90933

909330

1

SUPERVISOR'S USE ONLY

NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

Level 1 Chemistry, 2015

90933 Demonstrate understanding of aspects of selected elements

9.30 a.m. Tuesday 24 November 2015
Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of aspects of selected elements.	Demonstrate in-depth understanding of aspects of selected elements.	Demonstrate comprehensive understanding of aspects of selected elements.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

A periodic table and other reference material are provided in the Resource Booklet L1–CHEMR.

If you need more room for any answer, use the extra space provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–12 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Excellence

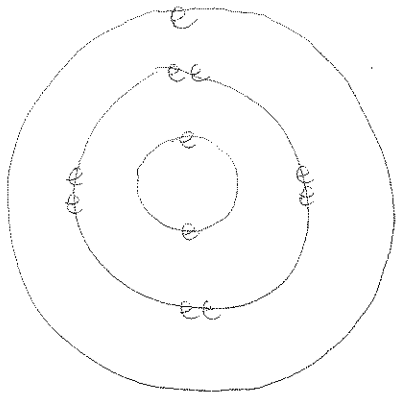
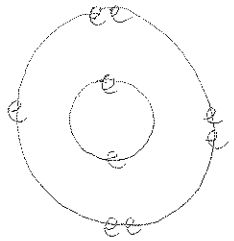
TOTAL 23

ASSESSOR'S USE ONLY

QUESTION ONE

ASSESSOR'S USE ONLY

(a) Draw the electron arrangement for the atoms sodium and fluorine in the boxes below.
You may refer to the periodic table in the resource booklet.

sodium	fluorine
	
2,8,1	2,7

(b) Explain why the electron arrangements for the sodium atom and the fluorine atom are different, but the electron arrangements for the sodium ion and the fluoride ion are the same.

In your answer, you should:

- give the electron arrangements for both ions
- relate your explanation to the positions of the atoms on the periodic table
- explain how the charges form on each of the ions.

// The electron arrangement for sodium atom is 2, 8, 1 because it has 11 electrons

The electron arrangement for the fluorine atom is 2, 7 because it has 9 electrons

// Although the two atoms have different number of electrons when they form ions they have the same number of electrons in the same arrangement of 2, 8 /

// This is because sodium is in group 1 and period 3 of the periodic table, consequently it has only one valence electrons. Atoms form ions in order to gain a full valence shell and become stable whilst gaining an electrical charge ~~Sodium~~ When sodium becomes an ion, it loses 1 electron because that is the method that takes the least amount of energy to gain a full valence shell, and sodium ion changes its electron arrangement to 2,8. As sodium now has one more proton than electron (sodium atom has 11 protons and this number does not change when becoming an ion) the sodium ion has a charge of 1+ //

// ~~Fluorine~~ Fluorine is in group 17 and period 2 of the periodic table, consequently it has 7 valence

electrons. When fluorine becomes an ion, it gains 1 electron, which differs from how sodium becomes an ion because this method has the least energy in fluorine's case thus it gains a full ~~electron~~ valence shell, with electron arrangement 2 8 the same as the sodium ion. However the fluorides charge differs because unlike sodium + ~~has~~ (and its atom) have 9 protons, hence when it becomes an ion it has one more electron than proton and ~~gains~~ a charge of 1-

Therefore sodium and fluorine atoms are in different groups of the periodic table, but form ions with the same electron arrangement of 2, 8 Sodium forms the Na^+ ion whilst Fluorine forms F^-

ASSESSOR'S USE ONLY

(c) Sodium and lithium are both Group 1 elements. You may have seen your teacher demonstrate reactions of these elements when added to water, or you may have seen videos of these reactions on the internet.

ASSESSOR'S USE ONLY

Compare and contrast the reactivity of these two elements.

In your answer, you should:

- give any observations seen when these elements are added (separately) to troughs of water
- link the observations to the reactants and products involved in the reaction of these elements with water
- predict how each of these elements would react with dilute sulfuric acid, and relate this to their positions on the periodic table
- write a word equation and a balanced symbol equation for the reaction of ONE of the elements with water.

