TEMASEK JUNIOR COLLEGE

2023 JC2 PRELIMINARY EXAMINATION

Higher 2

CHEMISTRY **9729/01**

Paper 1 Multiple Choice **18 September 2023**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Data Booklet

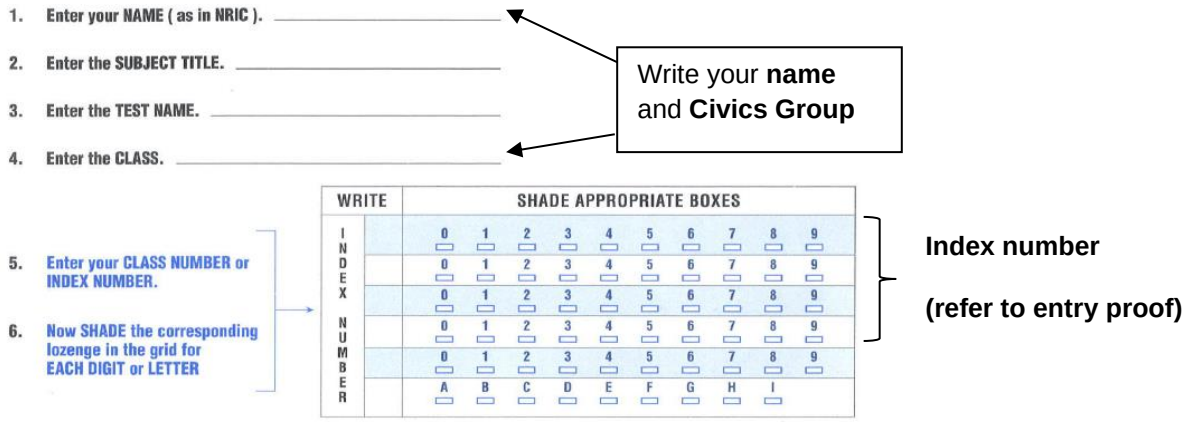
READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C**, **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.

Write your name & Civics Group on the Answer sheet. Shade your index number in the appropriate boxes.



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 **15** printed pages and 1 blank page.

1 Magnesium thiocyanate, $Mg(SCN)_2$, has been found to support heart health by promoting healthy blood circulation and maintaining normal blood pressure levels.

What are the numbers of electrons in the magnesium ion and the thiocyanate ion?

	Magnesium ion	Thiocyanate ion
A	12	29
B	10	29
C	10	30
D	10	31

2 In which pair of species do both species have only one *unpaired* p electron?

1 Ar^- and F

2 Ar^+ and Si^+

3 Ga and C^-

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

3 The ^{68}Ga isotope is used in positron emission tomography (PET) scan to detect tumors. The radioactive decay of ^{68}Ga isotope has a half-life of 68 days and produces the neutral particle, ^{68}X.

This transformation of ^{68}Ga occurs with a proton changing into a neutron.

Which of the following statement is **incorrect**?

A ^{68}X has 38 neutrons.

B ^{68}X is an isotope of zinc.

C There are 3 electrons in the valence shell of ^{68}X.

D 2.42 % of the original ^{68}Ga isotope remains after a year.

4 Which of the following species contain at least one *unpaired* electron?

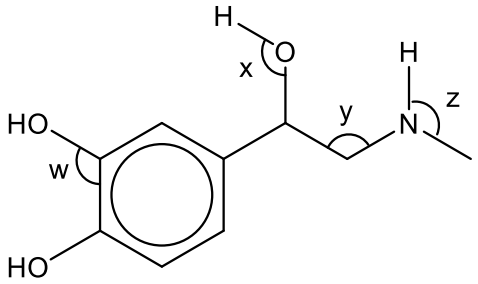
1 NO

2 NO_2

3 NO_2^-

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

5 Adrenaline is a hormone that is produced by the body during times of stress.



What are the bond angles *w*, *x*, *y* and *z* in adrenaline, from the smallest to the largest?

