CoimisiúnnaScrúduitheStáit
StateExaminationsCommission

Leaving Certificate 2024

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.

General Guidelines
In considering this marking scheme 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. Words, expressions or statements separated by a solidus, /, are alternatives which are equally acceptable.

3. 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 alternative valid answers are acceptable. Marks for a description may be obtained from a relevant diagram, depending on the context.

5. Where indicated, 1 mark is deducted for incorrect/no units.

6. Each time an arithmetical slip occurs in a calculation, one mark is deducted.

7. Cancellation may apply when a candidate gives a list of correct and incorrect answers.

8. The context and the manner in which the question is asked and the number of marks assigned to the answer in the examination paper determines the detail required in any question. Therefore, in any instance, it may vary from year to year.

9. 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 less than 75% of the total marks. In calculating the bonus to be applied decimals are always rounded down. The bonus table given on the next page applies to candidates who answer entirely through Irish and who obtained more than 75% of the total 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** of the following items.

(*a*) What is the SI unit of energy?
J / Nm **[6]**

[accept partial answer for 4]

(*b*) How long does it take a train, moving at a constant speed of 90 km/h, to travel40 km?
0.44 (hour) / 26.7(mins) **[6]**

[accept partial answer for 4]

(*c*) State one of Newton's laws of motion.
one law **[6]**

[accept F=ma]

[accept partial answer for 4]

(*d*) A loudspeaker produces sound waves with a frequency of 500 Hz.
How many sound waves pass a point in 3 seconds?
1500 **[6]**

[accept partial answer for 4]

(*e*) Pure zinc metal melts at 420 °C. What is this temperature on the absolute Kelvin scale?
693 (K) **[6]**

[accept partial answer for 4]

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

(large number of) particles or molecules / rapid motion / random motion / straight line motion / collisions occur (between particles or molecules) / collisions occur with walls of container / collisions elastic or involve neither loss nor gain of energy / negligible volume occupied by particles or molecules / negligible duration of collisions / no forces (between particles except during collisions), etc.

any one [6]

[accept partial answer for 4]

(*g*) State Charles' law of gases.
The volume (of a fixed mass of gas) is proportional to (the absolute) temperature at constant pressure / $V \propto T$ **[6]**

[accept partial answer for 4]

(*h*) State one use for a convex mirror.

Rear view mirror / security / sunglasses /reflector / etc **any one use[6]**

[accept partial answer for 4]

(*i*) What is the focal length of a concave mirror with a radius of curvature of 25 cm?
12.5(cm) **[6]**

[accept partial answer for 4]

(*j*) State a law of the reflection of light.
Incident (ray), reflected (ray) and normal (ray) are all on the same plane / Angle of incidence equals the angle of reflection **[6]**

[refraction instead of reflection (-1)]

[accept partial answer for 4]

(k) **Figure 1** shows an isolated negatively-charged conductor.
Copy the diagram and sketch the electric field pattern around it.
radial lines, arrows towards the conductor **[4 + 2]**

[incorrect direction …(-1)]

[accept partial answer for 4]

(*l*) What is the effective resistance of *two* 50 Ω resistors connected in series?
100 (Ω) **[6]**

[accept partial answer for 4]

(*m*) **Figure 2** shows a three-pin plug which contains a removable fuse.
Which effect of an electrical current may require the replacement of the fuse?
heating **[6]**

[accept partial answer for 4]

(*n*) List **two** items needed to make an electromagnet.
coil of wire, metal (iron core), source of EMF **any 2[4 + 2]**

(*o*) An inductive mat can be used to charge smart phones wirelessly.
State one law of electromagnetic induction.

The size of the induced EMF is directly proportional to the rate of change of flux / direction of the induced current is always such as to oppose the change producing it / E = $\frac{-d\emptyset}{dt}$ **Any one law[6]**

[accept partial answer for 4]

(*p*) Copy the diagram in **Figure 3** and sketch the magnetic field pattern produced by a straight current carrying conductor.

shape, direction indicated **[4 + 2]**

[incorrect direction…(-1)]

[accept partial answer for 4]

(*q*) Identify one method of detecting nuclear radiation.

