INTERNATIONAL GRAMMAR SCHOOL

Student Number

2019

YEAR 11 (PRELIMINARY) EXAMINATION

Chemistry

General 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 – 20 marks (pages 3 – 10)

- Attempt questions 1 – 20.
- Allow about 35 minutes for this section.

Section II – 55 marks (pages 11 – 24)

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

Section I – 20 marks

Attempt Questions 1-20

Allow about 35 minutes for this section

Use the multiple-choice answer sheet.

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

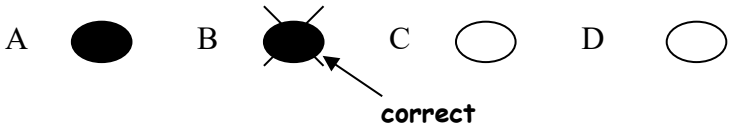
Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9



If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.



If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.



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. Which of the following equations correctly represents the reaction of magnesium carbonate with sulfuric acid?

(A) $MgCO_3(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2O(l) + CO_2(g)$

(B) $MgCO_3(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2O(l)$

(C) $MgCO_3(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2(g)$

(D) $MgCO_3(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2(g) + CO_2(g)$

5. In which of the following samples of matter would the particles have the most kinetic energy?

(A) A liquid at 100°C.

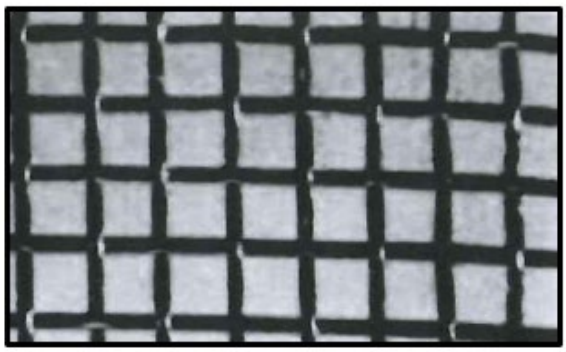
(B) A gas at 100°C.

(C) A solid at 0°C.

(D) A liquid at 0°C.

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 one of the following does NOT occur as we move from left to right across the third row of elements in the periodic table?

(A) Ionisation energy of the elements across the row decreases.

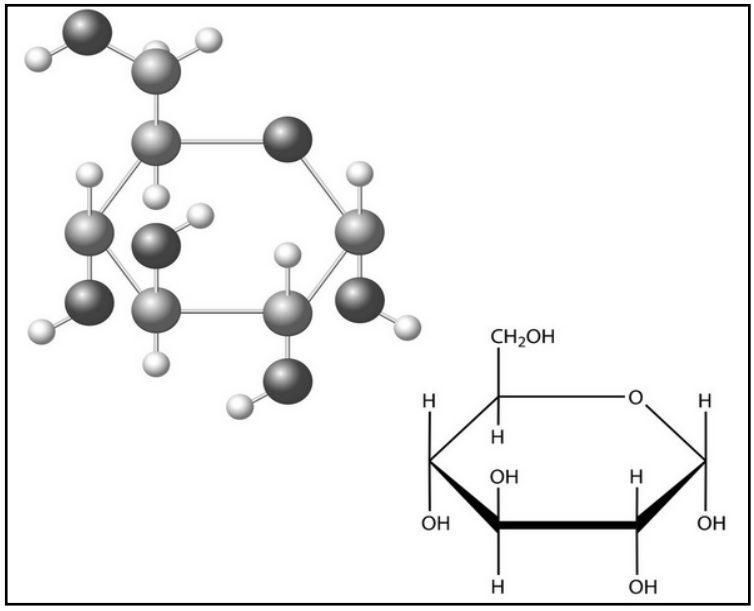
(B) The size of the atomic radius increases.

(C) Melting and boiling points increase up to the Group IV elements, then decrease.

(D) The number of outer energy level electrons increases.

