



CHEMISTRY

9647/01

Paper 1 Multiple Choice

Friday

23rd September 2011

1 hour

Additional materials: Data Booklet
Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, index number and CG on the Answer Sheet in the spaces provided.

There are **forty** 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.

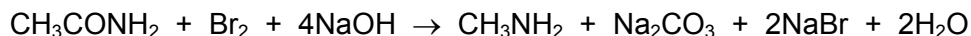
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

Section A

For each question there are four possible answers, **A**, **B**, **C** and **D**. Choose the **one** you consider to be correct.

- 1 The Hofmann degradation is an example of a step-down reaction between an amide and a mixture of bromine and sodium hydroxide solution to form amines.

The following shows an equation for the preparation of methylamine:



What is the mass of sodium hydroxide required for the reaction, given that 16.5 g of methylamine is produced?

[A_r of C = 12.0; H = 1.0; N = 14.0; O = 16.0; Na = 23.0]

- A** 5.3 g **B** 21.3 g **C** 66.2 g **D** 85.2 g

- 2 In an experiment, 0.0050 mol of a metallic salt reacted with 0.0025 mol of aqueous sodium sulfate(IV).

The half-equation for oxidation of sulfate(IV) ion is shown below.



If the original oxidation number of the metal in the salt was +3, what would be the new oxidation number of the metal?

- A** 0 **B** +1 **C** +2 **D** +4

- 3 Which of the following has the largest bond angle?

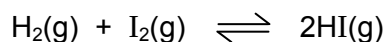
- A** PH_3 **B** SiCl_4 **C** IF_2^- **D** IF_4^-

- 4 The numerical value for the K_{sp} of calcium phosphate, $\text{Ca}_3(\text{PO}_4)_2$, in water at 25°C is 2.07×10^{-33} . Determine the solubility of calcium phosphate.

- A** $1.03 \times 10^{-6} \text{ mol dm}^{-3}$
B $3.42 \times 10^{-7} \text{ mol dm}^{-3}$
C $2.28 \times 10^{-7} \text{ mol dm}^{-3}$
D $1.14 \times 10^{-7} \text{ mol dm}^{-3}$

- 5 When 0.20 mol of hydrogen gas and 0.15 mol of iodine gas are heated at 723 K until equilibrium is established, the equilibrium mixture is found to contain 0.26 mol of hydrogen iodide.

The equation for the reaction is as follows.



What is the correct expression for the equilibrium constant K_c ?

- A $\frac{2 \times 0.26}{0.20 \times 0.15}$ C $\frac{(0.26)^2}{0.07 \times 0.02}$
- B $\frac{(2 \times 0.26)^2}{0.20 \times 0.15}$ D $\frac{(0.26)^2}{0.13 \times 0.13}$

- 6 The table below shows the values of the ionic product of water, K_w , at two different temperatures.

Temperature / °C	$K_w / \text{mol}^2 \text{dm}^{-6}$
25	1.00×10^{-14}
62	1.00×10^{-13}

Which of the following statements is correct for pure water?

- A The ionic dissociation of water is an exothermic process.
- B At 62 °C, $\text{pH} = 14 - \text{pOH}$.
- C At 62 °C, $\text{pH} < \text{pOH}$.
- D At 62 °C, $\text{pH} < 7$.

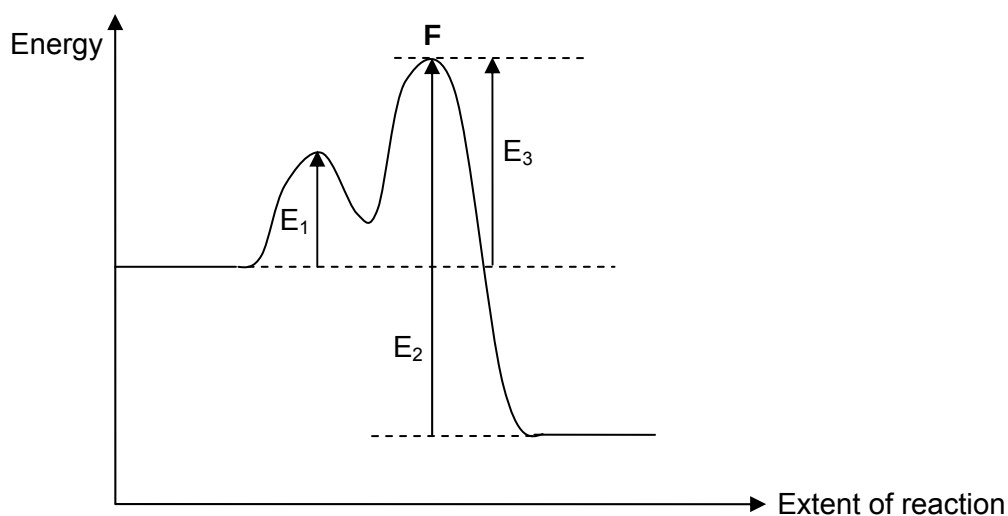
- 7 Consider the equation: $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{SO}_3(\text{g})$

$$\Delta H = -199 \text{ kJ mol}^{-1}, \Delta S = -190 \text{ J K}^{-1} \text{ mol}^{-1}$$

