

Subject knowledge tests: post-16 chemistry

Test 2: questions

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

1 Which statement offers a correct definition for an acid?

An acid ...

A ... is a proton donor.

B ... is a proton acceptor.

C ... is fully ionised in water to produce $\text{H}^+(\text{aq})$.

D ... is reduced during a neutralisation reaction.

2 Which response gives the correct overall charges on these complex ions?

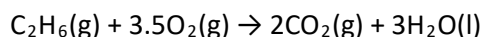
Tetrachlorocupro(II) $[\text{CuCl}_4]$

Hexacyanoferrate(III) $[\text{Fe}(\text{CN})_6]$

Hexa-amminenickel(II) $[\text{Ni}(\text{NH}_3)_6]$

	$[\text{CuCl}_4]$	$[\text{Fe}(\text{CN})_6]$	$[\text{Ni}(\text{NH}_3)_6]$
A	2^+	3^+	2^-
B	2^-	3^-	2^+
C	4^-	6^-	0
D	2^+	3^+	2^+

- 3 What is the enthalpy change of combustion occurring when one mole of ethane gas burns in oxygen?



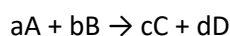
Bond enthalpy values (kJ mol^{-1}):

C–C = +347; C–H = +413; O=O = +498; C=O = +805; H–O = +464

- A $\Delta H_{\text{c}} = -(6 \times 413) - 347 - (3.5 \times 498) + (4 \times 805) + (6 \times 464)$
- B $\Delta H_{\text{c}} = +(6 \times 413) + 347 + 498 - (2 \times 805) - (3 \times 464)$
- C $\Delta H_{\text{c}} = +(6 \times 413) + 347 + (3.5 \times 493) - (4 \times 805) - (6 \times 464)$
- D $\Delta H_{\text{c}} = -413 - 347 - 498 + 805 + 464$
- 4 What is meant by the activation energy required for a reaction?
- A The minimum amount of energy required to initiate a chemical reaction.
- B The energy required to break specific bonds to start a chemical reaction.
- C The minimum amount of energy involved for a successful collision between two molecules.
- D The maximum kinetic energy required for a reaction to proceed.
- 5 How is K_{c} for any equilibrium mixture affected when changes to reaction conditions occur?
- A K_{c} is a constant so cannot be changed under any circumstances.
- B K_{c} changes only when temperature changes.
- C K_{c} changes only when pressure changes.
- D K_{c} changes only when a catalyst is present.



6 Here is a general rate equation for the reaction shown:

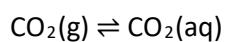


$$\text{Rate} = k [A]^m [B]^n$$

Which statement about rate equations is correct?

- A k , n and m can only be determined by experiment.
- B $m = a$ and $n = b$.
- C A rate equation is independent of the temperature at which the reaction occurs.
- D The rate constant, k , changes when a catalyst is present.

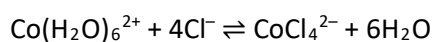
7 In a closed fizzy-drink bottle an equilibrium position exists between carbon dioxide gas in the head space above the drink and carbon dioxide in the drink itself:



The “fizz” of a fizzy drink can be kept for several hours by using a “fizz-keeper” in place of a bottle cap. Air is pumped into the bottle after pouring out a drink. Which statement best explains how a fizz-keeper works?

- A The equilibrium position re-establishes more quickly.
- B The increased overall pressure slows down the rate at which the carbon dioxide molecules diffuse from the drink.
- C The equilibrium shifts to the right, with air instead of CO_2 .
- D The extra air makes up the volume lost by pouring out the drink.

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



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

Two test tubes, one containing a solution of only the pink complex ion, and the other a solution of only the blue complex ion, are placed in a water bath at 60 °C. After 5 mins, both tubes contained purple solutions. Which statement best explains this observation?

- A The forward reaction is exothermic.
 - B The reverse reaction is exothermic.
 - C Both reactions are endothermic.
 - D Both reactions are occurring simultaneously in both tubes.
- 9 Which of the following statements about concentration and strength of an acid/alkali is true?
- A Concentration measures the amount of acid/alkali in a given volume.
 - B Strength measures the amount of acid/alkali in a given volume.
 - C Concentration measures the degree of ionisation in solution.
 - D Strength measures the rate at which acids and alkalis react.
- 10 What is produced when propanone (CH_3COCH_3) reacts with hydrogen cyanide (HCN)?
- A 2-Hydroxy-2-methylpropanenitrile $\text{CH}_3\text{CH}(\text{OH})(\text{CH}_3)\text{CN}$
 - B Propanocyanohydrin, $\text{CH}_3\text{CH}_2(\text{CH}_3)\text{CN}$, OH^- ions
 - C Propanal, $\text{CH}_3\text{CHOCH}_3$, CN^- ions
 - D Butanocyanohydrin, $\text{CH}_3\text{COCH}_2\text{CN}$, hydrogen, H_2

