Student Name:

Class:

SYDNEY BOYS HIGH SCHOOL

YEAR 11 CHEMISTRY

ASSESSMENT TASK 3

FINAL EXAMINATION

SEPTEMBER 2019

INSTRUCTIONS

- Reading time – 5 minutes.
- Working time – 2 hours.
- Write using black pen.
- Draw diagrams using pencil.
- For questions in Section II, show all relevant working in questions involving calculations.
- NESA approved calculators may be used.

Total marks: 75

Section I – Multiple Choice Questions (20 marks)

- Attempt questions 1 – 20.
- Use Multiple Choice Answer Grid Provided.
- Allow about 35 minutes for this section.

Section II – 55 marks

- Attempt questions 21 – 31.
- Answer all questions in this booklet.
- Allow about 1 hour and 25 minutes for this section.

Section I – Multiple Choice Questions.

20 Marks.

Attempt Questions 1 – 20.

Use the Multiple Choice Answer Grid provided.

Clearly mark one answer only per question.

Allow about 35 minutes for this section.

Questions 1 to 3 refer to the following information

A class of chemistry students designed the following experiment to investigate the relationship between the concentration of a solution in a reaction and how fast a product is produced.

Different concentrations of hydrochloric acid were added to a standardised sodium thiosulfate solution. The reaction produced solid sulfur, as shown in the equation below.

$$2HCl\,(aq) + Na_2S_2O_3\,(aq) \rightarrow 2NaCl(aq) + SO_2\,(g) + H_2O(l) + S(s)$$

A piece of paper with a cross was placed beneath the conical flask containing the reaction mixture. As soon as the reactants were added and mixed, the conical flask was placed on top of the cross, and the time taken for the cross to disappear due to the formation of the sulfur was timed with a stopwatch.

1. What is the *dependent* variable for student's investigations?

   (A) The time taken for the cross to disappear.

   (B) The total volume of liquids in the conical flask.

   (C) The rate of the reaction.

   (D) The mass of sulfur produced.

2. The type of data collected and the source of the data in the student's investigation is best characterised as:

(A) qualitative data; primary source.

(B) qualitative data; secondary source.

(C) quantitative data; primary source.

(D) quantitative data; secondary source.

3. While conducting the investigation, a group of students decided to take turns observing and timing when the cross disappeared.

Which of the following is a correct statement concerning this choice?

(A) It improves the methodology as it increases the efficiency of data collection.

(B) It makes the method less valid as it introduces more systematic errors.

(C) It improves the methodology because one person may take the readings more accurately.

(D) It is a poor decision as it is likely to decrease the reproducibility of the data collected.

4. Use the oxidation numbers to determine which element has been oxidised and which has been reduced in the following chemical reaction.

$Fe_2O_{3(s)} + 3CO_{(g)} \rightarrow 2Fe_{(s)} + 3CO_2$

(A) Both Carbon and Iron (III) are reduced.

(B) Both Carbon and Iron (III) are oxidised.

(C) Carbon is reduced and Iron (III) is oxidised.

(D) Carbon is oxidised and Iron (III) is reduced.

5. Which of the following statement is best outlines the trend in electronegativity across a period in the periodic table?

(A) Electronegativity decreases across a period as the number of protons in the nucleus increases.

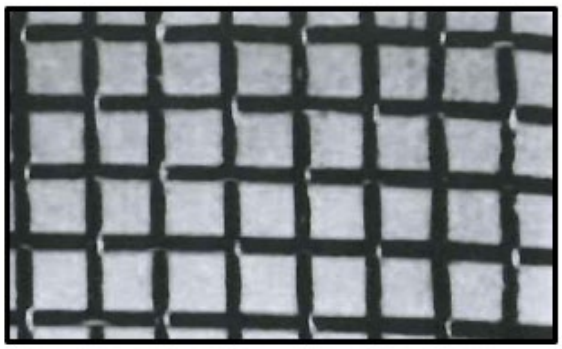
(B) Electronegativity increases across a period as the number of protons in the nucleus increases.

