity, X, of can B after the collision.

4.95 + 2.1 = 4.05 + 6.0u

= 0.5 ms^{-1} **(9+8+8+2+2+2+2)**

(*b*) An air fryer uses the heating effect of an electric current to prepare a range of foods.

(*i*) State two other effects of an electrical current.

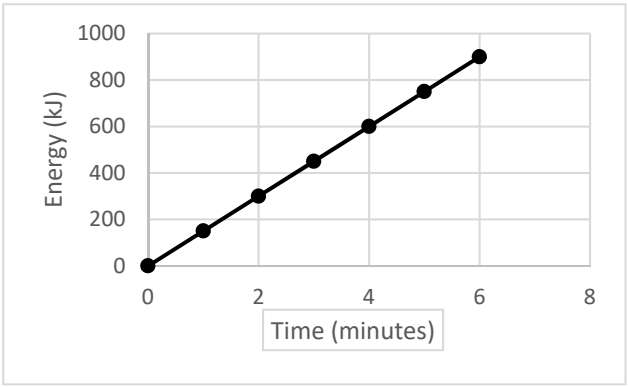
chemical

magnetic **(6+3)**

The table below indicates the electrical energy converted over a six-minute period by an air fryer.

Time (minutes)	0	1	2	3	4	5	6
Energy (kJ)	0	150	300	450	600	750	900

(*ii*) Draw a graph, on graph paper, of energy (y-axis) against time (*x*-axis).



label axis (3)
six points plotted correctly (6)
straight line (3)
(*max 6 marks to be awarded if graph paper not used*)

(*iii*) How many joules of electrical energy are converted during each minute?

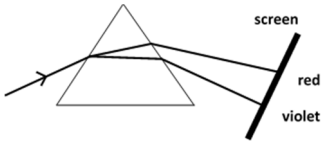
150000 **(6)**

(*iv*) Calculate the power rating (wattage) of this air fryer.

$\frac{150000}{60}$ **= 2500 W** **(6)**

[*accept partial answer for 3*]

(*c*) White light is a small part of the electromagnetic spectrum which can be detected by the human eye. A beam of white light is split into its component colours as it passes through a glass prism.



(*i*) Name the phenomenon that is associated with the separation of white light into its component colours.
dispersion **(6)**

(*ii*) State **one** property common to all parts of the electromagnetic spectrum.
speed/transverse waves/can travel through vacuum **(any one)** **(6)**

(*iii*) State **three** other component colours of white light.
orange// yellow// green//blue//indigo **(any three)** **(3×3)**

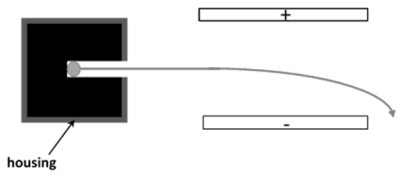
(*iv*) Identify the type of invisible radiation located just beyond the red visible light.
infrared **(6)**

(*v*) What is meant by the frequency of a wave motion?
number of waves passing per second **(3)**

(*vi*) State the unit of frequency.
hertz / s^{-1} **(3)**

(*d*) (*i*) Explain what is meant by radioactivity.
(spontaneous) emission **(3)**
of alpha particles /beta particles /gamma rays/radiation **(3)**
from unstable nuclei **(3)**

The image shows the path of positively charged alpha-particles, emitted by a radioactive substance, as they pass through a pair of oppositely charged plates.



(*ii*) State **two** other properties of alpha-particles.
high ionizing power, low penetrating ability, mass equal to helium nucleus **(2 × 3)**

(*iii*) Suggest a suitable chemical element which could be used for the housing of the radioactive substance.
lead, aluminium, *etc.* **(6)**

(*iv*) Describe the path a beta-particle would take as it passes through the same oppositely charged plates. State a reason for your answer.
bend towards positive plate **(3)**
negatively charged **(3)**

It is observed that gamma radiation passes through the oppositely charged plates undeflected.

