Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2018

Marking Scheme

Physics and Chemistry

Ordinary Level

Note to teachers and students on the use of published marking schemes

Marking schemes published by the State Examinations Commission are not intended to be standalone documents. They are an essential resource for examiners who receive training in the correct interpretation and application of the scheme. This training involves, among other things, marking samples of student work and discussing the marks awarded, so as to clarify the correct application of the scheme. The work of examiners is subsequently monitored by Advising Examiners to ensure consistent and accurate application of the marking scheme. This process is overseen by the Chief Examiner, usually assisted by a Chief Advising Examiner. The Chief Examiner is the final authority regarding whether or not the marking scheme has been correctly applied to any piece of candidate work.

Marking schemes are working documents. While a draft marking scheme is prepared in advance of the examination, the scheme is not finalised until examiners have applied it to candidates' work and the feedback from all examiners has been collated and considered in light of the full range of responses of candidates, the overall level of difficulty of the examination and the need to maintain consistency in standards from year to year. This published document contains the finalised scheme, as it was applied to all candidates' work.

In the case of marking schemes that include model solutions or answers, it should be noted that these are not intended to be exhaustive. Variations and alternatives may also be acceptable. Examiners must consider all answers on their merits, and will have consulted with their Advising Examiners when in doubt.

Future Marking Schemes

Assumptions about future marking schemes on the basis of past schemes should be avoided. While the underlying assessment principles remain the same, the details of the marking of a particular type of question may change in the context of the contribution of that question to the overall examination in a given year. The Chief Examiner in any given year has the responsibility to determine how best to ensure the fair and accurate assessment of candidates' work and to ensure consistency in the standard of the assessment from year to year. Accordingly, aspects of the structure, detail and application of the marking scheme for a particular examination are subject to change from one year to the next without notice.

General Guidelines

In considering this marking scheme the following points should be noted.

1. In many instances only key words are given, i.e. words that must appear in the correct context in the candidate's answer in order to merit the assigned marks.

2. 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 robot vacuum cleaner. The vacuum cleaner moves in a straight line at a speed of 0.32 m s^{-1}. What length of floor would it clean in 5 seconds? **2×3**
$v = \frac{s}{t}$ / $s = vt$ …3
(s =) 0.32 × 5 = 1.6 (m) …3

(*b*) In the equation, *F* = *ma*, what does '*a*' represent? **6**
acceleration …6

(*c*) A bag of cement of weight 196 N is lifted 3 m above the ground.
Calculate the work done. **2×3**
$W = Fs$ ...3
(W =) 588 (J) …3

(*d*) Name any two terminals inside a three-pin plug. **2×3**
live, neutral, earth any two …2×3

(*e*) The temperature on the surface of the moon can reach 123 °C.
What is this temperature on the Kelvin scale? **6**
(123 + 273 =) 396 (K) ...6
[123 – 273 = –150 (K) allow …3]

(*f*) Give one use for a concave mirror. **6**
magnification / in dentistry or for examining teeth / shaving or make-up mirror / reflector or in searchlight or headlamp or torch, etc …6
[shop mirror or use for convex mirror, e.g. security mirror or use for lens …3]

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

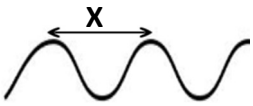


Figure 2

(*h*) An electric shower rated at 9 kW is in use for 6 minutes.
Calculate the number of units (kW h) used. **2×3**
0.1 (hour) …3
9 × 0.1 = 0.9 (kW h) ...3
[900 or 54 allow …3]

(*i*) Figure 3 shows a bar magnet.
Copy the diagram and sketch the magnetic field lines around the bar magnet. **4, 2**
magnetic field lines drawn linking north and south / …4
arrows indicating direction from north to south …2

Figure 3

[Allow indication of strong magnetic field density at poles ...3]

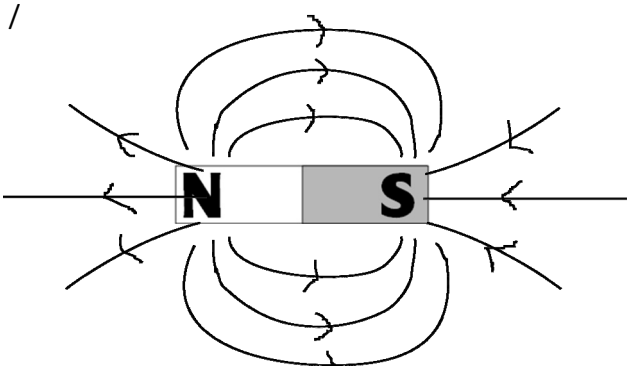


Figure 3 completed

(*j*) Copy and complete the following statement:
"A . . . . . .carrying conductor in a magnetic field experiences a . . . . . ." **2×3**
current …3
force / push / pull / movement …3

