WESTMINSTER SCHOOL
THE CHALLENGE 2016

CHEMISTRY

Thursday 28 April 2016

Time allowed: 30 minutes

Please write in black or blue ink.

Write your answers in the spaces provided.

For examiner use only

Total Mark	

Blank Page

C1. The following multiple choice questions test a range of chemical principles. For each question, circle the letter corresponding to your chosen answer.

a) The oxide of element **X** is dissolved in water. The resulting solution turns universal indicator paper red. **X** is most likely to be…

A a metal

B a non-metal

C a solid

D impossible to say

[1]

b) Which of the following techniques would be most appropriate for separating ethanol and water?

A filtration

B chromatography

C simple distillation

D fractional distillation

[1]

c) 2g of a gas is combusted in pure oxygen to produce 18g of a colourless liquid as the only product. What mass of oxygen has reacted?

A 2g

B 16g

C 18g

D Not enough information to calculate

[1]

d) Which of the following is a reversible process?

A smashing a test-tube

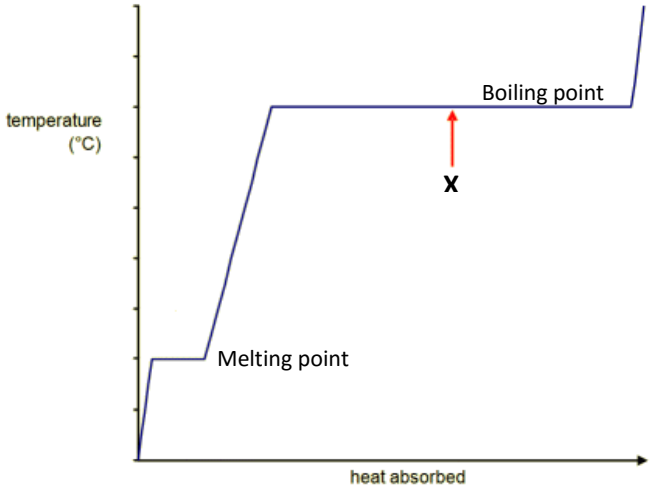
B iron rusting

C burning methane

D making ice

[1]

e) The following graph shows the temperature of a sample of water as it is being heated. What is present in the sample at the point indicated (**X**)?



A only water

B water and steam

C only steam

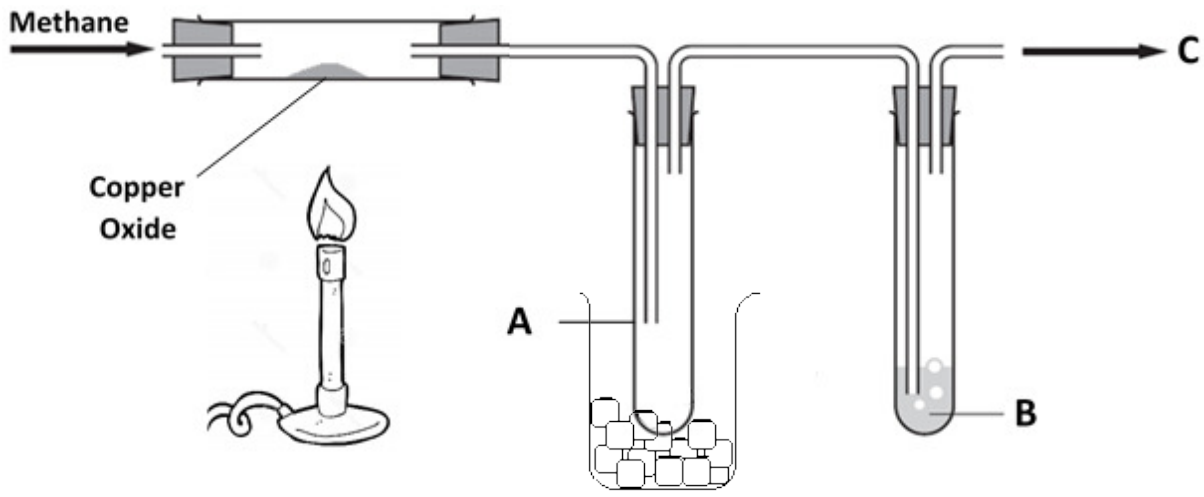
D ice, water and steam

[Total for C1: 5 marks]

Question C2 begins on the next page

C2. This question is about the reaction of methane with copper oxide.

A steady stream of methane gas is passed over copper oxide as it is heated, and the gaseous products passed through two test tubes. The first test tube (**A**) is placed in a beaker of ice-water, and the second contains a colourless solution (**B**). Gas **C** is allowed to escape from the apparatus.



At the end of the experiment a student noticed the following:

- The copper oxide had turned from a black solid to a pink solid.
- A colourless liquid had appeared in test tube **A**.
- Solution **B** had turned cloudy.
- The gas **C** could be ignited.

a) In terms of the arrangement and spacing of particles, describe the differences between copper oxide and methane.

