Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2019

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.

Coimisiún na Scrúduithe Stáit
State Examinations Commission

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 drone of mass 0.31 kg used in racing competitions.
Calculate the weight of the drone.
[acceleration due to gravity, g = 9.8 m s^{-2}] **2×3**
$W = mg$ …3
0.31 × 9.8 = 3.0(38) (N) …3

(*b*) A fitness app on a smartphone revealed that a person covered 4.3 km in 6,323 steps.
What was the person's average step length? **6**
4300 ÷ 6323 = 0.68 (m) / 4.3 ÷ 6323 = 0.00068 (km) ...6

(*c*) An athlete changes velocity from 6 m s^{-1} to 7 m s^{-1} in two seconds.
What is the acceleration of the athlete? **2×3**
$a = \frac{v-u}{t}$ / $v = u + at$ …3
($a = \frac{7-6}{2}$ =) 0.5 (m s^{-2}) …3

(*d*) Give one example of a thermometric property. **6**
height or length or volume (of liquid), pressure, resistance, emf, etc ...6

(*e*) Name the theory based on the idea that particles of a gas are in constant random motion. **6**
kinetic (theory of gases) ...6

(*f*) Give one use for a converging lens. **6**
correction of eye defect or glasses or spectacles or contact lens / cameras / telescopes / microscopes / magnifying glass, etc …6
[use for curved mirror ….3]

(*g*) Figure 2 shows a waveform.
What term is given to the distance marked X? **6**
amplitude …6
[allow height …6]

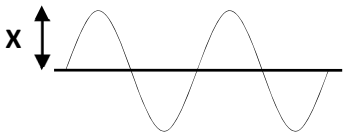


Figure 2

(*h*) What term describes what happens when two waves with same wavelength meet? **6**
(constructive or destructive) interference ...6
['cancel' or 'cancellation'…3]

(*i*) Figure 3 shows a set of wavefronts approaching a narrow opening.
Copy the diagram to show the path of the wavefronts after passing through the opening. **6**

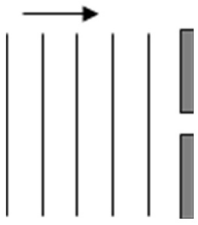


Figure 3

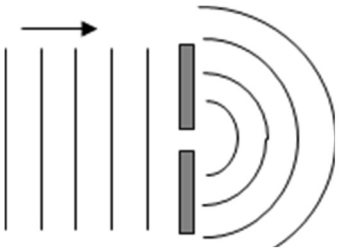


Figure 3 completed

diffraction shown for at least two wavefronts …6

(*j*) State the purpose of the fuse found inside a three-pin plug. **6**

to melt or blow or break (when current is too large) / circuit breaker ...6

['safety' with no explanation …3]

(*k*) What is produced across the ends of a length of copper wire in a changing magnetic field? **6**

emf or voltage or potential difference / current / electromagnetic induction …6

[Allow electricity …3]

(*l*) Define *capacitance*. **2×3**

$Q \div$ / ratio of charge to // ability to store (energy by separation of) …3

V / potential difference or voltage // charge …3

[Allow $C = \varepsilon A/d$….6]

(*m*) Figure 4 shows two 8 μF capacitors connected in parallel.
Calculate the effective capacitance of the combined capacitors. **2×3**

$C_1 + C_2 = C$ …3

(C =) 8 + 8 = 16 (μF) …3

[Allow 0.25 (μF) ...3][Allow 4 (μF) …2]

(*n*) Which subatomic particle is released from the surface of a metal as a result of the *photoelectric effect*? **6**

electron(s) …6

(*o*) Name the main nuclear process that takes place in the core of the sun. **6**

fusion …6

[Allow fission …3]

Question 2

State the law of conservation of energy. **5, 1**

energy cannot be created or destroyed …5

but can be converted from one form into another …1

Define *work* and state its S.I. unit of measurement. **2×6**

(work is done when) a force moves its point of application through a distance (in direction of force) /

(*W* =) *Fs* …6

(S.I. unit is) joule or J …6

Figure 5 shows a bow before and after it was prepared by an archer to fire an arrow at a target.
The archer used an average force of 180 N to pull the centre of the string back by 0.45 m.

