

Past-paper walk-through

Electrons, energy levels and atomic orbitals ■ 1.3

eXercise

Questions in this set

- 9701/11 N25 Q1 ■ 1 mark
- 9701/12 N25 Q1 ■ 1 mark
- 9701/12 N25 Q4 ■ 1 mark
- 9701/13 N25 Q1 ■ 1 mark
- 9701/22 N25 Q1 ■ 10 marks

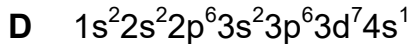
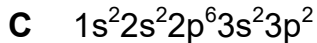
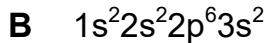
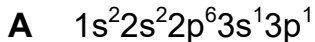
Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- **//** separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = “or words to that effect” – the wording need not match.

Question 1

9701/11 N25 ■ Q1 ■ 1 mark

1 What is the electronic configuration for the particle ${}_{13}^{27}\text{Al}^+$?



Solution 1

Answer: **B**

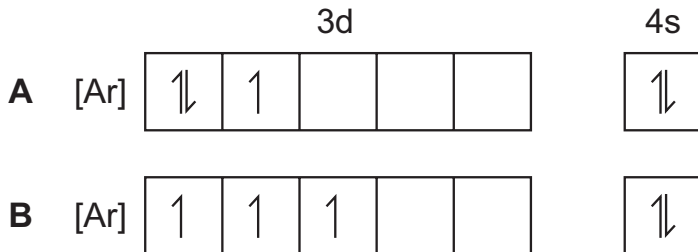
Why

- Aluminium has 13 electrons when neutral: $1s^2 2s^2 2p^6 3s^2 3p^1$.
- The + charge means one electron has gone, and it leaves from the highest-energy 3p orbital first.
- That leaves 12 electrons: $1s^2 2s^2 2p^6 3s^2$.

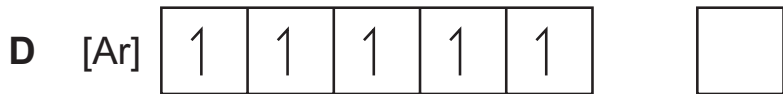
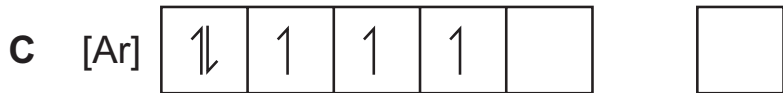
Question 1

9701/12 N25 ■ Q1 ■ 1 mark

1 What is the electrons in boxes notation for the Fe^{3+} ion?



Question 1



Solution 1

Answer: **D**

Why

- Iron is $[\text{Ar}]3d^64s^2$, and when it ionises the 4s electrons leave *first*.
- Fe^{3+} has lost both 4s electrons and one 3d, leaving $[\text{Ar}]3d^5$.
- Five electrons in five 3d orbitals means one in each, all unpaired, with 4s empty.

Question 4

9701/12 N25 ■ Q4 ■ 1 mark

4 Which statement is correct?

- A** The relative atomic mass of a ^{35}Cl atom is 35.5.
- B** The relative molecular mass of O_2 is 16.0.
- C** The relative formula mass of CaCO_3 is 100.1.
- D** The relative isotopic mass of a ^{24}Mg atom is 24.3.

Solution 4

Answer: **C**

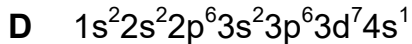
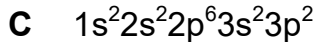
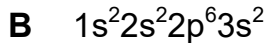
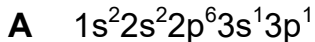
Why

- $\text{Ca } 40.1 + \text{C } 12.0 + 3 \times \text{O } 16.0 = 100.1$.
- A confuses relative *isotopic* mass (exactly 35 for ^{35}Cl) with the relative atomic mass 35.5.
- B gives the mass of one O atom rather than the O_2 molecule, and D quotes magnesium's relative atomic mass for a single isotope.

Question 1

9701/13 N25 ■ Q1 ■ 1 mark

1 What is the electronic configuration for the particle ${}_{13}^{27}\text{Al}^+$?



Solution 1

Answer: **B**

Why

- Aluminium has 13 electrons when neutral: $1s^2 2s^2 2p^6 3s^2 3p^1$.
- The + charge means one electron has gone, and it leaves from the highest-energy 3p orbital first.
- That leaves 12 electrons: $1s^2 2s^2 2p^6 3s^2$.

Question 1

9701/22 N25 ■ Q1 ■ 10 marks

- 1 Manganese, Mn, and its compounds are widely used in many chemical reactions.
 - (a) Mn is usually found as a single isotope, manganese-55.
 - (i) Determine the number of protons, neutrons and electrons in an atom of manganese-55.

Question 1

[1]

(ii) Define isotopes.

Question 1

- (iii) A sample of manganese from the Moon is found to contain manganese-53 in addition to manganese-55.

State the two pieces of information needed to determine the relative atomic mass, A_r , of manganese in this sample.

Question 1

Question 1

[2]

(b) The shorthand electronic configuration of manganese is $[\text{Ar}] 3d^5 4s^2$.

(i) Complete the full electronic configuration of manganese.

..... $3d^5 4s^2$

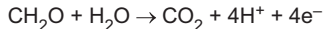
[1]

(ii) Deduce the total number of unpaired electrons in an atom of manganese.

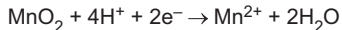
Question 1

- (c) Manganese(IV) oxide reacts with methanal, CH_2O , in acidic conditions to produce carbon dioxide. The movement of electrons to or from relevant species is shown in the following half-equations.

half-equation 1



half-equation 2



- (i) Identify the species that is reduced in half-equation 2. Explain your answer.

Question 1

(ii) The oxidation state of carbon in methanal is 0.

Calculate the oxidation state of carbon in carbon dioxide.

Question 1

- (iii) Construct the ionic equation for the reaction of manganese(IV) oxide with methanal in acidic conditions.

Question 1

[Total: 10]

Solution 1

(a)(i)

Mark scheme

- 25 protons 30 neutrons 25 electrons
- 1

(a)(ii)

Mark scheme

- (atoms of an element) with the same number of protons and different number of neutrons
- 1

Solution 1

(a)(iii)

Mark scheme

- M1 (relative) isotopic mass.
- OR (relative isotopic) mass of Mn-55 and Mn-53 **M2**
- (relative) abundance of each isotope
- 2

Solution 1

(b)(i)

Mark scheme

- 1s² 2s² 2p⁶ 3s² 3p⁶ (3d⁵ 4s²)
- 1

(b)(ii)

Mark scheme

- 5
- 1

Solution 1

(c)(i)

Mark scheme

- Mn / MnO₂ AND it gains electrons
- 1

(c)(ii)

Mark scheme

- (+)4
- 1

Solution 1

(c)(iii)

Mark scheme

- Due to an issue with question 1(c)(iii), the question has been removed from the question paper.
- N/A