PIONEER JUNIOR COLLEGE

JC2 PRELIMINARY EXAMINATION
HIGHER 2

CANDIDATE NAME								
CT GROUP	1	3				INDEX NUMBER		

CHEMISTRY 9647/01

Paper 1 Multiple Choice **26 September 2014**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your name, CT group and index number in the spaces at the top of this page and on the Answer Sheet in the spaces provided.
Do not use staples, paper clips, highlighters, glue or correction fluid.

There are **forty** questions in 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 separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

Section A

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

1 *Use of the Data Booklet is relevant to this question.*

How many molecules are present in 1 cm^3 of methane gas under room conditions?

A $\frac{1 \times 24000}{6.02 \times 10^{23}}$

B $\frac{1 \times 6.02 \times 10^{23}}{24000}$

C $\frac{6.02 \times 10^{23} \times 24000}{1 \times 1000}$

D $1 \times 6.02 \times 10^{23} \times 16$

2 *Use of the Data Booklet is relevant to this question.*

Sodium percarbonate, $(Na_2CO_3)_x.y(H_2O_2)$, is an oxidising agent in some home and laundry cleaning products.

5.0 cm^3 of 0.200 mol dm^{-3} sodium percarbonate releases 48.0 cm^3 of carbon dioxide at room conditions on reaction with excess hydrochloric acid.

An identical sample, on titration with 0.100 mol dm^{-3} acidified $KMnO_4$, requires 12.0 cm^3 before the first pink colour appears.

What is the ratio *x* : *y*?

A 1 : 3 **B** 2 : 3 **C** 3 : 2 **D** 4 : 3

3 When iron is reacted with aqueous iron(III) ions, iron(II) ions are formed.

Assuming the reaction goes to completion, how many moles of Fe and $Fe^{3+}(aq)$ would result in a solution containing only $Fe^{2+}(aq)$ once the reaction had taken place?

	No. of moles of Fe	No. of moles of $Fe^{3+}(aq)$
A	1	2
B	1	3
C	1	5
D	2	3

4 *Use of the Data Booklet is relevant to this question.*

What do the ions $^{36}S^{2-}$ and $^{37}Cl^{-}$ have in common?

A Both ions have an outer electronic configuration $2s^2\ 2p^6$.

B Both ions have more electrons than neutrons.

C Both ions have 20 neutrons in their nuclei.

D Both ions contain the same number of nucleons in their nuclei.

5 The shapes of three species, **E**, **F** and **G** are bent, square planar and T-shaped respectively.

What could **E**, **F** and **G** be?

	E	**F**	**G**
A	CS_2	BrF_4^-	BH_3
B	NO_2	XeF_4	$BrCl_3$
C	H_2O	PCl_4^+	XeF_3^+
D	H_2O	SF_4	ICl_3

6 An ideal gas obeys the general gas equation pV = nRT.

Which of the following statements is correct?

A The volume of a given mass of an ideal gas is doubled if the temperature is increases from 50 ^oC to 100 ^oC

