YISHUN INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME			
CG		INDEX NO	

CHEMISTRY 9729/01

Paper 1 Multiple Choice **16 September 2021**

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

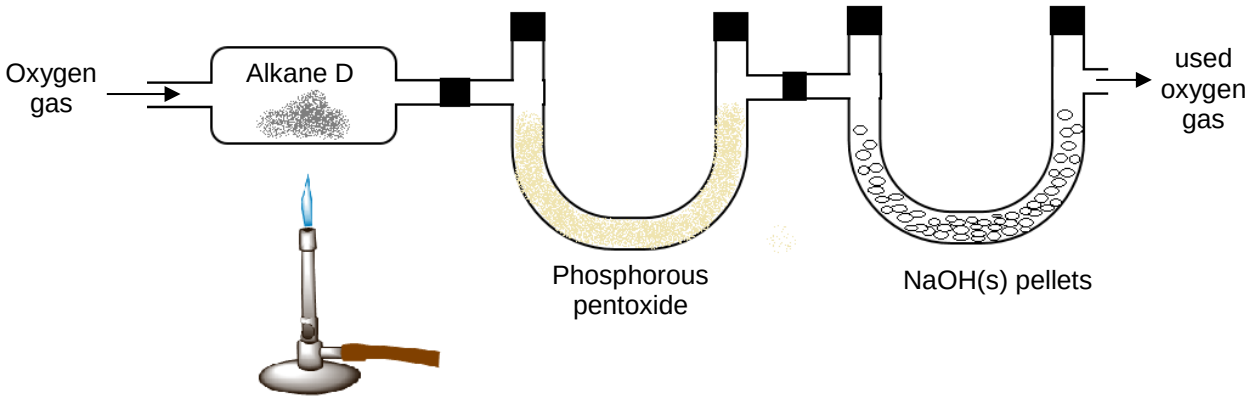
There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

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 A 1.00 g alkane D was burnt in an excess of oxygen, and the gases that were produced were first passed through a U-tube containing phosphorus pentoxide and another U-tube containing NaOH(s) as shown in the diagram. The phosphorus pentoxide U-tube increased in mass by 1.55 g, and the NaOH(aq) bottle increased in mass by 3.03 g. All volumes were measured at room temperature and pressure. What is the molecular formula of the alkane D?



A CH_4 **B** C_2H_5 **C** C_2H_6 **D** C_4H_{10}

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

What do the ions $^{36}S^{2-}$ and $^{37}Cl^{-}$ have in common?

A Both ions have more electrons than neutrons.

B Both ions have the same electronic configuration.

C Both ions contains the same number of nucleons.

D $^{36}S^{2-}$ has a smaller angle of deflection than $^{37}Cl^{-}$ in an electric field.

3 Boyle's law states that at constant temperature, the volume of a fixed mass of gas is inversely proportional to its pressure.

Which of the following statements shows application of Boyle's law?