(*v*) State a reason for this observation.
no charge / wave **(6)**

7. Any eleven parts

(*a*) What type of atomic orbital is shown on the right?

s **(6)**

[*accept partial answer for 3*]

(*b*) Which element is represented by the electron configuration: $1s^2$, $2s^2$, $2p^6$, $3s^2$?

magnesium/ Mg **(6)**

(*c*) State one property of a neutron.

no charge, mass of ≈1 (amu) **(*any one*)** **(6)**

(*d*) State the name of one of the allotropes of the element carbon.

graphite, diamond, fullerenes **(*any one*)** **(6)**

(*e*) Identify an element with a lower electronegativity value than sodium (Na).
(Refer to *Formulae and Tables* booklet, page 81)

any correct answer **(6)**

(*f*) State an example of a substance that contains hydrogen bonds.

water, ammonia, alcohols, carboxylic acids, DNA etc. **(*any one*)** **(6)**

[*accept partial answer for 3*]

(*g*) Select the two transition metals from the following list of elements:

~~aluminium~~ ~~boron~~ **chromium** ~~sulfur~~ **iron**

(4 + 2)

(*h*) How many molecules of oxygen are in 0.25 moles of oxygen gas (O_2)?
(Avogadro's constant = 6.0×10^{23} mol^{-1})

$0.25 \times 6.0 \times 10^{23} = 1.5 \times 10^{23}$ **(6)**

[*accept partial answer for 3*]

(*i*) Copy, complete and balance the following equation:

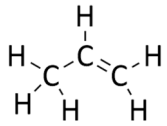
$Na + H_2O \rightarrow \frac{1}{2} H_2$ **+ NaOH** **(3+3)**

(*j*) What is meant by an amphoteric substance?

can behave as both an acid and a base **(6)**

[*accept partial answer for 3*]

(*k*) Draw the structural formula of C_3H_6 (propene).



(6)

[*accept partial answer for 3*]

(*l*) Calculate the pH of 0.1 M solution of nitric acid (HNO_3).

$-\log_{10}(0.1) = 1$ **(6)**

[*accept partial answer for 3*]

(*m*) State the chemical formula of copper(I) oxide.

Cu_2O **(6)**

[*accept partial answer for 3*]

(*n*) Calculate the percentage of hydrogen by mass in benzene (C_6H_6). (H = 1; C = 12)

Mr = 78

$\frac{6}{78}$ × 100 ≈ 7.7% **(4+2)**

(*o*) State Hess's law.

heat change for a reaction depends only on initial and final states **(6)**

[*accept partial answer for 3*]

(*p*) State one use for ethanoic (acetic) acid.

food flavouring/ food preservation/making esters **(6)**

[*accept partial answer for 3*]

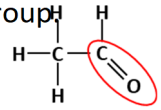
(*q*) Which alcohol can undergo dehydration to form ethene (C_2H_4)?

ethanol, C_2H_5OH **(6)**

[*accept partial answer for 3*]

(*r*) Copy the structural formula of ethanal (acetaldehyde) and circle the exact location of the carbonyl group

(6)



[*accept partial answer for 3*]

8. (*a*) What is meant by

(*i*) the atomic number and

number of protons in an atom

(*ii*) the mass number of an atom of an element

number protons and neutrons in nucleus **(8+4)**

(*b*) Pages 79 – 81 of the *Formulae and Tables* booklet may help answer the following questions. Bromine (Br) is located in group 17 of the Periodic Table of the Elements. Bromine reacts with sodium (Na) to form the compound sodium bromide (NaBr).

(*i*) State the group number of sodium.

1

(*ii*) What type of chemical bond is present in sodium bromide?

ionic

(*iii*) State **two** properties of compounds with this type of chemical bond.

crystalline solid/conduct electricity in molten (aqueous) state/high melting point/ high boiling point **[*any two*]**

(*iv*) State a reason why bromine does not form compounds with elements in group 18.

group 18 have full outer sublevel **(8+8+4+2+2)**

(*c*) Bromine is a volatile coloured liquid which exists as molecules at room temperature. Bromine (Br) atoms occur in two natural forms: $^{79}_{35}\mathrm{Br}$ and $^{81}_{35}\mathrm{Br}$.

(*i*) What is a molecule?

two or more atoms held together by chemical bonds **(6)**

(*ii*) Which **two** sub-atomic particles are identical in number in both forms of the bromine atoms?

protons

electrons **(8+4)**

Analysis of a sample of bromine atoms concluded that 50.7% of the atoms were $^{79}_{35}\mathrm{Br}$ and the rest were $^{81}_{35}\mathrm{Br}$.

(*iii*) Calculate the percentage of $^{81}_{35}\mathbf{Br}$ present in the sample.

49.3 % **(6)**

(*iv*) Calculate the relative atomic mass of bromine.