Calculate the work done by the archer in pulling the string on the bow. **6, 3**

(*W* =) *Fs* / (*W* =) 180 × 0.45 …6

(W =) 81 J …3

[no unit or incorrect unit (–1)]

What energy conversion takes places in the bow as the archer pulls back on the string? **2×6**

kinetic …6

(to) potential …6

[order reversed …6]

Explain why no work is done by the archer if the pulled string is held steady. **6**

no movement / work done only when something moves …6

During a practice session an arrow of mass 62 g is released with a speed of 60 m s^{-1}.
The arrow strikes the centre of a target after 1.2 seconds.
Calculate

(i) the mass of the arrow expressed in kilograms (kg) **6**

(62 ÷ 1000 =) 0.062 (kg) …6

(ii) the initial kinetic energy of the moving arrow **6, 3**

(*K.E.* =) $\frac{1}{2}mv^2$ …6

(*K.E.* =) ½ (0.062 × 3600) = 111.6 J …3

[no unit or incorrect unit (–1)]

(iii) the horizontal distance the arrow travels before striking the target. **2×3**

(*s* =) *vt* …3

(*s* =) 60 × 1.2 = 72 m …3

Question 3

The path of a light ray is changed by reflection in a mirror.

Give one other phenomenon which changes the path of a ray of light. **6**

refraction / dispersion / diffraction / interference / total internal reflection, etc …6

A plane mirror was used in an experiment to verify the relationship between the angle of incidence and the angle of reflection.

What is meant by the underlined term? **6**

flat / not curved / not convex nor concave …6

[Allow normal or usual …6]

Describe, with the aid of a diagram, how the angle of reflection could be found after a light ray strikes a plane mirror at an angle. **3×3**

incident ray and mirror drawn / mirror and pins drawn …3

incident and reflected ray described or drawn (arrows not essential) // two pins lined up with images of two pins indicating the reflected ray, described or drawn (arrows not essential) ...3

normal described or drawn / measure (angle of reflection) using protractor / angle of reflection labelled …3

State the relationship between the angle of incidence and the angle of reflection. **9**

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

Figure 6 shows a pin placed 12 cm in front of a curved mirror of focal length 4 cm.

Give the name of this type of curved mirror. **9**

concave …9

[converging …6][convex …3]

Copy the diagram and complete it to show how the two rays are reflected and then meet at the head of the image pin. **6, 3**

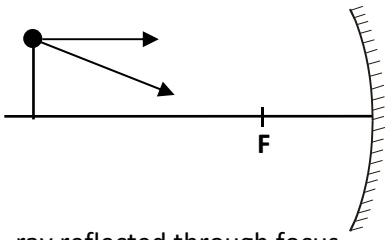


Figure 6

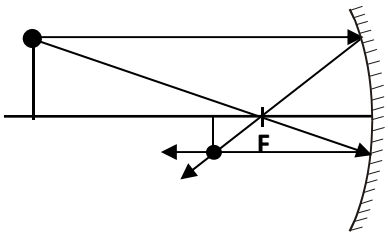


Figure 6 completed

ray reflected through focus

ray reflected parallel to principal axis

first ray drawn correctly …6, second ray drawn correctly …3

Give two differences between the properties of this image and the properties of images formed in plane mirrors. **5, 1**

this image in concave mirror:	*images in plane mirrors:*
real	virtual or imaginary
inverted or upside down	erect or right side up
diminished or smaller than object	same size as object or unmagnified
image distance and object distance differ	same distance behind mirror as object is in front

first line correct …5, second line correct …1

Take order of question if candidate does not indicate which properties are associated with which type of mirror

Give one use for

(i) a plane mirror, **6**

seeing one's image / for shaving / for applying make-up / send a signal / change direction of a beam of light, etc …6

(ii) a curved mirror. **6**

produce a magnified image / produce a diminished image / produce an inverted image / in dentistry / for shaving / for make-up application / reflector in lamp / security (mirror) / wide-field of view or blind exit mirror, etc …6

Question 4
Water freezes to form ice.
At what temperature does pure water freeze on the
(i) Celsius scale, **3**
0 / zero / 0.15 …3