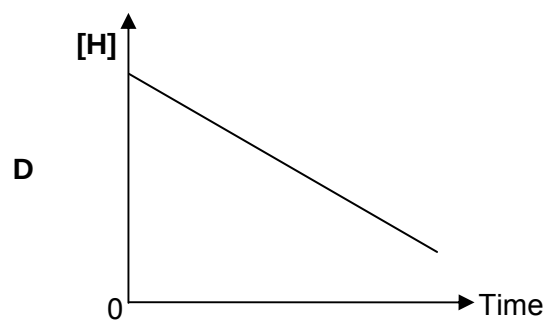
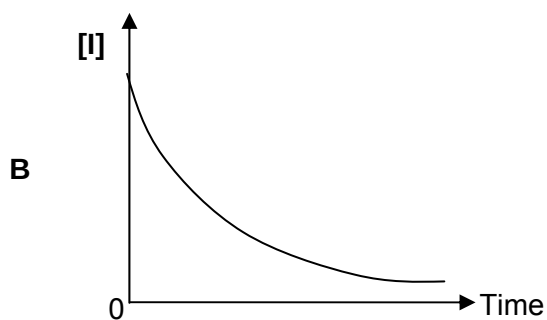
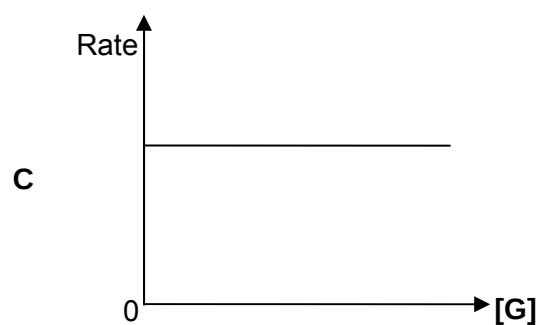
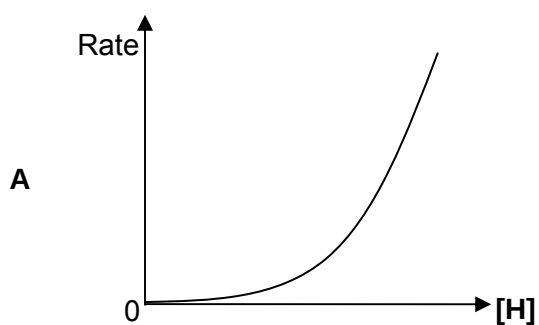
Which of the following statements is correct?

- A In the formation of products, the system becomes more disordered.
- B The products are energetically less stable than the reactants.
- C As temperature increases, the reaction becomes more spontaneous.
- D The reaction is spontaneous under standard conditions.

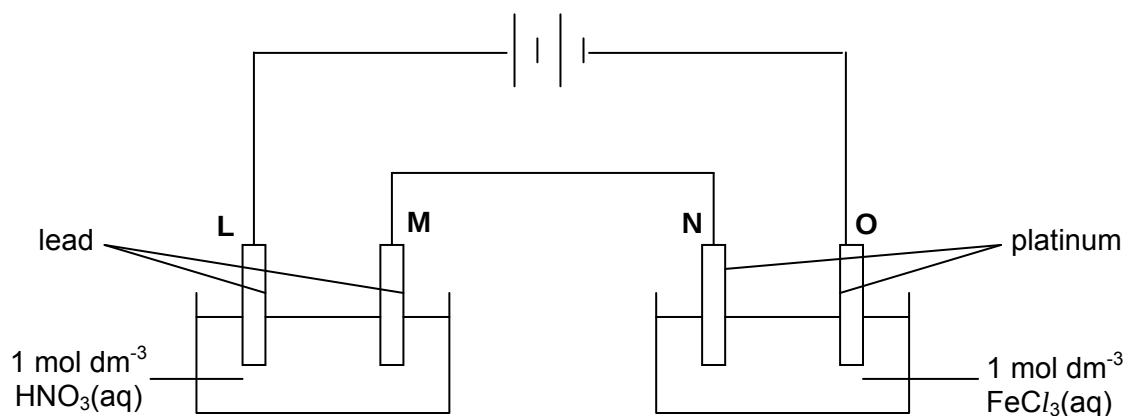
- 8 Which of the following statements is true about the energy profile below?



- A F is the intermediate formed.
- B The enthalpy change of the reaction is $E_3 - E_2$.
- C The reaction is catalysed by a heterogenous catalyst.
- D E_2 corresponds to the activation energy for the reaction in the second step.
- 9 The rate equation for the reaction, $\text{G} + \text{H} + \text{I} \rightarrow \text{J} + \text{K}$ is $\text{rate} = k [\text{H}] [\text{I}]$. Which of the following graphs is correct for the reaction, when I is in large excess?

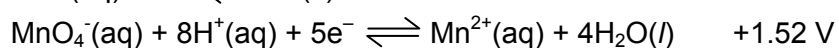


- 10 Two cells are connected in series as shown in the diagram where L, M, N and O are electrodes. Which of the following correctly shows the products formed at each electrode?



	L	M	N	O
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⁺

- 11 Given these standard electrode potentials



what would be the standard e.m.f. of the cell involving these two half-reactions and the polarity of the copper electrode?

