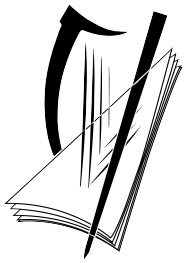


Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2017

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.

2017. M37

LEAVING CERTIFICATE EXAMINATION

PHYSICS AND CHEMISTRY – ORDINARY LEVEL

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. 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. 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.

Coimisiún na Scrúduithe Stáit

400@10%

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

Question 1
Any eleven parts **11×6**

(*a*) Figure 1 shows a stack of 20 fifty-cent coins. Each coin has a mass of 7.80 g. What is the total mass of the stack expressed in kilograms (kg)? **4, 2**
7.80 × 20 = 156 (g) …4
0.156 (kg) …2

(*b*) A car moves at a speed of 50 km/h. What distance does it move every three minutes? **2×3**
(*v* =)*d* / *t* /50 ÷ 60 = 0.833 (km/min) / 50000 ÷ 60 = 833.33 (m/min) // 3 min = 0.05 hours / 3 min = 1/20th hour // 50 × 3 = 150 ...3
0.8333 × 3 = 2.5 (km) / 833 × 3 = 2500 (m) // 50 × 0.05 = 2.5 (km) / 50000 × 0.05 = 2500 (m) // 150 ÷ 60 = 2.5 (km) …3

(*c*) In the equation $g = \frac{GM}{d^2}$, what does *d* represent? **6**
distance (from centre of Earth to surface) / radius (of Earth) …6

(*d*) Name the theory based on the idea that particles in a gas are in constant random motion. **6**
kinetic (theory) ...6
[allow ideal gas (theory) ….6]

(*e*) The metal mercury freezes at a temperature of –39 °C.
What is this temperature on the Kelvin scale? **6**
(–39 + 273 =) 234 (K) ...6
[attempt using 273, e.g. 39 + 273 = 312 ...(5)]

(*f*) Give an example of a longitudinal wave. **6**
sound / ultrasound / seismic (waves)or P-waves / explosions, etc …6
[allow transverse wave ...(3)]

(*g*) Why is the light from a laser classified as *monochromatic*? **6**
only one wavelength or frequency or colour …6

(*h*) Figure 2 shows the inside of a three-pin plug. What is the purpose of the fuse? **6**
to melt or blow or break when current is too large / circuit breaker / safety ...6

(*i*) An LED lamp has a rating of 16 W when connected to a 230 V supply. Calculate the current drawn by the lamp. **2×3**
P = *VI* / *I* = $\frac{P}{V}$ / 16 = 230 …3
(*I* =) 0.07 (A) …3
[allow 14.3 or 3680 …(3)]

(*j*) Figure 3 shows two 10 µF capacitor connected together in parallel.
What is the effective capacitance of this arrangement? **6**
20 (µF) …6
[allow 0.2 or 1/5 (µF) ….(3)]

(*k*) The electrical force between two point charges is 0.16 N. State the value of this force if the distance between the point charges is doubled. **6**

0.04 (N) …6

[allow quartered or four times smaller…6]

[$F=k\frac{Q_1Q_2}{d^2}$ allow…(4)][allow two times smaller...(3)]

(*l*) Figure 4 shows a magnetic field around a current carrying wire.
Copy the diagram and show the direction of the current in the wire. **6**

arrow showing current flowing up …6

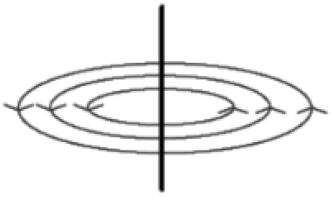


Figure 4

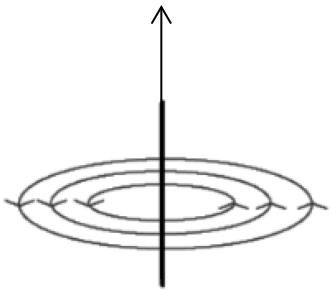


Figure 4 completed

(*m*) Copy and complete the following statement:
"During the photoelectric effect……are released from the …….. of a metal." **2×3**

electrons / negative charges …3

surface …3

(*n*) Name the chemical element commonly used to absorb nuclear radiations. **6**

lead / Pb …6

[allow other material that can act as absorber …(4)]

(*o*) A sample of a radioactive isotope has a half-life of 12 years.
What fraction of the sample would remain after 24 years? **2×3**

(24 years is) two half-lives / half left after 12 years …3

(quarter left after 24 years) …3

[25% left ….allow 6]

[allow ¾ left or 75% left ….(4)]

Question 2

(*a*) Define acceleration. **2×3**

rate of change // rate of change // v ÷ or $(v - u)$ ÷ ...3

of velocity // of speed in a given direction // t ...3

[no reference to direction (–1)]

Figure 5 shows an African cheetah which is the fastest land animal. Starting from rest it reaches a speed of 27 m s^{-1} in 3 seconds.