(ii) Kelvin scale? **3**
273 / 273.15 …3

'The …… of a fixed …… of gas is …… to the absolute …… at a constant ……'.
The following terms are missing from Charles law given above:
mass volume pressure temperature directly proportional
Copy and complete this statement of Charles' law in your answerbook. **6, 4×3**

'The volume of a fixed mass of gas is (directly) proportional to the absolute temperature at a constant pressure.'

first correct …6, next four correct…4×3

A balloon containing 100 cm^3 of neon gas at 300 K was cooled to 150 K.
Use Charles' law to predict the new volume of the gas in the balloon at 150K. **3×3**
$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ …3
$\frac{100}{300} = \frac{V_2}{150}$ …3
(V_2 =) 50 cm^3 …3
[no unit or incorrect unit (–1)]

The following data was collected during an experiment to investigate the relationship between the pressure and the volume of the gas in an apparatus at a constant temperature *T*:

Pressure (kPa)	600	300	200	150	120	100
Volume (L)	1.0	2.0	3.0	4.0	5.0	6.0

Draw a graph of pressure (*y*-axis) against volume (*x*-axis). **5×3**
x-axis labelled volume or L …3
y-axis labelled pressure or kPa …3
six points plotted correctly …3
points joined by a curve …3
of good fit …3
[Allow 12 (max) if graph paper not used.][No penalty if axes reversed].

Use your graph to estimate the pressure of this gas when it occupies a volume of 1.5 litres under similar conditions at temperature *T*. **6**
430 ± 50 (kPa) …6

Which Irish scientist has a gas law named in recognition of his work examining the relationship between the pressure and the volume of a gas at constant temperature? **6**
Boyle …6

What term is given to the gas which obeys the gas laws at all temperatures and pressures? **6**
ideal …6
[allow …3 for real]

Question 5

(*a*) State *Ohm's law*. **3×3**

current (in a conductor) // potential difference …3
at constant temperature is proportional to …3
potential difference // current (in a conductor) …3
[reference to temperature omitted (–1)] [Allow $V = IR$...6]

Figure 7 shows a circuit with two light bulbs, A and B, in series with a battery. A has a resistance of 5 Ω and B has a resistance of 10 Ω. The current in the circuit is 0.80 A.

Calculate

(i) the effective resistance of this combination of the two bulbs **6, 3**

$R = R_1 + R_2$ / $R = 5 + 10$ …6
($\Rightarrow R =$) 15 (Ω) …3
[parallel instead of series …3 max]

(ii) the potential difference (voltage) across the battery in the circuit **2×3**

$V = IR$ / $I = \frac{V}{R}$ …3
($\Rightarrow$ V =) 0.80 × 15 = 12.0V …3
[no unit or incorrect unit (–1) but once only in parts (ii) and (iii)]

(iii) the voltage across bulb A. **3**

$V = IR$ / $I = \frac{V}{R}$ ($\Rightarrow$ V =) 0.80 × 5 = 4.0V …3
[no unit or incorrect unit (–1) but once only in parts (ii) and (iii)]

Name a device to measure electric current. **6**

ammeter / galvanometer / multimeter …6

Give two effects of an electric current. **6, 3**

magnetic / heating / chemical first correct …6, second correct...3

(*b*) All electrical appliances in the home connected to mains voltage are supplied by a.c.
What does a.c. stand for? **2×3**

alternating …3
current …3

Electrical energy supplied to the home is billed depending on the number of 'units' used.

Figure 8 shows part of an energy label from a dishwasher indicating an average annual usage of 280 units.
Calculate the average number of units used per month. **3**

(280 ÷ 12 =) 23.333 (units per month) …3

If each unit costs 22 cent what is the average electrical cost of using the dishwasher per month? **6**

(23.3333 × 22 =) 513.333 cent / €5.13 …6
[no unit or incorrect unit (–1)]

Give two factors that contribute to the number of units billed when an appliance is used to carry out a certain task. **6, 3**

power (rating of appliance) / number of kilowatts or watts /
[allow energy or voltage or current or efficiency for power]
time (appliance is operating) / how long it takes (to do the task)
first correct…6, second correct…3

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

(*a*) What is meant by *momentum*? **2×3**
product of mass / m × ...3
and velocity / v ...3