	Smallest bond angle ⟶ Largest bond angle			
A	*x*	*z*	*y*	*w*
B	*x*	*z*	*w*	*y*
C	*y*	*x*	*z*	*w*
D	*w*	*y*	*z*	*x*

6 Organic liquids **P** and **Q** have identical boiling points. When equal volumes of **P** and **Q** are mixed together, there is no reaction and liquid mixture **R** is obtained. The vapour pressure of liquid mixture **R** is less than that of liquid **P** or liquid **Q** at the same temperature.

Which of the following statement is **incorrect**?

A **R** is less volatile that **P**.

B **P** and **Q** are constitutional isomers.

C The mixing of **P** and **Q** is exothermic.

D The average intermolecular forces in **R** is stronger than that in **P** or in **Q**.

7 The following redox reactions have been observed to occur spontaneously.

$$2VO^{2+} + H_2O_2 \longrightarrow 2VO_2^{+} + 2H^{+}$$
$$S_2O_8^{2-} + H_2O_2 \longrightarrow O_2 + 2SO_4^{2-} + 2H^{+}$$

Which of the following shows an increasing order of oxidising power?

A $H_2O_2 < VO^{2+} < S_2O_8^{2-}$

B $S_2O_8^{2-} < H_2O_2 < VO^{2+}$

C $VO^{2+} < H_2O_2 < S_2O_8^{2-}$

D $VO^{2+} < S_2O_8^{2-} < H_2O_2$

8 *Use of the Data Booklet is relevant for this question*.

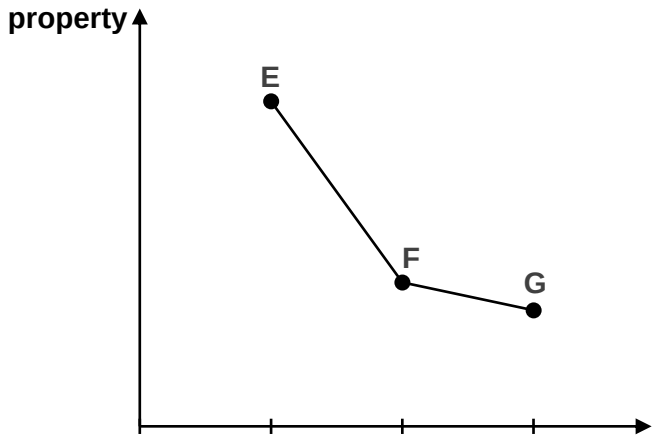
A 20 dm^3 vessel contains 0.25 mol ammonia gas and a 30 dm^3 vessel contains 0.42 mol hydrogen chloride gas. When the two vessels were connected at 500 K, the following chemical reaction occurs :

$$NH_3(g) + HCl(g) \longrightarrow NH_4Cl(s)$$

What is the resultant pressure in Pa in the combined vessel?

A 14127 **B** 20775 **C** 34902 **D** 55677

9 Which property of **E**, **F** and **G** will give the trend shown below?



	Property	**E**	**F**	**G**
A	boiling point	$SiCl_4$	PCl_5	BCl_3
B	volatility	HCl	HBr	HF
C	solubility in water	P_4O_{10}	SiO_2	MgO
D	reducing power	Mg	Ca	Ba

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

Element 117, Tennessine, that was discovered in 2010 is named after the state of Tennessee, USA.

Which property is Tennessine, Ts most likely to have?

A The covalent radius of Ts is less than 0.140 nm.

B The 7p orbitals of a Ts atom are completely filled.

C Ts produces bromine from a solution of sodium bromide.

D Ts is a dark coloured solid at room temperature and pressure.

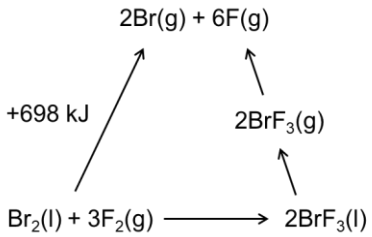
11 The ore iron(II) chromite, $FeCr_2O_4$, is mined in South Africa. The overall reaction for one of the stages in the mining process is as follows:

$$2Cr_2O_4^{2-} + 3O_2 + 4OH^- \longrightarrow 4CrO_4^{2-} + 2H_2O$$

How many oxygen molecules are required to react completely with one mole of chromite ions?

