



HWA CHONG INSTITUTION
C2 Preliminary Examination
Higher 2

**CANDIDATE
NAME**

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**CT
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CHEMISTRY

9729/01

Paper 1 Multiple Choice

22 September 2025

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.

Complete the information on the Answer Sheet as shown below.

1. Enter your **NAME** (as in NRIC). _____

2. Enter the **PAPER NUMBER**. _____

3. Enter your **CT GROUP**. _____

4. Enter your **NRIC NUMBER** or **FIN Number**

5. Now **SHADE** the corresponding
circles in the grid for
EACH DIGIT or **LETTER**

USE PENCIL ONLY FOR ALL ENTRIES ON THIS SHEET							
0	1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐	☐

NRIC / FIN											
(S)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(A)	(K)	(U)	
(F)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(B)	(L)	(V)	
(G)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(C)	(M)	(W)	
(T)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(D)	(N)	(X)	

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.

- 1 The successive ionisation energies of an element **X** are given below.

	1st	2nd	3rd	4th	5th	6th
ionisation energy / kJ mol ⁻¹	950	1800	2700	4800	6000	12300

What could be the formula of the chloride **X**?

- A** XCl **B** XCl_2 **C** XCl_4 **D** XCl_5

- 2 In which row are G and H atoms or ions of different isotopes of the same element?

	G			H		
	number of electrons	charge	nucleon number	number of electrons	charge	nucleon number
A	8	0	18	10	-2	18
B	17	+1	37	16	0	34
C	16	0	36	18	0	38
D	20	0	42	18	+2	40

- 3 Which pair of species has a similar shape?

- A** AlCl_3 and PCl_3
B BF_3 and NH_3
C SF_4 and XeF_4
D PH_4^+ and BF_4^-

- 4 A small bulb with a capacity of 10 m^3 is connected to another with a capacity of 30 m^3 . Before connection, the pressure in the smaller bulb is 50 kPa and that in the larger bulb is 120 kPa .

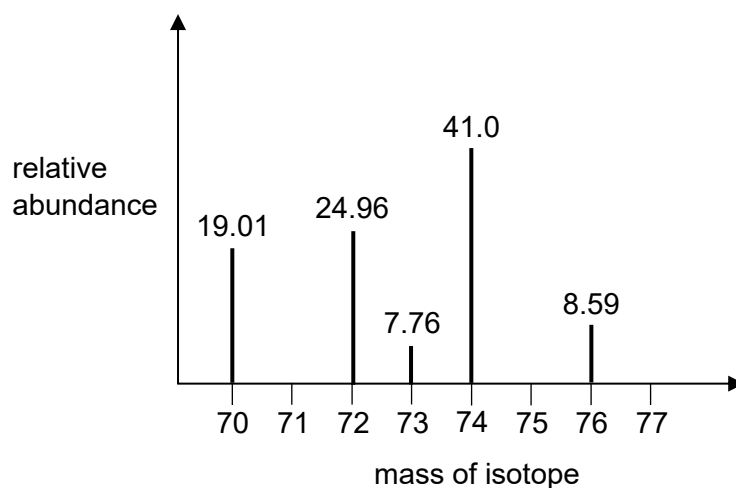
If all measurements are made at the same temperature, what is the pressure in the combined arrangement after connection?

- A** 67.5 kPa **B** 85 kPa **C** 103 kPa **D** 170 kPa

- 5 Which statement is correct?

- A** The relative isotopic mass of an element is the mass of one atom of an isotope of the element relative to $\frac{1}{12}$ the mass of one atom of ^{12}C .
- B** The relative atomic mass of an element is the mass of one atom of the element relative to $\frac{1}{12}$ the mass of one atom of ^{12}C .
- C** The relative molecular mass of a compound is the average mass of one molecule of the compound relative to the mass of one atom of ^1H .
- D** The relative formula mass of an ionic compound is the average mass of one formula unit of the ionic compound relative to the mass of one atom of ^{12}C .

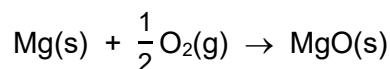
- 6 The relative abundance of all the isotopes present in a sample of germanium are shown.



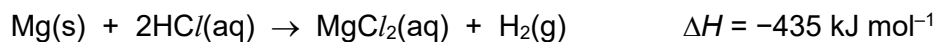
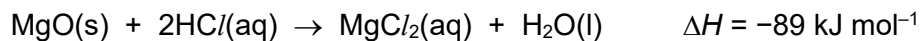
What is the relative atomic mass of germanium calculated from these data?

