Edexcel

A2

Chemistry

Practice Unit Test 5

PHILIP ALLAN
UPDATES

Practice Unit Test 5

Time allowed: 1 hour 40 minutes

Material required for examination: *Data Booklet*

Answer *all* questions.

In questions indicated by an asterisk, quality of written communication will be taken into account.

The total for the paper is 90 marks.

Use the periodic table printed at the back of the textbook (page 326).

Section A

You should aim to spend no more than 30 minutes on this section.

For each question, select one answer from A to D and put a cross in the box. If you change your mind, put a horizontal line through the cross and then mark your new answer with a cross.

1 What is the oxidation number of vanadium in VO^{2+}?

- ☐ **A** +2
- ☐ **B** +3
- ☐ **C** +4
- ☐ **D** +5

2 Which of the following is **not** a redox reaction?

- ☐ **A** $2CrO_4^{2-} + 2H^+ \rightarrow Cr_2O_7^{2-} + H_2O$
- ☐ **B** $PbO_2 + 6Cl^- + 4H^+ \rightarrow PbCl_4^{2-} + Cl_2 + 2H_2O$
- ☐ **C** $H_2O_2 + 2H^+ + 2I^- \rightarrow 2H_2O + I_2$
- ☐ **D** $Mg + Cl_2 \rightarrow MgCl_2$

3 A redox reaction will **not** take place if:

- ☐ **A** the standard cell potential is positive
- ☐ **B** the standard cell potential is negative
- ☐ **C** the value of the standard cell potential is less than 0.3 V
- ☐ **D** the value of the standard cell potential is less than 0.03 V

4 Consider the standard reduction potentials of sulfur and of iron(III) ions:

$$S(s) + 2H^+(aq) + 2e^- \rightleftharpoons H_2S(g) \quad E^\ominus = +0.14\,V$$

$$Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq) \quad E^\ominus = +0.77\,V$$

The standard cell potential for the oxidation of hydrogen sulfide, H_2S, by iron(III) ions is:

- ☐ **A** –0.63 V
- ☐ **B** +0.63 V
- ☐ **C** +0.91 V
- ☐ **D** +1.4 V

© Philip Allan Updates

5 The concentration of iodate(V) ions, IO_3^-, in a solution can be determined by adding excess potassium iodide and titrating the liberated iodine against standard sodium thiosulfate solution. The reactions are:

$$IO_3^- + 6H^+ + 5I^- \rightarrow 3I_2 + 3H_2O$$

$$I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$$

The ratio of iodate(V) ions to thiosulfate ions in the overall reaction is:

- ☐ **A** 1:6
- ☐ **B** 6:1
- ☐ **C** 1:3
- ☐ **D** 3:1

6 Which of the following statements about the reaction below is **false**?

$$[Cr(NH_3)_6]^{3+}(aq) + EDTA^{4-}(aq) \rightarrow [Cr(EDTA)]^-(aq) + 6NH_3(aq)$$

- ☐ **A** The EDTA complex has a higher stability constant than the ammine complex.
- ☐ **B** There is a decrease in the entropy of the system.
- ☐ **C** Both complex ions are octahedral.
- ☐ **D** The complex ions have different colours.

7 There will be a large jump in the successive ionisation energies of manganese, electron configuration [Ar] $3d^5\,4s^2$, between:

- ☐ **A** the first and second ionisations
- ☐ **B** the second and third ionisations
- ☐ **C** the sixth and seventh ionisations
- ☐ **D** the seventh and eighth ionisations

8 Which of the following species is coloured?

- ☐ **A** $CuSO_4(s)$
- ☐ **B** $[CuCl_2]^-$
- ☐ **C** $[CuCl_4]^{2-}$
- ☐ **D** $[Ti(H_2O)_6]^{4+}$

9 Which of the following complex ions is planar?

- ☐ **A** $[CrCl_4]^-$
- ☐ **B** $[Pt(NH_3)_2Cl_2]$
- ☐ **C** $[Cr(en)_3]^{3+}$
- ☐ **D** $[Cu(H_2O)_6]^{2+}$

10 The electrode potential for the reaction:

$$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightleftharpoons 2Cr^{3+}(aq) + 7H_2O(l) \qquad E^\ominus = +1.33\,V$$

- ☐ **A** will be increased by adding H^+ ions
- ☐ **B** will be increased by adding OH^- ions
- ☐ **C** will not be altered by adding H^+ ions
- ☐ **D** will be decreased by adding H^+ ions

