HWA CHONG INSTITUTION
C2 Preliminary Examinations
Higher 2

CANDIDATE NAME		CT GROUP	18S
CENTRE NUMBER		INDEX NUMBER	

CHEMISTRY

Paper 1 Multiple Choice

9729/01

25 September 2019

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.

There are **30** 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 Answer Sheet.
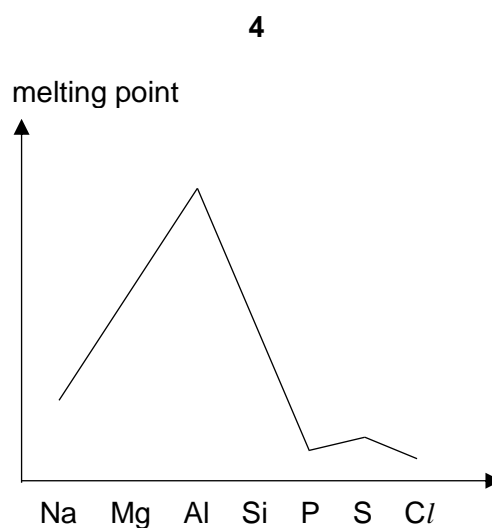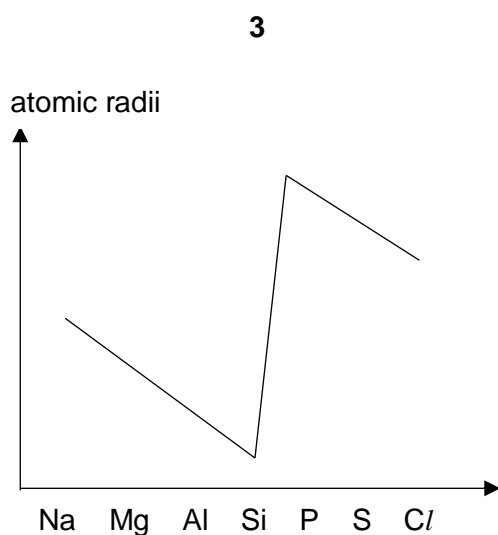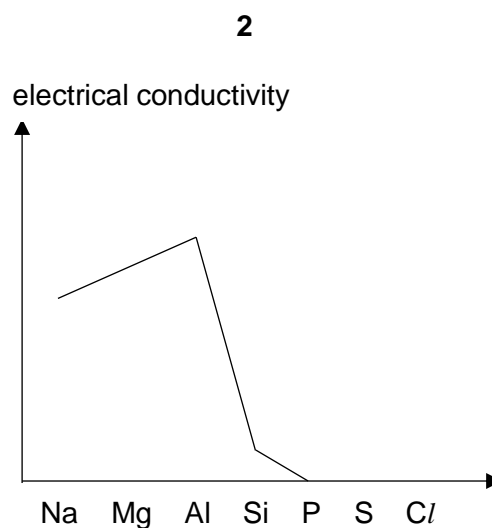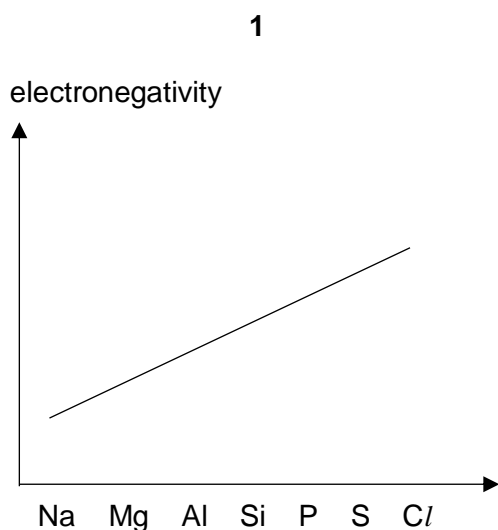
Read the instructions on the Answer Sheet very carefully.

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 **12** printed pages.

1 Which statement about relative atomic mass is correct?

A It is the average of the masses of all the isotopes of that element.

