

Year 11 Semester Two Examination, 2016

MARKING KEY

CHEMISTRY

1. Which of the following atoms will have the **smallest** atomic radius?
 - (a) F
 - (b) Cl
 - (c) S
 - (d) O
2. Which of the following pairs of elements will have the **largest difference** in electronegativities?
 - (a) boron and bromine
 - (b) chlorine and carbon
 - (c) rubidium and radium
 - (d) sodium and sulfur
3. In an atomic absorption spectroscopy (AAS) the wavelength of light absorbed is related to the
 - (a) number of electrons in the atom.
 - (b) differences between the energy levels for electrons in the atom.
 - (c) energy of the outer (valence) shell of electrons.
 - (d) mass of the ion formed when the atom is ionised.
4. Which one of the following was the major conclusion from Rutherford's gold foil experiment?
 - (a) Elements contain one type of atom.
 - (b) Most of the mass of the atom was contained in a relatively small nucleus.
 - (c) Electrons existed in shells with different energy levels.
 - (d) Metallic bonding in gold made the metal malleable.

5. Which one of the following isotopes will have a different number of neutrons from the other three?
- (a) carbon-14
 - (b) nitrogen-15
 - (c) oxygen-15
 - (d) fluorine-17
- Which one of the following statements about a mass spectrometer is **false**?
6. Which one of the following statements about a mass spectrometer is **false**?
- (a) Ionisation in a mass spectrometer always produces positive ions.
 - (b) The heavier particles will be deflected more in the magnetic field than the lighter particles.
 - (c) The charged ions are accelerated towards the magnetic field using an electric field.
 - (d) A mass spectrometer can provide information about relative amount of the isotopes in a sample.
7. In a gas chromatograph
- (a) the retardation factor indicates the identity of the substance.
 - (b) smaller particles have a longer retention time than larger particles.
 - (c) the retention time indicates the amount of the substance and the peak height indicates the identity of the substance present.
 - (d) The retention time indicates the identity of the substance and the area under the peak indicates the amount of the substance present.
8. Which one of the following ionic formulae is correct?
- (a) $\text{Al}(\text{PO}_4)_3$
 - (b) Na_2HCO_3
 - (c) $\text{Mg}(\text{NO}_3)_3$
 - (d) CaS
9. Which one of the following molecules is a polar molecule?
- (a) CO_2
 - (b) O_2
 - (c) NH_3
 - (d) CH_4
10. In which of the following pairs of molecules would dispersion forces be the most significant intermolecular force?
- (a) CO_2 and CO_2
 - (b) H_2O and H_2O
 - (c) NH_3 and H_2O
 - (d) SO_2 and SO_2

11. Which one of the following is the IUPAC name for the molecule shown below?



- (a) 3,5-methylhexane
- (b) 2,3-dimethylhexane
- (c) 2,3-dimethyloctane
- (d) 3,5-dimethylhexane

12. Which of the following would have a high melting point?

- i. magnesium chloride
- ii. magnesium
- iii. chlorine
- iv. graphite
- v. carbon tetrachloride

- (a) iv and v only
- (b) iii, iv and v only
- (c) ii and iv only
- (d) i, ii and iv only

13. Which one of the following is **not** a process used to treat water from ground water **or** seawater before it is supplied to houses as drinking water?

- (a) crystallisation
- (b) desalination
- (c) fluoridation
- (d) chlorination

14. Incomplete combustion of hydrocarbons

- (a) occurs when not all the hydrocarbon is combusted, leaving some of the hydrocarbon left over.
- (b) occurs when unsaturated hydrocarbons burn in oxygen.
- (c) may result in the production of carbon monoxide.
- (d) occurs when the heat supplied is not enough to overcome the activation energy for the reaction.

