XINMIN SECONDARY SCHOOL
新民中学
SEKOLAH MENENGAH XINMIN

Weighted Assessment 2 2024

CANDIDATE NAME			
CLASS		INDEX NUMBER	

CHEMISTRY — 6092

Secondary 4 Express — **Term 2 Week 7**

Setter: Ms Tiffany Lim
Vetter: Mr Lim Boon Ping — **40 minutes**

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.

Section A: Multiple Choice Questions (5 marks)
Answer **all** questions.
For each question, there are four possible answers **A**, **B**, **C** and **D**. Choose the one you consider correct and record your choice in the boxes at the end of the Section.
Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any rough working should be done in this booklet.

Section B: Structured Questions (10 marks)
Section C: Free Response Questions (15 marks)
Answer **all** questions.
The number of marks is given in brackets [ ] at the end of each question or part question.

The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use	
Section A	5
Section B	10
Section C	15
Total	30
Parent's Signature	

This document consists of **11** printed pages and **0** blank page(s).

The Periodic Table of Elements

Group																	
1	2											13	14	15	16	17	18
				Key			1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9			proton (atomic) number atomic symbol name relative atomic mass								5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24	3	4	5	6	7	8	9	10	11	12	13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

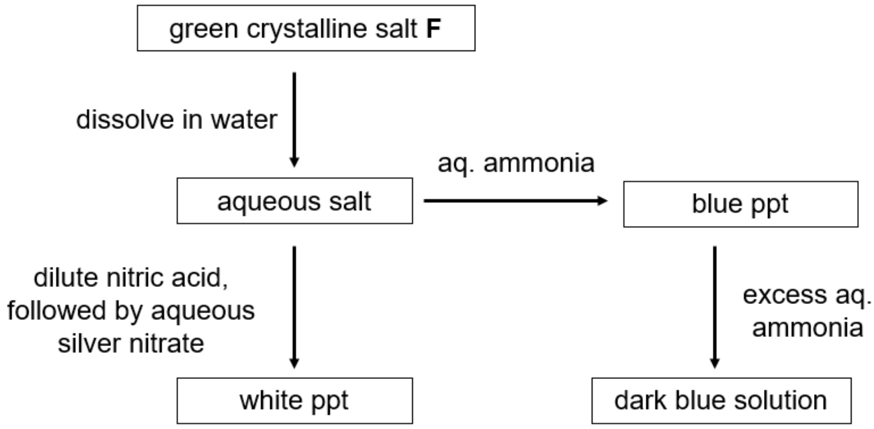
lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

The Avogadro constant, L = 6.02 x 10^{23} mol^{-1}

Section A [5 marks]
Answer **all** questions.
Write your answers in the boxes provided at the end of the section.

1 The scheme below shows the reactions of salt **F**.



What is the identity of salt **F**?

A copper(II) chloride

B copper(II) iodide

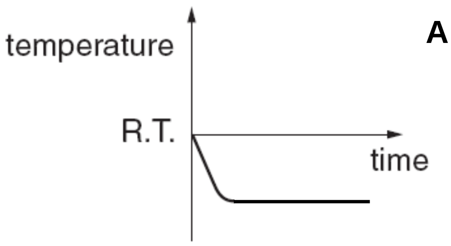
C iron(III) chloride

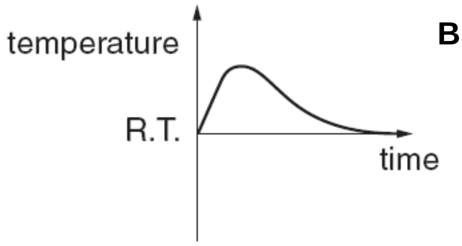
D iron(III) iodide

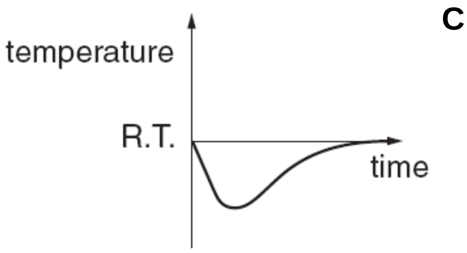
2 Dissolving potassium iodide in water is an endothermic process.

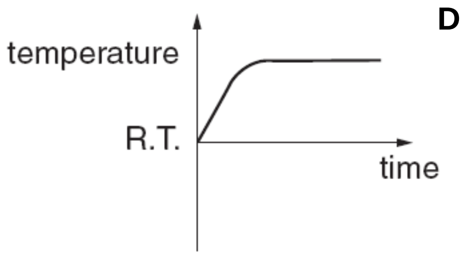
Which of the graphs below shows how the temperature changes when potassium iodide is stirred with water until there is no further change of temperature?

[R.T. = room temperature]









3 The elements W, X, Y and Z have increasing proton numbers. They are all in Period 3 of the Periodic Table but are not necessarily next to each other.

Which statement is correct?

A W and Z will both react with oxygen to form basic oxides.

