HWA CHONG INSTITUTION

C2 PRELIMINARY EXAMINATION

9746 H2 CHEMISTRY

Paper 1   Multiple Choice

16 September 2008   **1 hour**

READ THESE INSTRUCTIONS FIRST

Complete the information on the optical mark sheet (OMS) as shown below.

There are **40** questions in 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 OMS.

Each correct answer will score one mark. Marks will not be deducted for wrong answers.

You should have a *Data Booklet*.

You may use a calculator.

Any rough working should be done in this booklet.

This question booklet consists of **15** printed pages.

1   The Faraday constant was named after the British scientist, Michael Faraday, who contributed to the fields of electrochemistry and electromagnetism.

Which expression correctly defines the *Faraday constant*?

A   the number of electrons carrying a charge of 9.65×10^4 C

B   the amount of charge carried by 500 cm^3 of 2.0 mol dm^{-3} NaOH

C   the amount of charge required to liberate 1 g of hydrogen gas during electrolysis

D   the Avogadro constant divided by the electronic charge

2   In an experiment, 10 cm^3 of an organic compound in the gaseous state was sparked with excess oxygen. 20 cm^3 of carbon dioxide, 5 cm^3 of nitrogen and 35 cm^3 of steam were obtained among the products. All gas volumes were measured at the same temperature and pressure.

What is the likely formula of the organic compound?

A CH_3CN

B $CH_3CH_2NH_2$

C $CH_3CH_2CH_2NH_2$

D $H_2NCH_2CH_2CH_2CN$

3   The variation in the second ionisation energy of six consecutive elements in the Periodic Table is shown in the graph.

Which of these elements is a Group II element?
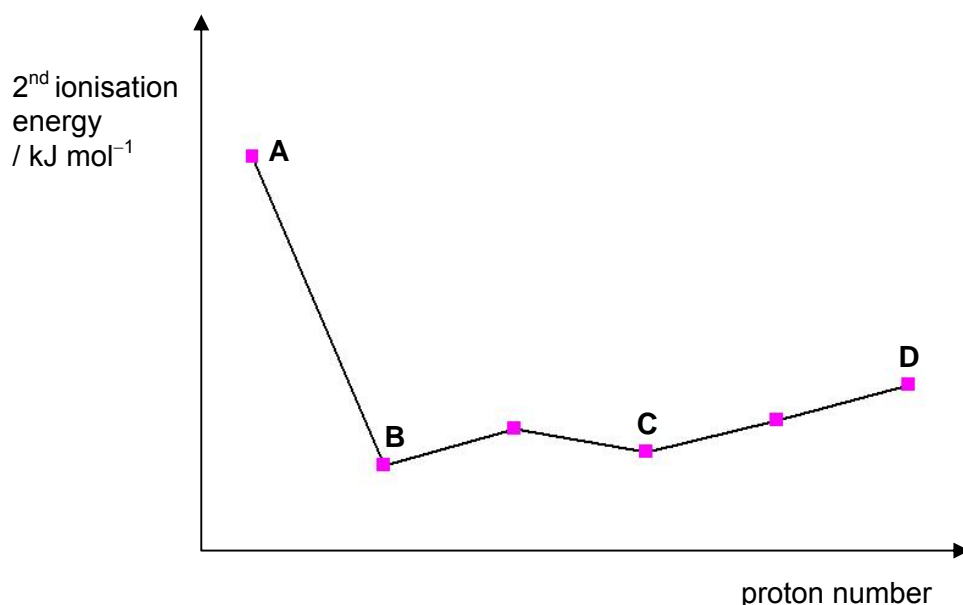
4 Hydrazine, N_2H_4, and hydrogen peroxide, H_2O_2, are both used as rocket propellants because they can produce large volumes of hot gases from a small volume of liquid.

Which of the following statements about these two compounds is **correct**?

A The bond angle in N_2H_4 is smaller than that in H_2O_2.

B The N—H bond is shorter than the O—H bond.

C The boiling point of N_2H_4 is lower than that of H_2O_2.
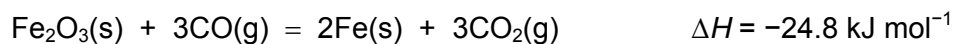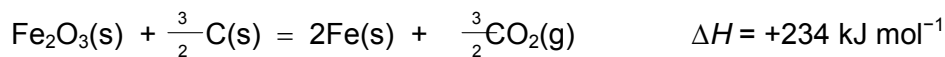
D N_2H_4 is a weaker base than H_2O_2.