A 4.01×10^{23} **B** 9.03×10^{23} **C** 1.81×10^{24} **D** 5.41×10^{24}

12 An energy cycle is drawn to calculate the average bond energy of Br-F bond in BrF_3.



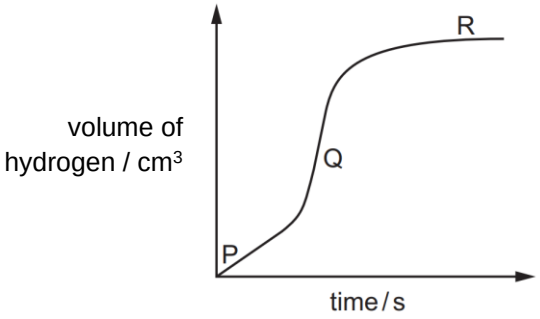
The enthalpy change of formation of $BrF_3(l)$ = –301 kJ mol^{-1}.

The enthalpy change of vapourisation of $BrF_3(l)$ = +44 kJ mol^{-1}.

What is the average bond energy, in kJ mol^{-1}, of the Br–F bond in BrF_3?

A 152 **B** 202 **C** 304 **D** 404

13 0.05 mol of shiny aluminium foil is added to 0.05 mol of hydrochloric acid and the volume of hydrogen gas produced is measured. The following graph is obtained.



Which of the following best explains the changes in the rate of reaction between points P and Q and between points Q and R?

	between points P and Q	between points Q and R
A	Reaction temperature is increasing	Concentration of HC*l* is decreasing
B	Reaction temperature is increasing	The A*l* foil is used up.
C	Reaction temperature is decreasing	Concentration of HC*l* is decreasing
D	Reaction temperature is decreasing	The A*l* foil is used up.

14 The reaction of hydrogen peroxide with iodide ions in acidic solution can be monitored by an initial rate method. The time taken for a fixed amount of iodine to be produced is measured.

$$H_2O_2(aq) + 2H^+(aq) + 2I^-(aq) \longrightarrow 2H_2O(l) + I_2(aq)$$

The table below shows the results obtained from a series of experiments with different volumes of reagent used.

experiment number	volume of H_2O_2 / cm^3	volume of H^+ / cm^3	volume of I^- / cm^3	volume of water / cm^3	time taken / s
1	8	8	4	0	30
2	4	8	4	4	60
3	8	4	6	2	20
4	4	8	6	2	40

Which describes the mechanism of this reaction?

A $H_2O_2 + H^+ \longrightarrow H_2O + OH^+$

$OH^+ + 2I^- + H^+ \longrightarrow H_2O + I_2$ (slow)

B $H_2O_2 + I^- \longrightarrow H_2O + IO^-$ (slow)

$H^+ + IO^- \longrightarrow HIO$

$HIO + H^+ + I^- \longrightarrow I_2 + H_2O$

C $2H^+ + 2I^- \longrightarrow 2HI$

$2HI + H_2O_2 \longrightarrow I_2 + 2H_2O$ (slow)

D $H_2O_2 + I^- + H^+ \longrightarrow H_2O + HIO$

$HIO + I^- \longrightarrow I_2 + OH^-$ (slow)

$OH^- + H^+ \longrightarrow H_2O$

15 Ethanoic acid is mixed with ethanol. The ethanol is found to be contaminated with trace amounts of methanol.

The following equilibria are established.

$CH_3CO_2H(l) + CH_3CH_2OH(l) \rightleftharpoons CH_3CO_2CH_2CH_3(l) + H_2O(l)$ $\quad K_c = K_1$

$CH_3CO_2H(l) + CH_3OH(l) \rightleftharpoons CH_3CO_2CH_3(l) + H_2O(l)$ $\quad K_c = K_2$

Which of the following statements is correct?

A Methyl ethanoate will not be produced as there is more ethanol present.

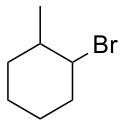
B The ratio $\frac{[CH_3CO_2CH_2CH_3]}{[CH_3CO_2CH_3]} = \frac{K_1}{K_2}$ in the mixture.