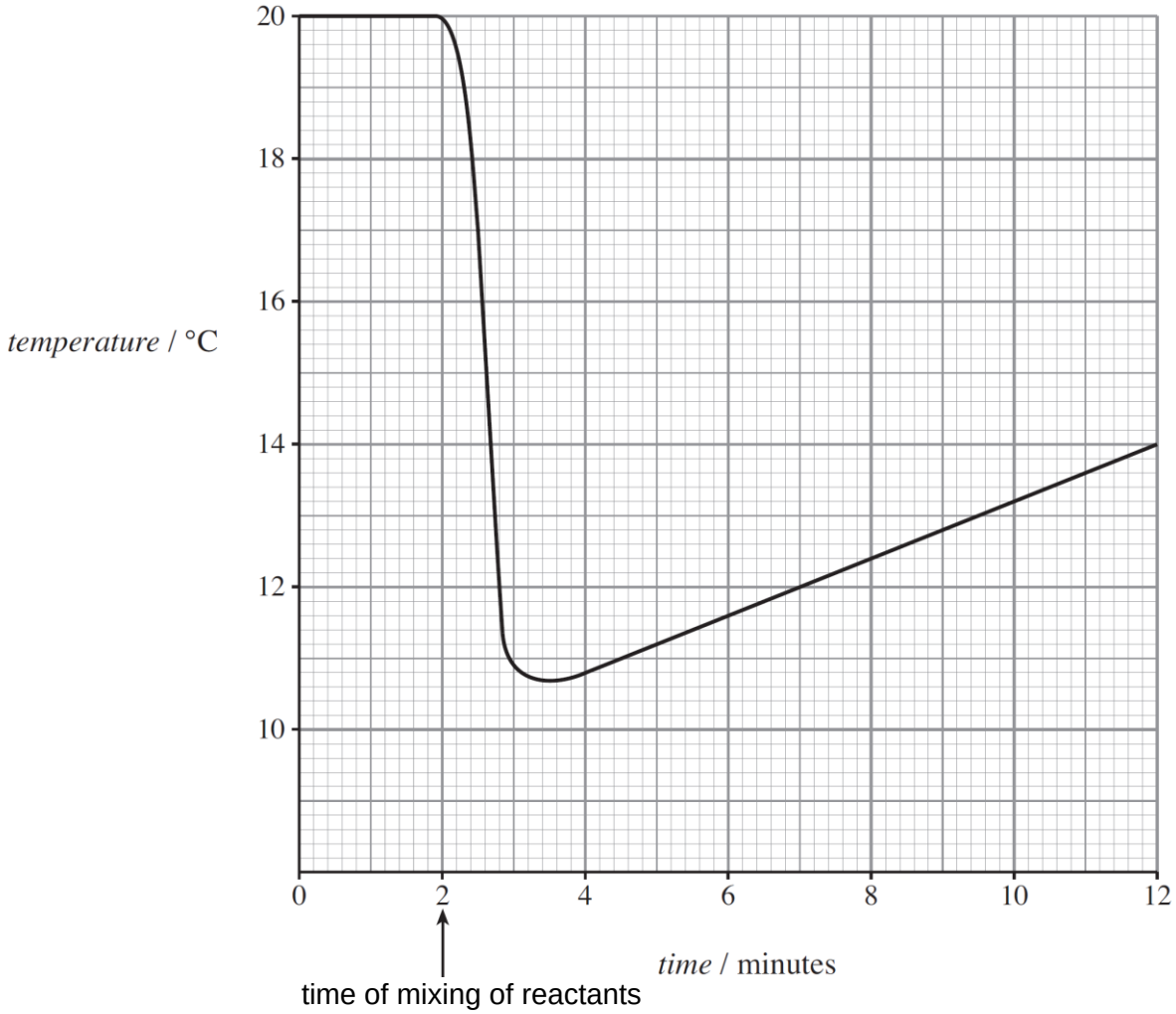
B For a given mass of an ideal gas, the pressure is proportional to its volume at constant temperature.

C One mole of any ideal gas occupies 22.4 dm^3 at 25 ^oC and 1 atm.

D The density of an ideal gas at constant pressure is inversely proportional to its temperature.

7 *Use of the Data Booklet is relevant to this question.*

In an experiment to determine the enthalpy change of solution of ammonium nitrate, 10.00 g of solid ammonium nitrate (M_r = 80.0) was added to 50 g of water. The temperature of the resultant solution monitored at various time intervals and the following graph was obtained.



What is the enthalpy change of solution of ammonium nitrate?

A +15.5 kJ mol^{-1}

B +16.7 kJ mol^{-1}

C −15.5 kJ mol^{-1}

D −16.7 kJ mol^{-1}

8 In a blast furnace, carbon or carbon monoxide can be used to reduce iron(III) oxide.

$2Fe_2O_3(s) + 3C(s) \rightarrow 4Fe(s) + 3CO_2(g)$ $\Delta H = +468$ kJ mol^{-1}

$Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$ $\Delta H = -24.8$ kJ mol^{-1}

Carbon monoxide can be formed by the following reaction.

$C(s) + CO_2(g) \rightarrow 2CO(g)$ ΔH_1

What is the value of ΔH_1 in kJ mol^{-1}?