	$E^{\ominus}_{\text{cell}} / \text{V}$	Polarity of the copper electrode
A	1.86	+
B	1.86	–
C	1.18	+
D	1.18	–

- C** Silver

- D** Iron

- Figure 1** shows the first six ionisation energies of an element **P**.

Figure 1

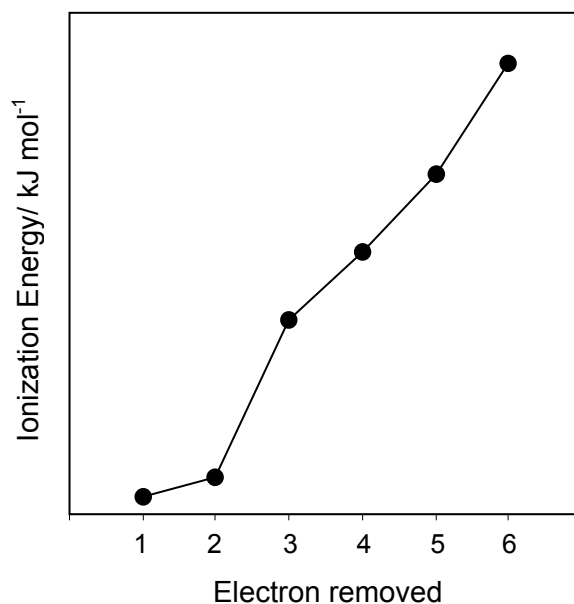
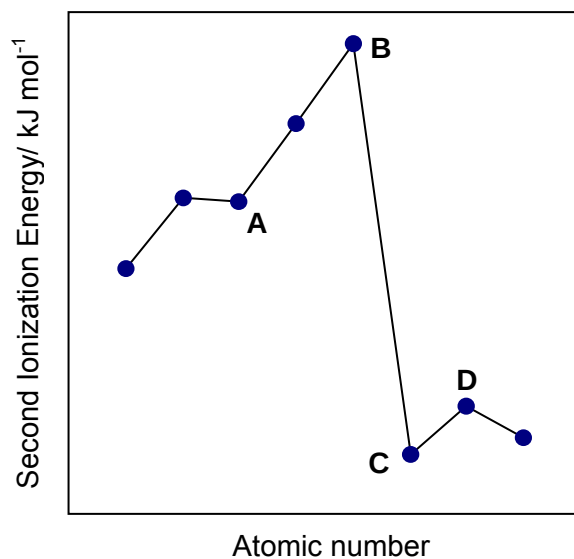


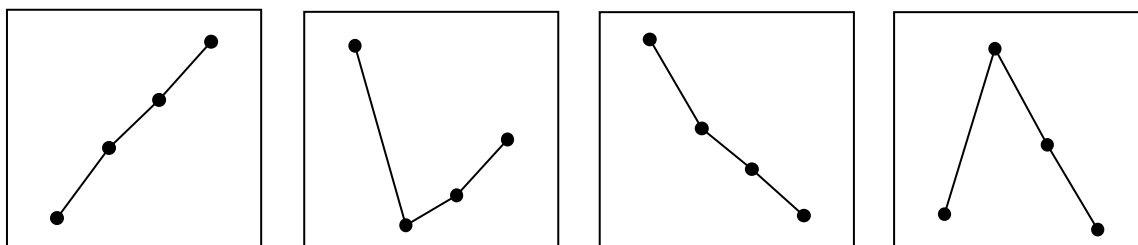
Figure 2 shows the second ionisation energies of eight consecutive elements (including **P**).

Figure 2



With reference to **Figure 2**, which of the options, **A**, **B**, **C** or **D**, corresponds to the second ionisation energy of element **P**?

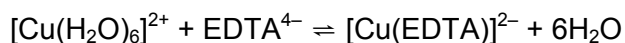
- 14 Which of the following statements regarding elements in Period 3 (i.e. sodium to chlorine) and their compounds is **incorrect** as the atomic number increases?
- A The oxides become increasingly acidic.
 - B The chlorides become increasingly covalent.
 - C The melting points of the elements generally increase.
 - D The atomic radii of the elements generally decrease.
- 15 Unlike all other Group I nitrates, lithium nitrate decomposes on heating in the same way as Group II nitrates. Which one of the following equations represents the reaction that occurs when lithium nitrate is heated strongly?
- A $2\text{LiNO}_3 \rightarrow 2\text{LiNO}_2 + \text{O}_2$
 - B $2\text{LiNO}_3 \rightarrow \text{Li}_2\text{O} + \text{N}_2\text{O} + 2\text{O}_2$
 - C $2\text{LiNO}_3 \rightarrow \text{Li}_2\text{O}_2 + 2\text{NO}_2$
 - D $2\text{LiNO}_3 \rightarrow \text{Li}_2\text{O} + 2\text{NO}_2 + \frac{1}{2}\text{O}_2$
- 16 The graphs given below show the trends in some properties related to the halogens X_2 (fluorine, chlorine, bromine and iodine) and their compounds down the group.



Which of the following properties is **not** illustrated in the four graphs above?

