Please check the examination details below before entering your candidate information

| Candidate surname | Other names |
|---|---|
| | |

**Pearson Edexcel International GCSE (9–1)**

Centre Number | | | | | |

Candidate Number | | | | |

# Wednesday 12 June 2019

Morning (Time: 1 hour 15 minutes) | Paper Reference **4CH1/2C**

# Chemistry

**Unit: 4CH1**
**Paper 2C**

**You must have:**
Calculator, ruler

Total Marks

## Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

## Information

- The total mark for this paper is 70.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

## Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

*Turn over* ▶

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# The Periodic Table of the Elements

| 1 | 2 | | | | | | | | | | | 3 | 4 | 5 | 6 | 7 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 1<br>**H**<br>hydrogen<br>1 | | | | | | | | | | 4<br>**He**<br>helium<br>2 |
| 7<br>**Li**<br>lithium<br>3 | 9<br>**Be**<br>beryllium<br>4 | | | | | | | | | | | 11<br>**B**<br>boron<br>5 | 12<br>**C**<br>carbon<br>6 | 14<br>**N**<br>nitrogen<br>7 | 16<br>**O**<br>oxygen<br>8 | 19<br>**F**<br>fluorine<br>9 | 20<br>**Ne**<br>neon<br>10 |
| 23<br>**Na**<br>sodium<br>11 | 24<br>**Mg**<br>magnesium<br>12 | | | | | | | | | | | 27<br>**Al**<br>aluminium<br>13 | 28<br>**Si**<br>silicon<br>14 | 31<br>**P**<br>phosphorus<br>15 | 32<br>**S**<br>sulfur<br>16 | 35.5<br>**Cl**<br>chlorine<br>17 | 40<br>**Ar**<br>argon<br>18 |
| 39<br>**K**<br>potassium<br>19 | 40<br>**Ca**<br>calcium<br>20 | 45<br>**Sc**<br>scandium<br>21 | 48<br>**Ti**<br>titanium<br>22 | 51<br>**V**<br>vanadium<br>23 | 52<br>**Cr**<br>chromium<br>24 | 55<br>**Mn**<br>manganese<br>25 | 56<br>**Fe**<br>iron<br>26 | 59<br>**Co**<br>cobalt<br>27 | 59<br>**Ni**<br>nickel<br>28 | 63.5<br>**Cu**<br>copper<br>29 | 65<br>**Zn**<br>zinc<br>30 | 70<br>**Ga**<br>gallium<br>31 | 73<br>**Ge**<br>germanium<br>32 | 75<br>**As**<br>arsenic<br>33 | 79<br>**Se**<br>selenium<br>34 | 80<br>**Br**<br>bromine<br>35 | 84<br>**Kr**<br>krypton<br>36 |
| 85<br>**Rb**<br>rubidium<br>37 | 88<br>**Sr**<br>strontium<br>38 | 89<br>**Y**<br>yttrium<br>39 | 91<br>**Zr**<br>zirconium<br>40 | 93<br>**Nb**<br>niobium<br>41 | 96<br>**Mo**<br>molybdenum<br>42 | [98]<br>**Tc**<br>technetium<br>43 | 101<br>**Ru**<br>ruthenium<br>44 | 103<br>**Rh**<br>rhodium<br>45 | 106<br>**Pd**<br>palladium<br>46 | 108<br>**Ag**<br>silver<br>47 | 112<br>**Cd**<br>cadmium<br>48 | 115<br>**In**<br>indium<br>49 | 119<br>**Sn**<br>tin<br>50 | 122<br>**Sb**<br>antimony<br>51 | 128<br>**Te**<br>tellurium<br>52 | 127<br>**I**<br>iodine<br>53 | 131<br>**Xe**<br>xenon<br>54 |
| 133<br>**Cs**<br>caesium<br>55 | 137<br>**Ba**<br>barium<br>56 | 139<br>**La***<br>lanthanum<br>57 | 178<br>**Hf**<br>hafnium<br>72 | 181<br>**Ta**<br>tantalum<br>73 | 184<br>**W**<br>tungsten<br>74 | 186<br>**Re**<br>rhenium<br>75 | 190<br>**Os**<br>osmium<br>76 | 192<br>**Ir**<br>iridium<br>77 | 195<br>**Pt**<br>platinum<br>78 | 197<br>**Au**<br>gold<br>79 | 201<br>**Hg**<br>mercury<br>80 | 204<br>**Tl**<br>thallium<br>81 | 207<br>**Pb**<br>lead<br>82 | 209<br>**Bi**<br>bismuth<br>83 | [209]<br>**Po**<br>polonium<br>84 | [210]<br>**At**<br>astatine<br>85 | [222]<br>**Rn**<br>radon<br>86 |
| [223]<br>**Fr**<br>francium<br>87 | [226]<br>**Ra**<br>radium<br>88 | [227]<br>**Ac***<br>actinium<br>89 | [261]<br>**Rf**<br>rutherfordium<br>104 | [262]<br>**Db**<br>dubnium<br>105 | [266]<br>**Sg**<br>seaborgium<br>106 | [264]<br>**Bh**<br>bohrium<br>107 | [277]<br>**Hs**<br>hassium<br>108 | [268]<br>**Mt**<br>meitnerium<br>109 | [271]<br>**Ds**<br>darmstadtium<br>110 | [272]<br>**Rg**<br>roentgenium<br>111 | Elements with atomic numbers 112-116 have been reported but not fully authenticated | | | | | | |