B It is the sum of the relative masses of the neutrons and protons in each atom.

C It is the ratio of the average mass of one atom of an element to the mass of one ^{1}H atom.

D It is the ratio of the mass of one mole of atoms of an element to one-twelfth the mass of one mole of ^{12}C atoms.

2 Which of the graphs correctly represent the trends in some properties of the Period 3 elements?

1

electronegativity

Na Mg Al Si P S C*l*

2

electrical conductivity

Na Mg Al Si P S C*l*

3

atomic radii

Na Mg Al Si P S C*l*

4

melting point

Na Mg Al Si P S C*l*

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

3 Which of the following correctly describes the structure and bonding present in the solid lattice of the substances given?

	substance	structure	bonding
A	ice	giant covalent	covalent bonding + hydrogen bonding
B	iodine	simple covalent	covalent bonding + permanent dipoles
C	aluminium chloride	giant ionic	ionic bonding + permanent dipoles
D	graphite	giant covalent	covalent bonding + dispersion forces

4 In which of the following pairs is the bond angle in the first species smaller than that in the second species?

A NH_4^+ XeF_4

B NF_3 NH_3

C NO_2^+ SO_2

D BCl_3 PCl_3

5 A container with a volume of 420 m^3 with an internal pressure of 1 bar at 293 K was joined to two containers as shown below. One of them has a volume of 13 m^3 with a vacuum within, while the other has a volume of 75.5 m^3 with an internal pressure of 2 bar and a temperature of 273 K.
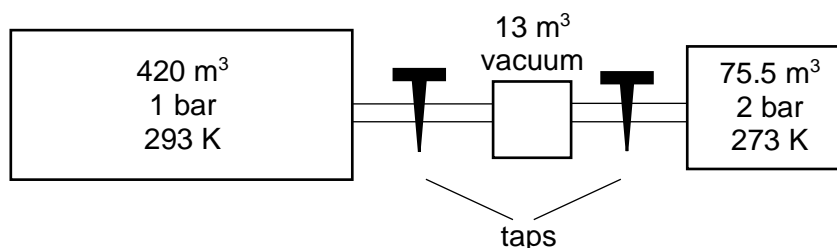
What is the final pressure, in bar, in the combined containers when the taps were opened and the temperature allowed to equilibrate to 298 K?

A 0.84 **B** 1.12 **C** 1.16 **D** 1.19

6 *Use of the Data Booklet is relevant to this question*

Sodium percarbonate, $(Na_2CO_3)_x \cdot y(H_2O_2)$, is an oxidising agent in some home and laundry cleaning products.

10.0 cm^3 of 0.100 mol dm^{-3} sodium percarbonate releases 45.4 cm^3 of carbon dioxide at s.t.p. on acidification.

An identical sample, on titration with 0.05 mol dm^{-3} KMnO$_4$, requires 24.0 cm^3 before the first pink colour appears. KMnO$_4$ reacts with H$_2$O$_2$ in the mole ratio 2 : 5.

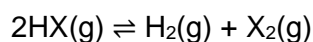What is the ratio $\dfrac{y}{x}$?

**A** $\dfrac{1}{3}$ **B** $\dfrac{2}{3}$ **C** $\dfrac{3}{2}$ **D** $\dfrac{3}{1}$

7 Which statement correctly explains why the change in Gibbs' free energy of the reaction below is relatively constant when the temperature changes?

$$2HX(g) \rightleftharpoons H_2(g) + X_2(g)$$

A ΔS is almost zero for all temperatures in which the reactants and products are gases.

B The equilibrium constant is not affected by a temperature change.

C ΔH and ΔS do not change with temperature, hence ΔG remains constant.

D The equilibrium position will shift in such a way to offset the changes in temperature.

8 The conversion of diamond into graphite is an exothermic reaction.

$$C(\text{diamond}) \rightarrow C(\text{graphite}) \qquad \Delta H < 0$$
$$\Delta G < 0$$
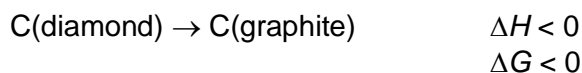
Which statements are correct?

