

AS Level Chemistry B (Salters)

H033/01 Foundations of chemistry

Friday 27 May 2016 – Morning

Time allowed: 1 hour 30 minutes



You must have:

- the Data Sheet for Chemistry B (Salters)
(sent with general stationery)

You may use:

- a scientific calculator



First name										
Last name										
Centre number						Candidate number				

INSTRUCTIONS

- Use black ink. HB pencil may be used for graphs and diagrams only.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION

- The total mark for this paper is **70**.
- The marks for each question are shown in brackets [].
- This document consists of **20** pages.

SECTION A

You should spend a maximum of 25 minutes on this section.

Answer **all** the questions.

Write your answer to each question in the box provided.

1 How many protons are in a hydroxide ion, OH^- ?

- A 1
- B 8
- C 9
- D 10

Your answer

[1]

2 Which of the following is the correct electronic configuration for a potassium ion, K^+ ?

- A $1s^2 2s^2 2p^6 3s^1$
- B $1s^2 2s^2 2p^6 3s^2 3p^6$
- C $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
- D $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

Your answer

[1]

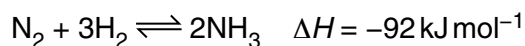
3 Which pair would give a bright yellow precipitate when mixed?

- A hydrochloric acid and copper(II) sulfate solution
- B sodium hydroxide solution and iron(III) sulfate solution
- C sodium iodide solution and lead(II) nitrate solution
- D sodium sulfate solution and barium nitrate solution

Your answer

[1]

- 4 Ammonia is made by the reaction shown below.



Which conditions will result in the greatest equilibrium yield of ammonia?

	Temperature	Pressure
A	high	high
B	low	high
C	high	low
D	low	low

Your answer

[1]

- 5 Why do the boiling points of the halogens increase down the group?

- A There is an increase in bond enthalpy.
 B There is an increase in bond polarity.
 C There is an increase in the strength of instantaneous dipoles.
 D There is a decrease in electronegativity.

Your answer

[1]

- 6 The depletion of ozone is catalysed by chlorine radicals.

Which of the following describes a termination step of the radical mechanism?

	Number of radicals	Enthalpy change
A	decreases	negative
B	increases	negative
C	decreases	positive
D	increases	positive

Your answer

[1]

7 What is the effect on the volume when the pressure of an ideal gas is doubled at the same time as the temperature (in Kelvin) is doubled?

- A halved
- B remains the same
- C doubled
- D quadrupled

Your answer

[1]

8 Concentrated sulfuric acid is warmed with sodium bromide.

Which products are formed?

- A HBr as the only gas
- B no products
- C H_2S , Br_2 and HBr
- D SO_2 , Br_2 and HBr

Your answer

[1]

9 Which reaction will **not** give bromoethane as a product?

- A Ethane with bromine in ultraviolet radiation.
- B Ethene with bromine at room temperature and pressure.
- C Ethene with hydrogen bromide at room temperature and pressure.
- D Ethanol with sodium bromide and concentrated sulfuric acid, heated under reflux.

Your answer

[1]

- 10 Tin reacts with concentrated nitric acid, as shown in the equation below.



