Part A

Multiple Choice: 10 marks
Attempt Questions 1-10
Allow about 10 minutes for this part

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

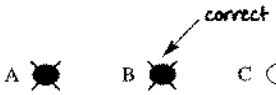
Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9

A ○ B ● C ○ D ○

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

A ● B ⊗ C ○ D ○

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.



▸ **Mark your answers for Questions 1 – 10 in the Answer Box on page 4**

1. How many atoms are there in 2.50 grams of pure carbon – 12?

   (A) 1.25×10^{23}
   (B) 2.50×10^{23}
   (C) 2.5
   (D) 5

2. The highest percentage of water occurs in which earth sphere?

   (A) biosphere
   (B) hydrosphere
   (C) lithosphere
   (D) atmosphere

3. Water is an agent of weathering.
   Which of the following properties of water contribute to its ability to weather rock?

   (i) Water has a relatively high boiling and melting point.
   (ii) Water is a good solvent for many substances
   (iii) Water has a lower density in the solid state than in the liquid state

   (A) (i) and (ii) only
   (B) (ii) and (iii) only
   (C) (i) and (iii) only
   (D) (iii) only

4. Which of the following is the strongest force between two molecules?

   (A) dispersion forces
   (B) dipole-dipole forces
   (C) hydrogen bonding
   (D) metallic bonding

5. Why does sucrose (sugar) dissolve when mixed with water?

   (A) Water breaks apart the covalent bonds within the molecules
   (B) Ionic bonds are formed between the water and the sucrose
   (C) Dispersion forces cause the sucrose molecules to repel each other
   (D) Water forms dipole-dipole forces with the polar bonds on the surface of the sugar.

6. Small animals, such as water striders, can walk across the surface of a pond.
Which of the following properties of water allows this to happen?

(A) viscosity
(B) surface tension
(C) boiling point
(D) density

7. 30 mL of 0.1 $molL^{-1}$ aluminium perchlorate, $Al(ClO_4)_3$, is diluted to a volume of 100 mL with water. What is the concentration of perchlorate ions in the final solution?

(A) 0.09 $molL^{-1}$
(B) 0.9 $molL^{-1}$
(C) 0.03 $molL^{-1}$
(D) 0.3 $molL^{-1}$

8. What is the concentration of a solution formed when 2.00g of sodium hydroxide is dissolved in water to make 50.0 mL of solution?

(A) 1.00 $molL^{-1}$
(B) 0.50 $molL^{-1}$
(C) 0.10 $molL^{-1}$
(D) 0.05 $molL^{-1}$

9. The equation below shows the simple reaction between water and chlorine.

$$H-O-H + Cl-Cl \rightarrow H-O-Cl + H-Cl$$

How many bonds are being broken in this reaction?

(A) 2
(B) 3
(C) 4
(D) 6

10 Which of these values will be altered when a catalyst is used in a reaction?

(A) activation energy
(B) ignition temperature
(C) specific heat capacity
(D) ΔH

Student No. ……

Part A: Answer grid for multiple choice questions. **Total ……/ 10**

1.	A O	B O	C O	D O
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Student No. …….

Part B. 38 marks
Attempt questions 11 -20
Allow about 35 minutes for this part
Show all relevant working in questions involving calculations

Question 11 (2 marks)

Explain why different measures of concentration are important **(2marks)**

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Question 12 (3 marks)

Ammonia and water have similar molecular masses but different melting points and boiling points.

(a) Draw a Lewis electron dot structure for ammonia in the box below. **(1 mark)**

(b) Explain the difference between the boiling points of water and ammonia.
(2 marks)

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Question 13 (5 marks)

Bore water is regularly tested to assess its suitability for drinking.

The quantity of chloride ion in bore water can be determined by the reaction of a sample with silver nitrate solution to produce a precipitate of insoluble silver chloride.

A 10.0 mL sample of bore water requires 24.7 mL of a 0.01 $molL^{-1}$ silver nitrate solution to react completely with all the chloride present.

(a) Write a balanced net ionic equation for this reaction**.** **(1 mark)**

…….

