



ANDERSON SERANGOON JUNIOR COLLEGE

2019 JC 2 PRELIMINARY EXAMINATIONS

CHEMISTRY

Higher 2

Paper 1 Multiple Choice

9729/01

19 September 2019

1 hour

Additional Materials: Multiple Choice Answer Sheet
 Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name and class on the Answer Sheet in the spaces provided.

There are **thirty** 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 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.

The use of an approved scientific calculator is expected, where appropriate.

This document consists of **18** printed pages and **2** blank pages.

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

The ^{68}Ge isotope is medically useful because it undergoes a natural radioactive process to give an isotope of a different element, ^{68}Q , which can be used to detect tumours. This transformation of ^{68}Ge occurs when an electron enters the nucleus and changes a proton into a neutron.

Which statement about the composition of an atom of ^{68}Q is correct?

- A It has 4 electrons in its outer p orbitals.
- B It has 13 electrons in its outer shell.
- C It has 37 neutrons.
- D Its proton number is 32.

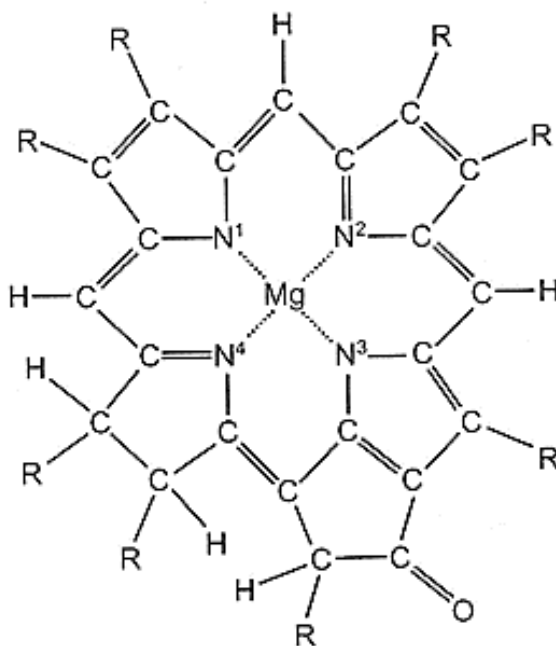
- 2 The successive ionisation energies (IE) of two elements **X** and **Y** are given in the table.

IE / kJ mol^{-1}	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th
X	786	1580	3230	4360	16000	20000	23600	29100
Y	1300	3380	5310	7460	8670	9330	22060	27070

What compound is most likely to be formed when **X** and **Y** are combined?

- A ionic, with formula X_2Y
- B ionic, with formula XY_2
- C covalent, with formula XY_2
- D covalent, with formula X_2Y

- 3 Plants appear green due to the presence of chlorophyll. There are several closely related chlorophylls and the diagram shows a simplified version of one. The various different side-groups are all shown as R.

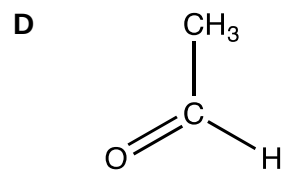
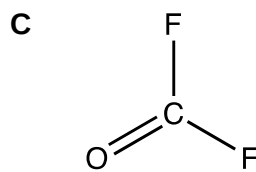
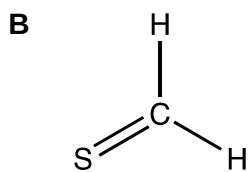
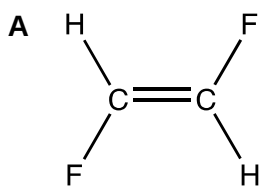


Note that the four N atoms and the Mg ion are planar.

Which of the descriptions of the bonds between Mg and the numbered N atoms is most likely to be correct?

	N atoms numbered	
	1 and 3	2 and 4
A	co-ordinate	ionic
B	co-ordinate	π
C	ionic	co-ordinate
D	π	co-ordinate

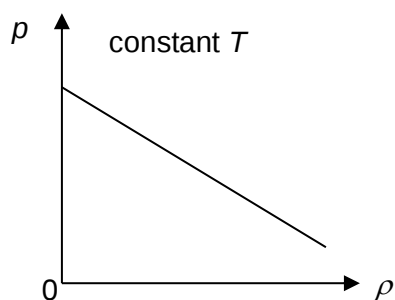
- 4 Which molecule has the largest dipole?