A +258.8 **B** +172.5 **C** +139.5 **D** +86.3

9 A student investigated the kinetics of the reaction between 1.00 mol dm^{-3} potassium iodide and 0.0500 mol dm^{-3} sodium peroxodisulfate.

$$S_2O_8^{2-}(aq) + 2I^-(aq) \rightarrow 2SO_4^{2-}(aq) + I_2(aq)$$

The two reactants were mixed in the presence of a known amount of sodium thiosulfate and a few drops of starch. The time taken for an intense blue colour to be observed was recorded.

Experiment number	Volume used / cm^3			Time / s
	KI	$Na_2S_2O_8$	H_2O	
1	10.0	5.0	25.0	170
2	15.0	5.0	20.0	113
3	15.0	10.0	15.0	56.5
4	20.0	20.0	0.0	***z***

What is the value of ***z***?

A 11 **B** 21 **C** 85 **D** 1360

10 A $Cu^{2+}|Cu$ half-cell was connected to a $Ag^+|Ag$ half-cell through a salt bridge that contained aqueous K_2SO_4. The voltmeter registered a reading of +0.44 V.

Which could be a reason for the discrepancy between the calculated E_{cell} and the observed value of +0.44 V?

A The piece of copper in the $Cu^{2+}|Cu$ half-cell was too small.

B The piece of silver in the $Ag^+|Ag$ half-cell was too large.

C The concentration of Cu^{2+} was larger than 1 mol dm^{-3}.

D The concentration of Ag^+ was larger than 1 mol dm^{-3}.

11 5.00 g of silver was deposited when electricity was passed through silver nitrate solution. The same quantity of electricity also liberated 3.02 g of an element **H** from a solution containing an unknown cation, $\mathbf{H}^{\mathbf{j+}}$.

It is known that the relative atomic mass of **H** is 197, what is the value of **j**?

A 1 **B** 2 **C** 3 **D** 5

12 A chemist carried out a series of experiments involving the following equilibrium.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g); \qquad \Delta H = +54 \text{ kJ mol}^{-1}$$

He performed the first set of experiment at a temperature T_1 K and found that the equilibrium constant, K_c has a value of 64.

In the second set of experiment, he added 1.0 mol of H_2 and 1.0 mol of I_2 into a 1 dm^3 flask, at a temperature of T_2 K. When equilibrium was established, the flask was found to contain 1.2 mol of HI.

What is the relationship between T_1 and T_2?

A $T_1 = T_2$

B $T_1 > T_2$

C $T_1 < T_2$

D The relationship cannot be determined based on his experiments alone.

13 Solutions **M**, **N**, **O** and **P** contain a strong acid, a weak acid, a salt of weak acid and a strong base, but not necessarily in the same order. The concentration and pH of each solution are shown below. (You may assume that all acids and bases react in a 1 **:** 1 ratio.)

Solution	*Concentration in mol dm^{-3}*	*pH*
M	1.0	2.4
N	1.0	9.4
O	0.010	12.0
P	0.001	3.0

Which of the following statements is **not** correct?