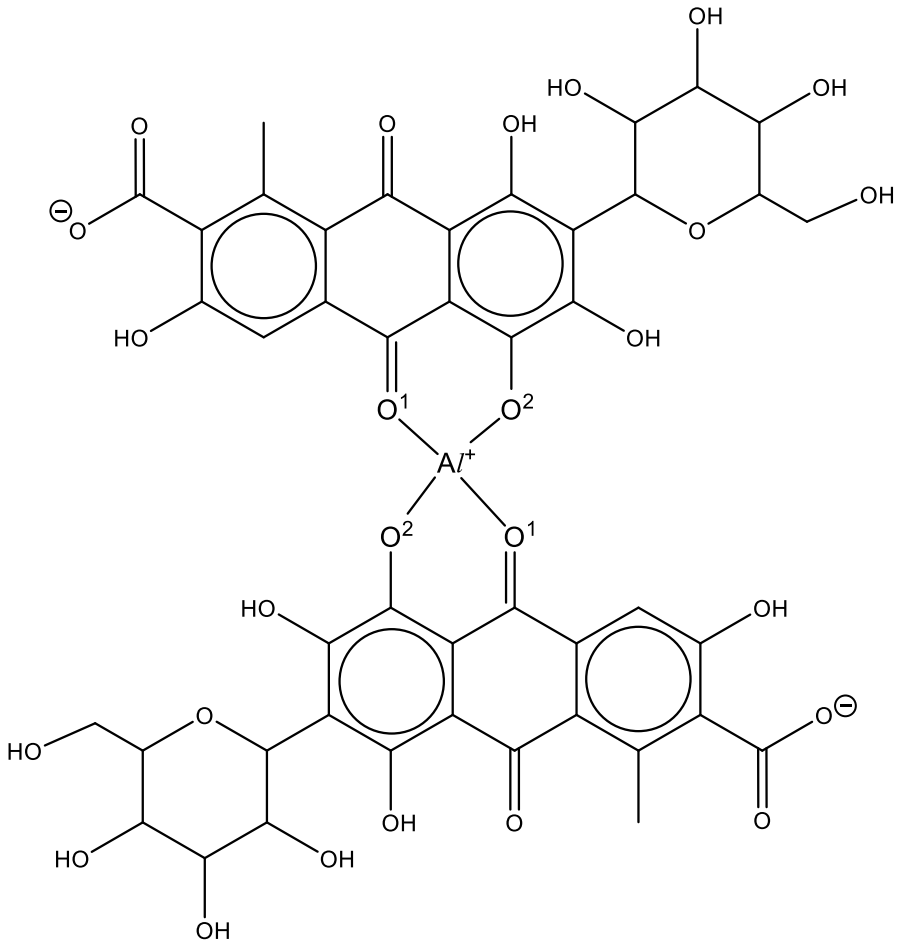
1 Human lungs, inhalation and exhalation.

2 Spraying paint from a can.

3 Working of hot air balloon.

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

4 Carmine is a red colorant extracted from the bodies of dead female insects, used in food colouring and lipsticks. The proposed structure of carmine is as shown.



The Al^+ ion is situated in the centre of a planar arrangement of numbered oxygen atoms.
Which of the following descriptions of the bonds between Al^+ and the numbered O atoms is most likely to be correct?

	O atoms numbered 1	O atoms numbered 2
A	co-ordinate	co-ordinate
B	co-ordinate	ionic
C	ionic	co-ordinate
D	ionic	ionic

5 The table shows the boiling point of some halogenoalkanes.

compound	boiling point/ °C
CH_3CH_2Cl	12.3
CH_3CH_2Br	34.8
CH_3CH_2I	70.0

Which of the following correctly explains the difference in the boiling point?

1 the electronegativity difference between the halogen and carbon increases from C−C*l* to C−I

2 the strength of permanent dipole-permanent dipole attraction increases from C−C*l* to C−I

3 the strength of instantaneous dipole-induced dipole attraction increases from CH_3CH_2Cl to CH_3CH_2I

4 the bond energy of C−X bond decreases from C−C*l* to C−I

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

6 The radioactive decay of element X is a first-order reaction. It take 16 days for element X to decay to 25% of its initial value.

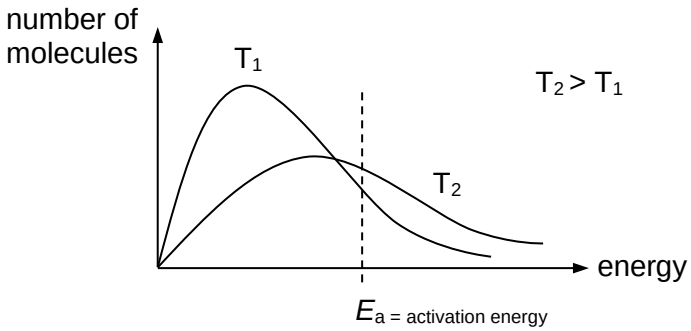
What fraction of element X would remain after 800 days?

A $\frac{1}{2^{10}}$ **B** $\frac{1}{2^{50}}$ **C** $\frac{1}{2^{80}}$ **D** $\frac{1}{2^{100}}$

7 The Boltzmann distribution of kinetic energies for the following equilibrium

$$N_2O_4(g) \rightleftharpoons 2NO_2(g) \qquad \Delta H = +57 \text{ kJ mol}^{-1}$$

is shown graphically below as temperature is increased.



