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**9647/01**

**21 September 2016**

**1 hour**

Additional Materials: Optical Mark Sheet (OMS)

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 optical mark sheet (OMS) as shown below.

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

[illegible]

2. Enter the **PAPER NUMBER**.

3. Enter your **CT GROUP**.

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

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)

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

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 OMS.

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.

## SECTION A

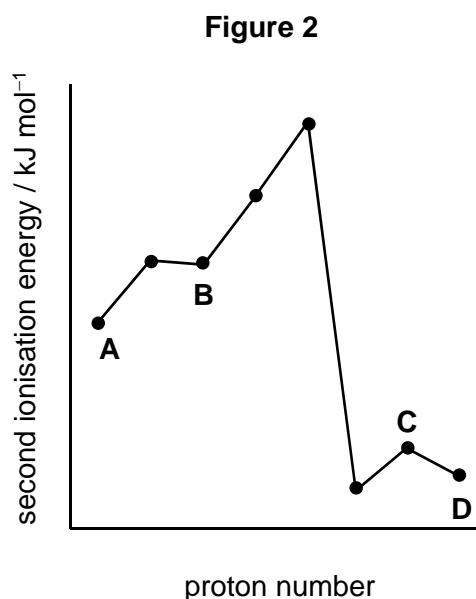
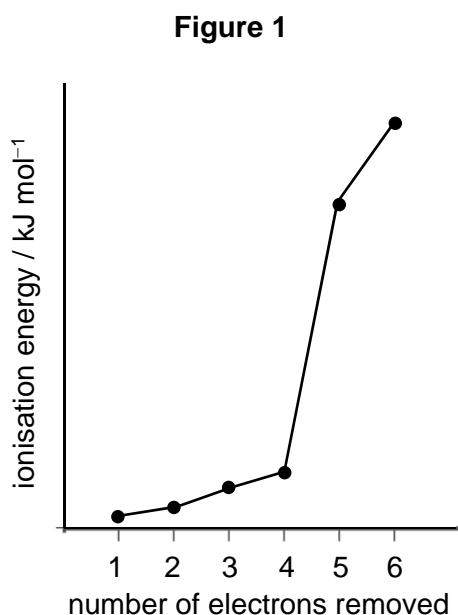
For each question, there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider to be correct.

- 1 Methyl mercaptan,  $\text{CH}_3\text{SH}$ , is one of the substances responsible for bad breath and is often used to impart a smell to natural gas in a pipeline. When a sample of  $10\text{ cm}^3$  of  $\text{CH}_3\text{SH}$  is exploded with  $60\text{ cm}^3$  of oxygen, the final volume of gas after burning is passed into an excess of aqueous alkali. The chemical equation for the combustion process is shown below.



What percentage of the final volume of gas after burning dissolves in the alkali? All gaseous volumes are measured at room temperature and pressure.

- A** 40.0%      **B** 28.5%      **C** 20.0%      **D** 14.3%
- 2 **Figure 1** shows the first six ionisation energies of an element **Q** while **Figure 2** shows the second ionisation energies of eight consecutive elements, including **Q**, in the Periodic Table.

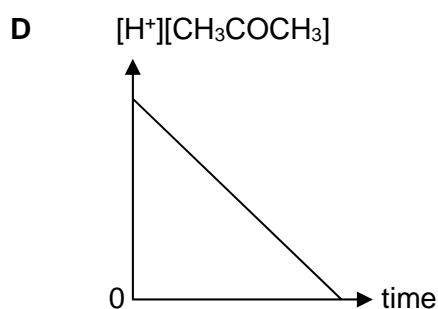
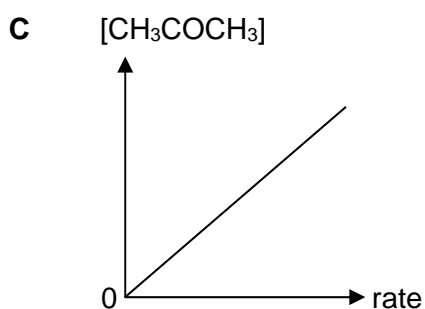
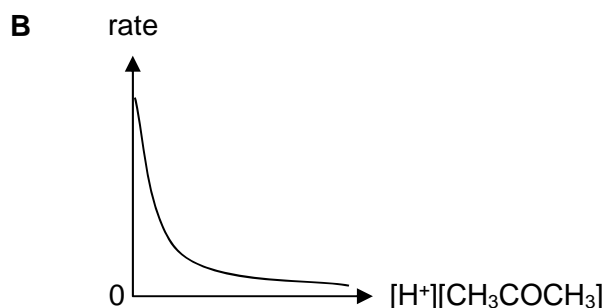
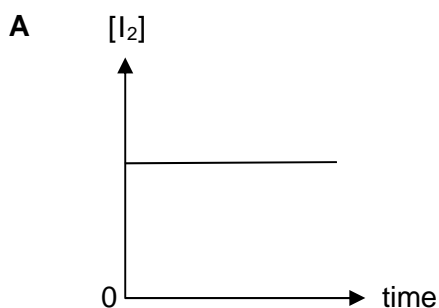


