



CANDIDATE
NAME

CG

INDEX NO

CHEMISTRY

9729/01

Paper 1 Multiple Choice

14 September 2022

1 hour

Additional Materials: Multiple Choice Answer Sheet
 Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

Write your name and class on the Answer Sheet in the spaces provided unless this has been done for you.

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 **16** printed pages.

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

The table shows the fifth, sixth, seventh, eighth and ninth ionisation energies of an element in the third period.

	5th	6th	7th	8th	9th
ionisation energy / kJ mol ⁻¹	6270	21270	25430	29870	35920

Which element has these ionisation energy values?

- A** P **B** S **C** Cl **D** Ar

- 2 Two elements X and Y have the following properties:

- X and Y form ionic compounds Na₂X and Na₂Y respectively.
- Element Y forms YF₆ molecule whereas X is not able to do so.

Which pair of electronic configurations for X and Y is correct?

	X	Y
A	[He] 2s ² 2p ⁴	[He] 2s ² 2p ²
B	[He] 2s ² 2p ²	[He] 2s ² 2p ⁶ 3s ² 3p ³
C	[He] 2s ² 2p ²	[He] 2s ² 2p ⁶ 3s ² 3p ²
D	[He] 2s ² 2p ⁴	[He] 2s ² 2p ⁶ 3s ² 3p ⁴

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

An element **G** forms an ionic nitrate with formula $\text{G}(\text{NO}_3)_2$.

In a sample of this compound, the ion **G** contains 80 electrons and 126 neutrons.

Which row describes:

- the Group where **G** is found,
- the nucleon number of **G** in this sample?

	Group	nucleon number
A	2	204
B	2	208
C	14	204
D	14	208

4 The table identifies the shape and polarity of four molecules.

Which rows are correct?

	molecule	molecular shape	polarity
1	beryllium chloride	bent	non-polar
2	nitrogen dioxide	bent	polar
3	sulfur trioxide	trigonal planar	non-polar
4	chlorine trifluoride	trigonal planar	polar

A 1, 3 and 4

B 2 and 3

C 2, 3 and 4

D 3 and 4

- 5 Hydrazine, N_2H_4 , and hydrogen peroxide, H_2O_2 , are both used as rocket propellants because they can produce large volumes of hot gases from a small volume of liquid.

Which statements about these two compounds are correct?

- 1 The bond angle in N_2H_4 is larger than that in H_2O_2 .
- 2 The N-H bond is shorter than the O-H bond.
- 3 N_2H_4 forms stronger intermolecular hydrogen bonds than H_2O_2 .
- 4 There are σ bonds formed by sp^3 -s orbital overlap in both molecules.

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

- 6 In an experiment, 0.100 g of a volatile liquid Q formed 0.0250 dm^3 of vapour at 100°C at 1 bar.

What is the relative molecular mass of Q?

- A** $\frac{0.100 \times 373}{0.0250 \times 22.7}$
- B** $\frac{0.0250 \times 273 \times 22.7}{0.100 \times 373}$
- C** $\frac{0.100 \times 273 \times 22.7}{0.0250 \times 373}$
- D** $\frac{0.100 \times 373 \times 22.7}{0.0250 \times 273}$

- 7 For the elements in Group 17, which trends down the Group are correct?

	volatility	oxidising power
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

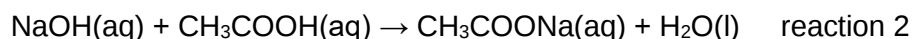
8 Which statement about relative molecular mass is correct?

- A It is the sum of the relative atomic masses of all the atoms within the molecule.
- B It is the ratio of the average mass of a molecule to the mass of a ^{12}C atom.
- C It is the ratio of the mass of 1 mol of molecules to the mass of 1 mol of ^1H atoms
- D It is the average mass of all the atoms within the molecule.

9 The enthalpy change of reaction 1 is -114 kJ mol^{-1} .

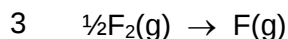
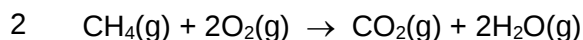
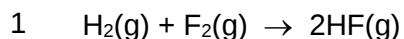


By using this information, what is the most likely value for the enthalpy change of reaction 2?