Geiger Muller tube / Solid State Detector / Ionisation Chamber / radon Detector /photographic film/electroscope / scintillations..etc

Any one method **[6]**

[accept partial answer for 4]

(*r*) Name **two** types of nuclear reaction.

fission, fusion **[4 + 2]**

[accept partial answer for 4]

2. (*a*)(i) State the principle of conservation of energy.
energy cannot be created or destroyed but can be converted from one form to another

Define (ii) work
force × distance /Fxs
(iii) potential energy.
mass×acceleration due to gravity×height /mgh /energy stored (in an object due to its position **[9+6+3]**
[accept partial answer for 4]

(*b*)Ten-pin bowling was a competitive event at the Special Olympics held in Berlin during June 2023. **Figure 4** shows a bowling ball used in such events.

(i) Calculate the weight of a bowling ball of mass 6.1 kg.
weight = (6.1)(9.8) = 59.8 N **[4+2]**
[no unit or incorrect unit (-1)] **[accept partial answer for 4]**

(ii) What type of energy has the bowling ball gained when it is lifted from the ground to a height of 85 cm?
potential energy **[3]**

(iii) Calculate the work done on the bowling ball when it has been lifted from the ground to a height of 85 cm.
work done = (59.8)(9.8)(0.85) = 50.8 J **[4+2]**
[no unit or incorrect unit (-1)] **[accept partial answer for 4]**

(iv) Sketch a diagram showing the forces acting on the bowling ball when it is held at this height.
arrow up, equal arrow down **[4 + 2]**
[accept partial answer for 4]

(v) State **two** factors which affect the kinetic energy of a moving bowling ball.
mass, speed **[4 + 2]**
[accept partial answer for 4]

(*c*)(i) Copy and complete the statement of *Newton's law of gravitation*:

"The force of attraction between two bodies is proportional to the **product** of their masses and inversely proportional to the **square** of the **distance** between them."

[6+2+1]

The acceleration due to gravity, *g*, on the surface of the moon is given by the equation:

$$g = \frac{GM}{r^2}$$

(ii) What do the symbols *G* and *M* stand for?

G = gravitational constant, M = mass **[4 + 2]**

[accept partial answer for 4]

(iii) Compare the vertical motion due to gravity of a feather and a bowling ball when dropped from the same height above the surface of the moon.

both fall at the same rate **[6]**

[accept partial answer for 4]

3. (*a*) **Figure 5** shows a ray of light emerging from a block of glass.

(i) Copy **Figure 5** and label *r*, the angle of refraction.
identify angle of refraction **[6]**
[accept partial answer for 4]

(ii) State one of the laws of refraction.
Incident (ray),refracted (ray) and normal (ray) are all on the same plane / the sin of the angle of incidence is proportional to the sine of the angle of refraction /sin i∞ sin r

any one law[6]
[reflection instead of refraction..(-1)]
[accept partial answer for 4]

(iii) Describe how to show the path of a light ray through a glass block**.**
pins **// ray box**
lined up **// ray shone through block** **[4+2]**
[accept partial answer for 4]

(iv) What would you use to measure the angle of refraction?
protractor **[6]**
[accept partial answer for 4]

(*b*) **Figure 6** shows the path of another light ray in the glass block.

(i) What name is given to the angle labelled **X** in this case?
critical angle **[6]**
[accept partial answer for 4]

(ii) State the value of the angle of refraction in **Figure 6**.
90° **[3]**

(iii) Describe, with the aid of a diagram, the path of the light ray when angle **X** is increased.
incident ray
reflected ray showing total internal reflection **[6+3]**
[accept partial answer for 4]

(*c*) **Figure 7** shows parallel rays of light approaching a glass lens.

(i) Copy and complete the diagram showing the path of the rays after they pass through the lens.
converging rays shown **[6]**
[accept partial answer for 4]

(ii) State the name of this type of lens.
converging / convex **[3]**

(iii) State **two** uses of lenses.
two uses **[6+3]**
[accept partial answer for 4]

(iv) What is the name given to the type of image that can be formed on a screen?
real **[6]**
[accept partial answer for 4]

4. (*a*) **Figure 8** shows a thermistor which uses the thermometric property of electrical resistance.

(i) Explain the underlined term.

a property of a material that changes measurably with temperature [6]

[accept partial answer for 4]

(ii) State one other example of a thermometric property.

any other example of a thermometric property [4]

[accept partial answer for 2]

(iii) Identify the **two** fixed points used to establish the Celsius scale.

