



CANDIDATE
NAME

TEACHER'S COPY

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

Answer: **A**

The element is P as there is a large jump between the 5th and 6th ionisation energies as seen in this table. The 6th electron for P is removed from an inner principal quantum shell.

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

Answer: **D**

Compounds Na₂X and Na₂Y show that X and Y forms anions of -2 charge so it means that they have 6 electrons in their valence shell.

Y must be a period three element in order for YF₆ to exist as it has an expanded octet structure.

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

Answer: **D**

The formula $\text{G}(\text{NO}_3)_2$ shows that element **G** can form a +2 cation.

G atom has 82 electrons, 82 protons and 126 neutrons, so the nucleon number is $82 + 126 = 208$.

Hence, **G** is Pb which is a Group 14 element with a mass number of 207.2 and a nucleon number of 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

Answer: **B**

Option 1 is incorrect as BeCl_2 is linear, not bent

Option 2 is correct as NO_2 is bent shaped and is polar

Option 3 is correct as SO_3 is trigonal planar and non-polar

Option 4 is incorrect as ClF_3 is T-shaped.

- 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

Answer: **A**

- 1 Correct.
The bond angle in N_2H_4 is 107° (3 bp, 1 lp) and the bond angle in H_2O_2 is 105° (2 bp, 2 lp).
- 2 Incorrect.
The atomic radius of O is smaller than N so the effectiveness of the orbitals overlap is higher and the O-H bond is shorter.
- 3 Incorrect.
The dipole moment of the O-H bond is bigger, hence the hydrogen bonds between the H_2O_2 molecules are stronger
- 4 Correct.
The electron pairs around N and O are in a tetrahedral arrangement and hence the N and O atoms are sp^3 hybridised and the H atoms consists of s orbitals. The N-H and O-H bonds are formed by sp^3 – s orbital overlaps

- 6 In an experiment, 0.100 g of a volatile liquid Q formed 0.0250 dm³ 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 $\frac{0.100 \times 373 \times 22.7}{0.0250 \times 273}$

Answer: **D**

Using $pV=nRT$

$$(100000)(0.0250 \times 10^{-3}) = \frac{0.100}{M_r} (R)(373)$$

$$M_r = \frac{0.100 \times 373 \times R}{100000 \times (0.0250 \times 10^{-3})}$$

1 mol of any gas occupies 22.7 dm³ at standard temperature and pressure

$$(100000)(22.7 \times 10^{-3}) = R (273)$$

$$R = \frac{100000 \times 22.7 \times 10^{-3}}{273}$$

$$M_r = \frac{0.100 \times 373 \times R}{100000 \times (0.0250 \times 10^{-3})} = \frac{0.100 \times 373 \times 100000 \times 22.7 \times 10^{-3}}{100000 \times (0.0250 \times 10^{-3}) \times 273} = \frac{0.100 \times 373 \times 22.7}{0.0250 \times 273}$$

- 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

Answer: **A**

Down Group 17,

- size of electron cloud of the halogens increases and more easily polarised
- stronger instantaneous dipole induced dipole interactions between molecules exists
- more energy needed to overcome the stronger intermolecular forces
- boiling point increases
- (Since boiling point is inversely proportional to volatility,) volatility of elements decreases down the group.



Down the group, the reactivity of the halogens as oxidising agents decreases as indicated by the less positive $E^\ominus$ values. The halogens have a lower tendency to be reduced.

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.

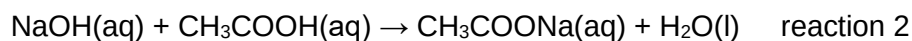
Answer: **A**

- A** Correct.
- B** Incorrect.
Relative molecular mass is the ratio of the average mass of one molecule to **one twelfth of the mass** of an atom of carbon-12.
- C** Incorrect.
Relative molecular mass is the ratio of the average mass of one molecule to **one twelfth of the mass** of an atom of carbon-12.
- D** Incorrect.
Relative molecular mass is not the average mass alone.

- 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}

Answer: **A**

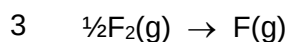
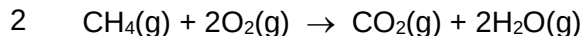
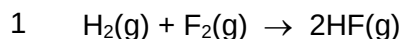
In reaction 1, when 2 mol of water is produced heat given out is = 114 kJ

In reaction 2, the neutralisation between CH_3COOH and NaOH produces 1 mol of water.

Thus, heat liberated = $\frac{1}{2} \times (114) = 57 \text{ kJ}$

Ethanoic acid is a weak acid which does not dissociate completely to give H^+ ions. Hence some energy is required to for complete dissociation of H^+ ions. Therefore ΔH is less exothermic for a weak acid and strong base compared to ΔH between a strong acid (H_2SO_4) and strong base (NaOH).

- 10 Which equations represent standard enthalpy changes at 298 K?



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

Answer: **D**

1 For equation 1, to represent the standard enthalpy change of formation of HF , 1 mol of HF should be formed.

2 For equation 2, to represent the standard enthalpy change of combustion of CH_4 , water formed should be in the liquid state.

3 Equation 3 represents the standard enthalpy change of atomisation of fluorine.

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?

