Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE 2009

MARKING SCHEME

PHYSICS & CHEMISTRY

HIGHER LEVEL

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General Guidelines

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

1. In many instances only key words are given, 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 alternati ves 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 form a relevant diagram, depending on the context.

6. 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.

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

Question 1

Any eleven parts **11×6**

(*a*) **Define work.**
product of force (applied)//point of application moves // $W = F \times s$ …3
and displacement/distance//in direction of force // explain terms, F, s …3

(*b*) **State Newton's law of gravitation.**
force is proportional to the product of two masses // $F \propto m_1m_2$ / $F = G\, m_1m_2$ …3
and inversely proportional to the square of the distance between them // $\div\ r^2$ …3
[$W = mg$ or $F = mg$ …3]

(*c*) **Distinguish between a vector and a scalar.**
vector has magnitude and direction …3
scalar has magnitude only …3
[two correct examples, one of each …3]

(*d*) **When an object is placed 3 cm in front of a concave mirror, a virtual image is formed 9 cm from the mirror as shown in Figure 1. What is the focal length of the mirror?**

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

$$\frac{1}{3}-\frac{1}{9}=\frac{1}{f}\ ,f = 4.5\ \text{(cm)}$$ …3

(*e*) **Give one difference between a transverse wave and a longitudinal wave.**
transverse waves can be polarized / longitudinal waves cannot be polarized / medium not (always) required for transverse / medium required for longitudinal/transverse vibrations perpendicular to direction of movement of wave and longitudinal vibrations parallel to di rection of movement of wave … 6
[two correct examples, one of each …3]

(*f*) **Give two properties of infrared radiation.**
low energy photons, low frequency, long wavelength, electromagnetic radiation, has a heating effect, can be detected with a thermometer, penetrates mist and fog, used in night vision equipment, security beams, travels at speed of light , etc. first property …5, second property …1

(*g*) **What is the *photoelectric effect*?**
release of electrons from a metal/zinc …3
when exposed to (electromagnetic) radiation/light above a certain frequency/ u.v. light / light of suitable frequency …3
[uv light shines on zinc …3]

(*h*) **Give an expression to define temperature on the Celsius scale.**

$$(\theta =)\ \frac{Y_\theta - Y_0}{Y_{100} - Y_0} \,/\, \frac{Y_0 - Y_\theta}{Y_0 - Y_{100}}$$ …3

$\times\ 100$ …3
or
$(\theta =)\ T - 273$ …6

(*i*) **What is Brownian movement?**
constant /continuous /random /zig-zag movement of particles / molecules (described or drawn)/ movement of visible particles colliding with invisible part icles …3
in a fluid /liquid / gas 3
[smoke in a box, other example …3]

(*j*) **F is the force between the two point charges. What is the force between the charges in terms of F when the distance between their centres is halved?**
4F 6

[$F \propto \frac{1}{r^2}$ / $F = k\frac{q_1 q_2}{r^2}$ …3]

(*k*) **State *Ohm's law*.**
current is proportional to potential difference/voltage / $V \propto I$ / $V = RI$, (R constant) 5
at constant temperature 1

(*l*) **What is *electromagnetic induction*?**
emf /current induced (in a conductor)// $E = -N\frac{d\phi}{dt}$ / $E = -\frac{d\phi}{dt}$ / $E = \frac{d\phi}{dt}$ 3
when there is a change in magnetic flux // explain terms 3

(*m*) **Figure 2 shows a transformer that has 5 turns in the secondary coil and 200 turns in the primary coil. Calculate the output voltage when the primary coil is connected to the 230 V mains supply.**
$\frac{n_s}{n_p} = \frac{V_s}{V_p}$ 3
$\frac{5}{200} = \frac{V_s}{230}$, 5.75 (V) 3

(*n*) **Why do alpha particles have a shorter range in air than beta particles?**
alpha particles are larger (heavier) / beta particles are smaller (lighter)/ alpha particles have greater
charge / alpha particles cause more ionization / beta particles have smaller charge / beta particles cause less ionisation any one… 6

(*o*) **A sample of radioactive iodine–131 had one sixteenth of its original activity after 32 days. What is the half-life of iodine–131?**
4 half-lives 3
32 ÷ 4 = 8 days 3

Question 2

Define acceleration. **2×3**

rate of change // $\frac{v-u}{t}$ / $\frac{dv}{dt}$ // $\frac{d^2s}{dt^2}$ …3

of velocity/of speed in a given direction //explain v, u, t /v, t // explain s, t …3

State *Newton's second law of motion*. **2×3**

rate of change of momentum ∝ to the force // F ∝ ($mv - mu$) ÷ t …3

and is in the same direction as applied force // explain the terms …3

Derive the relationship *force = mass* × *acceleration* from Newton's second law. **3×3**

$\frac{mv - mu}{t} \propto F$ / $\frac{m(v-u)}{t} \propto F$ …3

$F \propto ma$ …3

$F = kma$ and when k = 1, then $F = ma$ …3

[where candidates use = instead of ∝ (–1)]

In an experiment to verify Newton's second law, a force *F* was applied to a trolley that moves over a smooth horizontal surface as shown in Figure 3. The acceleration *a* of the trolley was measured. This procedure was repeated a number of times for different values of the applied force, keeping the mass accelerated constant each time. The values of *F* and the corresponding vales of *a* are given in the table.