0 (°C) / freezing point of water

100(°C) / boiling point of water [6+2]

[accept partial answer for 4]

(*b*) An experiment was carried out to investigate the effect of temperature on the resistance of a thermistor.

The following data were recorded using a digital multimeter.

Temperature (°C)	0	10	20	30	40	50	60
Resistance (kΩ)	100	60	37	24	15	10	7

(i) Draw a graph on graph paper of resistance (*y*-axis) against temperature (*x*-axis).

labelled axes [3]

six points plotted [6]

smooth curve [6]

(ii) Use your graph to estimate the temperature when the resistance is 50 kΩ.

14(°C) [6]

[accept partial answer for 4]

(*c*) The following terms are used in stating Boyle's law of gases:

temperature pressure mass volume inversely

(i) Copy and complete the following statement of Boyle's law in your answer book:

"The **volume** of a fixed **mass** of gas is **inversely** proportional to the **pressure** at constant **temperature**." **[6+2+2+2+2]**

Figure 9 shows a sealed syringe containing 20 cm^3 of gas.

(ii) Use Boyle's law to predict the volume of the gas, when the pressure applied to the syringe is doubled, if it remains at room temperature.
10(cm^3) **[6]**

[accept partial answer for 4]

(iii) What term is given to the gas which obeys the gas laws over all conditions?
ideal gas **[7]**
[accept partial answer for 4]

5. (*a*)(i) State Ohm's law.

current is proportional to voltage / voltage = current × resistance **[6]**

[constant temperature omitted ..(-1)]

[accept partial answer for 4]

In a circuit, a voltage was applied across a resistor and the current through it was measured.

The following data were collected:

Voltage (V)	0	2.0	4.0	6.0	8.0	10.0	12.0
Current (A)	0	0.15	0.30	0.45	0.60	0.75	0.90

(ii) Draw a graph on graph paper of current (*y*-axis) against voltage (*x*-axis).

labelled axes **[3]**

axes Scaled correctly **[3]**

Any six points plotted correctly **[6]**

line of best fit through the origin **[3]**

[each point plotted incorrectly ...(-1)]

[allow 9 max if graph paper not used]

(iii) How does the graph show that the resistor verified Ohm's law?

straight line through origin **[6]**

[accept partial answer for 4]

(iv) Use your graph to estimate the voltage across the resistor when the current is 0.55 A.

7.33(V) **[6]**

[accept partial answer for 4]

(*b*)(i) Define capacitance.

ratio of charge to its voltage / $\frac{\text{charge}}{\text{voltage}}$ / $\frac{Q}{V}$

[6]

[accept partial answer for 4]

Figure 10 shows the electric field between the plates of a parallel-plate capacitor when connected to a d.c. power supply unit (PSU).

(ii) A battery can be used in place of the PSU to give the same result. Explain why.

it provides d.c. **[6]**

[accept partial answer for 4]

(iii) Identify which plate is positively charged.

plate A **[6]**

(iv) Why is an a.c. power supply necessary to ensure that the lamp remains lit?

capacitor allows alternating current to flow **[6]**

[accept partial answer for 4]

Figure 11 shows two arrangements of capacitors.

(v) Which arrangement shows the capacitors connected in series?
arrangement B **[6]**

(vi) Which arrangement has an effective capacitance of 1 μF?
arrangement A **[3]**

6. (*a*) **Figure 12** shows two balls each of mass 165 g used in a game of pool.

During a game, ball **A** moving at a velocity of 0.85 m s^{-1} moves toward ball **B** which is at rest. After the collision both balls move in the same direction with ball **A** now moving at 0.56 m s^{-1}.

(i) State the principle of conservation of momentum.

(in a closed system) momentum before equals momentum after / (in a closed system)
$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ or $(m_1 + m_2)v$

[6]
[accept partial answer for 4]

(ii) State the SI unit of mass.
kilogram / kg **[6]**
[accept partial answer for 4]

(iii) Calculate

(*a*) the momentum of ball **A** *before* the collision,
0.140 (kg m s^{-1}) **[6]**
[accept partial answer for 4]

(*b*) the momentum of ball **B** *before* the collision,
0 (kg m s^{-1}) **[6]**
[accept partial answer for 4]

(*c*) the momentum of ball **A** *after* the collision,
0.092(kg m s^{-1}) **[3]**
[accept partial answer for 2]

(*d*) the velocity of ball **B** *after* the collision.
0.29(m s^{-1}) **[6]**

[accept partial answer for 4]

(*b*)**Figure 13** shows a wavefront of monochromatic light approaching a single narrow slit.

