Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2015

Marking Scheme

Physics & 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. Marks shown in brackets represent marks awarded for partial answers as indicated in the scheme.

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

4. 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.

5. 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.

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

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

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

9. 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.

10. 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.

Question 1
Any eleven parts **11×6**

(*a*) Figure 1 shows the greater roadrunner bird which can run at speeds of 8 m s^{-1}.
How far could it travel in 9 seconds at this speed? **2×3**
$s = v \times t$ / $d = s \times t$ …3
(s =) 8 × 9 = 72 (m) …3
[equation of motion allow …3][8 ÷ 9 or 9 ÷ 8 ...3] [9 × 60 × 8 (–1)]

(*b*) In the equation $g = \frac{GM}{d^2}$ what does *G* represent? **2×3**
(universal) gravitational ...3
constant …3
[gravity …5]

(*c*) Calculate the work done when a person of mass 70 kg climbs 3 m vertically up a rope ladder.
[acceleration due to gravity, g = 9.8 m s^{-2}] **2×3**
(W) = mgh …3
= 70 × 9.8 × 3 = 2058 (N) …3
[70 × 3 ...3] [70 × 9.8 ...3]

(*d*) Figure 2 shows a ray of light passing through a block of glass.
Name the phenomenon occuring at X. **6**
refraction …6
[bending / dispersion ...6] [reflection …3]

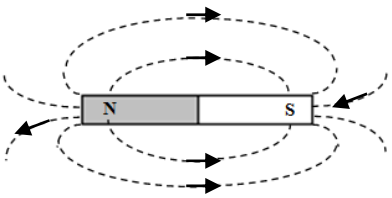
(*e*) What term is used to describe what happens when white light is split into its component colours? **6**
dispersion …6
[rainbow / spectrum allow …5][refraction ...3]

(*f*) What type of lens is used in a magnifying glass as shown in Figure 3? **6**
convex / biconvex / converging …6
[concave ...3]

(*g*) State *Boyle's law*. **5, 1**
volume is inversely proportional to pressure / pressure is inversely proportional to volume /
$p \propto 1/V$ / $p_1V_1 = p_2V_2$ / $pV = k$ ...5
for a fixed mass of a gas at constant temperature ...1

(*h*) Ice melts at 0 ºC. What is this temperature on the Kelvin scale? **6**
(0 + 273 =) 273 (K) ...6
[–273 …..5]

(*i*) Sketch the magnetic field lines around a bar magnet. **5, 1**
field lines …5
direction shown correctly by at least one arrow …1



(*j*) What is the *photoelectric effect*? **5, 1**

using light above or of a certain frequency / using suitable light
electrons released from a metal

first correct ...5, second correct ...1

(*k*) An energy efficient lamp with a rating of 11.5 W is connected to a 230 V supply. Calculate the current drawn by the lamp. **2×3**

power = potential difference (voltage) × current / $P = V\,I$ / $I = \frac{P}{V}$ …3

(I =) $\frac{11.5}{230}$ = 0.05 (A) …3

[230 ÷ 11.5 = 20 ...3]

(*l*) What is the purpose of an electrical transformer? **6**

to change the voltage of an ac supply / to step up or step down voltage …6
[reference to ac omitted ... (–1)][to charge phone, computer, etc ...3]

(*m*) A computer monitor rated at 25 W is used for eight hours per day. Calculate the number of units (kW h) it uses daily. **2×3**

25 ÷ 1000 = 0.025 (kW) ...3
0.025 × 8 = 0.20 (kW h) …3
[25 × 8 / any multiple of 0.2 ...5] [25 ÷ 8 …2]

(*n*) Why is the element lead (Pb) used when dealing with radioactive substances? **6**

shielding / blocking radiation / safety / protection / it absorbs radiation …6

(*o*) What happens to a nucleus of an atom during nuclear fission? **5, 1**

it splits ...5
into (two) smaller nuclei (and neutrons) …1
[definition of fusion ...3]

Question 2

Define (*i*) *mass*, **6**

measure of resistance to motion / measure of quantity of matter or heaviness or amount ...6

[unit allow ..3]

(*ii*) *acceleration.* **6**

rate of change of velocity / rate of change of speed / (a) = ($v - u$) / t ...6

[omit to explain u, v, t ...(–1)]

Give the SI unit of force. **3**

newton ...3

Copy and complete the following statement of Newton's first law of motion:
"An object remains at . . . . . or at a . . . . . velocity unless there is a resultant . . . . . acting on it." **6, 2, 1**

rest

constant

force

first correct ...6, second correct ...2, third correct ...1

What is meant by the *kinetic energy* of an object? **6**

energy due to motion / $1/2mv^2$ ...6

[mv^2 ...3]

