Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2014

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. Use of an incorrect multiple is an example of a mathematical slip.

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*) State one of *Newton's laws of motion*. **2×3**
an object remains at (rest or) constant velocity / an object stays at fixed speed (in a straight line) …3
unless acted upon by a force …3

or

rate of change of momentum is proportional …3
to applied force (and along line of force) …3

or

for every action / for every force …3
there is a reaction / there is an equal and opposite force …3

(*b*) Calculate the work done when a trolley is pushed 2 m across a floor with a force of 30 N. **2×3**
(W) = Fs …3
= 30 × 2 = 60 (J) …3

(*c*) In the equation $F = \frac{Gm_1m_2}{d^2}$ what does *d* represent? **6**
distance (between centres of m_1 and m_2) / radius …6

(*d*) Figure 1 shows a ray of light approaching a mirror. Copy the diagram to show the path of the ray after striking the mirror. **6**

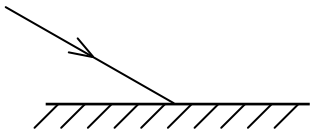


Figure 1

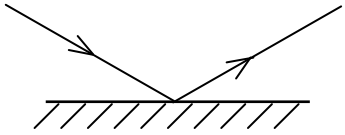


Figure 1 completed

correctly drawn reflected ray, arrow not required …6

(*e*) Give one use for a concave mirror. **6**
to produce a magnified image, for applying make-up, shaving, dentistry, etc, reflector for lamp, etc
any one…6
[correct use for a convex mirror or convex lens allow...3]

(*f*) Figure 2 shows a waveform. What term is given to the distance marked A? **6**
wavelength …6

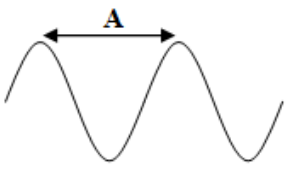


Figure 2

[amplitude allow …3]

(*g*) What name is given to the random motion of smoke particles suspended in air or of pollen grains suspended in water? **6**

Brownian motion / Brownian movement …6

(*h*) Give <u>two</u> assumptions of the kinetic theory of gases. **2×3**

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 any two…2×3

(*i*) Copy and complete the following statement about electric charges. "Two negative charges ……. but a negative charge and a ……. charge attract." **2×3**

repel …3

positive …3

(*j*) Figure 3 shows an isolated positively-charged conductor. Sketch the electric field pattern around the conductor. **5, 1**

Figure 3

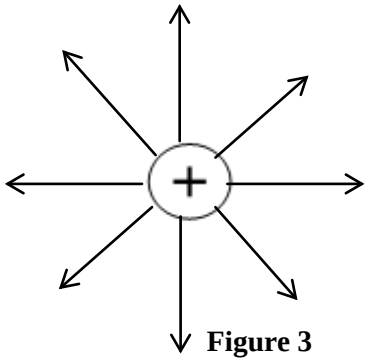


Figure 3 completed

arrows (radially) from surface …5

direction correct …1

(*k*) Figure 4 shows the inside of an electric plug. What is the purpose of the fuse? **6**

to melt when current drawn exceeds certain value, safety, protection, etc any one…6

(*l*) How could you detect a magnetic field? **6**

iron filings, (plotting) compass, suspended magnet swings out of North-South alignment, etc any one…6

(*m*) An electric food mixer, rated at 550 W is used continuously for fifteen minutes. Calculate the number of units (kW h) used. **2×3**

(energy =) power × time = / 0.550 × 0.25 …3

= 0.1375 (kW h) …3

[8.25 allow …5, 137.5 allow ...5, 8250 allow…4]

(*n*) Name the type of nuclear reaction where a large nucleus splits into two smaller nuclei. **6**

(nuclear) fission …6

[fusion allow ….3]

(*o*) In Einstein's famous $E = mc^2$ equation what does *c* represent? **6**

speed of light …6

[*c* is a constant ……3]

Question 2

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

energy cannot be created nor destroyed …5

but can be converted from one form into another …1

Give the SI unit of

(i) mass **5, 1**

kilogram /kg

[any multiple of kilogram, e.g. gram allow…2]

(ii) weight.

newton / N

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

Describe with the aid of a labelled diagram an experiment to measure the acceleration due to gravity, *g*.

Give <u>one</u> precaution to ensure an accurate result.