When the lithium metal (a grey solid) is placed in water (a colourless liquid), the lithium may melt, and float/move across the water surface. The lithium could also burn with a red flame. This is because the reaction between lithium and water produces heat as it is exothermic, and the heat melts the lithium and could cause hydrogen (another product produced in the reaction) to catch on fire and burn with a red flame. Eventually the lithium will dissolve into lithium hydroxide.

When sodium metal (a grey solid) is placed in water (a colourless liquid), the sodium metal melts and floats/moves across the water surface quite quickly. The reaction occurs vigorously with the sodium burning with a yellow-orange flame. This is because the reaction between sodium and water produces heat as it is exothermic, and also produces hydrogen gas. The hydrogen gas propels the metal across the water, and the exothermic heat lights the gas on fire, resulting in the yellow flame. Eventually the sodium dissolves into sodium hydroxide. This reaction is faster than the lithium and water reaction.

When reacting with dilute sulfuric acid, both the lithium metal and sodium metal will dissolve quickly and form (respectively) lithium sulfate and sodium sulfate. They will also both vigorously react and give off hydrogen bubbles of gas. However, comparatively sodium will react more violently/vigorously than lithium because of its position on the periodic table. Although both metals are in group 1 (alkali metals), sodium is in period 3 whilst lithium is in period 2. This is because sodium has 3 electron shells (electron arrangement 2,8,1) whilst lithium has 2 electron shells,

[PLEASE SEE EXTRA PAPER]

ASSESSOR'S USE ONLY

Word equation:

Lithium + water → lithium hydroxide + hydrogen

Balanced symbol equation:

$2Li + 2H_2O \rightarrow 2LiOH + H_2$

C

QUESTION TWO

ASSESSOR'S USE ONLY

(a) Some physical and chemical properties of three different metals A, B, and C are given in the table below.

Metal	Physical Properties	Chemical Properties
Metal A	It is a high density, soft and malleable metal. It is a relatively poor conductor of electricity.	It does not react with water.
Metal B	It is red-brown in colour, and an excellent conductor of heat and electricity.	It does not react with water or dilute hydrochloric acid.
Metal C	It is silver-grey in colour.	It does not react with water, but reacts slowly with dilute hydrochloric acid.

(i) Complete the table below to show the identity of metals A, B, and C. Choose from the following list of metals.

copper **silver** **lead** **magnesium** **zinc**

Metal A	Lead ✓
Metal B	Copper ✓
Metal C	Zinc ✓

(ii) Give a use for each of the metals A and B and explain why they are used this way by linking to a relevant physical AND chemical property for each of the metals.

Metal A

Use: ✓ Sinkers in water, anchors ✓

Explanation: ✓ Metal A (Lead) is used as a sinker / anchor in water because it is very dense. This is because the metal atoms are packed tightly together, and the lead atoms themselves ~~are~~ have a high atomic ~~weight~~ mass (relatively). Thus the metal is ~~dense~~ dense and will sink, acting as a good anchor / sinker. Lead is also resistant to corrosion. This is because it is low on the activity series, meaning it is not very chemically reactive. Thus it is useful as a sinker because it will not corrode and react readily when placed in water, even for long periods of time. ✓

ASSESSOR'S USE ONLY

Metal B

Use: Electrical wiring

Explanation: Metal B (copper) is used for electrical wiring because it is a good conductor of electricity. This is because it has many delocalised electrons that can move freely in the structure, thus being able to carry electrical charge from a negative to a positive terminal. It is also suitable because it does not react with water as copper is low on the activity series, meaning it is chemically unreactive. This makes it suitable for use in electrical wiring because it will not corrode or react when in contact with water, which is likely in underground or household wiring.

(b) Silver and magnesium are both shiny grey metals. However, only silver is used to make jewellery.

Justify why silver is used to make jewellery, but magnesium is not.

In your answer, you should refer to chemical AND physical properties of both metals.

Silver is used to make jewellery because it is unreactive, whereas magnesium is very reactive. Silver is low on the activity series, hence its chemical reactivity is low, and when it comes into contact with skin or water (which is likely in the case of jewellery) it will not react. On the other hand magnesium would react and corrode, which could be infectious (in the case of piercings) and undesirable/unsuitable for jewellery.