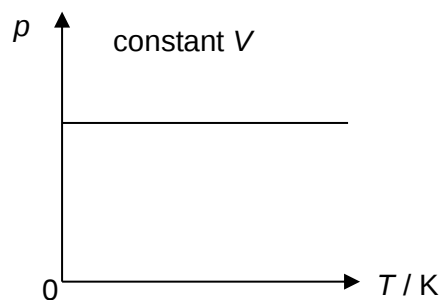
- 5 Which graph best represents the behaviour of a fixed mass of an ideal gas under the given conditions?

(ρ is the density of the gas)

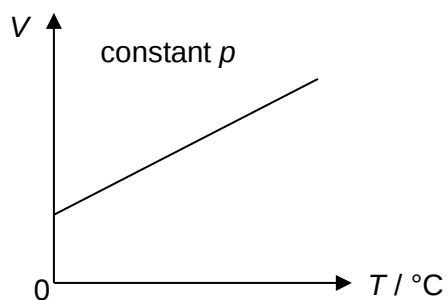
A



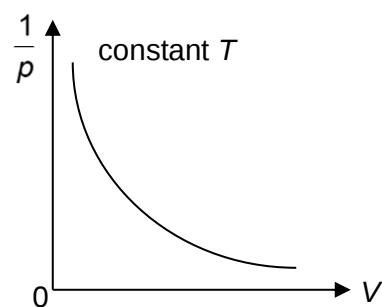
B



C



D



- 6 Which of the following, in aqueous solution, could be used to maintain the pH at about 5?

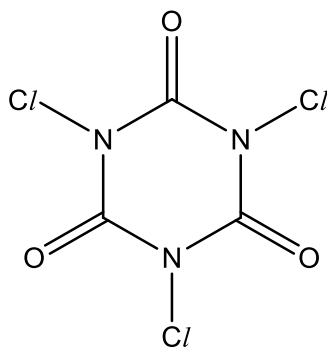
- A** ammonia and ammonium chloride
- B** ethanoic acid and sodium ethanoate
- C** sodium hydroxide and sodium ethanoate
- D** ethanoic acid only

- 7 Values of the ionic product of water, K_w , at different temperatures are given in the table.

temperature / °C	K_w / mol ² dm ⁻⁶
15	4.50×10^{-15}
30	1.47×10^{-14}

What can be deduced from this information?

- A The association of water molecules by hydrogen bonding increases as temperature increases.
- B Water is not a neutral liquid at 15 °C.
- C The concentrations of both H^+ and OH^- increase as temperature increases.
- D The ionic dissociation of water is an exothermic reaction.
- 8 Which property of the halogens increases on descending Group 17?
- A volatility of the halogens
- B bond energy of the halogen–halogen bond
- C ease of oxidation of the halide ion
- D thermal stability of the hydrogen halide
- 9 Trichloroisocyanuric acid is commonly used in swimming pools as a disinfectant. The recommended concentration level of the acid is 1.50 mg per litre of water.



trichloroisocyanuric acid

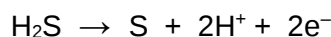
$$M_r = 232.5$$

How many chlorine atoms are present in a 2.50×10^6 litre Olympic-sized swimming pool filled with the recommended concentration level of trichloroisocyanuric acid?

- A 2.91×10^{25}
- B 2.91×10^{28}
- C 9.71×10^{24}
- D 9.71×10^{27}

- 10 When 720 cm³ of hydrogen sulfide gas, H₂S, is passed through 40 cm³ of 0.500 mol dm⁻³ nitric acid, HNO₃, a yellow solid of sulfur and a nitrogen-containing compound are formed.

The half-equation for oxidation of H₂S is shown below.

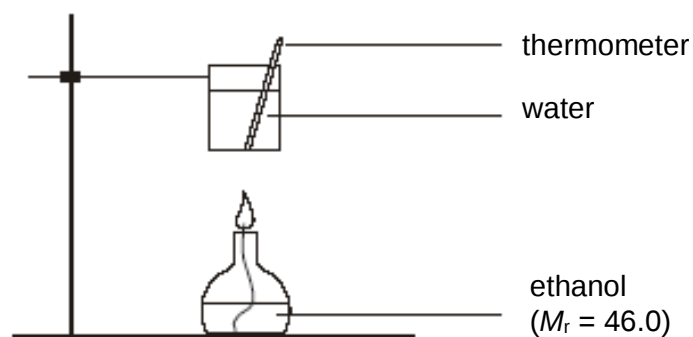


What could be the nitrogen-containing compound formed from the complete reaction?

