A Level Chemistry June 2020 P12

Thursday, November 5, 2020 2:15 PM

Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/12**

Paper 1 Multiple Choice **May/June 2020**

1 hour

You must answer on the multiple choice answer sheet.

You will need: Multiple choice answer sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data booklet

INSTRUCTIONS

- There are **forty** questions on this paper. Answer **all** questions.
- For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in soft pencil on the multiple choice answer sheet.
- Follow the instructions on the multiple choice answer sheet.
- Write in soft pencil.
- Write your name, centre number and candidate number on the multiple choice answer sheet in the spaces provided unless this has been done for you.
- Do **not** use correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

INFORMATION

- The total mark for this paper is 40.
- Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
- Any rough working should be done on this question paper.

I have used following colour codes:

- Blue colour used for facts or reasoning
- Red colour used for steps part of calculations along with its explanation
- Black colour used for right answer choice

This document has **16** pages. Blank pages are indicated.

[Turn over

Section A

For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider to be correct.

Use of the Data Booklet may be appropriate for some questions.

1 In which carbon allotrope are all electrons localised?

A buckminsterfullerene
B diamond
C graphite
D graphene

This is something which you are supposed to know that out of the four choices, diamond is the only one which has no delocalised electrons & thus does not conduct electricity

was $CuCO_3$ + a lot others

2 A copper ore contains 3.00% of copper carbonate, $CuCO_3$, by mass.

Which mass of copper would be obtained from 1 tonne of the ore?

A 1.91 kg **B** 3.71 kg **C** 15.4 kg **D** 58.4 kg

123.55

$\frac{3}{100} \times$ copper ore mass = copper mass ore

$123.55\,g$ of $CuCO_3 \longrightarrow 488.33\,g$ of copper ore

1 tonne of the ore has $30,000\,g$ of $CuCO_3$. To get separate masses:

$123.55\,g$ of $CuCO_3 \longrightarrow 63.546\,g$ of Cu

$30,000\,g$ of $CuCO_3 \longrightarrow 15430\,g$ of Cu

$\approx 15.4\,kg$

3 The catalysed formation of ammonia by the Haber process can be represented by the equation shown.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92\,kJ\,mol^{-1}$$

Which change in ~~conditions will~~ increase both the rate of formation and the equilibrium yield of ammonia?

A decrease in the temperature → this will decrease the rate
B increase in the temperature → this will increase the rate but decrease the yield bcz the reaction side which decreases temp. will be favoured & that is backward reaction
C increase in the pressure
D increase in the surface area of the catalyst → not a factor to increase equilibrium yield besides we should increase the surface area of reactants to increase the rate. NOT catalysts

4 Solid sulfur consists of S_8 molecules.

Which equation represents the standard enthalpy of atomisation of sulfur?

A $\frac{1}{8}S_8(s) \rightarrow S(g)$ ← energy to convert an element in its standard
B $\frac{1}{8}S_8(g) \rightarrow S(g)$ ← sulfur exists as a solid consisting of S_8 molecul
C $S_8(s) \rightarrow 8S(g)$

A $\frac{1}{8}S_8(s) \rightarrow S(g)$ energy to convert an element in its standard

B $\frac{1}{8}S_8(g) \rightarrow S(g)$ ← Sulfur exists as a solid consisting of S_8 molecul

C $S_8(s) \rightarrow 8S(g)$

D $S_8(g) \rightarrow 8S(g)$

Sulfur doesn't exist as a gas at standard conditions.

5 In this question you should use changes in oxidation numbers to balance a chemical equation.

The following reaction occurs when MnO_2 is warmed with dilute H_2SO_4.

$$a\,MnO_2 + b\,H^+ \rightarrow c\,Mn^{2+} + d\,MnO_4^- + e\,H_2O$$

What is the ratio of c : d in the correctly balanced equation?

A 1 : 1 **B** 1 : 2 . **C** 2 : 3 **D** 3 : 2

In these kind of Qs, you ought to first write all oxidation no.s on top of each atom/ion present. Write the differences in oxidation no.s of Mn on both sides of reaction. Next you must multiply both 2 and 3 with some number so that you get equal products. Here a to c gets 3 thus c = 3. Similarly, a to d gets 2. thus d = 2

6 In this question you should assume air contains 21% oxygen.

What is the minimum volume of air required to ensure complete combustion of 10 cm^3 of butane gas, under room conditions?