(C) Electronegativity increases across a period as the number of neutrons in the nucleus increases.

(D) Electronegativity decreases across a period as the number of neutrons in the nucleus increases.

6. Ethene gas (C_2H_4) reacts with hydrogen gas to produce ethane gas (C_2H_6) in a reaction known as a hydrogenation reaction.

To increase the rate of this reaction a piece of gauze made of platinum metal can be used as a catalyst (shown below).



How does the gauze increase the rate?

(A) It increases the temperature of the gases.

(B) It increases the pressure of the gases.

(C) It provides a greater surface area for reactants to combine on.

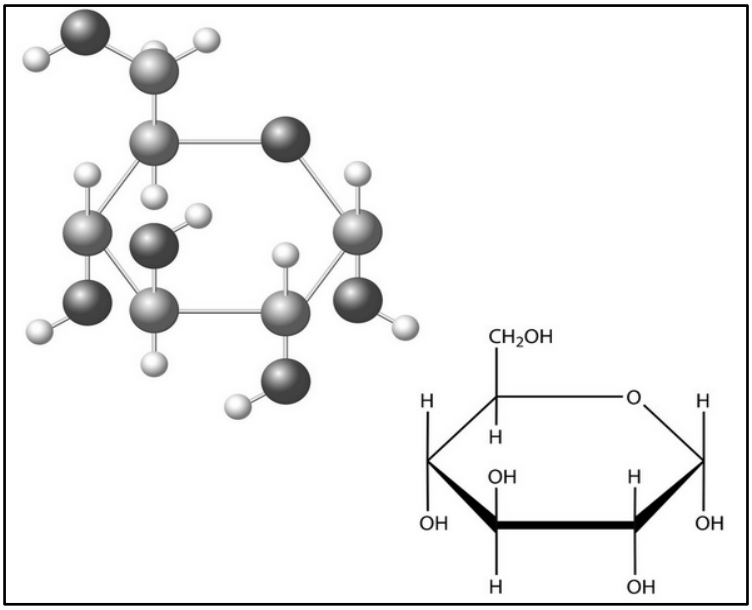
(D) It ensures that reactants have the correct molecular orientation.

7. Which of the following options shows the correct meaning of the signs of enthalpy changes (ΔH) and entropy changes (ΔS) for any process?

	ΔH		**ΔS**	
	Sign	**Meaning**	**Sign**	**Meaning**
(A)	Positive	Exothermic	Positive	Products more ordered.
(B)	Positive	Endothermic	Negative	Products more random.
(C)	Negative	Endothermic	Positive	Products more random.
(D)	Negative	Exothermic	Negative	Products more ordered.

Questions 8 and 9 refer to the image below.

The image shows two ways chemists may view the structure of a single molecule of glucose.



8. On the basis of *the diagram alone*, which of the statements below is correct?

(A) Part of the glucose molecule consists of a ring of 6 carbon atoms.

(B) For every carbon atom in a glucose molecule there are 2 hydrogen atoms.

(C) A glucose molecule is composed of three different atoms.

(D) Glucose molecules are made of the same elements found in other sugars.

9. What would be the approximate mass of 0.50 moles of glucose?

(A) 30 g

(B) 60 g

(C) 90 g

(D) 120 g

10. How many oxygen atoms would be present in a 2 mol sample of glucose?

(A) 6

(B) 12

(C) 6 x (6.022×10^{23})

(D) 12 x (6.022×10^{23})

11. The periodic table is a tool for organising elements according to their chemical and physical properties.

Which of the following is correct for the periodic table?

(A) The periodic table has five main blocks of elements. The elements in each block all have the same type of subshells (s, p, d, f, m) as their highest energy subshell.