Arrangement of apparatus shown in diagram **9, 6**

pendulum: suspended bob, string

freefall apparatus: ball, electromagnet, trapdoor or stop/start timing circuit

freely falling object: timer, defined drop

first correct ….9, second correct …..6

[no diagram allow 3 max]

Procedure **3**

pendulum: measure time for bob to complete one oscillation /

freefall apparatus: measure time for fall from electromagnet to trapdoor /

freely falling object: measure time for object to fall from rest through defined drop

any one…3

Measurements / Data handing **3**

pendulum: find g from formula $T = 2\pi\sqrt{\frac{l}{g}}$ or $T^2 = 4\pi^2\frac{l}{g}$ or graph T or T^2 versus $\sqrt{l}$ or l and find g from slope of graph /

free fall apparatus or freely falling object: find g using formula $s = \frac{1}{2}gt^2$ or graph s versus t^2 and find g from slope of graph

any one…3

Precaution **3**

pendulum: average time for several oscillations, repeat for different lengths of string, use long string, measure length to centre of bob, clamp with split cork, etc /

free fall apparatus: average time for several falls or minimum time for several falls of same length, repeat for different lengths of fall, use long fall, measure drop from bottom of ball to top of trapdoor, paper between ball and electromagnet, etc /

freely falling object: repeat to get average time or minimum time for several falls of same length, repeat with different defined drop lengths, use electronic start/stop and not manual start stop system, etc

any one…3

[Description of an experiment involving acceleration …….arrangement of apparatus 6, 3 …….allow 3 **each** for procedure, measurements/data handling and precaution]

During a spell of freezing weather a helicopter was sent to drop bales of hay to stranded animals on a farm. Figure 5 shows the helicopter hovering 70 m above the ground releasing a bale of hay of mass 20 kg. The bale was thrown with an initial downward velocity of 2 m s^{-1}.

Calculate

(iii) the weight of the bale of hay **max 6, 3**

($W =$) mg …6

$(W =)$ $20 \times 9.8 = 196$ N …3

[no unit or incorrect unit (–1)]

(iv) the potential energy lost by the bale of hay in its fall **max 6, 3**

($E =$) mgh …6

($E =$) $20 \times 9.8 \times 70 = 13720$ J …3

[no unit or incorrect unit (–1)]

or

($E =$) $\frac{1}{2}mv^2 - \frac{1}{2}mu^2$ / speed striking ground = 37.1 (m s^{-1}) ...6

$\frac{1}{2} \times 20 \times 37.1^2 - \frac{1}{2} \times 20 \times 2^2 \approx 13720$ J ...3

[no unit or incorrect unit (–1)]

(v) the downward velocity of the bale of hay 3 seconds after it left the helicopter. **max 6, 3**

(v) $= u + at$ …6

(v) $= 2 + (9.8 \times 3) = 31.4$ m s^{-1} …3

[no unit or incorrect unit (–1)]

first part correct ...9 max, second part ...6 max, third part correct ...3

What energy conversion took place as the bale of hay is falling? **max 3, 6**

potential energy (converted to) ...3

kinetic energy …6

[energies reversed ...6]

Explain why the bale of hay may not land vertically below where it is released if the helicopter was moving forward. **max 9**

bale has forward or horizontal motion (as well as downward motion) /wind, etc …9

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

Question 3

What is meant by the *refraction of light*? **5, 1**

bending / change in direction …5

as light travels from one medium to another …1

Copy and complete the following statement of *Snell's law* of the refraction of light. "The sine of the angle of . . . . . is . . . . . to the sine of the angle of . . . . . ." **2×3, 6**

incidence …3

proportional …3

refraction …6

[reflection instead of refraction …3]

A student recorded the following data when investigating Snell's law using a glass block placed on a sheet of paper and a ray of light, as shown in Figure 6.
Angle A……38º
Angle B……24º

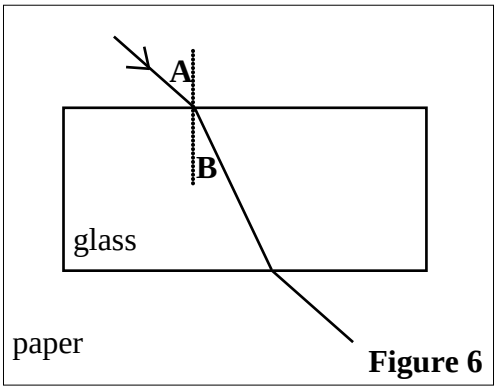


Figure 6

Describe how the student could follow and record the path of the light ray through the glass block. **6, 3**

outline position of glass block on the paper with pen or pencil /
mark incident and emergent ray positions with pen, pencil or pins /
draw lines to represent the incident ray, (emergent ray) and refracted ray /
use a protractor /
to mark in normal where incident ray entered block /
to measure angle of incidence or A and angle of refraction or B /

first correct 6, second correct 3

Use the data above to calculate the refractive index of the glass. **6, 3**

$(n =) \frac{\sin i}{sinr}$ …6

$(n =) \frac{\sin 38}{sin24} = \frac{0.6157}{0.4067} = 1.51$ [Accept 1.50 – 1.55] …3