State the *principle of conservation of momentum*. **2×3**
when no external force acts or in a closed system momentum before equals //
when no external force acts or in a closed system(total) momentum remains or is //
when no external force acts or in a closed system $m_1u_1 + m_2u_2 =$ …3
momentum after // constant // $m_1v_1 + m_2v_2$ or $(m_1 + m_2)v$ …3

[when no external force acts or in a closed system omitted (–1)]
[the rate of change of momentum is proportional to the applied force, allow…3]
[principle of conservation of energy, allow…3]

Figure 9 shows two spheres, A and B, each of mass 0.55 kg on a smooth floor.
Sphere B is at rest and sphere A is moving towards it at 4.8 m s^{-1}.
After they collide both spheres move in the same direction with sphere B now moving at 3.6 m s^{-1}.

Calculate
(i) the momentum of sphere A before the collision **2×3**
mv or mu / 0.55 × 4.8 = …3
2.64 kg m s^{-1} (to the right) …3
[no unit or incorrect unit (–1)]*

(ii) the momentum of sphere B after the collision **2×3**
mv or mu / 0.55 × 3.6 = …3
1.98 kg m s^{-1} (to the right) …3
[no unit or incorrect unit (–1)]*
*Penalise once only for no unit or incorrect unit for momentum throughout.

(iii) the velocity of sphere A after the collision. **3×3**
$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ / 2.64 + (0.55 × 0) = $m_1v_1 + m_2v_2$ / 2.64 = m_1v_1 + 1.98 / 2.64 = 0.55v_1 + 1.98 …3
0.55v_1= 0.66 kg m s^{-1} (to the right) / (cancelling mass) 4.8 = v_1 + 3.6 or v_1= 4.8 – 3.6 …3
(v_1 =) 1.2 m s^{-1} (to the right) …3
[no unit or incorrect unit (–1)]*

(*b*) Natural radioactivity is a process that was discovered in the late nineteenth century by the French scientist Henri Becquerel.
Consider the descriptions in the table:

A	**Unstable part of a radioactive atom**
B	**Subatomic particle emitted during β-decay**
C	**Time taken for 50% of a radioactive species in a sample to decay**
D	**Type of radiation stopped by paper and thin sheets of metal**
E	**Used to monitor exposure to radioactivity**
F	**Atoms differing only in the number of neutrons**
G	**Type of radiation *un*deflected by a magnetic field**

In your answerbook match each term below with its description (A, B, C, D, E, F or G) in the table. **7×3**

alpha **electron** **photographic films**
gamma **half-life** **isotopes**
nucleus

A	nucleus		gamma	G
B	electron		electron	B
C	half-life		photographic films	E
D	alpha		alpha	D
E	photographic films		half-life	C
F	isotopes		isotopes	F
G	gamma		nucleus	A

... 7×3

Give two uses of radioactive materials. **9, 3**
medical use or in diagnosis of illness / to treat cancer / 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

first correct…9, second correct...3

(*c*) Figure 10 shows some regions of the electromagnetic spectrum in order of increasing <u>wavelength</u>.

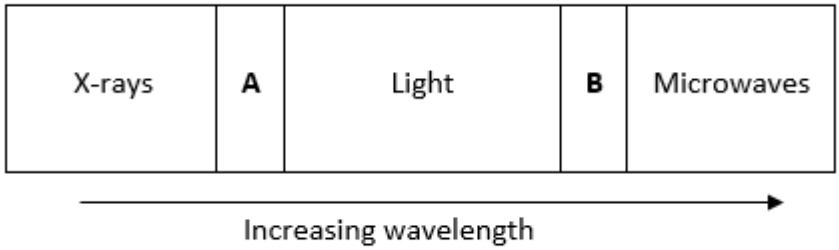
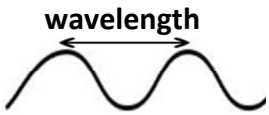


Figure 10

Explain, with the aid of a diagram, the underlined term. **<u>6, 3</u>**
distance from crest to crest / distance from trough to trough /
distance between corresponding points on consecutive waves …6

diagram



...3

[Allow unlabelled wave …3]

State one distinguishing property common to all the waves of the electromagnetic spectrum **<u>6</u>**
speed/ travel at 3×10^8 m s^{-1} / travel in a vacuum or space …6
[Allow velocity]