F/N	1.64	3.27	4.90	6.53	8.17	9.80	12.50
a/m s^{-2}	1.1	1.9	3.1	4.1	4.7	6.0	7.4

Describe how the acceleration of the trolley was measured. **6, 3**

a method to record or calculate initial and final velocity …6

measurement of interim distance or time/

acceleration calculated from $v = u + at$ / $v^2 = u^2 + 2as$ / $s = ut + ½at^2$ any one…3

Draw a suitable graph on graph paper to show the relationship between the applied force *F* and the acceleration *a*. **4×3**

axes labelled correctly (quantities and units) …3

correct scales …3

five points plotted correctly ...3

suitable straight line through the origin …3

[graph paper not used …deduct 3]*

From your graph, determine the mass accelerated. **3×3**

Select two points from graph to obtain slope …3

[origin and point from table acceptable only if line on graph shown to go through them, otherwise (-1) for each not on graph]

slope = $\frac{y_2 - y_1}{x_2 - x_1}$ /slope = $\frac{y}{x}$ (taking one point as origin) …3

m = 1.67 kg [1.57 – 1.75] …3

[incorrect units/no units/outside range (–1)] [inverse mass …6 maximum]

Calculate how far the trolley would travel in 0.5 s, starting from rest, if the force applied is 5 N. **3×3**

When F = 5 N, a = 3.0 (ms^{-2})[3.2 – 2.85] …3

$s = ut + ½at^2$ …3

s = ½(3.0)(0.5)^2 = 0.375 m [0.40 – 0.36] …3

incorrect units/no units (–1)

The experiment was rearranged, this time applying a constant force to a series of different masses and measuring the corresponding accelerations. What relationship between mass and acceleration was established? **6**

$a \propto \frac{1}{m}$ / $m \propto \frac{1}{a}$ / $a \propto \frac{F}{m}$ / $a \propto \frac{F}{a}$

Accept $F = ma$ …6

[acceleration increases when mass decreases …3]

Question 3

What is refraction of light? **6**

bending of light /deflection of light/light changes direction (as it passes from one medium to another) …6

When does refraction not occur as a ray of light travels from one medium into another? **3**

light strikes boundary (between the two media) at right angles/parallel to normal / (diagram showing) light entering semi-circular block along a line that is an extension of a radius / media have equal (optical) densities/ …3

Define (i) refractive index, **5, 1**

(i) $\dfrac{\sin i}{\sin r}$ // $\dfrac{c_1}{c_2}$ // $\dfrac{1}{\sin c}$ // $\dfrac{real\ depth}{apparent\ depth}$ …5

explain i and r // explain c_1 (speed in less dense medium) and c_2 (speed in less dense medium)/ explain c critical angle …1

(ii) critical angle.

(ii) angle of incidence (in denser medium) corresponding to angle of refraction of 90° …3
[diagram acceptable]

Describe an experiment to measure the refractive index of glass. **6×3**

glass block, ray box / pins, (drawing paper) …2×3

correct arrangement shown or stated …3
incident and emergent rays or refracted ray obtained/ apparent depth located …3
measure i and r /measure real and apparent depth …3
get sin i and sin r /calculate slope/use formula to obtain refractive index …3

Figure 4 shows a ray travelling from water to air from an underwater light source.

Calculate:

(i) the refractive index of water; **9**

$$\frac{\sin 27}{\sin 20} = 1.33$$ …9

(ii) the critical angle of water; **6**

$$n = \frac{1}{\sin c}$$ …3

$$1.33 = \frac{1}{\sin c},\ \sin c = 0.7519 \Rightarrow c = 48.75°$$ …3

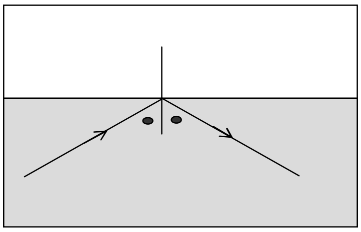
(iii) the speed of light as it travels through water. **3**

$$n = \frac{c_1}{c_2},\ 1.5 = \frac{3\times10^8}{c_2},\ c_2 = \frac{3\times10^8}{1.33} = 2.26\times10^8\ \text{ms}^{-1}$$ …3

[incorrect units/no units (–1)]

Draw a diagram to show what happens when a ray from the underwater light source strikes the water-air surface at an angle that exceeds the critical angle. **6**

reflection at a boundary shown …6



Name this phenomenon and give one application of it. **2×3**

total internal reflection …3

optical fibres, prisms in binoculars, periscopes, sparkle of gemstones, reflectors on bicycle pedals, rear vehicle lights, reflective clothing, etc any one…3

Question 4

***Boyle's law* describes the relationship between the volume and the pressure of a fixed mass of gas at constant temperature. The *kinetic theory* of gases describes the behaviour of the molecules of an *ideal gas*.**