(B) The periodic table has three main blocks of elements. The elements in each block all have the same type of subshells (s, p, d) as their highest energy subshell.

(C) The periodic table has four main blocks of elements. The elements in each block all have the same type of subshells (s, p, d, f) as their highest energy subshell.

(D) The periodic table has four main blocks of elements. The elements in each block all have the different type of subshells (s, p, d, f) as their highest energy subshell.

12. How many elements in the first row of the d-block have an electron configuration ending in $4s^1$?

(A) 1
(B) 2
(C) 3
(D) 4

Questions 13 and 14 refer to the table below.

Solder contains a mixture of lead and tin. The table shows the melting range of two types of solder.

Solder Composition (%)	Melting Range (°C)
Sn63/Pb37	182-183
Sn 62/Pb38	178-180

13. Which of the following statements is correct, based on the information shown in the table?

(A) Solder melting point increases with increasing lead content.

(B) Solder is a pure substance because it melts over a very narrow range.

(C) Solder is an example of homogeneous matter.

(D) Solder should be classified as a compound because the lead and tin combine in close to fixed proportions.

14. A 3.00g sample of solder was dissolved in nitric acid (HNO_3). Sulfuric acid was added to this solution, which precipitated out 1.69 g of $PbSO_4$.

Assuming that all of the lead was precipitated out in the $PbSO_4$, what is the percentage of *tin* in the sample?

(A) 35.2 %

(B) 38.5 %

(C) 61.5 %

(D) 64.8 %

15. Which of the following changes would have the greatest entropy increase?

(A) $O_2(g) + 2H_2(g) \rightarrow 2H_2O(l)$

(B) $CuCO_3(s) \rightarrow CuO(s) + CO_2(g)$

(C) $Cu(OH)_2(s) \rightarrow CuO(s) + H_2O(l)$

(D) $6CO_2(g) + 6H_2O(l) \rightarrow C_6H_{12}O_6(s) + 6O_2(g)$

16. Two identical flasks, X and Y, contain, respectively, 1.70 g of nitrogen gas and 4.91 g of an unknown gas. The gases in both flasks are held at the same temperature and atmospheric pressure. Which of the following gases could occupy flask Y?

(A) helium

(B) oxygen

(C) sulfur dioxide

(D) hydrogen bromide

17. Which of the following is the most likely reason for differences between laboratory (experimental) and literature (theoretical) values of the enthalpy of combustion of a liquid fuel?

(A) The calorimeter used in a school laboratory is not well-insulated.

(B) The purity of the fuel investigated in not high enough in a school laboratory.

(C) The amount of fuel burned in a school laboratory is too small.

(D) The thermometers used in school laboratories are not very accurate.

18. A solution is made by completely dissolving a solid mixture of sodium hydroxide and barium hydroxide in water.

Which of the following conditions must be true regarding the concentrations of each ion in the solution formed?

(A) $[Na^+] = [Ba^{2+}] = [OH^-]$

(B) $[Na^+] = [Ba^{2+}] = 3[OH^-]$

(C) $[Na^+] + [Ba^{2+}] = 3[OH^-]$

(D) $[Na^+] + 2[Ba^{2+}] = [OH^-]$

19. Three metals, "X", "Y" and "Z" were tested to compare their reactivity. Samples of each metal were placed separately into test tubes, each containing a nitrate solution of the other metal ions. The results are shown below.

	X (s)	**Y (s)**	**Z (s)**
$\mathbf{X^{2+}}$		no reaction	no reaction
$\mathbf{Y^{2+}}$	Solid Y forms		Solid Y forms
$\mathbf{Z^{2+}}$	Solid Z forms	no reaction	

Based on these results, which of the following shows the metals in order of decreasing reductant strength?

(A) Y > X > Z

(B) X > Z > Y

(C) Z > X > Y

(D) Y > Z > X

20. 10.79 g of powdered aluminium reacts with an accurately measured mass of oxygen gas, producing 20.39g of solid aluminium oxide.