List the two quantities that determine the kinetic energy of an object. **2×3**

mass / m ...3

velocity or speed / v ..3

Figure 4 shows a remote-controlled toy car and an electric car. The mass of the toy car is 650 g and the mass of the electric car is 1500 kg.
Convert the mass of the toy car to kilograms (kg). **6**

0.65 (kg) ...6

[650000 ...3]

The toy car starts from rest and takes 12 s to reach its top speed of 0.75 m s^{-1}.
Calculate

(*iii*) the acceleration of the toy car **2×3**

(a =) $\frac{v-u}{t}$ / $\frac{0.75-0}{0.12}$ …3

(a =) 0.0625 m s^{-2} …3

[no unit or incorrect unit (–1)]

(*iv*) the net force produced by the toy car during the acceleration **2×3**

(F =) ma …3

(F =) 0.650 × 0.0625 = 0.040625 N [0.0406 – 0.041 N] …3

[no unit or incorrect unit (–1)]

(*v*) the kinetic energy of the toy car at its top speed. **2×3**

(E =) $\frac{1}{2}mv^2$ …3

(E=) ½ × 0.650 × $(0.75)^2$ J = 0.183 J [0.182 – 0.183] …3

[no unit or incorrect unit (–1)][0.09 ...3, 0.24 ...3]

Why would a greater force be needed to change the speed of the other car by the same amount in the same time? **6**

greater mass …6

[heavier, more friction, etc ...6]

Question 3

When light strikes a shiny surface it reflects.

State the *laws of reflection of light.* **9, 3**

the angle of incidence is equal to the angle of refection / $i = r$ ...9

[refraction instead of reflection (–3)] [sines mentioned (–3)]

[allow 'object distance is equal to image distance' …6]

and

the incident ray or beam, the reflected ray or beam and the normal all lie in the same plane. ...3

[normal omitted (–1)]

[refraction instead of reflection (–1)]

A shoe shop uses plane mirrors to allow customers to look at shoes while trying them on.

Copy and complete Figure 5 to show how an image of object O is formed by a plane mirror. **9, 3**

any ray reflected at suitable angle …9

second ray / ray projected behind mirror /
image / normal / other relevant point …3

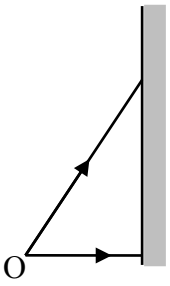


Figure 5

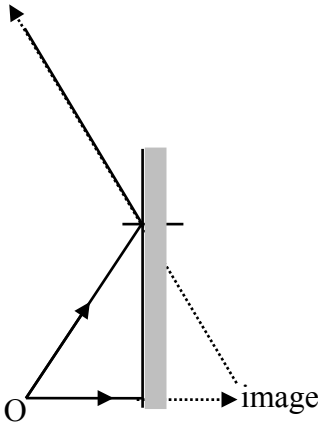


Figure 5 completed

Curved mirrors are also used in shops.

Give one use for a curved mirror in a shop and explain why it is used instead of a plane mirror. **9, 3**

security mirror // make-up mirror, etc

wider field of view / small curved mirror can reflect large space // produces magnified image

first correct ...9, second correct ...3

Figure 6 shows a pin placed 6 cm in front of a concave mirror of focal length 3 cm.

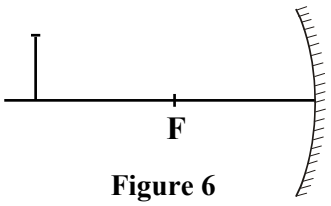


Figure 6

Copy and complete the diagram to show the formation of the image of the pin. **max 6, 2×3**

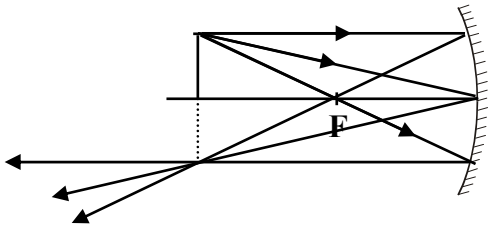


Figure 6 completed

two rays reflected correctly

first correct …6, second correct …3

image in correct position / same size as object / inverted ...3

How far from the concave mirror is the image of the pin located? **max 6, 2×3**

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ ...6

$\frac{1}{3} = \frac{1}{6} + \frac{1}{v} / \frac{1}{v} = \frac{1}{3} - \frac{1}{6} / \frac{1}{v} = \frac{1}{6}$ ...3