[All volumes are measured at room temperature and pressure conditions under which H₂S is a gas.]

- A N₂
- B NO
- C NO₂
- D NH₃

- 11 When m g of ethanol was burned under a container of water, it was found that the temperature of 300 g of water rose by T °C.



The enthalpy change of combustion of ethanol is $-1371 \text{ kJ mol}^{-1}$ and the specific heat capacity of water is $4.2 \text{ J g}^{-1} \text{ K}^{-1}$.

Which expression below gives the percentage efficiency of this process?

- A $\frac{m \times 4.2 \times T \times 46.0}{300 \times 1371 \times 1000} \times 100\%$
- B $\frac{m \times 1371 \times 1000}{300 \times 4.2 \times T \times 46.0} \times 100\%$
- C $\frac{300 \times 4.2 \times (T + 273) \times 46.0}{m \times 1371 \times 1000} \times 100\%$
- D $\frac{300 \times 4.2 \times T \times 46.0}{m \times 1371 \times 1000} \times 100\%$

- 12** The enthalpy change of the thermal decomposition of magnesium carbonate is given as $+117 \text{ kJ mol}^{-1}$.

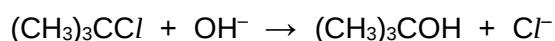


What information, other than that given above, is required to calculate a value for the enthalpy change of formation of $\text{MgCO}_3(\text{s})$?

- A** enthalpy change of formation of magnesium oxide and enthalpy change of combustion of carbon
- B** lattice energy of magnesium carbonate and of magnesium oxide
- C** first and second ionisation energies of magnesium
- D** bond energy of the C=O bonds in carbon dioxide
- 13** What will be the signs of the enthalpy and entropy changes when a liquid boils?

	ΔH	ΔS
A	+	+
B	–	+
C	–	–
D	+	–

- 14** The alkaline hydrolysis of 2-chloro-2-methylpropane, $(\text{CH}_3)_3\text{CCl}$, with $0.2 \text{ mol dm}^{-3} \text{ NaOH}$ produces 2-methylpropan-2-ol, $(\text{CH}_3)_3\text{COH}$.



20% of $(\text{CH}_3)_3\text{CCl}$ in a solution of concentration 0.02 mol dm^{-3} hydrolyses in 5 minutes at a certain temperature.

With reference to the overall order of this reaction, what percentage of $(\text{CH}_3)_3\text{CCl}$ in a solution of concentration 0.04 mol dm^{-3} would hydrolyse in 5 minutes at the same temperature?

- A** 10% **B** 20% **C** 30% **D** 40%

- 15 The equation for the oxidation of nitrogen monoxide is shown below.



The following rate equation was derived from initial rates experiments.

$$\text{rate} = k [\text{O}_2] [\text{NO}]^2$$

The results of the initial rates experiments are shown.

initial $[\text{O}_2]$ / mol dm^{-3}	initial $[\text{NO}]$ / mol dm^{-3}	initial rate / $\text{mol dm}^{-3} \text{ min}^{-1}$
2.0	1.0	8.0
1.0	1.0	s
1.0	t	16.0
0.5	0.5	u

What are the missing values, s , t and u ?

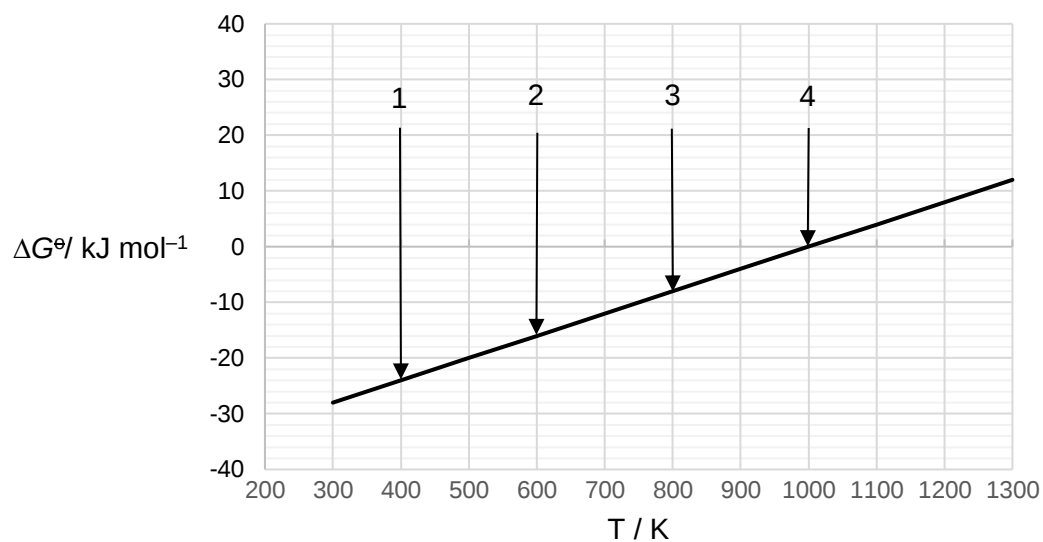
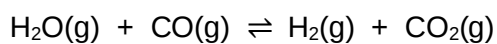
	s	t	u
A	4.0	1.0	0.5
B	4.0	2.0	0.5
C	2.0	1.0	1.0
D	2.0	2.0	1.0