$\frac{(79 \times 50.7)+(81 \times 49.3)}{100}$ = **79.986** **(6)**

9. (*a*) (*i*) What is meant by a Brønsted-Lowry acid?

proton (H^+) donor

(*ii*) Identify the two acids in the following equation: $HF + H_2SO_4 \rightleftharpoons H_2F^+ + HSO_4^-$

H_2SO_4

H_2F^+

(*iii*) What is meant by an acid-base conjugate pair?

two species that differ by a single proton (H^+)

(*iv*) According to the above equation which substance along with H_2SO_4 would form a conjugate pair?

HSO_4^-

(*v*) What term describes an acid which fully dissociates in water?

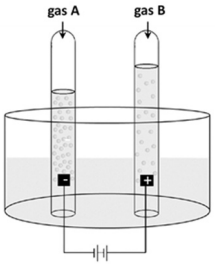
strong **(8+8+2+2+2+2)**

(*b*) Both oxidation and reduction occur during the process of the electrolysis of acidified water.

(*i*) Explain reduction in terms of electron transfer.

gain of electrons **(6)**

The image shows an apparatus that can be used to carry out electrolysis of acidified water using inert electrodes.



(*ii*) Suggest a suitable material for use as the inert electrodes.

graphite/platinum/ gold etc. **(*any one*)** **(6)**

(*iii*) Identify the electrolyte used during this process.

(acidified) water **(6)**

(*iv*) Name gas A and gas B.

A = hydrogen / H_2 **(6)**

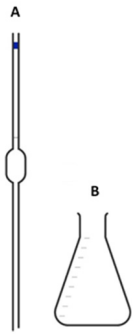
B = oxygen / O_2 **(6)**

(*v*) Describe a test to identify gas A.

hold lit splint to test tube of gas **(6)**

burns with a pop **(6)**

10. Exactly 25.0 cm^3 of a solution of potassium hydroxide (KOH) was delivered by A into B in preparation for a titration.



(*a*) (*i*) Identify the pieces of glassware labelled A and B.
A = pipette
B = (conical) flask

(*ii*) How was A prepared for use?
rinsed with (deionised) water/
rinsed with solution (KOH) **[any one]**

(*iii*) Name the piece of laboratory apparatus used to fill A.
pipette filler **(9+2+2+2)**

(*b*) A burette was prepared and filled with a solution of hydrochloric acid (HCl).

(*i*) State one safety precaution that should be taken when filling a burette.
use a funnel/ safety goggles / gloves, etc.

(*ii*) State one precaution to ensure an accurate reading is taken from the burette.
meniscus at eyelevel/clamp vertically/remove funnel

A white tile was placed under B and a few drops of another solution Z added.

(*iii*) What was the purpose of the white tile?
see endpoint more clearly / reduce error

(*iv*) What type of solution is Z?
indicator

(*v*) State the purpose of Z.
identify endpoint **(9+9+2+2+2)**

(*c*) The equation for the reaction between hydrochloric acid (HCl) and potassium hydroxide (KOH) is: $HCl + KOH \rightarrow KCl + H_2O$
A student recorded the following data from the burette containing the acid, HCl.

Volume of HCl in burette	Titration 1	Titration 2
at start	0.0 cm^3	19.7 cm^3
at end	19.7 cm^3	39.1 cm^3

(*i*) Explain why the results of Titration 2 would be more accurate than the results of Titration 1.
rough titration / know when to expect endpoint **(6)**

(*ii*) What volume of acid was used during Titration 2?
39.1 – 19.7 = 19.4 cm^3 **(6)**

The volume of 0.18 M hydrochloric acid used in Titration 2 neutralised 25 cm^3 of the potassium hydroxide solution.

(*iii*) Calculate the concentration of the potassium hydroxide solution.

$\frac{19.4 \times M}{1}$ **(3)**

$\frac{25 \times 0.18}{1}$ **(3)**

0.23 M [award 4 marks for formula if not other marks awarded] **(3)**

(*iv*) Name a technique that can be used to separate the salt, KCl, from the water.

evaporation / distillation **(6)**

[*accept partial answer for 3*]

11. (*a*) Natural gas consists of a mixture of component hydrocarbon gases including methane, ethane, propane and butane which are all alkanes.

(*i*) Explain the underlined terms.

