Carmel School

emistry: Semester 2 Examination, 2017

Question/Answer Booklet

Student Name:

_____

TIME ALLOWED FOR THIS PAPER
Reading time before commencing work: ten minutes
Working time for the paper: three hours

MATERIALS REQUIRED/RECOMMENDED FOR THIS PAPER

To be provided by the supervisor:
This Question/Answer Booklet
Multiple-choice Answer Sheet
Chemistry Data Book

To be provided by the candidate:
Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, eraser, correction tape/fluid, ruler, highlighters

Special items: up to three non-programmable calculators approved for use in the WACE examinations

IMPORTANT NOTE TO CANDIDATES
No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of exam
Section One: Multiple-choice	25	25	50	/50	/25

Section Two: Short answer	8	8	60	/70	/35
Section Three: Extended answer	5	5	70	/80	/40
					/100

Instructions to candidates

1.   Answer the questions according to the following instructions.

Section One: Answer all questions on the separate Multiple-choice Answer Sheet provided. For each questions shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. If you make a mistake, place a cross through that square then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Sections Two and Three: Write your answers in this Question/Answer Booklet.

2.   When calculating numerical answers, show your working or reasoning clearly. Express numerical answers to the appropriate number of significant figures and include appropriate units where applicable.

3.   You must be careful to confine your responses to the specific questions asked and to follow any instructions that are specific to a particular question.

4.   Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.
    • Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
    • Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

5.   The Chemistry Data Book is **not** handed in with your Question/Answer Booklet.

Section One: Multiple-choice   **25%   (50 marks)**

This section has **25** questions. Answer **all** questions on the separate Multiple-choice Answer Sheet provided. For each question, shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. If you make a mistake, place a cross through that square then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Suggested working time: 50 minutes.

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1.   How many valence electrons (bonding and non-bonding) are present in the nitrate ion?

        (a)   1
        (b)   6
        (c)   18
        (d)   24

2.   Which is the correct electron-dot diagram for ozone (O_3)?

        (a)   (b)

   (c)   (d)
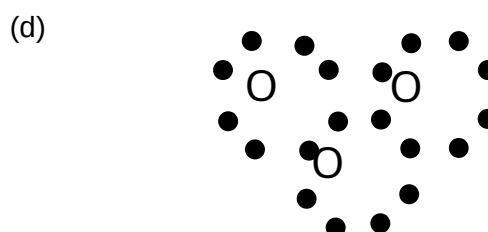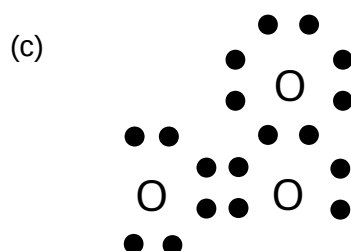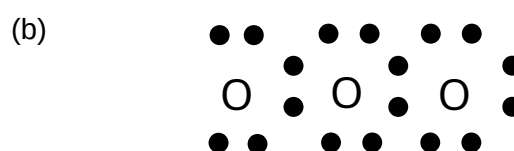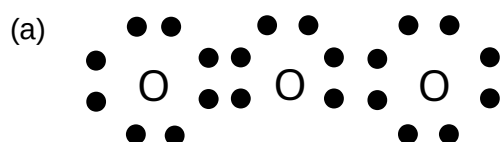
3.   Elements X and Y have the following electron shell configurations: X = 2, 6 and Y = 2, 8, 2. What would be the bonding type of the compound produced when X and Y react?

        (a)   Covalent network

        (b)   Hydrogen-bonded solid

        (c)   Ionic solid

        (d)   Molecular gas

4.   Metal M reacts completely with HCl so that 1.00 mol of M produces 1.50 mol of H_2 gas. What would be the ionic charge on M ions?

        (a)   1+
        (b)   2+
        (c)   3+
        (d)   4+

SEE NEXT PAGE

5.   In a furnace coal can react with steam to produce two fuels, hydrogen and carbon monoxide,
      according to the equation:

$$C(s) + H_2O(g) \rightarrow H_2(g) + CO(g) \qquad\qquad \Delta H = +130 \text{ kJ mol}^{-1}$$
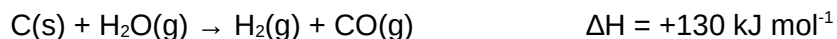
      From the following conditions, which would result in a higher reaction rate?

      (i)   Adding more coal   (ii) Increasing the pressure of H_2O

      (iii) Grinding up the coal   (iv) Lowering the temperature

      (a) (i) and (ii)   (b) (ii) and (iv)   (c) (i) and (iii)   (d) (ii) and (iii)

6.   Which of the following lists substances in **increasing** strength of intermolecular forces?

      (a) $H_2 < CH_4 < C_2H_6 < C_2H_5Cl < H_2O$

      (b) $C_2H_4 < C_2H_5OH < Cl_2 < NH_3 < H_2O$

      (c) $Cl_2 < NH_3 < C_2H_4 < H_2O < C_2H_5OH$

      (d) $NH_3 < Cl_2 < C_2H_5OH < C_2H_4 < H_2O$

7.   Which of the following compounds would decolorize bromine water fastest without a catalyst?

      (a) CH_4
      (b) C_2H_6
      (c) C_3H_6
      (d) C_4H_{10}

8.   1.25 g of NaCl is dissolved in 250 mL of water. What is the concentration of sodium ions in
      the solution?

      (a)   0.086 mol L^{-1}
      (b)   0.098 mol L^{-1}
      (c)   0.172 mol L^{-1}
      (d)   0.210 mol L^{-1}

9.   Water could be purified by a number of different processes. Which ones are most commonly
      used in practice?

      (i) Sedimentation   (ii) Addition of fluoride ion   (iii) Exposure to ultraviolet light

      (iv) Addition of iodide ion   (v) Addition of chlorine

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

SEE NEXT PAGE

10.   Which of the following shows the correct shapes of molecules?

| (a)	CO_2	Trigonal planar
(b)	BF_3	Linear
(c)	SO_2	V-shaped
(d)	NH_3	Tetrahedral

11.
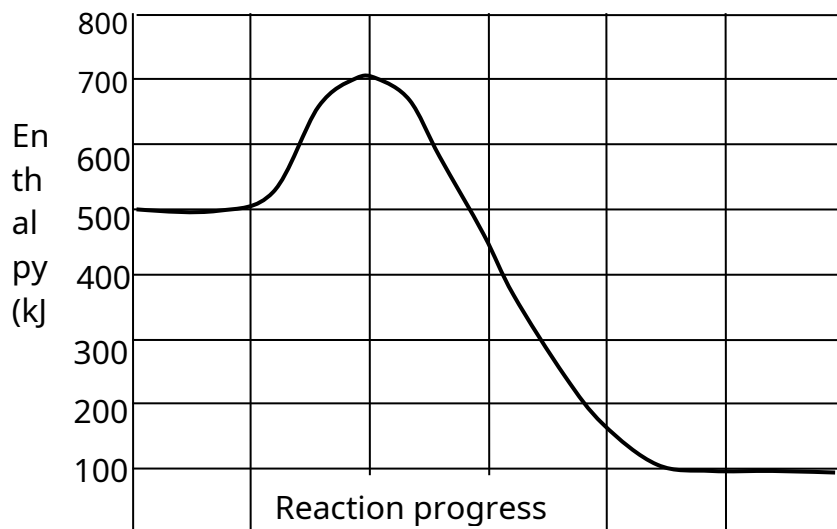


Referring to the enthalpy graph above for a reaction, which statements are both true?