A 14 cm^3 **B** 27 cm^3 **C** 65 cm^3 **D** 310 cm^3

lets assume air has a volume of x cm

$\frac{21}{100} \times x = 65$

$x = 309.5\,cm^3$

$\approx 310\,cm^3$

$C_4H_{10} + \frac{13}{2}O_2 \rightarrow 4CO_2 + 5H_2O$

1 : 6.5

1 cm³ : 2.708×10^{-3} moles of O_2 to burn 10 cm³ of butane gas

or to say 65 cm³ of O_2

7 When aqueous bromine is shaken with cyclohexane and allowed to stand, two layers form. The top cyclohexane layer is coloured and the bottom aqueous layer is almost colourless.

What is the most likely explanation for this observation?

A Bromine is reduced to bromide ions in the bottom layer.

B Bromine molecules are non-polar.

C Bromine reacts with water but cannot react with cyclohexane.

D The product of the reaction between bromine and cyclohexane is coloured.

$Br_2(aq)$ C_6H_{12}

8 In which change are **only** temporary dipole-induced dipole forces overcome?

A $C_2H_5OH(l) \rightarrow C_2H_5OH(g)$ This has hydrogen bonding present

B $H_2O(s) \rightarrow H_2O(l)$ This has hydrogen bonding too present

C $O_2(s) \rightarrow O_2(l)$

D $C_4H_{10}(l) \rightarrow C_4H_{10}(s)$ This is contraction so no forces are overcome

9 The complete combustion of 2 moles of an alkane produces 400 dm^3 of carbon dioxide measured at 301 K and 1×10^5 Pa. Carbon dioxide can be assumed to behave as an ideal gas under these conditions.

What is the formula of the alkane?

A C_8H_{18} **B** $C_{16}H_{34}$ **C** $C_{20}H_{42}$ **D** $C_{40}H_{82}$

moles of $CO_2 = \frac{PXV}{RXT} = \frac{10^5 \times 0.4}{8.314 \times 301} = 16$

To balance no. of carbon atoms, we should have 16 on the left too.

2 alkane + $O_2 \rightarrow 16CO_2 + H_2O$

400 dm^3 → 0.4 m^3

301 K

10^5 Pa

10 In which reaction does an element undergo the largest change in oxidation number?

A $\overset{0}{Cl_2} + 2\overset{-2+1}{OH^-} \rightarrow \overset{-1}{OCl^-} + \overset{-1}{Cl^-} + \overset{+1\ -2}{H_2O}$

B $3\overset{0}{Cl_2} + 6\overset{-2+1}{OH^-} \rightarrow \overset{+5\ -2}{ClO_3^-} + 5\overset{-1}{Cl^-} + \overset{+1\ -2}{3H_2O}$

C $\overset{+6\ -2}{Cr_2O_7^{2-}} + 6\overset{+2}{Fe^{2+}} + 14\overset{+1}{H^+} \rightarrow 2\overset{+3}{Cr^{3+}} + 6\overset{+3}{Fe^{3+}} + \overset{+1\ -2}{7H_2O}$

D $3\overset{+6\ -2}{MnO_4^{2-}} + 4\overset{+1}{H^+} \rightarrow \overset{+4\ -2}{MnO_2} + 2\overset{+6\ -2}{MnO_4^-} + \overset{+1\ -2}{2H_2O}$

11 PCl_5 decomposes as shown.

moles after equilibrium

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

1.0 mol of $PCl_5(g)$, 1.0 mol of $PCl_3(g)$ and 1.0 mol of $Cl_2(g)$ are placed in a container of volume 1 dm^3 at 250 °C and allowed to reach equilibrium.

At this temperature, the equilibrium mixture contains 1.8 moles of PCl_3.

What is the value of K_c at 250 °C?