(v =) 6 cm ...3
[no unit or incorrect unit (–1)] [calculation need not be shown for full marks to be given]

Two previous parts: first correct …12, second correct max…6

A concave mirror can form *real* and *virtual* images. **9, 3**
What is meant by a virtual image?
(formed by) the apparent intersection of light rays
[(formed) behind a mirror / (formed) in front of a lens …(–1)][definition of real image…(–2)]

Where must an object be placed in front of a concave mirror to form a virtual image?
inside the focus / between mirror and focus / any number smaller than 3

first correct ...9, second correct ...3

Question 4

(*a*) The *kinetic theory* can be used to describe the motion of molecules in a gas.

Give two assumptions of the kinetic theory of gases. **6, 3**

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

first correct …6, second correct…3

***Brownian motion* provides evidence for the kinetic theory of gases.** **12, 6**

What is Brownian motion?

the random or zig-zag motion of (relatively large) particles suspended in air or liquid

How can Brownian motion be demonstrated?

smoke in box or in air / pollen in water / in smoke cell / view with microscope / view with eye or lens or microscope

first correct …12, second correct…6

(*b*) A thermometer is based on a thermometric property.

Explain the underlined term. **6**

property that varies with temperature …6

Name a liquid used in thermometers. **6**

mercury / ethanol ...6

[allow ink or dye ….5]

A student calibrated the unmarked thermometer shown in Figure 7 by recording the length of the liquid inside the thermometer (*i*) in melting ice, (*ii*) in steam.

length of liquid in melting ice = 4.2 cm
length of liquid in steam = 26.7 cm

State the temperature difference (in ºC) between melting ice and steam.

100

Find the change in liquid levels corresponding to this temperature difference. **9, 3**

22.5 (cm)

first correct …9, second correct …3

Calculate the change in length of the liquid for every 1 ºC change in temperature. **8**

0.225 (cm / degree) …8

Calculate the change in length of the liquid for a change in temperature of 18 ºC. **6**

$0.225 \times 18 = 4.05$ cm …6

[no unit or incorrect unit (–1)]

What would the *actual* length of the liquid be when the temperature is 18 ºC? **1**

4.05 + 4.2 = 8.25 (cm) …1

Question 5

(*a*) The following terms are used in stating *Coulomb's law*.

inversely two product square directly

Copy and complete the statement of Coulomb's law inserting the above terms.

"The force between . . . . . charged particles is . . . . . proportional to the . . . . . of the charges and is . . . . . proportional to the . . . . . of the distance between the charges."

5×3

two, directly, product, inversely, square …5×3

The force between two charged particles can be attractive or repulsive.
State the necessary condition for the force to be attractive. **6**

opposite charges / one positive and one negative / like repels like …6

Figure 8 shows a positively charged electroscope. **9, 3**

What happens to the leaf when a positively-charged rod is brought near to its cap?

(leaf) diverges away from rod / (leaf) repelled by rod (more) / (leaves) diverge from one another

Explain how to discharge an electroscope.

earth cap / touch cap with finger

first correct …9, second correct …3

(*b*) Define *capacitance*. **2×3**

ratio of charge (stored) // Q // measure of ability of a conductor …3

to potential // ÷ V // to store energy electrostatically / to store charge …3

[reference to charge ….3]

Figure 9 shows a parallel-plate capacitor, C, connected to a battery.
Copy the diagram to show the charges on the plates of the capacitor. **3×3**

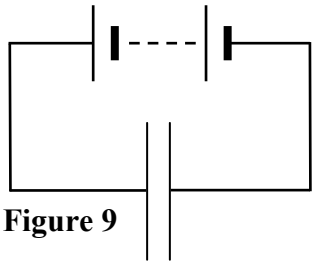


Figure 9

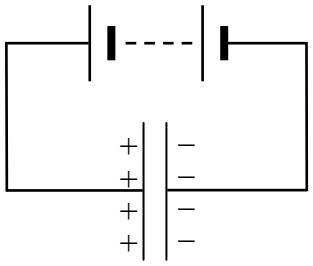


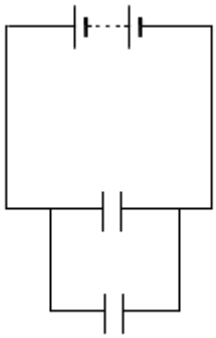
Figure 9 completed

opposite charge(s) on the two plates …3

equal charge(s) on both plates …3

positive charge on capacitor plate attached to positive terminal of battery …3

Sketch a diagram to show how two capacitors can be connected in parallel to a battery. **6**