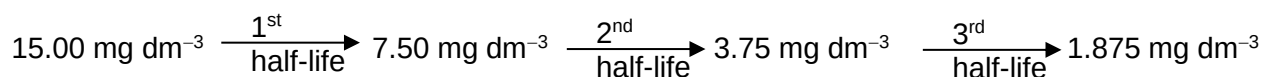
A 105

B 180

C 209

D 360

Answer: **C**



3 half-lives = 270 minutes, 1 half-life is 90 minutes

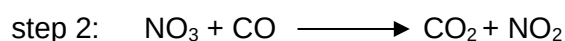
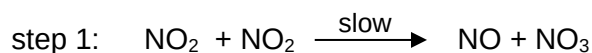
$$\frac{\text{final concentration of reactant}}{\text{initial concentration of reactant}} = \left(\frac{1}{2}\right)^n \text{ where } n = \text{number of half-lives.}$$

$$\frac{2}{10} = \left(\frac{1}{2}\right)^n$$

$$n = 2.3219$$

time taken = 2.3219 half-lives = $90 \times 2.3219 = 209$ minutes

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

Answer: **B**

1 Incorrect.

The rate equation is $\text{rate} = k[\text{NO}_2]^2$. Thus, the units for the rate constant $= \frac{\text{mol dm}^{-3} \text{ s}^{-1}}{(\text{mol dm}^{-3})^2}$
 $= \text{mol}^{-1} \text{ dm}^3 \text{ s}^{-1}$.

2 Correct.

NO_2 is used up in step 1 and regenerated in step 2 so NO_2 is a catalyst.

3 Correct.

Since the order of reaction with respect to $[\text{CO}] = 0$, the rate of reaction is independent on the concentration of CO.

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 | $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$ | $\Delta H = +57 \text{ kJ mol}^{-1}$ |

Answer: **D**

For the proportion of products to increase, the equilibrium position will have to shift to the **right** when changes to pressure and temperature are made.

For the equilibrium position to shift to the right when pressure is reduced, the right hand side of the equilibrium must have more moles of gaseous particles.

For equilibrium position to shift to the right when temperature is increased, the forward reaction must be endothermic.

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

Answer: **A**

As temperature increase from 25°C to 62°C, the value of K_w increased, this implies that the position of equilibrium shifted to the right (endothermic) to absorb excess heat. Hence, ionisation of water is endothermic.

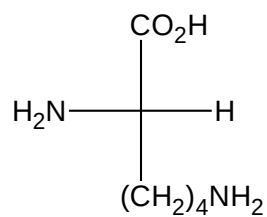
At 62°C, when pH = 7, $[\text{H}^+] = 10^{-7}$,

$K_w = [\text{H}^+][\text{OH}^-]$,

$$[\text{OH}^-] = \frac{1.00 \times 10^{-13}}{10^{-7}} = 1.00 \times 10^{-6} \text{ mol dm}^{-3} > 10^{-7} \text{ mol dm}^{-3}$$

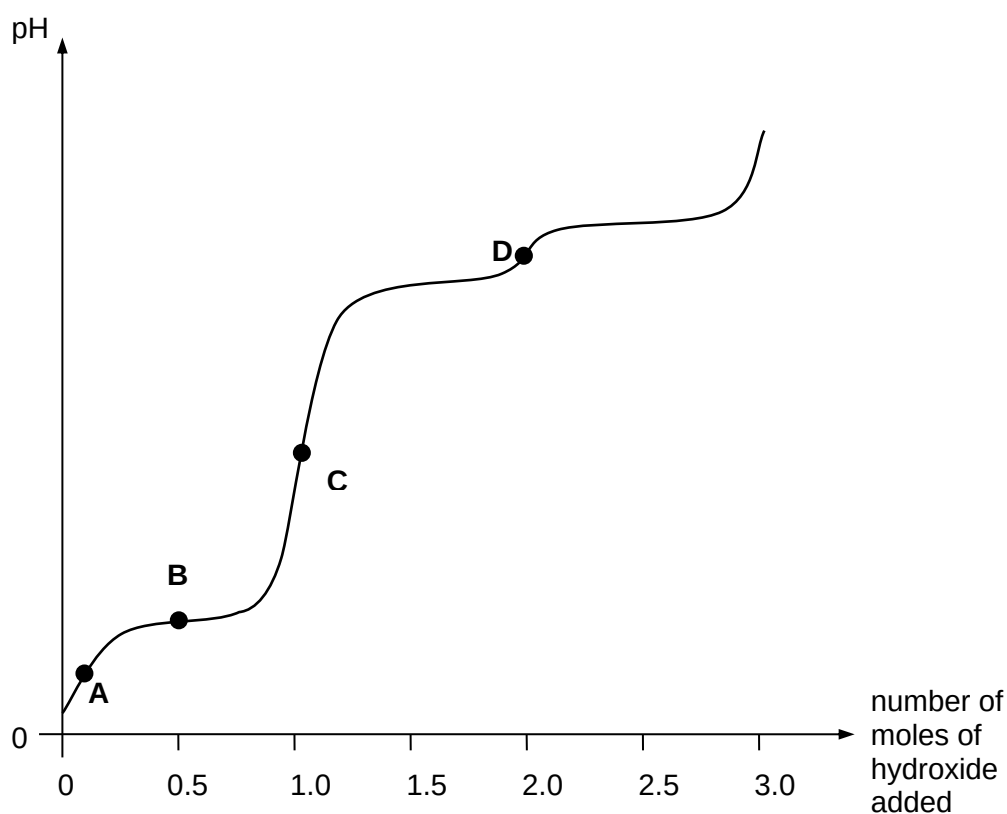
Since $[\text{OH}^-] > [\text{H}^+]$, solution is alkaline.