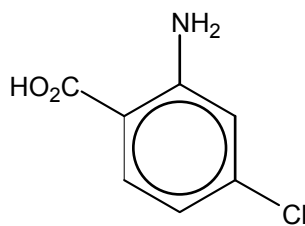
- A pH of 0.1 mol dm^{-3} aqueous HX
- B X-X bond dissociation energy
- C reactivity of X_2
- D boiling point of X_2

- 17 Which one of the following statements about the reaction below is **false**?



- A Both $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ and $[\text{Cu}(\text{EDTA})]^{2-}$ are octahedral complexes.
- B There is a change in colour.
- C It is a redox reaction.
- D $[\text{Cu}(\text{EDTA})]^{2-}$ is a more stable complex than $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$.
- 18 In which of the following mechanisms does the donation of an electron pair **not** take place?
- A Electrophilic substitution C Electrophilic addition
- B Nucleophilic addition D Free radical substitution

- 19 A student wishes to synthesise compound **Q** from benzene.

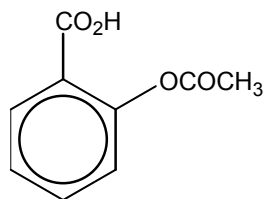


Compound **Q**

Which of the following routes would give the maximum yield of **Q**?

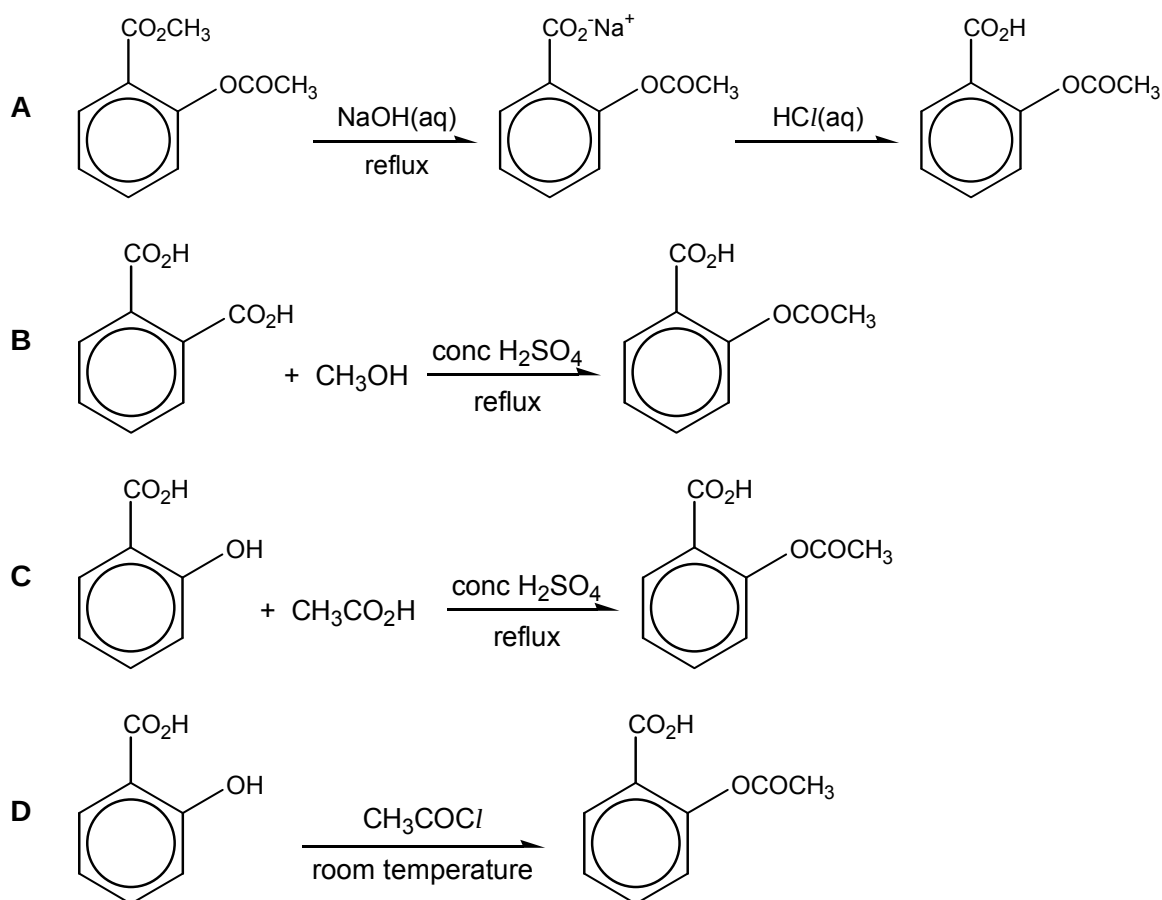
- A Alkylation → nitration → chlorination → reduction → oxidation
- B Alkylation → nitration → oxidation → chlorination → reduction
- C Nitration → alkylation → reduction → chlorination → oxidation
- D Chlorination → nitration → reduction → alkylation → oxidation

- 20 Aspirin is a drug often used as an analgesic to relieve minor aches and pains, as an antipyretic to reduce fever, and as an anti-inflammatory medication.



Aspirin

Which of the following could be used as a correct synthesis of aspirin?