From these data, which of the conclusions below can be drawn?

(A) Aluminium is the limiting reagent in this reaction.

(B) More oxygen added to the same mass of aluminium will result in a higher yield of product.

(C) The mole ratio of aluminium to oxygen gas used in the reaction was 4:3

(D) Equal moles of aluminium and oxygen were used in the reaction.

Question 21 (3 marks) **Marks**

Use the data provided to find the enthalpy change for the following reaction, by applying Hess's Law. **3**

$$\mathbf{CS_2(l) + 3O_2(g) \rightarrow CO_2(g) + 2SO_2(g)}$$

Reaction	ΔH (kJ/mol)
$C(s) + O_2(g) \rightarrow CO_2(g)$	- 394
$S(s) + O_2(g) \rightarrow SO_2(g)$	- 297
$C(s) + 2S(s) \rightarrow CS_2(l)$	+ 88

Show your working.

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Question 22 (1 mark)

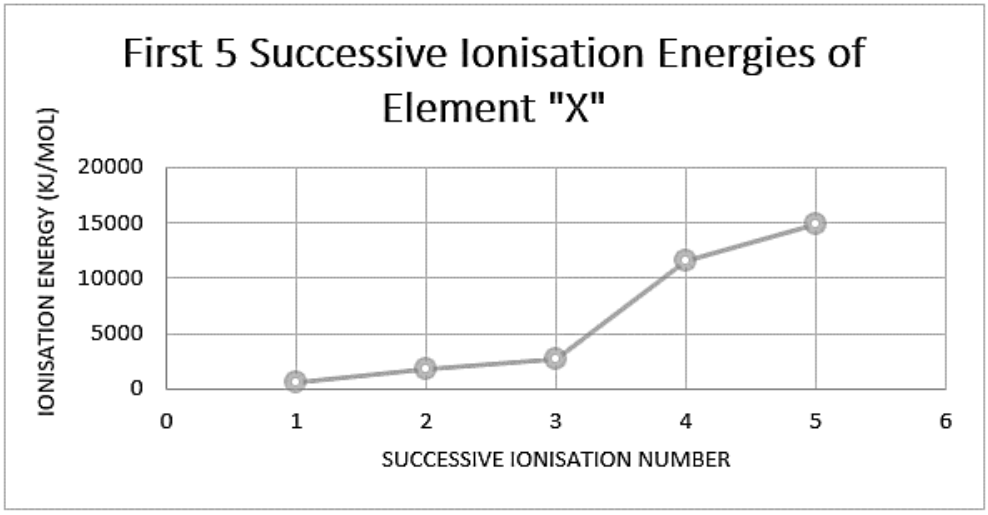
Hydrogen cyanide is a flammable, highly toxic chemical which boils at temperatures just above 25ºC and forms a miscible mixture with water. **1**

Draw an electron-dot diagram to represent this molecule.

Question 23 (4 marks)

Marks

The chart below shows data on the first 5 successive ionisation energies of an element, represented as "X".



(a) Use the data above to determine the formula of the chloride element "X" would form upon reaction with chlorine gas. *Use "X" to represent the symbol for the element.* **1**

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(b) Define the term 'successive ionisation energy' and explain how the data above can be used to make predictions about the electron configuration and valency of element "X". **3**

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Question 24 (6 marks) **Marks**

A student used the following equipment, together with a number of 1kg masses, to gather first-hand data to verify one of the '*gas laws'*.



The data they collected is shown in the table below.