Which of the elements **A**, **B**, **C** or **D** could be the element **Q**?

- 3 Which statement is **not** always true when an ionic solid dissolves in water?
- A** Energy is absorbed to separate the ions in the solid.
- B** Energy is absorbed to break the hydrogen bonding between water molecules.
- C** Energy is released when the ions are hydrated.
- D** Energy is released when the ionic solid dissolves completely.

- 4 Which of the following explains the non-ideal behavior of the gases present in the reaction chamber in the Haber process?
- A the presence of a catalyst
  - B the high temperature of 450 °C
  - C the high pressure of 150 atm
  - D the strong bonds between the atoms in the nitrogen molecules
- 5 Which enthalpy change would best indicate the relative strengths of the intermolecular forces in liquid hydrogen halides?
- A bond dissociation energy
  - B enthalpy change of formation
  - C enthalpy change of solution
  - D enthalpy change of vaporisation
- 6  $\text{CH}_3\text{COCH}_3$  and  $\text{I}_2$  react in the presence of an acid catalyst. The rate of reaction is independent of  $[\text{I}_2]$  but directly proportional to  $[\text{H}^+]$  and to  $[\text{CH}_3\text{COCH}_3]$ .

Which graph is correct?



- 7 When the system  $X_2(g) + 3Y_2(g) = 2XY_3(g)$  is at equilibrium at 500 K and 1 atm, the value of the equilibrium constant,  $K_p$ , is 100. What is the value of  $K_p$  at a pressure of 2 atm at the same temperature?

A 25                      B 100                      C 200                      D 400

- 8 The numerical values of the solubility product of  $BaSO_4$ ,  $BaCO_3$  and  $Ba(IO_3)_2$  at 25 °C are given in the table below.

Compound	Solubility product
$BaSO_4$	$1.1 \times 10^{-10}$
$BaCO_3$	$2.6 \times 10^{-9}$
$Ba(IO_3)_2$	$4.0 \times 10^{-9}$

An aqueous solution of  $BaCl_2$  was added slowly, until in excess, to a solution containing  $0.5 \text{ mol dm}^{-3} Na_2SO_4$ ,  $1.0 \text{ mol dm}^{-3} Na_2CO_3$  and  $1.5 \text{ mol dm}^{-3} NaIO_3$  at 25 °C.

What is the correct order of precipitation of the three barium salts?

	First to precipitate	→	Last to precipitate
A	$BaSO_4$	$BaCO_3$	$Ba(IO_3)_2$
B	$Ba(IO_3)_2$	$BaCO_3$	$BaSO_4$
C	$BaSO_4$	$Ba(IO_3)_2$	$BaCO_3$
D	$BaCO_3$	$Ba(IO_3)_2$	$BaSO_4$

- 9 What is the pH of the final solution formed when  $V \text{ dm}^3$  of dilute hydrochloric acid of pH 1.0 is mixed with  $V \text{ dm}^3$  of dilute sulfuric acid of pH 1.0, followed by the addition of  $2V \text{ dm}^3$  of water?

A 1.1                      B 1.3                      C 2.0                      D 4.0

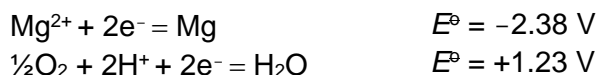
- 10 Stomach juices have a pH of 1.0.

Aspirin is a monobasic acid represented by HA ( $K_a = 10^{-4} \text{ mol dm}^{-3}$ ) which dissociates into  $H^+$  and  $A^-$  ions.