- A** 72.6 **B** 72.8 **C** 73.8 **D** 74.0

- 7** The combustion of magnesium in oxygen is shown in the equation below.



Some enthalpy changes are given below.

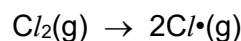


What is the enthalpy change of combustion for magnesium?

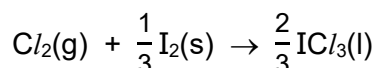
- A** -632 kJ mol^{-1} **B** -918 kJ mol^{-1}
C $-1262 \text{ kJ mol}^{-1}$ **D** $-1352 \text{ kJ mol}^{-1}$

- 8 Assuming the pressure of each system remains at 1 atm, which processes show an increase in entropy?

- 1 mol of $\text{Cl}_2(\text{g})$ at 298 K is heated to 373 K.
- 1 mol of $\text{Cl}_2(\text{g})$ at 298 K is added to 1 mol of $\text{N}_2(\text{g})$ at 298 K.
- 1 mol of $\text{Cl}_2(\text{g})$ at 1000 K is photolysed according to the following equation.

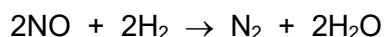


- 4 1 mol of $\text{Cl}_2(\text{g})$ at 298 K is reacted with iodine according to the following equation.

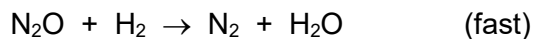
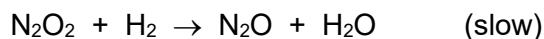


- A** 1, 2 and 3 only
- B** 1, 2 and 4 only
- C** 1, 3 and 4 only
- D** 2, 3 and 4 only

- 9 The equation for the reduction of nitrogen monoxide is shown below.

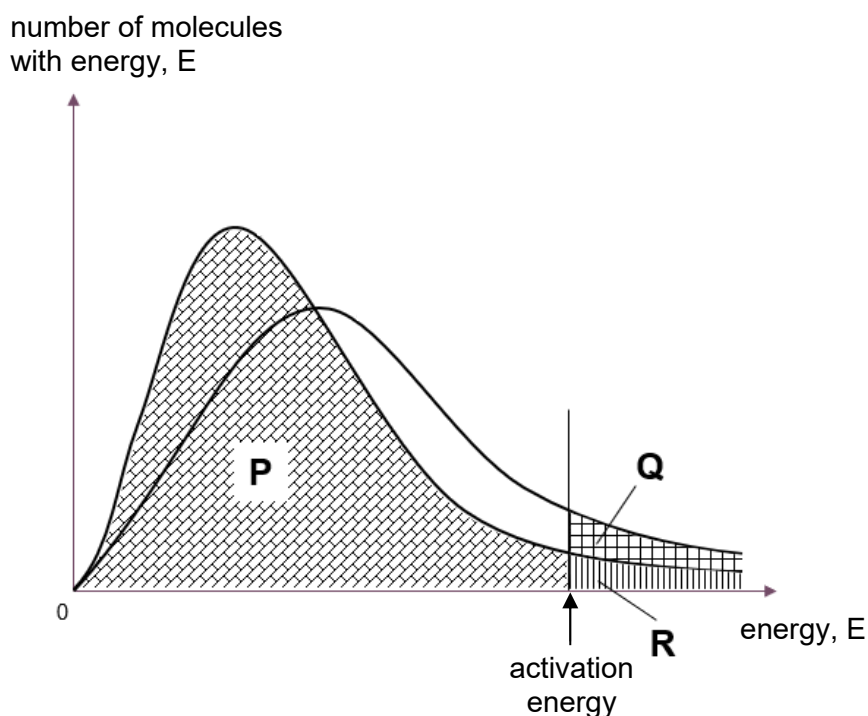


The mechanism involves the following steps.



Which statement about the reaction is correct?

- A** The overall order of the reaction is 4.
- B** The units of the rate constant are $\text{mol}^{-2} \text{dm}^6 \text{s}^{-1}$.
- C** The reaction is second order with respect to $[\text{H}_2]$.
- D** The reaction is zeroth order with respect to $[\text{NO}]$.
- 10 The distribution of the number of molecules with energy, E , for a reaction at two different temperatures is shown below. The letters P, Q and R refer to separate and differently shaded areas.