5 The value of pV is plotted against p for 2 gases, A and B, where p is the pressure and V is the volume of the gas.
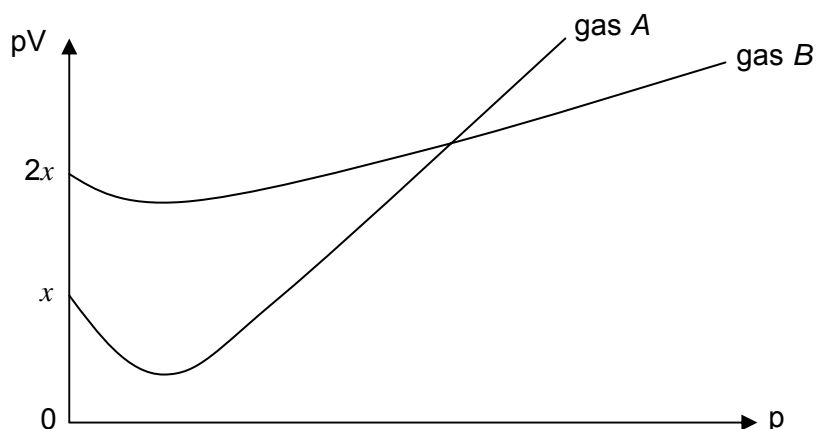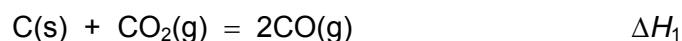

Which of the following could be the identities of the gases?

	gas A	gas B
A	0.5 mol of H_2 at 25 °C	0.5 mol of H_2 at 50 °C
B	0.5 mol of H_2 at 25 °C	1 mol of SO_2 at 25 °C
C	0.25 mol of SO_2 at 25 °C	0.5 mol of H_2 at 25 °C
D	1 mol of SO_2 at 25 °C	0.5 mol of H_2 at 25 °C

6 Either carbon or carbon monoxide can bring about the reduction of iron(III) oxide in a blast furnace.

$$Fe_2O_3(s) + \frac{3}{2}C(s) = 2Fe(s) + \frac{3}{2}CO_2(g) \qquad \Delta H = +234 \text{ kJ mol}^{-1}$$

$$Fe_2O_3(s) + 3CO(g) = 2Fe(s) + 3CO_2(g) \qquad \Delta H = -24.8 \text{ kJ mol}^{-1}$$

Carbon monoxide can be formed by the following reaction.

$$C(s) + CO_2(g) = 2CO(g) \qquad \Delta H_1$$

What is the value of ΔH_1?

A $+86.3 \text{ kJ mol}^{-1}$

B $+139.5 \text{ kJ mol}^{-1}$

C $+172.5 \text{ kJ mol}^{-1}$

D $+258.8 \text{ kJ mol}^{-1}$

7 At 1200 K, in the presence of gold wire as a catalyst, dinitrogen oxide, N_2O, decomposes in a closed container according to the equation below.

$$2N_2O(g) \rightarrow 2N_2(g) + O_2(g)$$
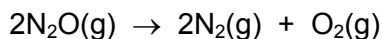
The following data is obtained in an experiment.

time, t / s	0	1030	2360	4230	7430
partial pressure of N_2O / kPa	25.0	20.0	15.0	10.0	5.0

Which of the following statements is correct?

A The partial pressure of N_2O at any given time is not affected by temperature.

B The reaction is first order with respect to N_2O.

C The value of the rate constant remains unchanged in the absence of gold.

D The total pressure at the completion of the reaction cannot be determined from the above data.

8 The numerical values of the equilibrium constant, K_p, for the reaction

$$Ag_2CO_3(s) \ = \ Ag_2O(s) \ + \ CO_2(g)$$
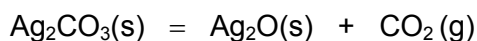
are 3.20×10^{-3} and 1.50 at 298 K and 500 K respectively.

What deduction can be made from this information?

A The yield of carbon dioxide will increase when Ag_2O is removed.

B The yield of carbon dioxide is independent of temperature.

