Please check the examination details below before entering your candidate information

| Candidate surname | Other names |
|---|---|
| | |

**Pearson BTEC Level 3 Nationals Certificate**

Centre Number | | | | | | |

Learner Registration Number | | | | | | | | |

# Wednesday 15 January 2020

Morning (Time: 40 minutes) | Paper Reference **31617H/1C**

# Applied Science / Forensic and Criminal Investigation

**Unit 1: Principles and Applications of Science I**

**Chemistry**

**SECTION B: PERIODICITY AND PROPERTIES OF ELEMENTS**

**You must have:**
A calculator and a ruler.

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 learner registration number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

## Information

- The exam comprises three papers worth 30 marks each.
  Section A: Structure and functions of cells and tissues (Biology).
  Section B: Periodicity and properties of elements (Chemistry).
  Section C: Waves in communication (Physics).
- The total mark for this exam is 90.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- The periodic table of elements can be found at the back of this paper.

## Advice

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

*Turn over* ▶

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P 6 3 9 4 2 A 0 1 1 2

Pearson

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

**Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.**

**1** Figure 1 shows a molecule of the covalent compound tetrachloromethane.

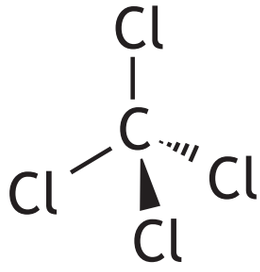


**Figure 1**

(a) Identify the reason why the molecule in Figure 1 has a tetrahedral shape.

**(1)**

☒ **A** Each chlorine atom forms four single bonds.

☒ **B** The carbon atom forms four single bonds.

☒ **C** The carbon atom forms two double bonds.

☒ **D** The molecule has four atoms.

(b) Complete the dot and cross diagram, in Figure 2, for tetrachloromethane, $CCl_4$.

Show outer electrons only.

**(2)**

Cl

Cl C Cl

Cl

**Figure 2**

(c) $CCl_4$ is a liquid at room temperature.

There are intermolecular forces between the molecules.

Name the intermolecular force between the $CCl_4$ molecules.

**(1)**

.....

(d) A sample of chlorine contains 80% chlorine-35 and 20% chlorine-37.

Calculate the relative atomic mass of this sample of chlorine.

Show your working.

**(2)**

relative atomic mass = .....

**(Total for Question 1 = 6 marks)**

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**2** Magnesium sulfate is an ionic compound.

(a) Describe the structure of an ionic compound.

**(2)**

.....

.....

.....

.....

(b) Magnesium reacts with sulfuric acid to form magnesium sulfate and hydrogen.

Complete the equation for this reaction.

**(2)**

..... + ..... → $MgSO_4$ + $H_2$

(c) (i) A learner is given 6.02 g of magnesium sulfate.

Calculate the number of moles of magnesium sulfate.

(relative formula mass of $MgSO_4$ = 120.4)

**(1)**

number of moles = .....

(ii) The learner dissolves the magnesium sulfate in distilled water to make 500 $cm^3$ of solution.

Calculate, using your answer to (c)(i), the molar concentration of this magnesium sulfate solution.

If you did not get an answer for (c)(i), use the value 0.04 for the number of moles.

Show your working.

**(3)**

molar concentration = ..... mol $dm^{-3}$

**(Total for Question 2 = 8 marks)**

**3** Fluorine, chlorine, bromine and iodine are the first four elements in group 7 (the halogens).

(a) Identify the halogen with the lowest first ionisation energy.

**(1)**

☒ **A** bromine

☒ **B** chlorine

☒ **C** fluorine

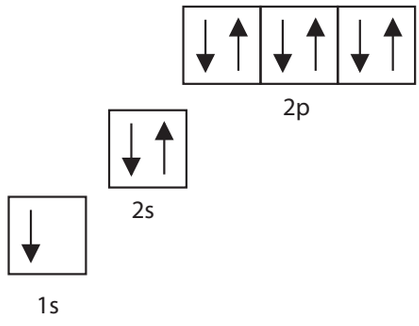
☒ **D** iodine

(b) The halogens all have similar chemical properties because of their electronic configuration.

