National Qualifications

# X813/77/02

# Chemistry
# Section 1 — Questions

Duration — 3 hours

Instructions for the completion of Section 1 are given on *page 02* of your question and answer booklet X813/77/01.

Record your answers on the answer grid on *page 03* of your question and answer booklet.

You may refer to the Chemistry Data Booklet for Higher and Advanced Higher.

Before leaving the examination room you must give your question and answer booklet to the Invigilator; if you do not, you may lose all the marks for this paper.

SQA ©

*X8137702*

**SECTION 1 — 25 marks**

**Attempt ALL questions**

**1.** According to the aufbau principle, electrons fill the atomic orbitals of potassium in the order

A 1s 2s 2p 3s 3p 3d

B 1s 2s 2p 3s 3d 3p

C 1s 2s 2p 3s 3p 4s

D 1s 2s 2p 3s 3d 4s.

**2.** Which of the following is **not** a possible quantum number for an outer electron in an atom of oxygen, in its ground state?

A $l = 0$

B $l = 1$

C $m_l = 0$

D $m_l = 1$

**3.** The number of unpaired electrons in a chromium atom, in its ground state, is

A 1

B 4

C 5

D 6.

**4.**

| Substance | $K_a$ |
|---|---|
| X | $1{\cdot}85 \times 10^{-11}$ |
| Y | $1{\cdot}57 \times 10^{-10}$ |
| Z | $1{\cdot}61 \times 10^{-5}$ |

Based on information in the table,

A X is less basic than Y

B X is more acidic than Z

C Y is more basic than Z

D Y is less acidic than X.

**5.** At 1400 K

$2C(s) + O_2(g) \rightarrow 2CO(g) \qquad \Delta G° = -475 \text{ kJ mol}^{-1}$

$2Zn(g) + O_2(g) \rightarrow 2ZnO(s) \qquad \Delta G° = -340 \text{ kJ mol}^{-1}$

For the reaction

$C(s) + ZnO(s) \rightarrow Zn(g) + CO(g)$

the standard free energy change, $\Delta G°$, in kJ mol$^{-1}$, at 1400 K is

A −67·5

B +67·5

C −135

D +135

**6.** Which of the following represents the enthalpy of formation of a compound?

A $2C(s) + O_2(g) \rightarrow 2CO(g)$

B $H_2(g) + Br_2(\ell) \rightarrow 2HBr(g)$

C $Mg(s) + \frac{1}{2}O_2(g) \rightarrow MgO(s)$

D $Na(s) + \frac{1}{2}Br_2(g) \rightarrow NaBr(s)$

**7.** Kinetic data for the reaction between bromate ions and bromide ions in the presence of hydrogen ions is shown below.

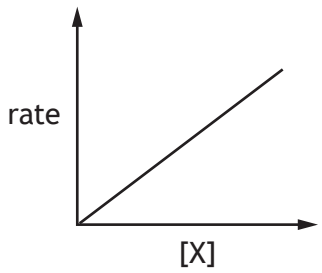
| Experiment | $[BrO_3^-]$ (mol l$^{-1}$) | $[Br^-]$ (mol l$^{-1}$) | $[H^+]$ (mol l$^{-1}$) | *Initial rate* (mol l$^{-1}$ s$^{-1}$) |
|---|---|---|---|---|
| **1** | 0·1 | 0·1 | 0·1 | $8·0 \times 10^{-4}$ |
| **2** | 0·2 | 0·1 | 0·1 | $1·6 \times 10^{-3}$ |
| **3** | 0·2 | 0·2 | 0·1 | $3·2 \times 10^{-3}$ |
| **4** | 0·1 | 0·1 | 0·2 | $3·2 \times 10^{-3}$ |

Which line in the table shows the order of reaction for each reactant?

| | $BrO_3^-$ | $Br^-$ | $H^+$ |
|---|---|---|---|
| A | 1 | 1 | 0 |
| B | 1 | 1 | 2 |
| C | 1 | 2 | 2 |
| D | 2 | 2 | 0 |