Which expression gives the fraction of molecules that have energy greater than or equal to the activation energy at the lower temperature?

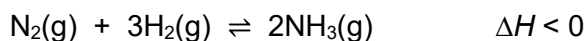
A $\frac{R}{P+R}$

B $\frac{Q+R}{P+R}$

C $\frac{R}{P}$

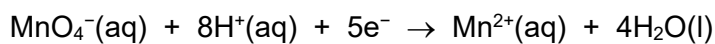
D $\frac{Q+R}{P}$

- 11 The Haber Process is an important industrial process in which nitrogen and hydrogen are reacted to give ammonia.

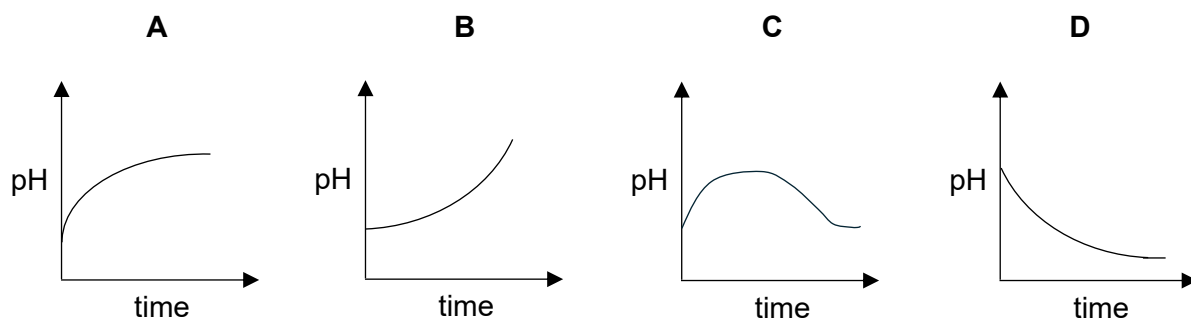


Which statement is correct?

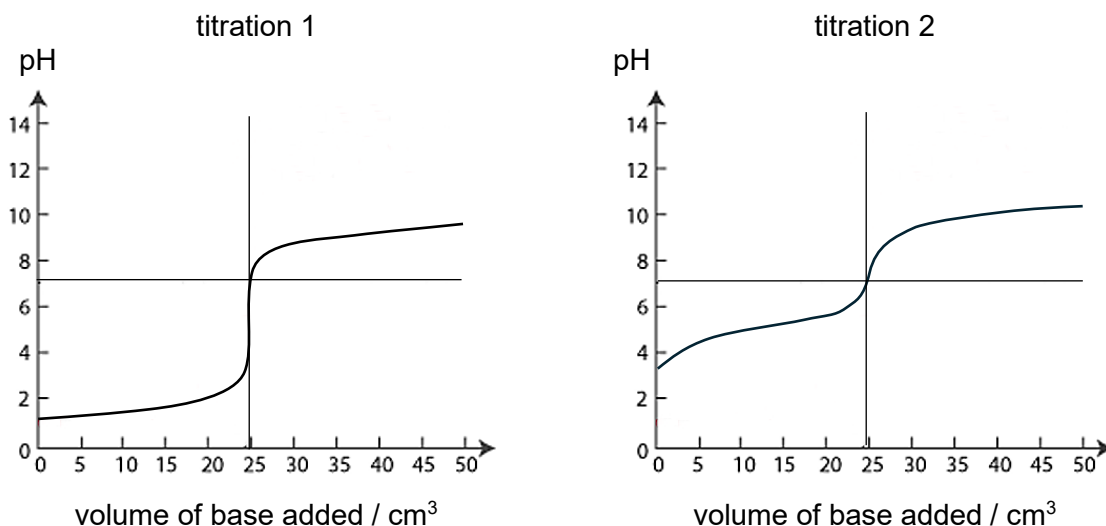
- A A temperature of 250 °C is used to ensure that the rate of reaction is fast enough.
 - B A moderately high pressure is used to ensure high yield without being too costly.
 - C Iron is added to increase the yield because the temperature cannot be too high.
 - D Ammonia is constantly removed from the system to increase the rate of reaction.
- 12 Sulfur dioxide gas is converted into sulfate ions when it is bubbled into aqueous manganate(VII) ions.