- 21 An ester **R** is reacted with dilute sulfuric acid and the resultant mixture was distilled to obtain distillate **S** and residue **T**.

Both distillate **S** and residue **T** reacted with aqueous alkaline iodine to give a yellow precipitate.

What formula could represent **R**?

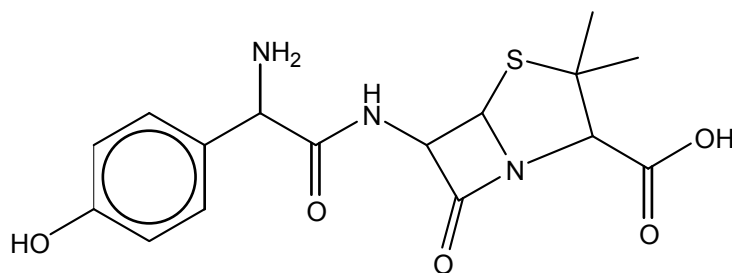
- A** $\text{HOCH}_2\text{CH}_2\text{OCOCH}_2\text{CH}(\text{OH})\text{CH}_3$
B $\text{CH}_3\text{CH}(\text{OH})\text{CO}_2\text{CH}_2\text{CH}_3$
C $\text{CH}_3\text{CH}(\text{CH}_2\text{OH})\text{OCOCH}_2\text{CHO}$
D $\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$

- 22 Compound **U**, $C_6H_{12}O$, is oxidised by acidified sodium dichromate(VI) to compound **V**. Compound **V** reacts with ethanol in the presence of a little concentrated sulfuric acid to give liquid **W**.

What is the formula of **W**?

- A $CH_3(CH_2)_4CO_2CH_2CH_3$ C $CH_3(CH_2)_2CH=CHCO_2H$
 B $CH_3(CH_2)_4CH_2COCH_2CH_3$ D $CH_3CH_2CO_2(CH_2)_4CH_3$

- 23 Amoxicillin is an antibiotic commonly prescribed to treat bacterial infections.

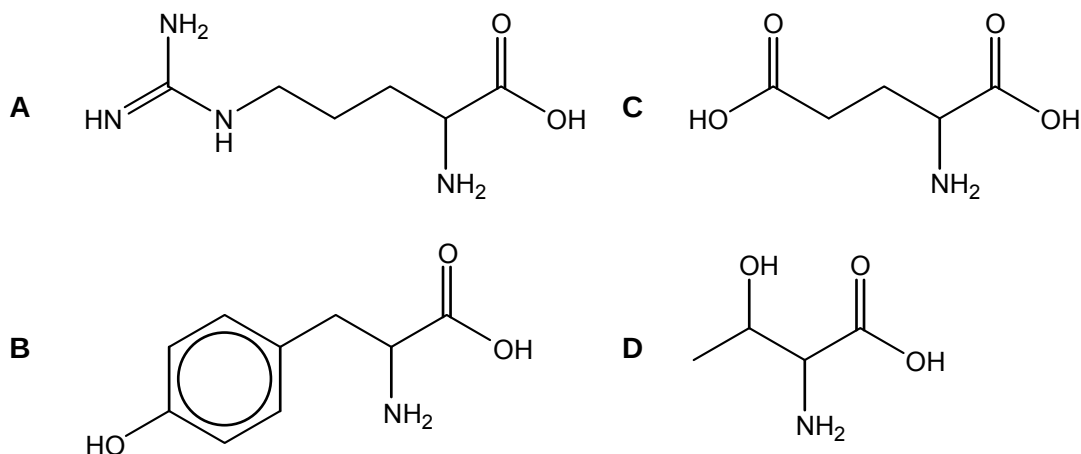


Amoxicillin

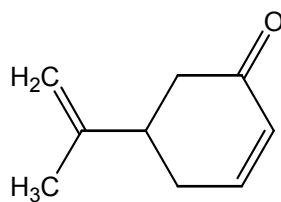
Which of the following can be used to test for the presence of amoxicillin?

- A 2,4-dinitrophenylhydrazine C Sodium hydroxide
 B Potassium dichromate(VI) D Neutral $FeCl_3$
- 24 Electrophoresis is an analytical method frequently used in molecular biology to analyse and separate proteins and amino acids. Amino acid samples are placed in a gel slab containing a buffer. The ends of the gel slab are connected to charged electrodes and the charged amino acid particles move towards the oppositely charged electrodes.

Which amino acid will move most readily towards the anode at pH 10?

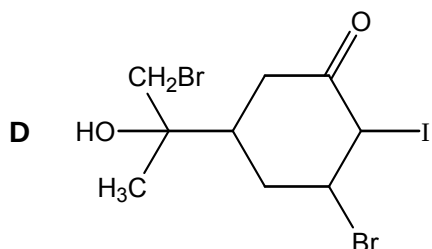
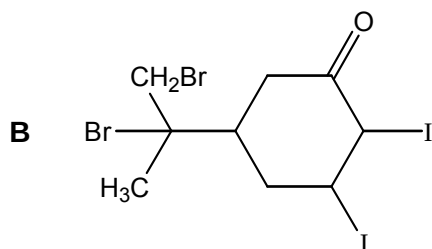
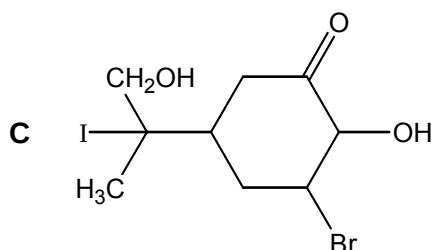
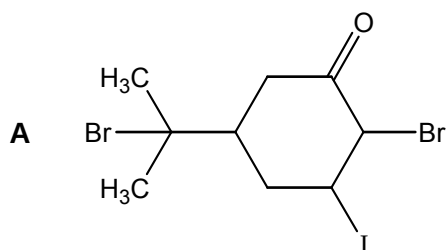


- 25 Carvone is the principal constituent of the oil from caraway seeds that gives the seeds their unique odour.