- A -50 kJ mol^{-1} B -57 kJ mol^{-1} C -114 kJ mol^{-1} D -228 kJ mol^{-1}

10 Which equations represent standard enthalpy changes at 298 K?



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

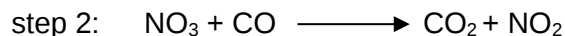
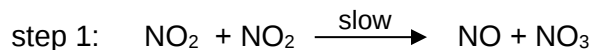
11 Melphalan is a drug used to treat infections.

The breakdown of melphalan in the blood is a first-order reaction. An original concentration of melphalan of 15.00 mg dm^{-3} decreases to 1.875 mg dm^{-3} after 270 minutes.

What is the time taken, in minutes, for the concentration of melphalan to decrease from 10.0 mg dm^{-3} to 2.00 mg dm^{-3} in the blood?

- A 105 B 180 C 209 D 360

- 12** The reaction between NO_2 and CO to produce NO and CO_2 is thought to occur in two steps:



Which statements are correct?

- 1 The rate constant has units of $\text{mol}^{-2} \text{dm}^6 \text{s}^{-1}$.
- 2 NO_2 is a catalyst.
- 3 The rate of reaction is independent on the concentration of CO .

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

- 13** Each of the following equilibria is subjected to two changes which are carried out separately:

- the pressure is reduced at constant temperature;
- the temperature is increased at constant pressure.

Which equilibrium will both changes result in an increase in the proportion of products?

- A** $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$ $\Delta H = +53 \text{ kJ mol}^{-1}$
- B** $4\text{NH}_3(\text{g}) + 5\text{O}_2(\text{g}) \rightleftharpoons 4\text{NO}(\text{g}) + 6\text{H}_2\text{O}(\text{g})$ $\Delta H = -950 \text{ kJ mol}^{-1}$
- C** $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ $\Delta H = -92 \text{ kJ mol}^{-1}$
- D** $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$ $\Delta H = +57 \text{ kJ mol}^{-1}$

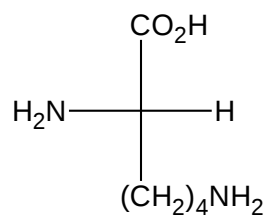
- 14** At 25°C , $K_w = 1.00 \times 10^{-14} \text{ mol}^2 \text{dm}^{-6}$.

At 62°C , $K_w = 1.00 \times 10^{-13} \text{ mol}^2 \text{dm}^{-6}$.

Which row is correct?

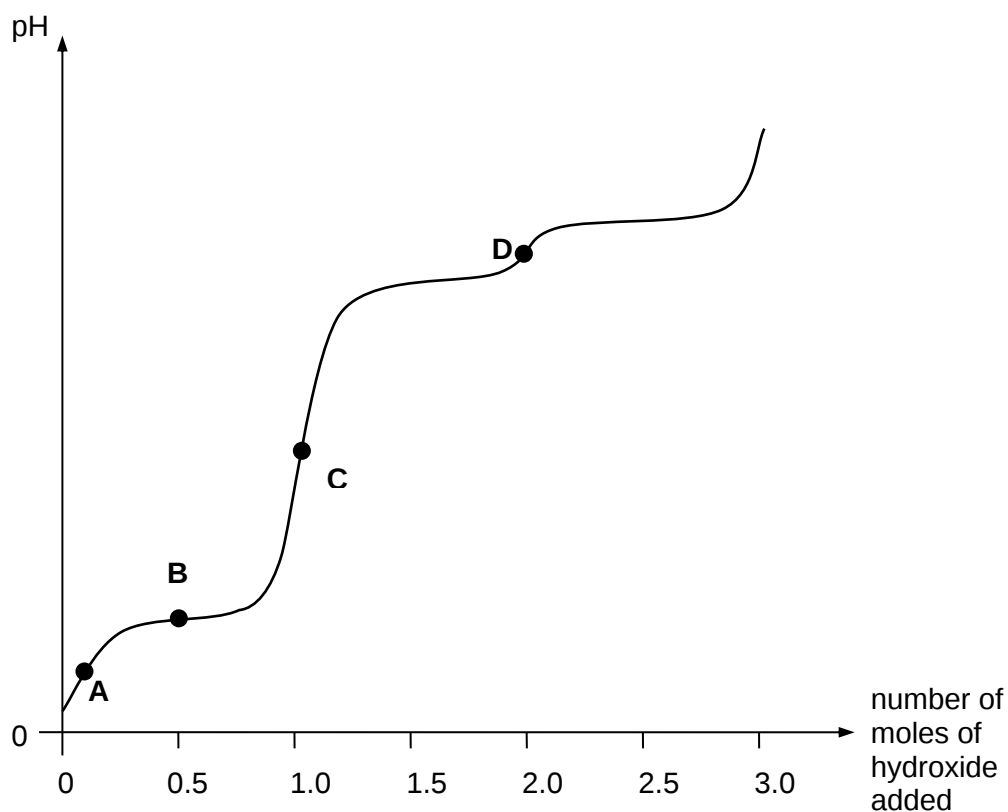
	the ionisation of water is	at 62°C , water with a pH of 7.0 is
A	endothermic	alkaline
B	endothermic	neutral
C	exothermic	alkaline
D	exothermic	neutral

