

9: Amount of substance – Topic questions

Paper 3

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
4	2015	March	32
5	2016	November	32
6	2015	June	32

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

4 (a) A compound **X** contains 82.76% of carbon by mass and 17.24% of hydrogen by mass.

(i) Calculate the empirical formula of compound **X**.

[2]

(ii) Compound **X** has a relative molecular mass of 58.

Deduce the molecular formula of compound **X**.

[2]

(b) Alkenes are unsaturated hydrocarbons.

(i) State the general formula of alkenes.

..... [1]

(ii) State the empirical formula of alkenes.

..... [1]

(c) What is meant by the term *unsaturated hydrocarbon*?

unsaturated

.....

hydrocarbon

.....

[2]

(d) Describe a test that would distinguish between saturated and unsaturated hydrocarbons.

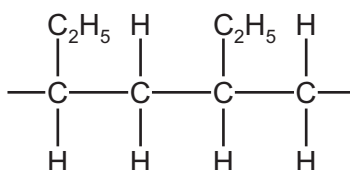
reagent

observation (saturated hydrocarbon)

observation (unsaturated hydrocarbon)

[3]

(e) Addition polymers can be made from alkenes. The diagram shows part of an addition polymer.



(i) Draw a circle on the diagram to show one repeat unit in this polymer. [1]

(ii) Give the structure and the name of the monomer used to make this polymer.

structure

name [2]

(iii) Give the structure of an isomer of the alkene in (e)(ii).

[1]

[Total: 15]

- 5** Cement is made by heating clay with limestone. Some of the limestone (calcium carbonate) breaks down to form calcium oxide and a gas which turns limewater milky.

(a) (i) Complete the chemical equation for this reaction.



[2]

(ii) What type of chemical reaction is this?

..... [1]

(iii) Determine the relative formula mass of calcium carbonate. Show all your working.

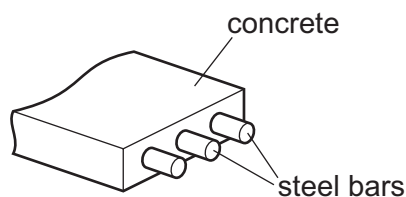
[2]

(b) Concrete is a mixture of cement, sand, water and small stones.
Calcium carbonate is a compound, but concrete is a mixture.

State **two** differences between a compound and a mixture.

.....
.....
.....
..... [2]

- (c) Reinforced concrete contains steel bars within the concrete.



Some properties of concrete and steel are shown in the table.

	relative strength	relative expansion when heated	relative heat conductivity	cost
concrete	60	12	1.5	low
steel	250	12	60.0	high

Use the information in the table to suggest why concrete must be reinforced with steel when it is used to make bridges.

.....
..... [1]

- (d) If reinforced concrete becomes cracked, liquids and gases can reach the steel bars. The steel bars rust.

Which **two** substances are needed for steel to rust?

..... and [2]

[Total: 10]

- 6** The Atacama desert in Chile has deposits of the salt sodium nitrate. Very large amounts of this salt were exported to Europe for use as a fertiliser. After the introduction of the Haber process in 1913, this trade rapidly diminished.

- (a) (i)** Explain why the introduction of the Haber process reduced the demand for sodium nitrate.

.....
..... [2]

- (ii)** Suggest why surface deposits of sodium nitrate only occur in areas with very low rainfall such as desert areas.

..... [1]

- (iii)** The desert has smaller surface deposits of potassium nitrate.

Suggest why potassium nitrate is a better fertiliser than the sodium salt.

..... [1]

- (b)** All nitrates decompose when heated. The extent to which a nitrate decomposes is determined by the metal in the salt.

- (i)** Sodium nitrate decomposes to form sodium nitrite, NaNO_2 .

Write the equation for decomposition of sodium nitrate.

..... [2]

- (ii)** Sodium nitrite is a reducing agent.

What would be observed if an excess of sodium nitrite solution was added to a solution of acidified potassium manganate(VII)?

..... [2]

- (iii)** Copper(II) nitrate decomposes to form copper(II) oxide, nitrogen dioxide and oxygen.

What is the relationship between the extent of decomposition and the reactivity of the metal in the nitrate?

.....
..... [1]

- (c) The equation for the decomposition of copper(II) nitrate is given below.



- (i) Predict what you would observe when copper(II) nitrate is heated.

.....
.....
..... [3]

- (ii) Copper(II) nitrate forms a series of hydrates with the formula $\text{Cu}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$.
All these hydrates decompose to form copper(II) oxide.
1 mole of $\text{Cu}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$ forms 1 mole of CuO.

What is meant by 1 mole of a substance?