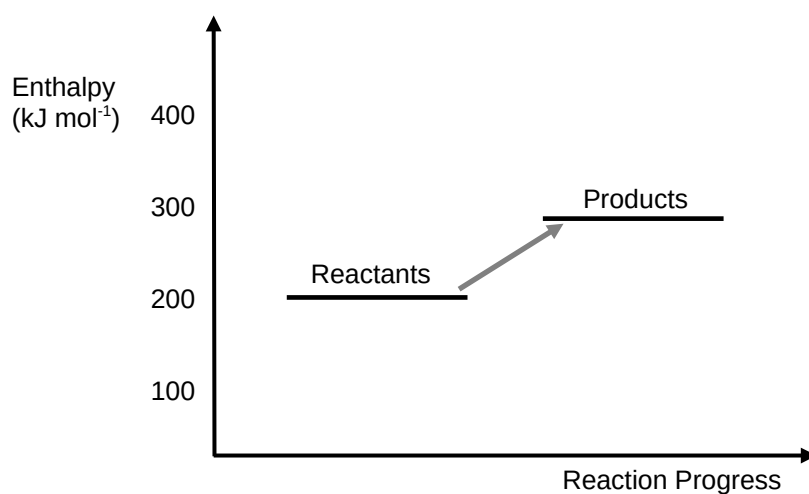
15. Read the following explanation:

“The rate of a chemical reaction is determined by the number of successful collisions. If more particles make up a solid are exposed, there will be a greater total number of collisions. Therefore, the number of successful collisions will increase and the reaction will proceed faster”

Which one of the following factors is this statement referring to?

- (a) using a catalyst
- (b) temperature
- (c) concentration
- (d) surface area

16. An enthalpy diagram for a chemical reaction is shown below.



Estimate the enthalpy change for the forward reaction.

- (a) + 300 kJ mol^{-1}
- (b) - 100 kJ mol^{-1}
- (c) - 300 kJ mol^{-1}
- (d) + 100 kJ mol^{-1}

17. The human stomach contains gastric juice, which contains approximately 1% (by mass) of hydrochloric acid. Which one of the following would most likely be the pH inside our stomachs?

- (a) 1
- (b) 6
- (c) 7
- (d) 9

18. Which one of the following equations represents a substitution reaction?

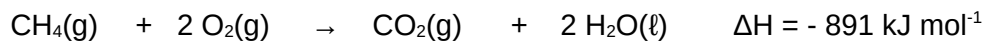
- (a) $\text{C}_3\text{H}_6 + \text{Br}_2 \rightarrow \text{C}_3\text{H}_6\text{Br}_2$
- (b) $2 \text{C}_4\text{H}_{10} + 13 \text{O}_2 \rightarrow 8 \text{CO}_2 + 10 \text{H}_2\text{O}$
- (c) $\text{C}_2\text{H}_6 \rightarrow \text{C}_2\text{H}_4 + \text{H}_2$
- (d) $\text{C}_6\text{H}_6 + \text{Cl}_2 \rightarrow \text{C}_6\text{H}_5\text{Cl} + \text{HCl}$

19. A student had two colourless solutions to identify. She knew that one was sodium carbonate and one was potassium chloride. Which of the following tests could be used to distinguish between the two solutions?

- i. adding dilute hydrochloric acid to both solutions
- ii. adding calcium nitrate solution to both solutions
- iii. adding universal indicator to both solutions
- iv. adding silver nitrate solution to both solutions

- (a) ii, iii and iv only
- (b) i and iii only
- (c) ii and iii only
- (d) i, ii, iii and iv

20. The equation for the combustion of methane is shown below:



Which one of the following can be deduced from this equation?

- i. it is an exothermic reaction
- ii. 2 moles of oxygen gas are required for the complete combustion of 1 mole of methane
- iii. it is a fast chemical reaction
- iv. at STP, 1.00 L of carbon dioxide is produced for each mole of methane combusted
- v. 891 kJ of energy is released when 16.04 g of methane is combusted

- (a) i, ii and iii only
- (b) i, ii, iii and v only
- (c) i and ii only
- (d) i, ii and v only

End of Section One

Section Two: Short answer**35% (56 Marks)****Question 21****(5 marks)**

Write ionic equations, including state symbols, for any reactions that occur in the following situations.