- 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 $\text{pH} = \text{p}K_{a1}$ where K_{a1} is the first acid dissociation constant of lysine?

Answer: **B**

The buffer region will be formed before the equivalence point since the weak acid is present with the salt. At the maximum buffer capacity, $\text{pH} = \text{p}K_a$, and it will be at half equivalence point where the $[\text{salt}] = [\text{weak acid}]$.

- 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

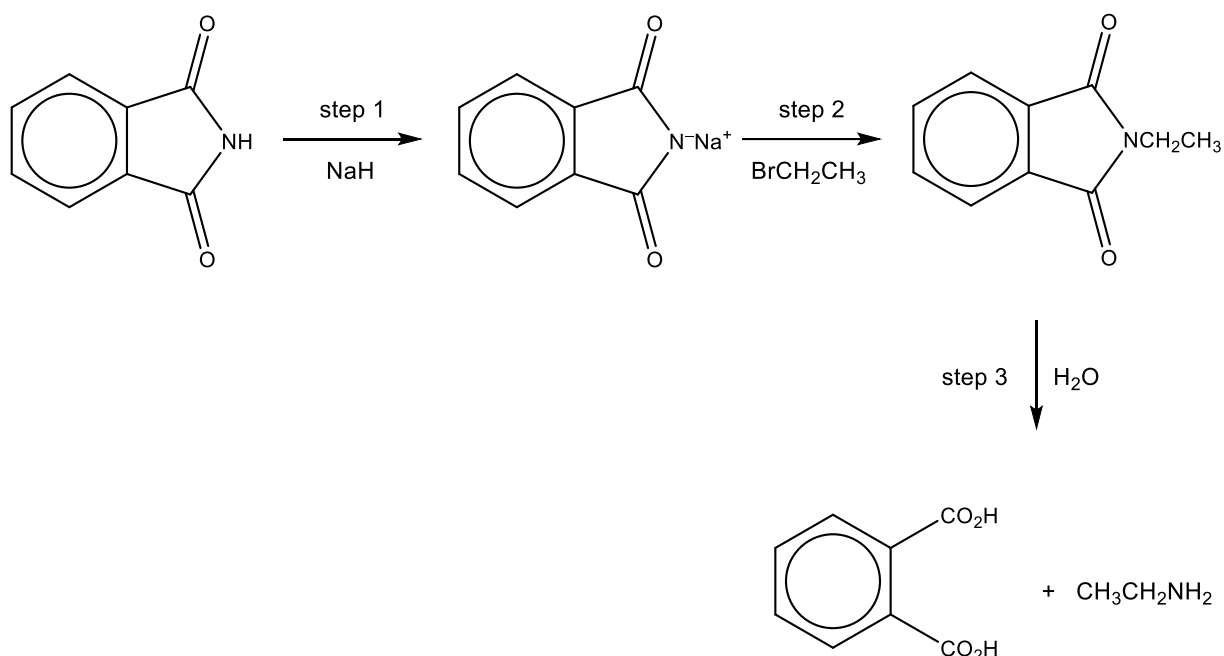
A 1, 2 and 3 **B** 1 and 2 **C** 2 and 3 **D** 1 only

Answer: **B**

The catalytic converter helps to oxidise carbon, carbon monoxide to carbon dioxide and water and reduce oxides of nitrogen to nitrogen.

Reaction 3 is incorrect as hydrocarbons do not contain oxygen and cannot oxidise CO to CO₂.

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

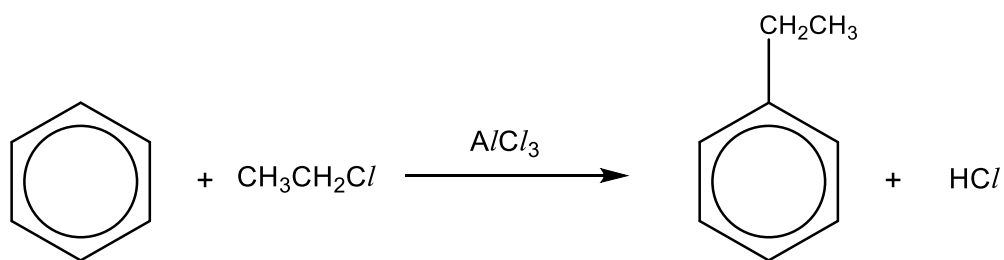
Answer: **B**

Step 1: Amide acts as acid and donates a H^+

Step 2: N^- acts as nucleophile and attacks the electron-deficient carbon bonded to bromine

