Edexcel

AS Chemistry

Practice Unit Test 2

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Practice Unit Test 2

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. 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 Which molecule is linear?

- ☐ **A** $BeCl_2$
- ☐ **B** H_2S
- ☐ **C** O=N–Cl
- ☐ **D** SCl_2

2 Which molecule is pyramidal?

- ☐ **A** BF_3
- ☐ **B** ClF_3
- ☐ **C** PF_3
- ☐ **D** SO_3

3 Which molecule or ion is polar?

- ☐ **A** HCN
- ☐ **B** $BeCl_2$
- ☐ **C** SO_4^{2-}
- ☐ **D** CO_2

4 Which molecule forms intermolecular hydrogen bonds?

- ☐ **A** CH_3COCH_3
- ☐ **B** CH_3OCH_3
- ☐ **C** CH_3CH_2F
- ☐ **D** $CH_3CH_2NH_2$

5 The strongest intermolecular forces between C_2H_5I molecules are:

- ☐ **A** hydrogen bonds
- ☐ **B** permanent dipole forces
- ☐ **C** induced dipole forces (London forces)
- ☐ **D** covalent bonds

6 Which compound is likely to be the most soluble in water?

- ☐ **A** $C_5H_{11}OH$
- ☐ **B** CH_3OH
- ☐ **C** CH_3F
- ☐ **D** CH_3I

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7 Consider the reaction:

$$K_2Cr_2O_7 + 3SO_2 + H_2SO_4 \rightarrow K_2SO_4 + Cr_2(SO_4)_3 + H_2O$$

What is the change in oxidation number of chromium?

- ☐ **A** up by 3
- ☐ **B** down by 3
- ☐ **C** up by 6
- ☐ **D** down by 6

8 Which of the following equations or half-equations is balanced?

- ☐ **A** $OCl^- + 2H^+ + e^- \rightarrow Cl_2 + H_2O$
- ☐ **B** $Fe^{3+} + Sn^{2+} \rightarrow Fe^{2+} + Sn^{4+}$
- ☐ **C** $Fe^{2+} + e^- \rightarrow Fe^{3+}$
- ☐ **D** $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$

9 Which does **not** give brown fumes when heated?

- ☐ **A** lithium nitrate
- ☐ **B** sodium nitrate
- ☐ **C** magnesium nitrate
- ☐ **D** calcium nitrate

10 Which does **not** produce a red flame in a flame test?

- ☐ **A** calcium chloride
- ☐ **B** lithium chloride
- ☐ **C** potassium chloride
- ☐ **D** strontium chloride

11 1.2 g of sodium hydroxide, NaOH, was dissolved in water and the solution made up to 50 cm^3. The concentration of the final solution, in mol dm^{-3}, is

- ☐ **A** 24
- ☐ **B** 0.60
- ☐ **C** 0.060
- ☐ **D** 0.0015

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

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12 An acid was titrated against an alkali. The three titres obtained were 27.00 cm^3, 26.65 cm^3 and 26.45 cm^3. The mean titre that should be used in a calculation is

- ☐ **A** 26.825
- ☐ **B** 26.70
- ☐ **C** 26.6
- ☐ **D** 26.55

13 Barium hydroxide reacts with hydrochloric acid according to the equation:

$$Ba(OH)_2 + 2HCl \rightarrow BaCl_2 + 2H_2O$$

25.00 cm^3 of barium hydroxide solution required 23.75 cm^3 of 0.0500 mol dm^{-3} hydrochloric acid. The concentration of the barium hydroxide solution is

- ☐ **A** 0.02375 mol dm^{-3}
- ☐ **B** 0.0475 mol dm^{-3}
- ☐ **C** 0.0950 mol dm^{-3}
- ☐ **D** 0.2375 mol dm^{-3}

14 Which equation is correct?

- ☐ **A** $Fe + Cl_2 \rightarrow FeCl_2$
- ☐ **B** $Cl^- + \frac{1}{2}Br_2 \rightarrow \frac{1}{2}Cl_2 + Br^-$
- ☐ **C** $Fe^{3+} + I^- \rightarrow Fe^{2+} + \frac{1}{2}I_2$
- ☐ **D** $Fe^{3+} + \frac{1}{2}Cl_2 \rightarrow 2Fe^{2+} + Cl^-$

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15 Which is the strongest acid?