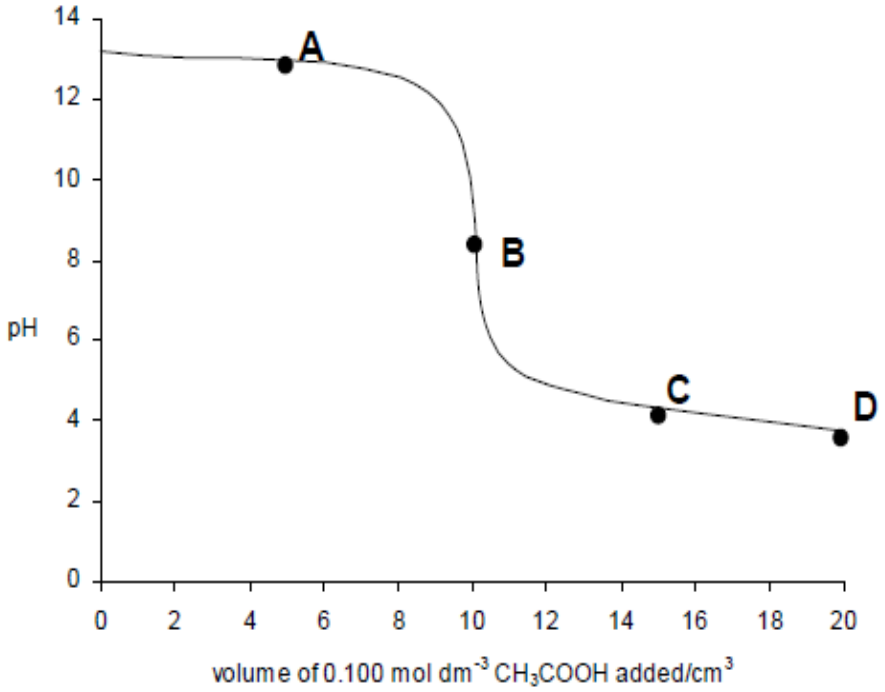
A **M** contains a weak acid while **P** contains a strong acid.

B Mixing 10 cm^3 of **M** and 500 cm^3 of **O** produces a buffer solution.

C Mixing 10 cm^3 of **O** and 500 cm^3 of **P** produces a buffer solution.

D Mixing 100 cm^3 of **M** and 100 cm^3 of **N** produces a buffer solution.

14 The pH change when 0.100 mol dm^{-3} CH_3CO_2H is added dropwise to 10.0 cm^3 of 0.100 mol dm^{-3} KOH(aq) is given in the graph below.



At which point on the graph does pH = pK_a, where K_a is the acid dissociation constant of the weak acid?

15 The solubility product of a substance is ***S***. If the concentration of the cation in a saturated solution is found to be $(\frac{9S}{4})^{\frac{1}{5}}$, what could be the substance?

A $CaCl_2$

B $Ca_3(PO_4)_2$

C $Al(OH)_3$

D $Al_2(SO_4)_3$

16 Element **Q** is in Period 3 of the Periodic Table. The following four statements were made about the properties of **Q** or its compounds.

Three statements are correct descriptions and one is false.

Which statement does **not** fit with the other three?

A Effervescence and a white precipitate are observed when Na_2CO_3(aq) is added to the solution resulting from the reaction of **Q**Cl_3 with water.

B The oxide of **Q** dissolves on reaction with NaOH(aq).

C The oxide of **Q** reacts with water to give an acidic solution.

D Element **Q** has the highest electrical conductivity.

17 What changes occur in the magnitude of

(i) the lattice energy
(ii) the enthalpy change of hydration
(iii) the solubility of the hydroxides

as Group II is descended?

	lattice energy	enthalpy change of hydration	solubility of hydroxides
A	decrease	decrease	increase
B	decrease	increase	decrease
C	increase	decrease	decrease
D	increase	increase	increase

18 When concentrated sulfuric acid is added to separate samples of sodium chloride, sodium bromide and sodium iodide, which set of halogen-containing substances is produced?

A HCl, HBr and HI only

B HCl, Br_2 and I_2 only

C Cl_2, Br_2 and I_2 only

D HCl, HBr, Br_2, HI and I_2 only

19 *Use of the Data Booklet is relevant to this question.*

Iron and aluminium are metals that are widely used in alloys. Each metal forms many compounds containing a M^{3+} ion.

Which statement about the electron arrangements in these atoms and ions is correct?

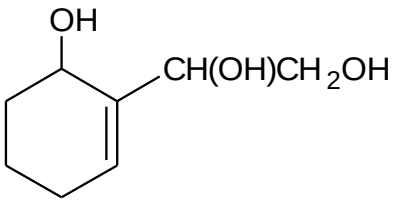
A A Fe atom has less unpaired electrons than an Al atom.

B Fe^{3+} and Al^{3+} ions have similar outer electron configurations.

C A Fe atom has one more occupied electron shell than an Al atom.

D A Fe^{3+} ion has three more occupied electron shells than an Al^{3+} ion.