Calculate

(i) the acceleration of the cheetah **2×3**

$v = u + at$ / $27 = 0 + (a \times 3)$ ...3

(a=) 9 m s^{-2} / (a =) 9 m / s / s ...3

[no unit or incorrect unit (–1)]

(ii) the distance covered by the cheetah in the 3 seconds **2×3**

$s = ut + ½\ at^2$ / $s = (0 \times 3) + ½\ (9 \times (3)^2)$ / any correct formula ...3

(s=) 40.5 m ...3

[no unit or incorrect unit (–1)]

(iii) the time taken by the cheetah to move the first 18 metres. **3×3**

$s = ut + ½at^2$ ...3

$18 = ½ \times 9 \times t^2$ ...3

$\Rightarrow t = 2$ s ...3

[no unit or incorrect unit (–1)]

Give two factors which determine the kinetic energy of the moving cheetah. **2×3**

mass ...3

velocity / speed ...3

[allow $½\ mv^2$ ...6]

(*b*) Define

(i) weight, **6**

product of mass and (acceleration due to) gravity / mg / $m \times g$ ...6

(ii) work **6**

point of application of force moves in direction of force / forces acts or moves a body through a displacement in same direction / product of force and displacement / Fs / $F \times s$ / Fd / $F \times d$ ...6

and state the SI unit of each. **2×3**

weight: newton / N ...3

work: joule / J ...3

Figure 6 shows a crane lifting industrial tyres onto a storage platform which is 8 metres above the ground. Each tyre has a mass of 60 kg and it takes the crane 50 seconds to move each one.

What type of energy do the tyres acquire when raised onto the platform? **3**

potential …3

Calculate

(iii) the weight of each tyre **3**

($W = mg$ = 60 × 9.8 =) 588 N …3

[no unit or incorrect unit (–1)]

(iv) the work done in storing each tyre **3**

($W = Fs = mgh$ = 60 × 9.8 × 8 =) 4704 J / (588 × 8 =) 4704 J …3

[no unit or incorrect unit (–1)]

(v) the maximum number of tyres that could be moved by the crane in one hour. **2×3**

1 hour = 3600 (s) …3

3600 ÷ 50 = 72 …3

Question 3

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

the angle of incidence is equal to the angle of reflection / $i = r$
[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
[normal omitted (–1)][refraction instead of reflection (–1)]

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

Two plane mirrors are arranged as shown in Figure 7. A laser pointer is directed at one of the mirrors which lies at an angle of 45° to the laser beam.

Copy and complete Figure 7 to show the path of the laser beam to reach an observer at X. **2×6**

beam reflected through 90° at first mirror in correct direction …6
beam reflected through 90° at second mirror in correct direction …6
[arrows not essential]

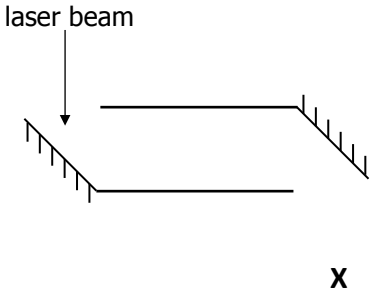


Figure 7

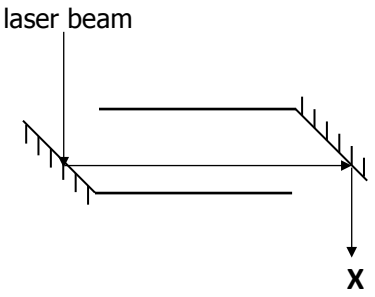


Figure 7 completed

Give two properties of the image formed by a plane mirror. **2×6**

virtual or imaginary, erect, laterally inverted or description of lateral inversion, same size as object or unmagnified, same distance behind mirror as object is in front, etc any two…6

Figure 8 shows a pinplaced 9 cm in front of a concave mirror of focal length 3 cm.