Which statements can be drawn from the graph?

1 At all energies, the number of molecules of N_2O_4 of a given value increases.

2 The maximum of the curve lowers and shifts to the right.

3 The reaction is first order with respect to $[N_2O_4]$.

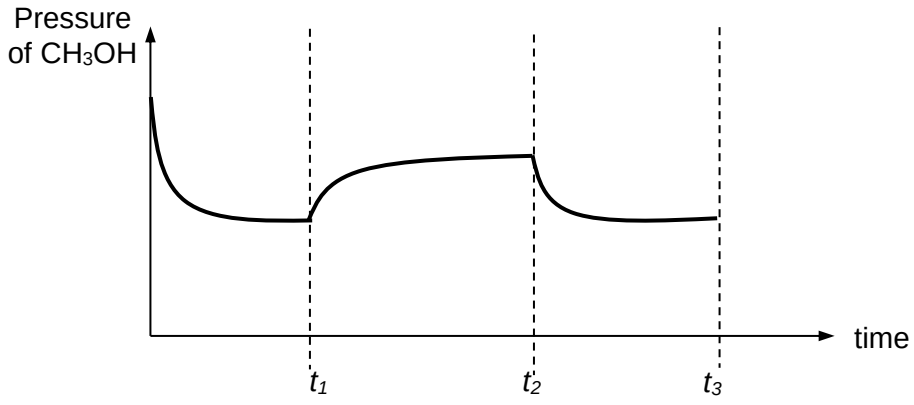
4 The number of molecules with energies equal or greater than *Ea* increases.

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

8 Methanol can be synthesised from hydrogen and carbon monoxide using a suitable catalyst at 480 K and a pressure of 3×10^6 Pa.

$$2H_2(g) + CO(g) \rightleftharpoons CH_3OH(g) \qquad \Delta H = -90.6 \text{ kJ mol}^{-1}$$

The reaction mixture reached equilibrium under the above conditions. The graph below shows how the pressure of CH_3OH varied with time.



What could be the changes made to the system at t_1 and t_2?

	t_1	t_2
A	CH_3OH was added	Temperature was decreased
B	CO was added	Temperature was increased
C	Temperature was decreased	CO was added
D	Temperature was increased	CH_3OH was added

9 A quantity of ethanol was burned underneath a copper can containing 400 g of water at 30 °C. The temperature of the water rose to 85 °C after the complete combustion of 5 g of ethanol (M_r = 46.0).

The efficiency of heat transfer to the water will not be 100% after taking into considerations the heat capacity of the copper can and heat loss to surroundings.

Given that the specific heat capacity of water is 4.2 J g^{-1} K^{-1} and the enthalpy change of combustion of ethanol is –1367 kJ mol^{-1}, what is the efficiency of heat transfer to the water?

A 27% **B** 39% **C** 62% **D** 96%

10 Which equation corresponds to the enthalpy change stated?

A	$2Al^{3+}(g) + 3O^{2-}(g) \rightarrow Al_2O_3(s)$	$2\Delta H^{\ominus}_{\text{lattice energy}}(Al_2O_3(s))$
B	$H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$	$\Delta H^{\ominus}_{\text{neutralisation}}(H_2O(l))$
C	$CaCl_2(s) \rightarrow Ca^{2+}(aq) + 2Cl^{-}(aq)$	$\Delta H^{\ominus}_{\text{solution}}(CaCl_2(s))$
D	$\frac{1}{4}P_4(s) + \frac{5}{2}O_2(g) \rightarrow \frac{1}{4}P_4O_{10}(s)$	$\Delta H^{\ominus}_{\text{formation}}(P_4O_{10}(s))$

11 Calcium reacts with water to form calcium hydroxide and hydrogen.

$$Ca(s) + 2H_2O(l) \rightarrow Ca(OH)_2(s) + H_2(g)$$

The standard enthalpy change for this reaction can be measured in the laboratory.

What further information is needed in order to calculate the standard enthalpy change of formation of calcium hydroxide, $\Delta H_f^{\ominus}$?