B X has more non-metallic character than Z.

C Y has a greater number of electron shells than W.

D Z forms bonds by sharing electrons with chlorine.

4 The reaction between lead(II) oxide and ammonia is shown.

$$PbO + 2NH_3 \rightarrow N_2 + 3H_2O + 3Pb$$

Which element has been reduced?

A H **B** N **C** O **D** Pb

5 Some properties of metal **H** are listed.

- **H** reacts slowly with cold water.
- **H** reacts with dilute hydrochloric acid.
- No reaction occurs when the oxide of **H** is heated with carbon.

What is a possible identity of metal **H**?

A copper

B iron

C magnesium

D potassium

Question	**1**	**2**	**3**	**4**	**5**
Answer					

Section B [10 marks]

Answer **all** questions.

Write your answers in the spaces provided.

6 Fig. 6.1 shows part of a Periodic Table.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
																	He
												B	**C**	**N**		**F**	**Ne**
Na															**S**	**Cl**	**Ar**
K			**Ti**						**Ni**							**Br**	

Fig. 6.1

Answer the questions by using only the symbols of elements shown in the diagram.

Each element can be used once, more than once or not at all.

(a) Which two elements react vigorously with cold water?

.... [1]

(b) Which element is a reddish-brown liquid at room temperature?

.... [1]

(c) Which element is able to displace chlorine from an aqueous solution of sodium chloride?

.... [1]

(d) Which two metallic elements have variable oxidation states?

.... [1]

[Total: 4]

7 **(a)** Three experiments **A**, **B** and **C** were set up as shown in Fig 7.1 below to investigate the corrosion of iron. All the metals are immersed in water and exposed to air.

In experiment **B** and **C**, the two metals are in contact.

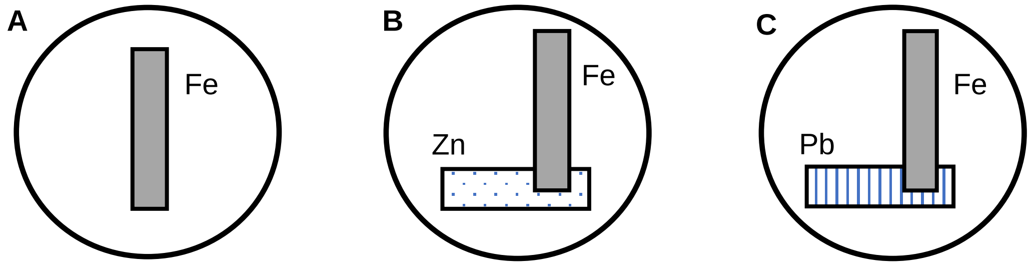


Fig 7.1

Some observations were recorded in the table below.

experiment	**is there corrosion observed on iron metal?**	**what is observed on surface of the iron metal?**
A	yes	red-brown deposits
B		
C		

(i) Complete the table above for **Experiment B** and **Experiment C**. [2]

(ii) Which of the above experiments shows that iron is protected from corrosion?

Name the method of protection and explain how the protection of iron is achieved.

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………………………………………………………………………………………………..

………………………………………………………………………………………………..

……………………………………………………………………………………………….. [2]

(b) Another experiment was carried out by dipping a new piece of iron metal into an aqueous solution of copper(II) sulfate. The equation for the reaction is shown below.

$$Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$$

In terms of oxidation states, explain why this reaction is a redox reaction.

…………………………………………………………………………………………………..

…………………………………………………………………………………………………..

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………………………………………………………………………………………………….. [2]

[Total: 6]

Section C [15 marks]

Answer **all** questions.

Write your answers in the spaces provided.

8 Ammonia is an important raw material used in the manufacture of fertilisers. It is produced using the Haber process, where nitrogen and hydrogen react according to the equation:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92.4 \text{ kJ/mol}$$

(a) Explain, in terms of bond breaking and bond forming, why the Haber process has a negative enthalpy change.

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…………………………………………………………………………………………………… [2]

(b) Using the axes below, draw the energy profile diagram of the **backward** reaction of the Haber process.

Your diagram should include:

- axis labels
- chemical formulae of the reactants and products of the reaction,
- labels to show the **enthalpy change of reaction** and the **activation energy**.

[3]

[Total: 5]

9 Colour Chemistry

Chemistry is said to be the most 'colourful' science due to the variety of chemical reactions that produce beautiful colours.

Origin of colour in fireworks

Fireworks were recorded as originating from China in the 8th Century where chemists accidentally invented some explosive black powder when they mixed potassium nitrate (also called saltpetre), sulfur and honey together. This mixture exploded when it was heated in a highly exothermic reaction. News about this explosive mixture spread across Asia and Europe and fireworks as we know them today were first created.

The explosive part of fireworks comes from gunpowder (a black powder) which is now made from *saltpetre*, sulfur and charcoal. The reason why fireworks appear to have many colours is because different chemicals, mostly made from metal compounds, are used to produce the different colours. For example, magnesium sulfate is responsible for the bright white fireworks while strontium carbonate produces red fireworks.

