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 $H^+(aq)$.

D … is reduced during a neutralisation reaction.

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

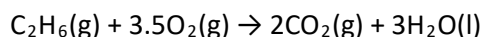Tetrachlorocupro(II) $[CuCl_4]$

Hexacyanoferrate(III) $[Fe(CN)_6]$

Hexa-amminenickel(II) $[Ni(NH_3)_6]$

	$[CuCl_4]$	$[Fe(CN)_6]$	$[Ni(NH_3)_6]$
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?

$C_2H_6(g) + 3.5O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$

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

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

A $\Delta H_C = -(6 \times 413) - 347 - (3.5 \times 498) + (4 \times 8050) + (6 \times 464)$

B $\Delta H_C = +(6 \times 413) + 347 + 498 - (2 \times 805) - (3 \times 464)$

C $\Delta H_C = +(6 \times 413) + 347 + (3.5 \times 493) - (4 \times 805) - (6 \times 464)$

D $\Delta H_C = -413 - 347 - 498 + 805 + 464$

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:

$aA + bB \rightarrow cC + dD$
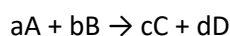
Rate = $k\ [A]^m[B]^n$

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:

$CO_2(g) \rightleftharpoons CO_2(aq)$
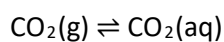
The "fizz" of a fizzy drink can be kept for several hours by using a "fizz-keeper" in place of a bottle cap. Air is pumped into the bottle after pouring out a drink. Which statement best explains how a fizz-keeper works?

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:

$Co(H_2O)_6^{2+} + 4Cl^- \rightleftharpoons CoCl_4^{2-} + 6H_2O$
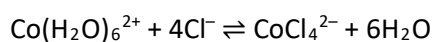
   PINK   BLUE

(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 $CH_3C(OH)(CH_3)CN$

B   Propanocyanohydrin, $CH_3CH_2(CH_3)CN$, OH^- ions

C   Propanal, CH_3CHOCH_3, CN^- ions

D   Butanocyanohydrin, CH_3COCH_2CN, hydrogen, H_2

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

	$CH_3CH(CH_3)CH(OH)CH_3$	$CH_3CH(CH_3)CH_2COOH$
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}?

$C_8H_{18} + 12.5O_2 \rightarrow 8CO_2 + 9H_2O$
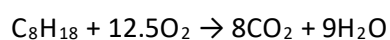
A_r values: H = 1, O = 16, C = 12; assume 1 mole of gas occupies 24 dm^3

A   570 / 114 × 12.5 × 24

B   114 / 570 × 12.5 × 24

C   570 / 114 × 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.
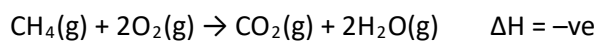
14   Use the expression:

$K_a = [H^+(aq)][A^-(aq)] / [HA(aq)]$

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

(K_a ethanoic acid = 1.7×10^{-5} mol dm^{-3} at 298 K)

pH of 1 mol dm^{-3}

A   3.39

B   1.7

C   2.38

D   4.12

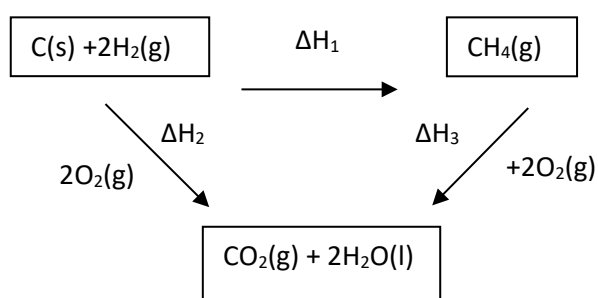15   Here is the equation for the reaction between methane and oxygen:

$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$ $\Delta H = -ve$

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?

ΔH_C (C) = −393 kJ mol^{-1}

ΔH_C (H$_2$) = −286 kJ mol^{-1}

ΔH_C (CH$_4$) = −890 kJ mol^{-1}

A ΔH_1 = 393 + 286 − 890

B ΔH_1 = −393 − 286 + 890

C ΔH_1 = −393 − (2 × 286) + 890

D ΔH_1 = 393 + (2 × 286) − 890

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

Li$_2$O   −2806

Al$_2$O$_3$ −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 $MgCl_2$?

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:

$Ca(OH)_2(aq) + 2HCl(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$

In a titration, 25 cm^3 calcium hydroxide solution reacted with 23 cm^3 0.5 mol dm^{-3} hydrochloric acid.

What is the concentration (mol dm^{-3}) of the calcium hydroxide solution?

A   0.5 × 25 / 1000

B   23 / 1000 × 0.5 × 2 × 1000 / 25

C   23 / 1000 × 0.5 × 0.5 × 1000 / 25

D   0.5 × 23 / 1000 × 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 $NaOH$, H_2O

    B Na^+, OH^-, H^+, H_2O

    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 $\Delta H_{solution} = -\Delta H^{\ominus}_{LE} + \Delta H_{hydration(cation)} + \Delta H_{hydration(anion)}$

B $\Delta H_{solution} = \Delta H^{\ominus}_{LE} + \Delta H_{hydration(cation)} + \Delta H_{hydration(anion)}$

C $\Delta H_{solution} = \Delta H^{\ominus}_{LE} - \Delta H_{hydration(cation)} - \Delta H_{hydration(anion)}$

D $\Delta H_{solution} = -\Delta H^{\ominus}_{LE} - \Delta H_{hydration(cation)} - \Delta H_{hydration(anion)}$

26   What is produced in the reaction occurring when excess concentrated ammonia solution is heated in a sealed tube with bromobutane?

$CH_3CH_2CH_2CH_2Br + 2NH_3 \rightarrow$?

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 °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 → 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:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H = -ve$$
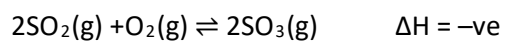
What conditions help produce the maximum yield of sulfur trioxide?

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.

$$Mg(s) + \tfrac{1}{2}O_2(g) \rightarrow MgO(s)$$
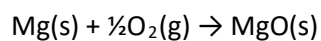
Which of these statements is correct?

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?