**Key**

relative atomic mass
**atomic symbol**
name
atomic (proton) number

**** The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.***

***The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.***

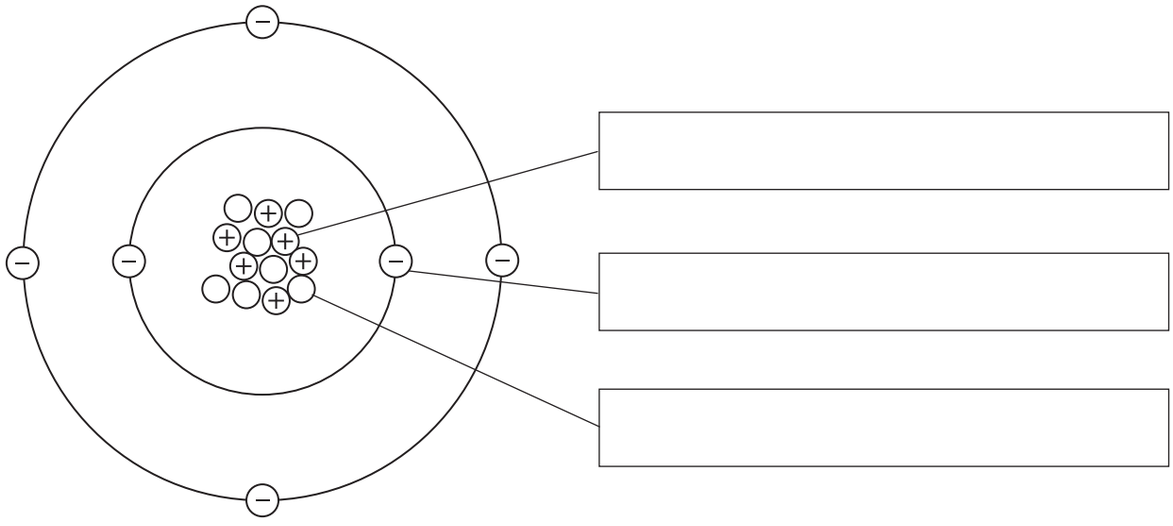
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**Answer ALL questions. Write your answers in the spaces provided.**

**1** The diagram shows the particles in an atom of an element.



(a) The box gives the names of some particles.

| electron | ion | molecule | neutron | proton |
|---|---|---|---|---|

Use words from the box to label the diagram.

**(3)**

(b) Give the mass number of this atom.

**(1)**

.....

(c) Complete the sentence about isotopes.

**(2)**

Isotopes are atoms that have the same number of .....

but have a different number of ..... .

**(Total for Question 1 = 6 marks)**

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**2** The table gives some information about the halogens, chlorine, bromine and iodine.

| Halogen | Physical state at room temperature | Colour |
|---|---|---|
| chlorine | gas | pale green |
| bromine | | red-brown |
| iodine | solid | |

(a) Complete the table.

**(2)**

(b) Chlorine has two isotopes of mass numbers 35 and 37

The relative percentage of each isotope in a sample of chlorine is

chlorine-35 77.78% chlorine-37 22.22%

Calculate the relative atomic mass of this sample of chlorine.

Give your answer to one decimal place.

**(3)**

relative atomic mass = .....

(c) A student is given an aqueous solution of chlorine and an aqueous solution of potassium bromide.

Explain how he can use these two solutions to compare the reactivity of chlorine with the reactivity of bromine.