How far is the image of the pin from the concave mirror? **3×3**

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ ...3

$\frac{1}{3} = \frac{1}{9} + \frac{1}{v} / \frac{1}{v} = \frac{1}{3} - \frac{1}{9} / \frac{1}{v} = \frac{2}{9}$ …3

(v =) 4.5 or 9/2 cm …3

[no unit or incorrect unit (–1)][accept work based on a diagram drawn to scale]

How does the size of the image compare with the size of the pin? **6**

(image) smaller / (image) diminished / pin bigger …6

Is the image of the pin *real* or *virtual*? Give a reason for your answer. **3, 6**

real ….3
formed by actual intersection of rays / can be projected or formed on a screen …6
[where virtual given, second (6) may be awarded if response consistent with virtual]

Give one use for a

(i) plane mirror, **3**

seeing one's image / for shaving / for applying make-up / send a signal / change direction of a beam of light, etc …3

(ii) a concave mirror. **3**

produce a magnified image / in dentistry / for shaving / for make-up application / reflector in lamp, etc …3

[give use for incorrect mirror or lens …(–1)]

Question 4

(*a*) Figure 9 shows how the volume of a sample of the ideal gas varies as its temperature changes.

What term is given to the temperature at A? **9**

(absolute) zero …9

What is the value of A on the Celsius temperature scale? **2×3**

minus / – …3

273(.15) …3

State *Charles's law*. **5, 3, 1**

volume is proportional to temperature / temperature is proportional to volume / $V \propto T$ / $T \propto V$ / $\frac{V}{T}$ is constant / $\frac{T}{V}$ is constant / $\frac{V}{T} = k$ / $\frac{T}{V} = k$ / $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ / $\frac{T_1}{V_1} = \frac{T_2}{V_2}$ // volume (of a gas) changes or increases or decreases by factor of 1/273th …5

measured on kelvin or absolute scale // for every change or increase or decrease of temperature by 1°C …3

for a fixed mass of gas / at constant pressure …1

A balloon contains 100 cm^3 of helium gas at 280 K.
The balloon is then placed in a flask of liquid nitrogen at a temperature of 70 K.
Calculate the volume of the gasat 70 K if the pressure remains the same. **3×3**

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ …3

$\frac{100}{280} = \frac{V_2}{70}$ …3

(V_2 =) 25 cm^3 …3

[no unit or incorrect unit (–1)]

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

Give an example of a thermometric property. **6**

height or volume (of liquid), pressure, resistance, emf, etc …6

A thermometer must also have a scale between two fixed points.
Identify the values of the fixed points used on the Celsius scale. **6, 6**

0 (°C) …6

100 (°C) …6

Describe an experiment to locate the fixed points and construct a scale on an unmarked laboratory thermometer. **5×3**

immerse thermometer in melting ice …3

mark lower fixed point …3

hold thermometer in steam above boiling water …3

mark higher fixed point …3

mark or create a scale (between the fixed points) …3

[allow marks for correctly labelled diagram]

Question 5

(*a*) Electrical energy is bought by consumers in units of kilowatt hours (kW h).
The table below shows the number of kilowatt hours used by a single appliance running continuously for a period of 7 hours.

kilowatt hours (kW h)	0	0.4	0.8	1.2	1.6	2.0	2.4	2.8
time (hours)	0	1	2	3	4	5	6	7

Draw a graph of kilowatt hours (*y*-axis) against time (*x*-axis). **5×3**
x-axis labelled kilowatt hours or kW h or unit …3
y-axis labelled time or hours …3
at least six points plotted correctly …3
joined by a straight line of good fit …3
through the origin …3
[allow (12) max if graph paper not used]

From the graph estimate the number of kilowatt hours used after 6.5 hours. **6**
2.6 (kW h) …6

Calculate the cost of using the appliance for 6.5 hours if the cost of each unit (kW h) was 20 cent. **3**
2.6 × 20 = 52 cent or €0.52 …3

What is the power rating of the appliance in watts? 3
400 W …3
[allow 0.4 kW …3]

The appliance contains a transformer. What is the purpose of a transformer? **6**
changes(ac) voltage / steps up (ac) voltage / steps down (ac) voltage …6

(*b*) State *Ohm's law*. **2×4, 1**
current(in a conductor) proportional to// potential differenceproportional to // $V \propto$ // $V =$ …4
potential difference // current (in a conductor) // I / IR …4
at constant temperature …1

In an electrical circuit resistors are used to control the current.
What is meant by the underlined term? **6**
(continuous) metallic connection / wire (joining electrical components) / conducting path / path of electrons or current …6