(b) Calculate the number of moles of chloride ions in the sample**.** **(2 marks)**

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(c) Determine the mass of chloride ions in the sample**.** **(1 mark)**

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(d) Calculate the concentration of nitrate ions in the final solution. **(1 mark)**

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Question 14 (4 marks)

A student writes two wrong explanations in a chemistry test. Re–write the statements demonstrating your superior knowledge of chemistry. **(4 marks)**

Wrong explanations	*Corrected explanations*
A large piece of wood burns faster than a bunch of twigs because it's a bigger object so the oxygen molecules in the air can collide with it easier. More collisions, faster rate.	
If the concentration of the reactants is reduced the reaction rate speeds up because it's easier for the particles to collide because it's not so crowded.	

Question 15 (3 marks)

(a) Identify an industrial catalyst. **(1 mark)**

…….

(b) Explain the role of catalysts in chemical reactions. **(2 marks)**

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Question 16 (3 marks)

Dieseline is a mixture composed mainly of cetane, $C_{16}H_{34}$.

(a) Write two balanced chemical equations showing cetane undergoing complete and incomplete combustion. **(2 marks)**

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(b) Identify a problem associated with incomplete combustion. **(1 mark)**

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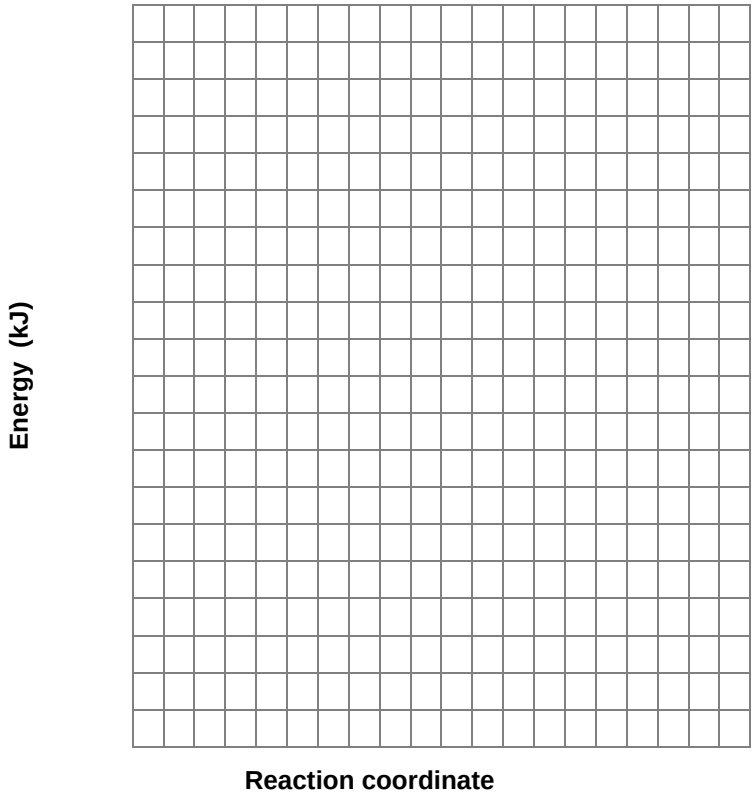
Question 17 (2 marks)

Draw an energy profile diagram on the graph grid for a reaction with a $\Delta H = +50$ kJ and an activation energy value of + 70 kJ. Each y-axis square represents 10 kJ. **(2 marks)**



Question 18 (6 marks)

A sample of 2.0 g aluminium metal was burned in pure oxygen.

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

…….

(b) What volume of pure oxygen, measured at 25 ^{o}C and 100 kPa, is required to react with all of the aluminium metal? **(3 marks)**

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(c) If the combustion were done in air, which is 21% oxygen by volume, what volume of air will be required?

(**1 mark)**

…….

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(d) Justify the recycling of aluminum over that of extracting it from its ore. **(1 mark)**

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Question 19 (5 marks)

Active metals combine readily with oxygen either at room temperature or when heated.

(a) In point form, write a procedure for a first hand investigation that will allow you to determine the mass change of magnesium when it combines with oxygen. **(3 marks)**

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(b) Outline how you are going to determine the empirical formula of the oxide formed. **(2 marks)**

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Question 20 (5 marks)

Two 1.0 L containers are each filled with chlorine gas and helium gas at the same temperature (25 ^{o}C) and pressure (100 kPa)

(a) Construct a table to compare the volume, the number of molecules and the number of atoms in each of the containers. **(3 marks)**

(b) State the law that allows you to make this comparison. **(2 mark)**

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End of Test

Part A

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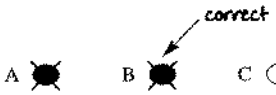

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$$H-O-H \;+\; Cl-Cl \;\rightarrow\; H-O-Cl \;+\; H-Cl$$

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Part A: Answer grid for multiple choice questions. **Total ……/ 10**

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Student No. …….