A 1 **B** 1.8 **C** 9 **D** 16.2

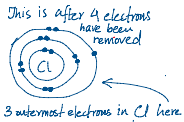
	$PCl_5 \rightleftharpoons$	PCl_3	+ Cl_2
moles at equil.	1	1	1
change	−0.8	+0.8	+0.8
moles after equil.	0.2	1.8	1.8

there is an increase of 0.8 moles to PCl_3 & mole ratio of PCl_3 to Cl_2 is 1:1 thus there should be 0.8 moles of increase in Cl_2 too. Since the mole ratio of PCl_5 to PCl_3 is 1:1 and PCl_5 converts to PCl_3 and Cl_2, there should be a decrease of 0.8 moles in PCl_5.

12 The fifth to eighth ionisation energies of four elements in Period 3 of the Periodic Table are shown.

Which row refers to chlorine?

	ionisation energies / kJ mol^{-1}			
	fifth	sixth	seventh	eighth
A	6280	21 200	25 900	30 500
B	6990	8 490	27 100	31 700
C	6540	9 330	11 000	33 600
D	7240	8 790	12 000	13 800



This is after 4 electrons have been removed

3 outermost electrons in Cl here should have similar ionisation energies and the 8th electron being removed is from shell nearer to nucleus so I.E should be very high

13 Magnesium nitrate, $Mg(NO_3)_2$, decomposes when heated to give a white solid and a mixture of gases. One of the gases released is an oxide of nitrogen, X.

7.4 g of anhydrous magnesium nitrate is heated until no further reaction takes place.

What mass of X is produced?

A 1.5 g **B** 2.3 g **C** 3.0 g **D** 4.6 g

$$Mg(NO_3)_2 \rightarrow MgO + 2NO_2 + \tfrac{1}{2}O_2$$

0.05 moles → 0.1 mole

1 → 2

mass = mole × molar mass

= 0.1 × 46

mass = 4.6 g

14 Which statement explains why iodine is less volatile than chlorine?

A Chlorine is more electronegative than iodine and so has more repulsion between its molecules.

B The greater number of electrons in iodine leads to larger temporary dipole-induced dipole forces.

C The I–I bond energy is smaller than the Cl–Cl bond energy.

D The iodine molecules have stronger permanent dipole-permanent dipole forces.

I_2 has more no. of electrons thus more van der waal forces and takes more time to break these bonds

has nothing to do with volatility

not present in I_2 or Cl_2 bc2 they are non-polar

15 Ammonium carbonate is a crystalline solid. On gentle warming a reaction occurs, forming ammonia as one product.

$(NH_4)_2CO_3$

$(NH_4)_2CO_3 \rightarrow NH_3 + \ldots$

How are the carbonate ions behaving during this reaction?

A Brønsted-Lowry acid

B Brønsted-Lowry base bc2 ammonium ion loses H^+ & becomes NH_3

C oxidising agent

D reducing agent

16 One molecule of an oxide of element Z reacts with six molecules of water to produce an acidic compound.

What is element Z?

A aluminium $Al_2O_3 + H_2O \rightarrow$ insoluble

B phosphorus $P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$

C silicon $SiO_2 + H_2O \rightarrow$ no reaction

D sulfur $SO_2 + H_2O \rightarrow H_2SO_3$

17 Which property shows an **increase** from magnesium to barium?

A the first ionisation energy of the elements decreases down the group

B the oxidising power of the metals decreases bc2 of increasing atomic radii

C the solubility of the hydroxides

D the solubility of the sulfates decreases down group II

brown gas

6 purple gas

18 A test-tube of HBr(g) and a separate test-tube of HI(g) are heated to the same temperature.

Which combination of observations is possible?

H–I has greater bond length than H–Br thus less time would be needed to break H–I bond and purple vapour forms first

	test-tube of HBr(g)	test-tube of HI(g)
A	a brown vapour appears	no change
B	a purple vapour appears	no change
C	no change	a brown vapour appears
D	no change	a purple vapour appears

19 Most modern cars are fitted with catalytic converters in the exhaust system.

Which three gases are removed by a catalytic converter?