Figure 10 shows two ways of combining two 100 Ω resistors.Calculate the effective resistance of the
(i) parallel arrangement in A **5, 1**
$(\frac{1}{R} =) \frac{1}{R_1} + \frac{1}{R_2}$ / $(\frac{1}{R} =) \frac{1}{100} + \frac{1}{100}$ …5
$(\Rightarrow R =)$ 50 Ω …1

(ii) series arrangement in B. **5, 1**
$R = R_1 + R_2$ / R = 100 + 100 …5
$(\Rightarrow R =)$ 200 Ω …1
[no unit or incorrect unit (–1) but once only]
[series and parallel reversed …(–1)]

A potential difference of 5 V is then connected across the arrangement in B. Calculate the current through each resistor. **4, 2**

$V = IR$ / $I = \frac{V}{R}$ …4

$(\Rightarrow I =) \frac{5}{200}$ = 0.025 A …2

[no unit or incorrect unit (–1)]

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

(*a*) Define *momentum*. **2×3**
product of mass / m × ...3
and velocity / v ...3

State the *principle of conservation of momentum*. **2×4, 1**
momentum before equals // (total) momentum remains or is // $m_1u_1 + m_2u_2 =$ …4
momentum after // constant // $m_1v_1 + m_2v_2$ or $(m_1 + m_2)v$ …4
when no external force acts / in a closed system …1

[the rate of change of momentum is proportional to the applied force, allow…(3)]
[principle of conservation of energy, allow…(3)]

Figure 11 shows trolley A of mass 350 g moving at 0.85 m s^{-1} on a smooth horizontal track approaching trolley B of mass 200 g which is at rest.
After the collision both trolleys move in the same direction with trolley A moving at 0.45 m s^{-1}.

Calculate
(i) the momentum of trolley A before the collision **2×3**
mv or mu / 0.350 × 0.85 =/ 350 × 0.85 = …3
0.2975 kg m s^{-1} (to the right) /= 297.5 g m s^{-1} …3
[no unit or incorrect unit (–1)]*

(ii) the momentum of trolley B after the collision **2×3**
$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ / 0.2975 + (0.20 × 0) = 0.2975 / 0.2975 = $m_1v_1 + m_2v_2$ /
0.2975 = (0.350 × 0.45) + 0.2 × v / 0.2975 = 0.1575 + 0.2v / 297.5 = 157.5 + 0.2v …3
($\Rightarrow$ 0.2v =) 0.14kg m s^{-1} (to the right) / ($\Rightarrow$ 0.2v =) 140 g m s^{-1} …3
[no unit or incorrect unit (–1)]*

(iii) the speed of trolley B after the collision. **2×3**
0.14 = 0.2v / 140 = 200v …3
v = 0.7 m s^{-1} (to the right) …3
[no unit or incorrect unit (–1)]*
*penalise once only for no unit or incorrect unit.

(*b*) All atoms of helium on earth are formed from alpha-particles released during radioactive decay of unstable isotopes.

What is the structure of an alpha particle? **2×3 or 6**

helium / He / 2 protons (and) …3

nucleus / two neutrons …3

or

$^{4}_{2}\mathrm{He}$ …6

Give one difference between the structures of an alpha–particle and of an atom of helium. **6**

helium atom has (two) electrons/ alpha-particle has no electrons / helium atom is neutral / alpha-particle is charged / helium atom has two more electrons than an alpha particle / alpha particle has two fewer electrons than a helium atom …6

Each alpha-particle gains two subatomic particles to become an atom of helium.

Identify the subatomic particles gained. **3**

electrons …3

Give one way to deflect an alpha-particle. **6**

(using an) electric (field) / (using a) magnetic (field) …6

Which type of nuclear radiation cannot be deflected in this way? **6**

gamma (radiation) or γ (radiation) …6

Give one use of radioactive isotopes. **6**

medical use / to treat cancer / in diagnosis of illness / to detect leaks / to measure thickness / to preserve food / for archaeological dating / in smoke detectors / in bombs or weapons / in nuclear reactors or to generate electricity, etc

any one…6

(*c*) Draw a labelled diagram of a gold-leaf electroscope. **4×3**

case ..3
leaf or leaves …3
cap …3
rod from cap to leaf or leaves / earth …3
[no labels max…(9)]

How would you use a positively-charged electroscope to determine whether a charged plastic rod was also positively-charged? **2×3**

bring (test) rod near cap (of charged electroscope) …3
divergence shows same type of charge …3

Figure 12 shows a negatively-charged rod held near two conducting spheres which are in contact. Both spheres are on insulated stands.