- ☐ **A** hydrogen fluoride, HF
- ☐ **B** hydrogen chloride, HCl
- ☐ **C** hydrogen bromide, HBr
- ☐ **D** hydrogen iodide, HI

16 Which statement is **not** true?

- ☐ **A** Hydrogen chloride gives steamy fumes with gaseous ammonia.
- ☐ **B** Chlorine disproportionates with hot aqueous sodium hydroxide.
- ☐ **C** Silver chloride is decomposed by light.
- ☐ **D** Iodine reacts with starch to form a blue complex.

17 Sulfur dioxide reacts with oxygen in a reversible exothermic reaction to form sulfur trioxide:

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

$$\Delta H = -196\ \text{kJ mol}^{-1}$$

(i) Which altered condition would give the greatest increase in the rate of reaction?

- ☐ **A** an increase in pressure and a decrease in temperature
- ☐ **B** an increase in pressure and an increase in temperature
- ☐ **C** a decrease in pressure and an increase in temperature
- ☐ **D** a decrease in pressure and a decrease in temperature

(ii) Which altered condition would drive the position of equilibrium to the right to the greatest extent?

- ☐ **A** an increase in pressure and a decrease in temperature
- ☐ **B** an increase in pressure and an increase in temperature
- ☐ **C** a decrease in pressure and an increase in temperature
- ☐ **D** a decrease in pressure and a decrease in temperature

18 An organic compound X reacts with sodium to give hydrogen, has no effect on acidified potassium dichromate(VI), does not fizz with sodium hydrogencarbonate and does not decolorise bromine water. X could be

- ☐ **A** $CH_3CH_2CH_2COOH$
- ☐ **B** $CH_2{=}CHCH_2CH_2OH$
- ☐ **C** $(CH_3)_3COH$
- ☐ **D** $CH_3CH(OH)CH_2CH_3$

19 Which molecule is the most polar?

- ☐ **A** CH_3CH_2F
- ☐ **B** CH_3CH_2Cl
- ☐ **C** CH_3CH_2Br
- ☐ **D** CH_3CH_2I

20 Which molecule reacts the fastest with aqueous sodium hydroxide?

- ☐ **A** CH_3CH_2F
- ☐ **B** CH_3CH_2Cl
- ☐ **C** CH_3CH_2Br
- ☐ **D** CH_3CH_2I

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21 Which halogenoalkane cannot be prepared from 50% sulfuric acid, an alcohol and the relevant potassium halide?

- ☐ **A** C_2H_5F
- ☐ **B** C_2H_5Cl
- ☐ **C** C_2H_5Br
- ☐ **D** C_2H_5I

22 Which is **not** a nucleophile?

- ☐ **A** a chloride ion, Cl^-
- ☐ **B** a chlorine radical, Cl•
- ☐ **C** a water molecule, H_2O
- ☐ **D** a hydroxide ion, OH^-

23 Which reaction occurs by nucleophilic substitution?

- ☐ **A** $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$
- ☐ **B** $C_2H_4 + Br_2 \rightarrow CH_2BrCH_2Br$
- ☐ **C** $C_2H_5Cl + KCN \rightarrow C_2H_5CN + KCl$
- ☐ **D** $C_2H_5OH + [O] \rightarrow CH_3CHO + H_2O$

24 What does this type of arrow represent in the attack by OH^- ions on a halogenoalkane?

- ☐ **A** the movement of an electron to an atom to form an ion
- ☐ **B** the movement of a pair of electrons to an atom to form an ion
- ☐ **C** the movement of an electron towards an atom forming a covalent bond
- ☐ **D** the movement of a pair of electrons towards an atom forming a covalent bond

25 12.3 g of 2-chlorobutane produced 7.54 g of butan-2-ol on treatment with aqueous sodium hydroxide. The percentage yield (to two significant figures) is

- ☐ **A** 61%
- ☐ **B** 77%
- ☐ **C** 80%
- ☐ **D** 83%

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

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26 One of the isomers of $C_5H_{10}O$ has a peak in its infrared spectrum at 1720 cm^{-1}, a peak at $m/e = 29$ in its mass spectrum and does not react with sodium. It is

- ☐ **A** $(CH_3)_2CHCH_2CHO$
- ☐ **B** $(CH_3)_2CHCOCH_3$
- ☐ **C** $CH_3CH_2CH{=}CHCH_2OH$
- ☐ **D** $CH_3CH{=}CHCH(OH)CH_3$

27 Which statement is **not** true about biodiesel?

- ☐ **A** It has to be mixed with petrodiesel.
- ☐ **B** It is made by a transesterification reaction.
- ☐ **C** Its manufacture also requires methanol.
- ☐ **D** It can be manufactured from certain algae.