© Philip Allan Updates

11 The carbon–carbon bond length in benzene is:

- ☐ **A** greater than the C–C bond length in ethane
- ☐ **B** equal to the C=C bond length in ethene
- ☐ **C** greater than the C=C bond length in ethene
- ☐ **D** less than the C=C bond length in ethene

12 Phenol reacts with bromine water to form:

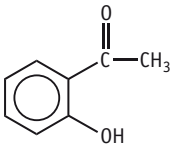
- ☐ **A** 2,4,6-tribromophenol
- ☐ **B** 2-bromophenol
- ☐ **C** 4-bromophenol
- ☐ **D** a mixture of 2-bromophenol and 4-bromophenol

13 Which statement is **not** true about the reaction of benzene with ethanoyl chloride?

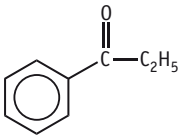
- ☐ **A** Phenylethanone is the only product.
- ☐ **B** The reaction mechanism is electrophilic substitution.
- ☐ **C** Anhydrous aluminium chloride is used as the catalyst.
- ☐ **D** An intermediate is formed that has a positive charge.

14 Compound **Z** burns with a smoky flame, gives a red precipitate with Brady's reagent, a silver mirror with Tollens' reagent, is insoluble in water but dissolves in aqueous sodium hydroxide. It could be:

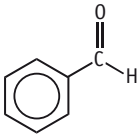
☐ **A**



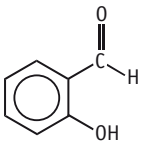
☐ **B**



☐ **C**



☐ **D**



15 Phenol does **not** react with:

- ☐ **A** ethanoic acid
- ☐ **B** chlorine water
- ☐ **C** sodium
- ☐ **D** aqueous sodium hydroxide

16 Phenylamine does **not** react with

- ☐ **A** H^+ ions
- ☐ **B** OH^- ions
- ☐ **C** ethanoyl chloride
- ☐ **D** chloroethane

© Philip Allan Updates

17 Which statement about benzene is true?

- ☐ **A** It has alternate single and double bonds.
- ☐ **B** When it reacts with hydrogen, the energy absorbed is less than three times the amount absorbed when cyclohexene reacts with hydrogen.
- ☐ **C** It reacts only by electrophilic substitution.
- ☐ **D** The p_z orbital in each carbon atom overlaps with the p_z orbitals of both adjacent carbon atoms.

18 Poly(ethenol) is:

- ☐ **A** made by polymerising ethenol
- ☐ **B** used because it is biodegradable
- ☐ **C** water-soluble because it has one –OH group in each repeat unit
- ☐ **D** rigid because it forms hydrogen bonds between adjacent strands of the polymer

19 Steam distillation is used to extract which of the following from a complex reaction mixture:

- ☐ **A** a volatile water-soluble substance
- ☐ **B** a volatile water-insoluble substance
- ☐ **C** a substance that boils below 100°C
- ☐ **D** a substance that melts below 100°C

20 Consider the following reaction scheme.

$$CH_3CH{=}CH_2 \xrightarrow{\text{step 1}} CH_3CHBrCH_3 \xrightarrow{\text{step 2}} CH_3CH(OH)CH_3 \xrightarrow{\text{step 3}} CH_3COCH_3 \xrightarrow{\text{step 4}} CH_3C(OH)(CN)CH_3$$

The correct set of reagents is:

	Step 1	Step 2	Step 3	Step 4
☐ **A**	HBr(g)	KOH(aq)	Cr^{3+}/OH^-	HCN + acid
☐ **B**	HBr(g)	NaOH(aq)	$H^+/Cr_2O_7^{2-}$	HCN + base
☐ **C**	HBr(aq)	KOH(aq)	Cr^{3+}/OH^-	KCN + acid
☐ **D**	HBr(aq)	NaOH in ethanol	$H^+/Cr_2O_7^{2-}$	KCN + base

Total: 20 marks

© Philip Allan Updates

Section B

Answer all the questions.

21 a Use the standard reduction potentials below to explain how Fe^{2+} ions can catalyse the oxidation of iodide ions, I^-, by persulphate ions, $S_2O_8^{2-}$

$S_2O_8^{2-}(aq) + 2e^- \rightarrow 2SO_4^{2-}(aq)$ $\quad E^{\ominus} = +2.01\,V$

$I_2(s) + 2e^- \rightarrow 2I^-(aq)$ $\quad E^{\ominus} = +0.54\,V$

$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$ $\quad E^{\ominus} = +0.77\,V$ **(4)**

.....