C The value of K_p depends on the amount of Ag_2CO_3 used.

D The forward reaction is endothermic.

9 During the industrial production of nitric acid, ammonia is oxidised to nitrogen oxide.

$$4NH_3(g) + 5O_2(g) = 4NO(g) + 6H_2O(g) \qquad \Delta H = -910 \text{ kJ mol}^{-1}$$
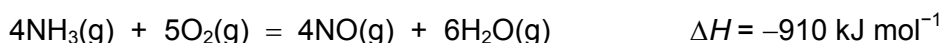
Which of the following conditions favour the highest proportion of NO in the equilibrium mixture?

	Temperature	Pressure
A	Low	Low
B	Low	High
C	High	High
D	High	Low

10 The value of the ionic product of water, K_w, varies with temperature as shown.

Temperature / °C	25	62
K_w / $mol^2\,dm^{-6}$	1.0×10^{-14}	1.0×10^{-13}

Which of the following is true for water at 65 °C?

A It is neutral and its pH is 7.

B It remains neutral and its pH < 7.

C It is not neutral and its pH > 7.

D It is not neutral and pH <7.

11 Human plasma is buffered mainly by dissolved CO_2 which has reacted to form carbonic acid.

$$H_2CO_3(aq) \ = \ H^+(aq) \ + \ HCO_3^-(aq)$$
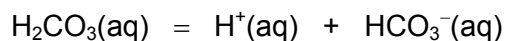
Usually the pH of human plasma is 7.4. The acid dissociation constant, K_a, of carbonic acid is 7.90×10^{-7} $mol\,dm^{-3}$.

Which of the following statements is correct?

A The ratio of $[HCO_3^-]$ to $[H_2CO_3]$ in human plasma is 1 : 20.

B The ratio of $[HCO_3^-]$ to $[H_2CO_3]$ in human plasma is 20 : 1.

C This buffer system is more efficient in removing excess base than excess acid.

D This buffer system can be prepared by mixing suitable amounts of sodium hydrogencarbonate and sodium hydroxide.

12 The solubility product of magnesium hydroxide is S at 25 °C. What is the pH of a saturated solution of magnesium hydroxide at 25 °C?

A $14 - \log_{10} (2S)^{1/2}$

B $14 + \log_{10} (S)^{1/2}$

C $14 - \log_{10} (2S)^{1/3}$

D $14 + \log_{10} (2S)^{1/3}$

13 The diagram shows an apparatus used to find the transition temperature (15 °C) at which white tin and grey tin are in equilibrium. Below 15 °C, white tin from **W** dissolves and is deposited on **G** as grey tin.
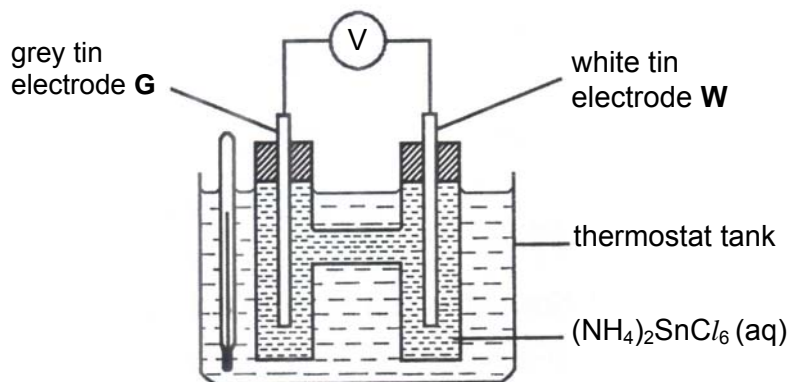
Which of the following statements is true?

A Increasing the size of the grey tin electrode will change the cell potential.

B At 15 °C, no current flows.

C Above 15 °C, electrons flow through the external circuit from **W** to **G**.

D The stable form of tin at 25 °C is grey.