Identify the type of electromagnetic radiation found at A. **<u>6</u>**
ultraviolet …6

State one characteristic property of the type of electromagnetic radiation found at B. **<u>6</u>**
heating effect / can be detected with a thermometer / used for night vision, etc …6
[Allow correct property for uv if infrared given for A …6]
[Infra-red given as answer – allow …3]

How would you show that visible light is composed of different wavelengths? **<u>6</u>**
split it up into a spectrum / dispersion / use a prism …6

(*d*) State *Coulomb's law of electrical forces*. **3×3**

force between two (point) charges / F …3

is proportional to the product of the charges / $\propto Q_1Q_2$ …3

(and) inversely proportional to the square of the distance between them / $\propto \frac{1}{d^2}$ …3

or

$F = k\frac{Q_1Q_2}{d^2}$ 9

Figure 11 shows two freely-suspended rods which are charged.

Figure 11

Copy and complete the table below to show the possible interactions between the rods depending on their net charges. **4×3**

Charge on rod A	**Charge on rod B**	**Force between rods**
positive		**repulsive**
negative		**attractive**
negative	**negative**	
positive		**attractive**

Charge on rod A	Charge on rod B	Force between rods
positive	**positive**	repulsive
negative	**positive**	attractive
negative	negative	**repulsive**
positive	**negative**	attractive

If the original force between the two rods is 0.02 N calculate the size of the force when

(i) one of the charges is doubled

0.04 (N)

(ii) the distance between the rods is halved. **9, 3**

0.08 (N)

first correct…9, second correct…3

Question 7

Any eleven parts **11×6**

(*a*) Figure 12 shows a *p*-orbital.
What is the maximum number of electrons which can occupy a *p*-orbital? **6**
2 …6
[Allow …6 for 3]

(*b*) How many neutrons has an atom of phosphorus, $^{31}_{15}\mathrm{P}$? **6**
16 …6
[Allow …3 for 15]

(*c*) Give the electron configuration (*s*, *p*) of an atom of boron (B). **2×3**
$1s^2\ 2s^2$ …3
$2p^1$ or $2p_x^1$ …3
[Allow …3 for 2, 3]

(*d*) Give the chemical symbol of the element with a higher electronegativity value than oxygen.
[*Formulae and Tables* booklet, page 81] **6**
F …6
[Allow fluorine ….5]

(*e*) Select the two transition metals from the following:
iron lead magnesium copper **4, 2**
iron
copper
first correct…4, second correct...2

(*f*) The four Bronze Age gold arm bands shown in Figure 13 were found recently in perfect condition by a farmer near Convoy, Co Donegal.
What does this tell you about the position of gold on the electrochemical (activity) series of metals? **6**
low down (electrochemical series) …6
[gold inert or unreactive or difficult to oxidise, etc …3]

(*g*) Define heat of combustion. **2×3**
heat released / heat change involved ...3
when one mole of a substance burns completely or burns in excess oxygen …3
[one mole omitted (–1); completely or in excess oxygen omitted (–1)]

(*h*) What is meant by an *exothermic reaction*? **6**
(reaction where) heat in given out / (reaction where) temperature rises …6

(*i*) Calculate the percentage of carbon by mass in ethyne (C_2H_2). **2×3**
[H= 1; C = 12]
(M_r =) 26 ...3
$\frac{24}{26} \times 100 = 92\%$ …3

(*j*) Identify the two gases produced when an electric current is passed through acidified water. **4, 2**
oxygen / O_2
hydrogen / H_2
first correct…4, second correct...2

[H and O…4]

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

$HCl + CaCO_3 \rightarrow CaCl_2 + H_2O +$ _____ **6**

$2HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$

CO_2 …3

balanced …3

(*l*) Calculate the number of molecules in 4.5 moles of a gas.