(a)   The forward reaction has an activation energy of 200 kJ and ΔH of +400 kJ

(b)   The reverse reaction has an activation energy of 600 kJ and ΔH of +400 kJ

(c)   The forward reaction has an activation energy of 600 kJ and ΔH of -400 kJ

(d)   The reverse reaction has an activation energy of 200 kJ and ΔH of -400 kJ

12.   When the salts of different metals are sprayed into a flame, different colours result. The colour of the flame can be used to identify the metal salts.
       These colours are produced because:

(a)   Light is being absorbed by the metal particles in the flame

(b)   Light is emitted when atoms absorb energy from the flame to become ions

(c)   Light is being absorbed when bonds are broken by the heat energy

(d)   Light is emitted when electrons fall from higher energy levels

13.   Ammonia is classified as a weak base, which means it is only partially ionised in solution. What is the likely value for pH of a 0.010 mol L^{-1} solution of ammonia?

(a)   2
(b)   5
(c)   9
(d)   13

SEE NEXT PAGE

14.   Which of the following is the correct arrangement for solutions - in order of electrical conductivity from lowest to highest.

(a)   Ethanoic acid < Potassium nitrate < Kerosene < Copper (II) chloride

(b)   Kerosene < Ethanoic acid < Potassium nitrate < Copper (II) chloride

(c)   Copper chloride < Potassium nitrate < Ethanoic acid < Kerosene

(d)   Kerosene < Potassium nitrate < Copper chloride < Ethanoic acid

15.   Which one of the following groups of formulae would represent members of an homologous series?

(a) CH_3Cl CH_2Cl_2 $CHCl_3$ CCl_4

(b) CH_2CH_2 $CH_2CH_2CH_2$ $CH_2CH_2CH_2CH_2$ $CH_2CH_2CH_2CH_2CH_2$

(c) CH_4 CH_3CH_3 $CH_3CH_2CH_3$; $CH_3CH_2CH_2CH_3$;

(d) CH_4 CH_3Cl CH_3OH $HCHO$

16.   Which of the diagrams below illustrates a hydrogen bond shown with a dotted line? ----
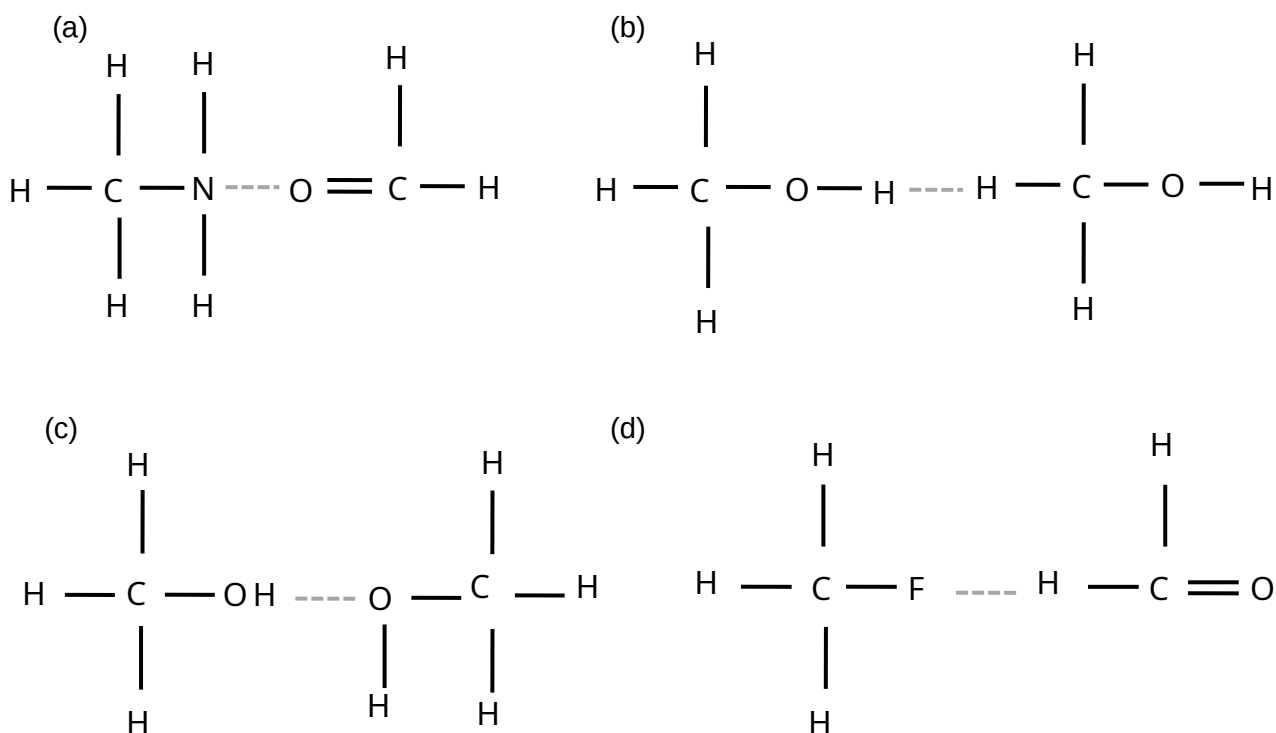
17.   Which of the following graphs correctly shows the relationship between the variables P, V, T
       for a constant number of moles of gas?

