

Subject knowledge tests: post-16 chemistry

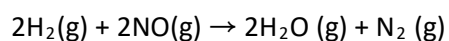
Test 1: questions

For each question, select the correct answer – A, B, C or D.

- 1 Identify the correct rate equation for the reaction between calcium carbonate and dilute hydrochloric acid:



- A rate = $k [\text{CaCl}_2] [\text{H}_2\text{O}] [\text{CO}_2]$
- B The rate equation cannot be identified from the equation for the reaction.
- C rate = $k [\text{HCl}]^2 [\text{CaCO}_3]$
- D rate = $k [\text{HCl}] [\text{CaCO}_3]$
- 2 Here is the balanced equation for the reaction between hydrogen and nitric oxide:



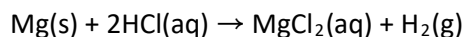
The rate of reaction was investigated by varying the concentration of the two reactants at 973 K.

[H ₂] mol dm ⁻³	[NO] mol dm ⁻³	rate × 10 ⁻⁶ mol dm ⁻³ s ⁻¹
0.01	0.01	0.38
0.02	0.01	0.77
0.01	0.02	1.54

What are the orders of reaction with respect to H₂ and NO?

	[H ₂]	[NO]
A	2	2
B	1	1
C	1	2
D	2	1

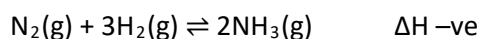
- 3 A piece of magnesium is dropped into dilute hydrochloric acid. Hydrogen gas is given off and a solution of magnesium chloride remains. The equation for the reaction is:



What particles are present in the reactants and products?

- | | Mg | HCl | MgCl ₂ | H ₂ |
|---|-----------|-----------|-------------------|----------------|
| A | Atoms | molecules | molecules | molecules |
| B | Atoms | ions | ions | molecules |
| C | Ions | molecules | molecules | molecules |
| D | Molecules | ions | ions | molecules |

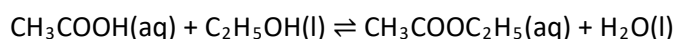
- 4 In the Haber process, hydrogen and nitrogen react to produce ammonia:



What conditions favour the maximum amount of ammonia being produced?

- A High temperature and high concentration of hydrogen.
- B Low temperature and high concentration of hydrogen.
- C High temperature and high pressure.
- D Low temperature and high pressure.
- 5 Which statement best explains the difference between a “strong” and a “weak” acid or alkali?
- A A strong acid/alkali is fully ionised when dissolved in water.
- B A weak acid/alkali does not dissolve easily in water.
- C A strong acidic/alkaline solution is always very concentrated.
- D A weak acid/alkali reacts more slowly than a concentrated one.

- 6 Equilibrium concentrations in mol dm⁻³ at 298 K of the reactants and products in this esterification reaction are shown.



0.33 0.33 0.67 0.67

What is the value of the equilibrium constant?

- A 0.2 mol dm⁻³
B 0.2
C 4.1 mol dm⁻³
D 4.1
- 7 Methane has the chemical formula CH₄. Which is the best explanation of why it is CH₄, not CH₃, CH₂ or CH?
- A The atoms of carbon and hydrogen want to form a molecule like this.
B Carbon must obey the Octet Rule when forming bonds.
C This formula is the most energetically favoured arrangement.
D This formula satisfies the valencies of carbon and hydrogen.
- 8 What will be observed when propanal and propanone are each warmed gently with Fehling's solution (containing Cu²⁺(aq) and OH⁻(aq))?

	Propanal	Propanone
	CH ₃ CH ₂ CHO	CH ₃ COCH ₃
A	Blue solution	No reaction
B	No reaction	Brick red precipitate
C	Brick red precipitate	Brick red precipitate
D	Brick red precipitate	No reaction

- 9 Why does the value of first ionisation enthalpy increase across a period of the periodic table?
- A Nuclear charge increases so electrons are held more tightly.
 - B As the number of electrons increases the first is harder to remove.
 - C Inter-atomic bonds increase in strength across the period.
 - D Atomic volume decreases so electrons are held more tightly.