Carvone

Which of the following products could be formed when Carvone is reacted with aqueous bromine in the presence of sodium iodide?



- 26 A typical protein forms several hundreds of hydrogen bonds and several thousands of van der Waals' forces in folding from primary to tertiary structures. Which thermodynamic state functions of the protein best represents the folding process?

	$\Delta H / \text{kJ mol}^{-1}$	$\Delta S / \text{J mol}^{-1} \text{K}^{-1}$
A	> 0	> 0
B	> 0	< 0
C	< 0	< 0
D	< 0	> 0

- 27 **X** is synthetic nonapeptide that is resynthesised from the amino acids found in honey bee venom. To investigate the sequence of amino acids in **X**, the nonapeptide was first hydrolysed by two enzymes. The protein fragments were then separated and their sequence determined.

The following protein fragments were obtained from the first enzyme which hydrolysed the peptide chain at the carboxylic end of the amino acid isoleucine, Ile.

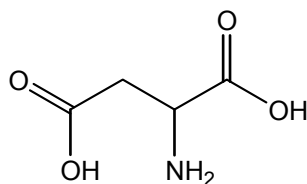
Arg-Ile
Ser-Lys-Trp-Ile
Lys-Leu-Arg

The second enzyme, which hydrolysed the peptide chain at the carboxylic end of the amino acid lysine, Lys, yielded the following fragments

Arg-Ile-Ser-Lys
Trp-Ile-Lys
Leu-Arg

Which of the following is the correct primary structure of the nonapeptide **X**?

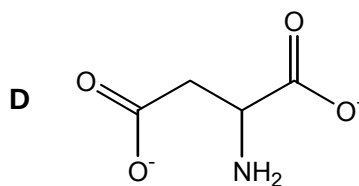
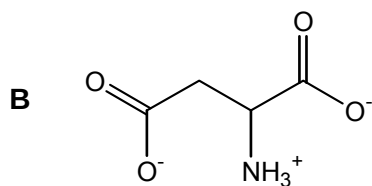
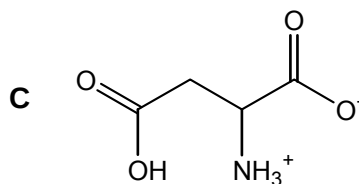
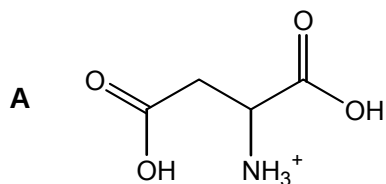
- A Lys-Leu-Arg-Ile-Ser-Lys-Trp-Ile-Lys
B Trp-Ile-Lys-Leu-Arg-Ile-Ser-Lys-Trp
C Arg-Ile-Ser-Lys-Trp-Ile-Lys-Leu-Arg
D Ser-Lys-Trp-Ile-Lys-Leu-Arg-Ile-Ser
- 28 Aspartic acid was first discovered in 1827 by Plisson. It is found in animal sources such as luncheon meats and sausages as well as vegetable sources such as sprouting seeds, oat flakes, avocado and asparagus.



Aspartic acid

There are three pK_a values associated with aspartic acid: 2.10, 3.86, 9.82.

Using the pK_a values, what is the major species present in solutions of aspartic acid at pH 7?



- 29 3-methylpentane can undergo reaction with chlorine to form monosubstituted compounds that are optically active. How many possible isomers, including stereoisomers, can be formed in the reaction?