C The $\frac{K_1}{K_2}$ ratio will increase with addition of ethanol.

D Adding methyl ethanoate to the mixture will increase the amount of ethyl ethanoate formed.

16 Compound **T**, $C_7H_{13}Br$, has two chiral centres.

Hot ethanolic NaOH is added to a sample of compound **T**.

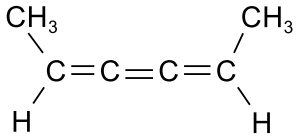


T

What is the maximum number of stereoisomers that is formed in the sample?

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

17 The structure of compound **K** is given below.



compound **K**

Which of the following correctly describes the properties of **K**?

	number of sp^2 carbon atoms	exhibit cis-trans isomerism	exhibit enantiomerism
A	2	Yes	No
B	4	No	Yes
C	2	No	Yes
D	4	Yes	No

18 Which of the following statements is correct for 1,1-difluoroethane and 1,1-dichloroethane?

1 1,1-difluoroethane is less reactive than 1,1-dichloroethane due to larger bond polarity of the C–F bond.

2 1,1-difluoroethane has zero net dipole moment.

3 At the upper atmosphere, 1,1-difluoroethane releases free radicals which deplete the ozone layer.

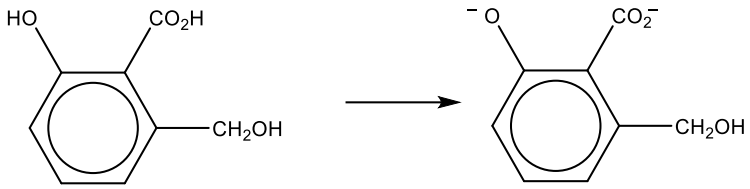
A 1 only

B 1 and 3 only

C 2 and 3 only

D None of the above

19 Which reagent can be used for the following conversion?

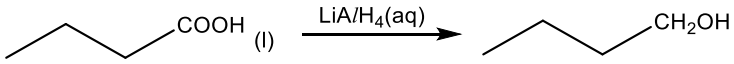


A $Na_2Cr_2O_7$ **B** Na_2CO_3 **C** NaOH **D** Na

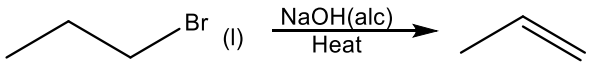
20 The reaction conditions for four different transformations are given.

Which transformation has the correct conditions?
[(alc) indicates an alcoholic solution.]

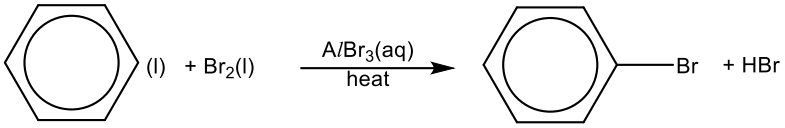
A



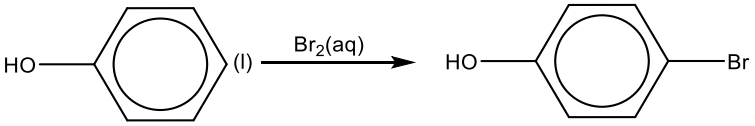
B

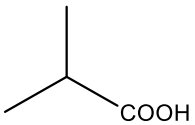


C



D



21 Which of the following compounds can be used to synthesise 

in a single step?

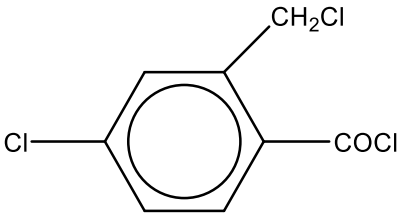
1 2-methylpropylmethanoate

2 2-methylpropan-1-ol

3 propan-2-ol

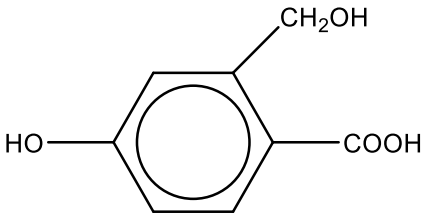
A 1 and 2 **B** 2 and 3 **C** 1 only **D** 2 only

22 Which of the following compounds is expected to be formed in the highest yield when compound **Z** is heated under reflux with aqueous sodium hydroxide followed by acidification?