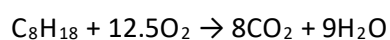


11 Which response gives the correct systematic names for these two compounds?



- A 1-methylbutan-2-ol 1-methylpentanoic acid
B 2-methylbutan-3-ol 3-methylpentanoic acid
C 3-methylbutan-2-ol 3-methylbutanoic acid
D pentan-2-ol pentanoic acid

12 What volume of oxygen is required to completely burn 570 g octane, C_8H_{18} ?



A_r values: H = 1, O = 16, C = 12; assume 1 mole of gas occupies 24 dm^3

- A $570 / 114 \times 12.5 \times 24$
B $114 / 570 \times 12.5 \times 24$
C $570 / 114 \times 24$
D 12.5×24

13 Which is the best description of the bonding between sodium and chloride ions in sodium chloride?

- A They are held by electrostatic attractions in a 3-D lattice in a 1:1 ratio.
B Ionic bonds form NaCl molecules which are held by electrostatic attractions in a 3-D lattice.
C The positive and negative ions alternate throughout a 3-D cubic crystal.
D The ions form NaCl molecules which alternate throughout a 3-D cubic crystal.

14 Use the expression:

$$K_a = \frac{[\text{H}^+(\text{aq})][\text{A}^-(\text{aq})]}{[\text{HA}(\text{aq})]}$$

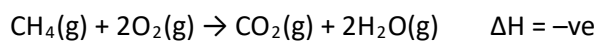
to calculate the pH of a solution of ethanoic acid, concentration 1 mol dm^{-3}

(K_a ethanoic acid = $1.7 \times 10^{-5} \text{ mol dm}^{-3}$ at 298 K)

pH of 1 mol dm^{-3}

- A 3.39
- B 1.7
- C 2.38
- D 4.12

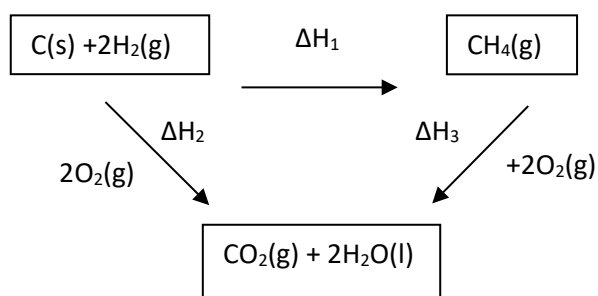
15 Here is the equation for the reaction between methane and oxygen:



What does " $\Delta H = -ve$ " tell you about the activation energy?

- A The reaction has a high activation energy.
- B The reaction has a negative activation energy.
- C The reaction has a low activation energy.
- D It gives no information about activation energy.

16 Here is an enthalpy cycle:



Which statement will give the correct value of ΔH_1 ?

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

$$\Delta H_c(H_2) = -286 \text{ kJ mol}^{-1}$$

$$\Delta H_c(CH_4) = -890 \text{ kJ mol}^{-1}$$

A $\Delta H_1 = 393 + 286 - 890$

B $\Delta H_1 = -393 - 286 + 890$

C $\Delta H_1 = -393 - (2 \times 286) + 890$

D $\Delta H_1 = 393 + (2 \times 286) - 890$

17 Here are two lattice enthalpy values (kJ mol^{-1}) for Period 1 oxides:

$$\text{Li}_2\text{O} \quad -2806$$

$$\text{Al}_2\text{O}_3 \quad -15916$$

What is the best explanation for the difference in lattice enthalpy values?

A The aluminium ion has a higher charge.

B Aluminium combines with three oxide ions.

C Aluminium is more reactive than lithium.

D Lithium is more reactive than aluminium.

- 18 Why does sodium chloride have the formula NaCl but magnesium chloride has the formula MgCl₂?
- A These formulae correspond to the valencies of sodium and magnesium.
 - B These formulae represent the ways that all atoms involved can have full electron shells.
 - C These are the most energetically favourable ratios for the ions involved.
 - D The valencies of sodium, magnesium and chlorine are satisfied by these formulae.
- 19 When calcium hydroxide solution and hydrochloric acid react, the equation is:
- $$\text{Ca(OH)}_2(\text{aq}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$$
- In a titration, 25 cm³ calcium hydroxide solution reacted with 23 cm³ 0.5 mol dm⁻³ hydrochloric acid.
- What is the concentration (mol dm⁻³) of the calcium hydroxide solution?
- A $0.5 \times 25 / 1000$
 - B $23 / 1000 \times 0.5 \times 2 \times 1000 / 25$
 - C $23 / 1000 \times 0.5 \times 0.5 \times 1000 / 25$
 - D $0.5 \times 23 / 1000 \times 25 / 1000$
- 20 Which reaction mechanism is characteristic of compounds containing a benzene ring?
- A Electrophilic addition
 - B Nucleophilic addition/elimination
 - C Electrophilic substitution
 - D Nucleophilic substitution