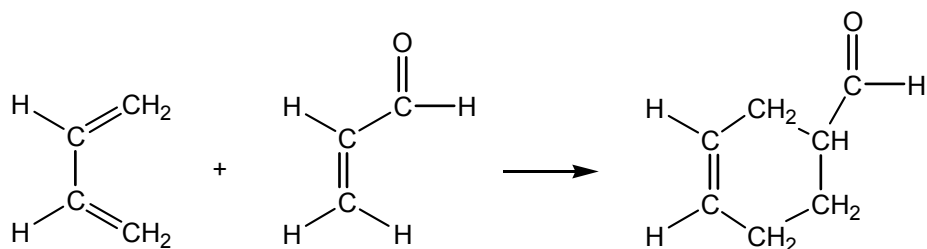
A 4

B 6

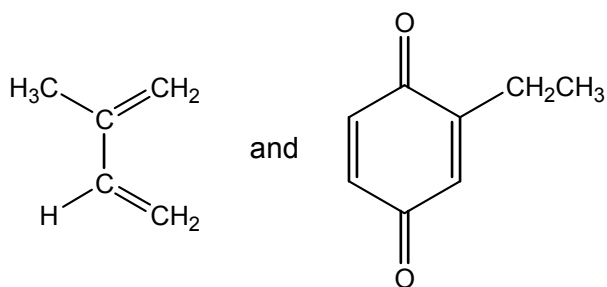
C 8

D 16

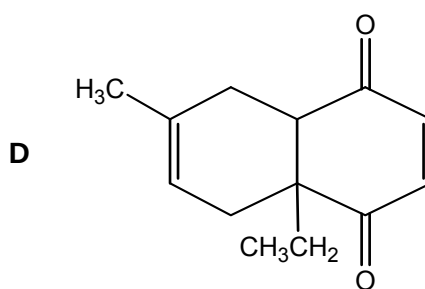
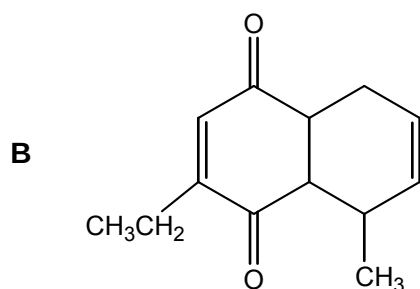
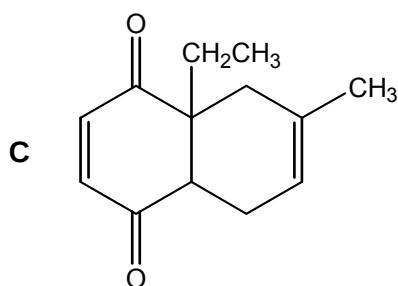
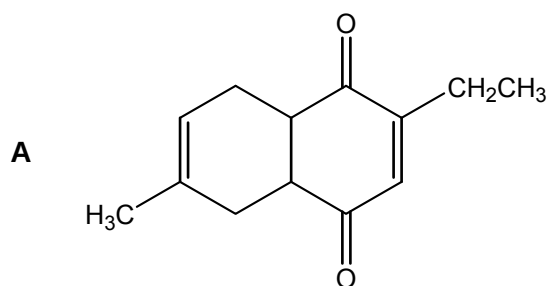
- 30 Unsaturated carbonyl compounds can undergo a useful reaction known as the Diels-Alder reaction with a diene. An example is shown below.



A student reacted the following diene and carbonyl compound together in a Diels-Alder reaction.



Which of the following would **not** be formed as a product?



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 which you consider to be correct).

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

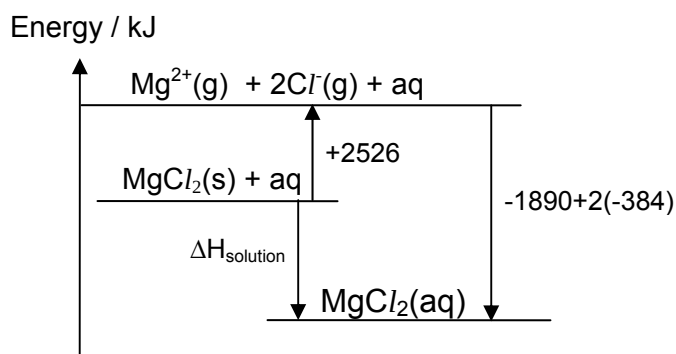
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

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

31 Which of following statements are **incorrect**?

- Any covalent compound that contains both hydrogen and oxygen in its molecule can form intermolecular hydrogen bond.
- Ionic compounds can be distinguished from metals by their electrical conductivity in the liquid states.
- All substances with covalent bonding have poor electrical conductivity.

32 The energy level diagram shown represents the dissolving of anhydrous magnesium chloride in a large volume of water.



Which statements about the process are correct?

- The lattice energy of magnesium chloride is $-2526 \text{ kJ mol}^{-1}$.
- The enthalpy change of hydration of the chloride ion is -384 kJ mol^{-1} .
- The enthalpy change of solution of anhydrous magnesium chloride is -132 kJ mol^{-1} .

- 33 Consider the following equilibrium system which is slightly endothermic at room temperature.



Which of the following changes are correct?

- 1 Adding CO causes the position of equilibrium to shift to the right.
 - 2 Adding CO₂ causes the position of equilibrium to shift to the left.
 - 3 Increasing the temperature causes the position of equilibrium to shift to the right.
- 34 With reference to the *Data Booklet* and the data below, deduce which of the following statements are correct.