This is theory which you must learn

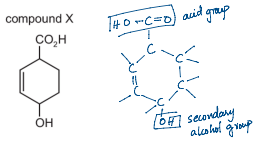
A carbon monoxide, hydrocarbons, nitrogen oxides

B carbon monoxide, carbon dioxide, nitrogen oxides

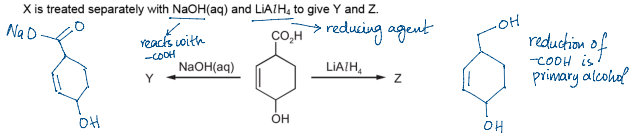
C carbon monoxide, nitrogen oxides, sulfur dioxide

D hydrocarbons, nitrogen oxides, sulfur dioxide

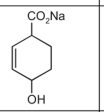
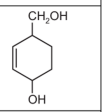
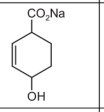
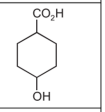
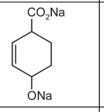
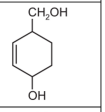
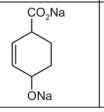
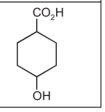
20 Compound X is shown.



X is treated separately with NaOH(aq) and $LiAlH_4$ to give Y and Z.



What are Y and Z?

	Y	Z
A		
B		
C		
D		

21 The table shows the molecular formulae of three molecules P, Q and R. None of the molecules are cyclic.

molecule	molecular formula
P	CH_4O
Q	CH_2O_2
R	CH_2O

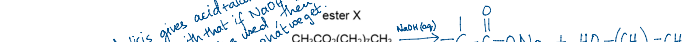
Which molecules show a strong absorption between 1610 cm^{-1} and 1750 cm^{-1} in their infra-red spectra?

A Q only **B** R only **C** Q and R only **D** P, Q and R

22 Which row correctly shows the type of mechanism of each of the two reactions?

	C_2H_5Br + KCN	CH_3COCH_3 + HCN
A	electrophilic substitution	electrophilic addition
B	electrophilic substitution	nucleophilic addition
C	nucleophilic substitution	electrophilic addition
D	nucleophilic substitution	nucleophilic addition

23 Ester X is shown.



Ester X is hydrolysed using aqueous sodium hydroxide.

What is the molecular formula of one of the products?

A $C_2H_4O_2$ **B** $C_2H_3O_2Na$ **C** $C_9H_{16}O$ **D** $C_8H_{17}O_2Na$

24 Which reagent could be used to distinguish between propane-1,2-diol and ethane-1,2-diol?

A alkaline aqueous iodine

B aqueous acidified dichromate(VI)

C ethanol and a few drops of concentrated sulfuric acid

D sodium metal

25 Which substance forms propanoic acid as one of the products when it reacts with hot concentrated acidified potassium manganate(VII)?

oxidising agent used for unsaturated compounds

A but-1-ene

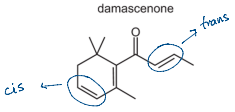
B but-2-ene

C 2-methylpropene

D 2-methylbut-1-ene

26 The structure of damascenone is shown.

damascenone



Including damascenone, how many stereoisomers exist with this structural formula?

A 1 **B** 2 **C** 4 **D** 8

27 How many isomeric esters have the molecular formula $C_4H_8O_2$?

A 2 **B** 3 **C** 4 **D** 5

28 Ethene reacts with aqueous bromine to give two products, CH_2BrCH_2Br and CH_2BrCH_2OH.

Which statement about these products is correct?

A Both products are obtained in this reaction by nucleophilic substitution. (electrophilic addition)

B Both products are obtained in this reaction by nucleophilic addition.

C Both products can be hydrolysed to form the same organic compound.

D Both products can form hydrogen bonds with water. (for hydrogen bonds, F N or O should be present with lone pair of electrons.)

29 PVC is used as a packaging material.

What holds the different polymer strands together in a piece of solid PVC?

This is part of theory that you must know

A covalent bonds

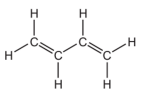
B hydrogen bonds

C ionic bonds

D van der Waals' forces

30 The diagram shows the structure of buta-1,3-diene.

buta-1,3-diene



The addition reaction between buta-1,3-diene and two molecules of hydrogen bromide can produce three structurally isomeric products.

How many of these products have at least one chiral centre?

A 0 **B** 1 **C** 2 **D** 3

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

Use of the *Data Booklet* may be appropriate for some questions.

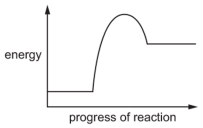
31 Scientists are trying to synthesise a new element with proton number 119. The element is predicted to be a Group 1 element in Period 8 of the Periodic Table. B
1 electron in its outermost shell transition elements
Which predictions are likely to be correct about this element?