20 Which statement about compound **R** is correct?



Compound **R**

A It has cis-trans isomers.

B It has three chiral centres.

C It has three sp^2 hybridised carbon atoms.

D It has four stereoisomers.

21 Which statement regarding the reaction of chloroethane with bromine in sunlight is correct?

A A possible product of the reaction is 2,3–dichlorobutane.

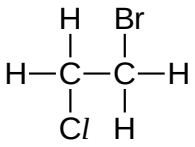
B During the reaction, there is no product formed that can rotate plane-polarised light.

C HBr is formed at the termination step.

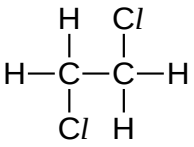
D The intermediates are more energetically stable than the reactants.

22 Which compound is **not** an addition product of the reaction between ethene with aqueous chlorine in the presence of potassium bromide?

A



B



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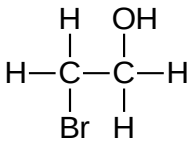
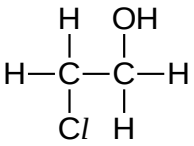


D



23 The reddish brown colour of aqueous bromine is decolourised when a solution of phenol is added to it. Which statement explains this observation?

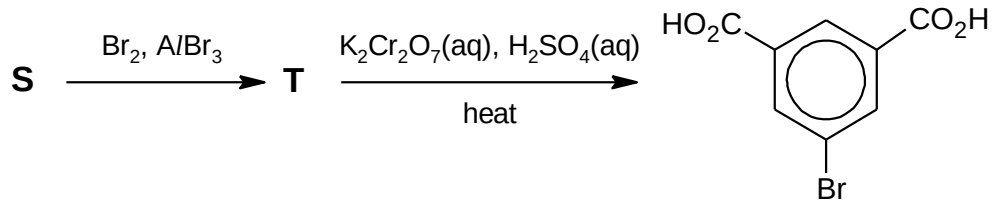
A Bromine substitutes hydrogen in the benzene ring.

B Bromine forms a colourless complex with phenol.

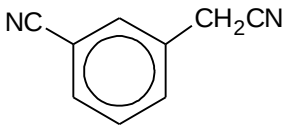
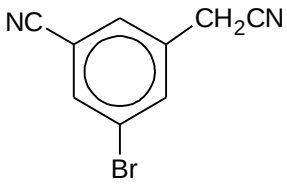
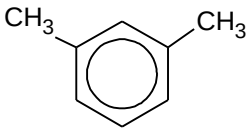
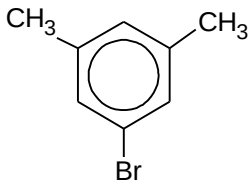
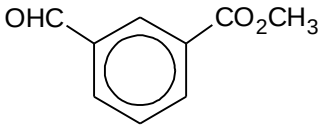
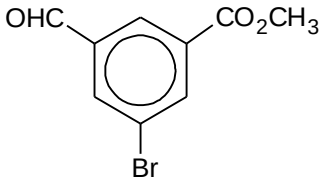
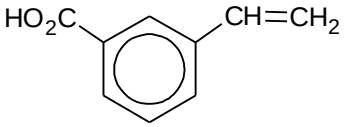
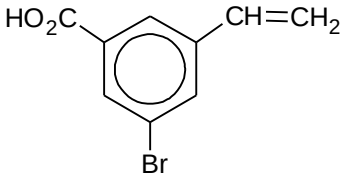
C Bromine is reduced to bromide ion by phenol.

D Bromine substitutes hydrogen in the OH group.

24 A reaction scheme showing the formation of a dicarboxylic acid from compound **S** is given below.



What could compounds **S** and **T** be?

	compound **S**	compound **T**
A		
B		
C		
D		

25 Propanone and propanal are separately reacted with hydrogen cyanide under the same conditions.

Which statement is correct?

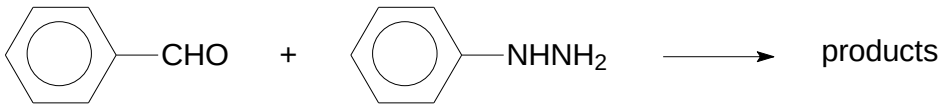
A The product mixture from the reaction with propanone is able to rotate plane-polarised light.