[*i/r* allow… 3]

Figure 7 shows the path of a ray of light through a triangular prism.
Name the phenomenon that occurs at X. **2×3**

total internal …3

reflection …3

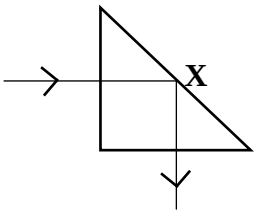


Figure 7

What is meant by the *critical angle* of a substance? **1, 5**

angle of incidence in less dense medium / …1

(corresponding to) angle of refraction of 90° / (that if exceeded) results in total internal reflection …5

The human eye forms an image which is real and inverted.
What is meant by a real image? **6**

formed by intersection of light rays / can be projected on a screen …6

Copy Figure 8 and complete it to show formation of a real, inverted image of O using any two rays.

2×6

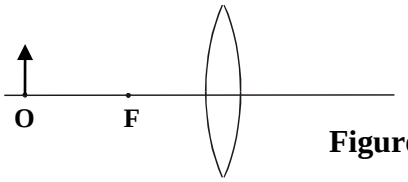


Figure 8

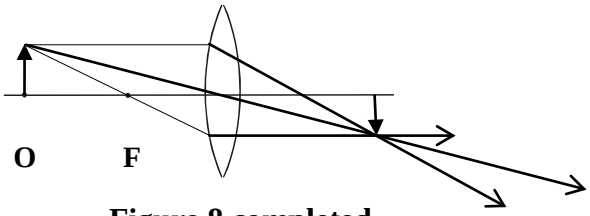


Figure 8 completed

ray through centre of lens undeviated /
ray parallel to principal axis refracted through focus /ray through focus refracted parallel to principal axis
any two… 2×6

[if object is at focus and correctly drawn ray in incorrect diagram …3 for each ray, two correct rays for a mirror ….max 9, one correct ray for a mirror ….3, two intersecting incorrect rays to get image….3]

Question 4

(*a*) The temperature of an object can be measured using the Kelvin scale or the Celsius scale.
What is meant by the *temperature* of an object? **2×3**
the degree of /measure of /reading of ...3
hotness ...3

What is the significance of (i) absolute zero on the Kelvin scale **6**
the lowest temperature (theoretically) possible / (state) when the molecules have (almost) no movement / temperature where graph of volume versus temperature of a gas cuts temperature axis / (state) when a gas (theoretically) has no volume, etc ...6

[if give -273 ^{o}C…..5 , if give 273 …..3]

(ii) 100º on the Celsius scale? **6**
boiling point of water / temperature at which water changes to steam or vice versa / upper fixed point on Celsius scale / 373 K, etc ...6

Convert 100º on the Celsius scale to its value on the Kelvin scale. **6**
100 º C = 100 + 273 = 373 (K) ...6

A thermometer is based on a *thermometric property*.
What is meant by a thermometric property? **3**
property that varies with temperature …3

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

(*b*) Using the terms: mass, volume, pressure and temperature, copy and complete the following statement of *Boyle's law*.
"The . . . . . of a fixed . . . . . of gas is inversely proportional to the . . . . . at constant . . . . . ." **4×3**
volume, mass, pressure, temperature // pressure, mass, volume, temperature …4×3

The air inside a car tyre had a volume of 11 litres at a pressure of 340 kPa.
The tyre suddenly burst.
Use Boyle's law to calculate the new volume of the air released from the tyre when it burst.
Assume the atmospheric pressure is 100 kPa. **6, 3, 6**
$p_1V_1 = p_2V_2$ ...6
$340 \times 11 = 100 \times V_2$ ...3
$V_2 = 37.4$ litres ...6
[no unit or incorrect unit (–1)]
[$p \propto 1/V$ ……3]

How do cold tyre pressures compare with warm tyre pressures? **6**
(cold tyre pressures) are less ...6

Question 5

(*a*) Figure 9 shows two ways of connecting a 2 Ω resistor with a 6 Ω resistor.
What term is given to the arrangement of resistors in (i) A, (ii) B? **2×6**
(i) A: series ..6
(ii) B: parallel …6
[reversed allow...3]

Each arrangement can be replaced by a single resistor.
What would the value of this resistor be for arrangement (iii) A, (iv) B? **4×3**
(i) A: $R_1 + R_2 = R$ ...3
(R =) 8 (Ω) ...3