(*a*) **Describe, with the aid of a labelled diagram, an experiment to verify Boyle's law.** <u>6×3</u>

fixed volume of gas shown in drawing …3
scale to read volume drawn …3
pressure guage/device to read pressure drawn …3
volume and corresponding pressure recorded /volume recorded and pressure changed …3
repeat (for a number of values of pressure and volume) …3
PV = constant / graph of P versus $1/V$ straight line through origin stated or shown in diagram …3
[no drawing, drawing with no label (-3)]

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

small quantity of gas has a very large number of molecules / particles,
molecules / particles are in constant (rapid) (random) motion , all collisions are elastic,
molecules / particles collide with each other and with walls of the container,
time spent colliding is small compared to time in between collisions,
there are no forces between the molecules / particles (except during collis ions) any two …2×3

What is an ideal gas? <u>2×3</u>

obeys gas laws / Boyle's law / satisfie s kinetic theory assumptions …3
at all temperatures and pressures …3

How does an increase in temperature affect the behaviour of molecules in an ideal gas? <u>3</u>

(molecules or particles) move around faster / have greater kineti c energy /collide more often / collide more often with walls of container …3

(*c*) **Explain how Boyle's law is consistent with the equation of state of an ideal gas, $PV = nRT$.**
<u>2×3</u>

from Boyle's law PV = constant at constant T//pressure inversely proportional to volume at constant T …3
from $PV = nRT$, PV = constant when n, R and T constant//pressure inversely proportional to volume when n, R and T constant …3

(*d*) **Each bubble of air released from an aerator placed at the bottom of a lake has a volume 1.2 cm^3 when it reaches the surface where the atmospheric pressure is 1.01 $\times$ 10^5 Pa. The temperature of the lake is 4 °C throughout.**
Calculate
(i) the pressure at the bottom of the lake if the bubbles expand to twice their original size as they rise through the water; <u>2×3</u>

$P_1V_1 = P_2V_2$ / $(1.01 \times 10^5)(1.2) = P_2 (0.6)$/ $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ where $T_1 = T_2 = 277$ …3

$P_2 = 2.02 \times 10^5$ Pa …3
[incorrect units/no units (–1)]

(ii) the number of moles of gas in each bubble of air. <u>4×3</u>

$PV = nRT$ …3
$PV = (2.02 \times 10^5)(0.6 \times 10^{-6}) = 0.1212$ /$(1.01 \times 10^5)(1.2 \times 10^{-6}) = 0.1212$ …3
$T = 277$ …3
$n = 5.27 \times 10^{-5}$ …3

(*e*) **Explain the term *thermometric property*.** <u>2×3</u>

property that changes (continuously or measureably) …3
with temperature/hotness …3

Name the thermometer that uses the pressure of a fixed mass of gas as its thermometric property. <u>3</u>

constant volume gas (thermometer) …3

Question 5

Define

(i) electric current, <u>**3**</u>
flow of charge (across a conductor) …3

(ii) the *ampere*, the SI unit of electric current. <u>**3×3**</u>
<u>two</u> <u>infinitely</u> long <u>parallel</u> <u>conductors</u>/wires …3
<u>one metre</u> apart in a <u>vacuum</u> …3
exert a <u>force</u> of <u>2×10^{-7}</u> <u>N per metre</u> …3
[(-1) for every underlined term missing]

Figure 5 shows a moving coil galvanometer. Explain how it measures a small electric current. <u>**6, 3**</u>
force on conductor (carrying current) in a magnetic field …6
restoring force on coil from springs / needle comes to rest on scale / two forces are equal but opposite …3

How is a moving coil galvanometer modified to measure larger currents? <u>**2×3**</u>
resistor / shunt …3
connected in parallel …3
[(-1) for large resistor]

Describe an experiment to demonstrate the heating effect of an electric current. <u>**4×3**</u>
container, water, thermometer, d.c. or a.c. supply, heating coil, ammeter and rheostat or other suitable device drawn or described …3
correct arrangement …3
procedure …3
observation …3

Why does an electricity supply company

(i) transmit electricity over long distances at high voltage; <u>**2×3**</u>
current less …3
less heat generated/ less energy wasted /less po wer lost / more efficient …3

(ii) use alternating current instead of direct current? <u>**6**</u>
transformers 6
[a.c. voltage but not d.c. voltage can be stepped up and down) …3

A power station supplies electrical energy at a voltage of 10 kV and at a rate of 2 MW to a factory. The cables connecting the power station and the factory have a resistanc e of 9.5 Ω.