How are the colours produced? When the electrons in a metal atom or ion undergo very strong heating, they become 'excited'. This means that the electrons, that were originally at a lower energy level (ground state) becomes promoted (jumps) to a higher energy level (excited state). This jump is temporary and as the electrons fall back down to ground state, energy is released as light.

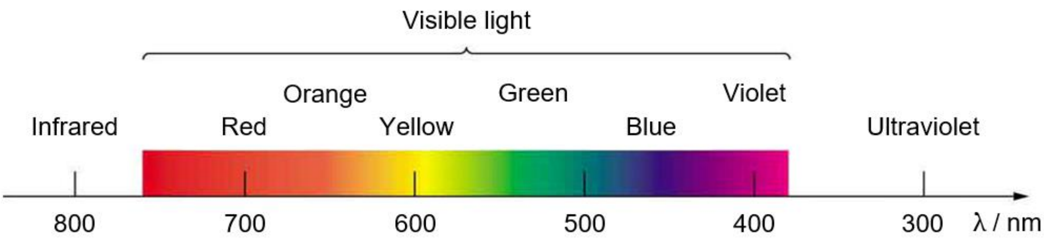
The energy released corresponds to a particular wavelength and can be calculated using Equation 9.1 shown below.

$$E = \frac{hc}{\lambda}$$

Equation 9.1

where E = light energy,
h = Planck's constant (6.63×10^{-34} Js)
c = speed of light (3.00×10^{8} m/s)
λ = wavelength

The colour of the fireworks observed corresponds to the wavelength of the light released as shown in Fig 9.1 below. The wavelengths that the human eye can see only fall within the visible light spectrum.



colour	red	orange	yellow	green	blue	violet
wavelength of visible light / nm	620 – 750	590 – 620	570 – 590	495 – 570	450 – 495	380 – 450

(1 nm = 10^{-9} m)

Fig 9.1

Some colours, like blue fireworks, are more difficult to obtain because the chemical compounds used to make the blue fireworks such as copper(II) carbonates and copper(II) oxides are unstable to heating. Purple fireworks are also difficult to obtain because they must be made from a mixture of red and blue compounds.

Colour in 'neon' signs
Noble gases such as neon, argon and krypton can be found inside lighting tubes and bulbs.

Similar to the fireworks above, the colour of 'neon' signs form when electrons in the noble gas atoms get 'excited'. In the case of neon lights however, an electric current is applied to the gas inside the light tube instead. This current provides so much energy to the gas atoms that it is sufficient to remove electrons from the atoms, causing the gas atoms to become ions.

Since these positively charged ions are unstable, they will return to their original low energy level and release the excess energy in the form of light.

Table 9.1 below shows typical emission spectral lines of some noble gases. An emission spectral line indicates the wavelength which corresponds to the colour produced when the electrons 'jump' from ground state to excited state and 'fall' back down.

Table 9.1

noble gas	emission spectral lines	colour glow
helium	706.5nm & 667.8nm	red, orange, pink
neon	614.3nm & 685.2nm	red, orange
argon	498nm & 465.8nm	blue
krypton	575.8nm & 530.9nm	green, yellow
xenon	459.3nm & 585.2nm	blue, green

While neon gas itself emits a reddish-orange light, other gases such as argon or krypton can be added to the mixture to produce different colours. This is because each gas has its own set of energy levels and emission wavelengths. By adjusting the composition of the gas mixture and the electrical parameters, it's possible to achieve a wide range of colours in 'neon' signs.

(a) **(i)** Using Equation 9.1, state the relationship between light energy and wavelength.

……………………………………………………………………………………

…………………………………………………………………………………… [1]

(ii) Describe one similarity and one difference between how the colours are formed in fireworks and in 'neon' signs.

Similarity: …..……………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

Difference: …………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………… [2]

(iii) Scientists suggest that there is a trend in the wavelengths of the emission spectral lines produced down Group 18.

Do you agree? Use information from Table 9.1 to support your answer.

……………………………………………………………………………………….

……………………………………………………………………………………….

……………………………………………………………………………………….

………………………………………………………………………………………. [2]

(b) **(i)** Calcium chloride is a common compound used in fireworks.

Given that the energy released when calcium chloride is heated strongly is 3.32×10^{-19} J, calculate the wavelength of the energy released.

[1]

(ii) Hence, with reference to Fig. 9.1, state the colour of the fireworks produced by calcium chloride.

………………………………………………………………………………………. [1]

(c) **(i)** Using ideas about reactivity of metals, explain why blue fireworks are harder to obtain.

……………………………………………………………………………………….

……………………………………………………………………………………….

……………………………………………………………………………………….

………………………………………………………………………………………. [2]

(ii) Suggest the names of **two** chemical compounds that can be mixed together to form purple-coloured fireworks.

………………………………………………………………………………………. [1]

[Total: 10]

End of paper