**(4)**

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**(Total for Question 2 = 9 marks)**

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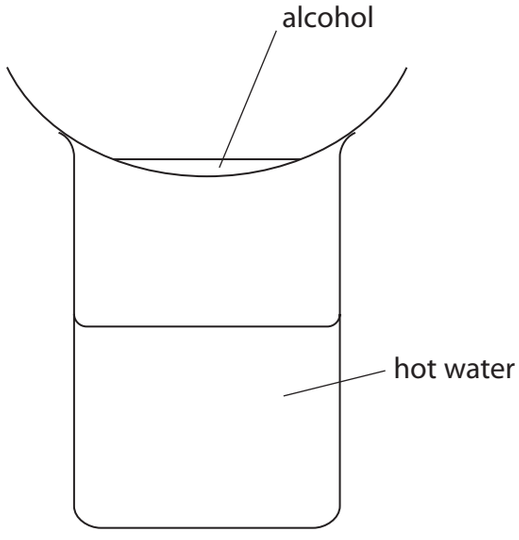
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**3** Methanol, ethanol, propanol and butanol are alcohols. They are all liquids that evaporate easily when warmed.

A student uses this apparatus to compare the time taken for the four liquids to evaporate.




She uses this method.

- pour some methanol into an evaporating basin
- place the evaporating basin on top of a beaker containing hot water
- measure the time taken for the methanol to evaporate completely
- repeat the experiment with each of the other alcohols, using the same apparatus

(a) State two variables the student should control to make sure her results are valid.

**(2)**

1 .....

.....

2 .....

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(b) State why it is not safe to heat the evaporating basin directly with a Bunsen flame.

**(1)**

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(c) The table shows the results of experiments done by four students, A, B, C and D.

| Alcohol | Formula of alcohol | Time taken for liquid to evaporate in s | | | | |
|---|---|---|---|---|---|---|
| | | Student A | Student B | Student C | Student D | Mean time in s |
| methanol | $CH_3OH$ | 20 | 24 | 22 | 26 | 23 |
| ethanol | $C_2H_5OH$ | 32 | 34 | 35 | 30 | 33 |
| propanol | $C_3H_7OH$ | 45 | 47 | 50 | 48 | 48 |
| butanol | $C_4H_9OH$ | 64 | 63 | 90 | 60 | |

(i) Calculate the mean (average) time for butanol to evaporate.

**(2)**

mean time = ..... s

(ii) Explain how the results show which alcohol evaporates most easily.

**(2)**

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(iii) State the relationship between the number of carbon atoms in the molecule and how easily the alcohol evaporates.

**(2)**

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**(Total for Question 3 = 9 marks)**

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**4** This question is about metals.

(a) Which statement describes metallic bonding?

**(1)**

☒ **A** electrostatic attraction between oppositely charged ions

☒ **B** electrostatic attraction between the nuclei of two atoms and a pair of electrons shared between them

☒ **C** electrostatic attraction between positively charged particles and delocalised electrons

☒ **D** electrostatic attraction between atoms

(b) Aluminium is malleable and can be easily shaped to make saucepans used for cooking food.

State two other properties of aluminium that make it suitable for saucepans used for cooking food.

**(2)**

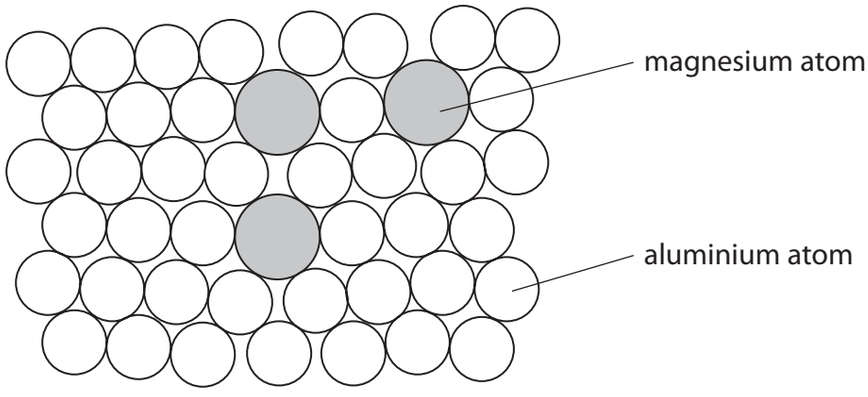
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(c) Magnalium is an alloy of aluminium and magnesium.

The diagram shows how the atoms are arranged in this alloy.




(i) State what is meant by the term **alloy**.

**(1)**

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(ii) Explain why magnalium is harder than aluminium.