The spheres are then moved apart by holding them by their stands.
State the net charge on sphere X and give a reason for your answer. **6, 3**

positive …6
(negatively-charged) rod repelled negative charge on spheres into Y …3

What is the net charge on sphere Y after it is earthed? **6**

zero …6

(*d*) Consider the descriptions in the table:

A	Part of the electromagnetic spectrum that has a heating effect
B	The change in direction of light which can occur when light moves to a denser medium
C	A type of wave motion
D	Where parallel rays meet after passing through a convex lens
E	A phenomenon which occurs when two or more waves meet
F	The splitting of light into its component colours
G	The distance between two consecutive crests of a wave

In your answerbook match each term below with its description (A, B, C, D, E, F or G).

interference	**wavelength**	**dispersion**
focus	**infrared**	**transverse**
refraction		

3×7, 3×2

A = infrared
B = refraction
C = transverse
D = focus
E = interference
F = dispersion
G = wavelength

first three correct ...3×7, second three correct... 3×2

What is meant by the diffraction of a wave? **6**

spreading (out of wave having passed through a gap or past an obstacle or into geometric shadow) …6

Question 7
Any eleven parts **11×6**

(*a*) In the periodic table of the elements, what is the group number of the element sodium (Na)? **6**
one / 1 / I / 1A …6

(*b*) Figure 13 represents an *s-orbital*.
What is the maximum number of electrons that an s-orbital can hold? **6**
two / 2 …6

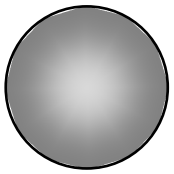


Figure 13

(*c*) An atom of fluorine has nine electrons. Give its electron configuration(*s*, *p*). **2×3**
$1s^2\ 2s^2$ …3
$2p^5$ / $2p_x^2\ 2p_y^2\ 2p_z^1$ …3
[allow subscripts instead of superscripts, allow arrows in boxes to represent electrons where boxes labelled with correct sublevel][allow 2, 7 ….(3)]

(*d*) What type of bond exists *between* water molecules? **6**
hydrogen (bonding) / dipole-dipole (bonding)/van der Waals (forces) …6
[intermolecular (bonding) allow…3]

(*e*) How many (i) protons, (ii) neutrons, are there in an atom of potassium, $^{39}_{19}K$? **6**
(i) 19 (protons) …3
(ii) 20 (neutrons) …3
[allow reversed …(3)]

(*f*) Calculate the pH of 0.025 M nitric acid (HNO_3). **2×3**
(pH =) –log0.025 …3
(pH =)–(–1.6020) = 1.6 …3
[pH = $-\log_{10}[H^+]$....(4)]

(*g*) Give a use for ethanoic acid (CH_3COOH). **6**
vinegar / flavour / preserving food, etc …6

(*h*) Calculate the percentage of zinc by mass in zinc oxide (ZnO), the major component of *Sudocrem*®, Figure 14. **2×3**
[O=16; Zn =65]
(M_r =) 81 …3
$\frac{65}{81} \times 100 = 80.25\%$ …3

(*i*) Define *electronegativity*. **2×3**
relative attraction / measure of power of attraction / measure of force of attraction …3
for electrons in a shared pair / for electrons in a covalent bond …3
['relative' or'measure of omitted' (–1)]
['in a shared pair' or 'in a covalent bond omitted (–1)]

(*j*) What is the purpose of a catalyst in a chemical reaction? **6**

to change or increase or decrease the rate or speed of a reaction
(without being consumed) …6

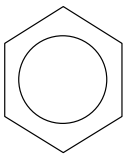


Figure 15

(*k*) Name the molecule represented by the symbol in Figure 15. **6**

benzene …6
[allow (cyclo)hexane …(3)]

(*l*) Select the two transition metals in the following :

aluminium copper magnesium iron beryllium **4, 2**

copper
iron

first correct….4, second correct…2

(*m*) Calculate the number of molecules in 15 moles of a substance.
[Avogadro constant = $6.0 \times 10^{23} mol^{-1}$] **2×3**

$15 \times 6.0 \times 10^{23}$ = ...3
9.0×10^{24} …3

(*n*) What are the two products when water undergoes electrolysis? **4, 2**

hydrogen
oxygen

first correct….4, second correct…2

(*o*) Figure 16 shows the structural formula of ethanol.
Copy the structure and draw a circle around the functional group. **6**

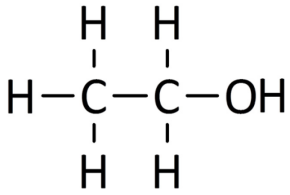


Figure 16

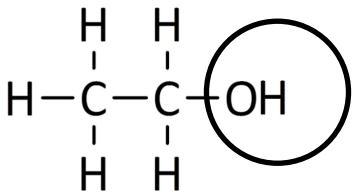


Figure 16 completed

…6

Question 8

(*a*) Define the mass number of an element. **6**

number of protons and neutrons (in an atom of the element) / number of nucleons (in an atom of the element) …6

The element gallium (Ga) exists as two isotopes, $^{69}_{31}$Ga and $^{71}_{31}$Ga.