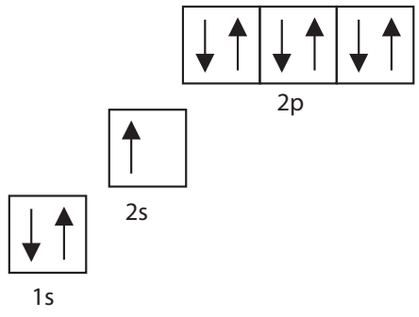
(i) Identify the correct electronic configuration for an atom of fluorine.

**(1)**

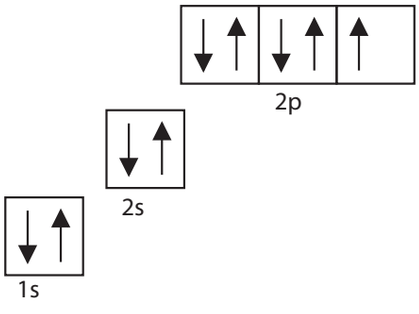
**A**



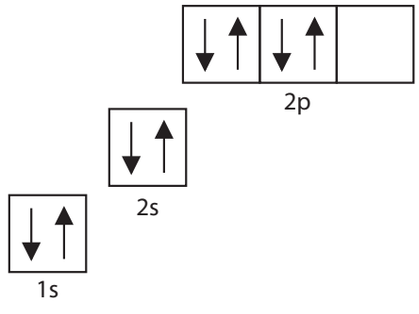

**B**




**C**




**D**




☒ **A**

☒ **B**

☒ **C**

☒ **D**

(ii) Fluorine atoms can react to become fluoride ions.

Electron affinity is one way of measuring how easily a fluorine atom becomes a fluoride ion.

Identify the correct word in each sentence to complete Paragraph 1.

Underline the words you have chosen.

**(2)**

The first electron affinity is the energy released

when one mole of fluorine atoms [gains / loses / shares] one mole of electrons.

For the electron affinity to happen,

the atoms must be in the [gas / liquid / solid] state.

**Paragraph 1**

(iii) The electronegativity of the halogens changes down group 7.

Explain how electronegativity changes down group 7.

**(3)**

(c) A displacement reaction is when a more reactive element displaces a less reactive element from a compound.

In a displacement experiment, different halogens were added to different sodium halide solutions.

Table 1 shows the results of the displacement experiment.

A tick (✓) shows when a displacement reaction occurred.

A cross (✗) shows when no displacement reaction occurred.

| | | sodium halide solution | | |
|---|---|---|---|---|
| | | **sodium bromide** | **sodium chloride** | **sodium iodide** |
| **halogen** | **bromine** | ✗ | ✗ | ✓ |
| | **chlorine** | ✓ | ✗ | ✓ |
| | **iodine** | ✗ | ✗ | ✗ |

**Table 1**

Identify and justify, using the results from Table 1, the order of reactivity of the **three** halogens.

**(3)**

**Order of reactivity**

Most reactive halogen .....

.....

Least reactive halogen .....

Justification.....

.....

.....

.....

**(Total for Question 3 = 10 marks)**

**4** Table 2 shows two substances, **X** and **Y**, and their ability to conduct electricity when in different states.

| substance | state | ability to conduct electricity |
|---|---|---|
| **X** | solid | good |
| | liquid | good |
| **Y** | solid | poor |
| | liquid | good |

**Table 2**

Explain, using the information in Table 2, which substance is ionic and which substance is metallic.

**(6)**

**(Total for Question 4 = 6 marks)**

**TOTAL FOR SECTION B = 30 MARKS**

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# The Periodic Table of Elements

| 1 | 2 | | | | | | | | | | | 3 | 4 | 5 | 6 | 7 | 0 (8) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 1.0 H hydrogen 1 | | | | | | | | | | (18) 4.0 He helium 2 |
| (1) | (2) | | | | | | | | | | | (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 | | | | | | | |

Key: relative atomic mass / **atomic symbol** / name / atomic (proton) number

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