1 The magnitude of the enthalpy change of atomisation of graphite is greater than that for diamond.

2 The magnitude of the enthalpy change of combustion of graphite is greater than that for diamond.

3 The bond energy of the C–C bonds in graphite is greater than that for diamond.

4 The conversion of diamond to graphite does not take place readily due to the high activation energy.

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

9 Thorium-234 undergoes radioactive decay to form protactinium-234 by emitting a beta particle. This radioactive decay is a first order reaction with a half-life of 24.1 hours.

A rock sample contains a 2 : 3 molar proportion of thorium-234 to protactinium-234. How many hours has the radioactive decay taken place if the sample was initially protactinium-234 free?

A 14.1 **B** 24.1 **C** 31.9 **D** 60.3

10 Which suggested mechanism is consistent with the experimentally determined rate equation?

|	rate equation	suggested mechanism	
1	rate = $k[NO]^2[H_2]$	$2NO + H_2 \rightarrow N_2O + H_2O$	slow
		$N_2O + H_2 \rightarrow N_2 + H_2O$	fast
2	rate = $k[O_2][N_2O_2]$	$2NO \rightarrow N_2O_2$	fast
		$N_2O_2 + O_2 \rightarrow 2NO_2$	slow
3	rate = $k[O_3][Cl]$	$Cl + O_3 \rightarrow OCl + O_2$	slow
		$OCl + O_3 \rightarrow 2O_2 + Cl$	fast

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

11 The key stage in the manufacture of sulfuric acid is the reaction between sulfur dioxide and oxygen to form sulfur trioxide.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$
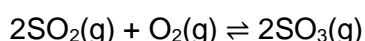
When 0.50 mol of SO_2 and 1.00 mol of O_2 were reacted together in a container of volume 0.5 dm^3, 0.30 mol of SO_3 was present in the equilibrium mixture.

What is the numerical value of the equilibrium constant, K_c, for the equilibrium reaction below?

$$SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g)$$
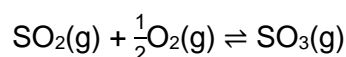
A 0.66 **B** 1.15 **C** 1.32 **D** 1.63

12 Which statement about the effect of adding a catalyst to a reversible reaction is correct?

A It increases the yield of product in the reaction.

B It increases the rate constant for the forward reaction.

C It increases the equilibrium constant of the forward reaction.

D It increases the activation energy of the reverse reaction.

13 Which graphs correctly show how the values of pH, α (degree of dissociation) and K_a for a weak acid vary with dilution at constant temperature?

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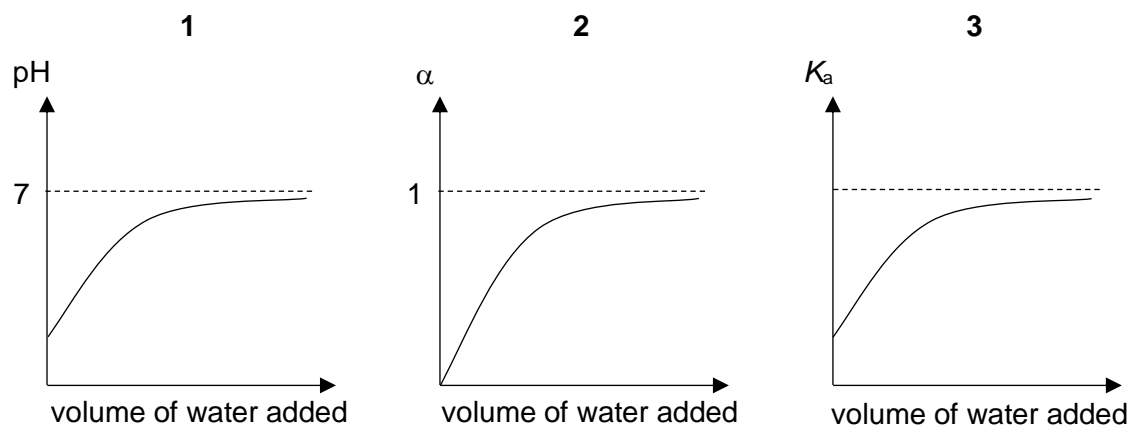
A 1 only	**B** 1 and 2	**C** 2 and 3	**D** 1, 2 and 3

14 Aluminium objects are surface treated by means of anodisation to increase the thickness of the corrosion resistant oxide layer.