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

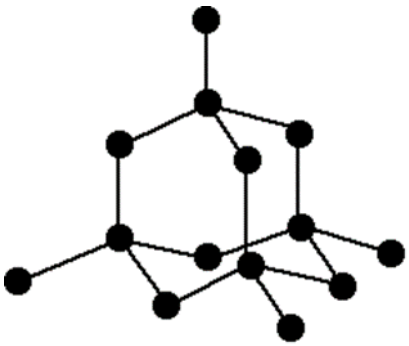
(C) 6 x (6.022×10^{23})

(D) 12 x (6.022×10^{23})

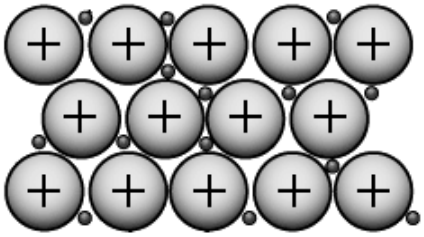
11. Solid "X" is a dull, brittle solid with a surface that scratches easily. It has a density of 2.27 g cm^{-3} and conducts electricity in the solid form.

Which model below is consistent with a substance with these physical properties?

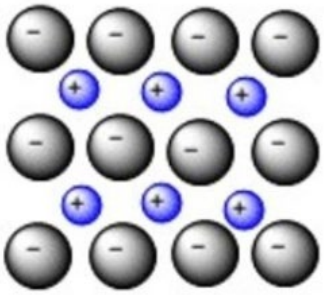
(A)



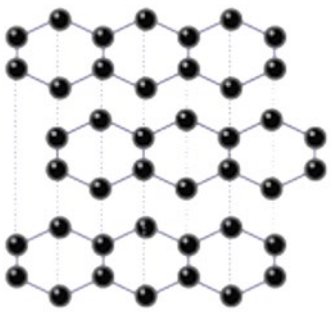
(B)



(C)



(D)



Questions 12 and 13 refer to the table below.

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

Sn63/Pb37	182-183
Sn 62/Pb38	178-180

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

(A) Solder must be classed as a chemical mixture.

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

(C) Solder is an example of heterogeneous matter.

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

13. 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 %

14. 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

15. Dispersion forces are the predominant type of force between atoms or molecules of:

(A) covalent molecular substances whose atoms or molecules are polar

(B) metals.

(C) covalent molecular substances whose atoms or molecules are non-polar.

(D) covalent network substances.

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. From this data, 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 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. By what percentage does the mass increase when Fe is oxidised to Fe_2O_3?

$$2Fe_{(s)} + 3/2O_{2(g)} \rightarrow Fe_2O_{3(s)}$$

(A) 86%

(B) 22%

(C) 43%

(D) 30%

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.

2019

YEAR 11 (PRELIMINARY) EXAMINATION

Chemistry

Section II
Answer Booklet

55 marks

Attempt Questions 21 – 31

Allow about 1 hour and 25 minutes for this part

Instructions

- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
- Show all relevant working in questions involving calculations.
- Extra writing space is provided at the back of this booklet. If you use this space, clearly indicate which questions you are answering.

Marks

Question 21 (3 marks)

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

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

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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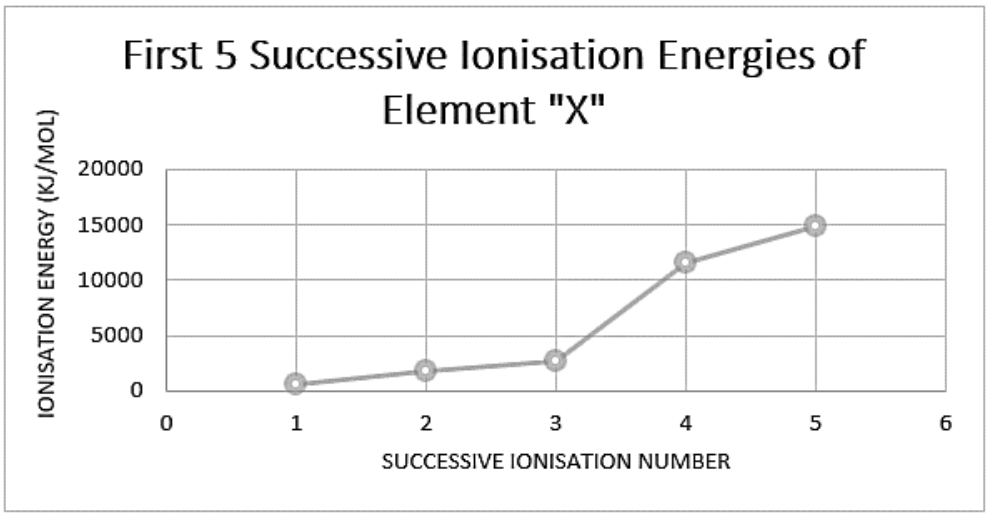
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Marks

