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 16 January 2019

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 will need:**
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: Structures 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 1 8 0 5 A 0 1 1 2

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**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** Aluminium is a metal.

Aluminium is used in power lines.

One reason why aluminium can be used in power lines is because it is ductile.

(a) (i) State **one** other physical property that makes aluminium suitable for use in power lines.

**(1)**

.....

.....

(ii) Explain why metals are ductile.
You should refer to atoms in your answer.

**(2)**

.....

.....

.....

.....

(b) (i) Aluminium oxide is a product of the thermite reaction.

Identify the type of bonding in aluminium oxide.

**(1)**

☒ **A** hydrogen

☒ **B** ionic

☒ **C** metallic

☒ **D** van der Waals

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

(ii) The thermite reaction can be used to join railway tracks together.

Aluminium is used in this reaction to produce iron from iron oxide.

$$Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$$

Explain why this reaction is a redox reaction.

**(4)**

**(Total for Question 1 = 8 marks)**

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**2** Figure 1 shows an outline of part of the periodic table.

The shapes show the positions of four elements.

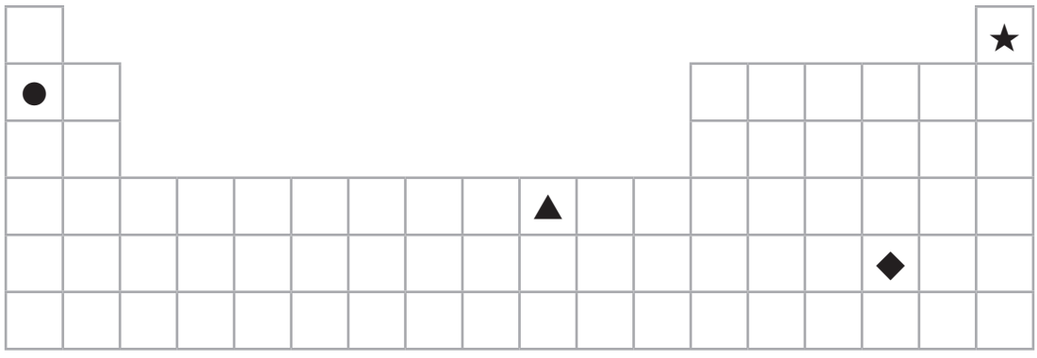

**Figure 1**

(a) (i) Identify the shape that shows the position of a transition metal in the periodic table.

**(1)**

☒ **A** ●

☒ **B** ▲

☒ **C** ◆

☒ **D** ★

(ii) Identify the shape that shows the position of a non-metal with low melting and boiling points in the periodic table.

**(1)**

☒ **A** ●

☒ **B** ▲

☒ **C** ◆

☒ **D** ★

(b) Element **X** has the electronic configuration $1s^2\,2s^2\,2p^6\,3s^2\,3p^5$.

(i) State the block of the periodic table where the element can be found.

**(1)**

.....

(ii) The element forms the ion $\mathbf{X}^-$.

Complete the electronic configuration of the $\mathbf{X}^-$ ion.

**(1)**

$1s^2\,2s^2\,2p^6\,3s^2\,3p$ .....

(c) (i) Figure 2 shows the relative melting points of some of the elements in period 2.