1 ✓ The outermost occupied orbital of one atom of this element will be an s orbital.

2 ✓ The atomic radius will be the largest of the seven elements in Group 1. bcz it increases down group I

3 ✗ It will have a greater first ionisation energy than element 118. on periodic table, 118 would be a noble gas so it would have higher i.e than 119

32 Which reactions would have the reaction profile shown? C



endothermic reactions have such energy graphs where products have higher energy than that of reactants

1 ✗ $NaOH + HCl \rightarrow NaCl + H_2O$ neutralisation

2 ✓ $CaCO_3 \rightarrow CaO + CO_2$ } decomposition which requires heating

3 ✓ $2MgO \rightarrow 2Mg + O_2$ }

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

33 Which factors can lead to an increase in the rate of a reaction? A

1 ✓ a lower activation energy

2 ✓ an increase in temperature

3 ✓ an increase in the concentration of a reactant

activation energy, temp., concentration of reactants, surface area of reactants affect rate of reaction

34 Sodium and fluorine are both reactive elements. Two atoms are described. A

	F	Na
atomic number	9	11
nucleon number	19	23

Na	Na^+	F	F^-
P-11	P-11	P-9	P-9
N-12	N-12	N-10	N-10
E-11	E-10	E-9	E-10

Which statements about these two atoms, and the ions they can form, are correct?

1 ✓ One Na atom has two more protons than one F^- ion.

2 ✓ One Na atom has two more neutrons than one F atom.

3 ✓ One Na^+ ion has the same number of electrons as one F^- ion.

35 In the atmosphere, which transformations can involve sulfur dioxide as either a reagent or a catalyst? D

1 NO_2 to NO $NO_2 + SO_2 \longrightarrow N_2 + SO_3$

2 ✗ NO to NO_2 $NO + O_2 \longrightarrow NO_2$

3 CO to CO_2

1 and 3 are not any of our choices hence 1

A

36 The bond .....P..... of the HBr molecule is .....Q..... than that of the HI molecule.

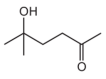
Which pairs of words correctly complete the above sentence?

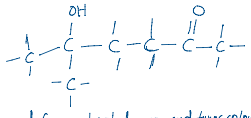
	P	Q
1	energy	greater
2	length	less
3	polarity	greater

These properties are all part of theory
Bond length ↑ down the group
Bond energy ↓ down the group
Bond polarity is greater on the top

37 Compound X has the structure shown. C

compound X





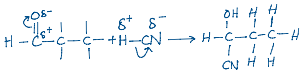
Which statements about compound X are correct?

X will decolourise cold, acidified $KMnO_4$(aq). → this is used for unsaturated comp. and turns colourless from purple when diols are added by expansion of double bond C=C

2 X gives an orange precipitate with 2,4-DNPH reagent. → it gives orange ppt. if aldehyde or ketone is present

3 X does not react with Tollens' reagent. → it turns silver from colourless mixture if aldehyde is present

38 Propanal reacts with hydrogen cyanide. A



Which absorptions are present in the infra-red spectrum of the product?

1 a weak absorption in the range 2200–2250 cm^{-1} → nitriles C≡N

2 a strong absorption in the range 3200–3600 cm^{-1} → alcohols O–H

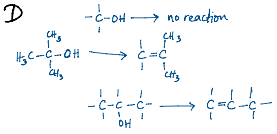
3 a strong absorption in the range 1040–1300 cm^{-1} → alcohols C–O

39 Which alcohols **cannot** be dehydrated to form alkenes? D

1 CH_3OH

2 $(CH_3)_3COH$

3 $CH_3CH(OH)CH_3$

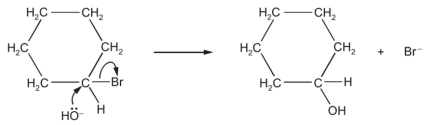


The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

40 A reaction mechanism is shown. B



Which statements about this reaction are correct?

1 Heterolytic bond fission occurs. C–Br → E_1 HO–X

2 It is a substitution reaction. OH replaces Br

3 OH^- behaves as an electrophile. → specie that wants electron pair

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