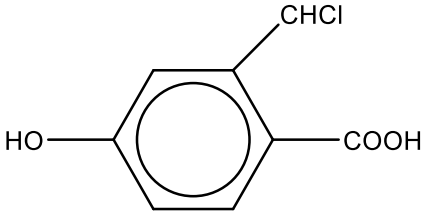


Z

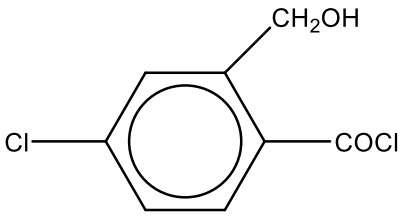
A



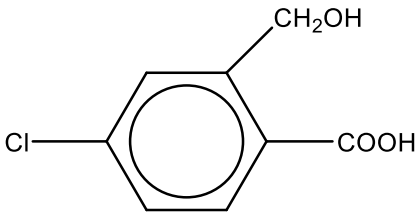
B



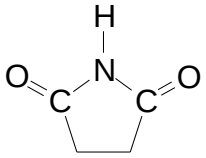
C



D



23 Compound **X** has the structural formula as shown below:



Which of the following statements regarding **X** are correct?

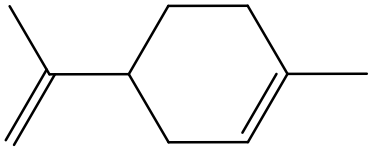
1 **X** can react with boiling aqueous NaOH with the evolution of NH_3.

2 **X** can react with Li*A*lH_4 in dry ether to form a cyclic secondary amine.

3 **X** can react with hot dilute HC*l* to yield an amino acid.

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

24 Limonene is a hydrocarbon found in the rind of citrus fruits.



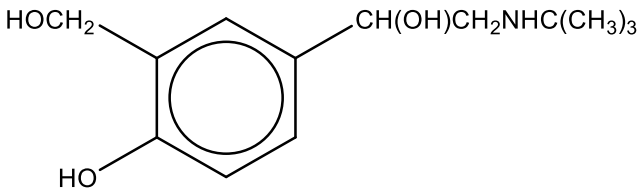
Limonene

Limonene is treated with hot, concentrated, acidified manganate(VII) ions to form an organic product **M**.

What is the molecular formula of limonene and **M**?

	Molecular formula of Limonene	Molecular formula of organic product, **M**
A	$C_{10}H_{14}$	$C_{10}H_{12}O_4$
B	$C_{10}H_{14}$	$C_{10}H_{14}O_4$
C	$C_{10}H_{16}$	$C_9H_{14}O_3$
D	$C_{10}H_{16}$	$C_9H_{14}O_4$

25 Salbutamol is a widely used anti-asthmatic drug. The structure of salbutamol is shown below.



Which of the following is likely to be a property of this drug?

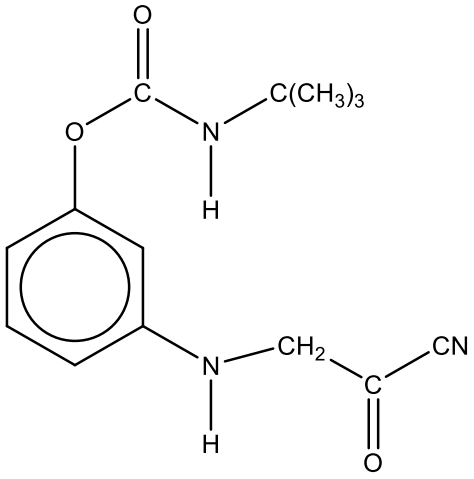
A It will decolourise aqueous bromine.

B It gives a precipitate with hot aqueous alkaline iodine.

C It reacts with hot sodium hydroxide to form two organic products.