(a)

PV

T

(b)

T   (V

P

(c)

P   (T

$\dfrac{1}{V}$

(d)

V   (P

T
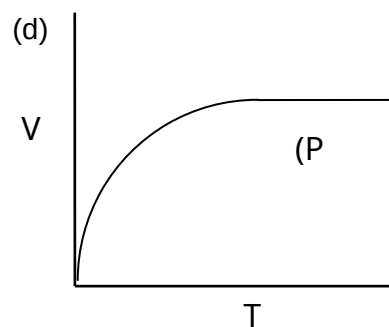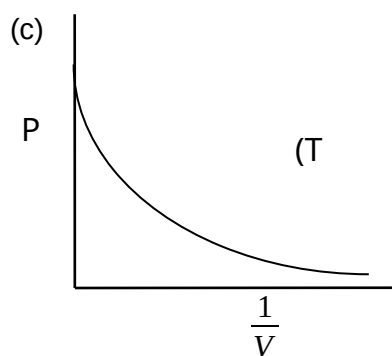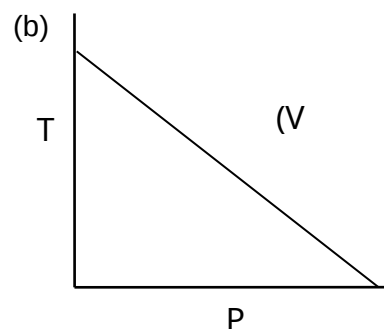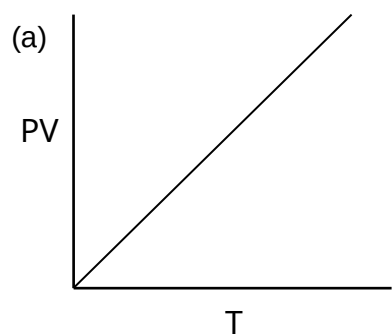
18.   Which of the following pairs of compounds are isomers of each other?

(I)

$$H - \underset{\underset{H}{|}}{\overset{\overset{Cl}{|}}{C}} - \underset{\underset{Cl}{|}}{\overset{\overset{H}{|}}{C}} - H \qquad\qquad H - \underset{\underset{Cl}{|}}{\overset{\overset{H}{|}}{C}} - \underset{\underset{Cl}{|}}{\overset{\overset{H}{|}}{C}} - H$$

(II) $CH_3CHCH_2CH_3$ $CH_3CH_2CHCH_3$
                     | |
                   CH_3 CH_3

(III)

$$\underset{\underset{H}{|}}{\overset{\overset{CH_3}{|}}{C}} = \overset{\overset{H}{|}}{C} - CH_3$$

$H_2C \text{———} CH_2$
  | |
$H_2C \text{———} CH_2$
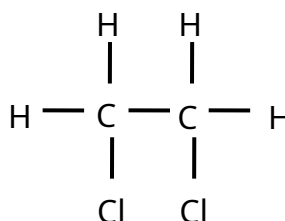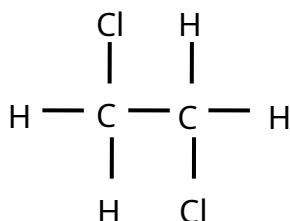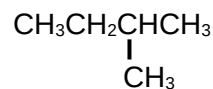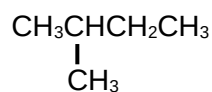
(a)   (II) only   (b)   (I) and (II)   (c)   (II) and (III)   (d)   (III) only

19.   The two main isotopes of element X have mass numbers of 36 and 39. The percentage abundance of X-36 is 77% and that of X-39 is 23%. The weighted average atomic mass of element X would be:

(a)   36.2
(b)   36.7
(c)   37.1
(d)   38.3

20.   Some elements are shown in the Periodic Table below.

	B												D			F
A															E		
											C						
																	G

Which of the following options has all the compounds listed with the correct chemical formulae?
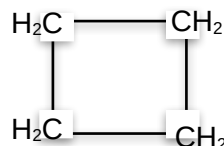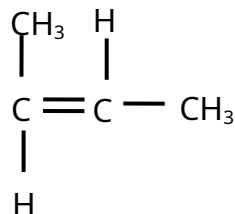
(a)   EF D_2 CE_2 B_3D_2

(b)   AE BE_2 F_2 BD

(c) BE_2 AE E_2 DE_3

(d) CD_2 CE   BE E_2

21.   The table below shows values for the boiling points of various hydrocarbons at 100 kPa of pressure.

Hydrocarbon	Boiling point (^{o}C)
Octane C_8H_{18}	126
Benzene C_6H_6	80
Water H_2O	100
Hexane C_6H_{14}	69

What facts can be deduced from the data in the table?

(a)   Water has a greater strength of dispersion forces than hexane

(b)   Hexane has greater dipole-dipole forces than benzene

(c)   The dispersion forces in octane are greater than the hydrogen-bonding forces in water

(d)   Octane is a more polar molecule than benzene or water

22. In which one of the following combinations of 0.30 mol L^{-1} solutions will a green precipitate be formed?

(a)   CrCl3, NasSO4, Cu(NO3)2

(b) $Fe(NO_3)_2$, NaCl, K_2SO_4

(c) $NiNO_3$, $CuSO_4$, K_2CO_3

(d) $FeCl_3$, KNO_3 Na_2CO_3, NaOH

23. The graph shows how the temperature of a substance X varies as it heated at a constant rate. Some important features are labelled A – D.
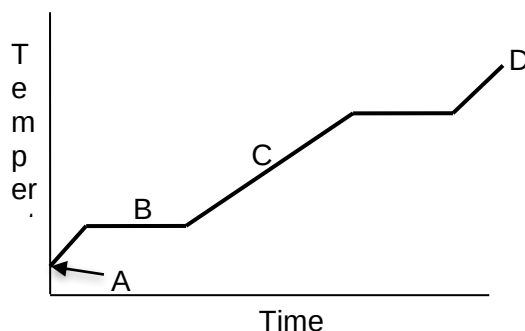
Which of the statements below is true?