14 Electrolysis of aqueous copper(II) sulphate was carried out using copper electrodes and a steady current.

Which graph shows the change in mass of the cathode with time?
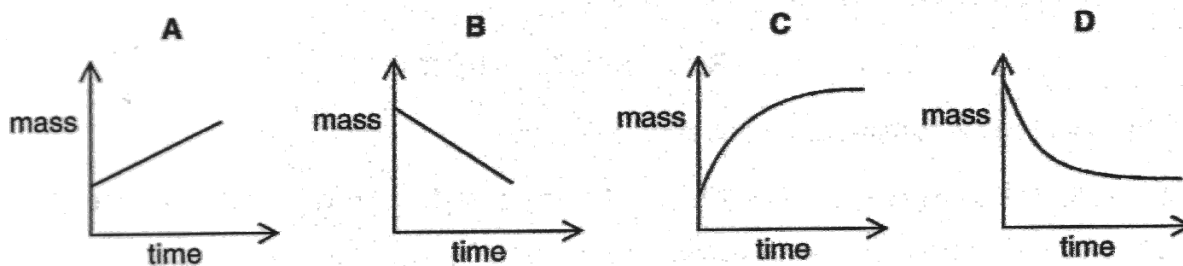
15 Which of the following elements forms an oxide with a giant structure and a chloride which is readily hydrolysed?

A barium

B sodium

C phosphorus

D silicon

16 Which of the following is true for the Group II element, strontium, or its compounds?

    A   Strontium does not react with steam.

    B   Strontium oxide reacts with both acids and bases.

    C   Strontium carbonate decomposes at a higher temperature than calcium carbonate.

    D   Strontium chloride dissolves in water to give a weakly acidic solution.

17 Which of the following observations about bromine or its compounds is **incorrect**?

    A   When sodium bromide is treated with concentrated sulphuric acid, a gas that turns moist starch-iodide paper black is evolved.

    B   When sodium bromide is treated with concentrated sulphuric acid, a gas that turns moist blue litmus paper red is evolved.

    C   When aqueous sodium chloride is added to aqueous bromine, the orange solution is decolourised.

    D   When aqueous silver nitrate is added to aqueous sodium bromide, a cream precipitate is observed.

18 Which of the following elements is a transition metal?

element	melting point / $^{\circ}C$	density / $g\ cm^{-3}$	electrical conductivity / $\Omega^{-1}\ m^{-1}$
A	113	2.07	5.0×10^{-16}
B	650	1.74	2.2×10^{7}
C	1744	11.3	6.0×10^{7}
D	3800	3.50	7.7×10^{-8}

19 β-Damascenone is a contributor to the aroma of roses and is an important fragrance chemical used in perfumery.
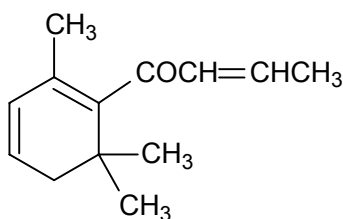
β-Damascenone

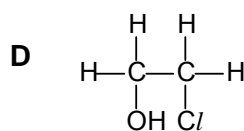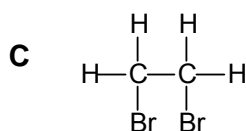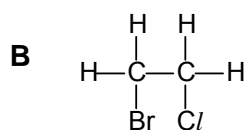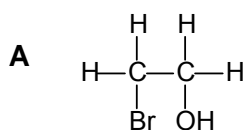The compound is reacted with excess hydrogen in the presence of a platinum catalyst.

How many chiral centres does the product have?

    A   1

    B   2

    C   3

    D   4

20 Pentane was reacted with limited chlorine in the presence of *uv* light. Assuming that only mono-chlorination takes place and the reaction occurs at the same rate at all carbon atoms, predict the ratio of the products obtained.

	1-chloropentane	:	2-chloropentane	:	3-chloropentane
A	3	:	2	:	1
B	1	:	2	:	3
C	1	:	3	:	2
D	3	:	1	:	2

21 Ethene is shaken with an aqueous mixture of bromine and sodium chloride.

Which of the following compounds will **not** be formed?

A

$$H-\underset{\underset{Br}{|}}{\overset{\overset{H}{|}}{C}}-\underset{\underset{OH}{|}}{\overset{\overset{H}{|}}{C}}-H$$

B

$$H-\underset{\underset{Br}{|}}{\overset{\overset{H}{|}}{C}}-\underset{\underset{Cl}{|}}{\overset{\overset{H}{|}}{C}}-H$$

C

$$H-\underset{\underset{Br}{|}}{\overset{\overset{H}{|}}{C}}-\underset{\underset{Br}{|}}{\overset{\overset{H}{|}}{C}}-H$$

D

$$H-\underset{\underset{OH}{|}}{\overset{\overset{H}{|}}{C}}-\underset{\underset{Cl}{|}}{\overset{\overset{H}{|}}{C}}-H$$

22 Which statement is true regarding the formation of chlorobenzene from benzene and chlorine?

A A catalyst is not required for the reaction to take place.