Calculate

(i) the current flowing in the cables; <u>**2×3**</u>
$P = VI$ …3
$2\,000\,000 = 10\,000I$, $I = 200$ A …3
[incorrect units/no units (–1)]

(ii) the power 'lost' in the cables due to heating. <u>**2×3**</u>
$P = RI^2$ …3
$P = 9.5(200)^2$, $R = 380\,000$ W …3
[incorrect units/no units (–1)]

If the supply voltage is maintained at 10 kV, how can power losses in the cables be reduced? <u>**3**</u>
use cables of lower resistance / greater cross sectional area …3

Question 6

Answer any two parts

Question 6 (*a*)

Define *kinetic energy*.	**2×3**
energy due to motion / work done by moving object	…6
or	
$E = ½mv^2$	…3
explain the terms m, v	…3
[$W = Fs$ …3]	

State the *principle of conservation of momentum*.	**2×3**
in a closed system / where no external force acts	…3
(total) momentum constant // momentum before = momentum after // $m_1u_1+m_2u_2= m_1v_1+m_2v_2$	…3

A cannon of mass 1000 kg containing a cannonball of mass 20 kg was at rest on a smooth horizontal surface as shown in Figure 6. The cannonball was fired with an initial horizontal velocity of 400 m s^{-1}.

Calculate

(i) the recoil velocity of the cannon;	**2×3**
$m_1u_1+m_2u_2= m_1v_1+m_2v_2$	…3
1000(0) + 20(0) = 1000v + 20(400)	
v = (–) 8 (ms^{-1})	…3

(ii) the kinetic energy of the cannon as it recoils.	**3×3**
$E = ½mv^2 =$	…3
$½(1000)(8)^2$	…3
= 32 000 J	…3
[incorrect units/no units (–1)][substitution must be consistent with (i)]	

Why does the cannon recoil?	**6**
for every action there is an equal and opposite reaction / Newton's third law	…6

Question 6 (*b*)

<u>Diffraction</u> and <u>interference</u> occur when a narrow beam of <u>monochromatic light</u> passes though a pair of narrow slits, whose separation is 0.5 mm, and then strikes a screen 1.2 m away. A pattern of bright and dark images is formed on the screen as shown in Figure 7. The distance from the fifth bright image to the central bright image is 7.1 mm.

Explain the underlined terms.	**<u>5×3</u>**
spreading out / bending of a wave	…3
as it passes behind an obstacle / through a (narrow) gap/ into geometric shadow	…3
[good diagram …2×3]	
two (or more) waves	…3
superimpose /meet	…3
[good diagram …2×3]	
Light of single frequency / one wavelength /one colour	…3
How does this experiment contribute to our understanding of the nature of light?	**<u>6</u>**
(evidence that) light has wave nature	6
[light not particulate …3][measures wavelength …3]	
Calculate the wavelength of the light.	**<u>4×3</u>**
$n\lambda = d\sin\theta$ / $n\lambda = \frac{dx}{D}$	…3
$5\lambda = (0.5\times 10^{-3})\sin\theta$ / $5\lambda = \frac{0.5\times10^{-3}x}{D}$ / $\sin\theta = \frac{x}{D} = 1.18\times10^{-3}$	…3
$\lambda = \frac{0.5\times10^{-3}\times(7.1\times10^{-3})}{5\times1.2}$	…3
5.92×10^{-7} m / 592 nm / 0.592 μm	…3
[incorrect units/no units (–1)]	

Question 6 (c)

Define *capacitance*. **2×3**

$Q \div V / \frac{Q}{V}$ …3

explain terms Q, V …3

[$Q \propto V$ …3]

Describe an experiment to investigate how the capacitance of a parallel plate capacitor depends on the separation between the plates. **5×3**

parallel plate capacitor, electroscope / GLE …3

correct arrangement shown or described …3

increase // decrease separation between plates …3

leaves diverge therefore potential difference/voltage increases // leaves collapse or converge therefore potential difference/voltage decreases …3

thus capacitance decreases // increases …3

Figure 8 shows a 6 V battery connected to an arrangement of capacitors.

Calculate

(i) the effective capacitance of the circuit; **3×3**

Capacitance of parallel arrangement = 2 + 1 = 3 (μF) …3

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

$\frac{1}{C} = \frac{1}{3} + \frac{1}{3} = \frac{2}{3}$, $C = 1.5$ (μF) …3

(ii) the charge stored in the circuit when the switch is closed. **3**

$Q = CV = (1.5 \times 10^{-6}) \times 6$ C $= 9.0 \times 10^{-6}$ C / 9 μC …3

[incorrect units/no units (–1)]

Question 6 (*d*)

Determine the value of *A*, the value of *Z* and the symbol of the element represented by X in the following nuclear fission reaction.

$^{235}_{92}\mathbf{U} + {}^{1}_{0}\mathbf{n} \rightarrow {}^{A}_{Z}\mathbf{X} + {}^{90}_{36}\mathbf{Kr} + 2\,{}^{1}_{0}\mathbf{n} + \textbf{energy}$ **3×3**

$A = 144$ …3

$Z = 56$ …3

X = Ba …3

[where candidate gives $Z \neq 56$ and corresponding correct **X** …3 for **X**]

Explain

(i) why a large quantity of energy is released in this reaction; **2×3**

small mass losses generate large quantities of energy …3

according to $E = mc^2$ …3

(ii) why fission of uranium–235 may result in a chain reaction. **2×3**

for every neutron used up//more fission / further reaction results …3

at least one neutron / one or more neutrons / an average of 2.5 neutrons produced // from neutron(s) released …3