Calculate the effective capacitance of two 5 μF capacitors connected

(*i*) in series, **2×3**

$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{5} + \frac{1}{5}$ ...3

(C =) 2.5 (μF) …3

[attempt using fractions …3]

(*ii*) in parallel. **2×3**

$C_1 + C_2 = C$ ...3

5 + 5 = 10 (μF) ...3

[parallel and series reversed max ...9]

Question 6
Answer any two parts **2×33**

(*a*) Define *momentum*. **2×3**
product of mass / m × ...3
and velocity / v ...3
[omit to explain m and v (–1)]

Figure 10 shows two cans each of mass 0.5 kg sliding in the same direction along a smooth worktop. Can A is moving at 0.6 m s^{-1} and can B at 0.4 m s^{-1} before they collide. After the collision can A continues to move in the same direction at 0.3 m s^{-1}.

Calculate
(*i*) the initial momentum of can A **3, 6**
mv or mu / 0.5 × 0.6 …3
= 0.3 kg m s^{-1} (to the right) …6
[no unit or incorrect unit (–1)]*
*Penalise once only for no unit or incorrect unit for momentum throughout.

(*ii*) the initial momentum of can B **6**
(mv or mu = 0.5 × 0.4 =) 0.2 kg m s^{-1} (to the right) …6
[no unit or incorrect unit (–1)]*

(*iii*) the total initial momentum **3**
($m_1v_1 + m_2v_2$ = 0.3 + 0.2 =) 0.5 kg m s^{-1} (to the right) …3
[no unit or incorrect unit (–1)]*

(*iv*) the final momentum of can B **2×3**
$0.5 = 0.5v_1 + 0.5v_2 \ / 0.5 = (0.5 \times 0.3) + 0.50v_2 \ / 0.5 = 0.15 + 0.5v_2$ …3
= 0.35 kg m s^{-1} (to the right) ...3
[no unit or incorrect unit (–1)]*

(*iv*) the final velocity of can B. **2, 1**
$0.35 = 0.5v_2$ …1
v_2 = (0.35 ÷ 0.5) = 0.7 m s^{-1} (to the right / in same direction as A / in same direction as before) …1
[no unit or incorrect unit (–1)]

(*b*) Figure 11 shows a wavefront of <u>monochromatic</u> light approaching a single narrow slit. **<u>9, 3</u>**
Explain the underlined term.
(light of) one colour or frequency or wavelength

Identify one source of monochromatic light.
laser / sodium lamp / white light passed through a filter

first correct …9, second correct …3

Copy the diagram and show the path of the wavefront after passing through the slit. **<u>9</u>**

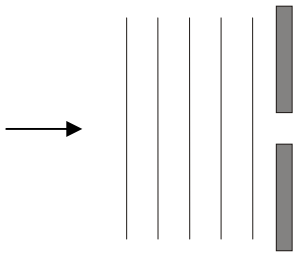


Figure 11

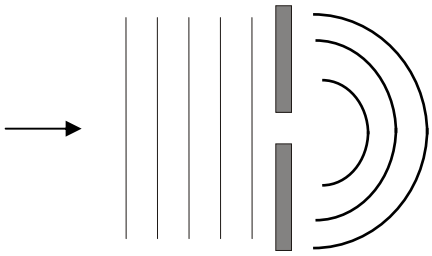


Figure 11 completed

curved wavefront(s) after gap ...9

Figure 12 shows the light pattern which forms on a screen if the single slit is replaced by a pair of narrow slits.
Give the names of the two wave phenomena which lead to the formation of this pattern. **<u>9, 3</u>**
diffraction
interference first correct …9, second correct …3

(*c*) State *Ohm's law.* **2×3**

(at constant temperature) current (flowing in a resistor) is proportional to // (at constant temperature) potential difference (across a resistor) is proportional to // $I \propto$ // $V \propto$ ...3

potential difference // current // V // I ...3

[$V = IR$ allow …6][omit to explain I and R (–1)]

Figure 13 shows a circuit with two lamps in series with a battery. Lamp A has a resistance of 3 Ω and lamp B has a resistance of 6 Ω. The current in the circuit is 0.4 A.