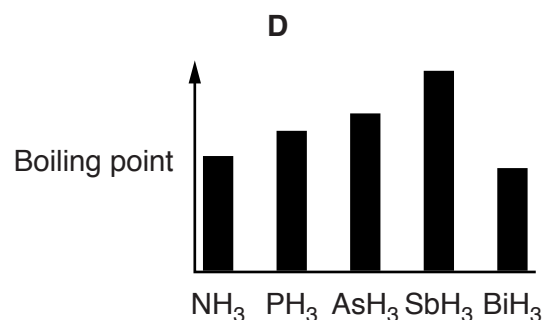
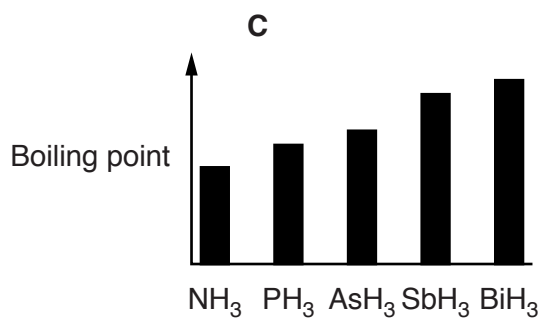
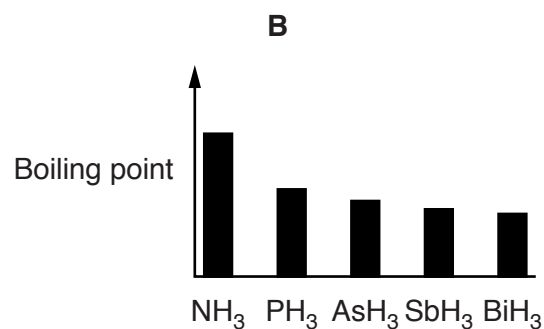
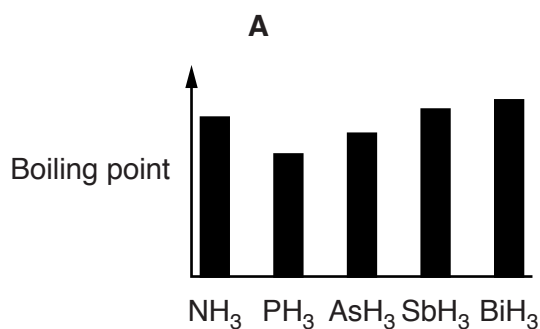
Which row represents the oxidation state changes for nitrogen and tin in this reaction?

	Nitrogen	Tin
A	increases by 1	decreases by 2
B	increases by 1	decreases by 4
C	decreases by 1	increases by 2
D	decreases by 1	increases by 4

Your answer

[1]

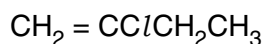
- 11 Which bar chart shows the boiling points of the group 15 hydrides?



Your answer

[1]

12 A substance has the formula shown below.



Which of the following is a structural **isomer** of this substance?

- A 2-chlorobut-1-ene
- B 3-chlorobut-4-ene
- C 2-chloromethylpropene
- D 1-chloromethylpropene

Your answer

[1]

13 Which molecule is linear in shape?

- A SO_2
- B H_2S
- C CS_2
- D Cl_2O

Your answer

[1]

14 The following data were collected for the equilibrium $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$ at 500 K.

$$[\text{H}_2(\text{g})]_{\text{eqm}} = 0.14 \text{ mol dm}^{-3} \quad [\text{I}_2(\text{g})]_{\text{eqm}} = 0.040 \text{ mol dm}^{-3} \quad K_c = \frac{[\text{HI}(\text{g})]_{\text{eqm}}^2}{[\text{H}_2(\text{g})]_{\text{eqm}} [\text{I}_2(\text{g})]_{\text{eqm}}} = 160$$

What will be the value of $[\text{HI}(\text{g})]_{\text{eqm}}$ under these conditions?

- A 5.9×10^{-3}
- B 0.45
- C 0.90
- D 0.95

Your answer

[1]

15 Which molecule is non-polar?

- A IBr
- B CH_2Cl_2
- C NF_3
- D BF_3

Your answer

[1]

16 Propan-1-ol is heated with Al_2O_3 . The organic product is then reacted with bromine.

What is the final outcome of these two reactions?

- A 1-bromopropane
- B 1-bromopropane and 2-bromopropane
- C 1,2-dibromopropane
- D 1,3-dibromopropane

Your answer

[1]

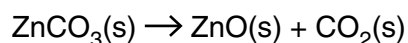
17 Which pair of compounds will react to form the ester $\text{CH}_3\text{CH}_2\text{COOCH}_2\text{CH}_2\text{CH}_2\text{CH}_3$?