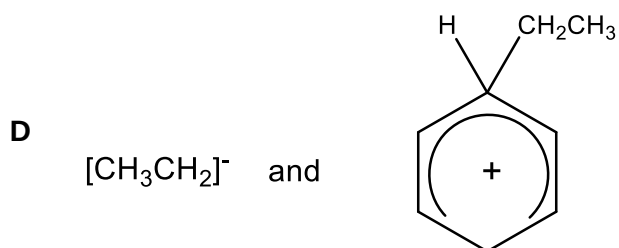
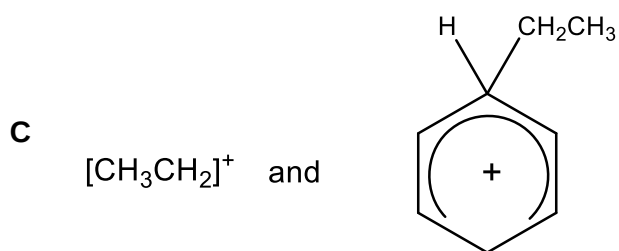
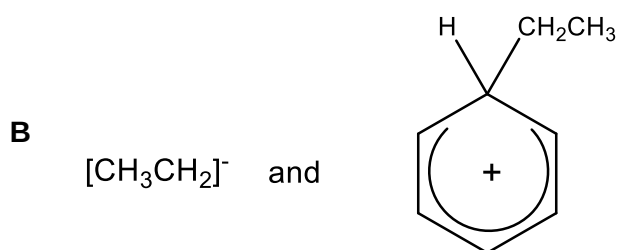
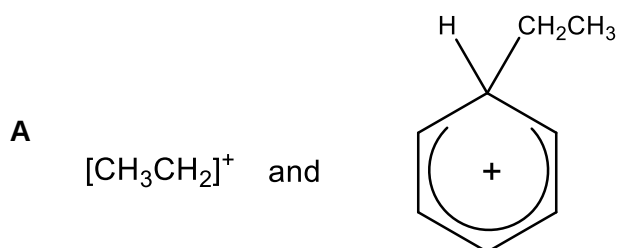
Step 3: Amide undergoes hydrolysis

18 Benzene reacts with chloroethane to form ethylbenzene.

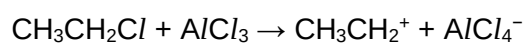


The reaction proceeds via several stages with two successive intermediates.

What could be the intermediates for this reaction?

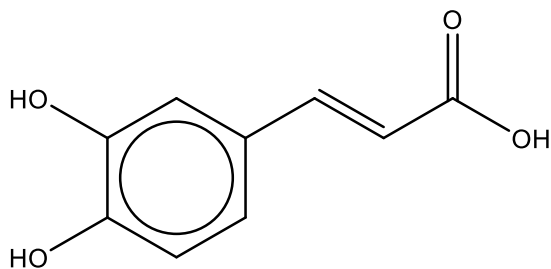


Answer: **A**



The positive charge in the arenium ion intermediate is delocalised over the 5 remaining sp^2 carbon atoms.

- 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

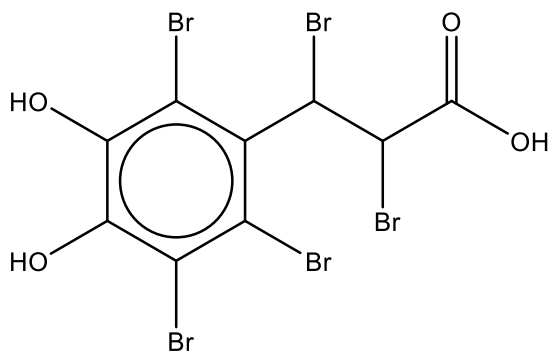
B 3

C 4

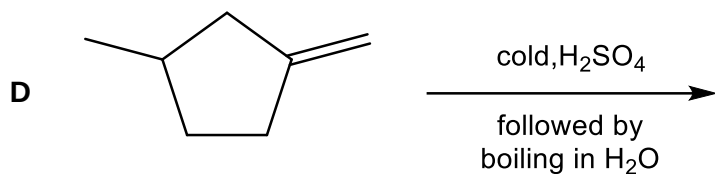
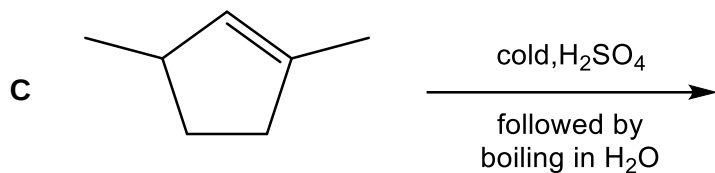
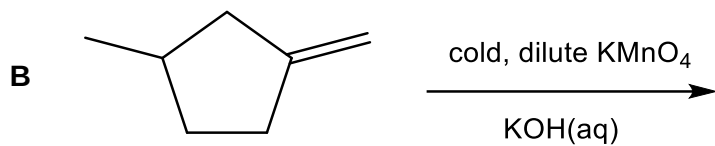
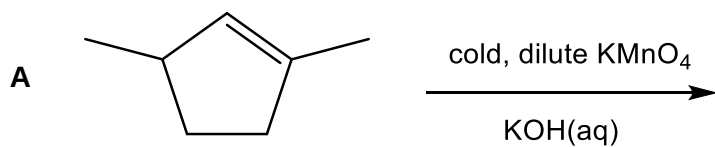
D 5