- 16 Which suggested mechanisms are consistent with the experimentally obtained rate equation?

	chemical equation	rate equation	suggested mechanism
1	$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{I}^- \rightarrow 2\text{H}_2\text{O} + \text{I}_2$	$\text{rate} = k_1 [\text{H}_2\text{O}_2] [\text{I}^-]$	$\text{H}_2\text{O}_2 + \text{H}^+ \rightarrow \text{H}_2\text{O} + \text{OH}^+$ (fast) $\text{OH}^+ + 2\text{I}^- + \text{H}^+ \rightarrow \text{H}_2\text{O} + \text{I}_2$ (slow)
2	$\text{CO} + \text{NO}_2 \rightarrow \text{CO}_2 + \text{NO}$	$\text{rate} = k_2 [\text{NO}_2]^2$	$\text{NO}_2 + \text{NO}_2 \rightarrow \text{N}_2\text{O}_3 + \text{O}$ (slow) $\text{N}_2\text{O}_3 + \text{CO} \rightarrow \text{CO}_2 + 2\text{NO}$ (fast)
3	$\text{H}_2 + \text{I}_2 \rightarrow 2\text{HI}$	$\text{rate} = k_3 [\text{H}_2] [\text{I}_2]$	$\text{H}_2 \rightarrow 2\text{H}$ (slow) $2\text{H} + \text{I}_2 \rightarrow 2\text{HI}$ (fast)

- A** 1, 2 and 3
B 1 and 2 only
C 2 and 3 only
D none

- 17 The graph shows how $\Delta G^\ominus$ changes with temperature for the reaction shown.

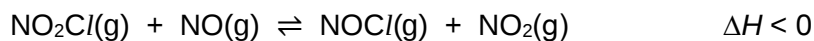


Equimolar amounts of H_2O and CO were introduced into a sealed container and allowed to reach equilibrium.

At which points on the graph above will the value of K_c be more than 1?

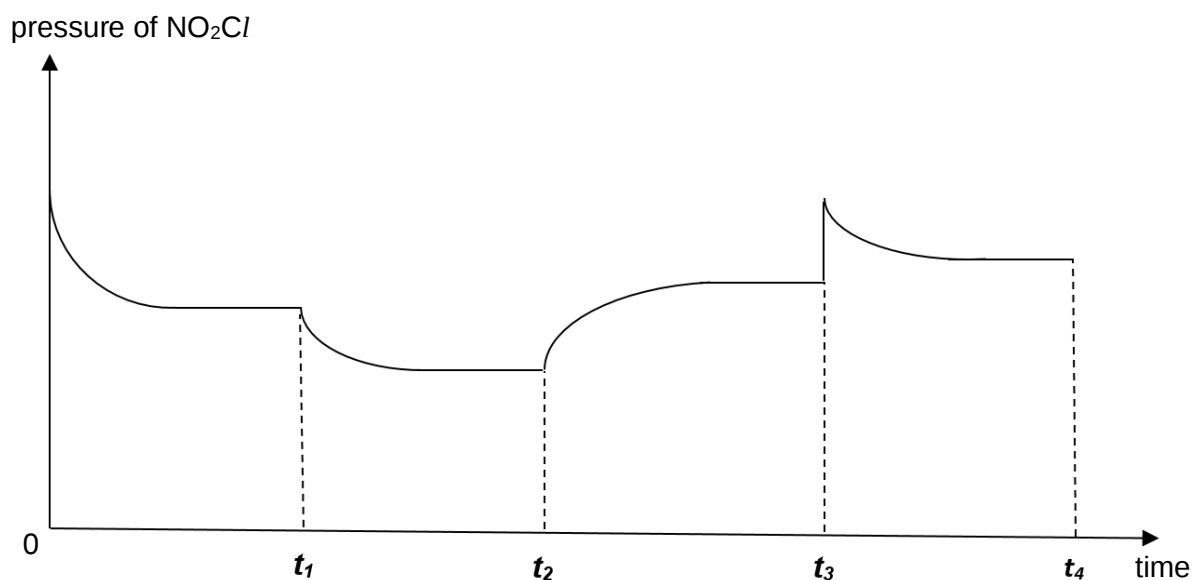
- A** 1 and 2 **B** 2 and 3 **C** 1, 2 and 3 **D** 1, 2, 3 and 4