- A $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ and $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$
- B $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ and $(\text{CH}_3\text{CO})_2\text{O}$
- C $\text{CH}_3\text{CH}_2\text{COOH}$ and $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$
- D $(\text{CH}_3\text{CH}_2\text{CO})_2\text{O}$ and $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$

Your answer

[1]

- 18 Some students wish to make 0.970 mol of zinc oxide by the reaction shown below. They are told that the reaction gives a 95.0% yield.



What mass of zinc carbonate should they heat?

- A 83.2 g
B 117 g
C 122 g
D 128 g

Your answer

[1]

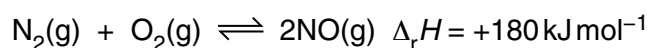
- 19 Which solution contains the greatest number of ions?

- A 10.0 cm³ of 0.500 mol dm⁻³ NaCl
B 0.300 dm³ of 0.0400 mol dm⁻³ NaCl
C 0.0200 dm³ of 0.500 mol dm⁻³ MgCl₂
D 40.0 cm³ of 0.150 mol dm⁻³ MgCl₂

Your answer

[1]

- 20 Nitrogen and oxygen combine, as shown below.



Which statement is correct for this reaction?

- A The reaction is exothermic.
B The activation enthalpy for the reverse reaction is smaller than the activation enthalpy for the forward reaction.
C Once energy equal to the activation enthalpy has been provided, the reaction will continue without further energy input.
D The sum of the bond enthalpies of bonds made is greater than the sum of the bond enthalpies of bonds broken.

Your answer

[1]

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Turn over for the next question

SECTION B

Answer **all** the questions.

- 21 'Silicon burning' is a fusion process that occurs in stars just before they collapse.

Each silicon nucleus, mass number 28, fuses with seven helium nuclei (${}^4_2\text{He}$) one after the other. The final product is an isotope of nickel.

- (a) Give the mass number of the nickel isotope produced and the number of protons and neutrons it contains.

mass number

protons

neutrons

[1]

- (b) Naturally occurring silicon has three isotopes, as shown in the table.

Isotope	Si-28	Si-29	Si-30
% abundance	92.17	4.71	3.12

Calculate an A_r value for Si from these data, showing your working.

Give your answer to **two** decimal places.

$A_r = \dots\dots\dots$ [2]

(c) Some students want to make a sample of pure dry nickel sulfate crystals, $\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$. They react an excess of insoluble nickel carbonate with dilute sulfuric acid.

(i) Describe the steps in their method (without details of the apparatus used).

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.....
.....
.....
.....
..... [4]

(ii) The students calculated the mass of crystals they were expecting and found that the percentage yield of their process was much less than 100%.

Some students give explanations for this low percentage yield.

Student A The crystals are damp at the end.

Student B Some nickel carbonate remains unreacted at the end.

Student C The nickel sulfate has lost some of its $6\text{H}_2\text{O}$ water of crystallisation.

For each explanation, say whether it could be correct and explain your answer.

Student A

.....
.....
.....

Student B

.....
.....
.....

Student C

.....
.....
..... [3]

- 22 'Isobutylene' is an important hydrocarbon, used to make some petrol additives. The skeletal formula of isobutylene is shown below.



isobutylene

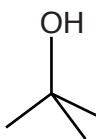
- (a) Give the systematic name for isobutylene.

..... [1]

- (b) Isobutylene has a structural isomer that shows *E/Z* isomerism. Draw the *Z* isomer.

[1]

- (c) Alcohol **A** can be made from isobutylene. The structure of alcohol **A** is shown below.

alcohol **A**

- (i) Give the reagents needed to make alcohol **A** from isobutylene.

.....
 [1]

- (ii) Classify alcohol **A** as primary, secondary or tertiary, giving a reason.