Deuterium $^{2}_{1}$H is an isotope of hydrogen. Write a balanced equation for the nuclear fusion reaction when two deuterium nuclei combine to produce a helium nucleus and energy. **3×3**

$^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{4}_{2}He$ + energy / $2\,{}^{2}_{1}H \rightarrow {}^{4}_{2}He$ + energy

mass balanced and atomic numbers balanced …3

correct atomic symbol for helium `…3

energy included …3

Explain why fusion only occurs at extremely high temperatures. **3**

high temperature supplies high (kinetic) energies required /

to overcome repulsive forces / to force or push nuclei together …3

Question 7

Any eleven parts **<u>11×6</u>**

(*a*) **What are isotopes?**
atoms of the same element / same atomic number /same number of protons …3
different mass numbers /different numbers of neutrons …3

(*b*) **What do the terms E_2 and f represent in the relationship $E_2 - E_1 = hf$?**
Energy (of electron in excited state) …3
frequency (of emitted photon) …3

(*c*) **Define *electronegativity*.**
relative attraction / measure of attraction an atom has …3
for shared pair of electrons/for electrons in a (covalent) bond …3

(*d*) **What is the maximum number of electrons that can occupy (i) the third shell, (ii) the 3*p* subshell, of an atom?**
(i) 18 …3
(ii) 6 …3

(*e*) **State the number of (i) neutrons, (ii) protons in the $^{27}_{13}Al^{3+}$ ion.**
(i) 14 …3
(ii) 13 …3

(*f*) **What colour change is observed when chlorine gas is bubbled through a solution of sodium iodide as shown in Figure 9?**
colourless …3
[clear, white, milky : 0 marks]
(to) red brown/golden brown/ orange/yellow …3

(*g*) **Name a metallic element whose salts give a lilac colour to a Bunsen flame.**
potassium …6
[potassium salt (-1)]

(*h*) **Calculate the pH of a 0.2 M solution of sulfuric acid.**
(pH =) $-\log_{10}[H^+]$ …3
(pH =) $-\log_{10}[0.4] = 0.40$ …3

(*i*) **Name two oxides that are involved in the formation of *acid rain*.**
carbon dioxide, sulfur dioxide, nitrogen dioxide, dinitrogen tetroxide, nitrous oxide / nitrogen monoxide any two… 2×3

(*j*) **Define the *heat of formation* of a compound.**
heat change for formation of one mole (of a compound) from its elements …5
in their standard states …1

(*k*) **Explain why the molecule NH_3 has a *dipole moment* while BF_3 does not.**
NH_3 polar bonds not symmetrically arranged *in space* /centre of positive (charge) does not coincide with centre of negative (charge) …3
BF_3 has *spatially* symmetrical arrangement of bonds / centre of positive charge coincides with centre of negative charge …3
[clear diagrams …2×3]

(*l*) **Figure 10 shows gigantic gypsum crystals discovered recently in a cave in Mexico. Calculate the percentage by mass of water of crystallisation in gypsum which has the chemical formula $CaSO_4\,2H_2O$.**

$M_r = 172$ …3

$$\frac{36}{172} \times 100 = 20.93 = 21\%$$ …3

(*m*) **Figure 11 shows *Milk of Magnesia* tablets containing the active ingredient $Mg(OH)_2$ being added to neutralise excess hydrochloric acid in the stomach. Write a balanced equation for this reaction.**

2HCl + $Mg(OH)_2$ □ $MgCl_2$ + $2H_20$

correct formulae for reactants and products …3

balanced …3

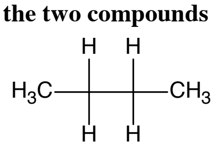
(*n*) **Name a reagent used to distinguish between an aldehyde and a ketone.**

Fehling's reagent /Benedict's reagent/ $Cu(OH)_2$ solution / Tollen's reagent / ammonical silver nitrate …6

[silver mirror test …3]

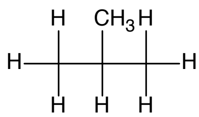
(*o*) **Draw the structures of the two compounds that have the molecular formula C_4H_{10}.**

$CH_3CH_2CH_2CH_3$ /



…3

$CH_3CH(CH_3)CH_3$ /



…3

Question 8

Explain the term *atomic orbital*. <u>**2×3**</u>
region in space/ around the nucleus / in an atom …3
[area unacceptable]
where there is a high probability of finding an electron …3

Write the electron configuration of

(i) a carbon atom, <u>**6**</u>
$1s^2\ 2s^2\ 2p_x^{\ 1}\ 2p_y^{\ 1}$ / $1s^2\ 2s^2\ 2p^2$ …6

(ii) an iron atom. <u>**2×3**</u>
$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ …3
$4s^2\ 3d^6$ …3

(*a*) **Diamond and graphite are crystalline solids of carbon. Explain in terms of bonding why diamond and graphite differ**

(i) in their hardness, <u>**2×3**</u>
strong / covalent bonds in diamond …3
weak van der Waals bonds (hold) graphite (layers togethe r)/each carbon atom forms three strong/covalent bonds and one weak (van der Waals) bond (to another layer of carbon atoms) …3