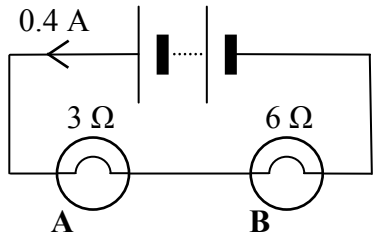


Figure 13

Calculate

(*i*) the effective resistance of the two resistors **2×3**

$R_1 + R_2 = R$ / 3 + 6 = R ...3

(R =) 9 (Ω) ...3

[parallel instead of series (R=) 2 (Ω) ....3]

(*ii*) the voltage (potential difference) across the battery. **6, 3**

$V = IR$ ...6

$V = 0.4 \times 9 = 3.6$ V …3

[no unit or incorrect unit (–1)]

[9 ÷ 0.4 = 22.5 ...3]

Which lamp will glow brighter? **6**

B / 6 Ω ...6

Give a reason for your answer. **6**

resistance bigger / voltage (potential difference) bigger / more power used / more electrical energy converted to heat energy ...6

(*d*) Radon–222 is a radioactive isotope. It has a half-life of 4 days and it emits alpha-particles. Explain the underlined terms. **9, 3**

time taken for half (a radioactive sample) to decay / time taken for the activity (of a radioactive sample to halve max...9

(alpha particle) consists of two protons and two neutrons / is a helium nucleus / $^4_2$He // definition: max...9

or

has a (relative) charge of +2 / has relative mass of 4 / is deflected in an electric field / has low penetration / is very ionising any two properties: first correct …6, second correct …3

What property of an alpha-particle causes it to be deflected when it enters a magnetic field?
charge / speed or velocity ...9

What fraction of a given sample of radon–222 remains after 8 days?
8 days is two half-lives ...6
¼ remaining …3

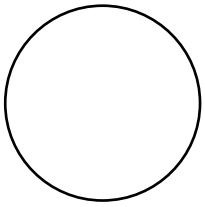
Two previous parts for (12): first correct …9, second correct max…3

Alpha-particles are one type of nuclear radiation.
List two other types of nuclear radiation. **6, 3**
β or beta(-radiation), γ or gamma(-radiation)
first correct…6, second correct …3

Question 7
Any eleven parts **11×6**

(*a*) Figure 14 shows objects made of two different forms of the element carbon (C).
What term is used to describe different physical forms of the same element? **6**
allotropes …6
[isotopes ….3]

(*b*) Sketch an *s* orbital. **6**
sphere …6



[*p* orbital …3]

(*c*) Why is the element helium (He) very unreactive? **6**
stable (electron arrangement), full outer shell, two electrons in outer shell, noble gas, reaction will not stablilise any one …6

(*d*) Why is a catalyst sometimes used in chemical reactions? **6**
to alter the rate of reaction, to speed up the reaction, to slow down the reaction any one …6

(*e*) Define electronegativity. **1, 2 × 2, 1**
relative / measure of the power of / measure of force of ...1
attraction ...2
for electrons ...2
in a shared pair / in a covalent bond ...1

(*f*) Copy and complete the following statement about Bohr's atomic theory.
'When an electron in an excited state in an atom falls to a lower energy level it emits .....' **6**
electromagnetic radiation, light, any named type of electromagnetic radiation, a photon any one…6
[allow energy or heat …3]

(*g*) Name the gas detected if it causes a chemical reaction with limewater as shown in Figure 15. **6**
carbon dioxide …6

(*h*) Which one of the following oxides is amphoteric? **6**
Na_2O CO_2 Al_2O_3
Al_2O_3 ...6

(*i*) Copy, complete and balance the following equation.
____ + H_2O → NaOH + ____ **2×3**
Na + H_2O → NaOH + ½ H_2 / 2Na + $2H_2O$ → 2NaOH + H_2
Na / H_2 …3
balanced …3

(*j*) Calculate the pH of a 0.04 M solution of nitric acid (HNO_3). **5, 1**
(pH =) $-\log[H^+]$ / $-\log 0.04$ …5
(pH =) $-(-1.3979) = 1.4$ …1

(*k*) Name the process used to decompose liquids using an electric current. **6**

electrolysis ...6

(*l*) A silica gel (SiO_2) sachet, as shown in Figure 16, is used to absorb moisture.
Calculate the percentage by mass of silicon in SiO_2.
[O = 16; Si = 28] **2×3**

$M_r = 60$ …3

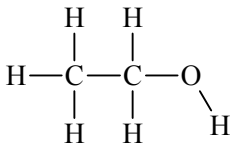
$\frac{28}{60} \times 100 = 46(.66) - 47\%$ …3

(*m*) Name the carboxylic acid found in vinegar. **6**

ethanoic / acetic …6

(*n*) Sketch the structural formula of ethanol (C_2H_5OH). **6**

…6



[Allow either 2 carbon atoms joined together …3 or OH group present …3]

(*o*) The relative molecular mass of ethyne is 26.
Calculate the number of molecules in 13 g of ethyne.
[Avogadro constant = 6.0×10^{23} mol^{-1}] **2×3**

$13 \div 26 = 0.5$ (moles) …3

$0.5 \times 6 \times 10^{23} = 3 \times 10^{23}$ …3

Question 8

In the periodic table the elements are arranged in order of increasing atomic number.
Lithium is the first metallic element and its ions are used in batteries to power mobile electronic devices.