Question 22 (5 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". **4**

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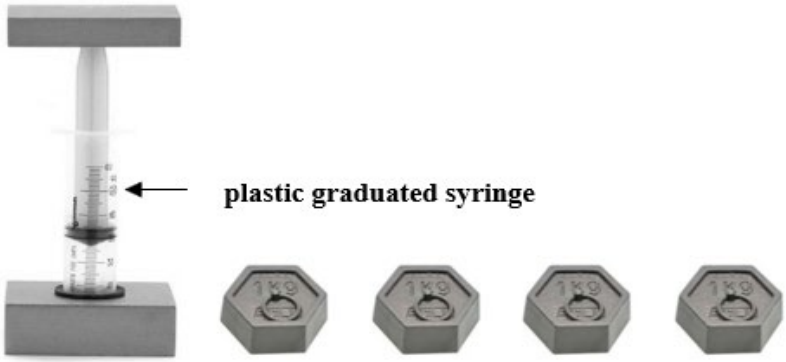
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Question 23 (6 marks) **Marks**

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 are 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) <u>Describe</u> 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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Marks

Question 24 (6 marks)

List the formulae of the common chlorides of the first 5 elements in Period 3 and explain how differences in the structure and bonding of the chloride of sodium and the chloride of silicon affect their properties. **6**

Include relevant diagrams with your answer.

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Marks

Question 25 (4 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. Show your working. **1**

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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 $Cr_2O_7^{2-}/Cr^{3+}$. **1**

What was the maximum theoretical voltage produced?

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Marks

Question 26 (5 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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Marks

Question 27 (4 marks)

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

(a) Draw a Lewis electron-dot diagram to represent this molecule. **1**

(b) By referring to an appropriate theory, predict the shape of this molecule and explain why it is soluble in water. **3**

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Marks

Question 28 (3 marks)

A 14.6 g sample of a compound containing carbon and hydrogen only (which could be represented as C_xH_y) was burnt in excess oxygen to produce 44.0 g of carbon dioxide (CO_2) and 24.0 g of water vapour.

Determine an empirical formula for this compound, showing your working. **3**

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Marks

Question 29 (7 marks)

A student uses a gas syringe (shown below) to measure the volume of hydrogen gas produced when zinc metal reacts with dilute hydrochloric acid, and they recorded the data shown in the table below.

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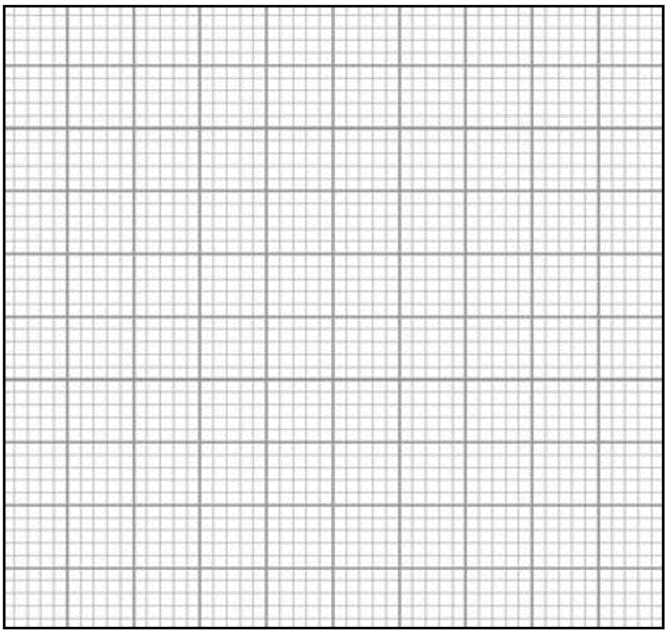