(i) What is meant by the underlined term?
one wavelength / one colour **[6]**
[accept partial answer for 4]

(ii) Identify a source of monochromatic light.
laser / sodium vapour lamp / etc

Any one source **[6]**
[accept partial answer for 4]

(iii) Copy the diagram and show the path of the wavefront after it passes through the narrow slit.
waves spreading out **[6]**
[accept partial answer for 4]

Figure 14 shows the pattern formed if the single slit is replaced by a pair of narrow slits.

(iv) Which **two** wave phenomena occur in the formation of this pattern?
diffraction, interference **[6 + 3]**
[accept partial answer for 4]

(v) What is observed if white light passes through this pair of narrow slits?
spectra / white at the centre **[6]**

[accept partial answer for 4]

(*c*) **Figure 15** shows a set-up to demonstrate the photoelectric effect.

(i) Match the following terms with the appropriate labels in your answerbook.

ultraviolet light	Electromagnetic radiation with greater energy than visible light
electroscope	A device used to detect the presence of electrical charge
gold	A suitable metal used for the leaves
zinc	A metal which requires preparation and then is placed on the cap
electron	The sub-atomic particle emitted

[6+6+2+2+2]

(ii) How should the metal be prepared before it is placed on the cap?
cleaned **[6]**
[accept partial answer for 4]

(iii) State the overall type of charge that should be present on the leaves before switching on the lamp.
negative **[6]**
[accept partial answer for 4]

(iv) What will be observed during a successful demonstration of the photoelectric effect?
leaves collapse **[3]**

[Leaves move .(-1)]

(*d*)Beta emission occurs during the radioactive decay of tritium. Tritium is a naturally occurring unstable isotope of hydrogen.

(i) Which sub-atomic particle can be added to an atom to form an isotope?
neutron **[6]**
[accept partial answer for 4]

(ii) Which sub-atomic particle is emitted in beta emission?
electron **[6]**
[accept partial answer for 4]

Tritium has a half-life of 12.3 years.

(iii) What is meant by the underlined term?
time taken for half of the nuclei in a sample to decay **[6]**
[accept partial answer for 4]

(iv) How many half-lives have passed after 24.6 years?
two half-lives **[6]**
[accept partial answer for 4]

(v) What fraction of tritium remains in a given sample after 24.6 years?
quarter **[3]**

(vi) State one precaution taken when working with radioactive isotopes.
one precaution **[6]**
[accept partial answer for 4]

7. (*a*) Explain what is meant by the atomic number of an atom of an element.
number of protons in the nucleus **[6]**

[accept partial answer for 4]

(*b*) What is the maximum number of electrons in a *p*-orbital?
two **[6]**
[accept partial answer for 4]

(*c*) Select **two** alkali metals from the following list:
potassium, lithium **[4+2]**

(*d*) What is the difference between an atom and an ion?
atom is neutral / ion has a charge **[6]**
[accept partial answer for 4]

(*e*) State one characteristic of metallic bonding.

delocalized electrons / malleability / ductility / lustre,/high thermal conductivity ..etc..
Any one characteristic **[6]**
[accept partial answer for 4]

(*f*) Define the *electronegativity* of an atom of an element.
measure of attraction for shared pair of) electrons in a covalent bond **[6]**
[accept partial answer for 4]

(*g*) Name a substance containing *hydrogen bonding*.
Water / Ammonia / Hydrogen Fluoride

Any one substance[6]
[accept partial answer for 4]

(*h*) Calculate the percentage by mass of oxygen in beryllium oxide (**BeO**).
64% **[6]**
[accept partial answer for 4]

(*i*) The modelling balloon shown in **Figure 17** was inflated with 0.033 mol of nitrogen gas.
How many molecules of nitrogen does it contain?
1.98×10^{22} molecules **[6]**
[accept partial answer for 4]

(*j*) What is the purpose of a catalyst in the decomposition of hydrogen peroxide?
increases the rate of reaction **[6]**
[accept partial answer for 4]