Explain the underlined terms. **2×3, 2×6**

elements cannot be divided into simpler substances ...3
chemically ...3
[have one type of atom ….6]

number of protons (in an atom) / number of electrons in neutral atom …6
[omit neutral (–1)]

charged atom / charged (group of) atoms / (species with) unequal number of protons and electrons / a positive or negative atom / a positive or negative atom group of atoms / an atom that has lost or gained electrons / group of atoms that has lost or gained electrons ...6
[Allow (3) for 'charged' or '**charged** particle'.]
[example of ion ….3]

A sample of lithium consists of a mixture of two isotopes, $^{6}_{3}$Li and $^{7}_{3}$Li.
Copy and complete the table below, filling in the missing numbers. **2×5, 2×3, 2×1**

isotope	atomic number	number of neutrons	mass number
$^{6}_{3}$**Li**	3	3	6
$^{7}_{3}$**Li**	3	4	7

first two correct...2×5, second two correct ...2×3, third two correct ...2×1

The relative atomic mass of lithium is 6.941.
Which of its two isotopes, $^{6}_{3}$Li or $^{7}_{3}$Li, exists in greater abundance? **3**

$^{7}_{3}$Li / lithium–7 ...3

Give a reason for your answer. **3**

Relative atomic mass closer to 7 than to 6 …3

What is the electron configuration of a lithium atom? **6**

$1s^2\ 2s^1$ / 2, 1 …6

Why do $^{6}_{3}$Li and $^{7}_{3}$Li have the same electron configuration? **6**

they have the same number of electrons / they are isotopes / same atomic number / (atoms of) same element ...6

Lithium forms an ionic bond with chlorine.
In the compound lithium chloride (LiCl) state the charge on

(*i*) each lithium ion **3**

plus one / +1 / one / 1 ...3

(*ii*) each chloride ion. **3**

minus one / –1 ...3

Give one property common to ionic compounds. **6**

high melting point, high boiling point, crystalline, solid, conduct electricity when molten, conduct electricity when in solution (with water) any one...6

Question 9

(*a*) In terms of electrons, explain why oxidation and reduction always occur together. **2×6**

electrons gained by one substance ...6
must be lost by another ...6
or
oxidation is loss of electrons …6
reduction is gain of electrons …6
[allow 3 for words loss or gain where word electron is omitted]

Figure 17 shows a strip of magnesium ribbon placed in a solution of copper ions.
The following reaction occurs:

$$Mg + Cu^{2+} \rightarrow Mg^{2+} + Cu$$

State which species is (*i*) oxidised, (*ii*) reduced. **9**

substance oxidised: Mg
substance reduced: Cu^{2+}

first correct...6, second correct...3

[allow marks for reversed if consistent with (*a*) above]

Would copper metal react if placed in a solution of magnesium (Mg^{2+}) ions? **6**

no ...6

Which metal, magnesium or copper, is more easily oxidised? **6**

magnesium ...6

(*b*) Define an acid in terms of the Brønsted-Lowry theory. **2×3**

(an acid is a) proton / H^+ …3
donor …3
[allow acid produces H^+ (ions in solution) ...5]

Identify two acids in the following reaction.

$$HCl + H_2O \rightleftharpoons H_3O^+ + Cl^-$$ **9, 3**

HCl /
H_3O^+

first correct 9, second correct 3

[if consistent with incorrect definition of acid above, two bases …6, one base …3]

On the label of a bottle of Irish mineral water is stated 'pH = 7.2 at source'.
Is this water source *acidic* or *basic*? **3**

basic ...3

Give a reason for your answer. **3**

solutions with pH below 7 are acidic / solutions with pH above 7 are basic …3

'Sparkling water' is manufactured by adding carbon dioxide gas under high pressure to 'still water'.
Will the addition of carbon dioxide gas *increase* or *decrease* the pH of the water? **3**