.....

.....

.....

.....

.....

b Iron forms compounds that contain Fe^{3+} ions and compounds that contain Fe^{2+} ions. Zinc forms Zn^{2+} only.

Complete the electron configurations below and explain why iron is classified as a transition metal whereas zinc is not. **(3)**

Fe^{2+}: [Ar].....

Zn^{2+}: [Ar].....

.....

.....

c (i) Write an equation to show why an aqueous solution of hydrated iron(III) ions is acidic. **(1)**

.....

(ii) Write an equation to show the ligand exchange reaction of hydrated iron(III) ions with cyanide ions. **(1)**

.....

(iii) Explain why hydrated iron(III) ions are coloured. **(4)**

.....

.....

.....

.....

.....

.....

© Philip Allan Updates

(iv) Give an example of a reaction in which iron metal is a catalyst. **(1)**

.....

***(v)** Hydrated iron(III) ions react with 1,2-diaminoethane, $NH_2CH_2CH_2NH_2$, to form the complex ion $[Fe(NH_2CH_2CH_2NH_2)_3]^{3+}$. 1,2-diaminoethane acts as a bidentate ligand. Explain the meaning of the term **bidentate ligand** and explain how 1,2-diaminoethane acts as a bidentate ligand. **(2)**

.....

.....

.....

.....

.....

d The concentration of iron(III) ions can be found by adding excess iodide ions and titrating the iodine produced against a standard solution of sodium thiosulfate. The equations are:

$$2Fe^{3+} + 2I^- \rightarrow 2Fe^{2+} + I_2$$

$$I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$$

A solution containing 1.00 g of impure iron(III) chloride, $FeCl_3$, was mixed with excess potassium iodide and the liberated iodine was titrated against a 0.200 mol dm^{-3} solution of sodium thiosulfate. The end point was reached after the addition of 27.3 cm^3 of sodium thiosulfate.

Calculate the percentage purity of the iron(III) chloride. **(5)**

Total: 21 marks

© Philip Allan Updates

22 a Ethylamine is a volatile compound. Aqueous solutions of ethylamine have a pH of approximately 11.

***(i)** Explain why ethylamine is soluble in water. **(3)**

.....

.....

(ii) Describe what you would see when a solution of ethylamine in excess is added to a solution of copper(II) sulfate. **(2)**

.....

.....

b Outline how you would prepare phenylamine, $C_6H_5NH_2$, from nitrobenzene. State the reagents for each step. **(3)**

.....

.....

.....

c (i) State the reagents needed to convert phenylamine into benzenediazonium ions. **(1)**

.....

***(ii)** This reaction must be carried out at a temperature between 0°C and 5°C. Explain why the temperature must be neither higher nor lower than these limits. **(2)**

.....

.....

.....

(iii) Write the formula of the substance obtained when the benzenediazonium ions are reacted with phenol. **(2)**

Total: 13 marks

© Philip Allan Updates

23 a Ethene reacts rapidly with bromine, but benzene requires a catalyst of anhydrous iron(III) bromide. Write the mechanisms for the reaction of bromine with:

(i) ethene **(3)**

(ii) benzene **(4)**

© Philip Allan Updates

***b** Use your answers to (**a**) to explain why benzene reacts by substitution whereas ethene reacts by addition. **(3)**

.....

.....

.....

.....

.....

.....

.....

c Write equations for the reactions of:

(i) benzene with a mixture of concentrated nitric and sulfuric acids **(1)**

(ii) benzene with ethanoyl chloride in the presence of a catalyst of anhydrous aluminium chloride **(1)**

(iii) benzene with fuming sulfuric acid **(1)**

d (i) Write the equation for the reaction of phenol with bromine water. **(1)**

© Philip Allan Updates

*(ii) Compare the reactivity of the benzene ring in phenol with that in benzene itself. (2)

.....

.....

.....

.....

.....