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……

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[2]

b)

(i) What would you expect to have happened to the mass of the solid at the end of the experiment? Justify your answer.

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……

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[2]

(ii) Identify the pink solid left at the end of the reaction.

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[1]

c)

(i) Give the **chemical formula** for the colourless liquid produced in test tube **A**?

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[1]

(ii) Suggest why the test tube is immersed in ice water.

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[1]

d) Identify the colourless solution **B** and suggest why it turned cloudy during the reaction.

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[2]

e) What is the gas **C** that can be ignited?

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[1]

f) Name another substance that could be used in place of methane to turn the copper oxide into the pink solid. Write a word equation for the reaction that you suggest.

Substance: ……

Word equation: ……

[2]

[Total for C2: 12 marks]

C3. This question is about distinguishing substances.

You are presented with five unknown substances (labelled **A** – **E**). All are either white solids or colourless liquids/solutions, and are one of the following.

White solids	**Colourless liquids/solutions**
Sodium chloride (salt)	Water
Sodium carbonate	Hydrochloric acid
Pure sand	

a) Your teacher challenges you to work out which substance is which by mixing them together in various combinations. Using the following observations, work out which label belongs to which substance.

	A	**B**	**C**	**D**	**E**
A		Solid sinks to bottom of solution	No observable change	Fizzing	Colourless solution formed
B	X		Solid sinks to bottom of solution	Mixture of white solids	Mixture of white solids
C	X	X		Colourless solution formed	Colourless solution formed
D	X	X	X		Mixture of white solids
E	X	X	X	X	

A ..... [1]

B ..... [1]

C ..... [1]

D ..... [1]

E ..... [1]

b) A student suggests that the fizzing produced between **A** and **D** might be due to hydrogen. Describe a test that could be carried out to determine whether they are correct.

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[2]

c) When sodium carbonate is mixed with hydrochloric acid, sodium chloride is formed. Give the name of another substance that could also be mixed with hydrochloric acid to produce sodium chloride.

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[1]

[Total for C3: 8 marks]

C4. This question is about the carbon dioxide dissolved in fizzy drinks.

Carbon dioxide is a gas that is only partially soluble in water, forming a mixture of dissolved CO_2 and carbonic acid (H_2CO_3). Its solubility is affected by the temperature of the water and the pressure of the gas. The table below gives the mass (in grams) of carbon dioxide that can dissolve in 1 litre of water at various **temperatures**. One of the values is missing.

Temperature (°C)	CO_2 solubility (g/L)
0	3.3
5	2.8
10	2.3
15	2.0
20	1.7
25	
30	1.3
35	1.1
40	1.0
45	0.9

a) **On the graph paper on the next page**, plot the data from the table, putting temperature on the horizontal axis and solubility on the vertical axis. You should choose a suitable scale and draw a curve of best fit through the data points.

[3]

b) Using your graph, estimate the solubility of carbon dioxide at 25°C.

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[1]

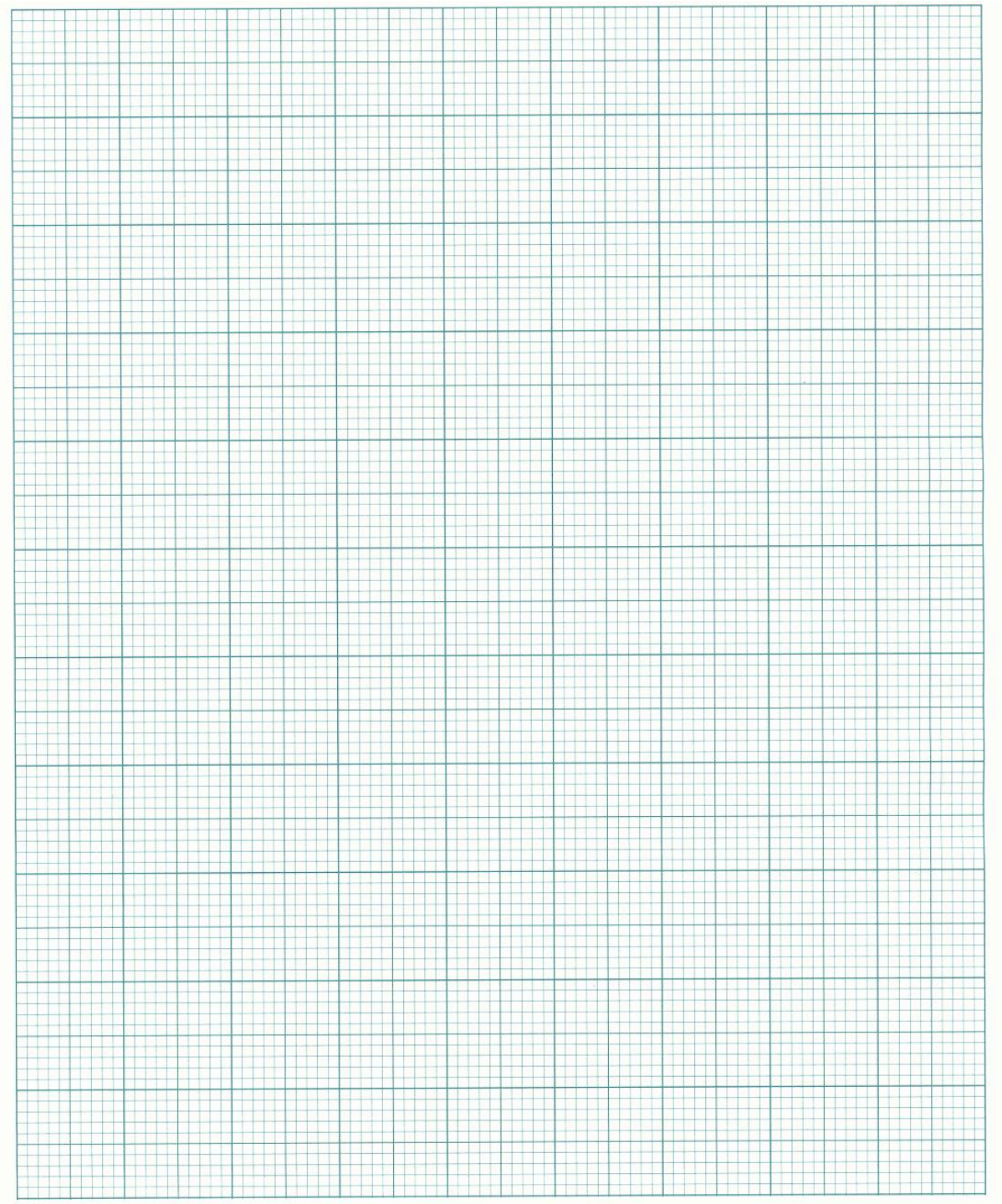
c) Carbon dioxide gas is more soluble in water than oxygen gas at all temperatures. Suggest why this might be the case.