Pressure (kPa)	**Volume of gas inside the syringe (L) x 10^{-2}**			
	Trial 1	Trial 2	Trial 3	Average Volume
0.79	8.0	8.2	7.9	
1.1	5.7	5.9	6.0	
1.2	5.4	7.1	5.5	
1.6	3.8	4.0	3.9	

(a) Complete the final column of the table using the most appropriate data for each trial. **2**

(b) Describe the gas law being investigated, including a relevant equation, and explain how the apparatus used and the specific data gathered can be shown to support the law. **4**

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Question 25 (6 marks)

Students want to set up two half cells so that the resulting galvanic cell will generate an EMF. One half-cell was constructed using magnesium metal in a solution of magnesium nitrate, and the other half-cell was constructed using zinc metal in zinc nitrate solution.

(a) Draw a fully labelled diagram of the galvanic cell, including direction of electron flow. **3**

(b) Write half equations for both half cells and using these construct a balanced overall equation to represent the reaction for the galvanic cell. **2**

(c) Calculate the EMF generated by this galvanic cell. **1**

Question 26 (4 marks) **Marks**

The dichromate ion found in compounds such as potassium dichromate ($K_2Cr_2O_7$) is such a powerful oxidant that it can oxidise inert metals such as platinum to form its ion (Pt^{2+}).

The reduction potential of platinum has been measured at 1.2V.

(a) Write an oxidation half-equation to represent the oxidation of Pt as described above. **1**

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(b) The half-equation for the reduction of $Cr_2O_7^{2-}$ is shown on the data sheet. Use this to determine the *change* in oxidation state that chromium undergoes in the reduction. **1**

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(c) Combine the equations in (a) and (b) to produce a balanced net ionic equation for the reaction that would occur when platinum metal was placed into a solution of acidified potassium dichromate. **1**
Show your working.

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(d) A galvanic cell was produced from coupling a standard Pt/Pt^{2+} half cell with a standard half-cell for $Cr_2O_7^{2-}/Cr^{3+}$.

What was the maximum theoretical voltage produced? **1**

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Question 27 (5 marks) **Marks**

Sulfur dioxide gas can react with oxygen gas to form sulfur trioxide gas. The temperature of the reaction vessel becomes hot as the reaction proceeds.

(a) Write a balanced chemical equation for this reaction. **1**

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(b) Sketch a labelled energy profile diagram for this reaction. **2**

(c) Vanadium pentoxide is a catalyst for this reaction.

Explain its role and show how the energy profile diagram for the catalysed reaction differs from the one shown above, without a catalyst. **2**

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Question 28 (8 marks)

Magnesium reacts with hydrochloric acid according to the following equation.

$$Mg_{(s)} + HCl_{(aq)} \rightarrow MgCl_2 + H_{2(g)}$$

In an experiment the hydrogen gas was collected in a container and the volume of the gas produced over a period of time was recorded as shown below.

Time (s)	0	5	10	15	20	25	30	35	40	45
Volume of Hydrogen gas	0	12	22	30	36	41	45	48	50	50

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(a) Plot a graph showing volume of hydrogen gas produced versus time. Label this as curve 1.

Question 28 continues on the next page.

(b) Explain why the volume of hydrogen gas collected in each 5 second interval becomes smaller and smaller. **2**

(c) Draw another curve on the **same grid** showing the effect of raising the temperature by 5°C. Label as curve 2. (Shape/position only; No Data points). **1**

(d) Draw another curve on the **same grid** showing the effect of using a more dilute hydrochloric acid solution. Label as curve 3. (Shape/position only; No Data points). **1**

Question 29 (6 marks)

The simplified solubility rules below may help you to answer this question.

General Rule	Exceptions
all Group I, nitrate and ammonium compounds are soluble	none
most chlorides are soluble	silver and lead (insoluble)
most sulfates are soluble	barium and lead (insoluble) calcium and silver (sparingly soluble)
most hydroxides are insoluble	group I, ammonium and barium compounds (soluble) calcium (slightly soluble)
most carbonates are insoluble	group I and ammonium compounds

Question 29 continues on the next page.

A science teacher mixes solutions of magnesium nitrate and sodium hydroxide.