- 10 Here are some lattice formation enthalpy values (kJ mol^{-1}) for oxides of Group 1 metals:

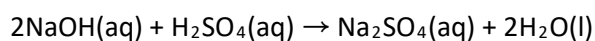
Li_2O -2806

Na_2O -2488

K_2O -2245

What is the best explanation for the change observed in the lattice formation enthalpy value from Li_2O to K_2O ?

- A The ionic radius of the metal cation increases.
 - B The ionic radius of the metal cation decreases.
 - C Potassium is more reactive than lithium.
 - D The potassium oxide lattice is less stable.
- 11 When sodium hydroxide and sulfuric acid react, the equation is:



In a titration, 25 cm^3 sodium hydroxide reacted with 21 cm^3 0.1 mol dm^{-3} sulfuric acid.

What is the concentration of the sodium hydroxide solution?

- A $0.1 \times 25 / 1000$
- B $21 / 1000 \times 0.1 \times 2 \times 1000 / 25$
- C $21 / 1000 \times 0.1 \times 0.5 \times 1000 / 25$
- D $0.1 \times 21 / 1000 \times 2 \times 25 / 1000$

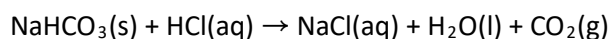
- 12 A solution of 1 mol dm^{-3} hydrochloric acid is diluted to 0.01 mol dm^{-3} .
What happens to the pH value?
- A Nothing, it would stay the same.
 - B It would increase by 2 pH units.
 - C It would decrease by 2 pH units.
 - D It would increase by 1 pH unit.
- 13 What is a buffer solution?
- A A solution that reacts with both acids and alkalis.
 - B A fully ionised solution of an acid and an alkali mixed in equal amounts.
 - C A solution of pH 7 that contains approximately equal amounts of acid and alkali.
 - D A solution that maintains relatively constant pH when a small amount of acid or alkali is added.
- 14 What particles are present in hydrochloric acid, HCl(aq) ?
- A H^+ , OH^- , Cl^-
 - B HCl , H_2O
 - C H^+ , OH^- , OCl^-
 - D H_2O , H_3O^+ , OH^- , Cl^-
- 15 Which equation represents the reaction of a Group 2 metal with water?
- A $\text{M(s)} + \text{H}_2\text{O(l)} \rightarrow \text{MO(aq)} + \text{H}_2\text{(aq)}$
 - B $2\text{M(s)} + 2\text{H}_2\text{O(l)} \rightarrow 2\text{MOH(aq)} + \text{H}_2\text{(g)}$
 - C $\text{M(s)} + 2\text{H}_2\text{O(l)} \rightarrow \text{M(OH)}_2\text{(aq)} + \text{H}_2\text{(g)}$
 - D $2\text{M(s)} + \text{H}_2\text{O(l)} \rightarrow \text{M}_2\text{O(aq)} + \text{H}_2\text{(aq)}$

- 16 The equation for the reaction between hydrated barium hydroxide and ammonium chloride is:



What does “ $\Delta H +ve$ ” tell you about the rate of reaction?

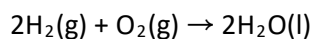
- A The rate of reaction is slow.
 - B The reaction needs a catalyst to make it “go”.
 - C The activation energy is high.
 - D It gives no information about rate of reaction.
- 17 When solid sodium hydrogen carbonate is added to hydrochloric acid, a spontaneous reaction occurs and the temperature drops. The equation for the reaction is:



Which of these statements is correct?

- A ΔH is $-ve$ ΔS is $+ve$
 - B ΔH is $+ve$ ΔS is $+ve$
 - C ΔH is $-ve$ ΔS is $-ve$
 - D ΔH is $+ve$ ΔS is 0
- 18 What is the best definition for the term “complex ion”?
- A A central metal atom or ion surrounded by negatively charged ions or neutral molecules each with a lone electron pair.
 - B A central metal cation surrounded by two or more negatively charged ions each with a lone electron pair.
 - C A central metal atom or ion bonded datively to two or more negatively charged ions or molecules.
 - D A central metal cation bonded datively to two or more negatively charged ions.

19 When hydrogen and oxygen gases react, the equation is:

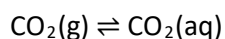


What volume of oxygen is needed to react with 20 cm³ of hydrogen?