(a) Dilute nitric acid solution is added to solid copper(II) carbonate. (3 marks)

(b) Solid sodium hydroxide pellets are added to distilled water. (2 marks)

Question 22**(6 marks)**

(a) For each of the following reactions, describe expected observations, including any

(i) Dilute sulfuric acid is added to zinc metal (2 marks)

(ii) $2 \text{HCl}(\text{aq}) + \text{Ag}_2\text{O}(\text{s}) \rightarrow 2 \text{AgCl}(\text{s}) + \text{H}_2\text{O}(\text{l})$ (2 marks)

(b) A student noted the following observations in his notebook.

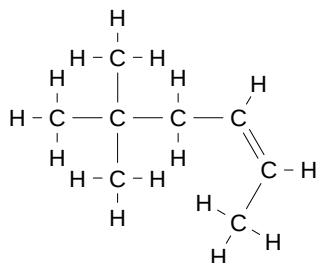
“A colourless solution and a pale pink solution were added together and a pale pink precipitate was formed. No gas was produced.”

Write an ionic equation (including state symbols) for a reaction that would produce these observations. (2 marks)

Question 23

(6 marks)

Examine the displayed structure of *cis* 5,5-dimethylhex-2-ene below.



- (a) Draw the displayed structure of a **structural isomer** of this compound and name the isomer that you have drawn.
- (b) Draw the displayed structure and name the product of the reaction of this molecule with bromine. (2 marks)
- © Explain why 5,5-dimethylhex-2-ene exhibits geometric (*cis/trans*) isomerism but the molecule that is your answer to part (b) does not. (2 marks)

Question 24**(7 marks)**

The following answers were seen on a Year 11 student's chemistry test. Unfortunately, they are all incorrect. For each one, rewrite the statement making it correct.

- (a) 'Dispersion forces only occur between non-polar molecules.' (2 marks)

Correct statement:

- (b) 'Chlorine has a larger atomic radius than phosphorus because chlorine atoms contain more electrons than phosphorus atoms.' (2 marks)

Correct statement:

- (c) 'Sodium chloride is soluble because the bonds between the sodium ions and the chloride ions are weak.' (3 marks)

Correct statement:

Question 25

(13 marks)

- (a) For each molecule listed in the table below draw the structural formula, representing **all** valence shell electron pairs as : or as —, indicate the shape of the species by a sketch or a name and state the polarity of the molecule. (9 marks)

Species	Electron Dot Diagram (Lewis diagram)	Shape (sketch or name)	Polarity (polar or non-polar)
trichloromethane (chloroform) CHCl_3			
methanal (formaldehyde), CH_2O			
Ammonia, NH_3			

- (b) (i) Which substance above would display hydrogen bonding between (1 mark)

- (ii) Draw a diagram showing how this hydrogen bonding is formed. (3 marks)

Question 26**(10 marks)**

The 'pop test' is used to test for the presence of hydrogen gas. The test normally involves an up-side down test tube being filled with hydrogen and a flame is brought close to the open end of the test tube. Hydrogen gas undergoes an exothermic reaction with oxygen gas in the air to produce water vapour. The 'pop' is made by the air in the test tube expanding out of the end of the test tube.

- (a) Draw a fully labelled enthalpy diagram for this reaction, including activation energy. (5 marks)

- (b) Explain why a flame is used to start the reaction. (2 marks)

- © Explain why the air in the test tube expands out of the end of the test tube. (3 marks)

Question 27**(9 marks)**

A sample of nitrogen was analysed in a mass spectrometer and the following results were obtained:

Relative mass of N ⁺ ion	Relative intensity
14.0	34.0
15.0	0.370

- (a) Calculate the relative atomic mass of this sample of nitrogen. (2 marks)
- (b) Comment on whether you think this is would be a naturally occurring sample of nitrogen. (2 marks)
- (c) The mass spectrum for this sample also contained peaks at relative masses of 28, 29, and 30.
- (i) Account for the appearance of the peak seen at a relative mass of 29. (2 marks)
- (ii) Which one of these three peaks would have the lowest relative intensity? (1 mark)
- (iii) Which one of species causing these three peaks (28, 29, and 30) would have been deflected most by the magnetic field? Briefly explain your answer. (2 marks)

End of Section Two**MARKING KEY**

Section Three: Extended answer**40% (64 Marks)****Question 28****(17 marks)**

Sulfuric acid is used as the electrolyte in car batteries.

