Write your name here

| Surname | Other names |
|---|---|
| | |

**Pearson Edexcel**
**International**
**Advanced Level**

Centre Number | | | | | |

Candidate Number | | | | |

# Chemistry

## Advanced

## Unit 6: Chemistry Laboratory Skills II

Tuesday 27 January 2015 – Afternoon
**Time: 1 hour 15 minutes**

Paper Reference
**WCH06/01**

**Candidates may use a calculator.**

Total Marks

### Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

### Information

- The total mark for this paper is 50.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, including your use of grammar, punctuation and spelling.
- A Periodic Table is printed on the back cover of this paper.

### Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

*Turn over* ▶

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P 4 5 0 4 6 A 0 1 1 6

PEARSON

**Answer ALL the questions. Write your answers in the spaces provided.**

**1** A white solid, **A**, has one metal cation, and an anion containing two non-metallic elements.

(a) A flame test is carried out on **A**.

(i) Describe how you would carry out this flame test in the laboratory.

**(3)**

(ii) A yellow flame is seen. Give the **formula** of the metal ion present.

**(1)**

(b) Solid **A** dissolves in water to form a colourless solution.

This solution decolorises a dilute aqueous solution of iodine.

Dilute hydrochloric acid is added to a fresh solution of **A**.
A very pale yellow precipitate, **B**, forms slowly and an acidic gas, **C**, is given off.

Gas **C** turns acidified sodium dichromate(VI) from orange to green.

(i) Identify, by name or formula, the precipitate **B** and the gas **C**.

**(2)**

Precipitate, **B** .....

Gas, **C** .....

(ii) What is the colour of a **dilute** aqueous solution of iodine?

**(1)**

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(iii) Give the **name** of the anion in compound **A**.

**(1)**

.....

(iv) Give the **formula** of compound **A**.

**(1)**

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**(Total for Question 1 = 9 marks)**

**2** A white solid, **D**, is formed when ethanoyl chloride is added to a concentrated solution of ammonia. The molecular formula of **D** is $C_2H_5ON$.

When solid **D** is heated with excess aqueous sodium hydroxide solution, ammonia gas is given off and a solution, **E**, is formed.

(a) Ammonia has a distinctive smell. Give **two** other tests, each of a different type, which could be used to show the presence of ammonia. Give the result of each test.

**(3)**

Test 1 .....

.....

Test 2 .....

.....

(b) Excess dilute sulfuric acid is added to solution **E** and an organic liquid, **F**, is distilled from the mixture.

(i) Draw a labelled diagram of the apparatus used for this distillation.

**(2)**

(ii) Addition of pure liquid **F** to aqueous sodium carbonate gives effervescence.

Identify liquid **F** by name or formula.

**(1)**

.....

(c) (i) Give the name and displayed formula of solid **D**.

**(2)**

Name .....

Displayed formula

(ii) Write an equation for the formation of solid **D** from ethanoyl chloride and concentrated ammonia solution. State symbols are not required.

**(1)**

**(Total for Question 2 = 9 marks)**

**3** This is an experiment to determine the oxidation number of vanadium in a purple solution, **T**, of a vanadium compound.

**Preparation of solution T**

Solution **T** was formed when 25.00 $cm^3$ of a 0.100 mol $dm^{-3}$ solution of sodium vanadate(V), $NaVO_3$, was reduced by heating with excess zinc and dilute sulfuric acid.

When the reduction was complete, the yellow $NaVO_3$ solution had turned purple.

**Titration of solution T**

The mixture was filtered through glass wool, directly into 50.00 $cm^3$ of 0.0200 mol $dm^{-3}$ potassium manganate(VII), $KMnO_4$, solution.

Further potassium manganate(VII) solution of the same concentration was added from a burette to this reaction mixture, which was kept at a temperature of about 80 °C. The end point is reached when all the vanadium ions had been oxidized back into vanadate(V) ions by the manganate(VII) ions.

The end point occurred when a further 25.00 $cm^3$ had been added.

(a) (i) Draw a diagram of the apparatus for carrying out the titration, while **keeping** the titration mixture at about 80 °C.

**(2)**

(ii) What is removed from the reaction mixture by filtering through glass wool?

**(1)**

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(iii) Suggest why the mixture is filtered directly into potassium manganate(VII) solution before carrying out the rest of the titration.

**(1)**

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(iv) Explain why an indicator is **not** required for this titration.

**(1)**

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(b) (i) Calculate the number of moles of vanadate(V) ions, $VO_3^-$, in 25.00 $cm^3$ of a 0.100 mol $dm^{-3}$ solution of sodium vanadate(V), $NaVO_3$.