What is meant by each of the underlined terms? **6, 2×3**

element: cannot be made simpler by chemical means / consists of atoms with same atomic number …6

isotopes: (atoms that have the) same atomic number / (atoms that have the) same number of protons / atoms of the same element …3

different mass number /different number of neutrons …3

State the number of neutrons in each of the two types of gallium atom. **2×6**

$^{69}_{31}$**Ga**: 38 …6

$^{71}_{31}$**Ga**: 40 …6

A sample of gallium consists of 60% $^{69}_{31}$Ga and 40% $^{71}_{31}$Ga.

Calculate the relative atomic mass (A_r) of this sample of gallium. **3×3**

60 × 69 = 4140 / 40 × 71 = 2840 …3

4140 + 2840 = 6980 ...3

6980 ÷ 100 = 69.8(0) …3

[69.72 from tables …(3)]

(*b*) What change of state occurs in a substance at its melting point? **3**

(changes from) solid to liquid / (changes from) liquid to solid …3

The table below gives information about four compounds A, B, C and D.

Substance	Melting point (°C)	Boiling point (°C)
A	–114	78
B	0	100
C	730	1380
D	–210	–195

(i) Which two substances are liquids at room temperature? **2×3**

A …3

B …3

(ii) Which substance do you think is composed of ions? **9 or 3**

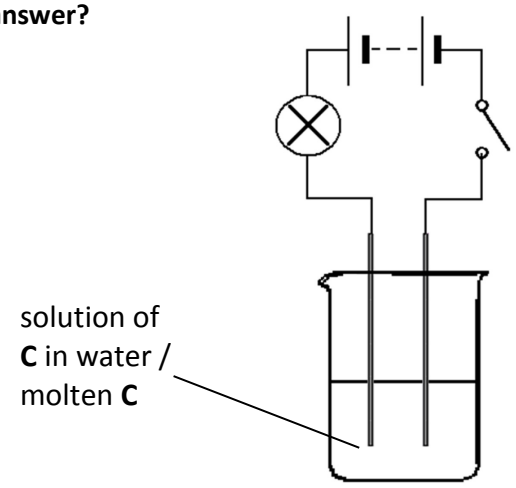
C …9 or …3

How could you carry out a test to verify your answer? **3×1 or 3×3**

dissolve **C** in water / melt **C** …1 or …3

set up circuit …1 or …3

bulb lights confirms **C** is ionic …1 or …3



first correct …9, second correct …3

(iii) What is the difference (in °C) between the melting point and theboiling point of substance D? **3**

21 (°C) …3

What do the low values of the melting point and the boiling point of substance D tell you about its bonding? **3**

purecovalent / weak intermolecular forces …3

Question 9

(*a*) When sodium metal reacts with chlorine gas, sodium is <u>oxidised</u> and chlorine is <u>reduced</u>.

(i) Explain the underlined words in terms of electron transfer. **<u>2×6</u>**

oxidised: electron(s) lost or taken …6

reduced: electron(s) gained or added …6

[allow (3) each for words lost and gained where word 'electron' is omitted]

[reversed ...(6)]

(ii) Write a balanced equation for this reaction. **<u>6</u>**

$Na + ½ Cl_2 \rightarrow NaCl$ / $2Na + Cl_2 \rightarrow 2NaCl$ …6

[allow ….3 for reactants and products correct; allow ...3 for balancing]

A sample of black copper oxide was heated in a stream of hydrogen gas.