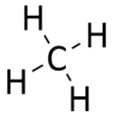
substance consisting of hydrogen and carbon only **(6)**

hydrocarbons with C—C single bonds only **(6)**

(*ii*) Name the component with one carbon atom.

methane **(3)**

(*iii*) Draw the structural formula of the component named in (*ii*).



(3)

(*iv*) How many extra hydrogen atoms are found in a molecule of butane when compared to a molecule of propane?

two **(3)**

(*b*) (*i*) What is meant by the term unsaturated?

contains at least one carbon – carbon double (triple) bond **(6)**

[*accept partial answer for 3*]

(*ii*) Name an unsaturated hydrocarbon with two carbon atoms.

ethene **(6)**

(*iii*) Describe how you would test a hydrocarbon for unsaturation.

bubble (shake) gas through **(3)**

bromine water (acidified potassium manganate (VII)) **(3)**

solution decolourises **(3)**

(*c*) The heat of formation of carbon dioxide is represented by the following equation:

$$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)} \qquad \Delta H = -393 \text{ kJ mol}^{-1}$$

(*i*) What is meant by the heat of formation?

amount of heat absorbed or released when one mole of a compound is formed from its elements in its standard states **(6)**

(*ii*) Is this reaction *exothermic* or *endothermic*? State a reason for your answer.

exothermic **(6)**

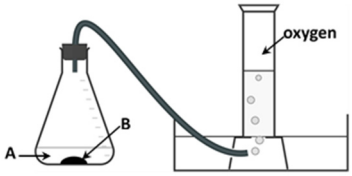
Δ*H* is negative **(6)**

(*iii*) Calculate the heat change involved when 15 moles of carbon dioxide are formed.

–393 × 15 = – 5895 kJ **(6)**

12. Answer any two of parts (a), (b), (c). Each part carries 33 marks.

(a) The diagram below shows a set up for the preparation and collection of oxygen (O_2) gas by the decomposition of liquid A in the presence of a solid catalyst B.



(i) Identify A and B.
A = hydrogen peroxide
B = manganese dioxide

(ii) Explain the role of a catalyst in a chemical reaction.
speeds up a chemical reaction

(iii) Describe a test to verify that the gas collected is oxygen.
light a splint until its glowing with no flame
hold over test tube of gas
glowing splint relights

(iv) State one use for oxygen gas.
respiration/ combustion etc. **(9+8+8+2+2+2+2)**

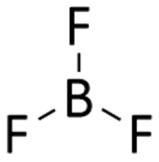
(*b*) Consider the following descriptions of quantities in various areas in chemistry:

(*i*) In your answerbook match each term to its description (A, B, C, etc.) in the table.

Letter	Description	
A	number of electrons in a single neutral atom of hydrogen	**one**
B	total number of electrons in a $1s^2$, $2s^2$, $2p^3$ configuration	**seven**
C	number of electrons present in the triple bond in ethyne (C_2H_2)	**six**
D	number of lone pairs of electrons on the central atom of a BF_3 molecule	**zero**
E	total number of hydrogen atoms around carbon in methane	**four**
F	total number of types of sub-atomic particles in an atom of helium (He)	**three**
G	number of electrons present in a molecule of hydrogen (H_2)	**two**

(6+5+2+2+2+2+2)

(*ii*) Sketch a diagram showing the arrangement of atoms in one molecule of BF_3.



(6)

(*iii*) State the bond angle in BF_3.

120° **(6)**

(*c*) (*i*) What is meant by s.t.p.?

standard temperature and pressure **(6)**

Concrete blocks are formed from the reaction between cement and other natural materials.

During the manufacture of cement, calcium carbonate ($CaCO_3$) decomposes, when heated, to produce calcium oxide (CaO) according to the equation:

$$CaCO_3 \rightarrow CaO + CO_2$$

(C = 12, O = 16, Ca = 40, volume at s.t.p. = 22.4 litres)

(*ii*) Calculate the mass of one mole of $CaCO_3$.

40 + 12 + (3 × 16) = 100 **(6)**

(*iii*) How many moles of $CaCO_3$ are present in 500 g?

$\frac{500}{100}$ **= 5 (moles)** **(6)**

(*iv*) Calculate the mass of CaO produced when 500 g of $CaCO_3$ decomposes.

40 + 16 = 56 **(6)**

56 × 5 = 280 g **(3)**

(*v*) What volume of CO_2 is produced at s.t.p. when 500 g of $CaCO_3$ decompose?

5 × 22.4 = 112 L **(6)**