1 $\Delta H_f^{\ominus}$ for $H_2O(l)$

2 $\Delta H_f^{\ominus}$ for $H_2(g)$

3 $\Delta H_{\text{atomisation}}^{\ominus}$ for Ca(s)

4 first and second ionisation energies of Ca(s)

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

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

Water undergoes self–ionisation according to the equation:

$$H_2O\ (l) \rightleftharpoons H^+(aq) + OH^-\ (aq)$$

At 60 °C, the ionic product of water, K_w, has the value of 9.5×10^{-14} mol^2 dm^{-6}.

Which statement concerning water at 60°C is correct?

A The pH is 6.51.

B $[OH^-] = 4.75 \times 10^{-7}$ mol dm^{-3}

C The water is slightly acidic.

D Heating water from 25 °C to 60 °C causes water to ionise to a lesser extent.

13 Values of two solubility products are given

	K_{sp} value at 25 °C
$CaCO_3$	8.7×10^{-9}
CaF_2	4.0×10^{-11}

Solid $CaCO_3$ is shaken with water. The remaining solid is filtered off, leaving behind a saturation solution X.

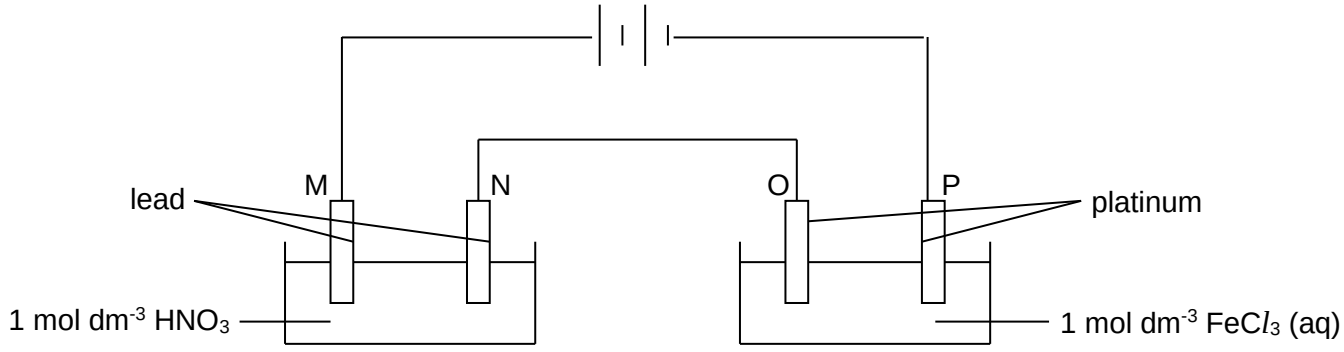
Drops of $F^-(aq)$ are added to solution X until CaF_2 just precipitates. Which row of the table is correct?

	$[Ca^{2+}(aq)]$ in solution X / mol dm^{-3}	$[F^-(aq)]$ when CaF_2 just precipitates / mol dm^{-3}
A	9.33×10^{-5}	6.55×10^{-4}
B	9.33×10^{-5}	9.67×10^{-3}
C	2.15×10^{-4}	6.55×10^{-4}
D	2.15×10^{-4}	4.31×10^{-4}

14 Which factors determine the number of atoms of copper deposited on the cathode of an electrolytic cell?

	current	time	$[Cu^{2+}(aq)]$	size of electrode
A	✓	✓	✓	✓
B	×	×	✓	✓
C	✓	✓	×	×
D	×	✓	✓	×

15 Two cells are connected in series as shown in the diagram where M, N, O and P are the electrodes.



Which of the following correctly shows the products formed at each electrode?

	M	N	O	P
A	O_2	H_2	O_2	Fe^{2+}
B	O_2	Pb	Cl_2	H_2
C	Pb^{2+}	H_2	Cl_2	H_2
D	Pb^{2+}	H_2	O_2	Fe^{2+}

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

An excess of zinc reacts with a warm solution containing VO_2^+ ions.

What will be the final oxidation state of vanadium?

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

17 What is the lowest number of carbon atoms a ketone molecule must contain to have chiral carbon atom?

A 5 **B** 6 **C** 7 **D** 8

18 When alkane G, C_6H_{14}, was reacted with bromine under ultraviolet light, it produced only three isomeric monobromo compounds.