Silver is also used to make jewellery because it is more malleable than magnesium. This is because its atoms are arranged regularly and when pressure is applied the atoms slide past each other, whereas in magnesium the atoms have higher bond and so it is less malleable. Malleability is important in jewellery as that it can be moulded into different aesthetic shapes, hence silver is used in jewellery for its malleability, but magnesium is not.

Silver is also used to make jewellery because it is MORE shiny/lustrous than magnesium. This is because its sea of delocalised electrons reflects light better than in magnesium, hence silver is better at reflecting light and is more lustrous. This is important for the aesthetic properties of jewellery, hence silver is used rather than magnesium, which does not reflect light as well. Magnesium also does not reflect light because it readily reacts with oxygen in the air to create a dull oxide coating, making it less lustrous, and not as suitable for jewellery.

(c) Steel is an alloy composed of iron and carbon, alloyed with certain additional elements such as chromium and copper.

ASSESSOR'S USE ONLY

Explain why alloys can be more useful than pure metals.

In your answer, you should explain how the properties of steel can be affected by the addition of other elements.

// Alloys are a mixture of two or more elements, one or more of which is a metal. ~~Steel~~ Alloys are advantageous because they can often increase the strength / hardness, whilst decreasing the chemical reactivity (likelihood of corrosion), in comparison to pure metals. //

// For instance steel is harder than pure iron or ~~the~~ copper because it consists of a mixture of many types of ~~iron~~ atoms. Usually in pure metals they are soft / malleable because the regular and tight arrangement of atoms allows ~~them~~ them to slide past each other when pressure is applied. In alloys, such as steel this is ~~scattered~~ scattered as the mixture of different-sized atoms like carbon, chromium, copper, can etc ~~disrupt~~ disrupts the regular arrangement of atoms and ~~then~~ prevents the atoms from sliding ~~over~~ each other easily, thus making it harder. This could be more useful as the hard material can be used for other purposes such as construction which require hard metals / alloys. /

// Steel is also less reactive than pure iron. This is because it has the addition of copper, which is lower on the activity series. Being ~~lower~~ lower on the activity series means that copper is less reactive than iron and will resist corrosion more. ~~This~~ Therefore steel, with the addition of a less reactive metal, will be more resistant to corrosion than pure iron. This ~~makes~~ makes it useful as ~~the~~ corrosion resistance is necessary in construction materials that are exposed to the environment ~~the~~ and can come into contact with water / oxygen, thus steel is more useful than ~~pure~~ pure metals (iron). /

QUESTION THREE

ASSESSOR'S USE ONLY

Iron metal and carbon (charcoal), can both react with oxygen when they are held in a blue Bunsen flame.

(a) (i) Complete the following word equation and balanced symbol equation for the reaction of iron with oxygen.

Word equation:

iron + oxygen → iron oxide

Balanced symbol equation:

$2\,Fe + O_2 \rightarrow 2FeO$

(ii) Write a word equation and a balanced symbol equation for the reaction of carbon with oxygen.

Word equation:

carbon + oxygen → carbon dioxide

Balanced symbol equation:

$C + O_2 \rightarrow CO_2$

(b) Chlorine is added to water supplies to make the water safer for people to drink.

ASSESSOR'S USE ONLY

Explain the chemistry involved in this process.

In your answer, you should:

- describe the reaction of chlorine with water
- explain the nature of the aqueous solution formed
- link the properties of chlorine to making water safer for people to drink
- include a balanced symbol equation for the reaction of chlorine with water.

When chlorine is added to water, hydrochloric acid and hypochlorous acid are formed. Both these products are acids, meaning they have a low pH ($pH < 7$) and are acidic in nature.

~~Hypo~~ Chlorine ~~is~~ can make water safe to drink because chlorine solution contains ~~hypo~~ hypochlorous acid, which reacts / oxidises the cell wall of bacteria and other microbes. This causes the cell wall to disintegrate, ~~and eventually ruptures~~ resulting in cellular death. Hence chlorine ~~gas~~ solution can kill a harmful microbes and help disinfect water through the ClO^- ions.