(*k*) State Hess's law.
heat change for a reaction
independent of path followed / depends only on initial and final states **[6]**

[evolved instead of change ...(-1)]

[accept partial answer for 4]

(*l*) Copy and complete the following reaction between a metal and an acid:
$Zn + H_2SO_4 \rightarrow$ _____ +_____

$ZnSO_4$,H_2 **[6]**
[accept partial answer for 4]

(*m*) Calculate the pH of 0.045 M solution of nitric acid (**HNO_3**).
1.3 **[6]**
[accept partial answer for 4]

(*n*) Name **two** gases formed during the electrolysis of water.
hydrogen, oxygen **[4+2]**
[accept partial answer for 4]

(*o*) Name a chemical used to test for unsaturation of a hydrocarbon.
bromine test / acidified potassium permanganate

Any one test **[6]**
[accept partial answer for 4]

(*p*) How many electrons are present in the triple bond between the two carbon atoms in ethyne (**C_2H_2**)?
six **[6]**
[accept partial answer for 4]

(*q*) State the name of the molecule represented by the structural formula in **Figure 18.**
ethanol **[6]**
[accept partial answer for 4]

(*r*) State a property of an ester.

Polar/soluble in water/flammable etc **any one property[6]**
[accept partial answer for 4]

8. Refer to page 79 of the *Formulae and Tables* booklet when answering this question.

(*a*)Hydrogen and helium have the same period number, but different group numbers on the periodic table of the elements. At room temperature, hydrogen gas exists as molecules and helium gas exists as atoms.

(i) Define the underlined terms.
element: composed of only one type of atom
molecule: smallest part of a compound / group of *two or more atoms bonded together*
atom: smallest part of an element **[9+6+3]**

(ii) What are the group numbers of hydrogen *and* helium?
1 and 18/8/0 **[4+2]**

Electrons in the lowest energy state of hydrogen and helium occupy the 1s orbital.

(iii) Sketch an s-orbital.
orbital shape **[6]**
[accept partial answer for 4]

(iv) State the electron configuration of helium.
$1s^2$ **[6]**
[accept partial answer for 4]

(*b*)**Figure 19** represents the type of bonding present in a molecule of hydrogen.

(i) What type of bonding is shown in **Figure 19**?
(pure) covalent bonding **[6]**
[accept partial answer for 4]

(ii) State **two** properties of this type of bonding.
low melting point/ low boiling point / low solubility (in water)..etc
[4+2]
[accept partial answer for 4]

(iii) State one use for hydrogen gas.
fuel / production of ammonia ..etc
Any one use **[6]**
[accept partial answer for 4]

(iv) Explain why helium does not combine with other atoms.
outermost shell is full / Helium is stable **[6]**
[allow full energy level ...(6)]
[accept partial answer for 4]

(v) State one use for helium gas.
balloons / air bags / production of semi conductor chips ..etc **any one use[6]**
[accept partial answer for 4]

9. (*a*) Both reduction and oxidation occur during a redox reaction.

(i) Explain the underlined word in terms of the movement of electrons.
loss of electrons **[6]**
[accept partial answer for 4]

(ii) Which substance is oxidised in the following reaction?
Mg **[6]**
[accept partial answer for 4]

(iii) Copy and complete the equation for the following redox reaction:
Cu, H_2O **[6 + 6]**
[accept partial answer for 4]

(iv) Identify the *oxidising agent* in the redox reaction from **part (iii)**.
Cu / CuO **[6]**
[accept partial answer for 4]

(*b*) (i) What is a *base* according to the Brønsted-Lowry theory?
proton acceptor **[6]**
[accept partial answer for 4]

(ii) Identify the **two** bases in the following reaction:
OH^-, NH_3 **[6 + 6]**
[accept partial answer for 4]

(iii) State one example of an acid-base conjugate pair in this reaction.
NH_3&NH_4^+ or OH^-&H_2O **[6]**
[accept partial answer for 4]

(iv) What term is used to describe bases which do *not* fully dissociate?
weak **[6]**
[accept partial answer for 4]

(v) A base which dissolves in water will form an alkaline solution.
State a typical pH value for such a solution.
between 7 and 14 **[6]**
[accept partial answer for 4]

10. A titration involves the accurate measurement of the volumes of two solutions.

One of these solutions must be previously standardised.