What is the likely identity of alkane G?

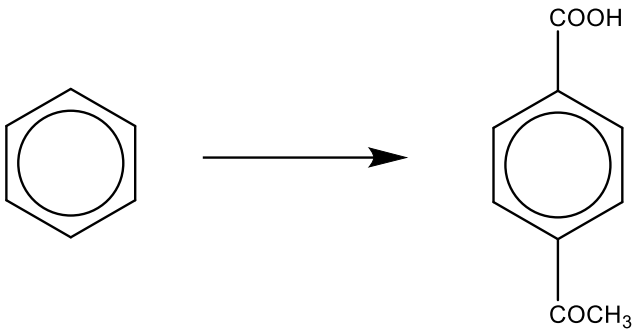
1 $CH_3(CH_2)_4CH_3$

2 $CH_3CH_2CH(CH_3)CH_2CH_3$

3 $CH_3C(CH_3)_2CH_2CH_3$

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

19 4-acetylbenzoic acid can be produced from benzene in three steps.



Which is the best method for this synthesis?

	step 1	step 2	step 3
A	CH_3COCl, anhydrous $FeCl_3$	CH_3Cl, anhydrous $FeCl_3$	dilute H_2SO_4, $KMnO_4$, heat
B	CH_3COCl, anhydrous $FeCl_3$	CH_3Cl, anhydrous $FeCl_3$	dilute H_2SO_4, $K_2Cr_2O_7$, heat
C	CH_3Cl, anhydrous $FeCl_3$	CH_3COCl, anhydrous $FeCl_3$	dilute H_2SO_4, $KMnO_4$, heat
D	CH_3Cl, anhydrous $FeCl_3$	dilute H_2SO_4, $KMnO_4$, heat	CH_3COCl, anhydrous $FeCl_3$

20 Which of the following property does benzene have because of the delocalised π electrons?

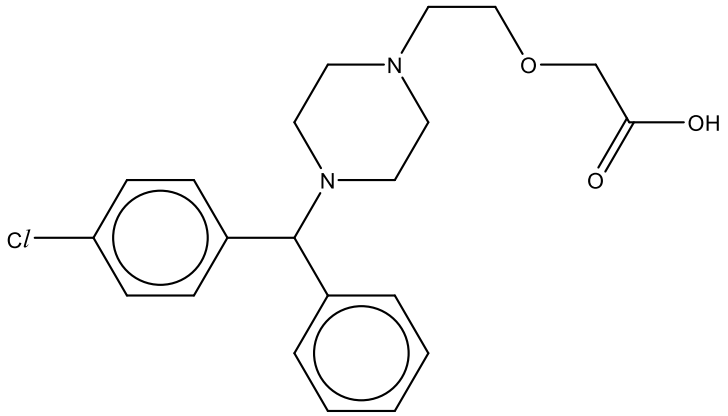
A Benzene is a good electrical conductor.

B Benzene undergoes addition reactions more readily than substitution reactions.

C Substitution in benzene occurs at one particular carbon atom.

D The carbon-carbon bond lengths are between those of C−C bonds and C=C bonds.

21 Cetirizine is an antihistamine that is used to relieve allergy symptoms such as runny nose and itching.



cetirizine

The C-O-C bond is inert.
Which of the following statements about cetirizine are correct?

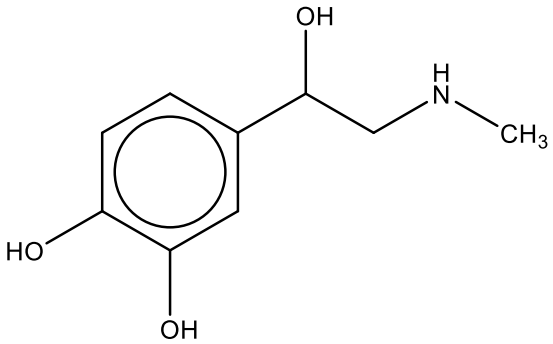
1 After heating with dilute sulfuric acid, 2 organic products are formed.