- 15 Lysine is an essential amino acid found in the body. It has three pK_a values associated with it.



lysine

The pH curve below is obtained when one mole of the protonated lysine is titrated with hydroxide, OH^- , ions.



At which point on the graph does $\text{pH} = pK_{a1}$ where K_{a1} is the first acid dissociation constant of lysine?

- 16** Vehicles produce exhaust emissions when the engine is running. These emissions can include harmful pollutants such as carbon monoxide, oxides of nitrogen and unburnt hydrocarbons.

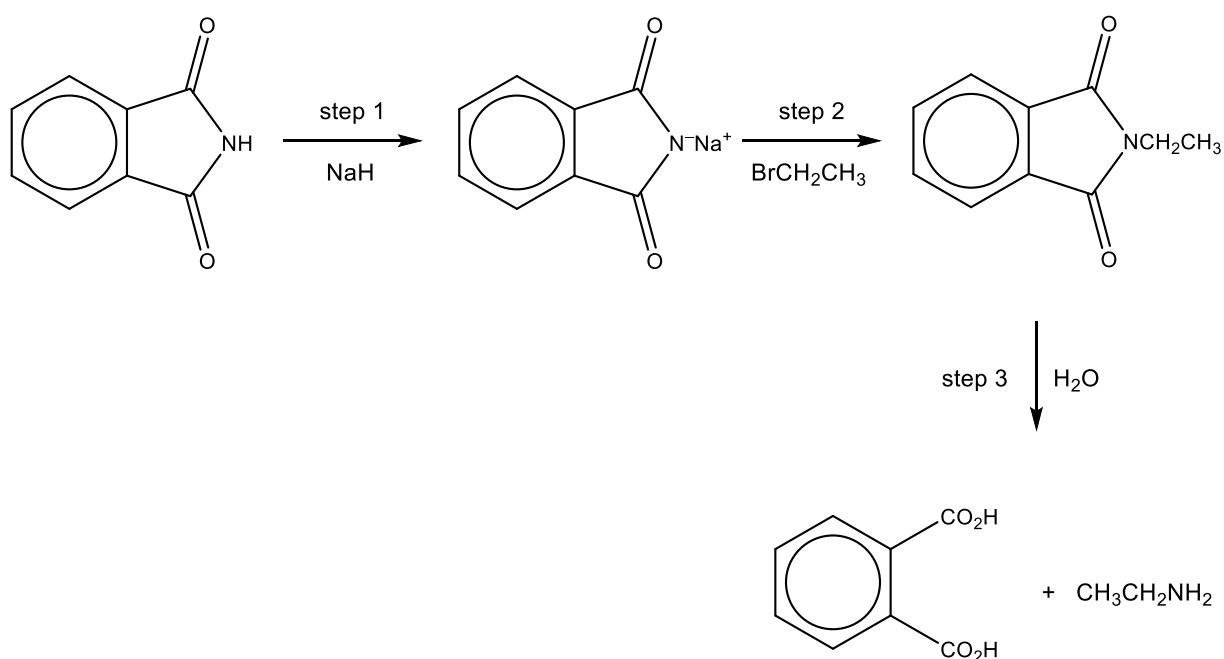
A catalytic converter is used to change the gases emitted through chemical reactions.

Which reactions between the stated compounds occur in the catalytic converter?