28 Which does **not** destroy ozone in the stratosphere?

- ☐ **A** ultraviolet light
- ☐ **B** nitric oxide
- ☐ **C** CFCs
- ☐ **D** HCFCs

Section A total: 29 marks

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Section B

Answer *all* questions in this section.

29 (a) Explain why the first ionisation energy of the group 2 elements decreases as the atomic number increases. **(3)**

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(b) Write equations for the following reactions:

(i) calcium and water **(1)**

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(ii) calcium oxide and water **(1)**

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(iii) the effect of heating calcium nitrate **(1)**

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Total: 6 marks

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30 **(a)** Define the term 'nucleophile'. **(1)**

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(b) The cyanide ion, $(:C{\equiv}N:)^-$, reacts with halogenoalkanes in a nucleophilic substitution reaction:

$$(C{\equiv}N)^- + CH_3I \rightarrow CH_3C{\equiv}N + I^-$$

Suggest a mechanism for this reaction. Your answer should include curly arrows and any intermediate or transition state. **(3)**

(c) Explain, interms of bonding and kinetics, why the rate of a nucleophilic reaction is faster with 2-iodopropane than with 2-bromopropane. **(2)**

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(d) Explain, in terms of collision theory, why an increase in temperature causes an increase in the rate of a reaction. Your answer should be in terms of the frequency and energy of the collisions and their relative effect on the rate. **(4)**

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Total: 10 marks

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31 **(a)** Write the formula of the organic product of the reactions of 2-iodopropane with

(i) concentrated excess ammonia **(1)**

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(ii) a solution of potassium hydroxide in ethanol **(1)**

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(b) 2-iodopropane can be prepared from propan-2-ol. Name the reagents needed and state the conditions. **(2)**

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(c) Write the formula of a branched-chain primary alcohol containing five carbon atoms. **(1)**

Total: 5 marks

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32 (a) **(i)** Write the ionic half-equation for the oxidation of iodide ions to iodine. **(1)**

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(ii) Write the ionic half-equation for the reduction of iodate(V) ions, IO_3^-, in the presence of H^+ ions, to form iodine and water. **(1)**

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(iii) Use your answers from (i) and (ii) to write the overall equation for the reaction between iodide ions and iodate(V) ions in acid solution. **(1)**

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(b) Phosphorus and iodine react to form phosphorus triiodide, PI_3. Draw the shape of the PI_3 molecule and explain why it is this shape. **(3)**

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(c) Is the PI_3 molecule polar? Explain your answer.
(Electronegativities: phosphorus 2.1; iodine 2.5) **(2)**

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(d) Phosphorus triiodide is a solid at room temperature whereas phosphorus trichloride is a liquid. Explain why the melting temperature of phosphorus trichloride is lower than that of phosphorus triiodide. **(2)**

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Total: 10 marks

Section B total: 31 marks

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Section C

Fuels for motor vehicles can be liquids or compressed gases. Liquid fuels must be volatile, so that they vaporise easily when injected into the engine's cylinder. However, the vapour from the fuel must not have too low a flash point, which is the lowest temperature at which it can form an ignitable mixture in air. The carbon footprint of the fuel should be as low as possible and it should be able to be made from fossil fuels or from biomass.

Gaseous fuels pose problems of storage in the vehicle. The energy density in kJ dm^{-3} of gases is low, unless they are compressed to very high pressures. This requires strong, heavy containers and causes a higher fuel consumption. Gases such as propane and butane can be liquefied under moderate pressure, and so their energy density is then similar to that of liquid fuels. Gases such as methane and hydrogen cannot be liquefied by pressure alone — they must be cooled to very low temperatures.

33 (a) Butan-2-ol, $CH_3CH_2CH(OH)CH_3$ could be used as a fuel. The standard enthalpy of combustion of butan-2-ol is –2650 kJ mol^{-1}, its boiling temperature is 102°C and its density is 0.80 g cm^{-3}.