(ii) in their ability to conduct electricity. <u>**2×3**</u>
no free electrons in diamond /(valence) electrons in diamond involved in covale nt bonding/localised/not free to move/unavailable …3
(some valence) electrons in graphite involved in delocalised bonding/free to move/available …3

(*b*) **Iron is a transition metal.**
How is a transition element identified from its electron configuration? <u>**3**</u>
incomplete d-subshell/ d-orbitals/ form an ion with outer electron(s) in a d -sublevel …3

State two characteristic properties of transition metals. <u>**2×3**</u>
variable valency, form coloured compounds, are good catalysts any two…2×3

The metallic crystalline structure of iron is shown in Figure 12. Describe the bonding in a metallic crystal. <u>**2×3**</u>
positive ions …3
in a sea of electrons/(valence) electrons involved in delocalised bonding / free to move / released …3

(*c*) **What type of bond exists in a water mol ecule?** <u>**3**</u>
polar (covalent bond) …3

State the shape of a water molecule and explain, using the *electron pair repulsion theory*, how this shape arises. <u>**4×3**</u>
v-shaped (planar) stated or shown in a diagram …3
two lone pairs and two bond pairs stated or shown in clear diagram …6
[tetrahedral / four pairs of electrons …3]
bond angle reduced to 104.5°/lone pair lone pair repulsions > lone pair bond pair repulsions > bond pair bond pair repulsions /lp lp > lp bp > bp bp …3

What forces hold the water molecules to gether in an ice crystal? <u>**3**</u>
hydrogen bonds …3

What type of crystal lattice is formed in ice? <u>**3**</u>
molecular crystal …3

Question 9

Define

(i) **a strong acid** <u>**2×3**</u>

good//has weak ...3

proton donor//conjugate base ...3

[fully dissociated ...3]

(ii) **a conjugate pair, in terms of Brønsted-Lowry theory** <u>**3**</u>

two species or a pair that differ by a proton ...3

State the conjugate base of the hydrogen sulfate ion HSO_4^- and the conjugate acid of ammonia NH_3.

<u>**2×3**</u>

SO_4^{2-} ...3

NH_4^+ ...3

Ammonium hydroxide is a solution of ammonia gas in water. To determine the concentration of an ammonium hydroxide solution, it was titrated against a standard solution of sulfuric acid. The balanced equation for the titration reaction is

$$2NH_4OH + H_2SO_4 \rightarrow (NH_4)_2SO_4 + 2H_2O$$

One rough and two accurate titrations were carried out. On average 18.6 cm^3 of 0.12 M sulfuric acid solution was required to neutralise 20 cm^3 samples of the ammonium hydroxide solution.

(*a*) **Describe how a burette was rinsed and then filled with the sulfuric acid solution.** <u>**6, 3, 3**</u>

rinse with deionised water ...6

rinse with sulfuric acid /rinse with solution it is to hold

fill using funnel, remove funnel before adjusting to zero, fill above zero mark first, fill part below tap, adjust until bottom of meniscus lies on zero mark, read at eye level, ensure no bubbles, any two ...2×3

(*b*) **Explain why methyl orange is a suitable indicator for this titration. What colour change is observed at the end point in this titration?** <u>**3×3**</u>

suitable for strong acid and weak base titration / changes colour at endpoint / changes colour in correct pH range ...3

(from) yellow ...3

(to) orange/ pink/peach /red ...3

(*c*) **(i)** **Why are the sides of the conical flask washed down during a titration?** <u>**3**</u>

wash down any drops of acid or base on the sides /to ensure all the acid and base react ...3

(ii) **Why is deionised water used in washing down the sides of the conical flask?** <u>**6**</u>

deionised water contains no chemicals / ions / impurities/will not interfere/will not react/ will not affect the results/ will not cause inaccuracy/ is pure/is neutral/will not alter the number of moles or molecules (of acid or base) (although it dilutes concentration /molarity) ...6

(iii) **Why is the conical flask placed on a white tile during the titration?** <u>**3**</u>

the colour change / end point can be seen clearly ...3

(*d*) **Calculate:**

(i) the molarity of the ammonium hydroxide solution; **6, 3**

$\frac{V_1M_1}{n_1} = \frac{V_2M_2}{n_2}$ /(volume × molarity × proticity)$_1$ = (volume × molarity × proticity)$_2$ …6

$\frac{20 \times M_1}{2} = \frac{18.6 \times 0.12}{1}$, M_1 = 0.2232 = 0.22 (M) [0.2232 - 0.22 (M)] …3

(ii) the concentration of the ammonium hydroxide solution in grams per litre (d m^3); **2×3**

35 …3

0.22 × 35 = 7.7 (g/L) [7.7 – 7.812 (g/L)] …3

(iii) the mass of ammonia gas dissolved in 500 cm^3 of the solution. **2×3**

(0.22 ÷ 2) × 17 = 1.87 (g) [1.87 – 1.90 (g)] …3

Question 10

Define in terms of electron transfer (i) oxidation, (ii) oxidising reagent. <u>**2×3**</u>