Which factor will affect the mass of the oxide coating in the anodisation process?

    A   size of the current

    B   size of the cathode

    C   concentration of electrolyte

    D   surface area of the aluminium object

15 Compound V has the molecular formula $C_6H_{14}O$. V has an aliphatic carbon skeleton that is branched and contains a secondary alcohol functional group.

How many constitutional isomers fit this description of V?

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

16 Tamoxifen is an important drug used in the prevention of breast cancer. The first two steps in the synthesis of Tamoxifen is shown below.
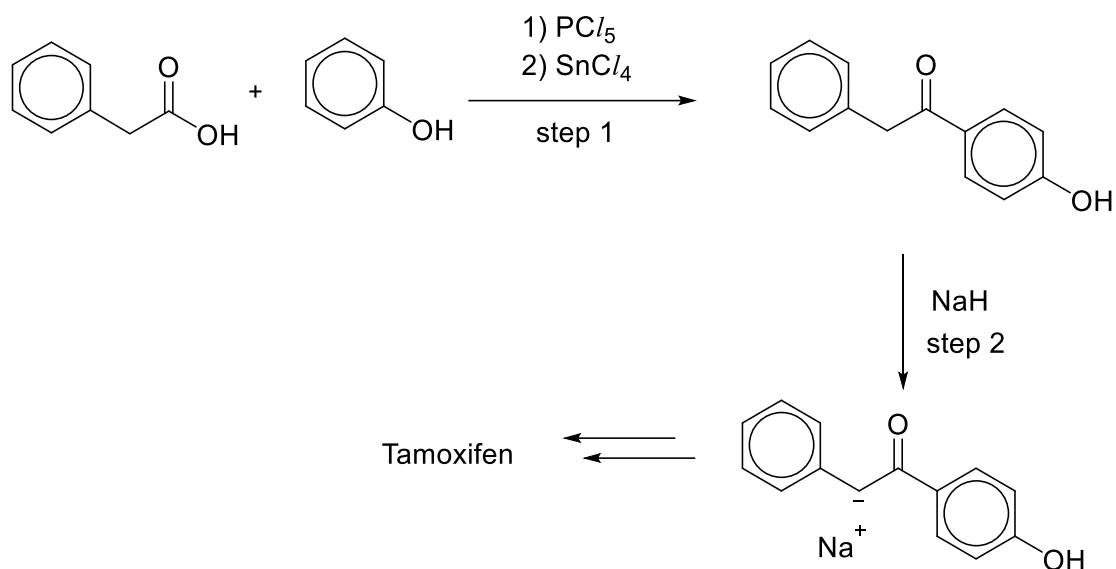
Which of the following correctly describes the type of reaction in each step in the above synthetic pathway?

	step 1	step 2
A	nucleophilic addition	acid-base
B	condensation	elimination
C	electrophilic substitution	elimination
D	electrophilic substitution	acid-base

17 Compound W is a cyclic oligopeptide.

W
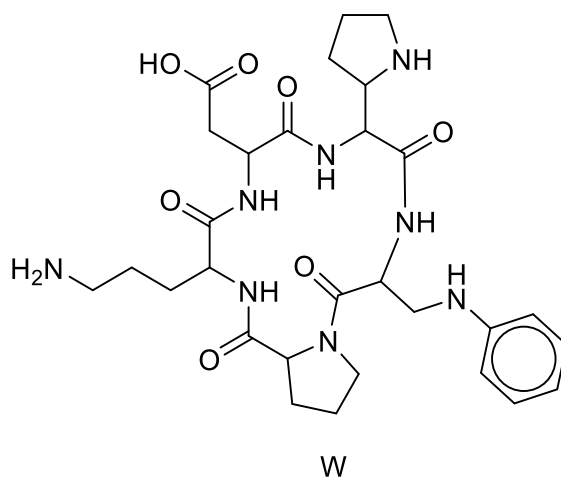
How many amide linkages exist in compound W?

