

Past-paper walk-through

Formulae ■ 3.1

eXercise

Questions in this set

- 0620/21 N25 Q9 ■ 1 mark
- 0620/22 N25 Q11 ■ 1 mark
- 0620/23 N25 Q9 ■ 1 mark
- 0620/23 N25 Q10 ■ 1 mark
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Question 9

0620/21 N25 ■ Q9 ■ 1 mark

9 The molecular formulae of four compounds are listed.



Which molecular formulae are also the empirical formulae for the compounds?

A 1 and 2

B 1 and 3

C 2 and 4

D 3 and 4

Solution 9

Answer: **B**

Why

- A molecular formula is also the empirical formula only when it cannot be simplified.
- CH_4 and C_3H_8 have no common factor, so they are already simplest.
- C_2H_6 simplifies to CH_3 and C_3H_6 to CH_2 , so those two are not.

Question 11

0620/22 N25 ■ Q11 ■ 1 mark

11 A compound contains 40.0% carbon, 6.7% hydrogen and 53.3% oxygen only.

The relative molecular mass, M_r , of the compound is 60.

Which row shows the empirical formula and the molecular formula of the compound?

	empirical formula	molecular formula
A	CH_2O	CH_2O
B	CH_2O	$\text{C}_2\text{H}_4\text{O}_2$
C	$\text{C}_3\text{H}_7\text{O}_3$	$\text{C}_3\text{H}_7\text{O}_3$
D	$\text{C}_3\text{H}_8\text{O}$	$\text{C}_3\text{H}_8\text{O}$

Solution 11

Answer: **B**

Why

- The percentages give the empirical formula CH_2O , exactly as in the earlier question.
- CH_2O has a mass of $12 + 2 + 16 = 30$.
- $60/30 = 2$, so the molecular formula is $\text{C}_2\text{H}_4\text{O}_2$.

Question 9

0620/23 N25 ■ Q9 ■ 1 mark

- 9 Which compound has an empirical formula that is the same as its molecular formula?
- A butane
 - B but-1-ene
 - C butanoic acid
 - D butan-1-ol

Solution 9

Answer: **D**

Why

- A molecular formula equals the empirical formula only when it has no common factor.
- Butane C_4H_{10} simplifies to C_2H_5 , but-1-ene C_4H_8 to CH_2 , butanoic acid $\text{C}_4\text{H}_8\text{O}_2$ to $\text{C}_2\text{H}_4\text{O}$.
- Butan-1-ol is $\text{C}_4\text{H}_{10}\text{O}$, which has no common factor, so it cannot be simplified.

Question 10

0620/23 N25 ■ Q10 ■ 1 mark

10 Which row identifies the charge on the chromium ion and on the sulfate ion in $\text{Cr}_2(\text{SO}_4)_3$?

	Cr	SO_4
A	2+	3–
B	2–	3+
C	3+	2–
D	3–	2+

Solution 10

Answer: **C**

Why

- The sulfate ion always carries a $2-$ charge.
- Three of them give $6-$ in total, so the two chromium ions must supply $6+$.
- That is $3+$ on each chromium.

Question 8

0620/21 J25 ■ Q8 ■ 1 mark

8 Three organic molecules are described.

- The molecular formula of propanoic acid is $\text{CH}_3\text{CH}_2\text{COOH}$.
- The molecular formula of lactic acid is $\text{CH}_3\text{CH}(\text{OH})\text{COOH}$.
- A glucose molecule consists of 6 carbon atoms, 6 oxygen atoms and 12 hydrogen atoms only.

Which molecules have the same empirical formula?

- A** propanoic acid, lactic acid and glucose
- B** propanoic acid and lactic acid only
- C** propanoic acid and glucose only

Question 8

D lactic acid and glucose only

Solution 8

Answer: **D**

Why

- Work out each molecular formula: propanoic acid $\text{C}_3\text{H}_6\text{O}_2$, lactic acid $\text{C}_3\text{H}_6\text{O}_3$, glucose $\text{C}_6\text{H}_{12}\text{O}_6$.
- Lactic acid and glucose both reduce to the same empirical formula, CH_2O .
- Propanoic acid does not, and none of the three is a structural isomer of another.

Question 8

0620/22 J25 ■ Q8 ■ 1 mark

- 8 Aluminium reacts with iron(III) oxide to form aluminium oxide and iron.

Which chemical equation for the reaction between aluminium and iron(III) oxide is correct?

- A** $Al + FeO \rightarrow AlO + Fe$
- B** $2Al + Fe_2O \rightarrow Al_2O + 2Fe$
- C** $Al + Fe_2O_3 \rightarrow Al_2O_3 + Fe$
- D** $2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe$

Solution 8

Answer: **D**

Why

- Aluminium oxide is Al_2O_3 and iron(III) oxide is Fe_2O_3 – get the formulae right first.
- Balancing gives $2\text{Al} + \text{Fe}_2\text{O}_3 \rightarrow \text{Al}_2\text{O}_3 + 2\text{Fe}$.
- Check both sides: 2 Al, 2 Fe and 3 O each.

Question 8

0620/23 J25 ■ Q8 ■ 1 mark

- 8 A compound is analysed and found to contain 85.7% carbon and 14.3% hydrogen only.

What is its empirical formula?

A CH

B CH₂

C C₂H₄

D C₆H

Solution 8

Answer: **B**

Why

- Divide each percentage by the relative atomic mass: C $85.7/12 = 7.14$, H $14.3/1 = 14.3$.
- The ratio is $7.14 : 14.3$, which is $1 : 2$.
- So the empirical formula is CH_2 – C_2H_4 is a molecular formula, not the simplest ratio.

Question 9

0620/22 M25 ■ Q9 ■ 1 mark

- 9** Which formula for the named compound is correct?
- A** calcium oxide, CaO
 - B** cobalt(II) chloride, Co_2Cl
 - C** sulfur dioxide, S_2O_2
 - D** anhydrous copper(II) sulfate, $\text{Cu}(\text{SO}_4)_2$

Solution 9

Answer: **A**

Why

- Ca^{2+} and O^{2-} balance one to one, so calcium oxide is CaO .
- Cobalt(II) chloride is CoCl_2 and sulfur dioxide is SO_2 .
- Anhydrous copper(II) sulfate is CuSO_4 , since Cu^{2+} balances SO_4^{2-} one to one.

Question 11

0620/22 M25 ■ Q11 ■ 1 mark

11 An organic compound, Q, contains carbon, hydrogen and oxygen only.

Q contains 40.0% carbon and 6.7% hydrogen by mass.

What is the empirical formula of Q?

A CHO

B CH₂O

C C₂HO₂

D C₃H₆O₃

Solution 11

Answer: **B**

Why

- Oxygen makes up $100 - 40.0 - 6.7 = 53.3\%$.
- Divide each by its relative atomic mass: C $40.0/12 = 3.33$, H $6.7/1 = 6.7$, O $53.3/16 = 3.33$.
- The simplest ratio is 1 : 2 : 1, so CH_2O – D is a multiple of it, not the simplest form.