**(3)**

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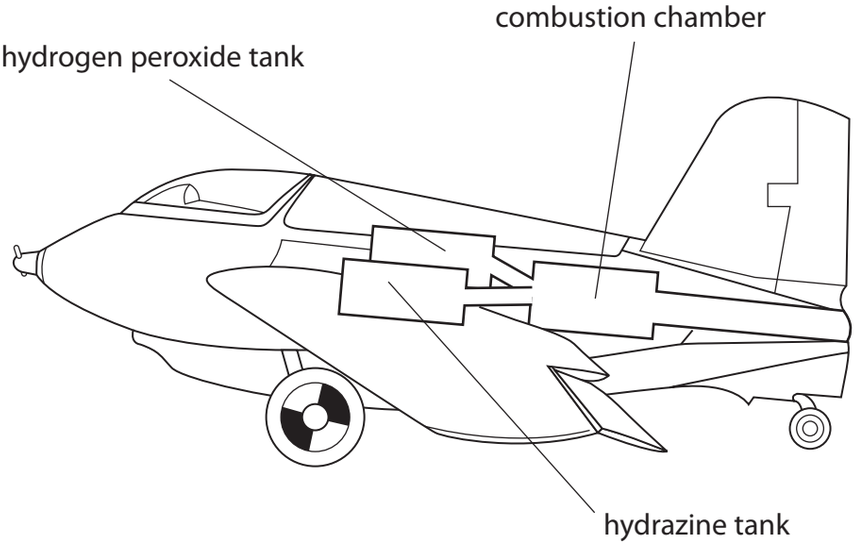
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**(Total for Question 4 = 7 marks)**

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**5** During the Second World War, engineers developed a rocket-powered aircraft.




The aircraft carried these two liquids

- hydrazine, $N_2H_4$
- hydrogen peroxide, $H_2O_2$

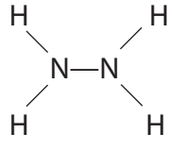
When these two liquids mix in the combustion chamber, they evaporate and then react rapidly to form nitrogen gas, $N_2$, and steam, $H_2O$

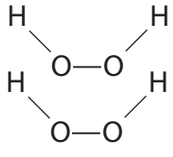
The reaction is exothermic.

The equation for the reaction is

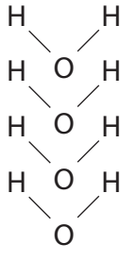
$$N_2H_4 \quad + \quad 2H_2O_2 \quad \rightarrow \quad N_2 \quad + \quad 4H_2O$$

The displayed formulae for the reactants and products are









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(a) The tables give the bond energies for the bonds broken in the reactants and the bonds made in the products.

| Bonds broken | |
|---|---|
| bond | bond energy in kJ/mol |
| N—N | 159 |
| N—H | 391 |
| O—O | 143 |
| O—H | 463 |

| Bonds made | |
|---|---|
| bond | bond energy in kJ/mol |
| N≡N | 945 |
| O—H | 463 |

(i) Use the data in the tables to calculate the total amount of energy required to break all of the bonds in the reactants.

**(1)**

energy required = ..... kJ

(ii) Use the data in the tables to calculate the total amount of energy released when all of the bonds in the products are made.

**(1)**

energy released = ..... kJ

(iii) Calculate the enthalpy change, $\Delta H$, in kJ/mol, for the reaction. Include a sign in your answer.

**(3)**

$\Delta H$ = ..... kJ/mol

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(b) Explain, in terms of bonds broken and bonds made, why this reaction is exothermic.

**(2)**

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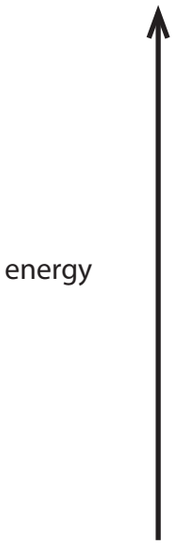
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(c) Draw an energy level diagram for the reaction between $N_2H_4$ and $H_2O_2$

**(3)**




**(Total for Question 5 = 10 marks)**

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**6** Some cars in Brazil use ethanol, $C_2H_5OH$, as a fuel instead of petrol.

The ethanol is made by the fermentation of glucose which is obtained from sugar cane.

The sugar is extracted from the sugar cane and then dissolved in water to make a sugar solution.

(a) (i) Name the substance that is added to the sugar solution that causes glucose to ferment.

**(1)**

.....

(ii) Which temperature is the most suitable for fermentation?