Half-equation	E^θ/V
$\text{VO}_2^+(\text{aq}) + 2\text{H}^+(\text{aq}) + \text{e}^- \rightarrow \text{VO}^{2+}(\text{aq}) + \text{H}_2\text{O}(\text{l})$	+1.00
$\text{VO}^{2+}(\text{aq}) + 2\text{H}^+(\text{aq}) + \text{e}^- \rightarrow \text{V}^{3+}(\text{aq}) + \text{H}_2\text{O}(\text{l})$	+0.34
$\text{V}^{3+}(\text{aq}) + \text{e}^- \rightarrow \text{V}^{2+}(\text{aq}) + \text{H}_2\text{O}(\text{l})$	-0.26

- 1 An excess of zinc is capable of reducing $\text{VO}_2^+(\text{aq})$ to $\text{V}^{2+}(\text{aq})$ in acidic conditions.
 - 2 $\text{Fe}^{3+}(\text{aq})$ is capable of oxidising $\text{V}^{2+}(\text{aq})$ to $\text{VO}_2^+(\text{aq})$ in acidic conditions.
 - 3 $\text{Zn}^{2+}(\text{aq})$ ions will oxidise $\text{V}^{2+}(\text{aq})$ ions to $\text{V}^{3+}(\text{aq})$ ions.
- 35 For the sequence hydrogen iodide, hydrogen bromide and hydrogen chloride, there is an increase in
- 1 thermal stability.
 - 2 acidity.
 - 3 ease of oxidation.
- 36 Cobalt has the electronic structure $1\text{s}^2 2\text{s}^2 2\text{p}^6 3\text{s}^2 3\text{p}^6 3\text{d}^7 4\text{s}^2$. Which of the following cobalt compounds are **unlikely** to exist?
- 1 $\text{K}_2\text{Co}_2\text{O}_9$
 - 2 Co_3O_4
 - 3 K_2CoF_6

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

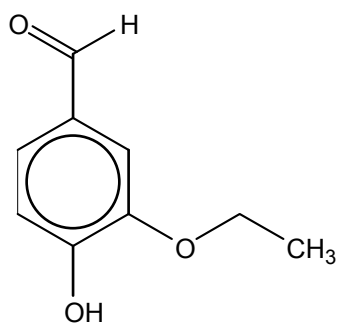
No other combination of statements is used as a correct response.

- 37** **Y** is a hydrocarbon with the formula C_5H_{10} .

Which of the following statements about **Y** are **always** correct?

- 1** 1 mole of **Y** produces 112 dm^3 of gas at stp on complete combustion.
- 2** **Y** has 5 possible isomers including structural isomers and stereoisomers.
- 3** **Y** can decolourise bromine water.

- 38** Ethylvanillin is a synthetic flavorant used in the manufacture of chocolate and is approximately three times as potent as vanillin which is found in the extract of vanilla beans.



Ethylvanillin

Which of the following statements about ethylvanillin are correct?

- 1** It can form hydrogen bonds.
- 2** It gives a red precipitate with Fehling's solution.
- 3** It can undergo hydrolysis when heated with a dilute acid.

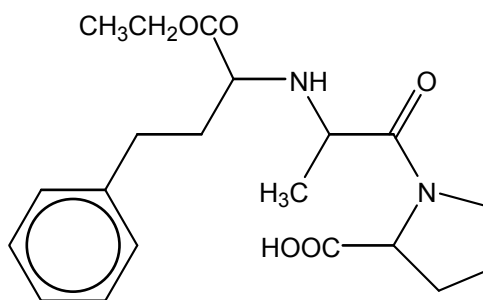
39 Which of the following reactions will most likely form a product which is racemic?

1 CH_3CHO with HCN in trace amounts of alkali, $10-20^\circ\text{C}$.

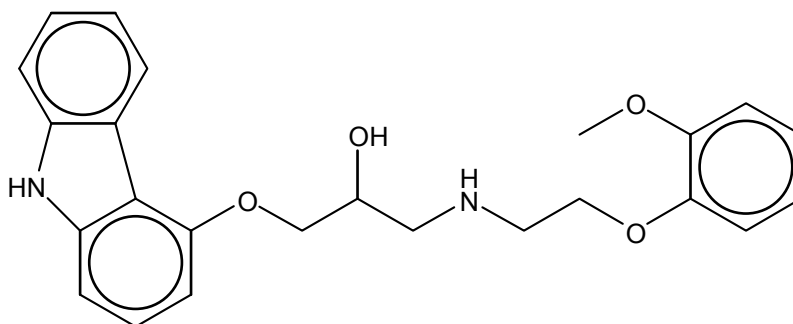
2
$$\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3\text{CH}_2\text{CH}_2-\text{C}-\text{Cl} \\ | \\ \text{CH}_3\text{CH}_2 \end{array}$$
 with aqueous sodium hydroxide, reflux

3
$$\begin{array}{c} \text{CH}_3 \quad \text{H} \\ | \quad | \\ \text{CH}_3\text{CH}_2\text{CH}_2-\text{C}=\text{C}-\text{CH}_3 \end{array}$$
 with HBr dissolved in CCl_4

40 Enalapril and Carvedilol are two compounds that are used in the treatment of heart failure and disease.



Enalapril



Carvedilol

Which of the following can be used to distinguish between the two compounds?

- 1 Aqueous bromine
- 2 Sodium carbonate
- 3 Acidified potassium manganate(VII), reflux

Answers to 2011 TJC H2 Chem Prelims P1

1	D	11	D	21	B	31	A
2	C	12	C	22	A	32	A
3	C	13	C	23	D	33	A
4	D	14	C	24	C	34	D
5	C	15	D	25	D	35	D
6	D	16	A	26	C	36	D
7	D	17	C	27	C	37	D
8	B	18	D	28	B	38	D
9	C	19	A	29	C	39	A
10	D	20	D	30	B	40	B