Part B. 38 marks
Attempt questions 11 -20
Allow about 35 minutes for this part
Show all relevant working in questions involving calculations

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Question 11 (2 marks)

Explain why different measures of concentration are important **(2marks)**

Answer

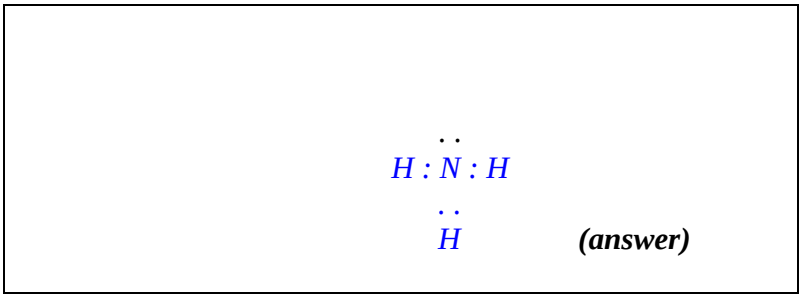
Many different groups, organizations and industries measure concentration, e.g. Environmentalists may measure the levels of toxic metals in fish in ppm, alcohol in drinks is calculated in %vol/vol and chemists may use mol/L. Different measures of concentration are needed for different applications to express the appropriate measurement.

Marking Criteria	**Marks**
• Explains why different measures of concentration are important with examples	2
• Identifies at least two examples of different measures of concentration e.g. ppm g/L etc	1

Question 12 (3 marks)

Ammonia and water have similar molecular masses but different melting points and boiling points.

(a) Draw a Lewis electron dot structure for ammonia in the box below. **(1 mark)**



(b) Explain the difference between the boiling points of water and ammonia.

(2 marks)

Answer

Water and ammonia both have H-bonding. The oxygen of the water molecule can hydrogen bond with 2 H in other molecules whereas the nitrogen in the ammonia molecule can only H-bond with one H in another molecule. Therefore, there is greater H-bonding in water then in ammonia so the mp/bp are higher.

(a) Marking criteria.
Correctly draws ammonia. - 1 mark

(b)

Marking Criteria	**Marks**
• Indicates there is greater or more H-bonding in water, therefore higher mp/bp	2
• Identifies H-bonding as the intermolecular force	1

Question 13 (5 marks)

Bore water is regularly tested to assess its suitability for drinking.

The quantity of chloride ion in bore water can be determined by the reaction of a sample with silver nitrate solution to produce a precipitate of insoluble silver chloride.

A 10.0 mL sample of bore water requires 24.7 mL of a 0.01 $molL^{-1}$ silver nitrate solution to react completely with all the chloride present.

(a) Write a balanced net ionic equation for this reaction**.** **(1 mark)**

…….

(b) Calculate the number of moles of chloride ions in the sample**.** **(2 marks)**

…….

…….

…….

…….

(c) Determine the mass of chloride ions in the sample**.** **(1 mark)**

……

……

……

(d) Calculate the concentration of nitrate ions in the final solution. **(1 mark)**

……

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Answers

(a) $Ag^+ + Cl^- \rightarrow AgCl_{(s)}$ *(subscript required)*

(b) *mol AgCl* = *cV*

= *0.01 x 0.0247*

= *2.47 x 10 $^{-4}$ mol*

mol Cl^- = *mol AgCl* = ***2.47 x 10 $^{-4}$ mol***

(c) *mass Cl^-* = *mol x mm* = *2.47 x 10 $^{-4}$ mol x 35.45*

= ***8.76 x 10^{-3} g***

(d) *mol NO_3^-* = *2.47 x 10 $^{-4}$ mol*

[NO_3^-] = *mol/V*

$$= \frac{2.47 \times 10^{-4}}{0.01 + 0.0247}$$

= ***7.12 x 10-3 molL^{-1}***

Marking criteria

a,c and d, 1 mark for correct answer

b, 1 mark mol AgCl, 1 mark identifying mol AgCl = mol Cl^-

Question 14 (4 marks)