(*k*) The electrical force between two identical point charges is 0.24 N.
State the value of the force if the magnitude of *each* charge were doubled. **2×3**
$F \propto \frac{Q_1 Q_2}{d^2}$ **…3**
0.96 (N) …3
[allow …3 for 0.48 (N)]

(*l*) Give one use of a gold leaf electroscope. **6**
detect charge / identify whether charge is positive or negative / identify whether an object is insulating or conducting / estimate magnitude of charge / detect radioactivity / detect photoelectric effect, etc …6

(*m*) List the following types of electromagnetic radiation in order of *increasing* energy:
x-rays gamma ultraviolet **6**
ultraviolet, x-rays, gamma …6
[reversed ...3]

(*n*) Which part of an atom of a radioactive isotope is unstable? **6**
nucleus …6
[centre or middle part, etc allow…5]

(*o*) State Einstein's equation which relates energy and mass. **6**
$E = mc^2$ …6

Question 2

What is meant by

(i) potential energy **6**

energy due to height or position or condition (with respect to a reference point) / stored energy / mgh …6

(ii) kinetic energy? **6**

energy of a moving body / $\frac{1}{2}mv^2$ …6

State the law of conservation of energy. **2×3**

energy cannot be created or destroyed …3

but can be converted from one form into another …3

Figure 4 shows a diver of mass 60 kg about to step off a platform and drop into a pool which is 7.5 m below.

What is the potential energy gained by the diver when she climbs up onto the platform from pool level? **6, 3**

(E =) mgh / (E =) $60 \times 9.8 \times 7.5$ ...6

(E =) 4410 J …3

[no unit or incorrect unit (–1)]

At an instant during the drop the diver's potential energy is 3,660 J.

Calculate

(i) the kinetic energy of the diver at this instant **9**

4410 – 3660 = 750 (J) …9

[no unit or incorrect unit (–1)]

(ii) the speed of the diver at this instant. **2×3**

$750 = \frac{1}{2}mv^2$ / $1500 = mv^2$ / $25 = v^2$ …3

(v =) 5 m s^{-1} …3

[no unit or incorrect unit (–1)]

[Where no marks awarded in (i) and (ii) allow 9 for (E =) = $\frac{1}{2}mv^2$.]

Calculate how long it takes, from the instant she steps off the platform, for the diver to strike the water 7.5 m below. **9, 3 or 2×6**

$s = ut + \frac{1}{2}at^2$ / $7.5 = (0 \times t) + \frac{1}{2}(9.8 \times t^2)$ …9

(t =) 1.24 s …3

[no unit or incorrect unit (–1)]

or

$mgh = \frac{1}{2}mv^2$ / $v^2 = u^2 + 2as$ /

($4410 = \frac{1}{2} \times 60 \times v^2$ or $v^2 = 0^2 + 2 \times 9.8 \times 7.5 \Rightarrow v = 12.12$ (m s^{-1}) / $v^2 = 147$ (m s^{-1})^2 …6

($v = u + at \Rightarrow 12.12 = 0 + 9.8 \times t$) $\Rightarrow$ (t =) 1.24 s …6

[Where no marks awarded for 'how long' allow 6 for any equation of motion, e.g. $v = u + at$ and $s = vt$, etc.]

The next dive is from the 10 m platform.

Does the speed at which she strikes the water change? **6**

yes / speeds up

Explain your answer. **6**

accelerates more / more potential energy at platform / more kinetic energy hitting water / more distance to accelerate / more distance to fall …6

Question 3

State Snell's law of refraction of light. **2×3**

the sine of the angle of incidence is proportional to / sin$i \propto$ // $\frac{\sin i}{\sin r}$ …3

the sine of the angle of refraction / sin$r$ // constant or n or μ ...3

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

[where no other marks awarded, 'the incident ray or beam, the refracted ray or beam and the normal all lie in the same plane' ...3]

Figure 5 shows the path of a laser passing through a transparent prism of refractive index 1.4.