[Avogadro constant = $6.0 \times 10^{23} mol^{-1}$] **2×3**

$4.5 \times 6.0 \times 10^{23}$ = …3

2.7×10^{24} …3

(*m*) What is the pH of a 0.028 M solution of nitric acid (HNO_3)? **2×3**

$pH = -\log[H^+]$ …3

(pH =) 1.55 or 1.6 …3

(*n*) Give one use for ethanoic (acetic) acid. **6**

flavouring / (food) preservative / pickling / solvent / reagent / acid, etc ...6

(*o*) Name the organic molecule represented by the symbol in Figure 14. **6**

benzene …6

[C_6H_6....3]

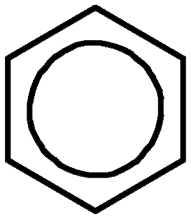


Figure 14

Question 8
As referred to in Figure 15, 2019 has been designated International Year of the Periodic Table of Chemical Elements by UNESCO.

What is an element? **6**
cannot be made simpler (by chemical means) / consists of atoms with same atomic number / consists of one kind of atom …6

Which group of elements in the periodic table on page 79 of the *Formulae and Tables* booklet is chemically unreactive? **6**
Group 18 / Group 8 / last group / noble gases / inert gases …6

Give a reason for your answer. **6**
stable (electron configuration) / stable arrangement of electrons (in outer shell) / 8 (or 2) electrons in valence shell / maximum number of electrons in valence shell …6
[Allow 'full outer shell'.]
[Allow 'outer' for 'valence'.]

What is a molecule? **6**
(group of atoms) joined together chemically / (group of) atoms bonded together / smallest particle of a compound that exists …6

In the table below A is a dot and cross diagram that represents the bond formed between two *atoms* in a molecule. B is a dot and cross diagram representing the bond formed between two *ions*.

What name is given to the type of chemical bonding shown in
(i) A, **6**
polar / covalent …6

(ii) B? **6**
ionic …6

Give an example of a substance containing the type of bonding shown in
(iii) A, **6**
HCl or hydrogen chloride / H_2 or hydrogen, etc …6

(iv) B. **6**
NaCl or salt or sodium chloride / MgO or magnesium chloride, etc …6

Is a substance with the type of bonding shown in B likely to be a solid, or a liquid, or a gas, at room temperature? **6**
solid …6

Give a reason for your answer. **6**
ionic / crystalline or have a lattice or have high melting points / because of the bonding present …6

Substances with the type of bonding shown in B conduct electricity under certain conditions. State one of these conditions. **6**
molten / dissolved in water …6

Question 9

(*a*) Give the Brønsted-Lowry definition of

(i) an acid, **2×3**

(an acid is a) proton / H^+ …3

donor …3

[Allow acid produces protons or H^+ (in solution) ...5]

(ii) a base. **2×3**

(a base is a) proton / H^+ …3

acceptor …3

[Allow base produces hydroxide ions or OH^- (in solution) ...5]

Identify the two bases in the following equation.

$HSO_4^- + OH^- \rightleftharpoons SO_4^{2-} + H_2O$ **9, 3**

OH^-

SO_4^{2-}

first correct…9, second correct...3

What is meant by an acid-base conjugate pair? **3**

two substances that differ by a proton ..3

Give an example of an acid-base conjugate pair from the equation above. **6**

HSO_4^- and SO_4^{2-} / OH^- and H_2O …6

What term describes an acid which *fully* dissociates in water? **6**

(Arrhenius) strong (acid) …6

(*b*) Define oxidation in terms of electron transfer. **6**

loss (of electron(s)) …6

Identify the substance oxidised in *each* of the following reactions:

(i) $CuO + H_2 \rightarrow Cu + H_2O$

(ii) $2KI + Cl_2 \rightarrow 2KCl + I_2$ **9, 3**

(i) hydrogen / H_2

(ii) KI or I^- or (potassium) iodide

first correct…9, second correct...3

Copy, complete and balance the following equation:

$HCl + Mg \rightarrow$ _____ + _____ **2×3**

$2HCl + Mg \rightarrow MgCl_2 + H_2$ …6

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

(iv) Identify the *oxidising agent* in this reaction. **3**

hydrogen chloride / HCl / H^+ …3

[Allow hydrochloric acid.]

Question 10

Figure 16 shows pieces of glassware A and B. B was used to deliver exactly 20 cm^3 of a solution of potassium hydroxide (KOH) into A in preparation for a titration.