Total: 16 marks

Section B total: 50 marks

© Philip Allan Updates

Section C

24 Read the following passage carefully and then answer all the questions that follow.

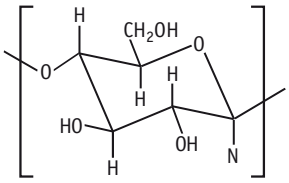
Natural and man-made polymers

There are many natural polymers. Some, for example polyamides and polyethers, are condensation polymers — monomers combine with the loss of a simple molecule such as water between each pair of monomers. Others, such as rubber, are addition polymers — a double bond in each monomer breaks allowing many units to join together in a long chain.

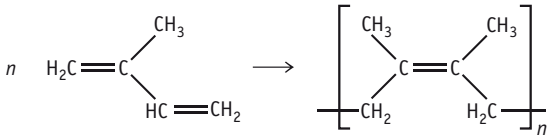
Hair, feathers and silk are all natural polyamides. Hair consists of α-keratin, which contains a high proportion of the amino acids glycine, NH_2CH_2COOH, and alanine, $NH_2CH(CH_3)COOH$. The strands are coiled in a helix and are cross-linked with sulfur bridges between cysteine residues. β-keratin consists of a chain of similar amino acids, but the polymer is folded in sheets. This allows greater hydrogen bonding and so the polymer is much harder. Turtle shells are made from β-keratin.

Silk is a polyamide containing about 10 to 15% serine, $NH_2CH(CH_2OH)COOH$. The fibre consists of alternating crystalline regions, which give it tensile strength, and amorphous regions, which give it flexibility.

Cotton and cellulose are examples of polyethers. Glucose molecules condense and form long chains, each repeat unit being joined to the next with a C–O–C bond. The repeat unit has the formula $C_6H_{10}O_5$.



Rubber is an addition polymer of isoprene. The configuration across the remaining double bond in the repeat units is *cis*. This gives rubber the property of increasing strength as the rubber is stretched because the chains line up, forming crystalline regions.



Isoprene Poly(*cis*-isoprene)

The first polymer made from synthetic materials was Bakelite®. This is a phenol/methanal thermosetting plastic invented in 1907 by the Belgian chemist Leo Baekeland. Later that century, addition polymers such as poly(ethene) and poly(vinylchloride) were made. These were followed by a number of polyesters and polyamides. Nomex® is a fire-resistant material used by fire-fighters, Formula 1 racing drivers and military aircrew. It does not burn, melt or drip and has excellent heat insulation properties. It is a polyamide made from benzene-1,3-dicarboxylic acid and 1,3-diaminobenzene in a condensation reaction.

Biopol® is a biodegradable polyester. The bacterium *Alcaligenes eutrophus* makes 3-hydroxybutanoic acid, $CH_3CH(OH)CH_2COOH$, as a food store. This chemical can be extracted and polymerized to give Biopol®.

a Nomex®, Biopol® and natural polymers such as keratin and silk are examples of condensation polymers. Explain the term 'condensation polymer'. **(1)**

.....

.....

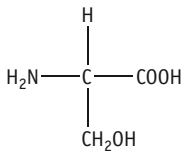
© Philip Allan Updates

b Nomex® is a polyamide that contains many peptide bonds.

(i) Draw the structural formulae of the monomers from which Nomex® is made. **(2)**

(ii) Draw the repeat unit of Nomex®. **(1)**

c Silk is a natural polyamide fibre based on the amino acid serine, 2-amino-3-hydroxy-propanoic acid:



Serine is a chiral molecule and melts at 228°C.

(i) Define the term **chiral molecule** and mark the chiral centre on the structural formula above. **(2)**

.....

.....

© Philip Allan Updates

*(ii) Serine exists as a zwitterion. Draw the structural formula of the zwitterion. Explain, in terms of all the forces between particles, why serine has a higher melting temperature than pentanoic acid, C_4H_9COOH, which has the same number of electrons as serine. **(5)**

.....

.....

.....

.....

.....

.....

(iii) Write the structural formulae of the products obtained when serine reacts with

- aqueous hydrogen ions **(1)**

- aqueous hydroxide ions **(1)**

© Philip Allan Updates

- phosphorus pentachloride **(2)**

d Biopol is made from 3-hydroxybutanoic acid. Outline how 3-hydroxybutanoic acid can be prepared in the laboratory from 4-hydroxybut-1-ene, $CH_2{=}CHCH_2CH_2OH$. Identify all the intermediates and state the reactants needed for each step. You do not need to give the conditions. **(5)**

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Section C total: 20 marks

Paper total: 90 marks

© Philip Allan Updates