What name is given to (i) angle A, (ii) angle B? **2×6**

(i) angle of incidence …6

(ii) angle of refraction …6

[reversed (unless labelled correctly) ...6]

Using Snell's law, calculate angle B when angle A is 35°. **6, 2×3**

$n = \frac{\sin i}{\sin r}$ / 1.4 = $\frac{\sin i}{\sin r}$ / 1.4 = $\frac{\sin A}{\sin B}$ / 1.4 = $\frac{\sin 35}{\sin r}$ / sin$r$ = sin35 ÷ 1.4 …6

sin$r$ = 0.4097 / sinB = 0.4097 …3

(B = r =) 24.2° / 24° …3

[no unit or incorrect unit (–1)]

Identify the phenomenon which occurs at C. **2×3**

total internal …3

reflection …3

How does angle D compare in size with the critical angle for the material in the prism? **6**

(D) exceeds (critical angle) …6

Figure 6 shows a convex lens on its principal axis and indicates the positions of the focus F and the point 2F. A magnified *real* image is formed when an object is placed between F and 2F. **9, 6**

Identify where on the principal axis an object should be placed to form a magnified *virtual* image.

inside F / between F and lens

[may be shown on diagram]

In what other way do these magnified images differ?

one erect, the other inverted / one image on same side of lens as object, the other on the opposite side

first correct …9, second correct …6

Copy Figure 6 and show the formation of *either* a magnified real image *or* a magnified virtual image. **3×3**

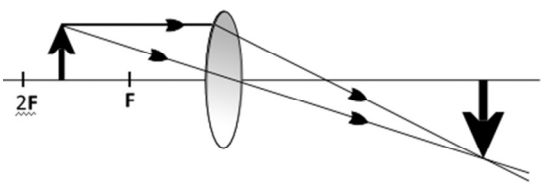


Figure 6, completed

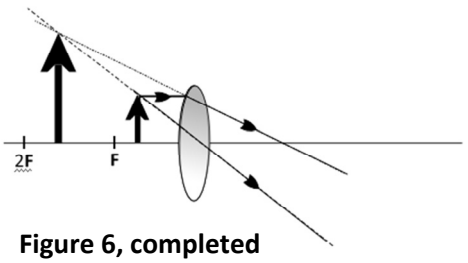


Figure 6, completed

first ray refracted correctly …3

second ray refracted correctly …3

magnified inverted image on opposite side from object, outside 2F / magnified upright image on same side of lens as object ….3

[arrows not essential]

Question 4

(*a*) State two assumptions of the kinetic theory of gases. **2×6**

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…2×6

What is meant by *Brownian motion*? **3×3**

random or zig-zag motion // visible particles …3
of (relatively large) particles // colliding with …3
suspended in air or gas or liquid // invisible particles …3
[Example only …3]

Describe an experiment to show Brownian motion. **2×6**

smoke in box or in air / pollen in water / smoke cell, etc …6
view with microscope / view with eye or lens or microscope …6

(*b*) The resistance of a metal is an example of a thermometric property.
Explain the underlined term. **2×3**

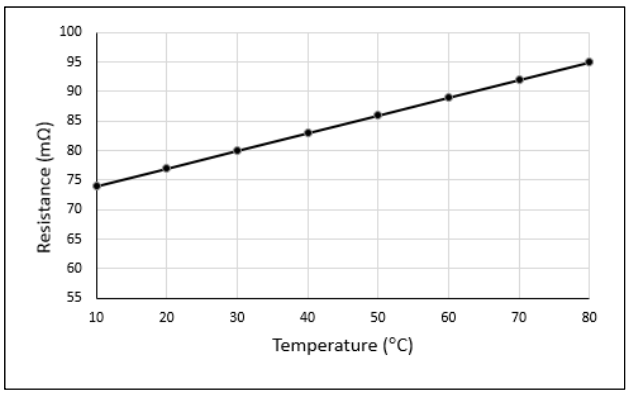
(physical) property …3
that varies with temperature …3
[heat instead of temperature (–1)]

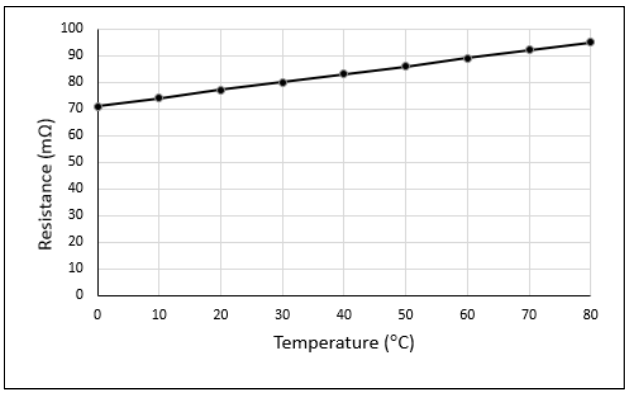
A student collected the following data for the resistance of a length of copper wire over a range of temperatures:

Resistance (mΩ)	74	77	80	83	86	89	92	95
Temperature (°C)	10	20	30	40	50	60	70	80

Draw a graph of resistance (*y*-axis) against temperature (*x*-axis). **7×3**

x-axis labelled temperature or °C …3
y-axis labelled resistance or mΩ …3
suitable scale (*x*-axis need not include 0 °C) …3
suitable scale on *y*-axis …3
any five points plotted correctly …3
all points plotted correctly …3
joined by a line of good fit …3
[Allow 12 (max) if graph paper not used.][Allow axes reversed.]