B The six carbon atoms in benzene remain sp^2 hybridised throughout the reaction.

C The relative molecular mass of the organic product is 35.5 greater than that of benzene.

D The reaction involves an intermediate which contains 4 delocalised electrons.

23 Compound **W** was used in the following synthesis route.
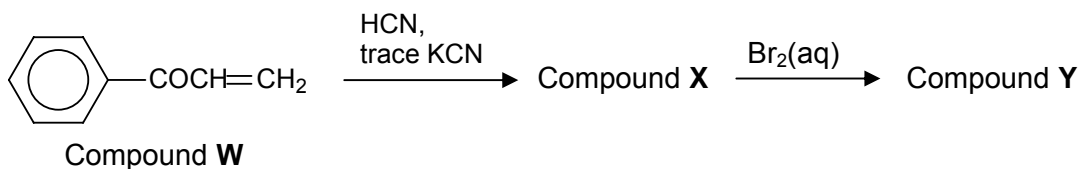
Compound **W**

What are the numbers of sp, sp^2 and sp^3 hybridised carbon atoms in compound **Y**?

A 0, 6, 4

B 0, 7, 3

C 1, 6, 3

D 1, 7, 2

24 Methylbenzene, phenol and phenylamine all undergo electrophilic substitution with suitable reagents.
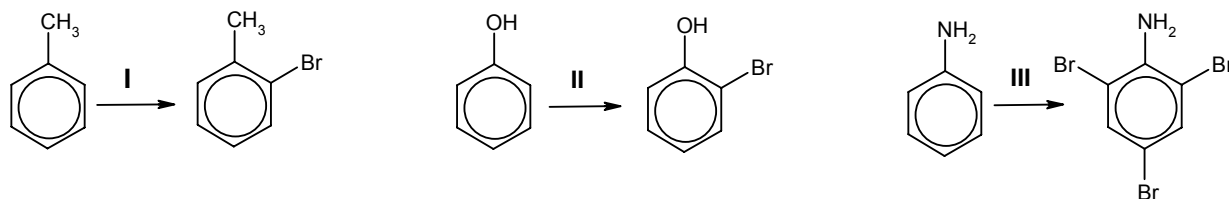
Which of the following could the reagents be?

	I	**II**	**III**
A	Br_2, Fe	Br_2 in CCl_4	$Br_2(aq)$
B	Br_2, $FeBr_3$	$Br_2(aq)$	Br_2 in CCl_4
C	$Br_2(aq)$	Br_2 in CCl_4	Br_2, Fe
D	Br_2 in CCl_4	Br_2, $FeBr_3$	$Br_2(aq)$

25 Compounds **P** and **Q** both give an orange precipitate with 2,4-dinitrophenylhydrazine.

Only one of them gives a yellow precipitate with alkaline aqueous iodine and decolourises hot acidified potassium manganate(VII).
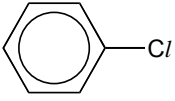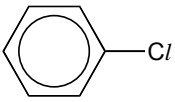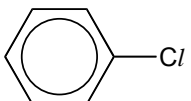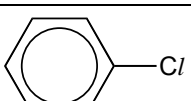
Which of the following pairs could **P** and **Q** be?

	P	**Q**
A	CH_3CHO	CH_3COCH_3
B	CH_3CH_2CHO	$CH_3COCH_2CH_3$
C	$CH_3CH(OH)CH_3$	$CH_2=CHCHO$
D	CH_3CH_2CHO	$CH_2=CHCOCH_3$

26 Which of the following gives the compounds in order of decreasing K_a?

A	CH_3CH_2OH	>	C_6H_5OH	>	CH_3CO_2H
B	$CH_3CF_2CO_2H$	>	FCH_2CHFCO_2H	>	$F_2CHCH_2CO_2H$
C	$CH_3CH_2CO_2H$	>	$ClCH_2CH_2CO_2H$	>	$CH_3CHClCO_2H$
D	$BrCH_2CO_2H$	>	$ClCH_2CO_2H$	>	FCH_2CO_2H