- 18** Nitrosyl chloride, NOCl , is a yellow gas that can be formed between nitryl chloride, NO_2Cl , and nitric oxide, NO , in the following reaction.



NO_2Cl and NO were initially allowed to react in a closed vessel at 800 K and equilibrium was established.

The graph below shows how the pressure of NO_2Cl varied with time.

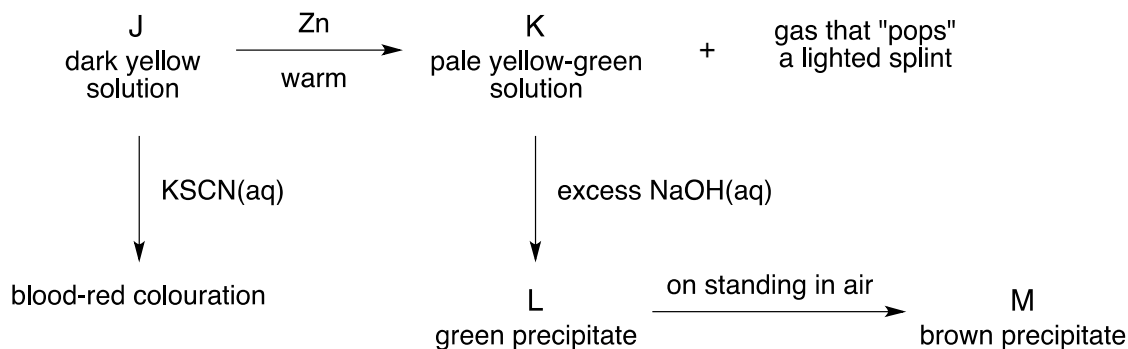


What could be the changes made to the system at t_1 , t_2 and t_3 ?

	t_1	t_2	t_3
A	NO_2Cl was removed	temperature was increased	NO_2Cl was added
B	temperature was decreased	NO_2Cl was added	NO_2 was added
C	NO_2 was removed	temperature was increased	NO_2Cl was added
D	NO_2Cl was removed	NO_2Cl was added	temperature was decreased

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

Consider the following reaction scheme starting from solution J.

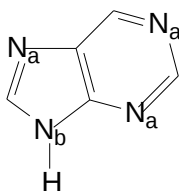


Which of the following statements are correct?

- 1 The gas produced is able to reduce Fe^{2+} to Fe.
- 2 The conversion from K to L involves a ligand exchange reaction.
- 3 The cation present in solution K reacts with Na_2CO_3 to produce a gas that gives a white precipitate with $\text{Ca(OH)}_2(\text{aq})$.

- A 3 only
 B 1 and 3
 C 2 and 3
 D none

20 Purine is a heterocyclic aromatic compound. The nitrogen atoms, labelled as N_a and N_b , in purine have different basicity. N_a is basic whereas N_b is non-basic.

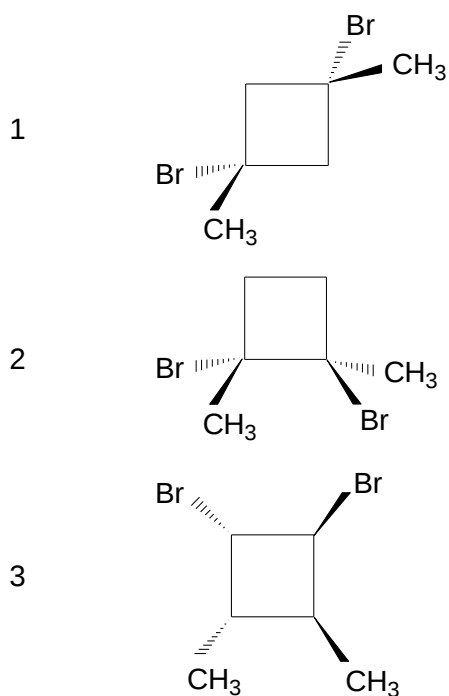


Purine

Based on the above information, which bond is **not** present in purine?