B The product mixture from the reaction with propanal is able to rotate plane-polarised light.

C Propanal reacts faster due to less steric hindrance at the carbonyl carbon atom.

D Propanone reacts faster due to greater inductive effect of the two methyl groups.

26 The reaction of benzaldehyde with phenylhydrazine is similar to that of 2,4–dinitrophenylhydrazine.

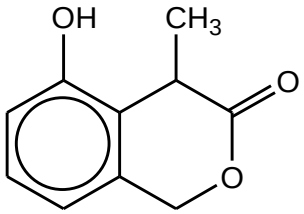


phenylhydrazine

What changes in bonding occur during the reaction?

	Number of sigma bonds broken	Number of pi bonds broken	Number of new sigma bonds made	Number of new pi bonds made
A	2	1	1	1
B	2	1	2	1
C	3	1	1	1
D	3	1	3	1

27 Which deduction about the reactions of compound **U** can be made from its structure?



Compound **U**

A It gives white fumes of HC*l* with PCl_5.

B It gives a yellow precipitate with aqueous alkaline iodine.

C It gives an orange precipitate with 2,4–dinitrophenylhydrazine.

D It gives hydrogen gas with sodium metal.

28 Which reaction does **not** yield a carbon compound incorporating deuterium, D? [D = ^2H]

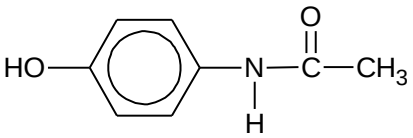
A $CH_3CH{=}CH_2 \xrightarrow{Br_2,\ D_2O}$

B $CH_3CONH_2 \xrightarrow[\text{heat}]{NaOD,\ D_2O}$

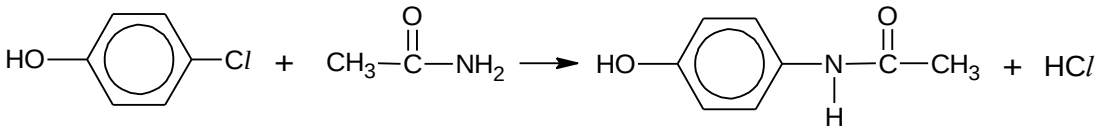
C $CH_3CO_2H \xrightarrow{LiAlD_4 \text{ in dry ether}}$

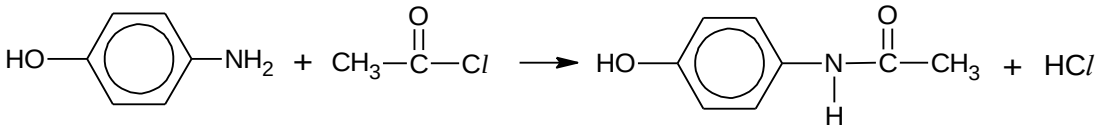
D $C_6H_5COCl \xrightarrow{D_2O}$

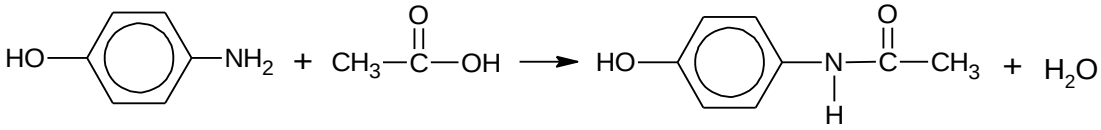
29 Acetaminophen is a drug used in headache remedies. It has the structure:

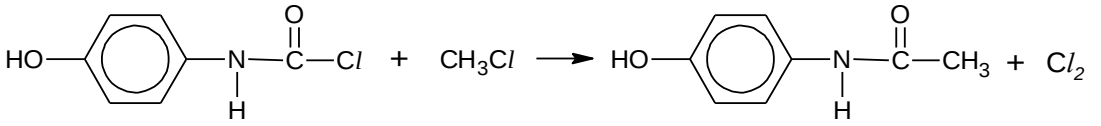


Which equation gives the best method for its synthesis?