- 1 hydrocarbons + oxides of nitrogen $\rightarrow$ carbon dioxide + water + nitrogen
- 2 carbon monoxide + oxides of nitrogen $\rightarrow$ carbon dioxide + nitrogen
- 3 carbon monoxide + hydrocarbons $\rightarrow$ carbon dioxide + water

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

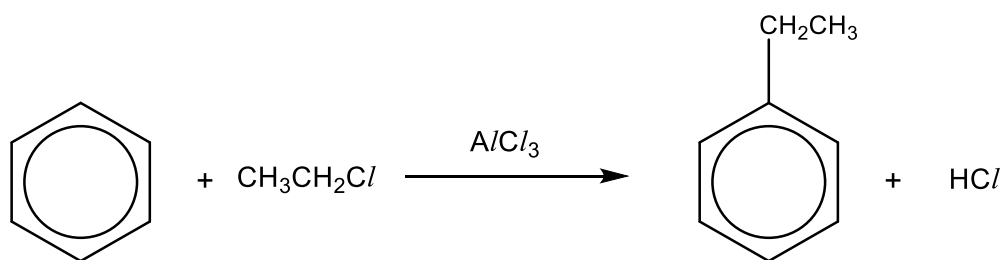
- 17** The Gabriel synthesis is a useful method of preparing primary amines.



What are the types of reactions occurring in each of the steps?

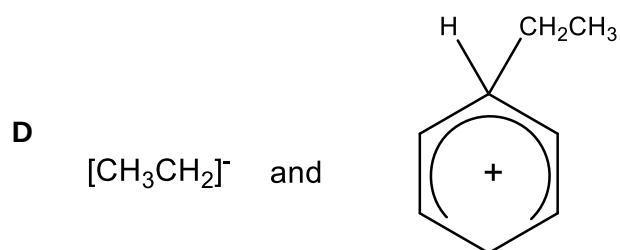
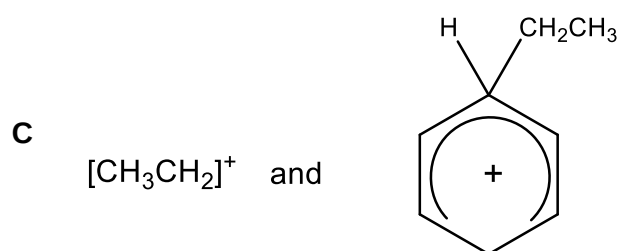
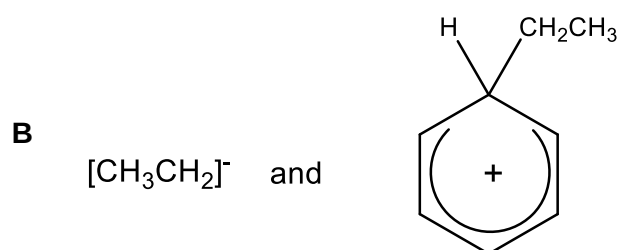
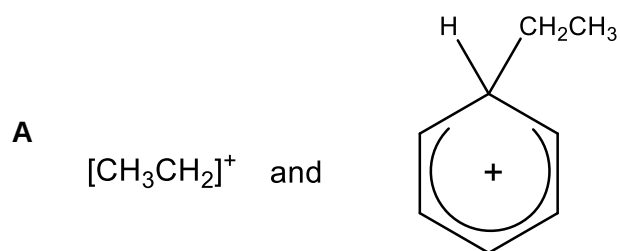
	step 1	step 2	step 3
A	acid-base	electrophilic substitution	hydrolysis
B	acid-base	nucleophilic substitution	hydrolysis
C	oxidation	electrophilic substitution	oxidation
D	oxidation	nucleophilic substitution	oxidation

18 Benzene reacts with chloroethane to form ethylbenzene.

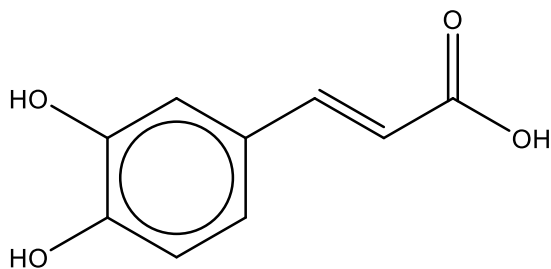


The reaction proceeds via several stages with two successive intermediates.

What could be the intermediates for this reaction?



- 19** Caffeic acid is found at relatively high levels in spearmint and star anise. It shows antioxidant and anti-inflammatory activities.