(ii) B: $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{2} + \frac{1}{6}$ ...3
(R =) 1.5 (Ω) …3
[attempt using fractions or formula for parallel resistors …3]

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]

Calculate the current flowing through A when it is connected to a 12 V battery. **2×3**
$V = IR$ / $I = \frac{V}{R}$ …3
$\frac{12}{8}$ = 1.5 A …3
[no unit or incorrect unit (–1)]

(*b*) Why is electrical power transmitted at high voltages over long distances? **6**
more efficient, less energy lost, less power loss, costs less, etc any one ...6

A transformer produces a different output *a.c.* voltage compared to its input *a.c.* voltage.
What does *a.c.* stand for? **3**
alternating current ...3

Give one example of a device in the home that uses a transformer. **6**
mobile phone charger, charger for laptop, charger for power tool, doorbell, TV, etc ...6

A transformer produces an output voltage of 11.5 V when connected to a 230 V supply. If the primary coil has 460 turns, calculate the number of turns on the secondary coil. **3×3**
$\frac{V_i}{V_o} = \frac{N_P}{N_S}$ ...3
$\frac{230}{11.5} = \frac{460}{N_S}$ ...3
(N_s =) 23 …3

What is the principle on which the transformer is based? **6**
(electromagnetic) induction, voltage or current induced in secondary coil as a result of changing (magnetic) flux, etc any one...6
[information on transformer operation ……3, for each piece of information….max 2×3]

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

(*a*) State the *principle of conservation of momentum*. **6, 2×3**
momentum before // momentum // $m_1u_1 + m_2u_2$ …6
equals // remains or is // = …3
momentum after // constant // $m_1v_1 + m_2v_2$ or $(m_1 + m_2)v$ …3
[the rate of change of momentum is proportional to ..3, (and in the same direction as) the applied force…3]
[principle of conservation of energy, allow…6]

Figure 10 shows a large suitcase of mass 20 kg moving on a smooth surface in a straight line at a constant velocity of 0.8 m s^{-1} towards a smaller stationary suitcase of mass 10 kg.
After the collision the smaller suitcase moves with a velocity of 1.2 m s^{-1}.

Calculate
(i) the initial momentum of the larger suitcase **6, 3**
mv / 20 × 0.8 …6
= 16 kg m s^{-1} …3
[no unit or incorrect unit (–1)]

(ii) the velocity of the larger suitcase after the collision **3×2**
$(20u_1 + 10u_2 = 20v_1 + 10v_2)$ / (20 × 0.8) + (10 × 0) = (20 × v) + (10 × 1.2) …2
16 / 20v + 12 …2
v = (4 ÷ 20) = 0.2 m s^{-1} …2
[no unit or incorrect unit (–1)]

(iii) the kinetic energy of the smaller suitcase after the collision. **2×3**
(E_k =) ½mv^2 ...3
(E_k =) ½(10 × $(1.2)^2$) = 7.2 J ...3
[no unit or incorrect unit (–1)]

(*b*) Consider the descriptions in the table.

A	**Radiation detected by a heat sensor**
B	**A group of waves with a common speed of 3×10^8 m s^{-1}**
C	**A wave in which particles of the medium vibrate parallel to the direction in which the wave travels**
D	**Formation of a new wave when two waves with a similar frequency meet**
E	**Release of electrons from a metal surface when light shines on the metal**
F	**Separation of white light into its component colours**
G	**Spreading out of waves around an obstacle**

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

longitudinal waves **photoelectric effect** **diffraction**
infrared radiation **electromagnetic spectrum** **dispersion**
interference

8, 8, 8, 1, 1, 1

Description	Term
A	infrared radiation
B	electromagnetic spectrum
C	longitudinal waves
D	interference
E	photoelectric effect
F	dispersion
G	diffraction

first 3 correct... 3×8, second three correct 3×1

Identify one type of electromagnetic radiation that would be suitable to demonstrate the phenomenon described in E. **6**

uv light / light of high frequency …. 6

(*c*) 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

Figure 11 shows two charged plates of a parallel-plate capacitor.
Copy the diagram and show the electric field pattern between the plates. **2×3**

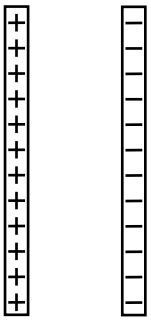


Figure 11

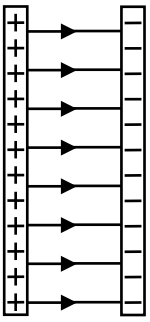


Figure 11 completed

electrical field lines between plates perpendicular to plates …3
arrows in correct direction …3
[arrows reversed (–1)]