(iii) Copy and complete the chemical equation:

$CuO + H_2 \rightarrow$ _____ + _____ **<u>2×3</u>**

$CuO + H_2 \rightarrow Cu + H_2O$ …6

[allow ….3 for products correct; allow ...3 for balancing]

(iv) Give the name of the substance oxidised. **<u>3</u>**

hydrogen …3

(v) How could you tell that a chemical reaction has occurred? **<u>6</u>**

copper metal shine / black copper oxide used up / steam formed / droplets observed / water formed / mass of solid less at end …6

(*b*) State the Brønsted-Lowry definition of an acid. **<u>2×3</u>**

(an acid is a) proton / H^+ …3

donor …3

[allow acid produces H^+ (ions in solution) ...6]

Sulfuric acid is a <u>strong acid</u> commonly used in school laboratories.

What is meant by the underlined term? **<u>6</u>**

good proton donor / good H^+ producer …6

Give an example of a *weak acid*. **<u>6</u>**

ethanoic, acetic, tannic, lactic, etc …6

[allow strong acid other than sulfuric acid ....(3)]

Identify two bases in the following equation:

$NH_3 + CH_3COOH \rightleftharpoons NH_4^+ + CH_3COO^-$ **<u>6, 3</u>**

NH_3

CH_3COO^-

first correct…6, second correct…3

Give an example of an acid-base conjugate pair in this reaction. **<u>6</u>**

CH_3COOH and CH_3COO^-/ $NH_3$and NH_4^+ …6

Question 10

Solid potassium hydroxide was dissolved in water and made up to the mark on a volumetric flask. 20 cm^3 portions of this mixture was then titrated with 0.15 M hydrochloric acid. Figure 17 shows some of the glassware used in this activity.

(*a*) What term describes a mixture of a solid dissolved in a liquid? **6**

solution / homogeneous …6

(*b*)

(i) Give two safety precautions when carrying out a titration. **2×6**

wear gloves /
wear goggles or eye protection /
use a hair-tie /
wear a lab-coat /
mop-up any spills, etc

any two…2×6

(ii) Name the piece of glassware A. **6**

funnel …6

(iii) In a titration experiment,what piece of glassware is filled using A? **6**

burette / volumetric flask …6
[allow wash bottle …(3)]

(iv) Howshould B be prepared before use? **2×3**

rinsewith deionised or distilled water …3
rinsewith base or KOH or solution it will contain …3
[omit deionised / distilled ...(–1)]

(v) When filling B, how would you know when it contained exactly 20 cm^3? **6**

(bottom of) meniscus /curve / lies on mark/ (read at eye) level …6

(vi) Give a precaution to ensure the delivery of exactly 20 cm^3 when using B. **6**

do not blow out or shake out or dislodge last drop (inside) /
wait 15 or 20 or 30 seconds drainage time /
tip the pipette tip or tip of **B** gently against wall of conical flask to dislodge any drop clinging to outside …6

(vii) Why is an indicator used when carrying out a titration? **6**

to find or detect the end point / to indicate when sufficient acid has been added to neutralise the base /
reference to colour change …6

(viii) Name an indicator used in titrations. **3**

phenolphthalein, methyl orange, litmus, starch, etc

any named indicator…3

(c) The titration was complete when 23.6 cm^3 of 0.15 M hydrochloric acid reacted with 20 cm^3 of the potassium hydroxide mixture.
The equation for the reaction is:
$HCl + KOH \rightarrow KCl + H_2O$
Calculate the concentration of the potassium hydroxide mixture. **6, 3**

$\frac{V_1M_1}{n_1} = \frac{V_2M_2}{n_2}$ …6

$\frac{\mathbf{23.6 \times 0.15}}{\mathbf{1}} = \frac{\mathbf{20 \times M_2}}{\mathbf{1}}$ / (M_2 =) 0.177 – 0.18 (mole/l) …3

[correct formula, incorrect substitution …(6) max]

Question 11

Figure 18 shows two products which contain the gas butane (C_4H_{10}), a member of the alkane series. Both products carry the symbol shown in Figure 19.

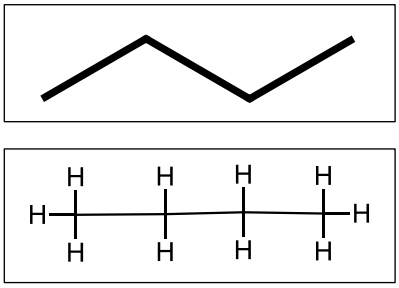
What does this symbol tell you about butane? **6**

flammable …6

Figure 19

Sketch the structure of a butane molecule. **9**

$CH_3CH_2CH_2CH_3$ …9



Why is butane classified as

(i) a hydrocarbon, **6**

compond of carbon and hydrogen (only) …6

(ii) asaturated compound? **6**

all single / no double or triple (carbon-carbon bonds) …6

Name and draw the structure of

(iii) another alkane **6, 3**

name: methane, ethane, propane, etc — any correct alkane

structure: — correct structure of named hydrocarbon

first part correct…6, second part correct…3

(iv) a hydrocarbon that is unsaturated. **6, 3**

name: ethene, ethyne, benzene, etc — any correct hydrocarbon that is unsaturated

structure: — correct structure for the named compound

first part correct…6, second part correct…3

Butane reacts with oxygen according to the following equation:

$$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O \qquad \Delta H = -5756 \text{ kJ}$$