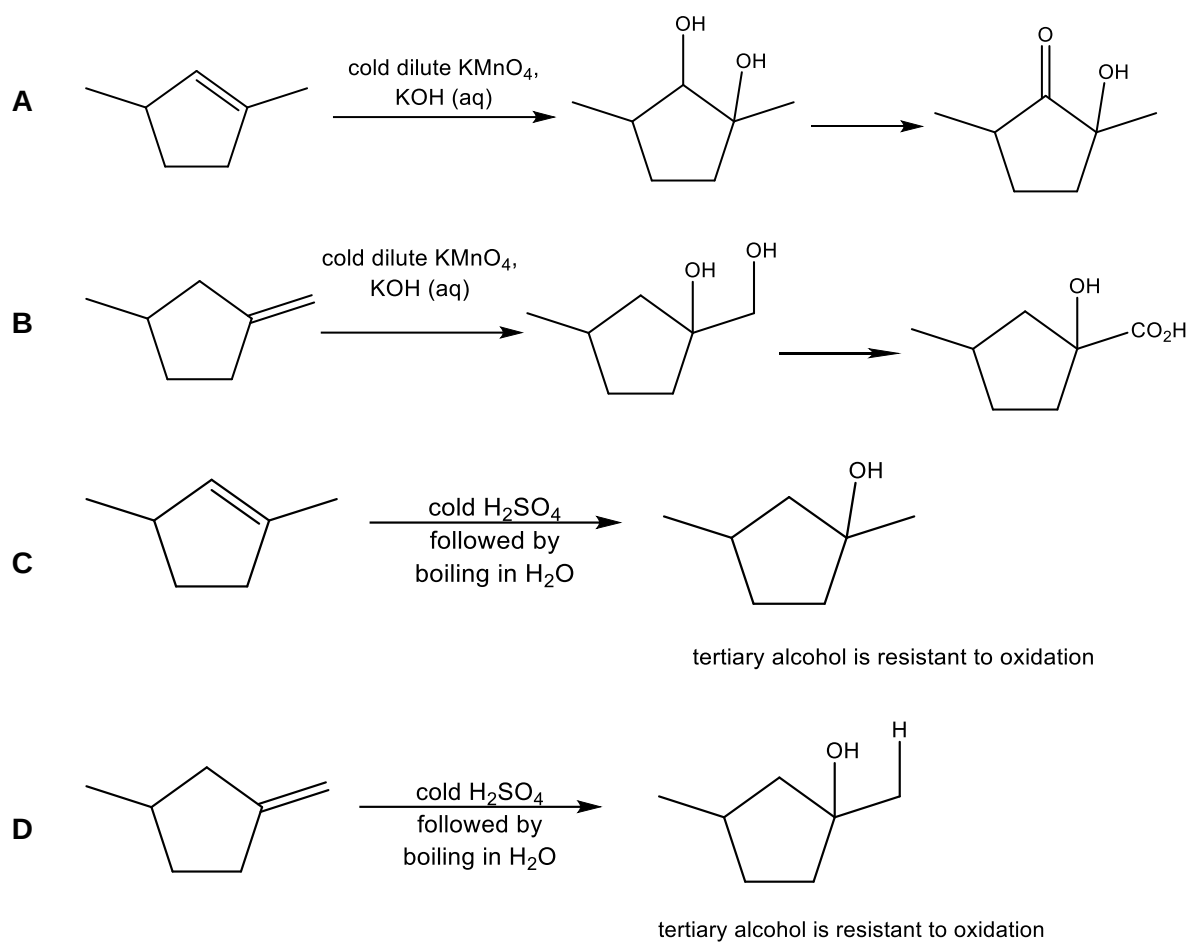
Answer: **D**

Phenol undergoes electrophilic substitution at carbon atoms 2, 4 and 6 relative to the carbon atom bonded to phenol, while the alkene group undergoes electrophilic addition to form bromoalcohol as the major product and 1,2-dibromoalkane as the minor product.