27 Which of the following gives the correct order of the ease of hydrolysis?

	most easily hydrolysed ⟶ least easily hydrolysed		
A	CH_3Cl	$H_3C-\underset{\displaystyle \overset{\displaystyle O}{\|\|}}{C}-Cl$	⬡—Cl
B	$H_3C-\underset{\displaystyle \overset{\displaystyle O}{\|\|}}{C}-Cl$	CH_3Cl	⬡—Cl
C	CH_3Cl	⬡—Cl	$H_3C-\underset{\displaystyle \overset{\displaystyle O}{\|\|}}{C}-Cl$
D	$H_3C-\underset{\displaystyle \overset{\displaystyle O}{\|\|}}{C}-Cl$	⬡—Cl	CH_3Cl

28 Paracetamol is an over-the-counter drug commonly used for the relief of fever and headaches. While safe for human use at recommended doses, acute overdoses of paracetamol can cause potentially fatal liver damage.
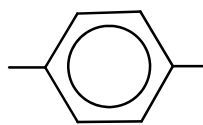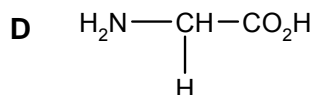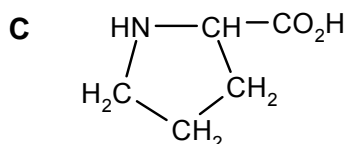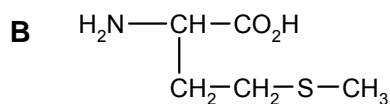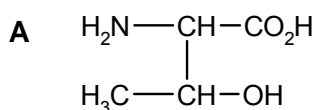

paracetamol
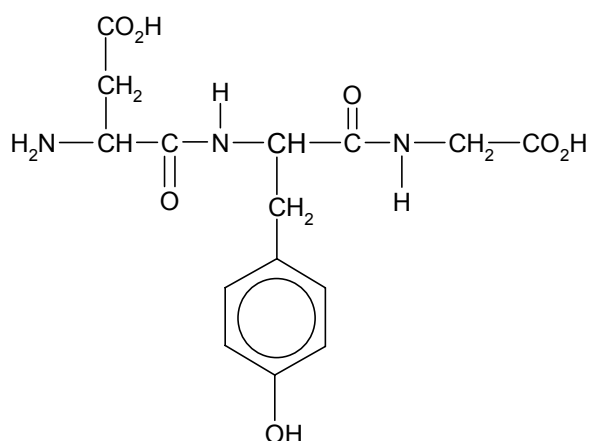
Which of the following is true about paracetamol?

A It gives effervescence with aqueous Na_2CO_3.

B It reacts with aqueous Br_2 in a mole ratio of 1:1.

C It dissolves in hot aqueous NaOH to give two ionic salts.

D It can be prepared by reacting CH_3CO_2H with H_2N—⬡—OH

29 In the tertiary structure of a water-soluble globular protein extracted from barley grains, it was found that the types of amino acid residues present on the outer surface of the protein were different from those present on the inside.
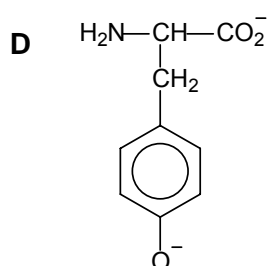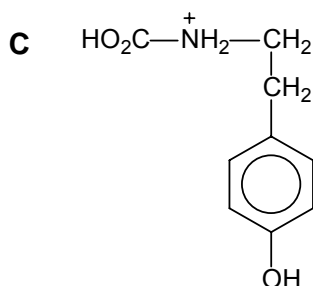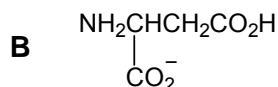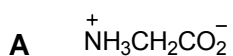
Which of the following amino acids is most likely to be incorporated into the outer surface of such proteins?

A
$$H_2N-CH-CO_2H$$
$$H_3C-CH-OH$$

B
$$H_2N-CH-CO_2H$$
$$CH_2-CH_2-S-CH_3$$

C
$$HN-CH-CO_2H$$
$$H_2C \quad CH_2$$
$$CH_2$$

D
$$H_2N-CH-CO_2H$$
$$H$$

30 The tripeptide below was boiled with aqueous sodium hydroxide, and subsequently left to cool. The components of the resulting mixture were then separated by electrophoresis using an agarose gel at pH 10.0.