**8.** Which of the following graphs would be obtained for a reaction that is zero order with respect to reactant X?

A

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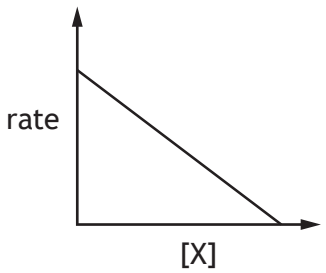


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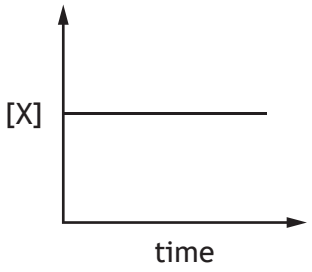


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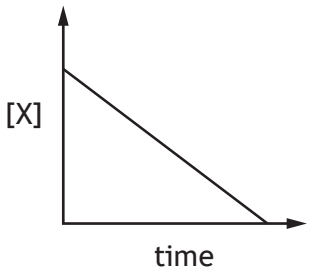


**9.** For the reaction

$2P + 2Q \rightarrow R$

the rate equation is

$rate = k[P]^2[Q]$.

Which of the following shows a possible mechanism for this reaction?

| | | |
|---|---|---|
| A | $P + 2Q \rightarrow X$ | slow |
| | $X + P \rightarrow R$ | fast |
| B | $2P + Q \rightarrow X$ | slow |
| | $X + Q \rightarrow R$ | fast |
| C | $P + 2Q \rightarrow X$ | fast |
| | $X + P \rightarrow R$ | slow |
| D | $2P + Q \rightarrow X$ | fast |
| | $X + Q \rightarrow R$ | slow |

**10.** For the reaction

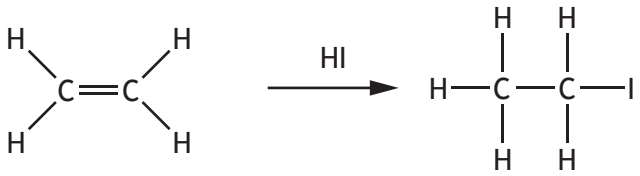
$CH_3CHBrCH_3 + OH^- \rightarrow CH_3CH(OH)CH_3 + Br^-$

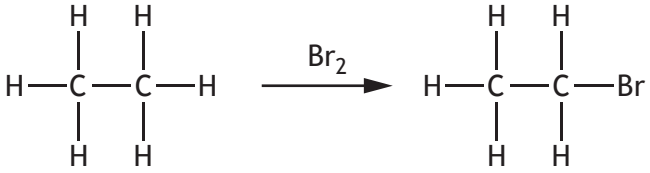
which line in the table is correct?

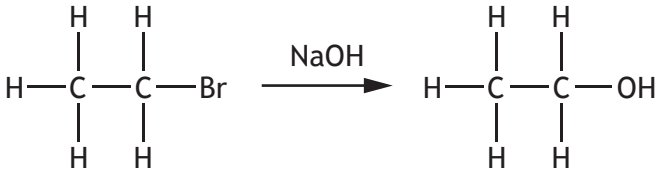
| | $OH^-$ | $CH_3CH(OH)CH_3$ |
|---|---|---|
| A | nucleophile | secondary |
| B | electrophile | secondary |
| C | nucleophile | tertiary |
| D | electrophile | tertiary |

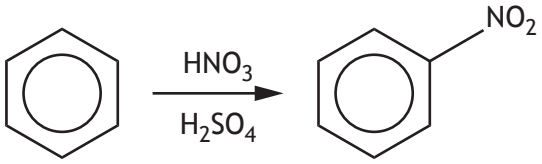
**[Turn over**

**11.** Which of the following reactions involves homolytic fission?

A 


B 

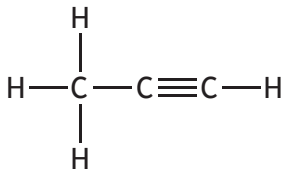

C 


D 


**12.** Which of the following has the fewest sigma bonds?

A Hexane
B Hex-1-ene
C Hex-1-yne
D Cyclohexane

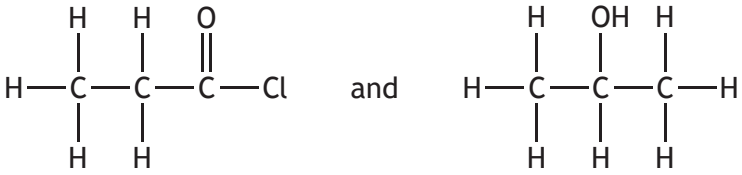
**13.** Propyne undergoes addition reactions.