Using your graph estimate the resistance of the copper wire at 0 °C. **6**

approximately 71 mΩ …6
[no unit or incorrect unit (–1)][accept work leading to about 71 mΩ even if 0 °C not on graph]

Question 5

(*a*) Figure 7 shows a mobile phone charger. It contains a transformer which connects to an alternating current (*a.c.*) supply. **9, 2×3**

What is meant by the underlined term?

current that does not flow in one direction only / electrons oscillate or move to and fro in circuit

Give one source of *a.c.*

mains / transformer / alternator

What is the purpose of a transformer?

converts from one voltage to another / steps up or steps down voltage

first correct …9, second corrrect …3, third correct…3

Figure 8 shows the main parts of a transformer.

Identify the parts labelled A, B and C. **3×3**

A: primary coil …3

B: secondary coil …3

C: core / laminated iron …3

Part A has 4600 turns and is connected to a 230 V a.c. supply.

If the output voltage is 5 V a.c. how many turns are required on Part B? **6, 3**

$\frac{N_p}{N_s} = \frac{V_p}{V_s}$ / $\frac{4600}{N_s} = \frac{230}{5}$ …6

N_s = 100 …3

(*b*) Figure 9 shows two 150 Ω resistors connected to a 9 V d.c. supply.

What term describes this arrangement of the resistors? **6**

series …6

Calculate

(i) the effective resistance of this arrangement of the two resistors **6**

150 + 150 = 300 Ω …6

[no unit or incorrect unit (–1)]

(ii) the current in the circuit **6, 3**

$V = IR$ / $I = \frac{V}{R}$ / (I =) $\frac{9}{300}$ …6

(I =) 0.03 A …3

[no unit or incorrect unit (–1)]

(iii) the power lost by the resistors. **2×3**

$P = VI$ / $P = RI^2$ …3

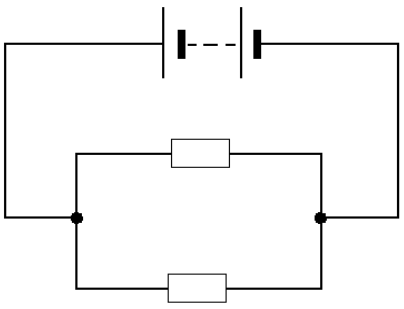
(P = 9 × 0.03 =) 0.27 W / (P = 300 × 0.03 × 0.03) = 0.27 W …3

[no unit or incorrect unit (–1)]

Draw a circuit using the same components that will conduct a larger current. **2×3**

two resistors in parallel …3

connected to battery …3



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

Question 6 (*a*)
What is the *principle of conservation of momentum*? **3×3**
momentum before // (total) momentum // $m_1u_1 + m_2u_2$ …3
equals, when no external force acts, / equals, in a closed system, …3
momentum after // a constant // $m_1v_1 + m_2v_2$ or $(m_1 + m_2)v$ …3
[when no external force acts / 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]

Give the SI unit of momentum. **3**
kg m s^{-1} …3

Figure 10 shows two airport trolleys each of mass 25 kg on a smooth floor.
Trolley A is carrying a suitcase of mass 20 kg and trolley B is carrying a suitcase of mass 10 kg. **2×3**
What is the total mass of
(i) trolley A and its baggage
45 kg …3

(ii) trolley B and its baggage?
35 kg …3

Trolley A moving at 2.2 m s^{-1} collides with trolley B which is at rest. After the collision they connect and move together in the same direction.
Calculate the initial momentum of trolley A and its baggage. **2×3**
mv or *mu* / 2.2 × 45 …3
99 kg m s^{-1} (to the right) …3
[no unit or incorrect unit (–1)]*

Use the principle of conservation of momentum to find the speed of the connected trolleys and their baggage after the collision. **3×3**
$m_1u_1 + m_2u_2 = (m_1 + m_2)v$ / $m_1u_1 + m_2u_2 = 99 + (35 \times 0)$ / $m_1u_1 + m_2u_2 = 99$ / $99 = (m_1 + m_2)v$ …3
$99 = (80 \times v)$ …3
($\Rightarrow v =$) 1.2(375) kg m s^{-1} …3
[no unit or incorrect unit (–1)]*
*Penalise once only for no unit or incorrect unit for momentum.