(*a*) Give one piece of safety equipment that should be worn when carrying out a titration. **6**

goggles or eye protection / gloves / hair-tie / lab-coat …6

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

conical flask ...6

(*c*) How was B prepared for use? **6, 3**

rinse with deionised or distilled or pure water
rinse with KOH or base or solution it will contain
[Deionised or distilled omitted ...(–1)]

first correct…6, second correct…3

(*d*) Give a *safety* precaution taken when using B. **6**

attach a pipette filler / fill with pipette filler / be careful attaching pipette filler that pipette doesn't break / do not suck solution into mouth (if mouth pipetting) / do not mouth pipette / handle carefully to avoid breaking glass / wear additional piece of safety equipment not awarded marks at (*a*) / etc …6

A burette was prepared and filled with a standard solution of 0.18 M hydrochloric acid (HCl).

(*e*) What is meant by the underlined term? **6**

(solution of) known concentration …6

A was placed on a white tile and a few drops of an indicator were added.

(*f*) What happened to the indicator during the titration? **6**

changes colour (at end point) …6
[Allow 'end point detected' or 'indicates when sufficient acid added to neutralise the base'…6.]

(*g*) What was the purpose of the white tile? **6**

colour change of indicator clearer or easier to see …6

Readings were taken from the burette before the titration was carried out and at the end point.
The average volume of HCl added to A was 17.8 cm^3.

(*h*) Give a precaution when taking a reading from a burette. **6**

read at eye level / read bottom of meniscus / place a white or dark surface behind burette at liquid level, etc …6

(*i*) Why should the titration be repeated a number of times? **6**

to get an average / average more accurate than an individual reading / to cancel errors / good (scientific) practice / to ensure accuracy / part of procedure, etc …6

The equation for the reaction between hydrochloric acid and potassium hydroxide is:

HCl + KOH → KCl + H_2O

(*j*) Using the data above calculate the concentration of the KOH solution. **3×3**

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

$\frac{\mathbf{17.8 \times 0.18}}{\mathbf{1}} = \frac{\mathbf{20 \times M_2}}{\mathbf{1}}$ …3

(M_2 =) 0.16 – 0.1602 (mole/l) …3

[correct formula, incorrect substitution …6 max]

or

moles of HCl used = $\frac{17.8 \times 0.18}{1000}$ …3

(moles HCl used) = 0.0032 …3

0.0032 moles of KOH in 20.0 $cm^3 \Rightarrow \frac{0.0032 \times 1000}{20}$ = 0.16 (moles /L) [0.16 – 0.1602 M] …3

Question 11

Ethene (C_2H_4) is a <u>hydrocarbon</u> and is the first member of a particular <u>homologous series</u>.

Explain the underlined terms.

hydrocarbon: **5, 1**

compound of carbon and hydrogen …5

only …1

homologous series: **6**

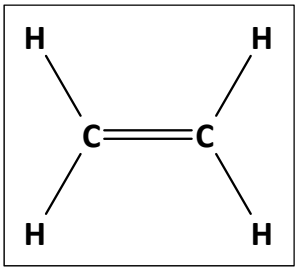
(series of) compounds with similar or same properties /
(series of) with same functional group /
(series of) compounds that differ by CH_2 /
(series of) compounds with gradation of physical properties

any one…6

To which homologous series does ethene belong? **6**

alkenes ….6

Sketch the structure of ethene to show all of its atoms and all of its bonds. **6**



…6

Methane (CH_4) is also a hydrocarbon.

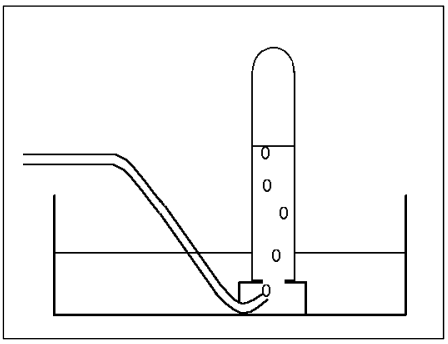
Explain why it is not a member of the same homologous series as ethene. **6**

(methane is) an alkane / (methane has) no double bond / (methane is) saturated /
(methane contains) all single bonds …6

Figure 17 shows part of a laboratory set-up to prepare and collect samples of ethene gas for testing. In the experiment vaporised ethanol is passed over a hot catalyst C.