(a)   A shows the melting point of solid X

(b)   At B no heat is being absorbed

(c)   C is where the liquid X is absorbing more heat energy

(d)   D is boiling point of X

24. Which of the following lists the elements in order of increasing 1st ionisation energy, from lowest to highest?

(a)   Li   Na   Al   P   S

(b)   Na   Al   P   Bi   Pb

(c)   Ba   Sr   Sn   Sb   Bi

(d)   Rb   K   Ge   Se   Br

25. Which of the following are examples of addition reactions?

(I)

$+ Br_2$ →(Catalyst)→   Br $+ HBr$

(II)

$CH = CH_2$ $+ Br_2$ →(Catalyst)→ $CHBrCH_2Br$

(III)

$+ Br_2$ →(Catalyst)→   Br / Br $+ H_2$

(IV) $+ Br_2$ →(Catalyst)→   Br / Br
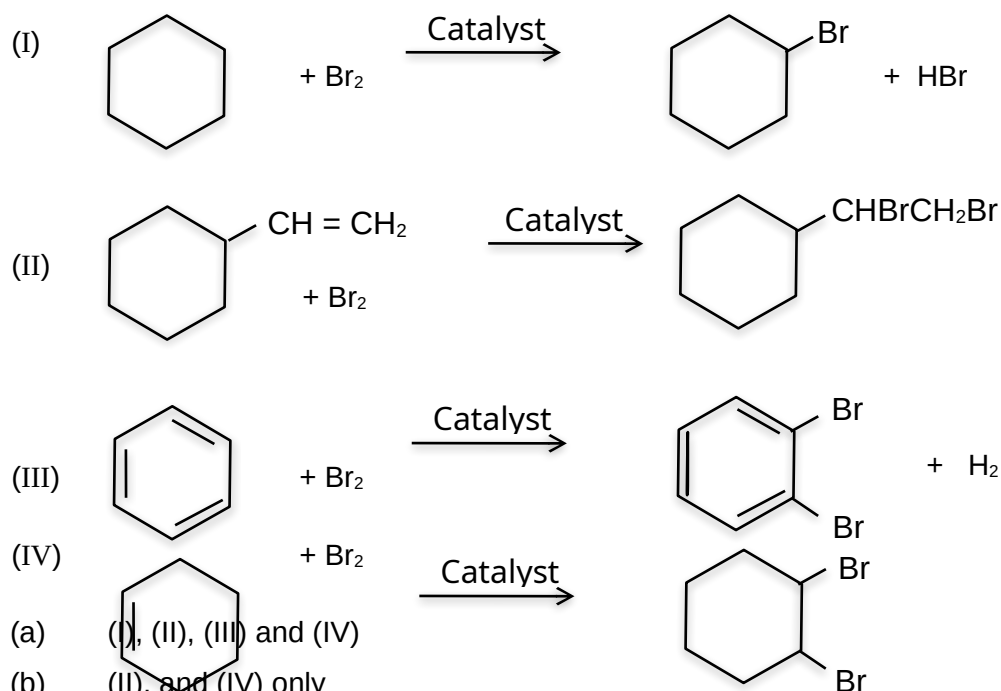
(a) (I), (II), (III) and (IV)
(b) (II), and (IV) only
(c) (I) and (III) only
(d) (III) only

Section Two: Short answer   **35%   (70 marks)**

This section has **8** questions. Answer **all** questions. Write your answers in the spaces provided. When calculating numerical answers, show your working or reasoning clearly. Express numerical answers to the appropriate number of significant figures and include appropriate units where applicable.

Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.
- Planning: If you use the spare pages for planning, **indicate** this clearly at the top of the page.
- Continuing an answer: If you need to use the space to continue an answer, **indicate** in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Suggested working time: 60 minutes.

Question 26   **(9 marks)**

A French brand of bottled vinegar called Vinaigre comprises a dilute solution of 7.50 g of acetic acid (CH_3COOH) in every 250 g of solution – call this solution X.

(a)   Calculate the number of moles of acetic acid in the 250 g of solution X.   (2 marks)

_____

_____

(b)   Assuming that the volume of 250 g of Vinaigre solution X is 250 mL, what is the concentration of acetic acid in moles per litre?   (1 mark)

_____

_____

_____

(c)   Write the equation for the ionisation of acetic acid, showing states.   (2 marks)

_____

(d)   Acetic acid is classified as a **weak** acid. Explain what this means.   (2 marks)

_____

_____

(e)   If the degree of ionisation of acetic acid is quoted as 1.3%, use your answer to part (b) to find the concentration of hydrogen ions in solution X.   (2 marks)

_____

_____

_____

Question 27 **(8 marks)**

An organic compound has a formula $C_3H_4Cl_2$ and can exist as several different **isomers**.

(a)   One form of $C_3H_4Cl_2$ has a *cis* and *trans* isomer. Draw in the **Cl** and **H** atoms onto the basic structures shown below to show these two isomers. (2 marks)
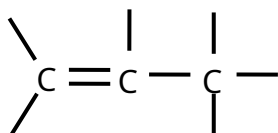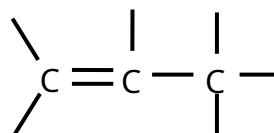
cis form   *trans* form

(b)   The *trans* form of $C_3H_4Cl_2$ shown above reacts with HBr under suitable conditions. Draw below the structural form of the resulting organic compound formed as a product in this reaction. (2 marks)

(c)   A chemist claimed she had produced the compound 2,2-dichloropropene. Comment on this claim. (2 marks)

_____

_____

_____

(d)   A chemist found the reaction was occurring too slow and decided to try using a catalyst. Explain how the catalyst would change the reaction rate? (2 marks)

_____

_____

_____

Question 28   **(8 marks)**
Two positions of the same syringe are shown.
A syringe shown in position X contains 540 mL of CO_2 at STP and is
then compressed to a smaller volume, as in position Y at the same
temperature.

(a)   Explain why the pressure in the cylinder has changed in going
      from position X to position Y in terms of the kinetic theory of
      gases.   (2 marks)

_____

_____

_____

_____

_____
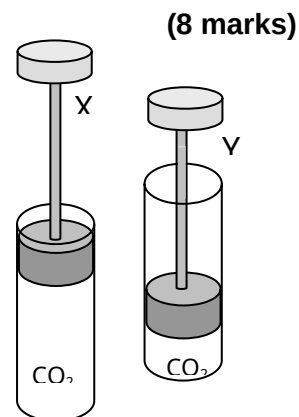
(b)   Calculate the mass of CO_2 in the cylinder as shown by diagram X.   (3 marks)

_____

_____

_____

_____

(c)   How does the mass of gas when in position X compare with the mass of gas when in
      position Y?   (1 mark)

_____

(d)   In going from position X to Y the gas volume was changed from 540 mL to 180 mL at the
      same temperature. Calculate the new pressure of the CO_2 inside the syringe at position Y.
                                                                      (2 marks)

_____

_____

_____

SEE NEXT PAGE

Question 29   **(9 marks)**

Enthalpy (kJ mol⁻¹)