Question 6 (*b*)

Figure 11 shows a self-illuminating device that can be attached to an object to locate it in the dark. It contains a tiny amount of tritium, a radioactive isotope of hydrogen, in a sealed transparent container.

What is meant by the underlined term? **2×3**

an unstable atom / unstable isotope / atom or isotope emits one or more types of radiation …3

that undergoes decay / that undergoes nuclear disintegration / that breaks-up …3

As the tritium decays it emits electrons which cause a phosphor coating to glow.

Name the type of nuclear radiation emitted by tritium. **6**

beta or β …6

The half-life of tritium is 12.3 years.

What fraction of undecayed tritium will remain in the device after 24.6 years? **2×3**

(24.6 years is) two half-lives / half left after 12.3 years …3

¼ (left after 24.6 years) …3

[allow 25% left]

Does the device become brighter or dimmer over time? **6**

dimmer …6

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

less tritium remaining / more tritium decayed or used up / less radiation (radioactivity) …3

Give one safety precaution taken when using radioactive isotopes. **6**

use shielding or lead, do not handle, use tongs, do not eat or drink, minimise exposure or time, maximise distance, wear protective clothing, etc any one ...6

Question 6 (*c*)

Over 200 years ago Thomas Young demonstrated that visible light has wave properties.

Give two properties characteristic of wave motion. **9, 3**

interference (possible)

diffraction (possible)

first correct …9, second correct…3

[Allow reflection, refraction, polarisation, dispersion, etc.

Figure 12 shows a beam of visible light passing through a glass prism. **3×6, 3**

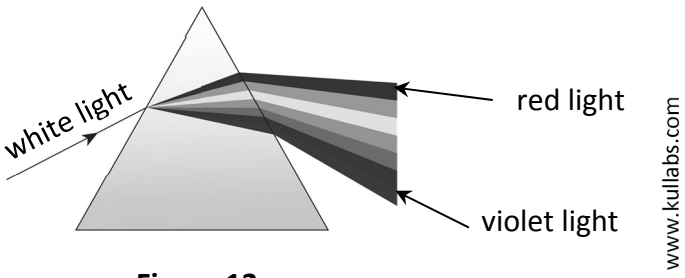


Figure 12

List three colours of light found between the red light and the violet light. **6**

any three from: orange, yellow, green, blue, indigo …6

Identify the type of invisible radiation located just beyond
(i) red light,
infrared

(ii) violet light.
ultraviolet

Describe how you would detect one of these radiations.
infrared: using a (sensitive) thermometer, photographic film in dark, night sights, etc
ultraviolet: by fluorescence, Vaseline, etc, glowing, photographic film in dark, etc

first two correct 2×6, third correct …3

Question 6 (*d*)
Capacitors are commonly found in electronic devices.

Give two devices which contain capacitors. **9, 3**
radio, television, photo flash, voltage detector, etc

first correct ...9, next correct... 3

Consider the descriptions in the table:

A	Stored on the plates of a capacitor
B	The unit used to measure capacitance
C	Defined as the ratio of charge to potential difference (voltage)
D	Substance commonly found between the plates of a parallel-plate capacitor
E	Type of current blocked by a capacitor
F	Arrangement of capacitors if total capacitance is the sum of their capacitances
G	Type of field which exists between the plates of a charged capacitor

In your answer book match *each* of the descriptions (A, B, C, D, E, F or G) above with *one* of the words below. **9, 6×2**

air	**charge**	**parallel**
direct	**capacitance**	**electric**
farad		

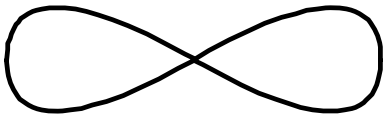
A = charge
B = farad
C = capacitance
D = air
E = direct
F = parallel
G = electric

first correct ...9, next six correct... 6×2

Question 7
Any eleven parts **11×6**

(*a*) What are *isotopes* of an element? **2×3**
atoms with the same atomic number / atoms of same element / atoms with the same number of protons …3
and different mass numbers / with different number of neutrons / with different masses …3

(*b*) Sketch a *p*-orbital. **6**
…6



[allow …3 for *s*-orbital]

(*c*) What general term is given to elements with atomic numbers 22 to 29? **6**
transition (metals) or transition (elements) / *d*-block (element) or *d*-block (metals) …6