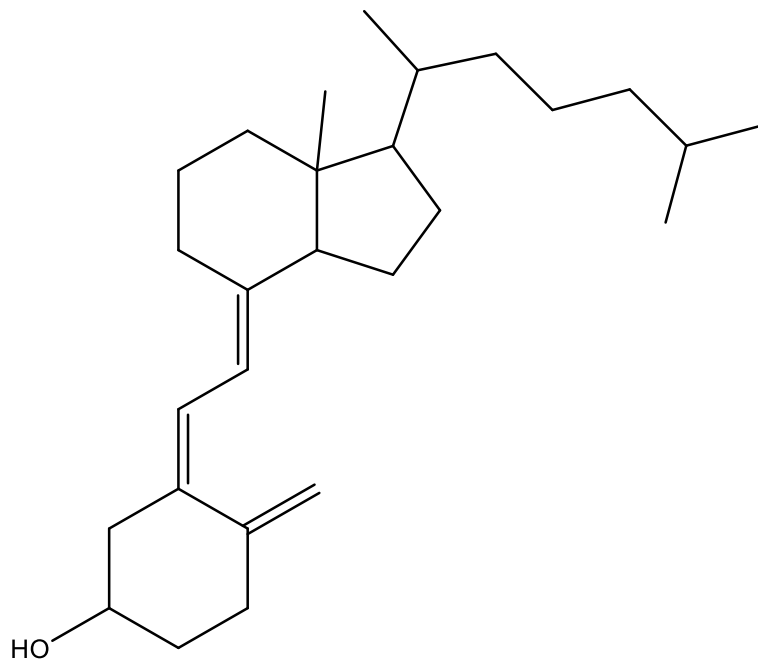


20 Which reaction forms a product which can be further oxidised to form a carboxylic acid?



Answer: **B**

- 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

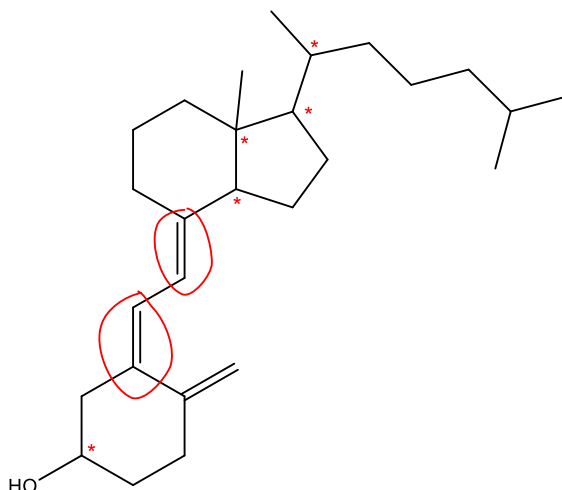
B 1 and 2

C 1 and 3

D 1, 2 and 3

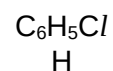
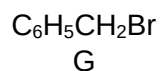
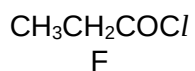
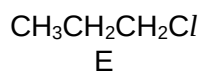
Answer: **D**

- 1 Correct.
There are 5 chiral centres and 2 alkenes that can exhibit cis-trans isomerism. $2^7 = 128$.



- 2 Correct.
The alcohol group can undergo condensation with ethanoyl chloride to form ester.
- 3 Correct.
The 3 alkene groups undergo strong oxidation. The terminal alkene gives 1 mole of CO_2 while ethanedioic acid undergoes further oxidation to give 2 moles of CO_2 .

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

Answer: **C**

Acyl chloride (F) will undergo hydrolysis fastest, while chlorobenzene (H) will be resistant to hydrolysis.

Bromoalkane (G) will react faster than chloroalkane (E) due to C–Br bond being weaker than C–Cl bond.

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) , $\text{I}_2\text{(aq)}$, 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

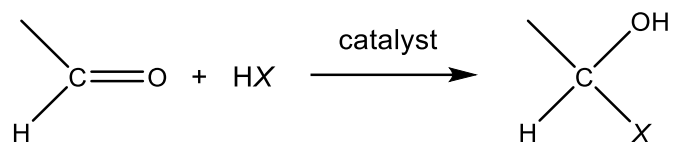
C 2 and 3

D 3 only

Answer: **C**

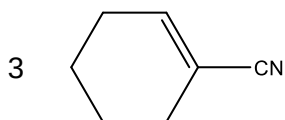
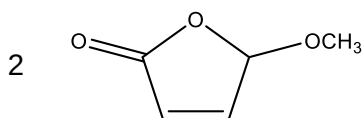
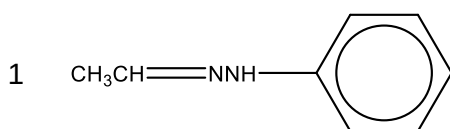
- Incorrect.
Both carboxylic acid and alcohol will give effervescence of H_2 gas.
- Correct.
Ester and amide undergo alkaline hydrolysis. Ethanol formed from hydrolysis of ester will give a pale yellow ppt with alkaline iodine.
- Correct.
Primary amide undergoes alkaline hydrolysis to liberate NH_3 gas.

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

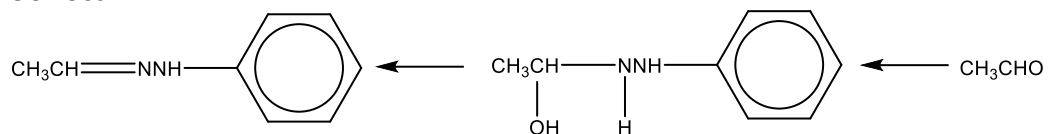
C 2 and 3

D 3 only

Answer: **B**

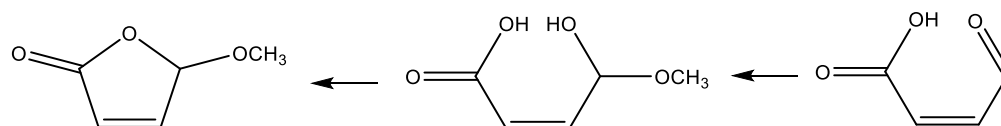
Working backwards, add in a H_2O followed by removal of the HX (where X is not necessarily a halogen; X can be $-\text{CN}$, $-\text{OCH}_3$, etc.) to obtain the $\text{C}=\text{O}$ (i.e. HX is removed across the $\text{C}-\text{O}$ bond) and hence the original reactant is obtained.