**(1)**

(ii) Calculate the **total** volume of potassium manganate(VII) solution.
Hence the **total** number of moles of potassium manganate(VII) used to oxidize the purple vanadium solution, **T**.

**(2)**

(iii) Complete the half equation for the reduction of manganate(VII) ions to manganese(II) ions.

**(1)**

$MnO_4^-$ + .....$H^+$ + .....$e^-$ ⟶ $Mn^{2+}$ + .....$H_2O$

(iv) By considering either the number of electrons transferred or by using the changes in oxidation numbers, calculate the oxidation number of vanadium in the purple solution, **T**.

You **must** show your working.

**(3)**

(c) In acidic solution, the vanadate ions, $VO_3^-$ are changed into $VO_2^+$.
Write an ionic equation for this reaction. State symbols are not required.

**(1)**

(d) Some standard electrode potentials of tin and vanadium are given below.

| | |
|---|---|
| $Sn^{2+}(aq)\|Sn(s)$ | –0.14 V |
| $V^{2+}(aq)\|V(s)$ | –1.18 V |
| $V^{3+}(aq),V^{2+}(aq)\|Pt$ | –0.26 V |
| $[VO^{2+}(aq) + 2H^{+}(aq)], [V^{3+}(aq) + H_2O(l)]\|Pt$ | +0.34 V |
| $[VO_2^{+}(aq) + 2H^{+}(aq)], [VO^{2+}(aq) + H_2O(l)]\|Pt$ | +1.00 V |

Use these values to predict the lowest oxidation number of vanadium that can be produced from $VO_2^{+}$ using tin as the reducing agent. Explain your reasoning.

**(2)**

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**(Total for Question 3 = 15 marks)**

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**4** Cholesteryl benzoate was the first liquid crystal to be discovered. It can be prepared by the following procedure.

**Step 1** Dissolve 1.0 g of cholesterol in 3 $cm^3$ of pyridine in a conical flask.

**Step 2** Add 0.40 $cm^3$ of benzoyl chloride.

**Step 3** Heat the mixture on a steam bath for about 10 minutes.

**Step 4** Cool the mixture, and add 15 $cm^3$ of methanol.

**Step 5** Collect the solid cholesteryl benzoate by suction filtration. Rinse the flask and the crude crystals with a little cold methanol.

**Step 6** Recrystallize the cholesteryl benzoate using ethyl ethanoate as the solvent.

Some physical data for the chemicals involved are shown below.

| | Molar mass / g $mol^{-1}$ | Density / g $cm^{-3}$ | Melting temperature / K | Boiling temperature / K |
|---|---|---|---|---|
| Cholesterol | 386.7 | | | 633 |
| Benzoyl chloride | 140.6 | 1.21 | | 470 |
| Cholesteryl benzoate | 490.8 | | 423 | |
| Pyridine | 79.1 | | | 388 |
| Ethyl ethanoate | 88.1 | | 190 | 350 |

(a) Suggest the apparatus you would use to measure the volume of benzoyl chloride.

**(1)**

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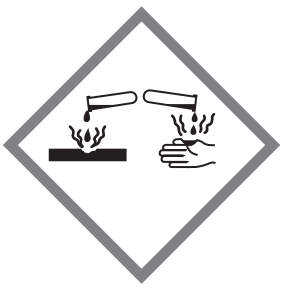
(b) The warning symbols on a bottle of benzoyl chloride are shown below. Write the meaning of each symbol in the space provided.

**(2)**



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(c) 1 mol of cholesterol reacts with 1 mol of benzoyl chloride to form 1 mol of cholesteryl benzoate.

(i) Determine which reactant is in excess by calculating how many moles of cholesterol and of benzoyl chloride are used in the preparation.

**(3)**

(ii) Calculate the percentage yield when 0.65 g of cholesteryl benzoate is obtained.

**(2)**

(d) Suggest how the mixture is cooled in **Step 4**.

**(1)**

.....

.....

(e) Suggest why methanol is added to the cooled mixture in **Step 4**.

**(1)**

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(f) Describe how to carry out the recrystallization to obtain pure dry crystals of cholesteryl benzoate in **Step 6**.

**(5)**

(g) How would you show that the recrystallized cholesteryl benzoate crystals in **Step 6** are purer than the crude crystals obtained in **Step 5**?