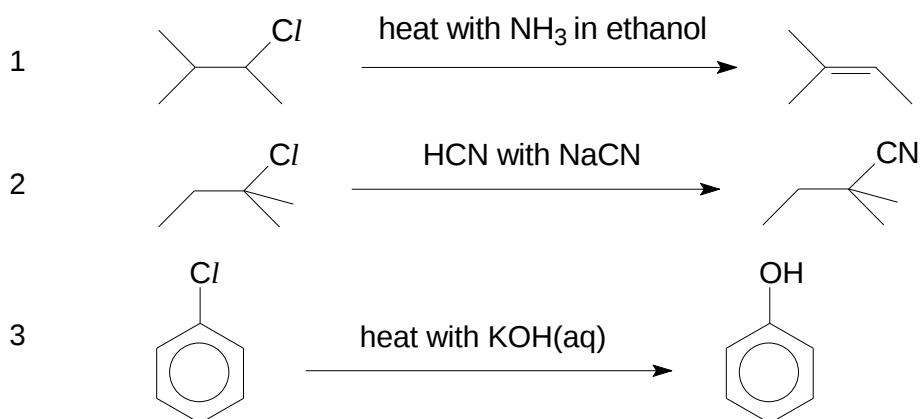
- A A σ bond formed by 2sp^2 – 2sp^3 overlap
 B A σ bond formed by 1s – 2sp^2 overlap
 C A π bond formed by 2p – 2p overlap
 D A σ bond formed by 2sp^2 – 2sp^2 overlap

21 Which molecules are optically active?



- A 1 and 2 only
 B 1 and 3 only
 C 2 and 3 only
 D none

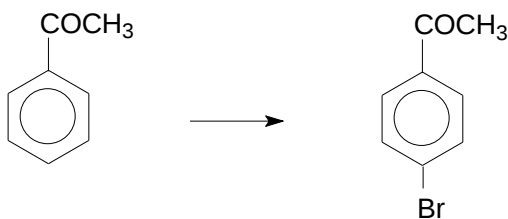
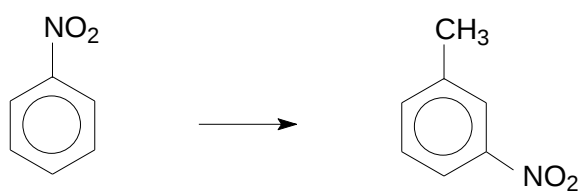
22 Which reactions would give the products stated?



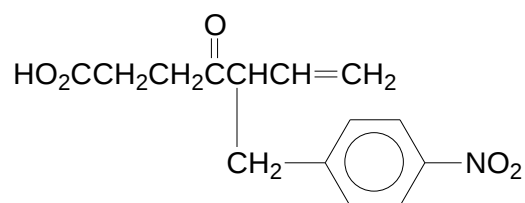
- A 1 and 2 only
 B 2 only
 C 2 and 3 only
 D none

23 Use of the Data Booklet is relevant to this question.

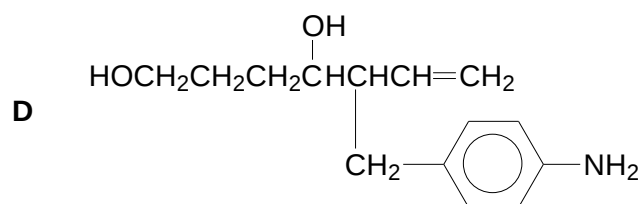
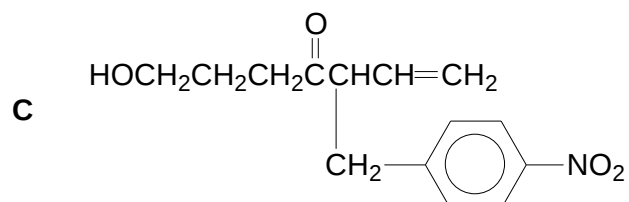
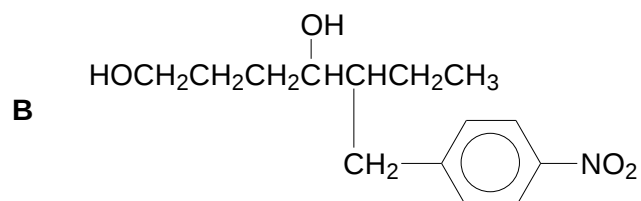
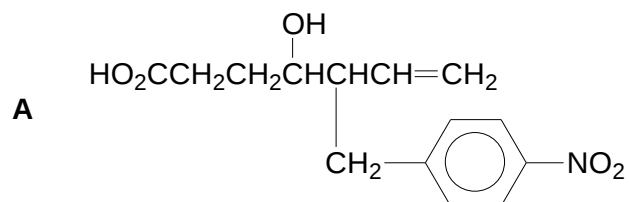
Which transformation can be readily achieved by only one substitution reaction?