A student writes two wrong explanations in a chemistry test. Re–write the statements demonstrating your superior knowledge of chemistry. **(4 marks)**

Wrong explanations	*Corrected explanations*
A large piece of wood burns faster than a bunch of twigs because it's a bigger object so the oxygen molecules in the air can collide with it easier. More collisions, faster rate.	***A bunch of twigs burns faster than a large piece of wood because the twigs have a greater surface area exposed to the oxygen in the air, hence increased collision frequency and reaction rate.***
If the concentration of the reactants is reduced the reaction rate speeds up because it's easier for the particles to collide because it's not so crowded.	***If the concentration of the reactants is increased the reaction rate increases because more particles are present per unit volume, hence a greater chance of a collision.***

Question 15 (3 marks)

(a) Identify an industrial catalyst. **(1 mark)**

Ans.
Vanadium pentoxide (V_2O_5) (1 mark) is used in the industrial production of sulfuric acid.

(b) Explain the role of catalysts in chemical reactions. **(2 marks)**

The role of a catalyst is to greatly speed-up the reaction rate (1 mark) by lowering the activation energy. (1 mark)

Question 16 **(3 marks)**

Dieseline is a mixture composed mainly of cetane, $C_{16}H_{34}$.

(a) Write two balanced chemical equations showing cetane undergoing complete and incomplete combustion. **(2 marks)**

Answer:

$$2C_{16}H_{34\,(l)} + 49O_{2\,(g)} \rightarrow 32CO_{2\,(g)} + 34H_2O_{(l)}$$

$$2C_{16}H_{34\,(l)} + 43O_{2\,(g)} \rightarrow 4C_{(s)} + 4CO_{(g)} + 24CO_{2\,(g)} + 34H_2O_{(l)}$$

► ***Many other incomplete combustion variations are possible.***

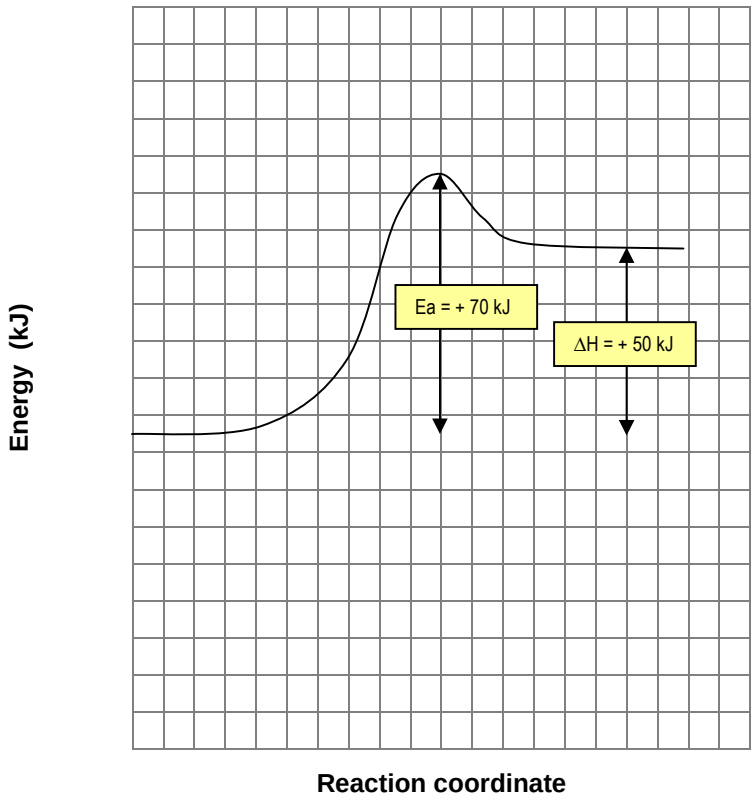
(b) Identify a problem associated with incomplete combustion. **(1 mark)**

Answer:

Incomplete combustion produces pollution or it wastes energy as the fuel is not fully oxidised

Question 17 **(2 marks)**

Draw an energy profile diagram on the graph grid for a reaction with a $\Delta H = +50$ kJ and an activation energy value of + 70 kJ. Each y-axis square represents 10 kJ. **(2 marks)**



Question 18 (6 marks)

A sample of 2.0 g aluminium metal was burned in pure oxygen.