(i) Explain what is meant by a standardised solution.
(a solution with) a known concentration **[6]**
[accept partial answer for 4]

In preparation for a titration 20.0 cm^3 of a solution of sodium hydroxide (**NaOH**) was accurately measured and transferred into a conical flask.

(ii) Describe the correct procedure for rinsing, filling and emptying a pipette.
rinse with deionised or distilled water /rinse with sodium hydroxide or solution it will contain //fill (until bottom of meniscus is on graduation mark)with a pipette filler //

allow to drain under gravity /tip the pipette tip gently against wall of conical flask to dislodge any drop clinging to outside **[6+2+1]**

(iii) Explain why a conical flask is used when reacting the solutions.
to avoid splashing / easier to swirl (without spilling) **[6]**
[accept partial answer for 4]

Before the start of the titration the piece of glassware in **Figure20** was filled with0.12 M hydrochloric acid (**HCl**).

(iv) Name the piece of glassware in **Figure 20**.
burette **[6]**
[accept partial answer for 4]

(v) State one precaution when preparing the piece of glassware for use in the titration.

Rinse with deionised water/ rinse with HCl / fill using a funnel/ fill part below the tap.. etc one precaution **[6]**
[accept partial answer for 4]

The titration was completed when 17.8 cm^3 of 0.12 M hydrochloric acid reacted with 20.0 cm^3 of the sodium hydroxide solution.

(vi) What additional substance was needed to show the end point?
indicator **[6]**
[accept partial answer for 4]

(vii) Copy and complete the equation below:

NaCl **[6]**
[accept partial answer for 4]

(viii) Calculate the concentration of the sodium hydroxide solution.
0.1188 M

$\frac{M_1V_1}{n_1} = \frac{M_2V_2}{n_2}$ **[3]**

$\frac{17.8x0.12}{1} = \frac{20xM_2}{1}$ **[3]**

***M_2*= 0.107 moles per litre** **[3]**

Or

Moles HClin17.8cm^3 of 0.12M **HCl = (17.8x0.12 /1000) = 2.136 x10^{-3}** **[3]**

Moles NaOH in 20 cm^3 = 2.136 x10^{-3} **[3]**

Moles NH_4OH in 1L = 0.107 **[3]**

(ix) State **two** safety precautions taken when carrying out a titration.
two precautions **[6 + 6]**

[accept partial answer for 4]

11.(*a*)**Figure 21** shows an outdoor barbeque grill which uses butane (C_4H_{10}) as a fuel to cook various foods.

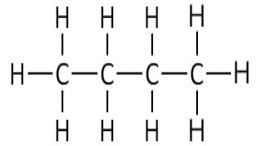
Butane is an aliphatic compound.

(i) Explain the underlined term.

carbon atoms are in (branched, straight or closed) chains / does not contain a benzene ring [6]

[accept partial answer for 4]

(ii) Sketch the structural formula of a molecule of butane.



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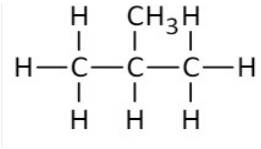

structural formula shown [6]

[accept partial answer for 4]

(iii) State another use of butane gas.

(fuel for) cigarette lighters/(fuel for)heating / (a propellant in)aerosols, a refrigerant

Any one other use [6]

[accept partial answer for 4]

(iv) In organic chemistry, what is meant by a homologous series?

compounds with the same functional group /(successive members) differ by CH_2 [6]

[accept partial answer for 4]

(v) State the chemical formula of a compound *before* butane in its homologous series.

