Edexcel

AS Chemistry

Practice Unit Test 1

philip allan UPDATES
www.philipallan.co.uk

Practice Unit Test 1

Time allowed: 1 hour 15 minutes
Use the periodic table printed at the back of the textbook (page 340).

Section A

Answer *all* questions in this section. You are advised not to spend more than 25 minutes on this section. For each question, select the one answer from **A**, **B**, **C** or **D** that you think is correct and put a cross in the box alongside the answer.

1 The relative isotopic mass is

- ☐ **A** the average mass of the atoms of that element relative to the mass of a ^{12}C atom
- ☐ **B** the average mass of the atoms of that element relative to $\frac{1}{12}$ the mass of a ^{12}C atom
- ☐ **C** the mass of one atom of that isotope relative to the mass of a ^{12}C atom
- ☐ **D** the mass of one atom of that isotope relative to $\frac{1}{12}$ the mass of a ^{12}C atom

2 Effluent water from a factory contains 5.4 ppm Al^{3+} ions. The mass of Al^{3+} ions in 1.0 dm^3 of water is

- ☐ **A** 5.4 mg
- ☐ **B** 0.146 mg
- ☐ **C** 0.2 mg
- ☐ **D** 2×10^{-4} g

3 10 g of a substance of molar mass 100 g mol^{-1} was dissolved in 250 cm^3 of water. The concentration in mol dm^{-3} of this solution is

- ☐ **A** 0.40
- ☐ **B** 0.00040
- ☐ **C** 0.0250
- ☐ **D** 25.0

Use this space for any rough working. Anything you write in this space will gain no credit.

4 Butane burns according to the equation:

$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(g)$$

Calculate the mass of carbon dioxide (the carbon footprint) produced when 1.0 dm^3 of butane gas is burnt. (The molar volume of gas at this temperature is 24 $dm^3\,mol^{-1}$.)

- ☐ **A** 1.8 g
- ☐ **B** 7.3 g
- ☐ **C** 14.7 g
- ☐ **D** 352 g

5 Chloroethane can be made by the reaction of phosphorus pentachloride with ethanol according to the equation:

$$PCl_5 + C_2H_5OH \rightarrow C_2H_5Cl + HCl + POCl_3$$

The atom economy is

- ☐ **A** 53.3%
- ☐ **B** 25.3%
- ☐ **C** 20%
- ☐ **D** it depends on the yield of the experiment

6 When 23 g of ethanol was oxidised by H^+ and $Cr_2O_7^{2-}$ ions, 16 g of ethanoic acid was produced. The percentage yield of this reaction is

- ☐ **A** 0.53%
- ☐ **B** 30.4%
- ☐ **C** 53.3%
- ☐ **D** 69.6%

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The following information is needed for questions 7 and 8.

Avogadro constant = 6.02×10^{23} mol^{-1}

7 The number of ions in 111.1 g of calcium chloride, $CaCl_2$, is

- ☐ **A** 6.02×10^{23}
- ☐ **B** 1.81×10^{24}
- ☐ **C** 1
- ☐ **D** 3

8 An athlete's urine sample contained 20 nmol of a steroid per dm^3 of a steroid. Calculate the number of molecules of the steroid in 100 cm^3 of solution.

- ☐ **A** 1.204×10^{14}
- ☐ **B** 1.204×10^{15}
- ☐ **C** 1.204×10^{16}
- ☐ **D** 1.204×10^{18}

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Use the following data to answer questions 9–11:

Standard enthalpy of formation/ kJ mol^{-1}	
Sulfur dioxide, $SO_2(g)$	−297
Sulfur trioxide, $SO_3(g)$	−395
Sulfur trioxide, $SO_3(s)$	−461

Standard enthalpy of combustion/ kJ mol^{-1}	
Ethane, $C_2H_6(g)$	−1560
Carbon, C(s)	−395
Hydrogen, $H_2(g)$	−286

Bond enthalpy/kJ mol^{-1}	
N≡N	+946
N–H in NH_3	+391
H–H	+436

9 Sulfur dioxide and oxygen react together according to the equation:

$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$

The standard enthalpy change/kJ mol^{-1} of this reaction is

- ☐ **A** −328
- ☐ **B** −196
- ☐ **C** −164
- ☐ **D** −98

10 The standard enthalpy change/kJ mol^{-1} of formation of ethane, $C_2H_6(g)$, is

- ☐ **A** +88
- ☐ **B** −88
- ☐ **C** +879
- ☐ **D** −879

11 Nitrogen and hydrogen react according to the equation

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

The standard enthalpy change/kJ mol^{-1} of formation of ammonia, $NH_3(g)$, is

- ☐ **A** −46
- ☐ **B** +46
- ☐ **C** −92
- ☐ **D** +92

Use this space for any rough working. Anything you write in this space will gain no credit.