2 A white precipitate is observed when cetirizine is heated with ethanolic $AgNO_3$.

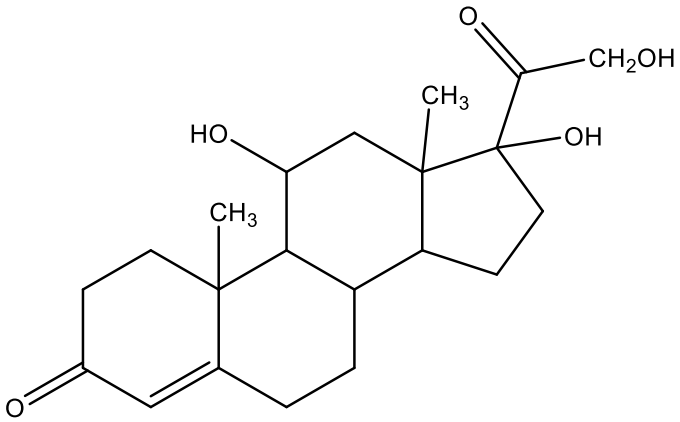
3 The purple colour of acidified $KMnO_4$ is discharged after heating with cetirizine.

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

22 Adrenaline and cortisol are hormones that are produced by the adrenal glands.



adrenaline



cortisol

Which of the following reagents can be used to distinguish the two hormones?

1 neutral iron(III) chloride solution

2 bromine in tetrachloromethane

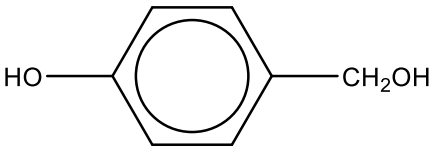
3 hot aqueous potassium dichromate(VI)

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

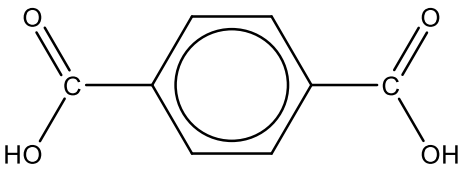
23 1 mole of compound Z reacts with 1 mole of NaOH. 1 mole of Z also reacts with PCl_5 to form 1 mole of HCl.

Which compounds can be Z?

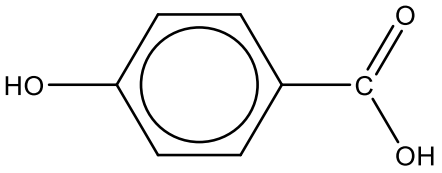
A



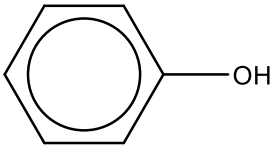
B



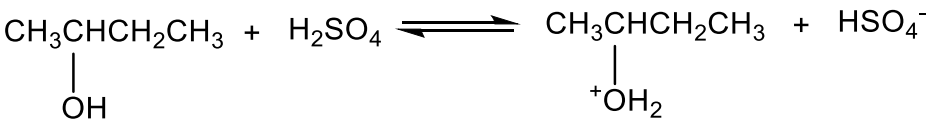
C

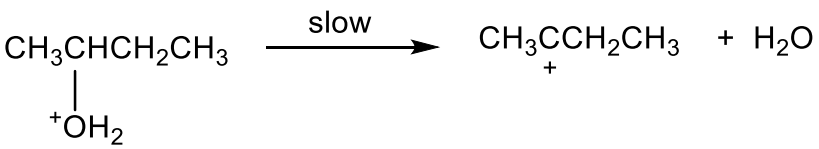


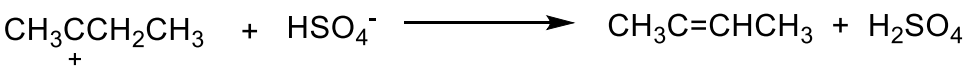
D



24 The dehydration of butan–2–ol to form but–2–ene is thought to involve the following steps.

step 1 

step 2 

step 3 

Which of the following statements is incorrect?