1 Correct.



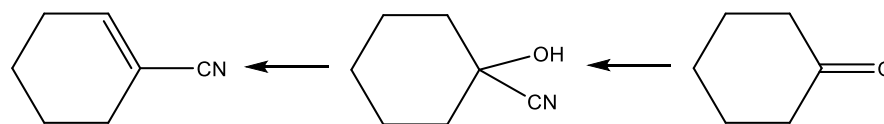
$\text{X} = -\text{NHNHC}_6\text{H}_5$

2 Correct.



$\text{X} = -\text{OCH}_3$

3 Incorrect.



$\text{X} = -\text{CN}$

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.

Answer: C

- A Incorrect.
Its name is phenyl butanoate.
- B Incorrect.
 $\text{C}_3\text{H}_7\text{CO}_2\text{C}_6\text{H}_5$ undergoes alkaline hydrolysis to form sodium butanoate and sodium phenoxide.
- C Correct.
 $\text{C}_3\text{H}_7\text{CO}_2\text{C}_6\text{H}_5$ undergoes acidic hydrolysis to form butanoic acid and phenol.
- D Incorrect.
Phenol is too weak of a nucleophile to undergo condensation with carboxylic acid. Butanoyl chloride should be used instead.

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

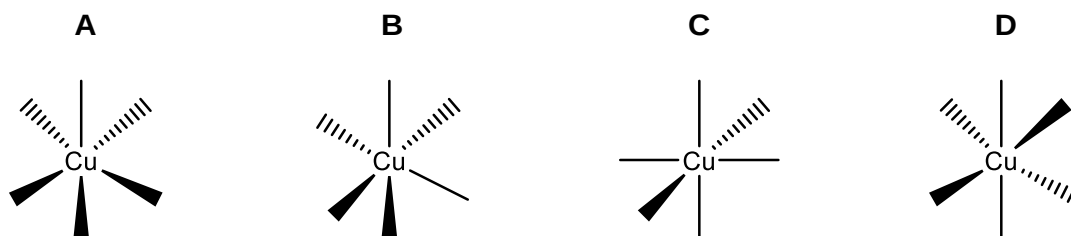
Answer: **C**

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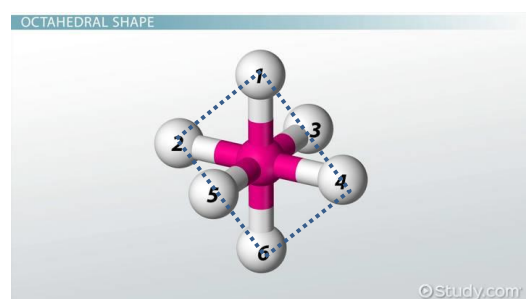
pro - val - thr
      thr - ser - asn
            asn - val - pro
                  pro - gly - his
    