(*d*) Give the electron configuration (*s*, *p*) of an atom of carbon. **2×3**
$1s^2\ 2s^2$ …3
$2p^2$ / $2p_x^1\ 2p_y^1$ …3
[allow superscripts instead of subscripts, allow arrows in boxes to represent electrons where boxes labelled with correct sublevel][allow …3 for 2, 4]

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

(*f*) Figure 13 shows the liquid level in a 50 cm^3 burette.
What is the observed reading? **6**
18.7 (cm^3) …6
[Allow 19.3 (cm^3) ...3]

(*g*) Give an example of a substance containing *hydrogen bonding*. **6**
water or H_2O, ammonia or NH_3, hydrogen fluoride or HF, etc …6

(*h*) In the equation $E = hf$, what does $'f'$ represent? **6**
frequency …6

(*i*) Calculate the percentage of oxygen by mass in methanol (CH_3OH).
[H = 1; C = 12; O = 16] **2×3**
(M_r =) 32 ...3
$\frac{16}{32} \times 100 = 50\%$ …3

(*j*) State *Hess's law*. **2×3**
heat change (for a reaction) …3
is independent of path taken / only depends on reactants and products …3

(*k*) Select the two noble gases from the following:

oxygen helium nitrogen argon hydrogen **2×3**

helium ...3

argon …3

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

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

$3 \times 6.0 \times 10^{23}$ = ...3

1.8×10^{24} …3

(*m*) Copy and complete the following equation for the reaction between an acid and a metal.

H_2SO_4 + Zn → _____ + _____ **2×3**

$ZnSO_4$ …3

H_2 …3

(*n*) Give a name for the molecule represented by the structure in Figure 14. **6**

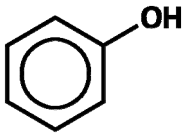


Figure 14

phenol / hydroxybenzene …6

[Allow benzene / alcohol …3]

(*o*) What name is given to the aromatic compound, C_6H_6? **6**

benzene …6

Question 8

Copy and complete the table below using information from the *Formula and Tables* booklet (pages 79 & 81). **2×6, 6×2**

Element	Atomic number	Relative atomic mass	Group number	Period number	Electronegativity value
Mg				3	
Cl					3.16

Element	Atomic number	Relative atomic mass	Group number	Period number	Electronegativity value
Mg	**12**	**24.31**	**2 or II**		**1.31**
Cl	**17**	**35.45 or 35.5**	**17 or 7 or VII**	**3**	

first two correct…2×6, next six correct…6×2

[take 35 for 35.45 or 35.5 as a rounding slip]

Identify another element with the same group number as magnesium. **3**
beryllium / Be / calcium / Ca / strontium / Sr / barium / Ba / radium / Ra any one…3

What do the elements with the same group number have in common? **3**
similar or same chemical properties /
same number of electrons in highest occupied energy level or outer shell …3

How many protons are there in an atom of magnesium? **6**
12 …6

What is meant by relative atomic mass (A_r)? **2×3**
mass of an atom (of an element) …3
relative to (1/12 of the mass) of the C–12 isotope or atom …3

or

average mass of all the isotopes or atoms (of an element) …3
taking their natural or relative abundances into account …3

10% of magnesium atoms have a mass number of 25.
How many neutrons are there in one of these atoms? **6**
13 …6

The type of bonding in the compound magnesium chloride can be predicted from the electronegativity values of magnesium and chlorine.
What type of bonding exists in this compound? **6**
ionic …6

Give two properties of substances with this type of bonding. **9, 3**
high melting points / high boiling points
crystalline / solid
water soluble
conduct electricity when molten or dissolved in water

first correct …9, second correct …3

Question 9

(*a*) Define (i) an acid, **2×3**

(an acid is a) proton or H^+ // acid produces H^+ …3

donor // (ions) in water or aqueous solution …3

[Allow …3 for turns blue litmus red, pH less than 7, sour, etc.]

(ii) pH. **6**

(pH =) $-\log[H^+]$ / (pH =) $-\log[H_3O^+]$ / (pH =) $-\log_{10}[H^+]$ / (pH =) $-\log_{10}[H_3O^+]$ / (pH =) minus the log (to the base ten) of the hydrogen ion concentration …6

[allow …3 for measure of acidity]

Calculate the pH of 0.015 M hydrochloric acid (HCl) solution. **2×3**

(pH =) –log(0.015) …3

(pH =) – (–1.8239) = 1.8 …3

Identify two acids, according to the Brønsted-Lowry theory, in the following equation:

$NH_3 + H_2S \rightleftharpoons NH_4^+ + HS^-$ **9, 3**

H_2S

NH_4^+

first correct …9, second correct …3

Give an example of an acid-base conjugate pair in this equation. **3**

H_2S and HS^- /

NH_4^+ and NH_3 …3

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

gain of electrons …6

Figure 15 shows water, acidified by the addition of a few drops of sulfuric acid undergoing electrolysis using platinum electrodes. Identify two ions present in the solution. **6, 3**