(i) Write the equation for the complete combustion of butan-2-ol in air. **(1)**

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(ii) Calculate its energy density in kJ cm^{-3} **(3)**

(iii) Petrol has a carbon footprint of 64 g of carbon dioxide per 1000 kJ of energy released. How does butan-2-ol compare with this? **(1)**

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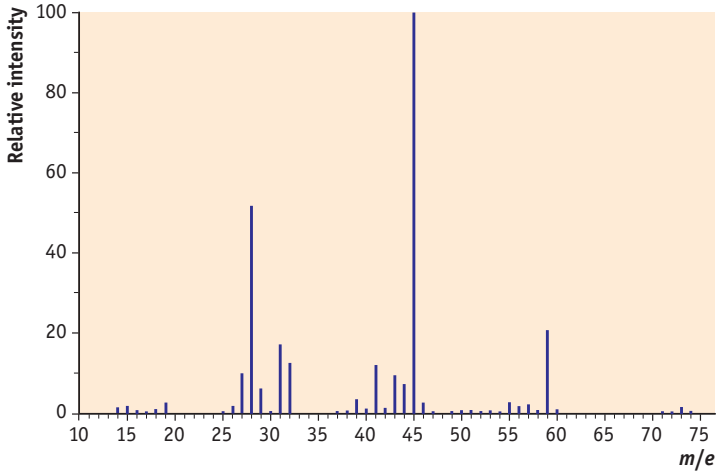
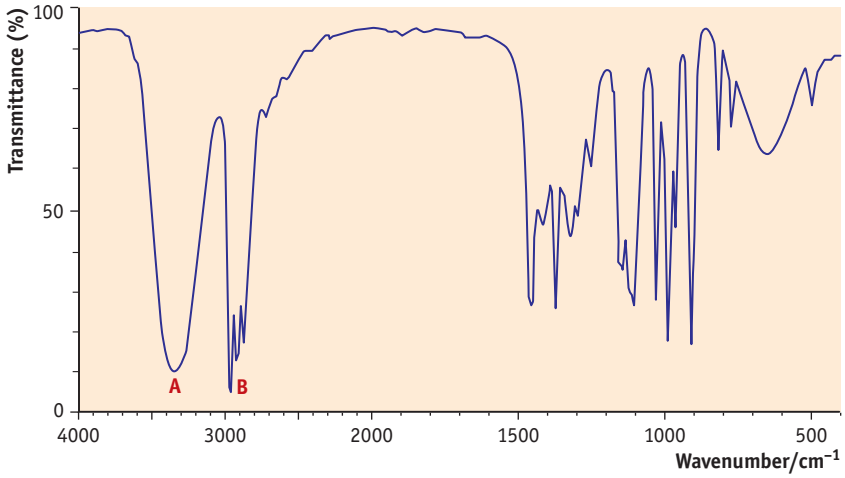
(iv) The mass and infrared spectra of butan-2-ol are shown below.





Bond	Compound containing the bond	Wavenumber of absorption/cm^{-1}
O–H	Alcohols (hydrogen bonded)	3200–3600
O–H	Alcohols (not hydrogen bonded)	3600–3700
O–H	Carboxylic acids	2500–3300
C=O	Aldehydes and ketones	1700–1740
C=O	Carboxylic acids	1700–1725
C–H	Alkanes	2850–3000
C–H	Alkenes	3000–3100
C–C	Alkanes	1360–1490

Use the spectra and the data in the table to identify the peaks at *m/e* values of 59 and 45 in the mass spectrum and the peaks marked A and B in the infrared spectrum. **(4)**

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(v) Describe a chemical test that could be used to distinguish between butan-2-ol and 2-methylpropan-2-ol. You must include the results of the test in your answer. **(2)**

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(vi) Write the structural formula of the organic product of the reaction between butan-2-ol and acidified potassium dichromate(VI) solution. **(1)**

(b) A major car manufacturer uses liquid hydrogen at below –240°C as a source of fuel for a prototype car.

(i) Suggest why it would be dangerous for the car to be stored in a garage overnight. **(1)**

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(ii) Explain why hydrogen is not a carbon-neutral fuel. **(2)**

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(iii) Hydrogen and oxygen react over a heterogeneous catalyst to form water and produce electricity. Explain the difference between a heterogeneous and a homogeneous catalyst. **(1)**

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(c) Draw labelled reaction profiles for:

(i) an uncatalysed exothermic reaction **(2)**

(ii) the same reaction in the presence of a catalyst **(2)**

Section C total: 20 marks

Paper total: 80 marks

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