A_r values: H = 1, O = 16

- A 20 cm³
- B 10 cm³
- C 40 cm³
- D 2 cm³

20 In a closed fizzy-drink bottle an equilibrium position exists between carbon dioxide gas in the head space above the drink and carbon dioxide in the drink itself:



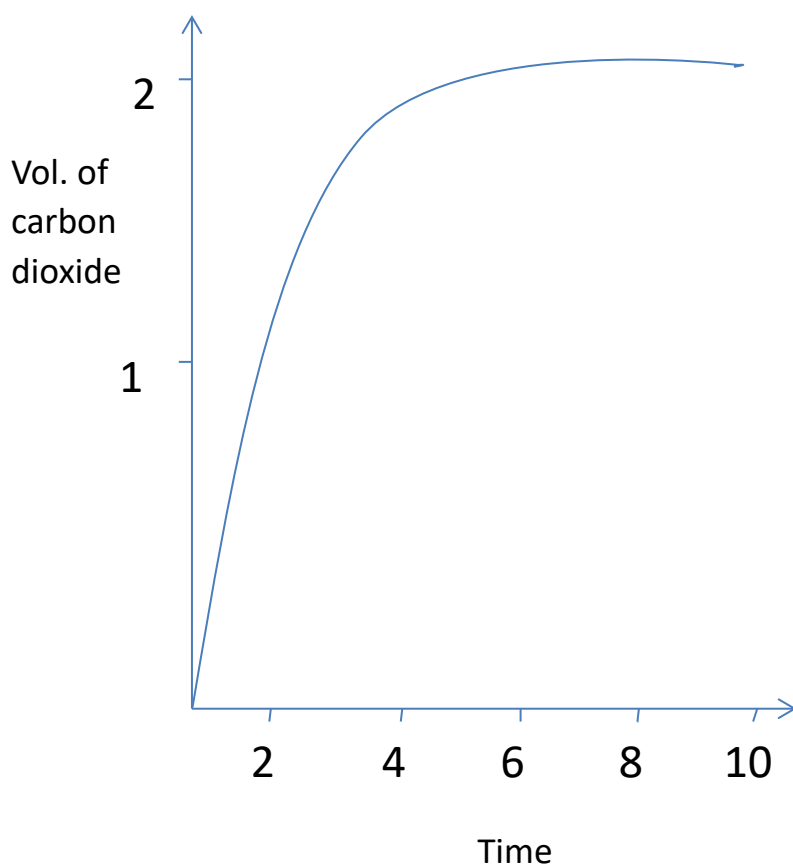
The bottle is opened, a drink poured out and the cap replaced. As this is repeated, the drink loses its fizz, becoming flat. Which is the best explanation for this?

- A The equilibrium position moves further to the left.
- B The volume above the drink increases.
- C The volume of drink in which the gas can dissolve decreases.
- D The equilibrium position concentrations decrease as drink is poured out.

21 The reaction between calcium carbonate and dilute hydrochloric acid was followed by measuring the volume of carbon dioxide gas produced over time.

Why does the rate slow down?

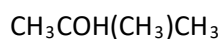
- A Particles lose energy.
- B Acid is used up.
- C Fewer successful collisions occur.
- D Calcium carbonate is used up.



- 22 Which statement is the best definition for first ionisation enthalpy?
- First ionisation enthalpy is the energy needed to remove ...
- A ... one electron from an atom.
 - B ... one electron from an atom in the gaseous state.
 - C ... one electron from every atom in 1 mole of an element.
 - D ... one electron from every atom in 1 mole of gaseous atoms of an element.
- 23 In general, raising the temperature increases the rate of reaction. Which statement best explains why this occurs?
- A The overall amount of energy distributed across the molecules increases.
 - B Molecules move faster because they have increased kinetic energy.
 - C More colliding molecules have the minimum activation energy required to react.
 - D Bonds within molecules break more easily at higher temperatures.

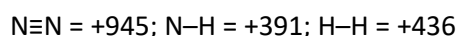


24 What is the systematic name of this compound?

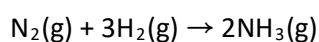


- A Methylpropan-2-ol
- B Butan-2-ol
- C 2-Ethylethanol
- D 2-Methylpropanol

25 Here are some bond dissociation enthalpies (in kJ mol^{-1}):

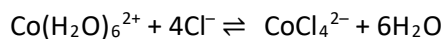


What is the enthalpy change for this reaction?