- A 
- B $(\text{CH}_3)_3\text{CCH}_2\text{F} \longrightarrow (\text{CH}_3)_3\text{CCH}_2\text{NH}_2$
- C 
- D $\text{CH}_3\text{CH}=\text{CH}_2 \longrightarrow \text{CH}_3\text{CH}=\text{CHCl}$

24 Compound Y has the following structure.



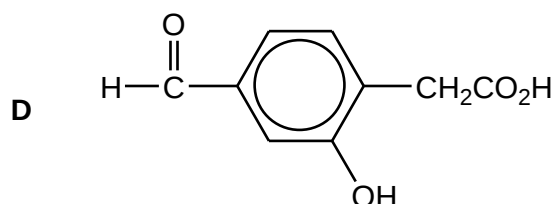
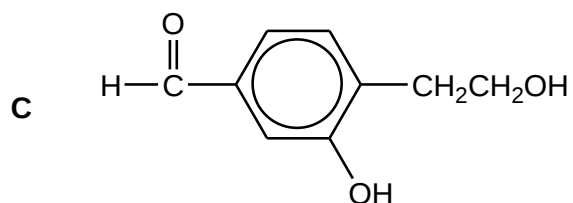
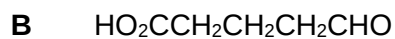
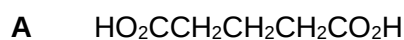
When Y is treated with sodium borohydride, what is the final product obtained?



25 Compound **Z** shows the following chemical properties.

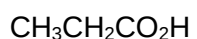
- It does not give any observation with Fehling's solution.
- 1 mole of **Z** reacts with 2 moles of sodium metal.
- When $\text{PCl}_5(\text{s})$ is added to **Z**, a sweet smelling product is obtained.

What could **Z** be?

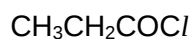


26 Equal amounts of compounds **P**, **Q**, **R** and **S** are separately shaken with 100 cm^3 of water.

The pH of each resultant solution is then measured.



P



Q

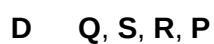


R



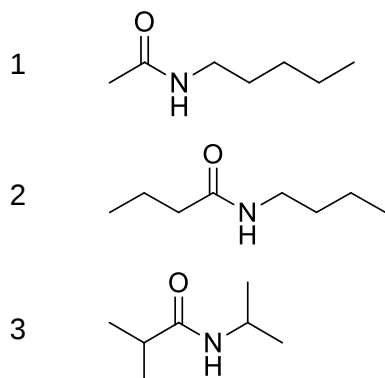
S

Which sequence shows the correct order of **decreasing** pH of the solutions formed?



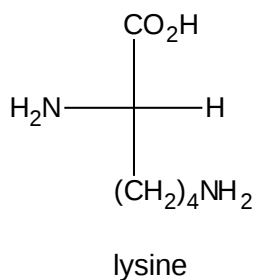
- 27 An amide, **M**, has the empirical formula $C_7H_{15}ON$. When **M** is hydrolysed by heating under reflux with dilute hydrochloric acid, a carboxylic acid with empirical formula C_2H_4O is obtained as one of the products.

What could be the skeletal formula of **M**?