1050
900
750
600
450
300
150

NH_4OCN

$NH_4^+ + OCN^-$

Reaction progress
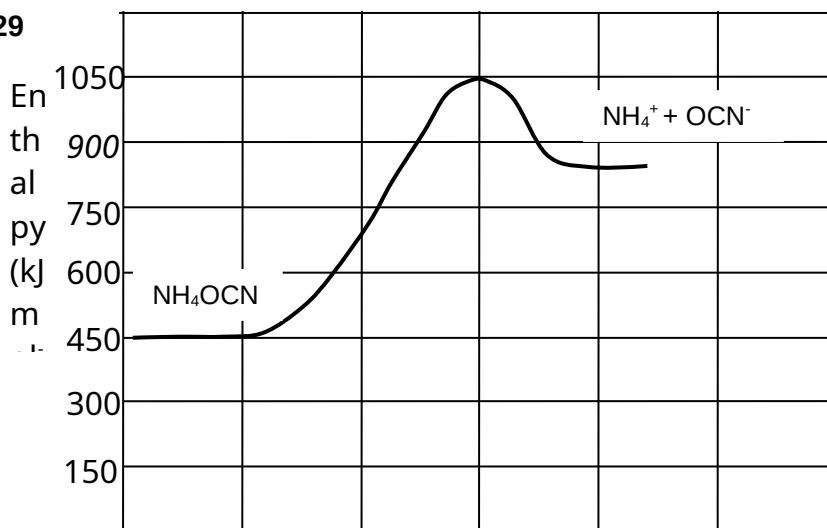
The diagram above shows the enthalpy graph for a reaction where 0.50 mole of ammonium cyanate (NH_4OCN) crystals dissolves in water: NH_4OCN (s) → NH_4^+(aq) + OCN^-(aq)

(a)   Which bonds are stronger, the NH_4^+ to OCN^- bonds in the NH_4OCN crystals or the ion-dipole bonds existing between H_2O and NH_4^+ ions and H_2O and OCN^- ions? Explain.   (2 marks)

_____

_____

(b)   As the ammonium cyanate crystals dissolve how would this affect the temperature of the

surrounding solution?   (1 mark)

_____

_____

(c)   What is the value for the Activation Energy for this reaction?   (1 mark)

_____

(d)   What is the value for ΔH for this reaction? (Show the correct units)   (2 marks)

_____

(e)   Draw a Lewis (electron) Dot structure for ammonia and the ammonium ion, NH_4^+.   (3 marks)

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SEE NEXT PAGE

Question 30   **(8 marks)**

Consider the elements in Period 3 of the periodic table.

(a)   Explain why chlorine has a higher 1st ionisation energy than magnesium.   (3 marks)

_____

_____

_____

(b)   Which has the higher 1st ionisation energy, iodine or chlorine?   (1 mark)

_____

(c)   The S-Cl bond is a polar covalent bond. Explain what causes this polarity.   (3 marks)

_____

_____

_____

(d)   How does the increasing polarity of molecules affect their physical properties?   (1 mark)

_____

_____

Question 31 **(9 marks)**

Compound X is a strong electrolyte, compound Y is a weak electrolyte and compound Z
is a non-electrolyte.

(a)   Explain the differences between compounds X, Y and Z when dissolved in water in terms of
their degree of ionisation and give an example of each type of substance.   (6 marks)

_____

_____

_____

Example of a compound like X _____

Example of a compound like Y _____

Example of a compound like Z _____

(b)   Explain how you could tell the difference between water solutions containing 1 mole per litre of
each of these substances.   (2 marks)

_____

_____

_____

(c)   A farmer uses bore water pumped up from an aquifer which has been found to contain about
1% salt. Name a method by which the farmer could obtain pure drinking water from this salty
bore water.   (1 mark)

_____

_____

_____

SEE NEXT PAGE

Question 32   **(10 marks)**

(a)   Explain why carbon can form 3 dimensional structures, like diamond, but sulfur cannot.

(3 marks)

_____

_____

_____

_____

The network structure of Graphene is shown here – a flat sheet of carbon atoms.

(b)   Explain why Graphene is a good conductor of electricity and yet diamond does not conduct at all.   (2 marks)

_____

_____

_____
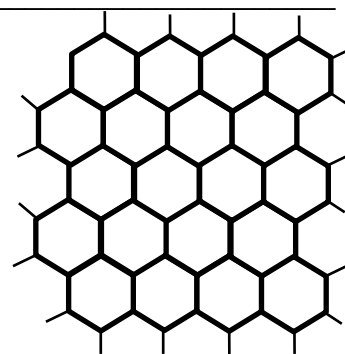
Graphene sheet

_____

_____

(c)   Determine the empirical formula of a compound containing 78.22% carbon, 4.38 % hydrogen and possibly sulfur.   (3 marks)

Many women's make-up products contain nanoparticles of titanium dioxide which give the skin an attractive bright sheen. The size of the TiO_2 particles is around 100 nanometres
(1 nanometre = 10^{-9} m).
Skin pores are small holes in the skin which allow the entrance of oxygen to the blood stream and are about 50 micrometres wide (50 x 10^{-6} m).

(d)   Explain why there might be concern over the use of nanoparticles in women's make-up.

(2 marks)

_____

_____

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SEE NEXT PAGE

Question 33 (9 marks)
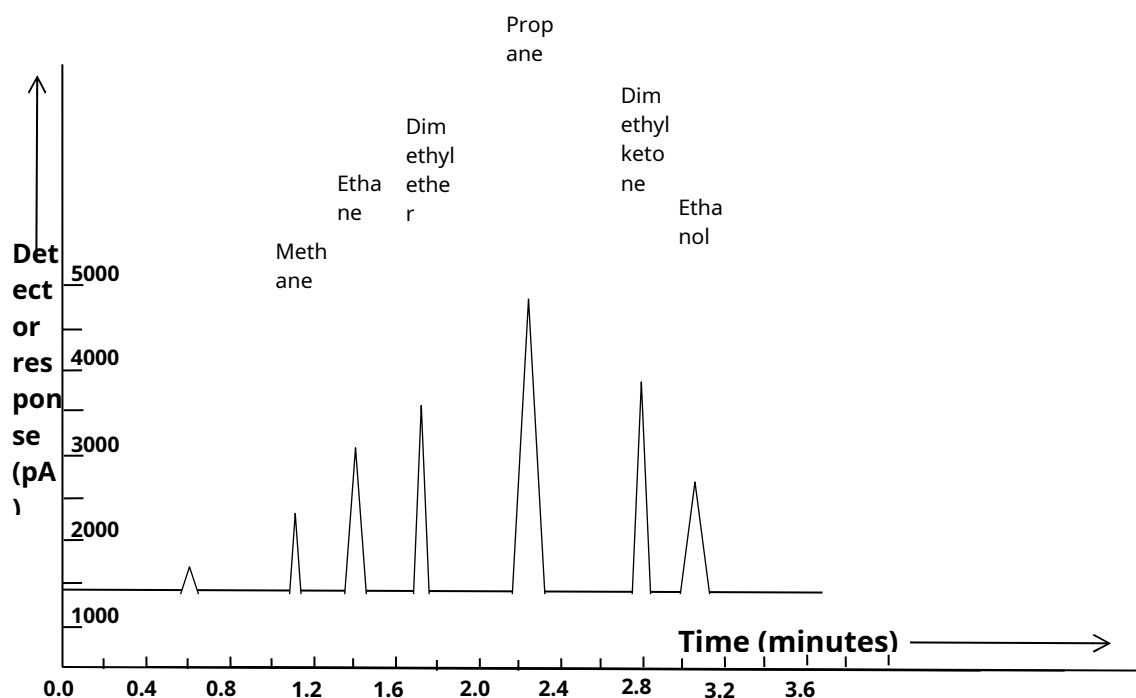
Above is the detector read-out from a high performance gas chromatography apparatus analysing the organic residues inside a chemical reaction tank using a polar stationary phase in the column. The mobile phase used was helium which had a column retention time of 0.6 minutes, as seen from the graph.