Assuming the reaction between propyne and hydrogen chloride, HCl, follows Markovnikov's rule, a possible product could be

A 1-chloropropane
B 2-chloropropane
C 1-chloropropene
D 2-chloropropene.

**14.** An ester is formed by a condensation reaction between



What are the products of this reaction?

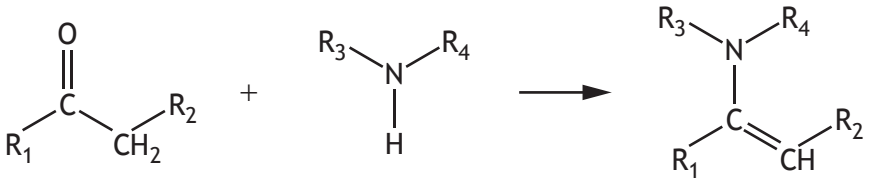
A $(CH_3)_2CHCOOCH_2CH_3 + H_2O$

B $CH_3CH_2COOCH(CH_3)_2 + H_2O$

C $CH_3CH_2COOCH(CH_3)_2 + HCl$

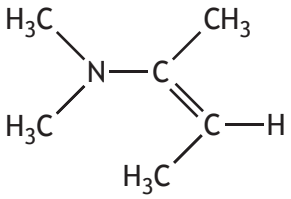
D $(CH_3)_2CHCOOCH_2CH_3 + HCl$

**15.** Secondary amines react with some carbonyl compounds to form unsaturated amines known as enamines.



an enamine

Which carbonyl compound would react with $(CH_3)_2NH$ to form the enamine with the following structure?



A Propanal

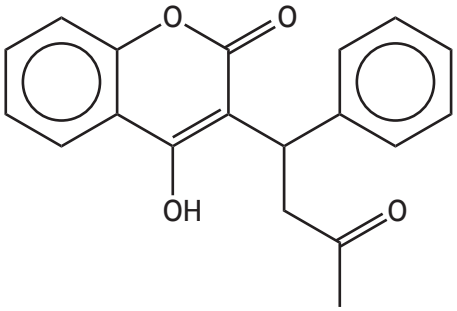
B Propanone

C Butanal

D Butanone

**[Turn over**

**16.**




warfarin

Which of the following functional groups is **not** present in warfarin?

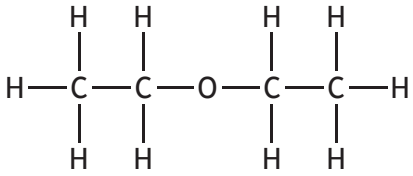
A Carbonyl

B Carboxyl

C Hydroxyl

D Phenyl

**17.** Which line in the table is correct for a high resolution $^{1}H$ NMR spectrum of ethoxyethane?



| | **Number of $^{1}H$ environments** | **Observed splitting patterns** |
|---|---|---|
| A | 2 | triplet, quartet |
| B | 2 | doublet, triplet |
| C | 4 | doublet, triplet |
| D | 4 | triplet, quartet |

**18.** Which of the following amines is likely to have the lowest boiling point?

A $C_4H_9NH_2$

B $C_3H_7NHCH_3$

C $C_2H_5NHC_2H_5$

D $C_2H_5N(CH_3)_2$

**19.** Ethane can be prepared by adding iodomethane to sodium.

$$2CH_3I + 2Na \rightarrow C_2H_6 + 2NaI$$

When a mixture of iodomethane and iodoethane is used, the only alkane(s) produced will be

A propane

B ethane and butane

C ethane, propane and butane

D methane, ethane, propane and butane.