A


B


C


D


30 Which sequence will give solutions of decreasing pH when equimolar quantities of the organic compounds are separately dissolved in water?

A ethanamide, phenol, ethanoic acid, ethanoyl chloride

B ethanamide, phenol, ethanoyl chloride, ethanoic acid

C ethanoyl chloride, ethanoic acid, phenol, ethanamide

D ethanoic acid, ethanoyl chloride, phenol, ethanamide

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.

31 Which pairs of compounds would the first compound have a higher melting point than the second compound?

1 AlF_3 $AlBr_3$

2 HBr HI

3 KCl NaCl

32 **X** and **Y** are ideal gases that do not react. The mass of 1 mole of gas **X** is four times that of gas **Y**.

Which statements about **X** and **Y** are true?

1 The average kinetic energy of a molecule of gas **X** is four times that of a molecule of gas **Y** at the same temperature.

2 The mass of 1 dm^3 of gas **X** is four times that of 1 dm^3 of gas **Y** at the same temperature and pressure.

3 The partial pressure of 1 g of gas **X** is a quarter of the partial pressure of 1 g of gas **Y** at constant volume and temperature.

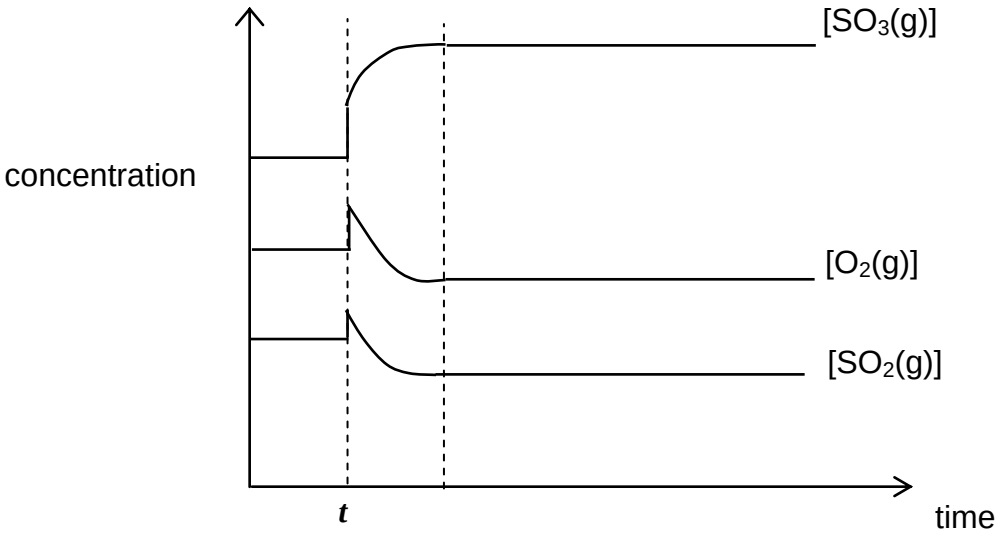
The responses **A** to **D** should be selected on the basis of

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 A reaction mixture containing three gases at equilibrium is subjected to a change at time ***t***, and allowed to reach a new equilibrium. The variation of the concentrations of the gases with time is shown below.

$$SO_2(g) + \tfrac{1}{2}O_2(g) \rightleftharpoons SO_3(g) \qquad \Delta H = -ve$$



What changes made at time ***t*** would result in the variation of the concentrations of the gases shown above?

1 The volume of the reaction vessel was decreased.

2 The temperature in the reaction vessel was decreased.

3 A suitable catalyst was added to the reaction vessel.

34 Which statements explain why silver chloride is soluble in aqueous ammonia but silver iodide is not?

1 The lattice energy of silver chloride is numerically larger than that of silver iodide.

2 The solubility product of silver chloride is numerically larger than that of silver iodide.

3 The equilibrium constant for the reaction,
$AgX(s) + 2NH_3(aq) \rightleftharpoons Ag(NH_3)_2X(aq)$, is numerically greater for X = C*l* than for X = I.