.....
..... [2]

- (iii) 7.26 g of a hydrate, $\text{Cu}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$, formed 2.4 g copper(II) oxide.

number of moles of CuO formed =

number of moles of $\text{Cu}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$ in 7.26 g =

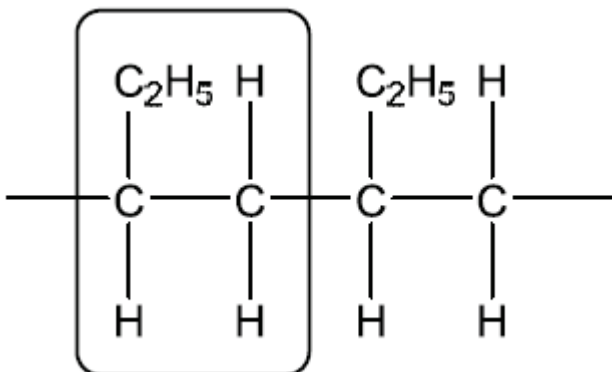
mass of 1 mole of $\text{Cu}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$ = g

mass of 1 mole of $\text{Cu}(\text{NO}_3)_2$ is 188 g

the value of x in this hydrate =

[4]

[Total: 18]

Question	Answer	Marks
4 (a) (i)	82.76/12 and 17.2(4)/(1)	1
	or evaluation: 6.89 / 6.9(0) and 17.2(4)	1
	C ₂ H ₅	1
	OR 82.76 / 100 × 58 = 48 and 17.24 / 100 × 58 = 10 or evaluation i.e. 48 and 10	1
	C ₂ H ₅	1
4 (a) (ii)	(C ₂ H ₅ =) 29	1
	(58 / 29 = 2) C ₄ H ₁₀	1
	OR: 82.76 / 100 × 58 = 48 and 17.24 / 100 × 58 = 10 or evaluation i.e. 48 and 10	1
	48 / 12 = 4 10 / 1 = 10 (therefore) C ₄ H ₁₀	1
4 (b) (i)	C _n H _{2n}	1
4 (b) (ii)	CH ₂	1
4 (c)	(contains) double bond / triple bond / multiple bond(s) / not all bonds are single	1
	(contains) carbon and hydrogen only	1
4 (d)	bromine / bromine water	1
	no change / stays brown / orange / yellow / red-brown or only changes in UV	1
	(brown / orange / yellow) to colourless / decolourised	1
4 (e) (i)	Circle / brackets around any 2 consecutive carbon atoms in the main chain and all attached atoms e.g.	1
		

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Question	Answer	Marks
4 (e) (ii)	CH ₃ CH ₂ CH=CH ₂ / C ₂ H ₅ CH=CH ₂ (double bond must be shown) butene / but-1-ene	1 1
4 (e) (iii)	(CH ₃) ₂ C=CH ₂ / CH ₃ CH=CHCH ₃ / (CH ₂) ₂ CHCH ₃ / (CH ₂) ₄	1
		Total: 19

Question	Answer	Marks
5 (a) (i)	CaO CO ₂	1 1
5 (a) (ii)	(thermal) decomposition	1
5 (a) (iii)	100 = [2] A _r = 40 (Ca), 12 (C), 16 (O) = [1]	2
5 (b)	any 2 from: <ul style="list-style-type: none"> compound has a fixed composition / mixture has not got a fixed composition (components of) compound cannot be separated (by physical means) / (components of) mixture can be separated (by physical means) compound has different properties from the elements it has been made from / substances in a mixture have the same properties as those used to make the mixture 	2
5 (c)	concrete is weaker / steel is stronger	1
5 (d)	oxygen / air water	1 1
		Total: 10

Continues on next page ...

Question	Answer	Marks
6 (a) (i)	(Haber process makes) ammonia / NH_3 ; (ammonia converted into) fertilisers / nitrates / ammonium salts or names or formulae of examples e.g. ammonium nitrate / NH_4NO_3 / ammonium sulfate / $(\text{NH}_4)_2\text{SO}_4$ / calcium nitrate / $\text{Ca}(\text{NO}_3)_2$ / urea / $\text{CO}(\text{NH}_2)_2$;	2
6 (a) (ii)	it (refers to sodium nitrate) / sodium nitrate would dissolve (in rain) / soluble (in water) / wash away / leach / drain off;	1
6 (a) (iii)	potassium (is required by plants as well as nitrogen) / NPK;	1
6 (b) (i)	$2\text{NaNO}_3 \rightarrow 2\text{NaNO}_2 + \text{O}_2$ species; balancing;	2
6 (b) (ii)	(colour changes) from pink / purple; to colourless / decolourised;	2
6 (b) (iii)	the more reactive the metal the lower the rate of decomposition / more difficult the decomposition / more stable the nitrate / more energy needed to decompose / decomposes at higher temperature ora;	1
6 (c) (i)	(changes from) blue solid / blue crystals; black solid formed; brown gas / brown vapour / (pungent) smell;	3
6 (c) (ii)	Avogadro('s) number / constant / 6.02×10^{23} ; COND particles; OR (the number of particles which is equal to the number of atoms in) 12 g of carbon 12; COND atoms; OR the mass in grams which contains Avogadro('s) Number; COND particles; OR (the amount of substance which has a mass equal to) its <u>relative</u> formula mass / RFM / <u>relative</u> atomic mass / A_r / <u>relative</u> molecular mass / M_r / molar mass; COND in grams; OR (the amount of substance which has a volume equal to) 24 dm^3 ; COND of a gas at RTP;	2

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Question	Answer	Marks
6 (c) (iii)	M1 (number of moles of CuO formed =) 0.03 ;	4
	M2 (number of moles of $\text{Cu}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$ in 7.26 g =) 0.03 ;	
	M3 (mass of 1 mole of $\text{Cu}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$ / 0.03 =) 242 (g); (mass of 1 mole of $\text{Cu}(\text{NO}_3)_2$ is 188 g)	
	M4 The value of x = 3 ;	
		Total: 18