12 The thermodynamic equations for the reactions of dilute hydrochloric acid with sodium hydrogencarbonate and with sodium carbonate are:

(i) $NaHCO_3(s) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l) + CO_2(g)$

$\Delta H = -y \text{ kJ mol}^{-1}$

(ii) $Na_2CO_3(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$

$\Delta H = -z \text{ kJ mol}^{-1}$

What is the enthalpy change (kJ mol^{-1}) for the reaction $2NaHCO_3(s) \rightarrow Na_2CO_3(s) + H_2O(l) + CO_2(g)$?

- ☐ **A** $z - y$
- ☐ **B** $y - z$
- ☐ **C** $2y - z$
- ☐ **D** $z - 2y$

13 A sample of a solid X of mass 1.0 g was dissolved in 100 cm^3 of water. The temperature of the water fell from 22.4°C to 18.7°C. Assume that the specific heat capacity of water is 4.18 $\text{J g}^{-1}\,^{\circ}\text{C}^{-1}$. The heat change (J), to three significant figures, is

- ☐ **A** 15.5
- ☐ **B** 93.6
- ☐ **C** 1550
- ☐ **D** 9360

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14 The enthalpy of neutralisation of hydrochloric acid was measured by placing 50 cm^3 of a solution of the acid into a beaker and adding 50 cm^3 of sodium hydroxide solution. The temperature before and after mixing was measured using the same thermometer.

Which would **not** cause an error in the value of the enthalpy of neutralisation of the acid?

- ☐ **A** using a thermometer that always reads 2°C too high
- ☐ **B** heat losses from the beaker
- ☐ **C** heat being absorbed by the thermometer
- ☐ **D** the sodium hydroxide solution being slightly more dilute than the acid

15 When 25 cm^3 of a 0.500 mol dm^{-3} solution of sulfuric acid, H_2SO_4, was neutralised by a sodium hydroxide solution, 1.46 kJ of heat energy was released.

$$H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

The enthalpy of neutralisation/kJ mol^{-1} of sulfuric acid is

- ☐ **A** +116.8
- ☐ **B** –116.8
- ☐ **C** +58.4
- ☐ **D** –58.4

16 The number 0.0210 is written to

- ☐ **A** five significant figures
- ☐ **B** four significant figures
- ☐ **C** three significant figures
- ☐ **D** two significant figures

Use this space for any rough working. Anything you write in this space will gain no credit.

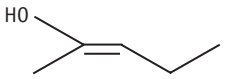
17 The equation that represents the first ionisation energy of bromine is

- ☐ **A** $Br(g) \rightarrow Br^+(g) + e^-$
- ☐ **B** $Br(g) + e^- \rightarrow Br^-(g)$
- ☐ **C** $\frac{1}{2}Br_2(g) \rightarrow Br^+(g) + e^-$
- ☐ **D** $\frac{1}{2}Br_2(l) \rightarrow Br^+(g) + e^-$

18 The electronic configuration of an O^+ ion is

- ☐ **A** $1s^2\ 2s^2\ 2p_x^{\ 1}\ 2p_y^{\ 1}\ 2p_z^{\ 1}$
- ☐ **B** $1s^2\ 2s^1\ 2p_x^{\ 1}\ 2p_y^{\ 1}\ 2p_z^{\ 1}$
- ☐ **C** $1s^2\ 2s^2\ 2p_x^{\ 1}\ 2p_y^{\ 1}$
- ☐ **D** $1s^2\ 2s^2\ 2p_x^{\ 2}\ 2p_y^{\ 1}\ 2p_z^{\ 1}$

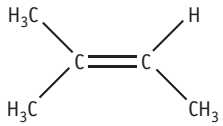
19 What is the name of the following compound?