What are the relative concentrations of  $H^+$ ,  $A^-$  and HA when aspirin from a tablet enters the stomach?

A  $[H^+] > [HA] > [A^-]$                       B  $[H^+] > [A^-] > [HA]$   
 C  $[HA] > [H^+] = [A^-]$                       D  $[H^+] = [A^-] > [HA]$

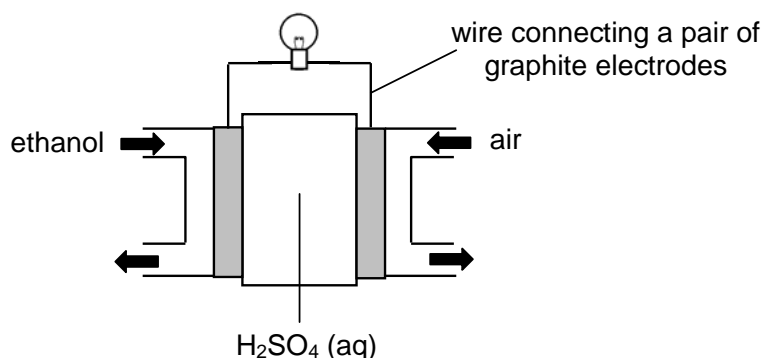
- 11 In the construction of heart 'pacemakers', a tiny magnesium electrode is used which creates an electrochemical cell with the inhaled oxygen. The relevant half-equations are as follows.



Under standard conditions, the cell e.m.f. would be 3.61 V. However, in the body, a potential of 3.25 V is more usual.

Which of the following is an explanation for this lower e.m.f. in the body?

- A the pH of about 7.4 of the body fluid surrounding the electrodes
  - B the low concentration of  $\text{Mg}^{2+}$  ions surrounding the electrodes
  - C the small size of the magnesium electrode
  - D the large amount of oxygen inhaled
- 12 Ethanol fuel cells are more practical than hydrogen fuel cells since ethanol is easier to store and transport than hydrogen. Ethanol is converted to carbon dioxide when the fuel cell is operated.



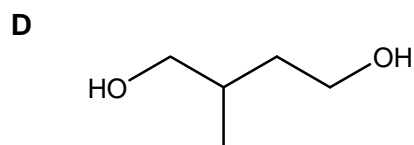
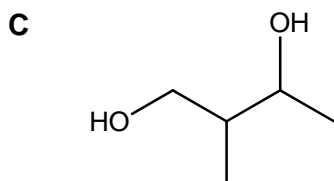
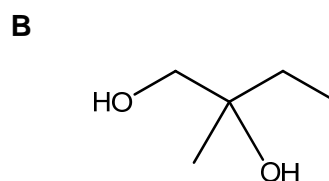
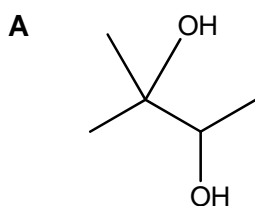
Which statement is correct about ethanol fuel cells?

- A Ethanol fuel cells can work indefinitely as long as there is a supply of ethanol and air.
- B For every 1 mol of ethanol oxidised, 6 mol of electrons are produced.
- C  $\text{H}^{+}$  ions react with air to produce water at the anode.
- D The acid needs to be replenished as hydrogen ions are being used up.

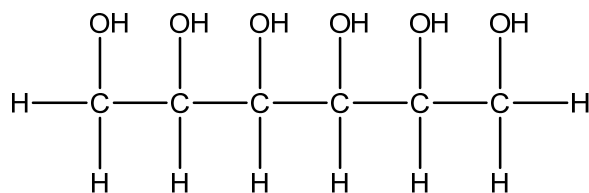
- 13 How many structural isomers of  $C_3H_4Br_2$  contain  $C=C$  and how many do not contain  $C=C$ ?

	structural isomers with $C=C$	structural isomers without $C=C$
<b>A</b>	4	0
<b>B</b>	4	2
<b>C</b>	5	0
<b>D</b>	5	2

- 14 2-methylbuta-1,3-diene,  $CH_2=C(CH_3)-CH=CH_2$ , is used as a monomer in the manufacture of synthetic rubbers. Which compound would **not** produce this monomer on treatment with excess concentrated sulfuric acid at  $170\text{ }^\circ\text{C}$ ?