What happens to the negative charges when the plates are connected by a piece of wire? **6**

(the negative charges) flow through the wire, the positive charge is neutralised or cancelled, a current flows, the wire gets hot, etc …6

State how the capacitance of this capacitor will change when
(i) the distance between the plates is *decreased*
capacitance increased / $C \propto 1/d$

(ii) the common area between the plates is *decreased*. **6, 3**
capacitance decreased / $C \propto A$

first correct …6, second correct…3

Figure 12 shows a tablet device which uses technology based on the principle of the parallel plate capacitor.
Give a reason why a user cannot interact with the tablet when wearing a regular glove. **3**
glove insulates finger, glove prevents charge distribution between device and finger, etc …3

Give one other example of a device that uses a capacitor. **3**
radio, TV, flash for camera, timer-switch, etc ...3

(*d*) Every <u>radioactive isotope</u> has a different <u>half-life</u>.
Explain the underlined terms. **<u>4×3</u>**

(radioactive isotope) is an unstable (atom or isotope) …3
that undergoes nuclear disintegration …3
[something that emits radiation…3][definition of isotope …3]

(half-life) is the time taken …3
for half a radioactive sample to decay / the activity of a radioactive sample to halve …3

Give <u>two</u> uses for radioactive substances. **<u>11, 1</u>**
medicine, treating cancer, archaeological dating, irradiating food, detecting leaks in pipes or cracks in metals, smoke detectors, nuclear reactors, weapons, etc
first corrrect …11, second correct …1

During alpha (α) decay positively-charged particles are emitted.
Which type of nuclear decay emits negatively-charged particles? **<u>6</u>**
beta-radiation

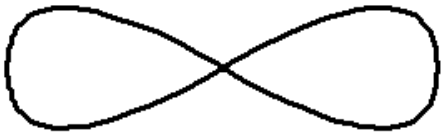
Give one way to deflect charged nuclear radiations. **<u>3</u>**
electrical field / magnetic field …3

Question 7
Any eleven parts **11×6**

(*a*) Figure 13 is a photograph of a neon sign. In the periodic table of the elements what is the *group number* of the element neon (Ne)? **6**
18, 8 or 0 …6
[inert gases, noble gases allow ...3]

(*b*) Copy and complete the following statement about allotropes.
"Allotropes are different …… forms of the same ……." **2×3**
physical …3
element …3

(*c*) Sketch the shape of a *p*-orbital. **6**



dumbell shape …6
[sphere allow…3]

(*d*) Give one property of a transition metal. **6**
hard, dense, solid, conducting, good catalysts, form coloured compounds, have variable valency, electrons in *d*-sublevel, etc any one…6

(*e*) Why is sodium metal very reactive? **6**
one electron in outer shell, unstable arrangement of electrons, alkali metals reactive, reacts to acquire stable arrangement of electrons any one…6
[unstable / reference to need to get a full shell allow …6]

(*f*) Give one example of an ionic compound. **6**
sodium chloride or NaCl, magnesium oxide or MgO, etc any one…6

(*g*) Name the chemical used to test for the presence of carbon dioxide (CO_2) gas. **6**
limewater …6
[sodium hydroxide or potassium hydroxide allow…3]

(*h*) Calculate the percentage of carbon by mass in benzene (C_6H_6).
[H=1; C=12] **2×3**
$M_r = 78$ …3
$\frac{72}{78} \times 100 = 92(.3076)\%$ …3
[total mass of carbon and total mass hydrogen not added....(–1)]

(*i*) Copy, complete and balance the following reaction.

HCl + ____ → **$ZnCl_2$** + ____ **2×3**

2**HCl** + Zn → **$ZnCl_2$** + H_2

Zn / H_2 …3
balanced …3
[2H ….(–1)]

(*j*) What is meant by an *amphoteric* substance? **6**

(substance) that reacts both as an acid and a base / (substance) that can react as an acid or a base / (substance) with acidic and basic properties …6

[correct example (water, ZnO or Al_2O_3) ....3]

(*k*) List the following metals in order of *increasing* activity:

gold magnesium zinc **6**

gold, zinc, magnesium …6

[reversed …3, any one in correct place …..2]

(*l*) Calculate the number of molecules in 4 moles of water. **2×3**

[Avogadro constant = 6.0×10^{23} mol^{-1}]