Which of the following species is most likely to be present in the gel?

A $\overset{+}{N}H_3CH_2CO_2^-$

B
$$NH_2CHCH_2CO_2H$$
$$CO_2^-$$

C
$$HO_2C-\overset{+}{N}H_2-CH_2$$
$$CH_2$$
(with benzene ring and OH)

D
$$H_2N-CH-CO_2^-$$
$$CH_2$$
(with benzene ring and O⁻)

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 In 1985, a molecular form of carbon, C_{60}, called buckerministerfullerene, was discovered in the products formed when graphite was vapourised. The structure proposed for the molecule is a roughly spherical collection of atoms in the shape of hexagons and pentagons, very much like a soccer ball.
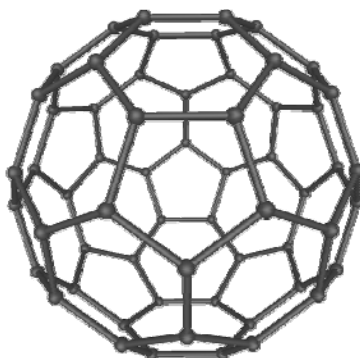
Which of the following properties is expected of buckerministerfullerene?

1 It dissolves in various organic solvents.

2 It contains delocalised electrons.

3 It can conduct electricity.

32 Which of the following would be required to determine the lattice energy of AlF_3 in a Born-Haber cycle?

1 first electron affinity of fluorine

2 enthalpy change of atomisation of AlF_3

3 bond energy of $Al–F$

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

33 In an enzyme-catalysed reaction, the rate is affected by the concentration of substrate as shown in the graph below.
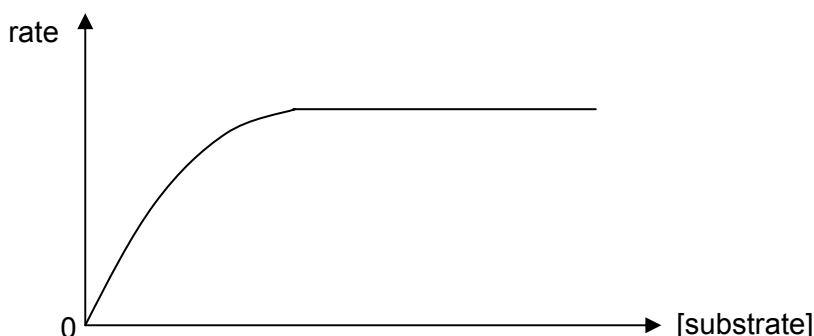
The steps that are common to most enzyme-catalysed reactions are

enzyme + substrate = enzyme-substrate complex (fast)

enzyme-substrate complex → enzyme + product (slow)
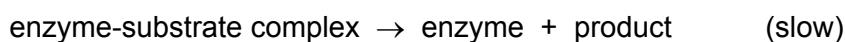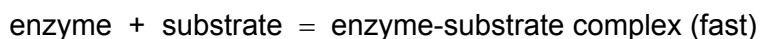
Which of the following conclusions can be drawn?

1 When [substrate] is low, the reaction is first order with respect to the substrate.

2 When [substrate] is high, the reaction is zero order with respect to the substrate.

3 The rate equation is given as: rate = k [enzyme-substrate complex].

34 Which of the following statements describing the characteristics of elements within any one particular group of the Periodic Table are correct?

1 The first ionisation energies of the elements decrease down the group.

2 The melting points of the elements decrease down the group.

3 The reactivity of the elements increases down the group.

35 Which of the following contains two covalent chlorides and two covalent oxides?

1 $SiCl_4$ $BeCl_2$ SiO_2 NO_2

2 BCl_3 $AlCl_3$ Al_2O_3 Cl_2O

3 SCl_2 $CsCl$ TiO_2 BaO_2

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

36 *The use of the Data Booklet is relevant to this question.*

An example of a reaction catalysed by transition metal ions is given below:

$$S_2O_8^{2-}(aq) + 2I^-(aq) \rightarrow 2SO_4^{2-}(aq) + I_2(aq)$$
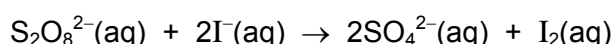
The E values for the half-reactions are:
$$E (I_2 / I^-) = +0.54 \text{ V}$$
$$E (S_2O_8^{2-} / SO_4^{2-}) = +2.01 \text{ V}$$

Which of the following transition metal ions can be used to catalyse this reaction?