H^+ or H_30^+ /

SO_4^{2-} /

OH^-

first correct…6, second correct…3

Name the electrode labelled

(i) A, **3**

anode / positive electrode …3

(ii) B. **3**

cathode /negative electrode …3

[electrodes reversed ….3]

At which electrode does reduction occur? **6**

B / cathode / negative electrode / electrode on right …6

What gas is produced at this electrode? **6**

hydrogen / H_2 …6

Question 10

A student followed a procedure to <u>standardise</u> a solution of sodium hydroxide (NaOH) using a burette containing 0.18 M hydrochloric acid (HCl).

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

determine or find concentration (of the sodium hydroxide) …6

[allow titrate …3]

What solvent was used in making up the solution of sodium hydroxide? **<u>5, 1</u>**

water …5

deionised …1

Figure 16 shows some of the equipment used.

(*a*) Give two safety precautions taken during this procedure. **<u>2×6</u>**

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

any two…2×6

(*b*) Name the pieces of equipment A, B and C. **<u>3×3</u>**

A: pipette …3

B: wash bottle / water bottle …3

C: conical flask / titration flask …3

(*c*) Why would a beaker not be a suitable alternative to C? **<u>6</u>**

spattering possible / difficult to swirl (without spilling) …6

(*d*) What is the purpose of B during the procedure? **<u>6</u>**

to wash down sides of C to ensure all the acid and base react /
to rinse glassware or pipette or burette /
to hold deionised water for rinsing …6

(*e*) A chemical was added to the sodium hydroxide solution in C in B before the addition of the acid solution. Why was this chemical added? **<u>6</u>**

indicator / to find end point / to change colour at end point / to indicate when NaOH is neutralised ...6

(*f*) The student recorded the following data from the burette containing the acid.

Initial reading	Final reading
24.5 cm^3	48.9 cm^3

(i) How much acid was used during the procedure? **<u>6</u>**

24.4 cm^3 …6

(ii) This volume of 0.18 M hydrochloric acid neutralised 20.0 cm^3 of the sodium hydroxide solution. The equation for the reaction is:

$$HCl + NaOH \rightarrow NaCl + H_2O$$

Calculate the concentration of the sodium hydroxide solution. **6, 3**

$\frac{V_1 M_1}{n_1} = \frac{V_2 M_2}{n_2}$ / $\frac{24.4 \times 0.18}{1} = \frac{20 \times M_2}{1}$ …6

(M_2 =) 0.22 (mole/l) …3

[correct formula, incorrect substitution …6 max]

or

$\frac{\text{volume HCl}}{1000} \times M$ / $\frac{24.4}{1000} \times 0.18$ / 0.004392 (moles HCl or NaOH used) …6

($\frac{0.04392}{20} \times 1000$ =) 0.22 (mole/l) …3

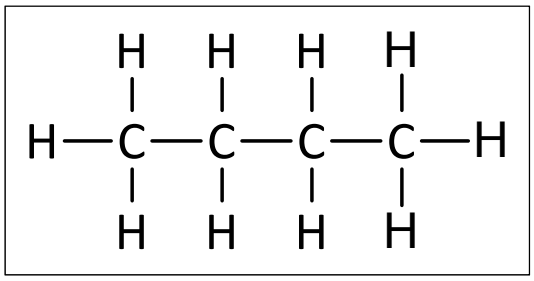
Question 11

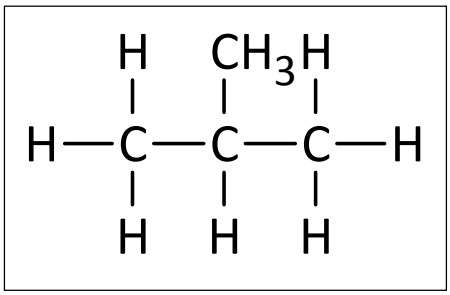
Figure 17 shows examples of common household products containing organic compounds.

Give the formula of butane, a propellant used in hairspray. **6**

C_4H_{10} …6

Sketch a structural formula for a butane molecule. **6**





…6

[Accept either correct C_4H_{10} structure]

Sunscreen contains unsaturated carbon compounds.