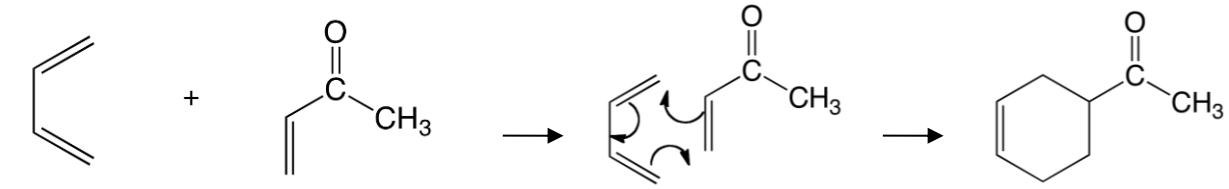
A Butan–2–ol serves as a base in step 1.

B H_2SO_4 is a catalyst in the dehydration reaction.

C A possible side product is $CH_3C(OSO_3H)CH_2CH_3$.

D Primary alcohols are more likely to proceed via this mechanism than tertiary alcohols.

25 The Diels–Alder reaction is an organic reaction between a conjugated diene and a substituted alkene to form a substituted cyclohexene system. One such reaction between buta–1,3–diene and but–3–en–2–one is shown below.

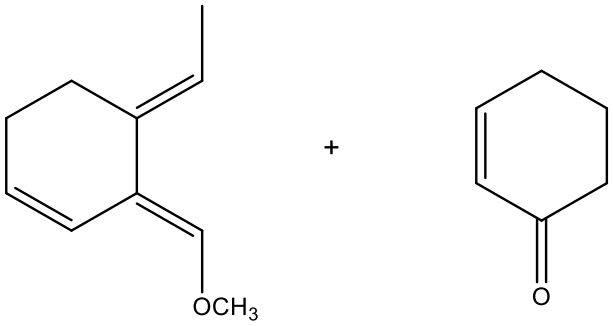


buta–1,3–diene

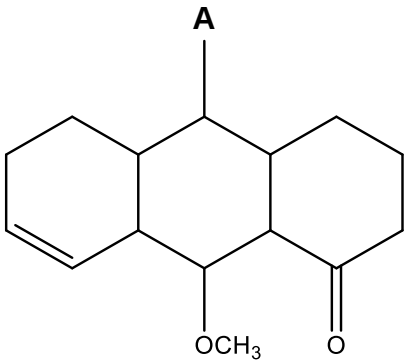
but–3–en–2–one

substituted cyclohexene

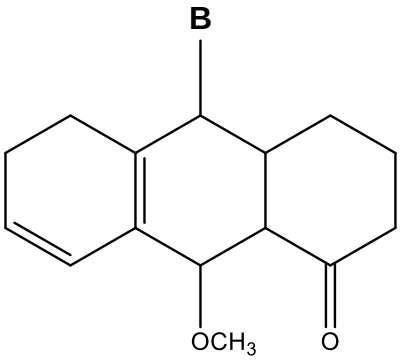
What would be the product formed when the following diene and substituted alkene reacts in a 1:1 ratio?