(a) Which compound in the tank was present in the greatest concentration? (1 mark)

_____

(b) Which compound had a Retention Factor of 0.34? Show calculations. (3 marks)

_____

_____

(c) Which compound being tested is the least polar? Explain. (3 marks)

_____

_____

(d) By considering the bonding types, explain why the Retention Time for ethanol would be the greatest. (2 marks)

_____

_____

_____

_____

End of Section Two

Section Three: Extended answer   **40%   (80 marks)**

This section contains **five (5)** questions. You must answer **all** questions. Write your answers in the spaces provided below.

Where questions require an explanation and/or description, marks are awarded for the relevant chemical content and also for coherence and clarity of expression. Lists or dot points are unlikely to gain full marks.

Final answers to calculations should be expressed to the appropriate number of significant figures.

Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.
• Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
• Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Suggested working time: 70 minutes.

Question 34   **(16 marks)**

A suggested method of removing CO_2 from the atmosphere is "Sequestration". One method of sequestration is to bubble CO_2 through a solution of calcium hydroxide, which produces calcium carbonate solid and can be stored.

(a)   Write a balanced equation for this reaction, including states.   (2 marks)

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(b)   Calculate how many grams of calcium carbonate would be produced if 100 L of pure CO_2 at STP were dissolved in an excess of calcium hydroxide solution.   (3 marks)

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In one such sequestering experiment performed in the laboratory, 150 L of CO_2 collected at STP produced 6.00×10^2 g of calcium carbonate.

(c)   From this figure, calculate the percentage efficiency of the experimental set-up.
       $(\% \, Efficiency = \dfrac{Mass \, produced}{Calculated \, mass} \, x \, 100)$ (3 marks)

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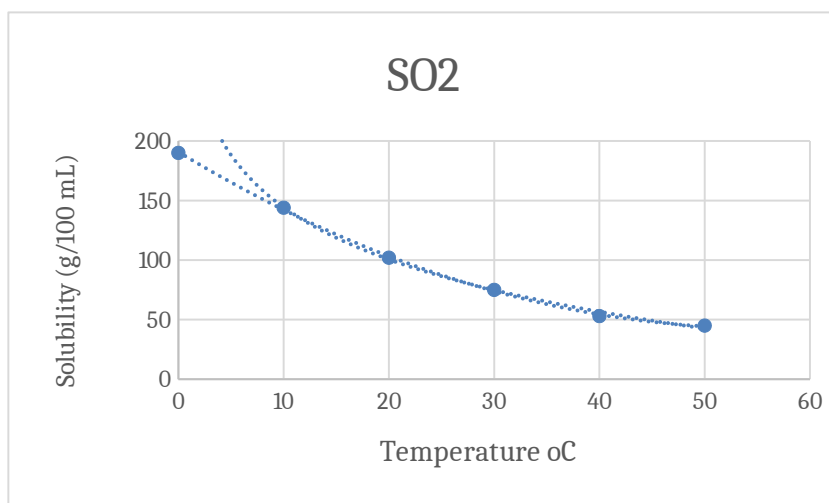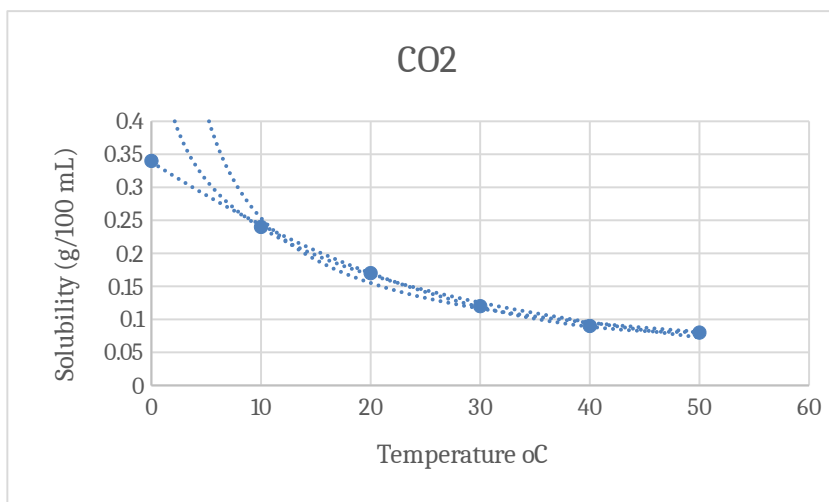
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Graphs of the solubility values for CO_2 and SO_2 gases at different temperatures are shown below.

(d)   How many more times soluble is SO_2 compared with CO_2 at a temperature of 10^oC? Show
       your working   (2 marks)

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SO_2 and CO_2 gases are emitted from coal-fired power stations and dissolve in rainwater to produce Acid Rain. This is a mixture of carbonic and sulfurous acids (H_2CO_3 and H_2SO_3 respectively).
When acid rain falls on historic buildings made of marble, it causes them to dissolve.

(e)   Write a balanced equation, including states, for the reaction of sulfurous acid (H_2SO_3) reacting with marble ($CaCO_3$).   (2 marks)

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(f)   If the pH is 3.5, what is the H+ ion concentration?   (1 mark)

A teacher keeps fish in a 50.0 litre tank outside the classroom which is at 10°C at night but rises to 20°C during the day.