Describe a test for unsaturated carbon compounds. **9, 3**

add bromine solution or Br_2 solution or bromine water or bromine in cycloxane, etc / add acidified potassium permanganate or $H^+/KMnO_4$ or H^+/MnO_4^- …9

solution decolorised is a positive result …3

Name the carboxylic acid found in vinegar. **6**

ethanoic (acid) / acetic (acid) …6

The equation for the heat of formation the ketone found in nail polish remover is:

$$\mathbf{3C + \tfrac{1}{2}O_2 + 3H_2 \rightarrow CH_3COCH_3 \qquad \Delta H = -249\ kJ\ mol^{-1}}$$

What is meant by heat of formation? **6, 3**

heat change when one mole of a substance …6

is formed from its elements in their standard states …3

[Deduct one mark for omission of one mole; deduct one mark for omission of standard states.]

Is this reaction exothermic or endothermic? **6**

exothermic …6

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

Δ*H* negative …3

Copy, complete and balance the equation for the combustion of the ketone. **2×6**

$$\mathbf{CH_3COCH_3 + \_\_\_\_\_ \rightarrow CO_2 + H_2}$$

$CH_3COCH_3 + 4O_2 \rightarrow 3CO_2 + 3H_2O$

O_2 …6

balancing …6

Name the ketone found in nail polish remover. **6**

propanone / acetone …6

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

Question 12 (*a*)
Silver nitrate ($AgNO_3$) decomposes upon heating as shown in the equation:

$$2AgNO_3 \rightarrow 2Ag + 2NO_2 + O_2$$

Describe the appearance of each of the three products at s.t.p. **3×3**
Ag: shiny or silvery or metallic or solid …3
NO_2: brown or gaseous …3
O_2: colourless or gaseous …3

What is the mass of one mole of silver nitrate? **6**
108 + 14 + (3 × 16) = 170 g …6
[no unit or incorrect unit (–1)]**

When 85 g of silver nitrate are decomposed, calculate
(i) the number of moles of silver produced **3**
$\frac{85}{170}$ = 0.5 (moles) …3

(ii) the mass of silver produced **2×3**
0.5 moles silver nitrate produces 0.5 moles silver / 0.5 moles Ag …3
0.5 × 108 = 54 g …3
[no unit or incorrect unit (–1)]**

(iii) the total number of moles of gases produced. **3×3**
0.5 moles silver nitrate produces 0.5 moles NO_2 / 0.5 moles NO_2 …3
0.5 moles silver nitrate produces 0.25 moles O_2 / 0.25 moles O_2 …3
0.75 (moles gas) …3
[N = 14; **O = 16**; **Ag = 108]**

** Penalise once only in 12 (*a*)

Question 12 (*b*)

Figure 18 shows sulfur dioxide (SO_2) gas being prepared in the laboratory by the reaction between dilute sulfuric acid and solid sodium sulfite as shown. The gas jar contains a piece of moist red litmus paper and a piece of moist blue litmus paper.

Identify liquid A. **5, 1**

sulfuric acid or H_2SO_4 …5

concentrated …1

Give the purpose of liquid A. **6**

to dry the gas or product or SO_2 …6

State one physical property of SO_2 gas. **6**

colourless / denser than air / soluble in water / choking or pungent or irritating smell …6

What is observed in the gas jar as the SO_2 is collected? **6**

blue litmus turns red or pink /

both litmus papers decolourised / blue litmus goes (pink and then) colourless …6

What chemical property of SO_2 is responsible for this observation?

Why should we limit the release of SO_2 gas in to the environment? **6, 3**

(SO_2 is) acidic /

(SO_2) is reducing or has bleaching affect

[linked to observation]

(SO_2 causes) acid rain / to avoid named effect of acid rain, e.g. deforestation or weathering of buildings /

SO_2 is toxic or poisonous or causes breathing difficulties

first correct …6, second correct …3

Question 12 (*c*)
Many elements react with oxygen to form stable compounds.
The table below refers to oxides of four elements.

Element			**calcium**	
Name of oxide	**water**			
Formula of oxide		**NO_2**		**CO**

Copy the table above and complete it by filling in the missing information. **2×6, 2×3, 2×2, 2×1**

Element	**hydrogen**	**nitrogen**		**carbon**
Name of oxide		**nitrogen dioxide / nitrogen(IV) oxide**	**calcium oxide**	**carbon monoxide**
Formula of oxide	**H_2O**		**CaO**	

first two correct …2×6
third and fourth …2×3
fifth and sixth correct …2×2
last two correct …2×1

From the table identify
(i) an acidic oxide, **3**
nitrogen dioxide / nitrogen(IV) oxide / NO_2 …3

(ii) a basic oxide and **3**
calcium oxide / CaO …3

(iii) a neutral oxide. **3**
carbon monoxide / CO …3
[allow water or H_2O]