$4 \times 6 \times 10^{23}$ …3

$= 2.4 \times 10^{24}$ …3

(*m*) Name the <u>two</u> gases produced when electricity is passed through acidified water. **5, 1**

hydrogen

oxygen

first correct …5, second correct …1

[Accept H_2 and O_2 …5, 1; H and O (–1) each]

(*n*) What is the functional group in ethanol (C_2H_5OH)? **6**

OH / hydroxyl …6

(*o*) What structural feature do aromatic compounds have? **6**

benzene ring / hexagon with ring drawn …6

[ring allow…3; hexagon drawn allow…3]

Question 8

(a) Define **9, 3**

(i) *atomic number*,

number of protons (in an atom)

(ii) *mass number*

number of protons and neutrons (in an atom) / number of nucleons (in an atom)

first correct…9, second correct...3

State (iii) the atomic number, (iv) the number of neutrons in an atom of fluorine, $^{19}_{9}F$. **2×3**

(iii) atomic number: 9 …3

(iv) number of neutrons: 10 …3

[reversed ...3]

Write the electron configuration (*s*, *p*) for a fluorine atom. **2×3**

$1s^2\ 2s^2$ …3

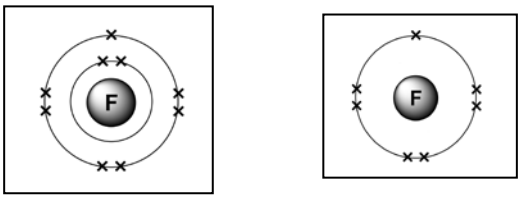
$2p^5$ …3

[2, 7 allow…3]

Chemical bonding determines the properties of substances.

Use a diagram to show how two atoms of fluorine bond together *covalently*. **4×3**

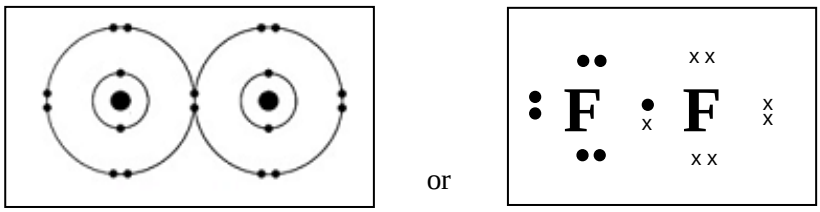
correct depiction of 9 electrons in shells of one fluorine atom using dots and/or crosses



...3

[accept outer shell with 7 electrons shown]

and



or

two atoms of fluorine depicted ...3

total 14 outer shell electrons …3

two electrons shared ...3

[ allow…6]

(b) Electronegativity values (page 81 of the *Formulae and Tables* booklet) are used to predict polarity of a covalent bond.

Classify the bonding in ammonia (NH_3) as pure covalent or polar covalent. **1, 5**

polar …1

covalent …5

[correct electronegativity values difference for N and H, allow...3]

Give a reason why the boiling point of ammonia (–33 ºC) is much higher than the boiling point of fluorine (–188 ºC). **9**

(ammonia has) polar covalent bonding, (ammonia has) stronger intermolecular forces, (ammonia has) hydrogen bonding, fluorine has non polar bonding, fluorine has weaker intermolecular forces, fluorine only has van der Waals forces any one…9

Figure 14 shows the arrangement of outer electrons in a molecule of ammonia.

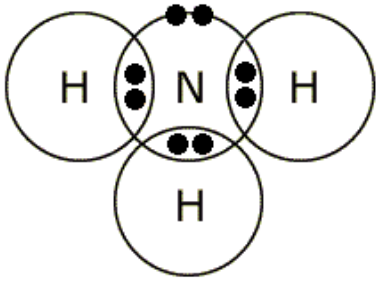


Figure 14

How many (i) bond pairs, (ii) lone pairs, of electrons are there in the outer shell of the nitrogen atom in a molecule of ammonia? **2×3**

(i) bond pairs = 3 ...3

(ii) lone pairs = 1 …3

The number of bond pairs and lone pairs of electrons in the outer shell of the central atom in a covalent molecule can be used to work out the shape of a molecule

What is the shape of an ammonia molecule? **9**

pyramidal …9

[tetrahedral …..6 , v-shaped planar / linear ….3]

Question 9

(*a*) Define (i) an acid, (ii) a base, according to Brønsted-Lowry theory. **4×3**

(i) (an acid is a) proton / H^+ …3
donor …3
[allow acid produces H^+ (ions in solution) ...6]

(ii) (a base is a) proton / H^+ ...3
acceptor ...3
[allow base produces OH^- (in solution) ...6]