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

18 When heated with chlorine, 2,2-dimethylbutane undergoes free radical substitution. In a propagation step, the free radical X• is formed by the loss of one hydrogen atom.

$$CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_2CH_3 \ + \ Cl\bullet \ \longrightarrow \ X\bullet \ + \ HCl$$
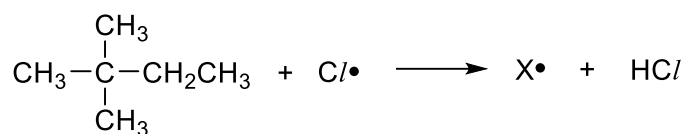
How many different forms of X• are theoretically possible?

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

19 When retinol reacts completely with cold alkaline $KMnO_4$, it forms product Y. How many stereoisomers do retinol and Y have?
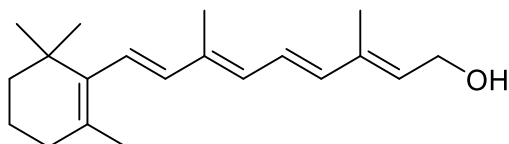
retinol

	retinol	Y
A	2^4	2^8
B	2^5	2^8
C	2^4	2^{10}
D	2^5	2^{10}

20 Which compounds may be a possible product of the reaction of $C_6H_5OCOCHBrCH_3$ with sodium hydroxide under different conditions?

1 $C_6H_5CO_2Na$

2 $CH_3CH(OH)CO_2Na$

3 $C_6H_5OCOCH=CH_2$

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

21 3-methylbutan-2-ol is treated with alkaline aqueous iodine. The mixture of products is then acidified.

Which compound is present in the final mixture of the products?

A propanoic acid

B butanoic acid

C 3-methylbutanoic acid
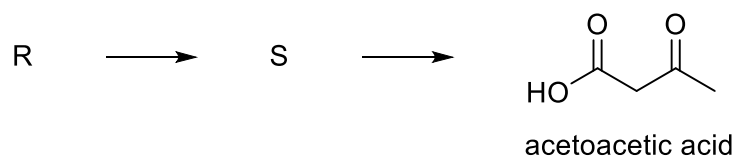
D 2-methylpropanoic acid

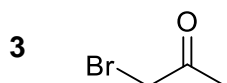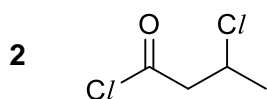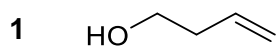**22** 1 mol of compound Z reacts with sodium hydroxide to produce 2 mol of water.

Which compound could Z be?

A

B

C

D
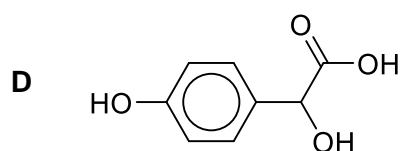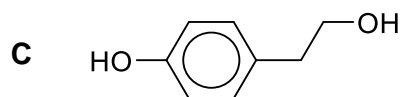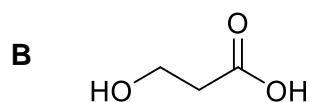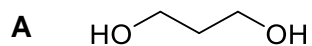
23 Acetoacetic acid can be synthesised in a two-step process starting from R.