**20.** Which of the following will react with lithium aluminium hydride but **not** react with Tollens' reagent?

A $CH_3COCH_3$

B $CH_3CH_2CHO$

C $CH_3OCH_2CH_3$

D $CH_3CH_2CH_2OH$

**21.** Two substances were analysed and found to have the empirical formula $CH_3O$.

From this information it can be concluded that the substances

A are isomers of each other

B have the same molecular mass

C have the same functional groups

D have the same percentage by mass of carbon.

**[Turn over**

**22.** The wavelength associated with a spectral line of hydrogen can be determined using the following relationship.

$$\frac{1}{\lambda} = R\left(\frac{1}{(n_1)^2} - \frac{1}{(n_2)^2}\right)$$

Where,

$\lambda$ is wavelength in m

$R$ is Rydberg constant ($1{\cdot}1 \times 10^7$ m$^{-1}$)

$n_1$ is the energy level to which the electron falls

$n_2$ is the energy level from which the electron falls.

When an electron falls from the ninth energy level to the second energy level, the wavelength, in m, associated with the spectral line is

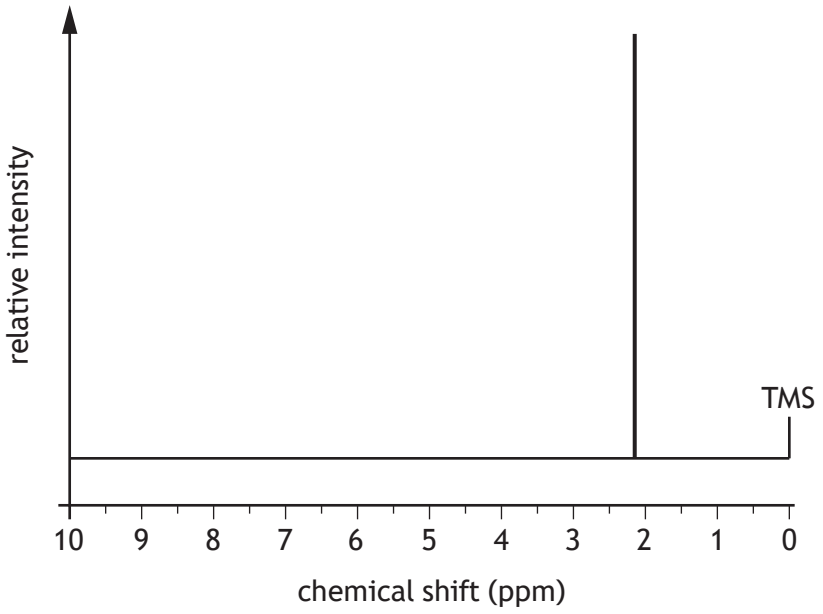
A $6{\cdot}55 \times 10^{-7}$

B $3{\cdot}83 \times 10^{-7}$

C $2{\cdot}34 \times 10^{-7}$

D $1{\cdot}86 \times 10^{-7}$

**23.** The low resolution $^1$H NMR spectrum for an organic compound is shown below.




Which of the following compounds gave this spectrum?

A Propane

B Propanal

C Propanone

D Propan-1-ol

**24.** Which of the following contains the greatest number of negatively charged ions?

A 400 $cm^3$ of 0·10 mol $l^{-1}$ $Zn(NO_3)_2(aq)$

B 500 $cm^3$ of 0·10 mol $l^{-1}$ $Na_2SO_4(aq)$

C 250 $cm^3$ of 0·12 mol $l^{-1}$ $BaCl_2(aq)$

D 300 $cm^3$ of 0·15 mol $l^{-1}$ KI(aq)

**25.** The covalent bond in a halogen molecule can be broken to produce halogen atoms when exposed to light of appropriate energy.

The bond enthalpy is the energy required to break one mole of bonds in a diatomic molecule.

Which halogen would require a minimum of $3{\cdot}22 \times 10^{-22}$ kJ to break one covalent bond?

A Fluorine

B Chlorine

C Bromine

D Iodine

**[END OF SECTION 1. NOW ATTEMPT THE QUESTIONS IN SECTION 2 OF YOUR QUESTION AND ANSWER BOOKLET.]**