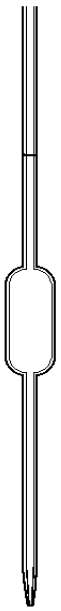
decrease …3

Give a reason for your answer. **6**

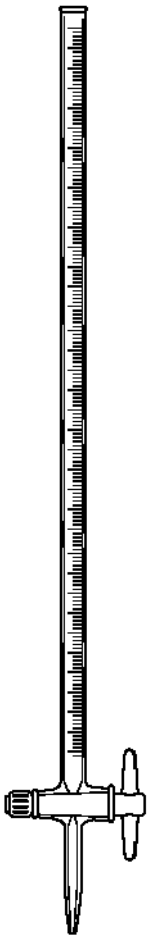
carbon dioxide is an acidic gas ...6

Question 10
Titrations are often used in chemistry to find the concentrations of solutions.
An acid-base titration was carried out to find the concentration of a solution of potassium hydroxide (KOH) by neutralising it with a standard solution of hydrochloric acid (HCl).
It was found that on average 18.6 cm^3 of a 0.15 M solution of hydrochloric acid was required to neutralise 20.0 cm^3 of the potassium hydroxide solution.

(*a*) Name and draw a diagram of the piece of apparatus used in the titration to measure
(*i*) the volume of the potassium hydroxide solution **2×3**
pipette 3, 3



(*ii*) the volume of the hydrochloric acid solution. **2×3**
burette 3, 3



(*b*) What is the correct procedure for rinsing a conical flask before use in a titration? **6**
rinse with (deionised) water …6
[apply cancellation if rinsed with another substance in addition to water...3]

(*c*) Describe how the volume of hydrochloric acid required for neutralisation was found. **6, 2×3**

(pipette or put 20 cm^3) base or KOH in conical flask /
add indicator or named indicator to conical flask /
add acid from burette (slowly) to conical flask /
until indicator changes colour /
take reading from burette or take reading where bottom of meniscus lies on mark

first correct …6, second two correct …2×3

State two precautions that should be taken to ensure an accurate result. **9, 3**

swirl (the flask), wash down sides with deionised or distilled water, add only 1or 2 drops of indicator / stand conical flask on a white tile, read burette at eye-level, add solution slowly from burette, etc

first correct ...9, second correct ...3

(*d*) Copy and complete the following equation for the titration reaction. **6, 3**

HCl + KOH → ____ + ____

HCl + KOH → KCl + H_2O
KCl
H_2O

first correct ...6, second correct ...3

(*e*) Calculate the concentration of the potassium hydroxide solution. **3×3**

$\frac{V_1 M_1}{n_1} = \frac{V_2 M_2}{n_2}$ …3

$\frac{\mathbf{18.6 \times 0.15}}{\mathbf{1}} = \frac{\mathbf{20 \times M_2}}{\mathbf{1}}$ …3

(M_2 =) 0.1395 – 0.14 (mole/l) …3

[correct formula, incorrect substitution …6 max]

(*f*) What safety equipment is worn while carrying out a titration? **6**

gloves, goggles or eye protection, hair-tie, lab coat , etc any one…6

Question 11

Biogas digesters that use bacteria to break down organic wastes from animal slurry are shown in the background in Figure 18. Biogas digesters produce the hydrocarbon gas methane (CH_4) which is then used as a fuel.

Why is methane classified as a hydrocarbon? **6**
contains carbon and hydrogen (only) …6

Give one other major source of methane gas. **6**
ruminants, paddy fields, bogs, decomposition of organic waste in land-fill, etc …6

Methane is the first member of the homologous series of alkanes
Explain the underlined term. **2×3**
series of compounds, with same chemical properties, have same functional group, have a general formula, show gradation in physical properties, etc any two... 2×3

Give the names of two other members of the alkane homologous series. **9, 3**
ethane, propane, butane, etc first correct ...6, second correct ...3

What is the structural difference between the members of the *alkane* homologous series and the members of the *alkene* homologous series? **6**
alkanes have no double bonds /
there is a double bond (between two carbon atoms) in an alkene ...6

Benzene (C_6H_6) is another hydrocarbon.
Why is benzene not classified as an alkane nor an alkene? **6**
alkanes and alkenes are aliphatic / benzene is aromatic / alkane or alkene carbons in chains / benzene carbons in ring ...6

Methane burns in oxygen according to the following equation.

$$\mathbf{CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O \qquad \Delta H = -890\ kJ\ mol^{-1}}$$

How does the information given above indicate that burning methane *releases* heat energy? **6**
ΔH is negative ...6