- ☐ **A** (*Z*)-2-hydroxypent-2-ene
- ☐ **B** (*E*)-2-hydroxypent-2-ene
- ☐ **C** (*Z*)-2-hydroxybut-2-ene
- ☐ **D** (*E*)-2-hydroxybut-2-ene

Use this space for any rough working. Anything you write in this space will gain no credit.

20 The formula of 2-methylbut-2-ene is:



Which is a correct statement about 2-methylbut-2-ene?

- ☐ **A** It does not exist as geometric isomers as the molecule can rotate about the C=C.
- ☐ **B** It does not exist as geometric isomers as there are two identical groups on one of the carbon atoms of the C=C group.
- ☐ **C** It is a *Z*-isomer.
- ☐ **D** It is an *E*-isomer.

21 A diatomic element X has three molecular ion peaks in its mass spectrum at *m/e* values 158, 160 and 162. The peak at 160 is twice as high as the other two peaks, which are the same height. Which is a true statement about X?

- ☐ **A** X consists of three isotopes, ^{79}X, ^{80}X and ^{81}X, in equal amounts.
- ☐ **B** X consists of three isotopes, ^{79}X, ^{80}X and ^{81}X, with twice as much of the ^{80}X isotope.
- ☐ **C** X consists of two isotopes, ^{79}X and ^{81}X, in equal amounts.
- ☐ **D** X consists of two isotopes, ^{79}X and ^{80}X, with more ^{80}X than ^{79}X.

22 An organic compound has the molecular formula C_7H_{14}. It does not decolorise bromine water. Which is **not** true?

- ☐ **A** Its empirical and molecular formulae are different.
- ☐ **B** It is an alkene.
- ☐ **C** It is a cycloalkane.
- ☐ **D** It is a hydrocarbon.

Use this space for any rough working. Anything you write in this space will gain no credit.

23 Question 23 is about the following consecutive ionisation energies/kJ mol^{-1}.

A	900	736	590	548	502
B	799	2420	3660	25 000	328 000
C	494	736	577	786	1 060
D	418	590	632	661	648

Which is the most likely to:

(i) be the successive ionisation energies of an element in group 3 of the periodic table

- ☐ **A**
- ☐ **B**
- ☐ **C**
- ☐ **D**

(ii) be the first ionisation energies of elements going down a group of the periodic table

- ☐ **A**
- ☐ **B**
- ☐ **C**
- ☐ **D**

(iii) be the first ionisation energies of the first five elements in period 3 of the periodic table

- ☐ **A**
- ☐ **B**
- ☐ **C**
- ☐ **D**

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Section A total: 25 marks

Section B

Answer *all* questions in this section.

24 This question is about mass spectrometry.

(a) A mass spectrometer can be used to find the percentage composition of the isotopes of an element. Explain how the following are achieved in a mass spectrometer:

(i) ionisation **(1)**

(ii) acceleration **(1)**

(iii) deflection **(1)**

(b) Analysis of a sample of iron in a mass spectrometer gave the following results:

Isotope	Relative isotopic mass	%
^{54}Fe	53.94	5.94
^{56}Fe	55.93	91.78
^{57}Fe	56.94	2.28

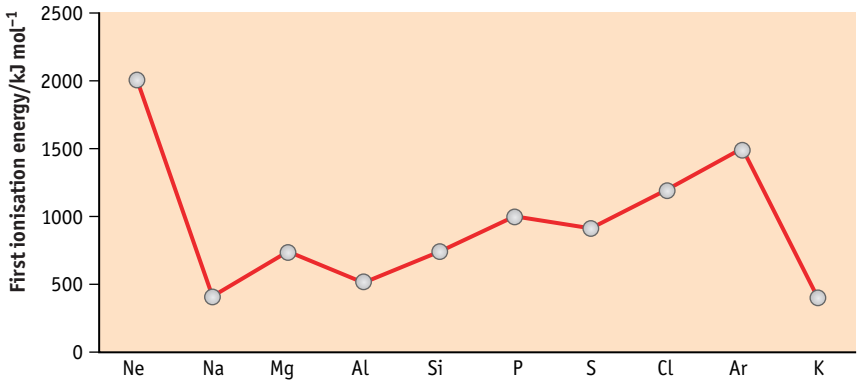
Calculate the relative atomic mass of iron to two decimal places. **(2)**

(c) State and outline one modern use of mass spectrometry. **(3)**

Total: 8 marks

25 (a) Define the term 'first ionisation energy'. **(3)**

(b) The variation of the first ionisation energy of the elements neon to potassium is shown in the graph below.