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.

35 Which statements are correct for the sequence of compounds below considered from left to right?

NaF MgO AlN SiC

1 The electronegativity difference between the elements in each compound decreases.

2 The formula units of these compounds are isoelectronic (have the same number of electrons).

3 The bonding becomes increasingly covalent.

36 When aqueous solutions of copper(II) sulfate and potassium iodide are mixed, a white precipitate in brown solution is observed. On the addition of sodium thiosulfate to this mixture, the brown solution decolourises.

Which processes occur in this sequence?

1 precipitation of copper(I) iodide

2 reduction of iodine

3 formation of $S_2O_8^{2-}$ ions

37 Compound **Z**, $CH_3CO_2CH_2CHO$, was reacted in separate experiments with

(i) 2,4–dinitrophenylhydrazine reagent;

(ii) Tollens' reagent $[Ag(NH_3)_2]^+(aq)$;

(iii) alkaline aqueous iodine

Which statements about these reactions are correct?

1 One mole of **Z** could only react with one mole of 2,4-dinitrophenylhydrazine in (i).

2 One mole of **Z** could form two moles of Ag in (ii).

3 One mole of **Z** could only form one mole of CHI_3 in (iii).

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.

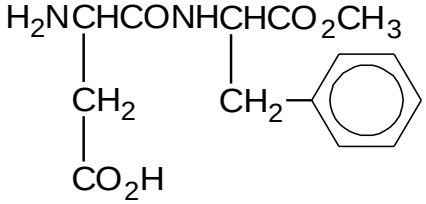
38 In a beehive, the queen bee secretes the substance below to cause worker bees to begin constructing royal colony cells.

$CH_3CO(CH_2)_5CH=CHCO_2H$
queen bee substance

What products would be formed when the queen bee substance is treated with the following reducing agents?

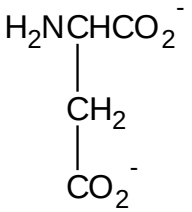
	reducing agent	*product obtained*
1	$NaBH_4$	$CH_3CH(OH)(CH_2)_5CH_2CH_2CO_2H$
2	$LiAlH_4$	$CH_3CH(OH)(CH_2)_5CH=CHCH_2OH$
3	H_2, Ni	$CH_3CH(OH)(CH_2)_5CH_2CH_2CO_2H$

39 Aspartame is a dipeptide derivative used as an artificial sweetening agent in many soft drinks. Its general usefulness is restricted because it loses its sweetness after hydrolysis.

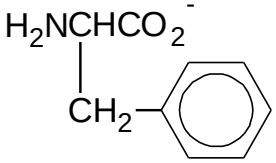


Which products would be formed after prolonged alkaline hydrolysis?

1



2



3 $CH_3O^-Na^+$

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 Lysine plays a major role in calcium absorption; building muscle protein; recovering from sports injuries; and the body's production of hormones, enzymes and antibodies.

$NH_2CH(CH_2CH_2CH_2CH_2NH_2)CO_2H$
lysine

The pK_a values of lysine are as follows: α-CO_2H, 2.2; α-NH_3^+, 9.0; side chain, 10.5.

Which statements about lysine are correct?

1 The zwitterion form of lysine is $NH_2CH(CH_2CH_2CH_2CH_2NH_3^+)CO_2^-$.

2 The predominant species at pH 4 will migrate to the cathode during electrophoresis.

3 At pH 9.5, there will be no movement of the predominant species to either electrode during electrophoresis.

End of Paper

Answers

1	B	**11**	C	**21**	A	**31**	D
2	B	**12**	B	**22**	C	**32**	C
3	A	**13**	C	**23**	A	**33**	D
4	C	**14**	D	**24**	C	**34**	C
5	B	**15**	B	**25**	C	**35**	A
6	D	**16**	C	**26**	D	**36**	B
7	B	**17**	A	**27**	D	**37**	B
8	B	**18**	D	**28**	B	**38**	C
9	B	**19**	C	**29**	B	**39**	B
10	C	**20**	D	**30**	A	**40**	A