Is this reaction exothermic or endothermic? **3**

exothermic …3

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

releases heat/ Δ*H* negative / all combustion reactions exothermic …6

What is the value of the *heat of combustion* of butane? **6**

(–)2878 (kJ mol^{-1}) …6

[allow –5756 .....3]

Which of the products of the reaction is of great concern in terms of global climate change? **6**

carbon dioxide / CO_2 …6

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

(*a*) What is meant by a mole of a substance? **6**
SI unit for amount (of a substance) / (amount that) contains Avogadro number or 6 ×10^{23} of particles or atoms or molecules) / molecular or atomic mass in grams …6

Magnesium metal is added to fireworks to give a brilliant white light flashes to displays as shown in Figure 20.
In a firework explosion, the magnesium reacts with oxygen according to the following equation:

$2Mg + O_2 \rightarrow 2MgO$

Give one source of oxygen gas. **6**
air, refrigeration of air, photosynthesis, electrolysis any one…6

When 36 g of magnesium react completely in this way,calculate
(i) the number of moles of magnesium used **2×3**
(M_r =) 24 …3
36 ÷ 24 = 1.5 (moles) …3

(ii) the mass of magnesium oxide produced **3×3**
1.5 moles ...3
(M_r = 24 + 16 =) 40 …3
1.5 × 40 = 60 (g) …3

(iii) the volume of oxygen gas, measured at s.t.p., required. **2×3**
[O = 16; Mg = 24; molar volume at s.t.p. is 22.4 litres]
0.75 (moles) …3
0.75 × 22.4 = 16.8 (litres) …3

(*b*) Figure 21 shows carbon dioxide (CO_2) gas being prepared in the laboratory by the addition of a liquid A on to solid B.

Give the names or formulae of A and B. **9, 3**

A: hydrochloric acid or HCl, etc

B: calcium carbonate or $CaCO_3$, etc

[allow any acid dropped on to any carbonate or hydrogencarbonate]

first correct…9, second correct…3

State (i) one physical property of CO_2,

dense, colourless, no odour or faint sweet odour, soluble in water, tasteless, etc any one

(ii) one chemical property of CO_2.

acidic, reacts with water to form carbonic acid, reacts with bases, reacts with limewater, etc any one

9, 3

first correct…9, second correct…3

Give two uses for carbon dioxide. **6, 3**

Fire extinguishant /
to carbonate water or beer(s) or beverage(s) /
photosynthesis /
stage effects /
refrigerant, etc

first correct…6, second correct …3

(*c*) The elements nitrogen, carbon, oxygen and chlorine all react with hydrogen to form compounds called hydrides. The table below refers to the simplest hydride of each of these elements.

	carbon	nitrogen	oxygen	chlorine
name of hydride		ammonia		hydrogen chloride
formula of hydride	**CH_4**			

Copy the table above and complete it by filling in the missing compound names and formulae.

3×4, 2, 1

	carbon	nitrogen	oxygen	chlorine
name of hydride	**methane**		**water**	
formula of hydride		**NH_3**	**H_2O**	**HCl**

Identify in your table (i) an acidic hydride, (ii) an amphoteric substance. **4, 2**

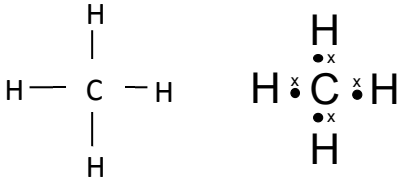
(i) *acidic*: HCl or hydrogen chloride

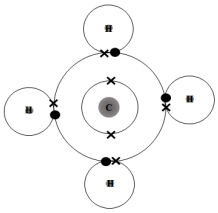
(ii) *amphoteric*: H_2O or water

first correct…4, second correct …2

Draw a diagram to show the bonding in a CH_4molecule. **9**

four bond pairs





…9

State the shape of a moleculeof CH_4. **3**

tetrahedral …3

[allow good drawing to represent tetrahedron…(3)]

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