Identify (iii) <u>one</u> base, (iv) <u>one</u> acid-base pair in the following reaction. **6, 3**

$$NH_3 + H_2S \rightleftharpoons NH_4^+ + HS^-$$

(iii) bases:
NH_3 / HS^-

(iv) conjugate pairs:
NH_3 and NH_4^+ / H_2S and HS^-

first correct…6, second correct..3

[ignore charges]

Define pH. **3**

$pH = -\log[H^+] / -\log[H_3O^+]$ …3

What is the pH of a 0.035 M solution of nitric acid (HNO_3)? **3×3**

(pH =) –log[0.0035] …3
(pH =) –(–1.4559) …3
(pH =) 1.46 …3

(*b*) Explain (i) oxidation, (ii) reduction, in terms of electron transfer. **4×3**

(i) oxidation: loss …3
of electrons …3
[addition of oxygen or loss of hydrogen …3]

(ii) reduction: gain …3
of electrons …3
[addition of hydrogen or loss of oxygen …3]

[oxidation and reduction reversed …6] [one reversed …3]

Oxidation and reduction are used to extract zinc metal from its oxide.
Identify (iii) the substance oxidised, (iv) the oxidising agent, in the following reaction.

$$ZnO + C \rightarrow Zn + CO$$

6, 3

(iii) the substance oxidised: C
(iii) the oxidising agent: ZnO

first correct…6, second correct..3

[reversed …..3]

Name the electrical process used to extract aluminium from its oxide. **6**

electrolysis ...6

Why is electricity usually used to extract aluminium from its oxide? **6**

aluminium high up electrochemical series / aluminium compounds not easily reduced / aluminium (relatively) reactive or easily oxidised / electricity is most powerful reducing agent / chemical methods or chemical reducing agents not powerful enough, etc any one …6

Question 10

An acid-base titration was carried out to find the concentration of a solution of sodium hydroxide (NaOH) using a standard solution of hydrochloric acid (HCl).

(*a*) What is a *standard solution*? **2×3**

(solution of) known ...3

concentration …3

(*b*) (i) Name the piece of glassware used to transfer exactly 20 cm^3 of the sodium hydroxide solution to a conical flask. **9**

pipette ...9

[burette allow...6]

(ii) Give the two liquids used to rinse this piece of glassware before use. **5, 1**

deionised or distilled water

sodium hydroxide solution / solution being transferred

first correct…5, second correct..1

[deionised or distilled omitted (–1)]

(*c*) A few drops of another liquid were also added to the conical flask. **9, 3**

(i) What was the purpose of this liquid?

to detect end point / to change colour at endpoint / change colour when enough (acid) added /(to act as) indicator

(ii) Suggest a suitable liquid for this purpose.

methyl orange, phenolphthalein, litmus, any named acid-base indicator

['indicator' allow ..3]

first correct…9, second correct..3

(*d*) (i) Sketch the piece of glassware used to add the hydrochloric acid solution to the conical flask. **6**

burette drawing ...6

['burette' only or drawing of pipette allow...3]

(ii) During the titration what should have been done with the conical flask as the hydrochloric acid solution was being added? **6**

swirl (the flask) / wash down sides with deionised or distilled water any one ...6

(*e*) What safety equipment should have been worn throughout this activity? **6**

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

(*f*) The balanced equation for the titration reaction is as follows:

$$\mathbf{HCl + NaOH \rightarrow NaCl + H_2O}$$

To neutralise 20 cm^3 of the sodium hydroxide solution, 24.8 cm^3 of 0.13 M hydrochloric acid was added to the conical flask.

(i) Calculate the concentration of the sodium hydroxide solution. **3×3**

$\frac{V_1M_1}{n_1} = \frac{V_2M_2}{n_2}$ / 26.335 …3

$\frac{\mathbf{24.8 \times 0.13}}{\mathbf{1}} = \frac{\mathbf{20 \times M_2}}{\mathbf{1}}$ …3

(M_2 =) 0.16(12) (mole/l) …3

[correct formula, incorrect substitution …6 max]

(ii) Give one everyday use for NaCl. **6**

flavouring food, preserving food, de-icing roads, (table) salt, etc any one...6

Question 11
Figure 15 shows an oil refinery where crude oil is used as a source of alkanes.