(g)   Using the CO_2 graph, estimate the extra volume of CO_2 (measured at STP) absorbed at night time when the tank temperature has changed from 20° to 10°.   (3 marks)

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Question 35 **(16 marks)**

Alkane	Boiling point (°C)
CH_4	-162
C_2H_6	-89
C_3H_8	-42
C_4H_{10}	-0.5
C_5H_{12}	36

Above is a table of boiling points of some alkanes.

(a)   Name the intermolecular force that is responsible for the rise in boiling points seen   (1 mark)

_____

(b)   Explain how this intermolecular force arises.   (3 marks)

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(c)   Refer to methane to explain what is meant by a **polar** bond and state whether the methane **molecule** is polar. Explain your answer.   (3 marks)

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(d)   Explain why the arrangement of bonds in methane is **tetrahedral**, rather than a flat planar
        cross configuration.   (3 marks)

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(e)   Water has a molar mass similar to methane, and yet its boiling point is more than 200 degrees
        higher ($100^{o}C$). Explain why there is such a large difference in boiling points of these two
        substances.   (3 marks)

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An unknown hydrocarbon X has a ratio of 2 hydrogen atoms for every carbon atom in its molecule.
The molar mass of X was determined by mass spectrometer to be around 56 g mol^{-1}.

f)   Use this data to determine the molecular formula of X.   (3 marks)

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Question 36 (16 marks)

A farmer's property is next to an old mine site and so some of his water supply is contaminated with dissolved silver salts.
He has one lake of clear water with a silver ion concentration of 3.75×10^{-4} mol L^{-1}.
The farmer decided to precipitate out the silver ions in a 5.00 L sample of lake water by adding just enough hydrochloric acid to precipitate all the silver as silver chloride.

(a) Write the balanced ionic equation for this precipitation reaction. (2 marks)

(b) State a method he could use to separate this precipitate out from the water and explain the separation principle involved. (2 marks)

(c) Calculate the mass of silver chloride that would be expected from the 5.00 L of lake water. (3 marks)

Having removed the silver from the lake water, the farmer attempted to produce pure water from the remaining 5.00 L of impure water.

(d) State the name of the process by which pure water could be obtained from the impure water and list the apparatus that would be used. (3 marks)

Process name:

Apparatus list :

After the water had been purified in this way, the remaining solid from the 5.00 L of lake water was found to be calcium nitrate (leached from the soil around the lake) which had a mass of 3.76 g.

(e)   Calculate the concentration of nitrate ions that would have been present in the lake water.

(3 marks)

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It was realised that the nitrate ions in the lake must have originally come from the run-off from the farmer's fields where he had used ammonium nitrate as a fertilizer (NH_4NO_3). Fertilizers add nitrogen to the soil to increase crop growth.

(f)   Calculate the percentage by mass of nitrogen in this fertilizer **and** the mass of nitrogen that
        would be added to the soil around the lake by the use of 150 kg of this fertilizer.   (3 marks)

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Question 37 **(17 marks)**

G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G1	G12	G13	G1	G15	G16	G17	G18
A														**F**		**G**	
	B																**H**
						D					**E**						
C																	

The diagram above illustrates part of the Periodic Table, as first arranged by Mendeleev.
Some of the elements contained are shown as the letters A - H.

(a)   Which element (A - H), would have an ion with a charge of 2 $^-$ and explain why it becomes
      charged in this way? (3 marks)

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(b)   (i)   Which two elements(A - H), shown would form a covalent compound? (1 mark)

_____

      (ii)   Give two possible formulas for the compound above. (This is easier to work out if you
            use the proper elemental symbols from the Periodic Table). (2 marks)

_____

      (iii)   Explain why these compounds would be covalent, rather than ionic. List two physical
             properties they would both exhibit. (3 marks)

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(c)   (i)   List four physical properties you would expect elements D and E to exhibit.   (2 marks)

_____

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      (ii)   One of these elements was found to have 3 main isotopes.
            Name the instrument **that** is used to determine the atomic masses of these isotopes.
                                                                                      (1 mark)

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SEE NEXT PAGE

(d)   The first four ionisation energies of element B are 736 kJ mol^{-1}, 1450 kJ mol^{-1}, 7740 kJ mol^{-1}
       and 10500 kJ mol^{-1} respectively.
       Explain why the ionisation energies for successive electrons being removed from the atom
       have this pattern.   (3 marks)

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(e)   Which of the elements A – H, when bonded with hydrogen would produce a bond with the
       highest polarity? Explain why.   (2 marks)

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Question 38   **(15 marks)**
The ChemCom Company has been contacted to analyse a sample of soluble baby-milk powder by the government of a developing country which suspects the powder contains unacceptably high concentrations of Pb^{2+} ions.
ChemCom uses an Atomic Absorption Spectrometer, where a selected wavelength of light λ_{Pb} would be absorbed by the Pb^{2+} ions present. λ_{Pb} is the wavelength having the greatest absorption by the lead ions.

(a)   Explain, in terms of atomic structure, why ions of lead (Pb^{2+}) would preferentially absorb this particular wavelength λ_{Pb}.   (3 marks)

The graph below shows the results from Experiment 1, where the absorption of light at different wavelengths by the lead ions in a solution of the milk powder was determined.
(Note: 1 nanometre = 1×10^{-9} m)

Absorbance graph (Experiment 1)

Percentage absorbance vs Wavelength used
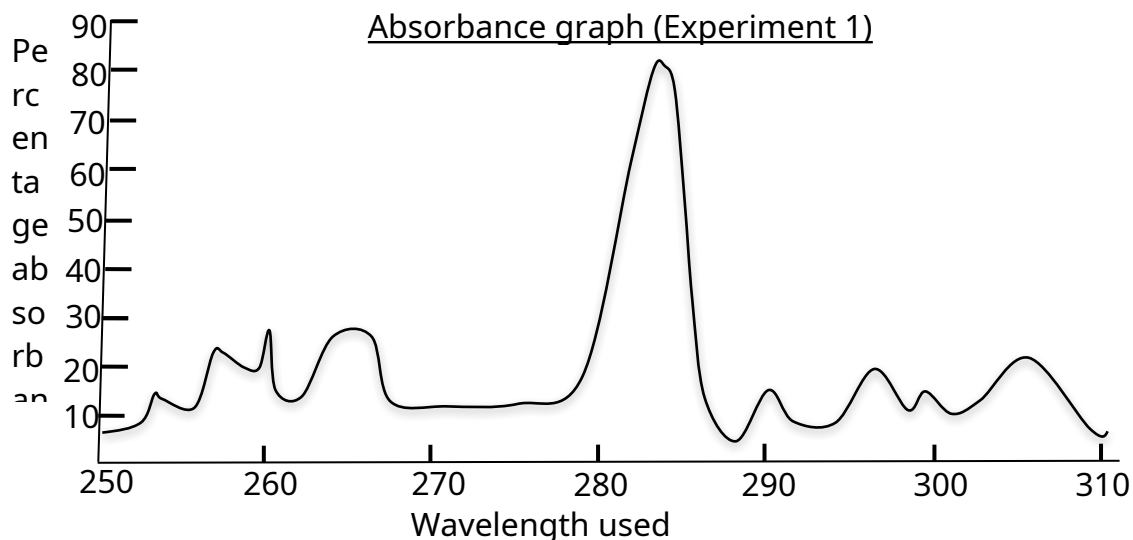
(b)   From the absorbance graph above estimate the wavelength of light that should be used in order to best detect the Pb^{2+} ions in the milk powder solution. (Circle your answer)   (1 mark)