Chlorine ~~molecules~~ also makes water safe to drink because ~~it~~ chlorine ~~gas~~ solution is acidic (containing HCl and HOCl) meaning that it can denature ~~proteins~~ proteins and enzymes often involved in ~~the~~ cellular like proteases, resulting in the cell being unable to function, and killing microorganisms.

Therefore chlorine can make water safe to drink by disinfecting it by killing microorganisms in it.

Balanced symbol equation:

$$Cl_2 + H_2O \longrightarrow HOCl + HCl$$

(c) Sulfur dioxide, SO_2, is often added to foods such as dried fruit, sausages, and wine to preserve them. The images below show dried apricots with and without sulfur dioxide added.

http://fyi.uwex.edu/safepreserving/files/2014/04/ApricotsSulfurDioxide.jpg

Explain how sulfur dioxide preserves food.

You should refer to the chemical properties of sulfur dioxide in your answer.

// Sulfur dioxide preserves food because it is a ~~oxidant~~ reductant. This means that it absorbs and reacts with oxygen in the cell walls of plants (food) so that the ~~drying~~ cell wall softens and the food becomes easier to dry. Drying food helps to ~~preserve~~ preserve it because it removes water, which is often essential in the life processes of microorganisms, so removing it can kill the microorganisms //

// Sulfur dioxide also preserves food because it removes oxygen (~~same~~ by the same reasons as above), and oxygen is also often used in cellular life processes, so removing it will kill microorganisms in ~~food~~ food //

// Killing microorganisms in food helps to preserve it because ~~the~~ microorganisms cause food to ~~rot~~ rot often by releasing decaying ~~matter~~ or acidic ~~waste~~ waste products //

// sulfur dioxide can also preserve food by reacting with water, forming a sulfurous acid ~~[redacted]~~ sulfurous acid is acidic (has a low pH) meaning that it can denature proteins and enzymes that microorganisms need to survive and grow (life processes), thus killing the microorganisms //

// Therefore SO_2 can be used to preserve food //

C

E8

Extra paper if required.
Write the question number(s) if applicable.

QUESTION NUMBER

ASSESSOR'S USE ONLY

1c) with electron arrangement 2,1. Hence Sodium has a greater atomic radius than lithium, with the distance ~~between~~ from the atom centre to the single valence electron greater than for lithium, and the attractive force (electrostatic) ~~between~~ bonding it to the nucleus weaker. Consequently when sodium reacts by ~~losing~~ losing its valence electron to gain a full outer shell, it is easier than the reaction of lithium because the attractive force is weaker. Thus the reaction of sodium and sulfuric acid ~~will~~ will be more rapid / vigorous because sodium is ~~more~~ more reactive than lithium (loses its valence electron easier)

90933

Excellence exemplar for Chemistry 90933 2015		Total score	23
Q	**Grade score**	**Annotation**	
1	E8	This is E8 because the candidate has comprehensively explained why Fluorine and Sodium have different electron configurations as elements but the same configurations as ions. This has been linked to the group number of the elements and the number of valence electrons lost/gained to become stable and the resulting charge on the ion. In part (c) the candidate gives comprehensive correct observations and predictions for the reactions (sodium and lithium in both water and dilute acid). Also included is an appropriate balanced symbol equation.	
2	E7	This is E7 as part (c) has a detailed explanation of how specific properties of an alloy can be obtained resulting in an alloy with more desirable characteristics than a single metal alone. Part (b) details why Silver is more suitable for jewellery making than Magnesium but relevant chemical and physical properties are only clearly explained for Magnesium and not for Silver. The answer may have been awarded E8 if the relevant chemical and physical properties of Silver had been more clearly explained.	
3	E8	The E8 grade has been awarded for having correctly balanced equations for iron and carbons reaction with oxygen in part (a). The candidate has gone on to comprehensively discuss the reaction of chlorine with water and how this can make it safe for consumption in part (b) and then also sulfur dioxide and how it can be used as a preservative in part (c). For this part to be comprehensive, and result in E8 (with the equations from part (a)), the ability that hypochlorous acis functions as an oxidant and reductant ability of sulfur dioxide had to be included.	