What term is used to describe reactions that release heat energy? **6**
exothermic ...6

Calculate
(*i*) the quantity of heat energy released when 6 moles of methane are burned **6**
$890 \times 6 = 5340$ (kJ mol^{-1}) …6
[890 ÷ 6…3]

(*ii*) the number of moles of methane needed to produce 13,350 kJ of heat energy. **6**
13,350 ÷ 890 = 15 (moles) ...6
[13,350 × 890 ....3]

Question 12
Answer any two parts. **2×33**

(*a*) Figure 19 shows the International Space Station (ISS). The ISS uses lithium hydroxide (LiOH) to absorb the carbon dioxide breathed out by those on board.
The equation for the reaction is as follows.

$$2LiOH + CO_2 \rightarrow Li_2CO_3 + H_2O$$

Give two physical properties of carbon dioxide gas. **9, 3**
denser than air, colourless, soluble in water, etc
first correct ...6, second correct ...3
[allow chemical properties ....2×3]

Why must carbon dioxide gas be removed from the atmosphere inside the ISS? **6**
it would cause suffocation / poisonous / bad for you / cannot respire (breathe) it ...6

When 96 g of lithium hydroxide react completely with carbon dioxide, calculate
(*i*) the number of moles of lithium hydroxide used **2×3**
24 …3
96 ÷ 24 = 4 (moles) …3

(*ii*) the mass of lithium carbonate produced. **3×3**
[H = 1; Li = 7; C = 12; O = 16]
2 moles ...3
(M_r =) 74 …3
74 × 2 = 148 (g) …3

(*b*) Figure 20 shows an arrangement that was set up in a fume cupboard to prepare, collect and test a small sample of dry sulfur dioxide (SO_2) gas.

Name the
(*i*) solid A **6**
sodium sulfite / Na_2SO_3 …6

(*ii*) liquid B. **6**
hydrochloric acid / sulfuric acid …6

Why is the gas collected by the upward displacement of air? **6**
soluble in water / denser than air …6

What would happen to moist blue litmus paper in the presence of sulfur dioxide gas? **6**
changes to red …6

Give one industrial use for sulfur dioxide gas. **3**
bleaching, making straw hats, making sulfuric acid, etc …3

Why should this preparation *only* be carried out in a fume cupboard? **6**
toxic, causes acid rain, causes pollution, safety (reasons), etc …6

(*c*) Consider the descriptions in the table below.

A	group of atoms chemically combined together
B	the type of bond where electrons are shared between atoms
C	the sub-atomic particle with negative charge
D	the type of attraction *between* water molecules
E	located in the nucleus of an atom
F	a group of electrons not involved in bonding
G	the shape of methane ($\mathbf{CH_4}$) molecule

In your answerbook match each term below with its corresponding descriptions (A to G).

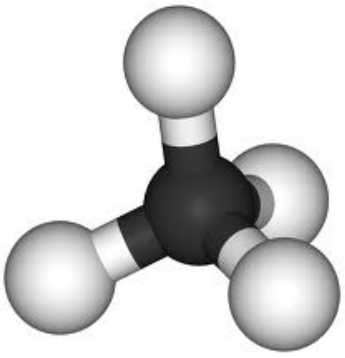
proton	**tetrahedral**	**lone pair**
covalent	**molecule**	**electron**
hydrogen bonding		

3×6, 3×2

A = molecule
B = covalent
C = electron
D = hydrogen bonding
E = proton
F = lone pair
G = tetrahedral

first three correct ...3×6, second three correct... 3×2

Sketch a diagram to show the arrangement of atoms in a molecule of methane ($\mathbf{CH_4}$). **9**
tetrahedral arrangement of four hydrogens around carbon …9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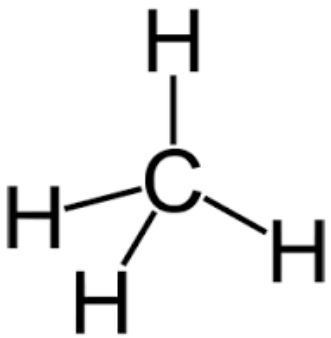

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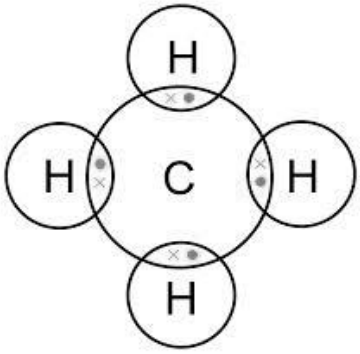

[Attempt of some merit …6 or 3]

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