(a) Write a balanced chemical equation (including states) for the reaction. **1**

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(b) Write the net ionic equation for the reaction. **1**

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(c) Using the solubility rules above, suggest a method that could be followed to determine which of the compounds below is present in an unlabelled bottle known to contain **one** of these dissolved compounds.

Explain how your observations would allow you to identify the unknown.

potassium nitrate, sodium sulfate, lithium hydroxide

(Assume you have access to typical laboratory equipment, as well as dropper bottles, each containing 0.1M solutions of any chemical you require in your procedure.) **4**

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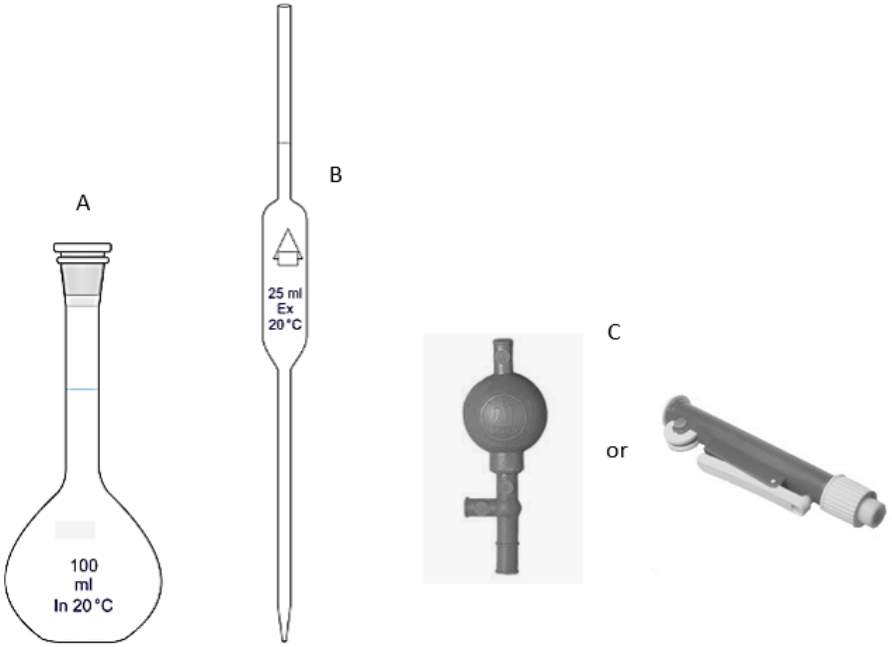
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Question 30 (5 marks)

A student used the following pieces of equipment (labelled A, B and C) once only each to produce a diluted solution of barium hydroxide from a bottle containing 0.0500 M barium hydroxide.



Describe the procedure the student should have followed to produce the solution accurately and calculate its concentration in $molL^{-1}$ and as a % (w/v), given the volumes shown on the equipment used.

Ensure equipment A to C is clearly identified in the procedure. **5**

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Question 31 (7 marks)

For reactions to be spontaneous, the entropy of the universe must increase. Scientists use a quantity called as Gibbs free energy to determine whether a process will be spontaneous.

(a) Discuss how Gibb's free energy is used to determine if a chemical reaction is spontaneous. **3**

(b) Methanol is used as a fuel for internal combustion engines. The following equation shows the reaction for combustion of methanol. **2**

$$CH_3OH_{(l)} + \frac{3}{2} O_{2(g)} \rightarrow H_2O_{(l)} + CO_{2(g)}$$

Predict the sign of ΔH for the above equation and justify your answer.

(c) Calculate Gibbs free energy at 25°C for the following reaction. **2**

$$CO_{(s)} + H_2O_{(l)} \rightarrow CO_{2\,(g)} + H_{2(g)}$$

Where ΔH = - 41.2 kJ and ΔS = -135 J/K
and predict if the reaction is spontaneous or not.

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Section II extra writing space.

If you use this space indicate clearly which question you are answering.

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