- 21 What particles are present in sodium hydroxide solution, NaOH(aq)?
- A NaOH, H₂O
 - B Na⁺, OH⁻, H⁺, H₂O
 - C NaO⁻, H⁺
 - D Na⁺, H⁺, OH⁻
- 22 How does the solubility of Group 2 hydroxides change from magnesium to barium?
- A Increases down the group.
 - B Decreases down the group.
 - C Stays the same.
 - D Increases to calcium then decreases.
- 23 Which statement best explains why Group 1 elements feature at the peaks in a graph of atomic radius against atomic number?
- A Group 1 elements have larger atomic volumes than other elements.
 - B Metallic bonds between Group 1 metal atoms are weak.
 - C Group 1 metals have the lowest first ionisation enthalpies of all elements.
 - D Single outer shell electrons of Group 1 metal atoms are less tightly bound than those of other elements.
- 24 Which statement is the best definition of a d-block element?
- An element with atoms that ...
- A ... have a full 4s electron shell, but partially filled d-shell.
 - B ... have a partially filled d-shell.
 - C ... form an ion with a partially filled d sub-shell.
 - D ... form two or more ions with variable oxidation states.



- 25 Which statement best represents enthalpy change of solution?
- A $\Delta H_{\text{solution}} = -\Delta H^{\circ}_{\text{LE}} + \Delta H_{\text{hydration(cation)}} + \Delta H_{\text{hydration(anion)}}$
- B $\Delta H_{\text{solution}} = \Delta H^{\circ}_{\text{LE}} + \Delta H_{\text{hydration(cation)}} + \Delta H_{\text{hydration(anion)}}$
- C $\Delta H_{\text{solution}} = \Delta H^{\circ}_{\text{LE}} - \Delta H_{\text{hydration(cation)}} - \Delta H_{\text{hydration(anion)}}$
- D $\Delta H_{\text{solution}} = -\Delta H^{\circ}_{\text{LE}} - \Delta H_{\text{hydration(cation)}} - \Delta H_{\text{hydration(anion)}}$
- 26 What is produced in the reaction occurring when excess concentrated ammonia solution is heated in a sealed tube with bromobutane?
- $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br} + 2\text{NH}_3 \rightarrow ?$
- A Butylamine
- B Butylamine, ammonium bromide
- C Bromobutylamine
- D 1-Bromo-2-aminobutane
- 27 Titanium(IV) chloride, TiCl_4 , is covalently bonded and magnesium chloride, MgCl_2 , is ionically bonded. They are mixed and heated to $1000\text{ }^{\circ}\text{C}$. The vapour only contains titanium(IV) chloride molecules. This is because:
- A Covalent bonds are weaker than ionic bonds so break more easily at high temperatures.
- B Covalent bonds are stronger than ionic bonds so the TiCl_4 molecules stay whole.
- C Ionic compounds have higher boiling points than covalent compounds.
- D Intermolecular bonds between covalently bonded molecules are weaker than attractions between ions.

28 A reaction has the general equation $2A + B \rightarrow C + D$

The rate of reaction was investigated by varying the concentration of the two reactants. The table shows the initial concentrations of the reactants and the relative rate of reaction.

[A]	[B]	relative rate
0.5	0.5	2
1.0	0.5	8
1.0	1.0	8
1.5	1.5	18

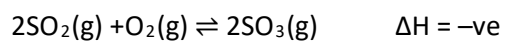
What are the orders of reaction with respect to A and B?

	[A]	[B]
A	2	1
B	4	0
C	0	2
D	2	0

29 Which equation represents the first ionisation enthalpy for an oxygen atom?

- A $O(g) + e \rightarrow O^-(g)$
- B $O(g) \rightarrow O^+(g) + e^-$
- C $O_2(g) \rightarrow O^{2+}(g) + e^-$
- D $O_2(g) + 2e^- \rightarrow O^{2-}$

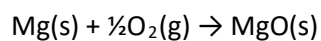
30 The main reaction in the contact process is:



What conditions help produce the maximum yield of sulfur trioxide?

- A High pressure and high temperature.
- B High pressure and low temperature.
- C Low pressure and low temperature.
- D Low pressure and high temperature.

31 When magnesium and oxygen react, a white solid is produced and light and heat are emitted.



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

- 32 The graph shows how rate of reaction changes over time for the decomposition of hydrogen peroxide. At which point, A, B, C or D, is the reaction complete?