Which graph shows how the pH changes as sulfur dioxide is bubbled at a constant rate into a well-stirred solution of manganate(VII) ions until its colour just fades?



13 The titration curves for two acid-base reactions are shown below.



The working ranges of some indicators are given in the table below.

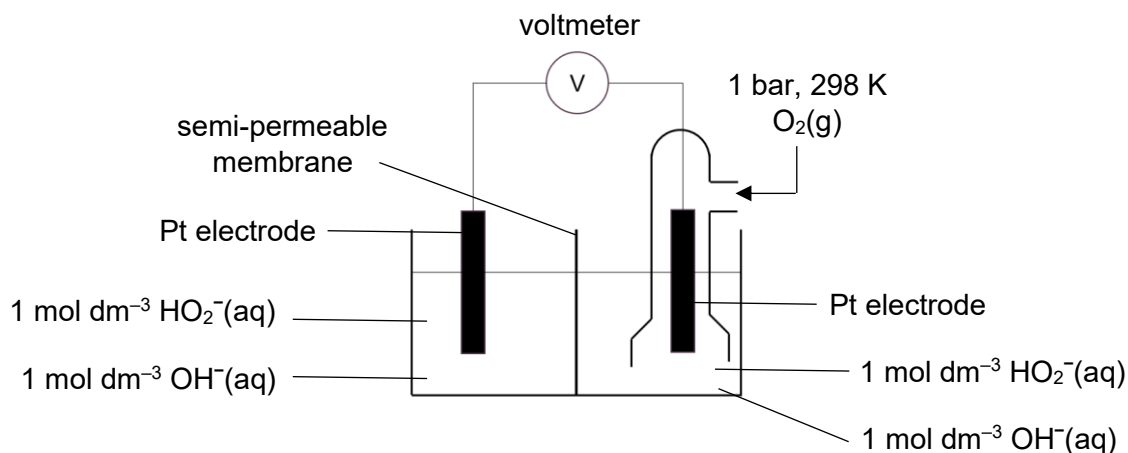
indicator	working range pH
methyl orange	3.1 – 4.4
bromothymol blue	6.0 – 7.0

Which statement about the two titrations is correct?

- A** Bromothymol blue may be used for titration 2.
- B** Methyl orange may be used for titrations 1 and 2.
- C** Both titrations involve weak acids.
- D** Both titrations involve weak bases.

14 Use of the Data Booklet is relevant to this question

Hydrogen peroxide deprotonates in alkaline medium to form HO_2^- . The diagram below shows an electrochemical cell set up to measure the cell potential for the decomposition of HO_2^- to form OH^- and O_2 gas.



Which statements are correct?

- 1 The voltmeter gives a reading of -0.96 V .
- 2 The reaction at the cathode may be given as $\text{HO}_2^- + \text{H}_2\text{O} + 2\text{e}^- \rightarrow 3\text{OH}^-$.
- 3 The semi-permeable membrane behaves like a salt bridge in the cell.

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

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

An electrolysis cell is set up with an anode made of an alloy of 75% Cu and 25% Ni by mass and a cathode made of pure Cu. The electrolyte is a solution which contains 1.0 mol dm^{-3} of $\text{NiSO}_4(\text{aq})$ and 1.0 mol dm^{-3} of $\text{CuSO}_4(\text{aq})$.

A current of 0.50 A is passed through the cell for 1.5 hours . The cathode increased in mass by 0.88 g .

What value of Avogadro's constant does **these figures** give?

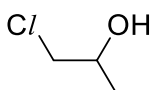
- A** 6.02×10^{23} **B** 6.09×10^{23} **C** 8.12×10^{23} **D** 1.22×10^{24}

16 Covalent bonds are formed by orbital overlap.

Which bond is **not** present in $\text{HC}\equiv\text{CCH}_2\text{CH}=\text{CH}_2$?

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

17 Which row correctly shows the nature of the reactive chlorine species?

	reaction	nature of reactive chlorine species
1	 + Cl ₂ →  + HCl	electrophile
2	 + Cl ₂ + H ₂ O →  + HCl	nucleophile
3	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array} + \text{Cl}_2 \longrightarrow \begin{array}{c} \text{Cl} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array} + \text{HCl}$	free radical

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

- 18 A non-cyclic molecule, J, has the formula $C_4H_7O_2N$.

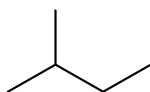
What are the possible combinations of functional groups present in molecule J?