Explain why:

(i) the first ionisation energy of sodium is less than that of magnesium **(3)**

(ii) the first ionisation energy of aluminium is less than that of magnesium **(2)**

(c) A compound containing sodium, sulfur and oxygen was analysed and the following percentages by mass were found.

Element % by mass: sodium 36.5; sulfur 25.4; oxygen 38.1

Calculate the empirical formula of this compound. **(2)**

Total: 10 marks

26 (a) Chlorine reacts with ethane, CH_3CH_3, and with ethene, $CH_2=CH_2$.

(i) Classify the reaction with ethane. **(1)**

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(ii) Classify the reaction with ethene. **(1)**

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(b) Ethene and but-1-ene are members of the same homologous series.

(i) Explain what is meant by the term 'homologous series'. **(3)**

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(ii) Write the equation for the reaction of but-1-ene with bromine. **(1)**

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(iii) Write the mechanism for the reaction between but-1-ene and bromine. **(3)**

(iv) Identify the major product of the reaction of but-1-ene with bromine water, $Br_2(aq)$. **(1)**

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(v) But-1-ene reacts with an aqueous solution of potassium manganate(VII). Describe what you would see and identify the organic compound produced. **(3)**

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(vi) But-2-ene can be polymerised to poly(but-1-ene). Draw a section of the structure of the polymer that shows one repeating unit. **(2)**

Total: 15 marks

27 (a) Define the term 'standard enthalpy of formation' and write an equation that represents the enthalpy of formation of chloroethane, CH_3CH_2Cl. **(4)**

(b) Enthalpies of formation of organic compounds cannot usually be measured directly, but they can be calculated from enthalpy of combustion data. The thermochemical equation for the combustion of chloroethane, C_2H_5Cl, is:

$$C_2H_5Cl(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(l) + HCl(g) \quad \Delta H_c^\circ = -1325 \text{ kJ mol}^{-1}$$

(i) Draw a labelled Hess's law diagram connecting the enthalpy of combustion of chloroethane with the enthalpies of formation of carbon dioxide, water and hydrogen chloride. **(2)**

(ii) Use your diagram, the value of $\Delta H_c^\ominus$ of chloroethane and the enthalpy of formation data in the table to calculate the enthalpy of formation of chloroethane. **(2)**

Substance	ΔH_f /kJ mol^{-1}
Carbon dioxide, $CO_2(g)$	−394
Water, $H_2O(l)$	−286
Hydrogen chloride, HCl(g)	−92.3

(c) Chloroethane can be produced by the reaction of ethene with hydrogen chloride:

$H_2C{=}CH_2(g) + H{-}Cl(g) \rightarrow H_3C{-}CH_2Cl(g)$

(i) Calculate the standard enthalpy change for this reaction given the following average bond enthalpies.

Bond	Average bond enthalpy/kJ mol^{-1}
C=C	+612
C–H	+467
C–C	+347
H–Cl	+432
C–Cl	+346

(3)

(ii) Draw a labelled reaction profile diagram for this reaction. **(2)**

(iii) The standard enthalpy of this reaction, calculated from enthalpy of formation data, is –97 kJ mol^{-1}. Explain why this is different from the value obtained in **(c)(i)**. **(1)**

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Total: 14 marks

28 (a) Draw a dot-and-cross diagram for the ions in magnesium iodide, showing outer electrons only:

(i) the magnesium ion

(ii) the iodide ion **(3)**

(b) Lattice energy values obtained from Born–Haber experimental data and those calculated from the ionic model are shown in the table below:

	Values from Born–Haber/kJ mol^{-1}	Values calculated from ionic model/kJ mol^{-1}
Magnesium iodide, $MgI_2(s)$	−2327	−1944
Magnesium fluoride, $MgF_2(s)$	−2957	−2913

(i) Explain why the difference between the two values for magnesium iodide is greater than the difference between the two values for magnesium fluoride. **(3)**

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(ii) Why is the lattice energy of calcium fluoride much less exothermic than that of magnesium fluoride? **(2)**

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Total: 8 marks

Section B total: 55 marks

Paper total: 80 marks