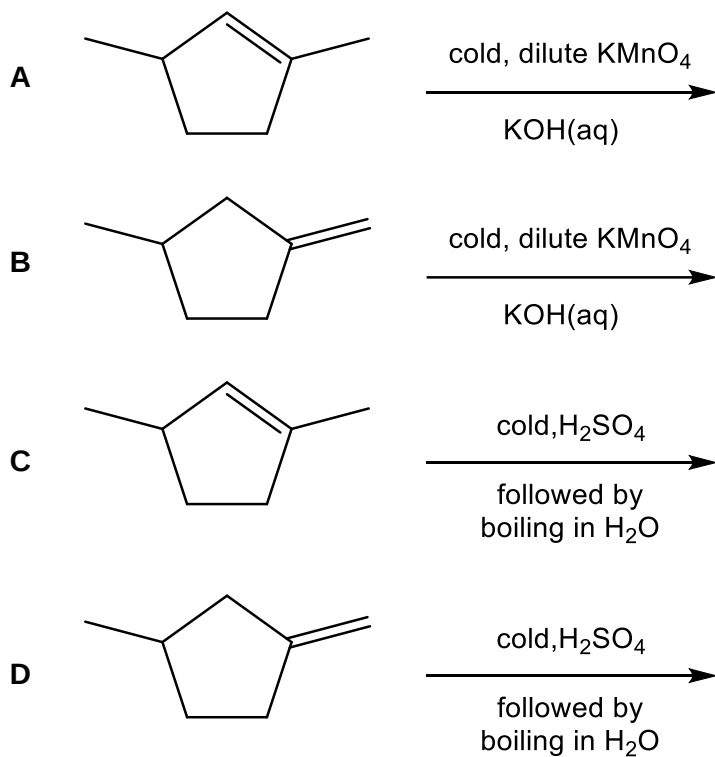


caffeic acid

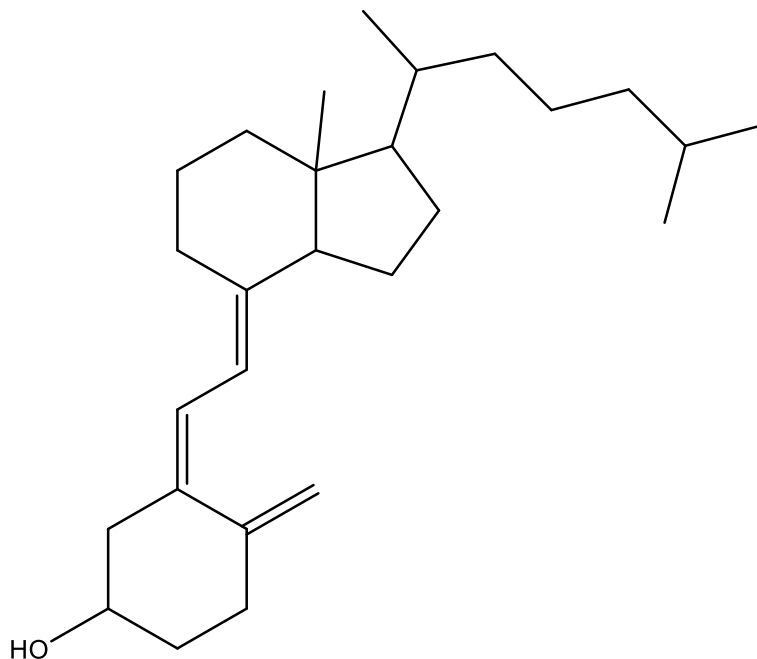
When treated with aqueous bromine, what is the maximum number of bromine atoms that can be incorporated into a molecule of caffeic acid?

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

- 20** Which reaction forms a product which can be further oxidised to form a carboxylic acid?



- 21** Cholecalciferol is a type of vitamin D that is made by the skin when exposed to sunlight. It can also be found in the flesh of fatty fish and fish liver oils.



cholecalciferol

Which statements about cholecalciferol are correct?

- 1 There is a maximum of 128 stereoisomers.
- 2 Cholecalciferol can react with ethanoyl chloride to form a sweet-smelling product.
- 3 1 mole of cholecalciferol produces 3 moles of carbon dioxide when heated with acidified KMnO_4 .