Explain, using a diagram, what additional apparatus must be added at X to collect the gas. **9**

Collect gas over water in gas jar or test tube, etc / gas syringe / gas fills balloon, etc …9



delivery tube …3

water / trough …3

gas jar/test tube/ container …3

What chemical was used as the catalyst C? **6**

aluminium oxide / alumina / Al_2O_3 …6

[Allow sulfuric acid or H_2SO_4]

When separate samples of methane and ethene are burned in excess oxygen the same two products are formed.

Give the chemical formulae for both products. **2×6**

CO_2 …6

H_2O …6

[Name instead of formula (–1)]

How could you distinguish between methane and ethene using bromine solution? **6, 3**

bring hydrocarbon or methane or ethene and bromine (solution) together /
red or brown or orange or yellow colour initially /
becomes colourless in case of ethene or decolourised by ethene or does not decolourise in case of methane or not decolourised by methane

first point …6, second correct…3

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

(*a*) Some vehicles have been fitted with start/stop technology which can momentarily turn off their engines, to save fuel and to reduce carbon dioxide (CO_2) emissions, when the car is delayed in traffic. The car dashboard display shown in Figure 18 indicates that this technology reduced the quantity of CO_2 released on a particular journey by 88 g.

(i) What is the mass of one mole of CO_2? **6**
(12 + (16×2) =) 44 (g) …6

(ii) How many moles of CO_2 are there in 88 g? **2×3**
88 ÷ 44 / $n = \frac{m}{M_r}$ …3
2 (moles) …3

(iii) What volume would 88 g of CO_2 occupy at s.t.p.? **2×3**
(molar volume =) 22.4 (litres) or 22, 400 (cm^3) …3
(2 × 22.4 =) 44.8 (litres) / 44800 (cm^3) …3
[C = 12; O = 16; molar volume at s.t.p. = 22.4 litres]

The car used octane as the fuel for this journey.
On complete combustion, 1 mole of octane produces 8 moles of carbon dioxide.
(iv) How many moles of octane were saved when the CO_2 emissions were reduced by 88 g, assuming there is complete combustion? **6**
0.25 (moles) …6

(v) Why should we limit the release of CO_2 gas into the environment? **9**
(to avoid) global warming / (to avoid) the greenhouse effect / (to avoid) flooding, climate change, loss of species, / (to avoid) acid rain (effects) / to avoid hurricanes or extreme weather or polar icecaps melting, etc …9

(*b*) Figure 19 shows oxygen (O_2) gas being prepared by the decomposition of hydrogen peroxide in the presence of a catalyst.
(i) Give the chemical formula for hydrogen peroxide. **6**
H_2O_2 ...6

(ii) What is the role of the catalyst in this chemical reaction? **6**
speeds up the reaction / changes rate of reaction …6

(iii) Name a suitable catalyst for this reaction. **6**
manganese dioxide / MnO_2 / liver / catalase / celery, etc …6

(iv) Describe a test to verify that the gas collected is oxygen.
relights a glowing splint

(v) Give one commercial use for oxygen gas. **9, 6**
medical or hospital / breathing apparatus / (oxy-acetylene) welding or (oxy-acetylene cutting) steel making / treating sewage /chemical industry /etc

first correct…9, second correct...6

(*c*) **The shape of a molecule can be predicted from the number of bond pairs of electrons and the number of lone pairs of electrons around the central atom.**
Explain the underlined term. **6**
(electrons) not involved in bonding …6

Copy the table below and complete it by filling in the missing information. **2×5, 4×2**

Molecule	Number of bond pairs of electrons	Number of lone pairs of electrons	Shape
BF_3		**0**	
CH_4		**0**	**tetrahedral**
H_2O	**2**		
NH_3		**1**	**pyramidal**

Molecule	Number of bond pairs of electrons	Number of lone pairs of electrons	Shape
BF_3	**3**	0	**trigonal**
CH_4	**4**	0	tetrahedral
H_2O	2	**2**	**v-shaped** allow planar or bent
NH_3	**3**	1	pyramidal

first two correct responses…2×5, then…5×2

State the size of the bond angle found in (i) BF_3, (ii) CH_4. **6, 3**
(i): 120
(ii): 109.5 [104 to 109.5]

first correct…6, second correct…3

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