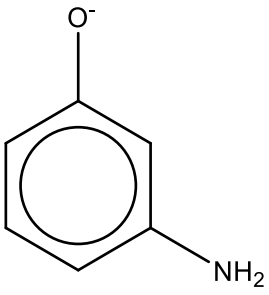
D It gives 3 moles of hydrogen chloride gas when reacted with phosphorus pentachloride.

26 The structure of **Q** is shown below.

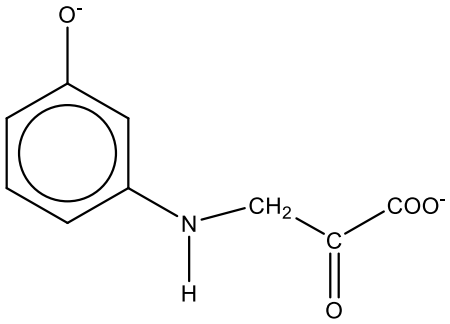


What would be formed by prolonged boiling of **Q** with aqueous sodium hydroxide?

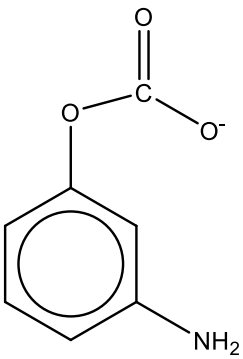
A



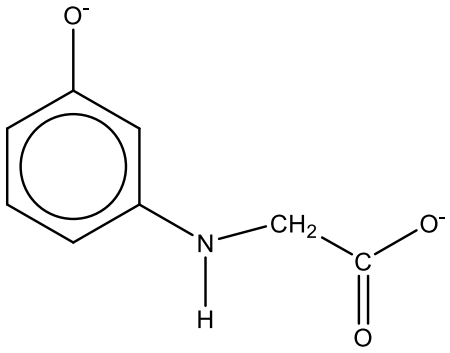
B



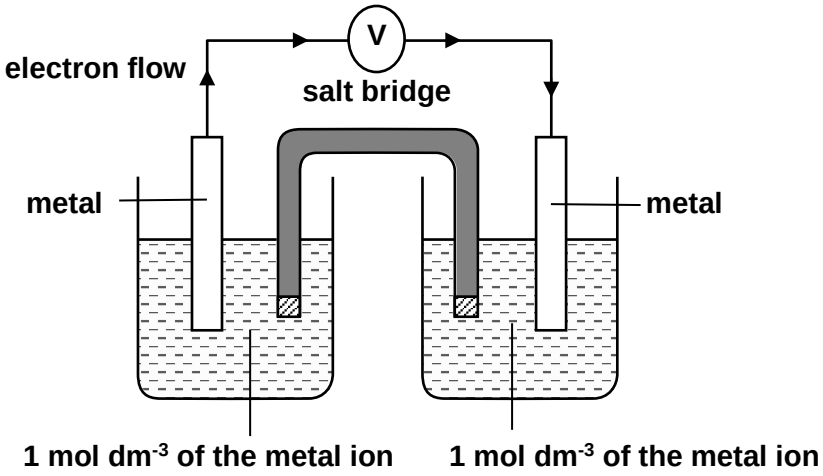
C



D



27 The half-cells for four metals: Mg, **P**, **Q** and **R** were in turn connected in pairs and the potential difference was recorded at 25°C.



The results obtained are as shown in the table below.

Positive electrode	Negative electrode	e.m.f /V
P	Mg	+2.10
Q	Mg	+2.72
Mg	**R**	+0.33

Which of the following is correct?

	strongest reducing agent		⟶	*weakest reducing agent*
A	**Q**	**P**	Mg	**R**
B	**P**	**Q**	Mg	**R**
C	**R**	Mg	**P**	**Q**
D	**R**	Mg	**Q**	**P**

28 In the electrolysis of a nitrate solution of metal **Y**, 0.76 g of the element was formed at the cathode by the passage of 0.5 A of current for 1930 seconds. Metal **Y** has a relative atomic mass of 152.

Which of the following statements about the above electrolysis are correct?