    A.   283 nm

    B.   310 nm

    C.   260 nm

    D.   265 nm

(c)   Explain why you chose your answer to part b)
                                                                                                                        (1 mark)

For Experiment 2, solutions with known concentrations of lead were used to see how absorption depends upon concentration. The table below displays known concentration values and their corresponding Absorbance values.

Note: Concentrations are measured in nanograms (ng) per litre (1 nanogram = 1×10^{-9} g)

Table

Concentration (ng per litre)	Pure water 0.00	1.00	2.00	4.00	6.00	7.00
Absorbance (%)	5.1	10.4	15.5	26.3	37.2	42.8

d)   Use the grid below to plot a labelled graph of absorbance on the vertical axis against concentration on the horizontal axis.   (5 marks)
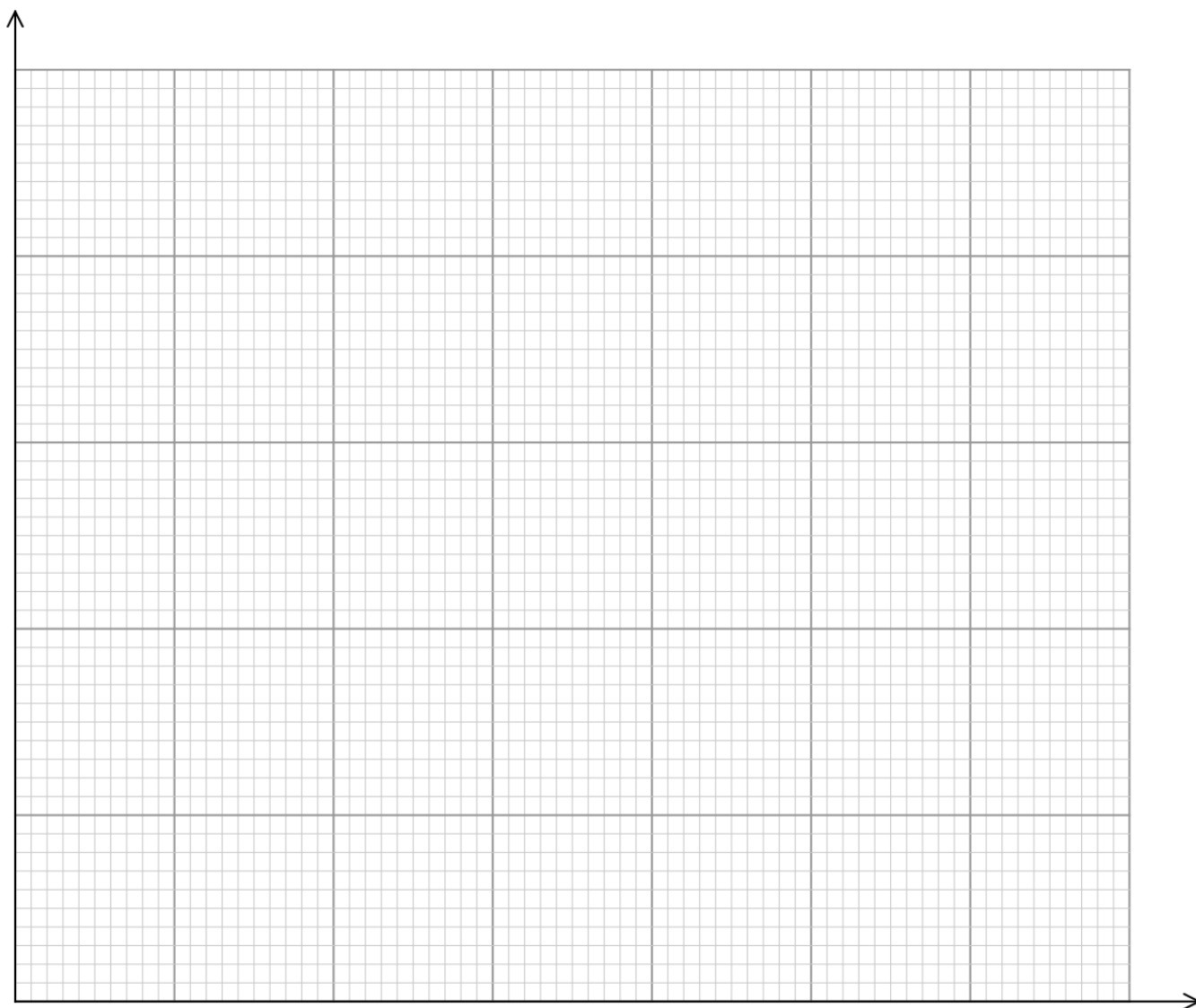
A sample of the milk powder to be tested was then added to water to make up a 100 mL solution and analysed in the Absorption Spectrometer for 3 trials.
The following results were obtained:

Trial	Trial 1	Trial 3	Trial 3	Average value
Absorbance (%)	24.3	24.7	24.0	

(e)   (i)   Calculate the average value of absorbance and insert this in the end column above.

_____

(1 mark)

(ii)   From the value you obtained for average absorption in part (i), calculate the concentration of lead in the foreign milk powder – expressed in ng L^{-1}. Show all construction lines in part d) on the graph and show your working below.   (1 mark)

_____

_____

(iii)   Express that answer to part (ii) in parts per million of lead in the solution i.e. the number of grams of lead in 1 million grams of solution (assume the solution has a mass of 1000 g per litre.)   (2 marks)

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(f)   An alternative way to determine the amount of lead in the milk would be to precipitate the lead ions out by adding sodium sulfate and weighing the precipitate.
Name a solution of **another** compound that could be used to produce a precipitate with lead ions, apart from sodium sulfate.   (1 mark)

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_____

End of questions

Spare answer page

Question number: _____

Spare answer page

Question number: _____

Question number: _____