.....

 [1]

- (iii) There are several alcohols that are structural isomers of alcohol **A**.

Give a laboratory test that would distinguish alcohol **A** from its isomeric alcohols.

.....

 [2]

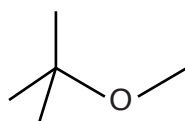
- (iv) Alcohol **A** has the lowest boiling point of the isomeric alcohols.

Suggest why this is so, naming the intermolecular bonds involved.

.....

 [2]

- (d) Isobutylene reacts with methanol to give 'MTBE'. This has been used as a petrol additive but its use has largely been phased out.



MTBE

- (i) Name the functional group in MTBE.

..... [1]

- (ii) Write an equation, using **molecular** formulae, for the reaction of isobutylene with methanol.

[1]

23 Bromide ions are present in seawater. A key reaction in the manufacture of bromine from seawater is the reaction of bromide ions with chlorine. The chlorine is made on site by electrolysis of brine.

(a) (i) Write an ionic equation for the reaction of bromide ions with chlorine.

[1]

(ii) What information does the reaction in **(i)** give about the relative reactivities of the two halogens involved?

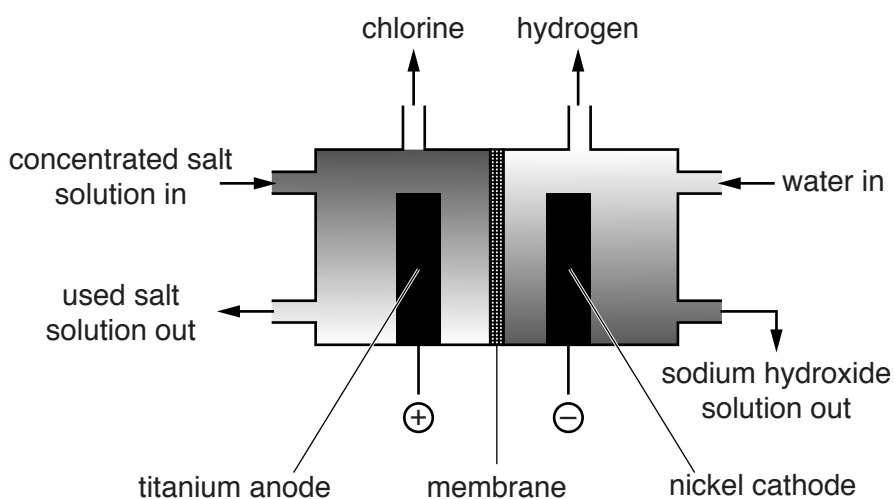
Give your answer in terms of electrons.

.....

.....

..... [1]

(b) Chlorine is usually manufactured from sodium chloride using a membrane cell.



(i) Some ions in the solution can move through the membrane but others cannot.

List these ions below.

Can move through the membrane

Cannot move through the membrane

[2]

- (ii) All three products from the membrane cell are used in the chemical industry.

Write the overall equation for the formation of these three products in the cell.

[1]

- (iii) State and explain the atom economy of the reaction in (ii).

.....

 [1]

- (iv) 37 kg of NaOH is produced (in solution) in a membrane cell.

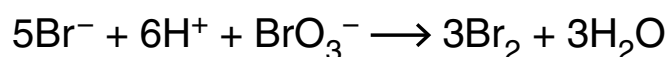
Calculate the volume of Cl_2 (in dm^3 at RTP) that will be produced at the same time.

Give your answer in standard form to an **appropriate** number of significant figures.

volume of Cl_2 = dm^3 [3]

- (c) Bromine can be produced in a laboratory by reacting Br^- and BrO_3^- ions.

- (i) Write the oxidation states of bromine on the dotted lines beneath the equation.



..... [1]

- (ii) State, with a reason, what has been reduced in the equation above.

.....