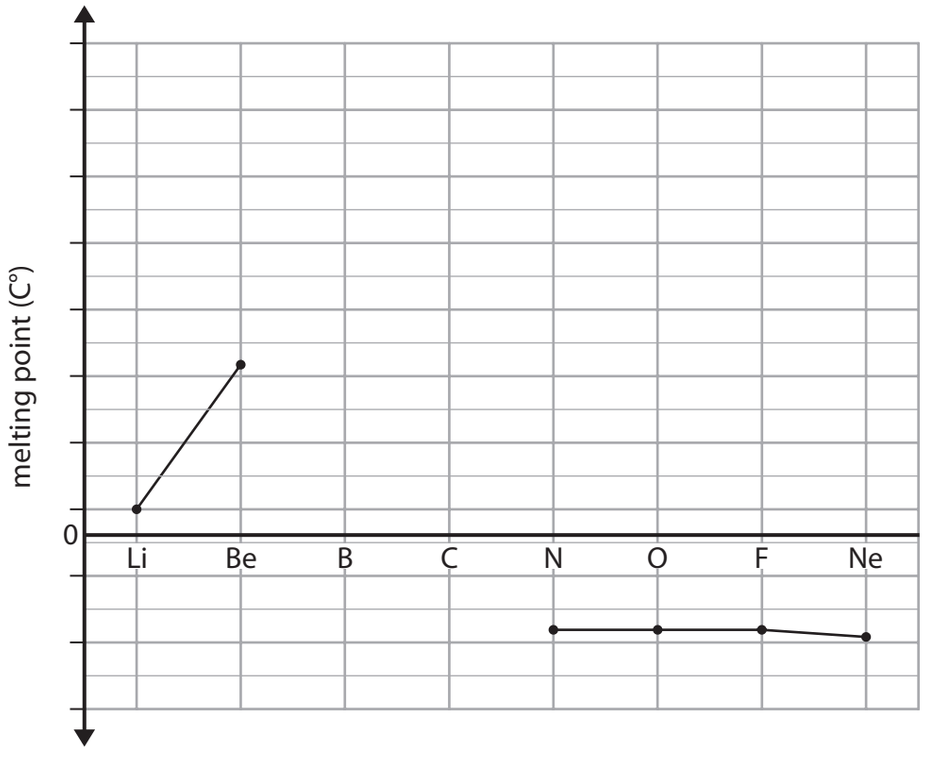


**Figure 2**

Complete Figure 2 to show how the relative melting points change from Be to N.

**(2)**

(ii) Table 1 shows the atomic numbers and melting points of the elements in group 7.

| group 7 | atomic number | melting point (°C) |
|---|---|---|
| fluorine | 9 | −220 |
| chlorine | 17 | −101 |
| bromine | 35 | −7 |
| iodine | 53 | 114 |
| astatine | 85 | 302 |

**Table 1**

Explain why the melting point increases as the atomic number increases.

**(3)**

.....

.....

.....

.....

.....

.....

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

**3** Oxygen exists as the molecule $O_2$ in the Earth's atmosphere and is needed for combustion.

(a) Draw the dot and cross diagram for a molecule of oxygen, $O_2$.

**(2)**

Show the outer electrons only.

(b) A student burns magnesium in air to produce 1.40 g of magnesium oxide.

The theoretical yield of magnesium oxide for the experiment is 2.00 g.

(i) Calculate the percentage yield for the student's experiment.

**(2)**

percentage yield = .....%

(ii) Magnesium reacts with oxygen to form magnesium oxide.

$$2Mg + O_2 \rightarrow 2MgO$$

2.43 g of magnesium was burned.

Calculate the theoretical yield of magnesium oxide.

**(3)**

theoretical yield of magnesium oxide = ..... g

**(Total for Question 3 = 7 marks)**

**4** A student collected some data about the atomic radius and ionic radius of three elements and their ions.

Table 2 shows the data.

| atomic radius (nm) | ionic radius (nm) |
|---|---|
| O = 0.073 | $O^{2-}$ = 0.140 |
| F = 0.071 | $F^{-}$ = 0.133 |
| S = 0.102 | $S^{2-}$ = 0.185 |

**Table 2**

Discuss the atomic radius and ionic radius data in Table 2.

**(6)**

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

**TOTAL FOR SECTION B = 30 MARKS**

# 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) | | Key | | | | | | | | | (13) | (14) | (15) | (16) | (17) | |
| 6.9 Li lithium 3 | 9.0 Be beryllium 4 | | relative atomic mass<br>atomic symbol<br>name<br>atomic (proton) number | | | | | | | | | 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

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| * Lanthanide series | 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 |
| * Actinide series | 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 |