(i) loss of electrons …3

(ii) substance that gains electrons / substance that removes electrons from another subst ance / substance reduced …3

Write a balanced equation for the reaction that occurs between calcium and warm water. <u>**2×3**</u>

$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$ / $Ca + H_2O \rightarrow CaO + H_2$

correct reactants and products …3

balanced …3

Identify the substance oxidised and the oxidising reagent in this reaction. <u>**2×3**</u>

calcium …3

water / hydrogen (atoms) in water …3

Place the following metals in order of increasing difficulty of oxidation. <u>**6**</u>

zinc calcium copper aluminium

calcium, aluminium, zinc, copper …6

[three in correct order or all in reverse order ….3]

Which of these metals can be found free in nature? <u>**3**</u>

copper …3

Why is iron resistant to corrosion when it is galvanised with zinc? <u>**2×3**</u>

zinc more easily oxidised/zinc loses electrons more easily/ zinc above iron /zinc reacts in preference to iron/ oxygen /air excluded from iron / any one …6

Describe what is observed when (i) aluminium is placed in copper (II) sulfate solution <u>**6**</u>

aluminium reacts or dissolves, copper metal appears, red precipitate appears, copper coats aluminium blue colour fades or disappears any one…6

(ii) when copper is placed in dilute sulfuric acid. <u>**3**</u>

no reaction …3

When 1.27 g of copper is added to excess concentrated sulfuric acid, the copper is oxidised. The balanced equation for the reaction is:

$$\mathbf{Cu + 2H_2SO_4 \rightarrow CuSO_4 + SO_2 + 2H_2O}$$

Calculate

(i) the number of moles of copper oxidised; <u>**2×3**</u>

$$n = \frac{m}{M_r}$$ …3

$$n = \frac{1.27}{63.5} = 0.02 \text{ (moles)}$$ …3

(ii) the mass of copper (II) sulfate produced; <u>**2×3**</u>

0.02 moles …3

$0.02 \times 159.5 = 3.19$ (g) …3

(iii) the volume of sulfur dioxide gas produced at STP; <u>**2×3**</u>

0.02 moles …3

$0.02 \times 22.4 = 0.448$ (litres) …3

(iv) the number of molecules of water formed. <u>**2×3**</u>

0.04 moles …3

$0.04 \times 6 \times 10^{23} = 2.4 \times 10^{22}$ (molecules) …3

Question 11

Define

(i) ***unsaturated compound*** **2×3**

contain (at least one) double // molecules which undergo // valencies ...3

or triple bond // addition reactions // not all satisfied ...3

(ii) ***functional group*.** **3**

atom/group of atoms / type of bond that determine the characteristic properties of a molecule ...3

Answer the questions below with reference to compounds X, Y, Z and W in the reaction scheme shown in Figure 13.

(*a*) **Name the compounds X, Y and Z.** **3×3**

ethene …3

ethanol …3

ethanoic acid …3

(*b*) **Name the homologous series to which compound Z belongs.** **3**

carboxylic acids / alkanoic acids …3

(*c*) **Explain why compound Y and compound Z are soluble in water.** **2×3**

polar (functional groups) …3

form hydrogen bonds with water/attracted to water molecules …3

(*d*) **Name the inorganic reagent used in the conversion of compound Y to compound X.** **3**

aluminium oxide/sulfuric acid …3

[accept formulae]

(*e*) **What is observed when compound X is bubbled through acidified potassium permanganate?** **6**

purple or pink colour disappears/decolourises …6

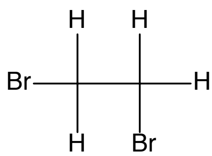
What type of reaction occurs? **3**

oxidation / redox / addition …3

Write a balanced equation for the reaction that occurs when bromine is added to X. **2×3**

$Br_2 \quad + \quad C_2H_4 \quad \rightarrow \quad C_2H_4Br_2$

$Br_2 \quad + \quad C_2H_4 \quad \rightarrow$



correct reactants and products …3

balanced …3

(*f*) **What type of reaction is involved in the conversion of compound Y to compound Z?** **3**

oxidation /redox …3

Identify the reagents required for this conversion. **2×3**

$Na_2Cr_2O_7$ / $K_2Cr_2O_7$ /sodium dichromate / potassium dichromate …3

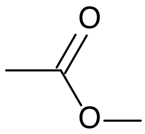
sulfuric acid / H_2SO_4 …3

(*g*) **Compounds Y and Z react together in the presence of sulfuric acid to form the ester W. Name the ester W.** **6**

ethyl …3

ethanoate …3

Draw the structure of the ester functional group. **6**



…6

[-COO- …3]

Question 12

Answer any three parts

Question 12 (a)

Figure 14 shows molten zinc chloride being electrolysed using inert electrodes.