1 The charge on an ion of **Y** is $\frac{0.5\times1930\times152}{96500\times0.76}$.

2 When the gas at the anode was collected and a glowing splinter was inserted into it, it bursts into flame.

3 The mass of **Y** obtained in 1930 s can be increased by using a more concentrated nitrate solution of metal **Y**.

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

29 Which solution will form a precipitate when aqueous silver nitrate is added?

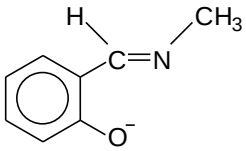
A $[Cr(NH_3)_3Cl_3]$

B $[Cr(NH_3)_6]Cl_3$

C $Na_3[CrCl_6]$

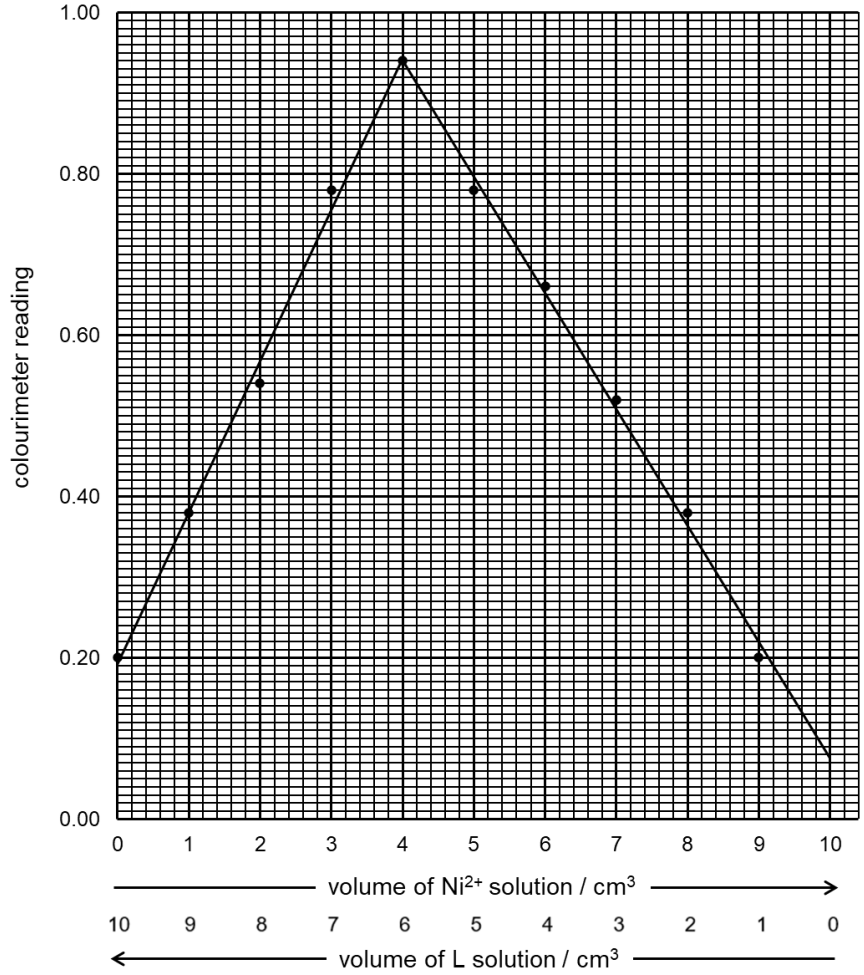
D $[Cr(en)(NH_3)_2Cl_2]NO_3$

30 Nickel(II) ion forms a red complex with ligand **L** at room temperature.



L

The following graph below was obtained when the colour intensities of mixtures of a 4 x 10^{-3} mol dm^{-3} solution of **L** and a 3 x 10^{-3} mol dm^{-3} solution of nickel(II) chloride were measured using a colorimeter at room temperature.



Which one of the following statements regarding the ligand **L** or the nickel(II) complex is correct?

A **L** is a monodentate ligand.

B The nickel(II) complex is negatively charged.

C The nickel(II) complex absorbs red light strongly.

D The co-ordination number of nickel in the complex is 4.

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