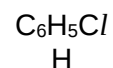
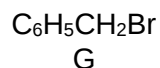
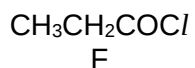
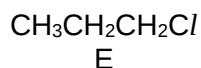
A 2 only

B 1 and 2

C 1 and 3

D 1, 2 and 3

- 22 A comparison is made of the rate of hydrolysis of four halogeno compounds by hot aqueous NaOH.



How will the rates of hydrolysis compare?

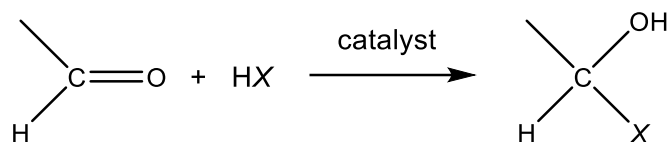
	fastest	—————→			slowest
A	E	G	H	F	
B	G	H	E	F	
C	F	G	E	H	
D	F	E	G	H	

- 23 Which pairs of compounds can be distinguished using the stated reagents and conditions?

	compounds	reagents and conditions
1	$\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$ and $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$	Na, room temperature
2	$\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}_3$ and $\text{CH}_3\text{CONHCH}_2\text{CH}_3$	NaOH(aq), I_2 (aq), heat
3	$\text{CH}_3\text{CON}(\text{CH}_3)_2$ and $(\text{CH}_3)_2\text{CHCONH}_2$	NaOH(aq), heat

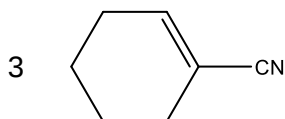
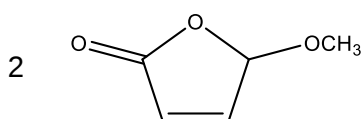
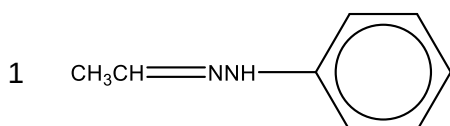
- A** 1, 2 and 3 **B** 1 and 2 **C** 2 and 3 **D** 3 only

- 24** There is a range of reactions of the aldehyde group which have the pattern



of which the formation of a cyanohydrin (where X = CN) is one.

Which compounds could be obtained by such an addition to an aldehyde group, followed by a dehydration?



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

- 25** The compound $\text{C}_3\text{H}_7\text{CO}_2\text{C}_6\text{H}_5$ is an ester.

Which statement about this ester is correct?

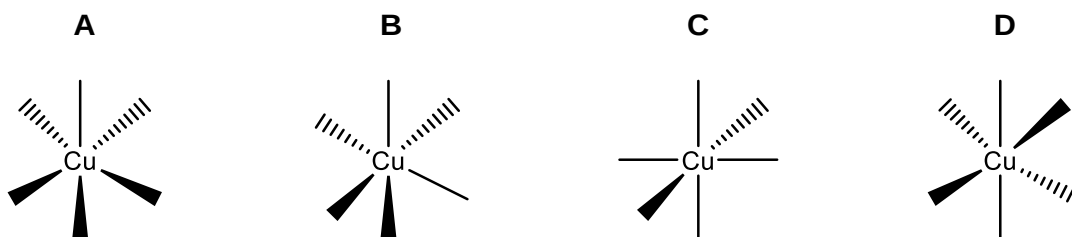
- A** Its name is phenyl propanoate.
B When heated with NaOH(aq) , phenol is one of the products formed.
C When heated with $\text{H}_2\text{SO}_4\text{(aq)}$, butanoic acid is one of the products formed.
D It can be formed using butanoic acid and phenol.

- 26 A nonapeptide was hydrolysed partially using an enzyme to yield the following tripeptide fragments:

thr – ser – asn
 pro – gly – his
 asn – val – pro
 pro – val – thr

What is the correct amino acid sequence in the nonapeptide?

- A asn – val – pro – gly – his – thr – ser – asn – val
 B thr – ser – asn – val – pro – gly – his – val – pro
 C pro – val – thr – ser – asn – val – pro – gly – his
 D his – gly – pro – val – asn – ser – thr – val – pro
- 27 Which diagram correctly shows the arrangement of the six coordinate bonds in a regular octahedral complex of copper?