**(1)**

☒ **A** 0 °C

☒ **B** 10 °C

☒ **C** 30 °C

☒ **D** 80 °C

(iii) Explain why fermentation is done in the absence of air.

**(2)**

.....

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(b) (i) State what is meant by the term **fuel**.

**(1)**

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(ii) Write a chemical equation for the complete combustion of ethanol in air.

**(2)**

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(c) Ethanol is also manufactured by reacting steam with ethene, $C_2H_4$

The equation for this reaction is

$$C_2H_4(g) + H_2O(g) \rightarrow C_2H_5OH(g)$$

State the conditions of temperature and pressure used in this process.

**(2)**

temperature .....

pressure .....

(d) When ethanol is heated with acidified potassium dichromate(VI), it is oxidised to ethanoic acid.

(i) State the colour change that occurs in the potassium dichromate(VI) during this reaction.

**(1)**

from ..... to .....

(ii) The structural formula of ethanoic acid is $CH_3COOH$

Draw the displayed formula of ethanoic acid.

**(2)**

(iii) Complete the equation for the reaction of ethanoic acid with sodium.

**(2)**

.....$CH_3COOH(aq)$ + .....$Na(s)$ → .....(aq) + .....(g)

**(Total for Question 6 = 14 marks)**

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**7** Dinitrogen tetraoxide, $N_2O_4$, is a colourless gas.

Nitrogen dioxide, $NO_2$, is a brown gas.

The two gases can exist together in dynamic equilibrium according to the equation

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

(a) Explain what is meant by the term **dynamic equilibrium**.

**(2)**

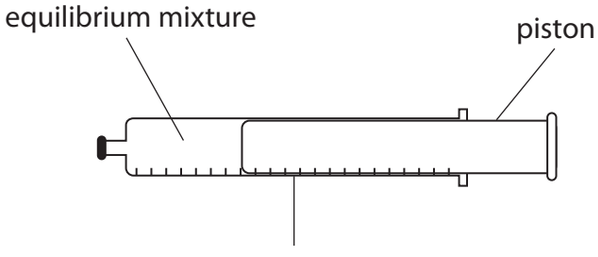
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(b) Some $N_2O_4$ and some $NO_2$ are put into a sealed gas syringe and allowed to form an equilibrium mixture.




This equilibrium mixture is brown.

(i) The pressure of the gas in the syringe is increased by pushing in the piston. The mixture is then allowed to reach a new equilibrium at the same temperature as before.

Explain why the new equilibrium mixture contains less $NO_2$ than the original equilibrium mixture.

**(2)**

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(ii) A student suggests that the new equilibrium mixture would be lighter in colour than the original equilibrium mixture, as there is now less $NO_2$ present.

Suggest why the new equilibrium mixture is actually darker than the original.

**(1)**

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.....

(c) Carbon monoxide, CO, and oxides of nitrogen are produced in a car engine when petrol is burned.

These oxides can be partly removed by using a catalytic converter fitted to the car's exhaust system.

(i) State how oxides of nitrogen are produced in the car engine.

**(1)**

.....

.....

(ii) Give a disadvantage of allowing oxides of nitrogen to escape into the atmosphere.

**(1)**

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(iii) Write a chemical equation for the reaction between nitrogen monoxide, NO, and carbon monoxide to form carbon dioxide and nitrogen.

**(1)**

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**(Total for Question 7 = 8 marks)**

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**8** The concentration of NaClO(aq) in a solution of bleach is found by reacting it with hydrochloric acid.

The equation for the reaction is

$$NaClO(aq) + 2HCl(aq) \rightarrow NaCl(aq) + H_2O(l) + Cl_2(g)$$

An excess of dilute hydrochloric acid is added to 4.00 $cm^3$ of bleach solution.

60.0 $cm^3$ of chlorine gas is produced.

(a) Explain a safety precaution that should be taken when doing this experiment.

**(2)**

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(b) (i) Calculate the amount, in moles, of chlorine gas produced.
Assume one mole of chlorine gas occupies 24 000 $cm^3$.

**(2)**

amount of chlorine = ..... mol

(ii) Determine the amount, in moles, of NaClO in 4.00 $cm^3$ of bleach.

**(1)**

amount of NaClO = ..... mol

(iii) Calculate the concentration, in mol/$dm^3$, of the bleach solution.

**(2)**

concentration = ..... mol/$dm^3$

**(Total for Question 8 = 7 marks)**

**TOTAL FOR PAPER = 70 MARKS**

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