```

pro - val - thr - ser - asn - val - pro - gly - his

27 Which diagram correctly shows the arrangement of the six coordinate bonds in a regular octahedral complex of copper?



Answer: **C**



In the octahedral geometry, atoms 1, 2, 4 and 6 are in the same plane and bonds are represented as solid lines. Atom 5 is going out of the plane and the bond is represented by a wedge. Atom 3 is going into the plane and the bond is represented by a dash.

28 The standard redox potential for the half-cell reaction



Which cell would be used to determine this standard value?

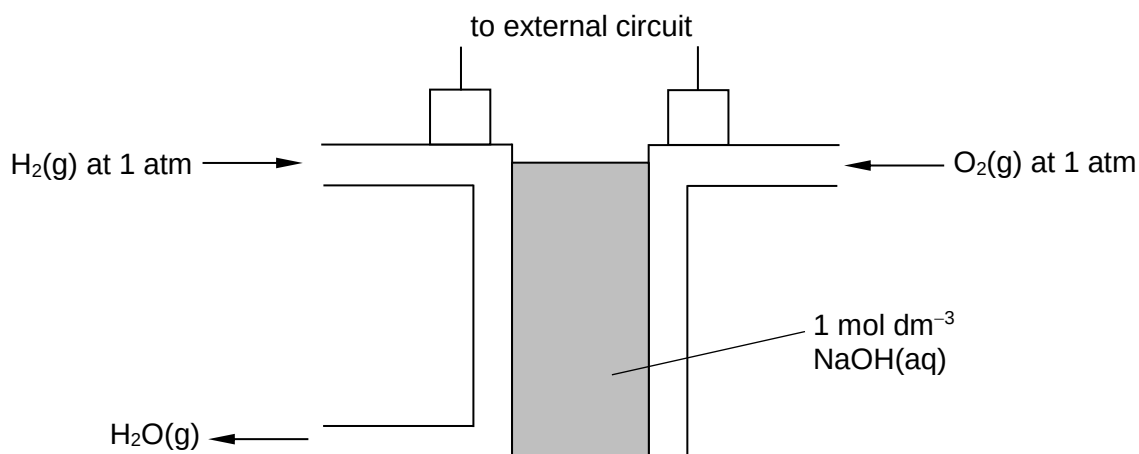
- A** Fe electrode in $1 \text{ mol dm}^{-3} \text{ Fe}^{3+}$ against Fe electrode in $1 \text{ mol dm}^{-3} \text{ Fe}^{2+}$
- B** Pt electrode in $1 \text{ mol dm}^{-3} \text{ Fe}^{3+}$ against Pt electrode in $1 \text{ mol dm}^{-3} \text{ Fe}^{2+}$
- C** Fe electrode in a solution containing $1 \text{ mol dm}^{-3} \text{ Fe}^{3+}$ and $1 \text{ mol dm}^{-3} \text{ Fe}^{2+}$ against a standard hydrogen electrode
- D** Pt electrode in a solution containing $1 \text{ mol dm}^{-3} \text{ Fe}^{3+}$ and $1 \text{ mol dm}^{-3} \text{ Fe}^{2+}$ against a standard hydrogen electrode

Answer: **D**

The standard electrode potential of an element is the potential difference between the element and the aqueous solution of its ion at 1 mol dm^{-3} relative to that of the standard hydrogen electrode at 298 K and 1 bar. The electrode here is a platinum electrode as there is no iron metal present in the equation.

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

A hydrogen-oxygen fuel cell is shown.



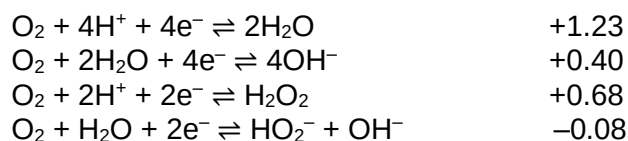
Which $E^\ominus$ value should be used for the cathode?

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

Answer: **B**

Reduction of O_2 occurs at the cathode.

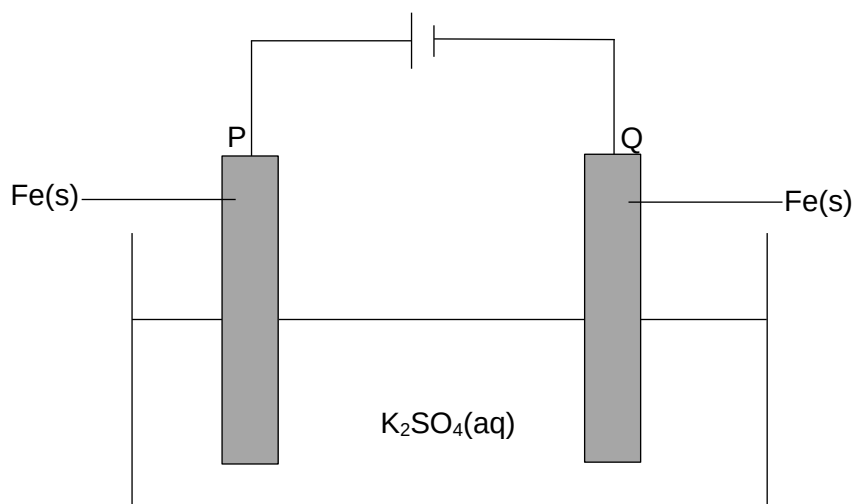
There are 4 equations in the *Data Booklet* that describes the reduction of O_2 :



We will select the half-equation with the most positive $E^\ominus$ value that is in the alkaline medium, i.e. +0.40V.

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?

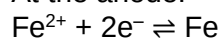
	electrode P	electrode Q
A	no change in mass	decrease in mass and H ₂ evolved
B	no change in mass	decrease in mass and SO ₂ evolved
C	decrease in mass	no change in mass and SO ₂ evolved
D	decrease in mass	no change in mass and H ₂ evolved

Answer: **D**

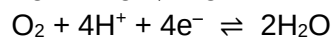
Electrode P is the positive anode, while electrode Q is the negative cathode

Since oxidation occurs at the anode, while reduction occurs at the cathode,

At the anode:



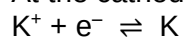
$$E^\ominus = -0.44 \text{ V}$$



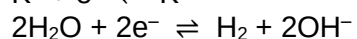
$$E^\ominus = +1.23 \text{ V}$$

Oxidation of the Fe anode will occur at electrode P since it has the most negative $E^\ominus$ and causing a decrease in the mass of the Fe electrode.

At the cathode:



$$E^\ominus = -2.92 \text{ V}$$



$$E^\ominus = -0.83 \text{ V}$$

The Fe electrode will not dissolve since Fe cannot be reduced and thus no change in mass of the Fe electrode.

H_2 gas will be evolved since it has the most positive $E^\ominus$.

ANSWER KEY

1	2	3	4	5
A	D	D	B	A
6	7	8	9	10
D	A	A	A	D
11	12	13	14	15
C	B	D	A	B
16	17	18	19	20
B	B	A	D	B
21	22	23	24	25
D	C	C	B	C
26	27	28	29	30
C	C	D	B	D