- 1 one amide group and one ketone group
- 2 one carboxylic acid group and one nitrile group
- 3 one alkene group, one ester group and one amine group
- 4 one nitrile group, one alcohol group and one aldehyde group

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

- 19 In the free radical substitution of 2-methylbutane with limited bromine in the presence of ultraviolet light, a mixture of mono-brominated products is obtained.

Which is the correct combination of the products obtained? Ignore stereoisomers.



2-methylbutane

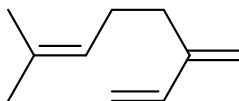
- A 5 possible products in the ratio of 3:3:3:2:1
- B 4 possible products in the ratio of 3:3:3:2
- C 4 possible products in the ratio of 6:3:2:1
- D 3 possible products in the ratio of 9:2:1

- 20 Modern cars are fitted with catalytic converters to reduce atmospheric pollution caused by unwanted reactions during the combustion of the fuel.

Which reaction does **not** occur in a catalytic converter?

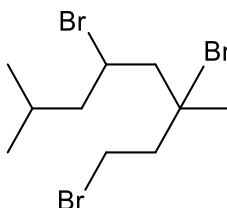
- A $\text{CO}_2 + \text{NO} \rightarrow \text{CO} + \text{NO}_2$
- B $2\text{CO} + 2\text{NO} \rightarrow 2\text{CO}_2 + \text{N}_2$
- C $4\text{C}_x\text{H}_y + (4x + y)\text{O}_2 \rightarrow 4x\text{CO}_2 + 2y\text{H}_2\text{O}$
- D $4\text{C}_x\text{H}_y + (8x + 2y)\text{NO} \rightarrow 4x\text{CO}_2 + 2y\text{H}_2\text{O} + (4x + y)\text{N}_2$

- 21 A species of termite produces a chemical defence secretion which contains the following molecule.



Which statement about this compound is correct?

- A It reacts with excess cold alkaline manganate(VII) ions to give an organic product with three chiral centres.
- B It reacts with excess hot acidified manganate(VII) ions to give three organic products.
- C It reacts with aqueous Br_2 to give a major product containing two secondary alcohol functional groups.
- D It can be formed from reacting the following compound with hot ethanolic sodium hydroxide.



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

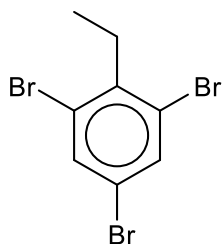
Which synthesis sequence, using benzene as the starting material, is expected to give the best yield of 2-bromo-4-nitromethylbenzene?

- A alkylation, nitration, bromination
- B alkylation, bromination, nitration
- C bromination, nitration, alkylation
- D nitration, bromination, alkylation

- 23 0.10 mol of liquid K, L and M are shaken separately for some time with hot ethanolic silver nitrate.

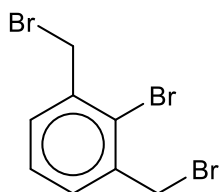
What are the relative amounts of pale cream precipitate formed by K, L and M?

1



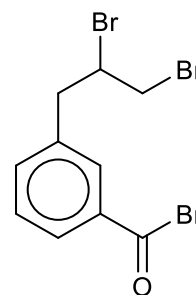
K

2



L

3



M

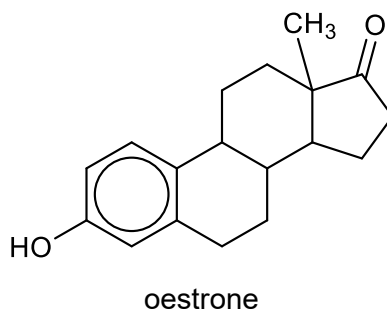
- A** $K = L < M$
B $K < L < M$
C $K < L = M$
D $M < L < K$

- 24 Compounds V, W and X all react with sodium to give hydrogen gas, but only one of them reacts with Fehling's reagent.

Which combination could be V, W and X?