- (a) Using the example of sulfuric acid explain what is meant by a strong acid. Use an equation in your answer. (3 marks)
- (b) The concentration of sulfuric acid in a car battery is found to be 2.15 mol L^{-1} . A car battery contains 0.650 L of sulfuric acid.
- (i) Calculate the mass of sulfuric acid in the car battery. (3 marks)

- (ii) Assuming the density of the acid in the battery is 1.07 g mL^{-1} calculate the concentration of the sulfuric acid as a percentage by mass. (2 marks)
- (c) The car battery was damaged and 0.300 L of the acid leaked onto the floor of the garage. 475 mL of a solution of 2.75 mol L^{-1} sodium hydroxide was used to neutralise the acid. Show by calculation that this was just enough to neutralise all the spilt acid. (4 marks)
- (d) Powdered aluminium oxide was then sprinkled over the area of the spillage to remove any excess chemicals. Aluminium oxide is an amphoteric substance, which means it can act as an acid or a base.
- (i) Explain why aluminium oxide is the substance chosen to complete the clean-up process (2 marks)
- (ii) Use your knowledge of reaction rates to explain why the aluminium oxide was used in a powdered form. (3 marks)

Question 29**(12 marks)**

In 2006 there was a serious pollution incident in the town of Esperance, caused by the escape of lead carbonate powder from a storage facility at the town's port.

A team of environmental scientists were asked to analyse a sample of drinking water for lead content. They added excess sodium iodide solution to 100 litres of the drinking water to form a precipitate of lead(II) iodide.

After filtering and drying, the mass of the residue was found to be 0.236 g.

- (a) Explain, in with reference to experimental error, why the residue had to be dried before weighing. (2 marks)
- (b) Calculate the concentration of lead(II) ions (Pb^{2+}) in the sample of water in
- (i) moles per litre. (3 marks)
- (ii) grams per litre. (2 marks)
- (c) Suggest one reason why using Atomic Absorption Spectroscopy (AAS) would be
- (i) a more **economic** method for working out the concentration of lead than precipitation. (2 marks)

- (ii) a more **accurate** method for working out the concentration of lead than precipitation. (2 marks)
- (d) As well as contamination of drinking water, it was found that lead was present in the air around the Port of Esperance. Name an analytical technique that could be used to determine the concentration of lead in the atmosphere. (1 mark)

Question 30**(13 marks)**

(a) Draw the structures of the following molecules

(i) 2,2-dimethylbutane

(1 mark)



(ii) hexane

(1 mark)



(b) These compounds are both saturated, non-polar hydrocarbons but they are isomers of each other that have different structures. Discuss, with explanations, equations and diagrams as required how these similarities and differences affect the behaviour of the compounds. Include in your answer types of reactions, solubility in water and boiling points. (11 marks)

Question 31**(22 marks)**

A class of Year 11 students carried out a series of experiments to investigate the factors that affect the rate of a chemical reaction. The reaction used was sodium thiosulphate reacting with dilute hydrochloric acid. The reaction causes the solution to become a suspension with small particles of solid floating in the reaction mixture.

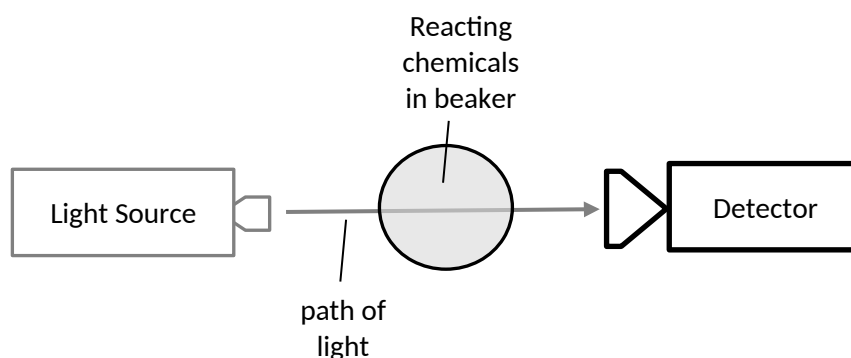
The molecular equation for this reaction is shown below.