- 28 The standard redox potential for the half-cell reaction

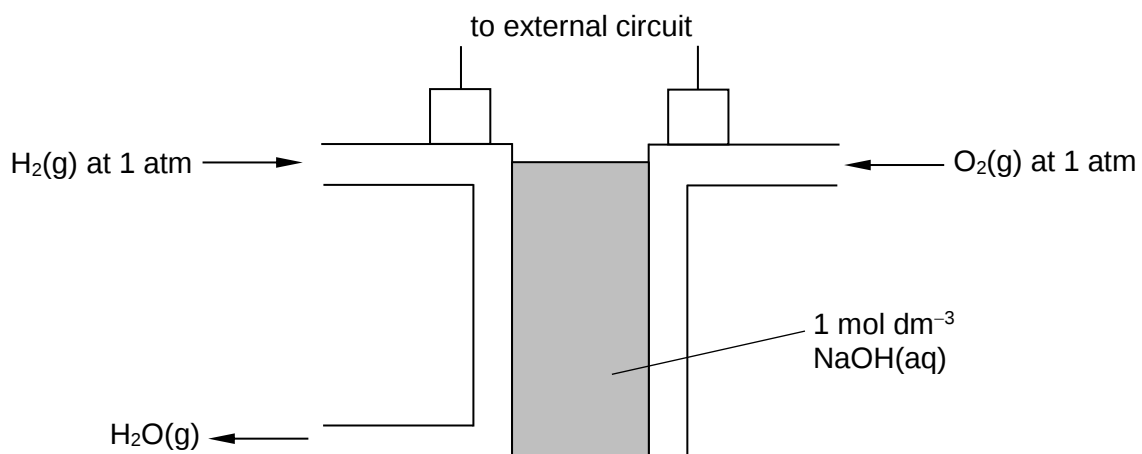


Which cell would be used to determine this standard value?

- A Fe electrode in 1 mol dm⁻³ Fe³⁺ against Fe electrode in 1 mol dm⁻³ Fe²⁺
 B Pt electrode in 1 mol dm⁻³ Fe³⁺ against Pt electrode in 1 mol dm⁻³ Fe²⁺
 C Fe electrode in a solution containing 1 mol dm⁻³ Fe³⁺ and 1 mol dm⁻³ Fe²⁺ against a standard hydrogen electrode
 D Pt electrode in a solution containing 1 mol dm⁻³ Fe³⁺ and 1 mol dm⁻³ Fe²⁺ against a standard hydrogen electrode

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

A hydrogen-oxygen fuel cell is shown.

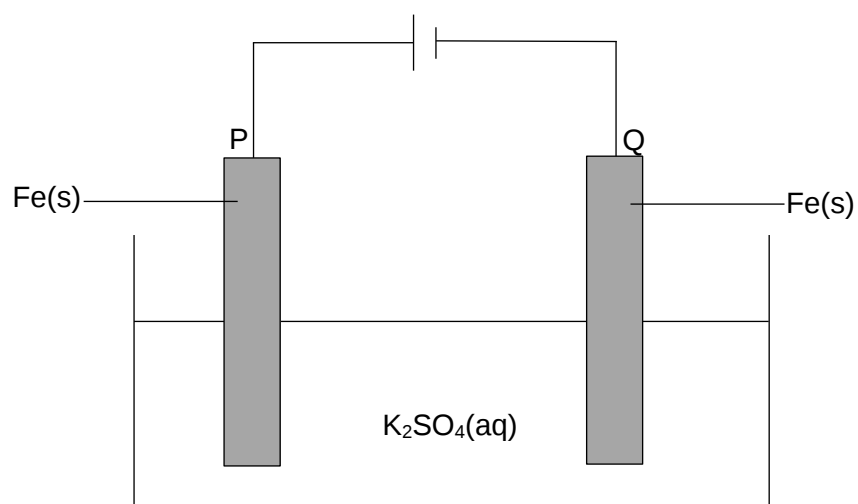


Which $E^\ominus$ value should be used for the cathode?

- A -0.08 V
- B $+0.40 \text{ V}$
- C $+0.68 \text{ V}$
- D $+1.23 \text{ V}$

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

An experiment is set up as shown to study the corrosion of iron.



What will occur at electrodes P and Q?

	electrode P	electrode Q
A	no change in mass	decrease in mass and H_2 evolved
B	no change in mass	decrease in mass and SO_2 evolved
C	decrease in mass	no change in mass and SO_2 evolved
D	decrease in mass	no change in mass and H_2 evolved