	V	W	X
A	$\begin{array}{c} \text{CH}_2\text{OH} \\ \\ \text{CH}_2\text{OH} \end{array}$	$\begin{array}{c} \text{CHO} \\ \\ \text{CHO} \end{array}$	$\begin{array}{c} \text{CO}_2\text{H} \\ \\ \text{CO}_2\text{H} \end{array}$
B	$\begin{array}{c} \text{CH}_2\text{OH} \\ \\ \text{CH}_2\text{OH} \end{array}$	$\begin{array}{c} \text{CH}_2\text{OH} \\ \\ \text{CHO} \end{array}$	$\begin{array}{c} \text{CHO} \\ \\ \text{CO}_2\text{H} \end{array}$
C	$\begin{array}{c} \text{CH}_2\text{OH} \\ \\ \text{CHO} \end{array}$	$\begin{array}{c} \text{CH}_2\text{OH} \\ \\ \text{CO}_2\text{H} \end{array}$	$\begin{array}{c} \text{CHO} \\ \\ \text{CO}_2\text{H} \end{array}$
D	$\begin{array}{c} \text{CH}_2\text{OH} \\ \\ \text{CO}_2\text{H} \end{array}$	$\begin{array}{c} \text{CHO} \\ \\ \text{CO}_2\text{H} \end{array}$	$\begin{array}{c} \text{CO}_2\text{H} \\ \\ \text{CO}_2\text{H} \end{array}$

- 25 The diagram shows the structure of a molecule of the hormone oestrone.



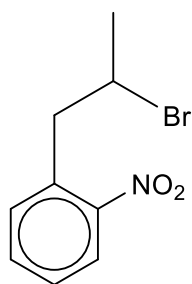
Which statement about oestrone is **incorrect**?

- A It gives an orange precipitate with 2,4-dinitrophenylhydrazine.
 - B It gives a salt with aqueous sodium hydroxide.
 - C It gives a dicarboxylic acid with hot acidified potassium manganate(VII).
 - D It gives white fumes with phosphorus(V) chloride.
- 26 The small hive beetle, which invades colonies of the honeybee, identifies these colonies by detecting the bees' own alarm signal, the pheromone 3-methylbutyl ethanoate.

How may this ester be made in the laboratory?

- A $(\text{CH}_3)_2\text{CHCH}_2\text{CO}_2\text{H} + \text{CH}_3\text{CH}_2\text{OH} \xrightarrow[\text{heat}]{\text{conc. H}_2\text{SO}_4} \text{ester} + \text{H}_2\text{O}$
- B $(\text{CH}_3)_2\text{CHCH}_2\text{CH}_2\text{CO}_2\text{H} + \text{CH}_3\text{OH} \xrightarrow[\text{heat}]{\text{conc. H}_2\text{SO}_4} \text{ester} + \text{H}_2\text{O}$
- C $\text{CH}_3\text{COCl} + (\text{CH}_3)_2\text{CHCH}_2\text{CH}_2\text{OH} \longrightarrow \text{ester} + \text{HCl}$
- D $\text{CH}_3\text{COCl} + \text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{OH} \longrightarrow \text{ester} + \text{HCl}$

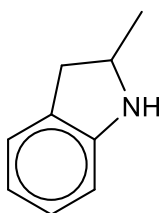
- 27 Compound Y is heated with tin and concentrated hydrochloric acid. Aqueous sodium hydroxide is then added to the hot mixture, producing compound Z.



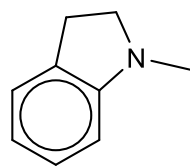
compound Y

What is the structure of compound Z?

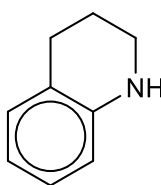
A



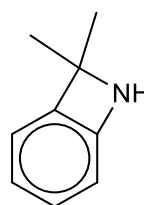
B



C



D



- 28 Which statement about Group 2 and Group 17 elements is correct?
- A The melting point of Group 2 elements increases down the group.
 - B The reducing power of Group 2 elements increases down the group.
 - C The volatility of Group 17 elements increases down the group.
 - D The oxidising power of Group 17 elements increases down the group.
- 29 Which statements explain the difference in density of vanadium compared to calcium?
- 1 Relative atomic mass is higher for vanadium.
 - 2 Outer shell electrons are more shielded in vanadium.
 - 3 The outer shell electrons of vanadium experience greater attraction to the nucleus.

A 1 only

B 2 only

C 1 and 3 only

D 2 and 3 only

- 30 Platinum(IV) chloride is combined with ammonia to form a new platinum(IV) complex with only chloride and ammonia as ligands. This complex ion has a 2+ charge and a co-ordination number of 6.

What is the number of ammonia ligands in this complex ion?

A 2

B 4

C 5

D 6

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