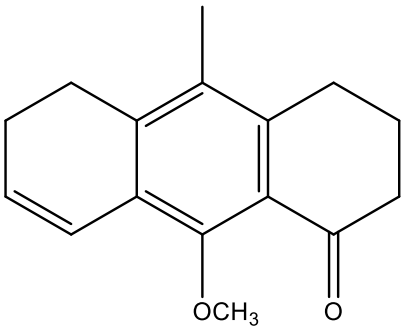
A



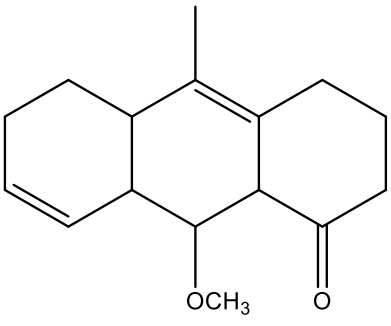
B



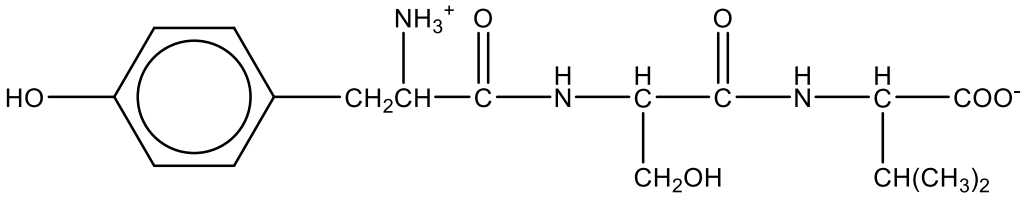
C



D

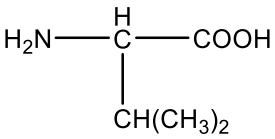


26 The therapeutic effect of tyroserleutide on lung cancer is currently being studied. It has the following structure:

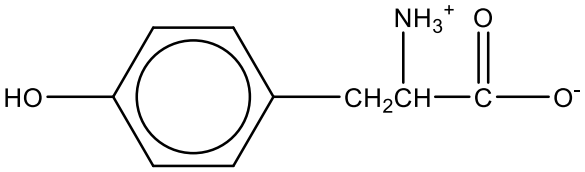


Which compound can be obtained when tyroserleutide reacts with hot dilute NaOH?

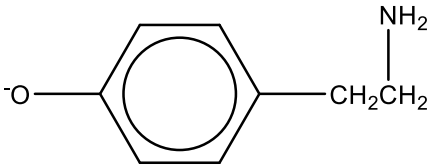
A



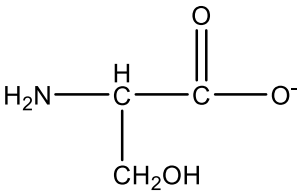
B



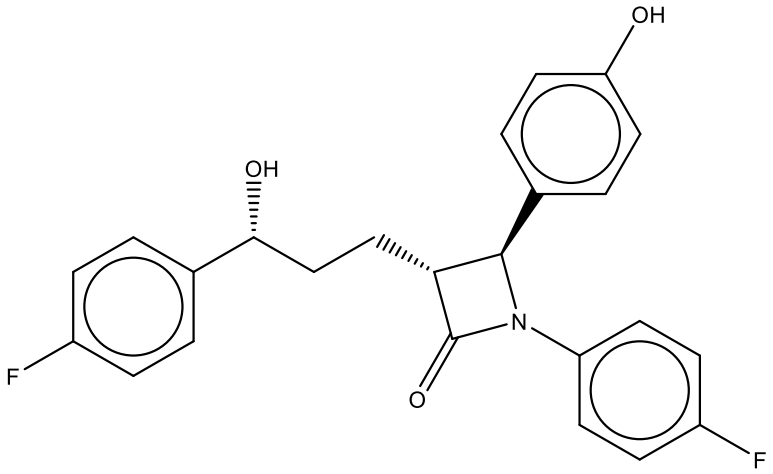
C



D



27 Ezetimibe is a medication used to treat high blood cholesterol.



Ezetimibe

When Ezetimibe is reacted with anhydrous $SOCl_2$, which groups will react?

A phenolic OH group

B halogenoarene

C alcoholic OH group

D amide group

28 Compounds of Period 3 elements dissolve in water to form aqueous solutions that are acidic, basic or neutral.

Which of the following sequence shows the order of increasing resultant pH when the compounds are added to water?

A $NaCl$, $MgCl_2$, $SiCl_4$

B $AlCl_3$, $SiCl_4$, PCl_5

C Al_2O_3, MgO, SO_2

D P_4O_{10}, SiO_2, MgO

29 Element Z is in Period 3 of the Periodic Table. The oxide of Z has a giant molecular structure while the chloride of Z is a simple molecule.

Which of the following statements about element Z and its compounds are correct?

1 Element Z is a solid at room temperature.

2 The oxide of Z reacts with water to give an acidic solution.

3 Element Z forms two chlorides with different oxidation states.

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

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

Some data relating to calcium and calcium chloride are as follows:

$Ca^{2+} + 2e^- \rightleftharpoons Ca$	$E^{\ominus} = -2.87$ V
Melting point of calcium chloride	782 °C

Which of the following is the most suitable method for extracting calcium metal from its ore?

A Electrolysis of aqueous calcium chloride.

B Electrolysis of molten calcium chloride.

C Reduction of calcium chloride with hydrogen.

D Reduction of calcium chloride with aluminium.