**(2)**

**(Total for Question 4 = 17 marks)**

**TOTAL FOR PAPER = 50 MARKS**

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# The Periodic Table of Elements

| 1 | 2 | | | | | | | | | | | 3 | 4 | 5 | 6 | 7 | 0 (8) (18) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 1.0 H hydrogen 1 | | | | | | | | | | 4.0 He helium 2 |
| (1) | (2) | | Key: relative atomic mass / atomic symbol / name / atomic (proton) number | | | | | | | | | (13) | (14) | (15) | (16) | (17) | |
| 6.9 Li lithium 3 | 9.0 Be beryllium 4 | | | | | | | | | | | 10.8 B boron 5 | 12.0 C carbon 6 | 14.0 N nitrogen 7 | 16.0 O oxygen 8 | 19.0 F fluorine 9 | 20.2 Ne neon 10 |
| 23.0 Na sodium 11 | 24.3 Mg magnesium 12 | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | 27.0 Al aluminium 13 | 28.1 Si silicon 14 | 31.0 P phosphorus 15 | 32.1 S sulfur 16 | 35.5 Cl chlorine 17 | 39.9 Ar argon 18 |
| 39.1 K potassium 19 | 40.1 Ca calcium 20 | 45.0 Sc scandium 21 | 47.9 Ti titanium 22 | 50.9 V vanadium 23 | 52.0 Cr chromium 24 | 54.9 Mn manganese 25 | 55.8 Fe iron 26 | 58.9 Co cobalt 27 | 58.7 Ni nickel 28 | 63.5 Cu copper 29 | 65.4 Zn zinc 30 | 69.7 Ga gallium 31 | 72.6 Ge germanium 32 | 74.9 As arsenic 33 | 79.0 Se selenium 34 | 79.9 Br bromine 35 | 83.8 Kr krypton 36 |
| 85.5 Rb rubidium 37 | 87.6 Sr strontium 38 | 88.9 Y yttrium 39 | 91.2 Zr zirconium 40 | 92.9 Nb niobium 41 | 95.9 Mo molybdenum 42 | [98] Tc technetium 43 | 101.1 Ru ruthenium 44 | 102.9 Rh rhodium 45 | 106.4 Pd palladium 46 | 107.9 Ag silver 47 | 112.4 Cd cadmium 48 | 114.8 In indium 49 | 118.7 Sn tin 50 | 121.8 Sb antimony 51 | 127.6 Te tellurium 52 | 126.9 I iodine 53 | 131.3 Xe xenon 54 |
| 132.9 Cs caesium 55 | 137.3 Ba barium 56 | 138.9 La* lanthanum 57 | 178.5 Hf hafnium 72 | 180.9 Ta tantalum 73 | 183.8 W tungsten 74 | 186.2 Re rhenium 75 | 190.2 Os osmium 76 | 192.2 Ir iridium 77 | 195.1 Pt platinum 78 | 197.0 Au gold 79 | 200.6 Hg mercury 80 | 204.4 Tl thallium 81 | 207.2 Pb lead 82 | 209.0 Bi bismuth 83 | [209] Po polonium 84 | [210] At astatine 85 | [222] Rn radon 86 |
| [223] Fr francium 87 | [226] Ra radium 88 | [227] Ac* actinium 89 | [261] Rf rutherfordium 104 | [262] Db dubnium 105 | [266] Sg seaborgium 106 | [264] Bh bohrium 107 | [277] Hs hassium 108 | [268] Mt meitnerium 109 | [271] Ds darmstadtium 110 | [272] Rg roentgenium 111 | | | | | | | |

Elements with atomic numbers 112-116 have been reported but not fully authenticated

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 140 Ce cerium 58 | 141 Pr praseodymium 59 | 144 Nd neodymium 60 | [147] Pm promethium 61 | 150 Sm samarium 62 | 152 Eu europium 63 | 157 Gd gadolinium 64 | 159 Tb terbium 65 | 163 Dy dysprosium 66 | 165 Ho holmium 67 | 167 Er erbium 68 | 169 Tm thulium 69 | 173 Yb ytterbium 70 | 175 Lu lutetium 71 |
| 232 Th thorium 90 | [231] Pa protactinium 91 | 238 U uranium 92 | [237] Np neptunium 93 | [242] Pu plutonium 94 | [243] Am americium 95 | [247] Cm curium 96 | [245] Bk berkelium 97 | [251] Cf californium 98 | [254] Es einsteinium 99 | [253] Fm fermium 100 | [256] Md mendelevium 101 | [254] No nobelium 102 | [257] Lr lawrencium 103 |

* Lanthanide series

* Actinide series