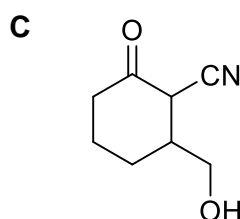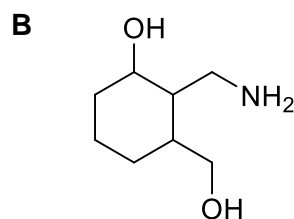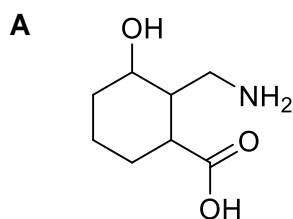R ⟶ S ⟶
acetoacetic acid

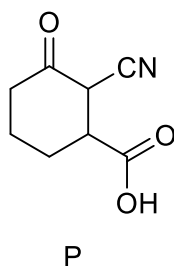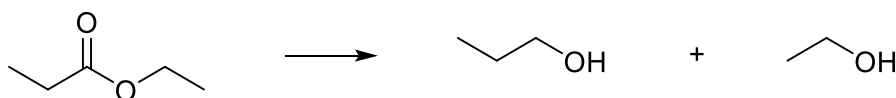What could be the structure of R?

1

2

3

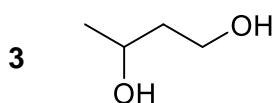**A** 1 only   **B** 1 and 2   **C** 2 and 3   **D** 1, 2 and 3
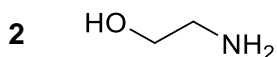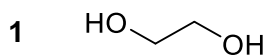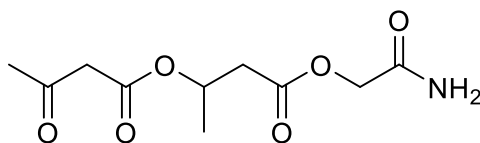
24 Which is the correct product formed when P undergoes reduction using excess hydrogen gas and nickel as catalyst?

P

A

B

C

D
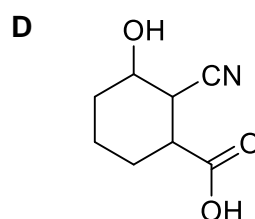
25 Esters can be reduced by LiAlH$_4$ in dry ether to give two alcohols as shown below.

What are the possible products formed when the following compound is reacted with LiAlH$_4$ in dry ether?

1

2

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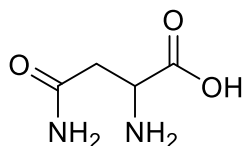
A 3 only   **B** 1 and 2   **C** 2 and 3   **D** 1, 2 and 3

26 Asparagine is required for the development and function of the brain.

asparagine

Which statements about its structure are correct?

1 Asparagine exists in aqueous solution as a zwitterion.

2 The side chain ($-CH_2CONH_2$) of asparagine is neutral.

3 When hot dilute H_2SO_4 is added to asparagine, a gas which turns damp red litmus paper blue is evolved.

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

27 What is the correct order of the pH of the resulting solutions when the oxides below are added to water?

lowest pH ⟶ highest pH

A	SO_3	SiO_2	MgO	Na_2O
B	Na_2O	MgO	SiO_2	SO_3
C	MgO	SiO_2	SO_3	Na_2O
D	SO_3	Na_2O	MgO	SiO_2

28 The electrical conductivities of two compounds, T and U, are shown in the table below.

	T	U
conductivity of the compound in the liquid state	good	does not conduct
conductivity of the mixture obtained by adding the compound to water	good	good

What could compounds T and U be?

	T	U
A	Al_2O_3	$SiCl_4$
B	NaF	Al_2O_3
C	NaF	$SiCl_4$
D	$SiCl_4$	Al_2O_3

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

$Na_4Fe(CN)_6$ can be oxidised to $Na_3Fe(CN)_6$.

Which reagent can be used to carry out this oxidation?

    A $SO_2(g)$

    B $NO_2(g)$

    C $Cu^{2+}(aq)$

    D $I_2(aq)$

30 The rate of reaction between iodide and peroxodisulfate(VI) ions is increased by the presence of small concentrations of $Fe^{2+}(aq)$.

$$S_2O_8{}^{2-}(aq) + 2I^-(aq) \rightarrow 2SO_4{}^{2-}(aq) + I_2(aq)$$
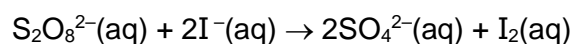
Which property of iron allows it to act as a homogeneous catalyst?

    A   high charge density

    B   partially filled d subshell

    C   variable oxidation states

    D   ability to form complex ions

END OF PAPER