C_3H_8 [6]

[accept partial answer for 4]

(*b*) **Figure 22** is the symbol used to represent a molecule of benzene

(i) Why are benzene and butane both classified as hydrocarbons?

composed of hydrogen and carbon atoms (only) [6]

[accept partial answer for 4]

(ii) State one difference between the structure of a molecule of butane and a molecule of benzene.

aromatic ring structure (in benzene) /more C in benzene / more H in butane

any one[6]

[accept partial answer for 4]

(*c*)A heat of reaction equation for butane is given as follows:

$2C_4H_{10}$ + $13O_2$ → $8CO_2$ + $10H_2O$ $\Delta H = -5760$ kJ

(i) What is the significance of the value of the heat of reaction being a *negative* quantity?
(indicates) an exothermic reaction / heat is given out **[6]**

[accept partial answer for 4]

(ii) Calculate the heat of combustion of butane.
2880(kJ mol^{-1}) **[6]**

[accept partial answer for 4]

(iii) How many moles of butane would release 28800 kJ of heat energy?
10 (moles) **[6]**

[accept partial answer for 4]

(iv) State one condition that could lead to the formation of carbon monoxide (**CO**) in the above reaction.
low levels of oxygen / poor ventilation **[6]**

[accept partial answer for 4]

12.(*a*)**Figure 23** shows laboratory apparatus used in the preparation of sulphur dioxide (**SO_2**) gas.

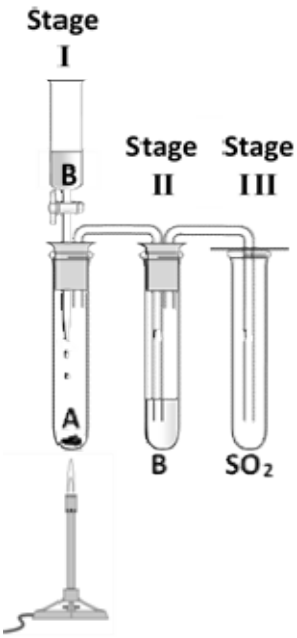

Figure 23

In **stage I**, a dilute form of liquid **B** is used in the preparation of the gas.

(i) Identify solid **A** used in **stage I**.
sodium sulfite **[6]**
[accept partial answer for 4]

In **stage II**, a concentrated form of liquid **B** is used in the separation of a pure sample of the gas.

(ii) Identify liquid **B**.
sulphuric acid **[6]**
[accept partial answer for 4]

(iii) Which product in the reaction is removed by liquid **B** in **stage II**?
H_2O **[6]**
[accept partial answer for 4]

In **stage III**, samples of the gas are collected.

(iv) What does this method of collection tell you about the density of **SO_2** compared to the density of air?
density greater than air **[6]**
[accept partial answer for 4]

(v) Describe a chemical test to verify that **SO_2** is an acidic gas.
(It turns moist) blue litmus paper red / (mix with water and add) universal indicator **[6]**
[accept partial answer for 4]

(vi) Why is this preparation carried out in a fume cupboard?
(SO_2 is) toxic/harmful **[3]**

(*b*) Lithium peroxide (Li_2O_2) is a chemical which absorbs carbon dioxide (CO_2) from an enclosed environment according to the equation:

$$2Li_2O_2 + 2CO_2 \rightarrow 2Li_2CO_3 + O_2$$

(i) What is meant by a mole of a substance?

amount of a substance that contains 6×10^{23} atoms or molecules **[6]**

[accept partial answer for 4]

(ii) Calculate the mass of one mole of Li_2O_2.

46(g) **[6]**

[accept partial answer for 4]

(iii) When 552 g of Li_2O_2 are completely reacted with CO_2, calculate

(a) the number of moles of Li_2O_2reacted,

12 (moles) **[6]**

[accept partial answer for 4]

(*b*) the number of moles of CO_2 absorbed,

12 (moles) **[3]**

(*c*) the volume of CO_2 absorbed at STP.

268.8(L) **[6]**

[accept partial answer for 4]

(iv) Suggest a reason why this type of reaction would be useful in crewed space missions.

(It provides) oxygen (to breathe) **[6]**

[accept partial answer for 4]

(*c*) Some elements react with hydrogen to form hydrides.

(i) Copy and complete the following table showing the hydrides formed:

	Nitrogen	Chlorine	Sulfur
Chemical formula of hydride	**NH_3**	**HCl**	**H_2S**
Chemical name of hydride	Ammonia	**Hydrogen Chloride**	**Hydrogen Sulfide**
Molecular shape of hydride	**pyramidal**	**linear**	v-shaped

[6+6+3+2+2+2]

(ii) Identify one of the hydrides as acidic.
hydrogen sulphide or hydrogen chloride **[6]**

(iii) Sketch the shape of a molecule of any of the hydrides to show the position of the atoms.
correct bonds // correct shape **[4+2]**
[accept partial answer for 4]

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