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

Answer

$4\ Al(s) + 3\ O_2\ (g) \rightarrow 2\ Al_2O_3\ (s)$

Marking Scheme

Criteria	***Mark***
correct balanced equation subscripts not marked	*1*

(b) What volume of pure oxygen, measured at 25 ^{o}C and 100 kPa, is required to react with all of the aluminium metal? **(3 marks)**

Possible solution:

$$moles\ O_2 = \frac{3}{4}\ moles\ Al = \frac{3}{4}\ x\ \frac{2.00}{M_{Al}} = \frac{3}{4}\ x\ \frac{2.00}{26.98} = 0.0556\ moles$$

2 marks *(1 mark for moles of oxygen, 1 mark for moles aluminium)*

$volume\ O_2 = moles\ O_2\ x\ molar\ volume = 0.0556\ x\ 24.79 = 1.38\ L$ **(1 mark)**

(c) If the combustion were done in air, which is 21% oxygen by volume, what volume of air will be required?

(1 mark)

Possible solution:

$$volume\ of\ air = \frac{volume\ O_2}{0.21} = 6.57\ L$$ ***(1 mark)***

(d) Justify the recycling of aluminum over that of extracting it from its ore. **(1 mark)**

Possible Answer*:*

Recycling helps conserve valuable metal resources, requires 5 times less energy to obtain the same mass of metal and avoids the environmental damage resulting from mining and the discharge of pollutants to the atmosphere.

Question 19 (5 marks)

Active metals combine readily with oxygen either at room temperature or when heated.

(a) In point form, write a **procedure** for a first hand investigation that will allow you to determine the mass change of magnesium when it combines with oxygen. **(3 marks)**

***Possible answer*:**

Procedure:

- *Remove oxide from the metal with steel wool or emery paper.*
- *Weigh an empty crucible and cover and then weigh again with the cleaned metal in it.*
- *Heat the crucibles containing the metals individually over a Bunsen flame. Cool then weigh again.*
- *Subtract the mass of the crucible containing the metal from that of the one containing the oxide of the metal to calculate the change in mass for each metal*

-
- removal of pre-existing metal oxide
- use of crucible for heating (evaporating basin was also marked correct)
-weighing before and after heating (cooling before weighing)
- determining the mass of the metal oxide

(3 marks for a set of procedure with the same ideas as the above):

(b) Outline how you are going to determine the empirical formula of the oxide formed. **(2 marks)**

(b) Determination of the empirical formula:

- *determine the mass of oxygen by subtracting the mass of the metal from that of the oxide*
- *determine the number of moles of the oxygen by dividing mass of O with atomic mass of oxygen and the number of moles of the metal by dividing the mass of the metal by the atomic mass of the metal*
- *the moles are compared and reduced to the simplest ratio*
- *the simplest ratio of the moles of oxygen to the moles of the metal constitutes the empirical formula for the oxide.*

Marking Scheme:

1 mark for determining the mass of oxygen
1 mark for determining the simplest ratio of the moles of oxygen and the moles of metal

Question 20 (5 marks)

Two 1.0 L containers are each filled with chlorine gas and helium gas at the same temperature (25 ^{o}C) and pressure (100 kPa)

(a) Construct a table to compare the volume, the number of molecules and the number of atoms in each of the containers. **(3 marks)**

Possible solution:

(a)

Gas	***volume (L)***	***No of molecules***	***No of atoms***
chlorine gas	*1.0*	*(1/24.79) x N_A* ***2.4 x 10^{22}***	*2 x (1/24.79) x N_A* ***4.8 x 10^{22}***
helium	*1.0*	*(1/24.79) x N_A* ***2.4 x 10^{22}***	*(1/24.79) x N_A* ***2.4 x 10^{22}***

Marking scheme:

well constructed table : ***1 mark***
Correct No of molecules for both He and Cl_2 : ***1 mark***
Correct No. of atoms for both He and Cl_2: ***1 mark***

(b) State the law that allows you to make this comparison. **(2 marks)**

Avogadro's law states that equal volumes of gases measured at the same temperature and pressure contain the same number of molecules. (2 marks)

End of Test