 [1]

16
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24 A group of students use a computer model to investigate the rate of depletion of ozone by chlorine radicals in the stratosphere.

(a) (i) What is the meaning of the term *radical*?

Explain how chlorine radicals are formed in the stratosphere, naming the type of bond breaking that occurs.

.....

.....

.....

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.....

[5]

(ii) Write **two equations** that show how chlorine radicals catalyse the breakdown of ozone and give the **overall equation**.

Two equations:

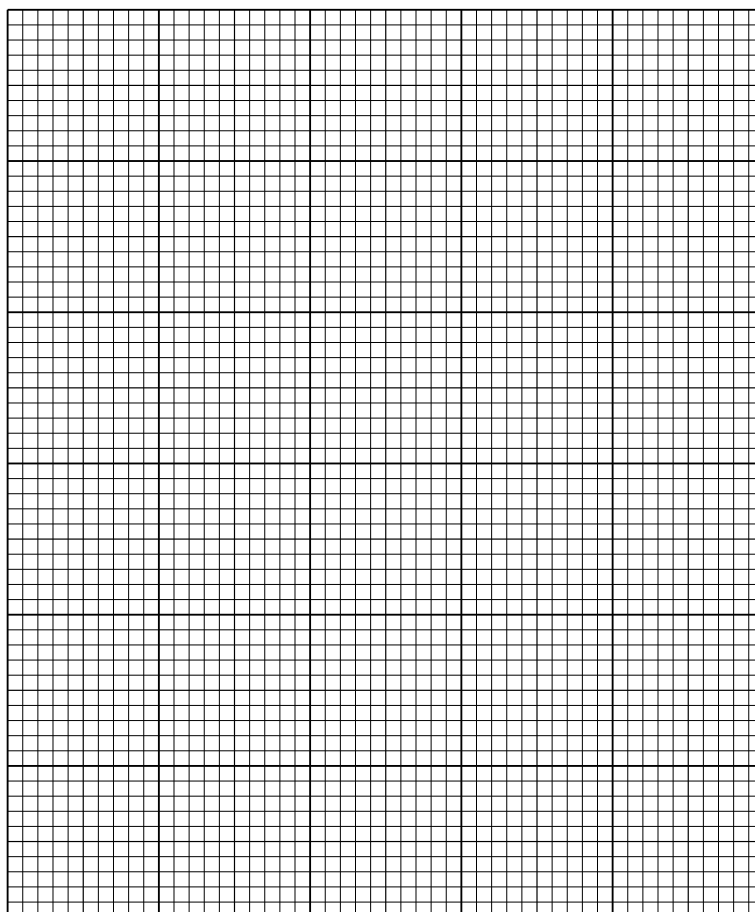
Overall equation:

[2]

- (b) (i) The students read the concentrations of ozone at certain times from the computer model.

Time/s	Concentration of ozone/molecules cm^{-3}
0	5.000×10^{12}
300	4.989×10^{12}
600	4.975×10^{12}
900	4.964×10^{12}
1200	4.953×10^{12}

Plot these results on the grid below.



[3]

- (ii) Use the graph to determine the concentration of ozone after 500 seconds.

concentration = molecules cm^{-3} [1]

- (iii) How does the rate of reaction vary with time?

Explain your answer.

.....
.....
..... [1]

- (c) The model uses a temperature of 300 K and a pressure of 1000 Pa.

Calculate the total number of molecules in 1.0 cm^3 of gas under these conditions.

total number of molecules in 1.0 cm^3 of gas = [4]

- (d) A data book gives the O–O bond enthalpy in ozone as $+302 \text{ kJ mol}^{-1}$ and shows that the highest frequency of UVA radiation is $9.5 \times 10^{14} \text{ Hz}$.

Show, using a calculation, whether UVA radiation can break this bond.

[3]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin.

A large rectangular area with a solid vertical line on the left side and horizontal dotted lines across the rest of the page, providing space for writing answers.



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