(a) Rewrite this equation as an ionic equation. (2 marks)

(b) State two characteristics of a solution that make it different to a suspension. (2 marks)

The rate of the reaction was monitored by using a light sensor as shown in the plan view below. As the suspension was formed, the solution became opaque and the light was blocked from reaching the sensor.



The timer was started when the chemicals were mixed and stopped when the sensor no longer detected light from the source.

(c) Name the product from the reaction that is preventing the light reach the detector. (1 mark)

The results from the whole class are shown below

Trial	Volume of 0.10 mol L ⁻¹ sodium thiosulfate (mL)	Volume of 0.10 mol L ⁻¹ HCl(aq) (mL)	Volume of water (mL)	Concentration of sodium thiosulphate in reaction (mol L ⁻¹)	Temperature of reaction (°C)	Time taken (s)	Rate of reaction (1/time) (s ⁻¹)
1	5.0	5.0	40.0	0.010	25	50	0.020
2	10.0	5.0	35.0	0.020	25	24	0.042
3	10.0	5.0	35.0	0.020	21	13	0.077
4	15.0	5.0	30.0	0.030	25	17	0.059
5	20.0	5.0	25.0	0.040	25	12	0.083
6	30.0	10.0	20.0	0.060	25	7	0.143
7	40.0	5.0	10.0	0.073	25	8	0.125
8	40.0	5.0	5.0	0.080	25	6	0.167

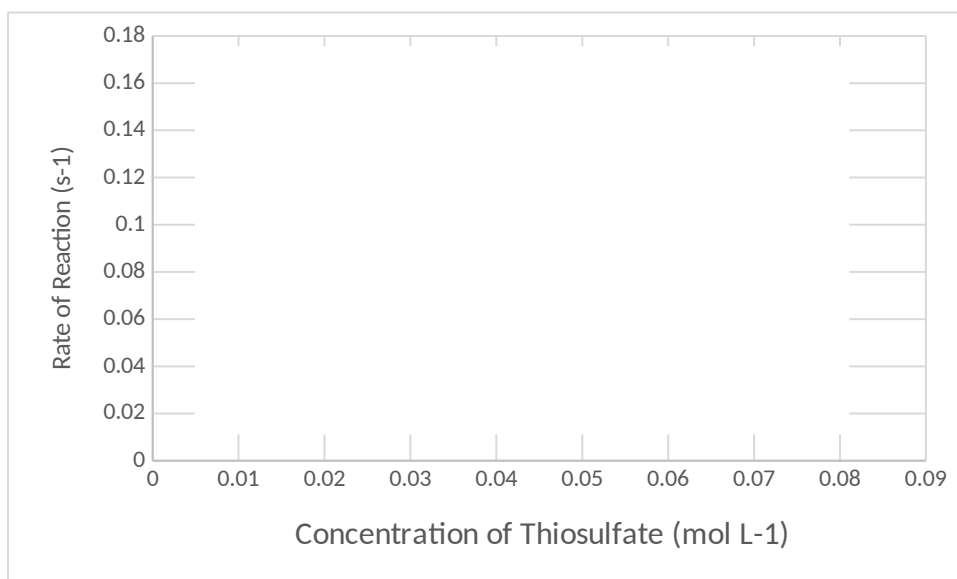
From these results your task is to identify the relationship between the concentration of the sodium thiosulphate and the rate of the reaction.

- (d) (i) List all the numbers of the trials from the results above that are not valid for this task and should **not** be used. (1 mark)

- (ii) Explain the reasoning for your selection of each of the trials selected in your answer to (d) part (i). (4 marks)

(f) Plot the valid results from the results on the grid below.

(5 marks)



(g) Describe, and, using the collision theory explain, the relationship between the concentration of the sodium thiosulphate and the rate of the reaction. (5 marks)

- (h) A version of this experiment can be carried out using the human eye to judge when to stop the stopwatch by looking through the reaction mixture and stopping the stopwatch when a cross on the opposite side of the mixture is obscured from view.

Will this method of measurement introduce systematic error, or random error to the experiment? Justify your answer. (2 marks)