- A $\Delta H_{\text{R}} = +945 + (3 \times 436) - (3 \times 391)$
- B $\Delta H_{\text{R}} = +945 + (3 \times 436) - (6 \times 391)$
- C $\Delta H_{\text{R}} = -945 - (3 \times 436) + (3 \times 391)$
- D $\Delta H_{\text{R}} = -945 - (3 \times 436) + (6 \times 391)$

26 Here is the equation for the reaction between two complex ions:



PINK	BLUE
(cobalt(II) hexahydrate complex ion)	(cobalt(II) tetrachloro complex ion)

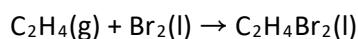
What will happen if a concentrated solution of chloride ions is added to the reaction at equilibrium?

- A A purple colour is produced.
- B A pink colour is produced.
- C A blue colour is produced.
- D It's impossible to tell without knowing the colour of the equilibrium mixture.

27 Which equation represents the lattice enthalpy for the formation of sodium chloride?

- A $\text{Na}^+(\text{s}) + \text{Cl}^-(\text{s}) \rightarrow \text{NaCl}(\text{s})$
- B $\text{Na}^+(\text{g}) + \text{Cl}^-(\text{g}) \rightarrow \text{NaCl}(\text{s})$
- C $2\text{Na}(\text{l}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{NaCl}(\text{s})$
- D $\text{Na}(\text{s}) + \frac{1}{2}\text{Cl}_2(\text{g}) \rightarrow \text{NaCl}(\text{s})$

28 What type of mechanism takes place in the reaction between ethene and bromine?



- A Electrophilic substitution
- B Nucleophilic addition/elimination
- C Electrophilic addition
- D Nucleophilic substitution

29 Which list shows chemical properties of alkenes?

	Reacts with bromine	Reacts with hydrogen	Reacts with water	Polymerises to form long chains
A	✓	✓	✓	✓
B	✓	✓	x	✓
C	✓	✓	✓	x
D	x	x	x	✓

30 Hot sodium reacts violently with chlorine gas in a gas jar. An exothermic reaction occurs that spatters sodium chloride on the sides of the jar. How do bonds form in sodium chloride?

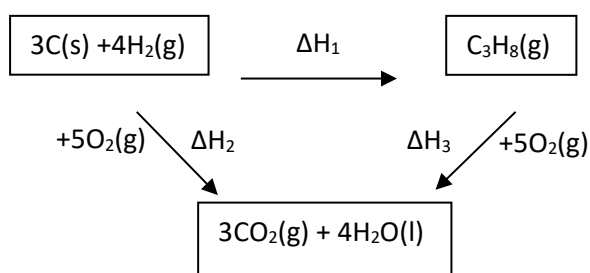
- A Ionically bonded sodium chloride molecules form by electron transfer, releasing energy.
- B An ionic lattice is formed when sodium and chloride ions bond, releasing energy.
- C Covalent bonds form making sodium chloride molecules.
- D The exothermic reaction makes covalently bonded sodium chloride molecules.



31 Which statement offers the best explanation for similarities in the behaviour of d-block elements?

- A They have the same number of outer shell electrons.
- B Their atoms all have partially filled d electron shells.
- C Electrons are added to d sub-shells which have similar energy levels.
- D They have similar first ionisation enthalpy values.

32 Use the information given below together with the enthalpy cycle shown to determine the enthalpy change, ΔH_1 .



Which statement will give the correct value of ΔH_1 ?

$$\Delta H_{\text{C}}(\text{C}) = -393 \text{ kJ mol}^{-1}$$

$$\Delta H_{\text{C}}(\text{H}_2) = -286 \text{ kJ mol}^{-1}$$

$$\Delta H_{\text{C}}(\text{C}_3\text{H}_8) = -2220 \text{ kJ mol}^{-1}$$

- A $\Delta H_1 = -(3 \times -393) - (4 \times -286) + (-2220)$
- B $\Delta H_1 = (3 \times -393) + (4 \times -286) - (-2220)$
- C $\Delta H_1 = -393 - 286 + 2220$
- D $\Delta H_1 = -393 - 286 - 2220$