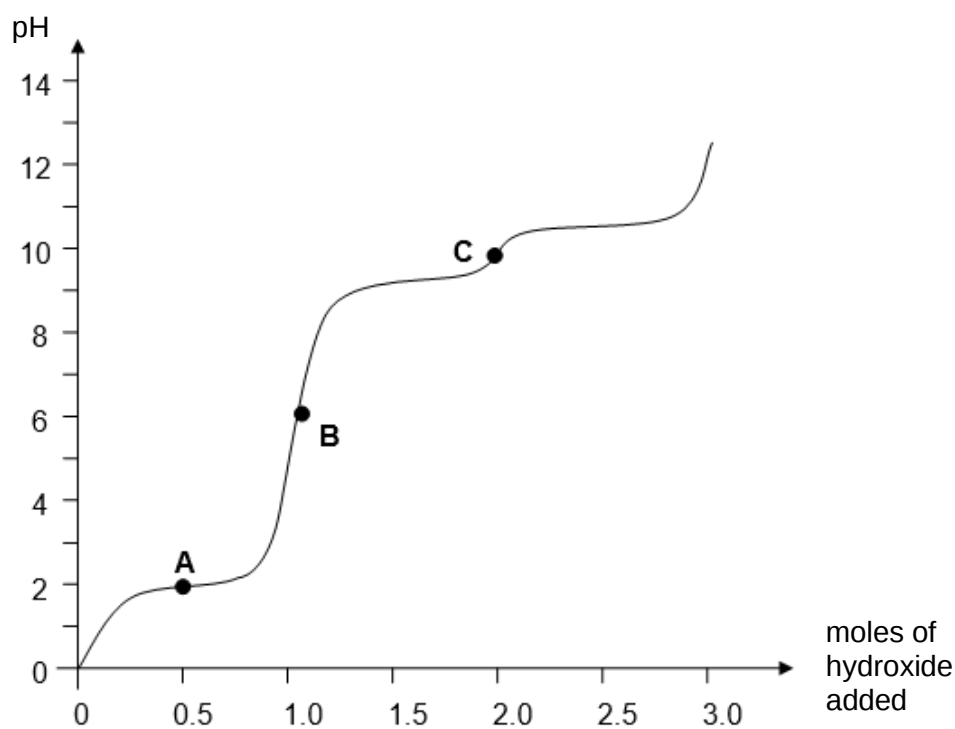
- A 1, 2 and 3
B 2 and 3 only
C 1 only
D 3 only

28 Lysine is an essential amino acid found in the body.



Lysine has pK_a values of 2.2, 9.0 and 10.5.

When one mole of protonated lysine was titrated against hydroxide ions, the following titration curve is obtained.



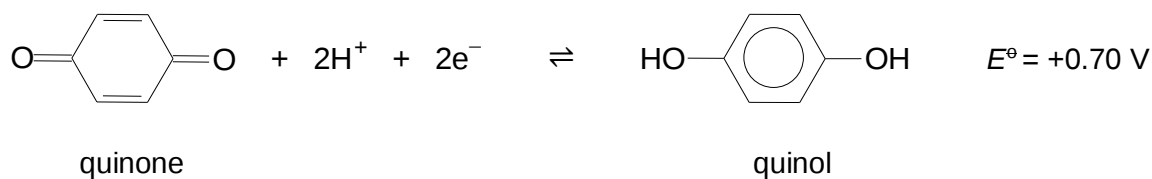
Which statements are correct with respect to the curve above?

- 1 The α -amino group has a pK_a value of 10.5.
- 2 Equal amounts of $\text{H}_3\text{N}^+\text{CH}(\text{CO}_2\text{H})(\text{CH}_2)_4\text{NH}_3^+$ and $\text{H}_3\text{N}^+\text{CH}(\text{CO}_2\text{H})(\text{CH}_2)_4\text{NH}_2$ are present at point **A**.
- 3 The major species present at point **C** has no net charge.
- 4 The major species present at point **B** will migrate towards the cathode of an electrolytic cell.

- A** 1 and 3 only
B 2 and 4 only
C 3 and 4 only
D 1, 2 and 4 only

29 Use of the Data Booklet is relevant to this question.

Quinone can be formed by oxidising quinol.



Which statements about this reaction are correct?

- 1 C bonded to O in quinone has an oxidation state of +2 while C bonded to O in quinol has an oxidation state of +1.
- 2 $E^\ominus_{\text{cell}}$ for the reaction between quinol and acidified KMnO_4 is positive.
- 3 SO_2 gas can be used to reduce quinone to quinol.

- A** 1, 2 and 3
B 1 and 3 only
C 2 and 3 only
D 1 only

30 Two separate electrolysis were performed as follows.

1. When aqueous sulfuric acid was electrolysed for 5 minutes, 0.01 mol of oxygen was collected at the anode.
2. When molten aluminium oxide was electrolysed for 5 minutes, 0.01 mol of aluminium was collected at the cathode.

If the current used in electrolysis 1 was I , what was the current used in electrolysis 2?

- A** $\frac{3}{4}I$ **B** I **C** $\frac{4}{3}I$ **D** $2I$

BLANK PAGE

BLANK PAGE