(i)	**Name a suitable material for the electrodes.**	**<u>6</u>**
	platinum / carbon / graphite	…6
(ii)	**Identify electrode X.**	**<u>3</u>**
	anode / positive electrode	…3
(iii)	**Write a balanced equation for the cathode reaction.**	**<u>2×2</u>**
	$Zn^{2+} + 2e^{-} \rightarrow Zn$	
	correct reagents and product	…2
	balanced	…2

Calculate the mass of zinc deposited when a current of 0.50 A flows for 15 minutes through the molten zinc chloride. **<u>3×3</u>**

$Q = It = 0.50\ (15 \times 60) = 450$ (C) …3

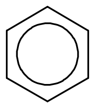
$450 \div 96\,500 = 0.00466$ (moles electrons) …3

$(.00466 \times 65) \div 2 = 0.14 = 0.15$ (g) [0.15 – 0.1625 (g)] …3

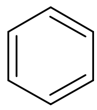
Question 12(*b*)

Distinguish between an *aliphatic* and an *aromatic* organic compound. <u>2×2</u>
do not have benzene ring or benzene nucleus/ have a chain (of carbon atoms) …2
contain a benzene ring or benzene nucleus …2

Draw the structure of the benzene molecule and describe i ts bonding. <u>3×3</u>
simple drawing as shown …6

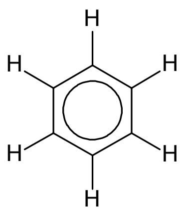


or

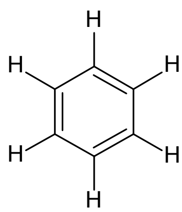


[diagram of cyclohexane unacceptable]

planar/flat arrangement of carbon atoms /each carbon atom has a single (covalent) bond to a hydrogen atom …3
or
detailed diagram as shown …9



or



[diagram of cyclohexane unacceptable]

Name the reagent and the catalyst used in the mono -bromination of benzene. <u>2×3</u>
bromine …3
iron /iron(III) bromide/ $FeBr_3$ …3

What type of reaction is the bromination of benzene? <u>3</u>
substitution …3

Question 12 (*c*)

Define the *first ionisation energy* of an element. **3×3**
minimum energy …3
required to remove the outermost /most loosely bound electron …3
from a neutral gaseous / isolated atom completely /fully …3
[(-1) for every underlined term missing]

What is the general trend in ionisation energy values across the second period of the Periodic Table? **6**
increase …6

Explain why beryllium has a high first ionisation energy value compared to the other elements in the second period. **3**
$1s^2\ 2s^2$ /full outer sublevel /more difficult to remove electron / more energy required to remove electron / stable electron configuration/ Be stable …3

Why is the second ionisation energy of an element always greater than the first? **2**
more difficult /more energy required to remove electron from positively charged ion/atomic radius decreases …2
[more energy required to remove electron from ion ..1]

The first, second and third ionisation energy values of beryllium, are 900 kJ mol^{-1}, 1760 kJ mol^{-1} and 14,800 kJ mol^{-1} respectively.
Explain the large increase between the second and third ionisation energy values of beryllium. **2**
third electron must be removed from first shell /from a full shell/ from closer to the nucleus/(significant) reduction in atomic radius/less screening …2

Question 12 (*d*)

Define *heat of combustion*. **2×3**
heat change / liberated / evolved when one mole (of a compound) …3
is burned in excess oxygen / is completely burned …3

State *Hess's law*. **2×3**
heat change for a reaction …3
is independent of path followed …3

At high temperatures, methane is converted to ethyne according to the equation:

$$2CH_{4\,(g)} \rightarrow C_2H_{2\,(g)} + 3H_{2\,(g)}$$

Calculate the heat change for this reaction using the following heats of combustion: **2×3, 2×2**

$CH_{4\,(g)} + 2O_{2\,(g)} \rightarrow CO_{2\,(g)} + 2H_2O_{(l)}$ $\Delta H = -891$ kJ mol^{-1}
$C_2H_{2\,(g)} + 2\tfrac{1}{2}O_{2\,(g)} \rightarrow 2CO_{2\,(g)} + H_2O_{(l)}$ $\Delta H = -1301$ kJ mol^{-1}
$H_{2\,(g)} + \tfrac{1}{2}O_{2\,(g)} \rightarrow H_2O_{(l)}$ $\Delta H = -286$ kJ mol^{-1}

$2CH_{4\,(g)} + 4O_{2\,(g)} \rightarrow 2CO_{2\,(g)} + 4H_2O_{(l)}$ $\Delta H = -1782$ (kJ mol^{-1}) …3
$2CO_{2\,(g)} + H_2O_{(l)} \rightarrow C_2H_{2\,(g)} + 2\tfrac{1}{2}O_{2\,(g)}$ $\Delta H = 1301$ (kJ mol^{-1}) …3
$3H_2O_{(l)} \rightarrow 3H_{2\,(g)} + 1\tfrac{1}{2}O_{2\,(g)}$ $\Delta H = 858$ (kJ mol^{-1}) …2

$2CH_{4\,(g)} \rightarrow C_2H_{2\,(g)} + 3H_{2\,(g)}$ $\Delta H = 377$* (kJ mol^{-1}) …2
[last line reversed …2]

Coimisiún na Scrúduithe Stáit

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 ghnáth ráta 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 Bonais
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 Bonais
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