Time (s)	Vol. H_2(g) produced (mL)
0	0
10	30
20	40
30	45
40	47
50	47
60	47
70	47

(a) Write a balanced chemical equation for the reaction that occurred. **1**

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(b) Graph the data shown in the table, plotting time on the x-axis. **3**



Question 29 continues on page 21.

(c) Use Collision Theory to explain the shape of your graph. **3**

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Question 30 (5 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

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

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

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Question 30 continues on page 22.

(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. **3**

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.)

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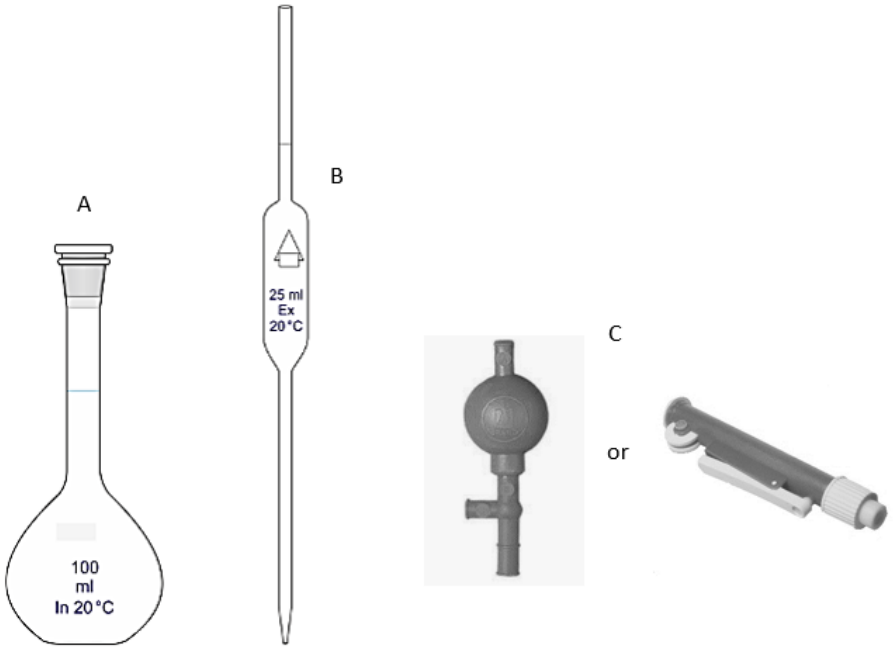
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Marks

Question 31 (7 marks)

A student used the following pieces of equipment (labelled A, B and C) to produce a diluted solution of barium hydroxide from a bottle containing 0.050M barium hydroxide.



(a) 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. **5**

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

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Question 31 continues on page 24.

Marks

Question 31 (continued)

(b) Two types of error can occur during investigations, 'random' and 'systematic' errors.

The meanings of these types of errors are described below

- ***Random*** *errors can occur (as the name suggests) completely randomly. They are unpredictable and may not be replicated when repeating the experiment. Depending on the nature of the error, the experimental value may be too high or too low, compared to the theoretical value.*
- ***Systematic*** *errors produce consistent experimental values, either a fixed amount (e.g. 0.5mL above the theoretical result) or a proportion (like 105% of the true value). If you repeat the experiment, you'll get a similar error.*

A student must make three diluted solutions using the equipment 'A', 'B' and 'C'.

The student notices that a small amount of solution remains in glassware 'B' each time it is emptied into 'A'. They decide to blow this last drop out into 'A' each time they make the solution.

Classify their technique as an example of a:

- correct step in the procedure OR
- a random error OR
- a systematic error

2

Justify your choice.

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Section II extra writing space.

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