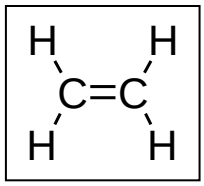
Which elements are found in an alkane? **2×6**
carbon …6
hydrogen …6

Name or give the formula of the first member of the alkanes. **6**
methane or CH_4 …6

Give one major use for this alkane. **6**
fuel, to make hydrogen, steam reforming, raw material, etc any one…6

Alkenes are another family of organic compounds that contain the same elements as the alkanes.
Alkenes are described as unsaturated compounds while alkanes are saturated.
What is meant by the underlined term? **6**
double or triple (carbon/carbon) bond / could add more hydrogen atoms / undergoes addition reactions ...6

Draw the structural formula for ethene (C_2H_4). **6**



…6

[neither carbon nor hydrogen atoms need be explicitly shown]

Describe, with the aid of a diagram, an experiment to produce ethene gas from ethanol. **2×6, 2×3**
glasswool, aluminium oxide and (ethanol) // sulfuric acid and (ethanol)
correct arrangement of test tube on its side // correct arrangement of reaction mixture in flask
source of heat
collection of ethene over water
first two correct ...2×6, second two correct ...2×3
[information may be given in labelled diagram or in words, no diagram (–3)]

Figure 16 shows a sample of ethene gas being bubbled through a test tube containing a solution of bromine (Br_2).
Describe the appearance of a solution of bromine. **3**
red-brown / red / brown / orange / yellow (solution) ...3

What is observed as the ethene is bubbled through the bromine? **3**
decolourises / becomes colourless / (red/brown / orange / yellow) colour disappears ...3

How will this test confirm that the gas bubbled through is an alkene and not an alkane? **6**
colour disappears for unsaturated compounds or in case of alkene / colour remains for unsaturated compounds or in case of alkane …6

Question 12

Answer any two parts. **2×33**

(*a*) Figure 17 shows a piece of coal, a major component of which is the element carbon. Coal often contains small quantities of sulfur in the form of iron sulfide (FeS).

Name the <u>two</u> oxides of carbon that can be produced when coal is burned. **8, 1**

carbon dioxide
carbon monoxide
[accept formulae]

first correct…8, second correct..1

Which <u>one</u> of these oxides is acidic? **3**

carbon dioxide …3

What poisonous gas with a choking smell is produced when coal containing sulfur is burned? **3**

sulfur dioxide / SO_2 …3
[SO, SO_3 allow…3]

What effect, if any, does this gas have on the colour of a piece of damp blue litmus paper? **6**

turns it red …6
[changes the colour allow…6]

The equation for the reaction between iron and sulfur is as follows:

$$\mathbf{Fe + S \rightarrow FeS}$$

When 84 g of iron reacted with sulfur according to the equation above, calculate

(i) the number of moles of iron used **2×3**

84 ÷ 56 …3
1.5 (moles) …3

(ii) the mass of iron sulfide produced. **2×3**

[S = 32; Fe = 56]

(M_r =) = 56 + 32 = 88 …3
88 × 1.5 = 132 …3

(*b*) Figure 18 shows an arrangement for the preparation of oxygen gas using a liquid A and a solid black catalyst B.

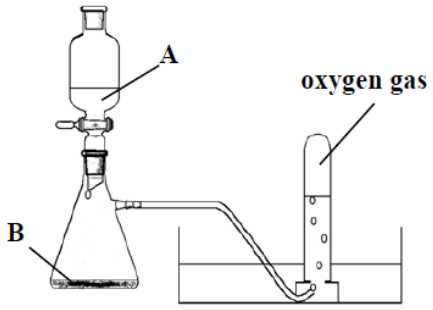


Figure 18

Name

(i) liquid A **6**
hydrogen peroxide …6

(ii) catalyst B. **6**
manganese dioxide …6
[accept formulae][allow liver ...6]

What is the purpose of a catalyst? **6**
to change the speed of a reaction / speed up a reaction …6

Describe a test for oxygen gas. **2×3**
relights …3
a glowing spint …3

Identify the second product of this reaction. **3**
water …3

Give one commercial use for oxygen gas. **6**
steel industry, medicine, for breathing apparatus, etc …6

(*c*) Define the *heat of combustion* of a substance. **5, 1**
heat given out or evolved or involved …5
when one mole (of a substance)is completely burned / is burned in excess oxygen …1

State *Hess's law*. **2×3**
heat change independent / …3
of how reaction is carried out / whether reaction is occurs in one step or several steps …3

What is meant by an *exothermic* reaction? **2×3**
heat …3
given out …3

Octane (C_8H_{18}) burns in air according to the equation:

$$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O \qquad \Delta H = -10{,}940 \text{ kJ}$$

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

Explain your answer. **9**
negative ΔH / all combustion reactions are exothermic …9
[reference to sign of ΔH…3]

Calculate the heat of combustion of octane. **3**
$-10{,}940 \div 2 = -5{,}470$ (kJ mol^{-1}) …3

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