1 Fe^{3+} **2** Co^{3+} **3** V^{3+}

37 Polystyrene is a synthetic macromolecule which can be made into vending cups and fast food containers.

This long-chain hydrocarbon can be produced by "joining up" many styrene molecules in the industrial process:

many styrene molecules   polystyrene
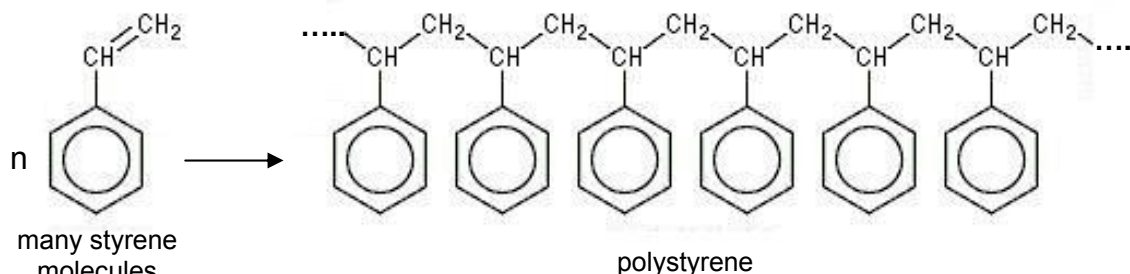
Which statements are correct?

1 Styrene decolourises aqueous bromine but polystyrene does not.

2 The conversion of styrene molecules into polystyrene involves addition reaction.

3 All the atoms lie on the same plane for styrene as well as polystyrene.

38 Disinfectants are solutions often containing a large percentage of alcohol. Which of the following statements explains their efficacy in destroying pathogens such as bacteria?

1 The alcohol destroys the primary structure of the bacterial proteins.

2 The alcohol destroys the secondary structure of the bacterial proteins.

3 The alcohol destroys the tertiary structure of the bacterial proteins.

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

39 Ferulic acid is an antioxidant that occurs widely in plants.
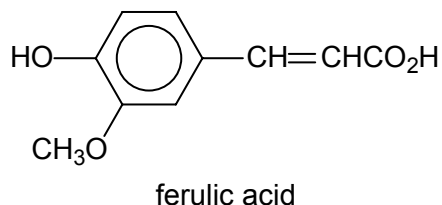
ferulic acid

Which statements are true about ferulic acid?

1 It decolourises hot acidified $KMnO_4$ with the evolution of CO_2.

2 It is not very soluble in water but dissolves in aqueous NaOH.

3 It can be prepared from using hot acidified $K_2Cr_2O_7$.

40 Saccharin is an artificial sweetening agent used in some soft drinks and is manufactured from methylbenzene by the following series of reactions:

Saccharin
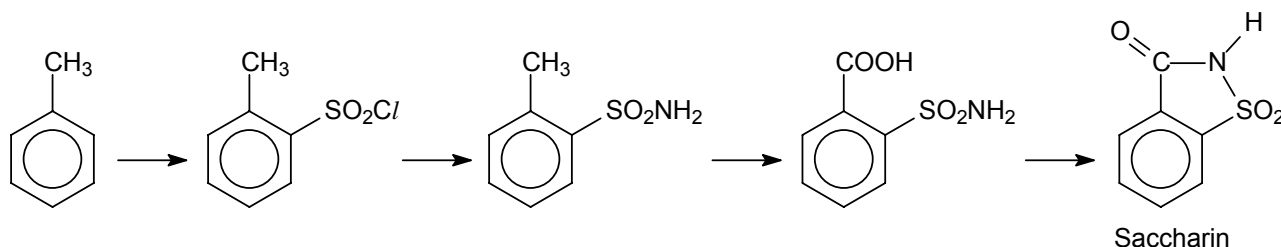
What types of reactions are involved in the series?

1 condensation

2 electrophilic subsitution

3 nucleophilic subsitution

~ End of Paper ~