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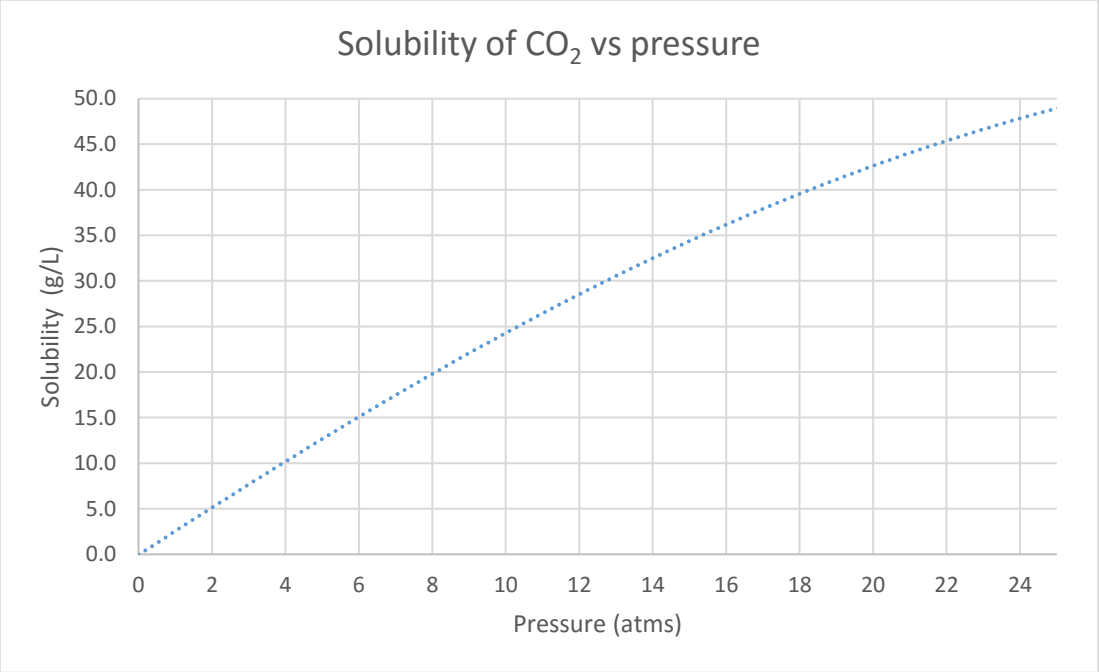
[1]

Graph of carbon dioxide solubility at various temperatures



The sketch below shows how the solubility of carbon dioxide varies with **pressure**, while keeping the temperature constant at 25°C.

The pressure at the surface of the earth is equal to 1 atmosphere (atm).



d) The contents of a fizzy drink can are kept under high pressure. Using information from the graph, explain fully why fizzy drinks fizz when the can is opened.

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[2]

e) A student takes a can of fizzy drink on holiday. When he opens the can on the plane, it fizzes much more than usual! Suggest why.

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[1]

[Total for C4: 8 marks]

[Total for Chemistry Section: 33 marks]