- 15 Sorbitol is a naturally-occurring compound with a sweet taste. It is often used as a substitute for sucrose by the food industry.



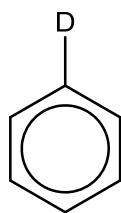
sorbitol

How many chiral centres are present in sorbitol?

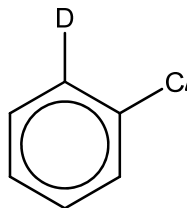
- A** 3                      **B** 4                      **C** 5                      **D** 6

- 16 Deuterium, D, is a heavy isotope of hydrogen. Deuteriobenzene is reacted with chlorine and  $AlCl_3$  under controlled condition so that only monochlorination takes place.

Assuming that the carbon-deuterium bond is broken as easily as a carbon-hydrogen bond, which proportion of the chlorinated products will be 2-chlorodeuteriobenzene?

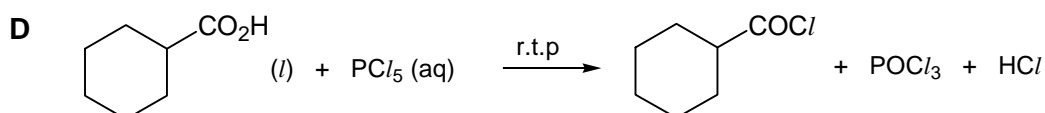
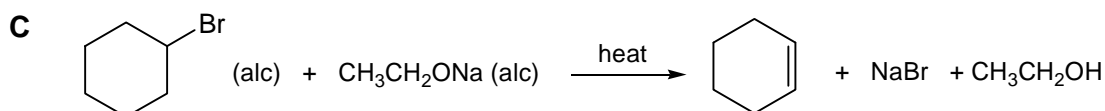
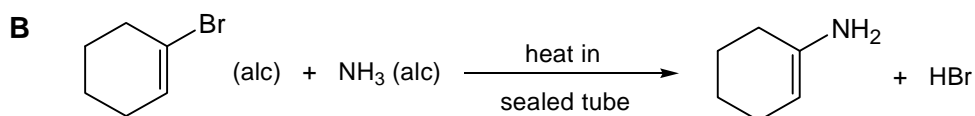
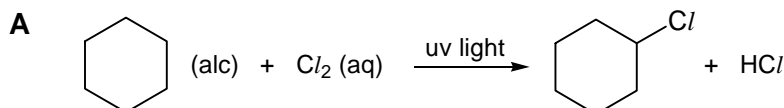


deuteriobenzene



2-chlorodeuteriobenzene

- A 16%                      B 20%                      C 33%                      D 40%
- 17 What is the correct set of reagents and conditions for the conversion of methylbenzene to 2-nitromethylbenzene?
- A dilute nitric acid, 100 °C
- B concentrated  $HNO_3$ , 30 °C
- C concentrated  $HNO_3$  and concentrated  $H_2SO_4$ , 30 °C
- D concentrated  $HNO_3$  and concentrated  $H_2SO_4$ , 100 °C
- 18 Which reaction gives the best yield of products? [(alc) indicates an alcoholic solution.]



- 19 Chlorofluorocarbons (CFCs) have been widely used in aerosol sprays, refrigerators and in making foamed plastics, but are now known to destroy ozone in the upper atmosphere.

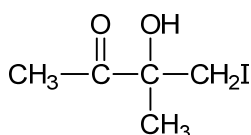
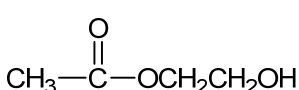
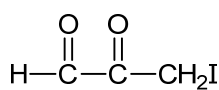
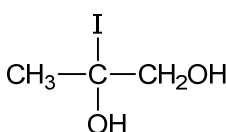
Which compound will **not** destroy ozone, and therefore can be used as a replacement for CFCs?

- A  $\text{CHBr}_3$   
 B  $\text{CCl}_3\text{CBr}_3$   
 C  $\text{CHCl}_3/\text{CF}_2$   
 D  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$

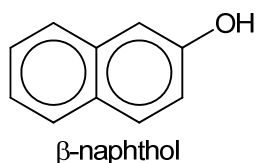
- 20 Compound **X** has the following properties.

- It changes the colour of acidified sodium dichromate(VI) from orange to green.
- It gives yellow precipitate with alkaline aqueous iodine.

Which compound could be **X**?

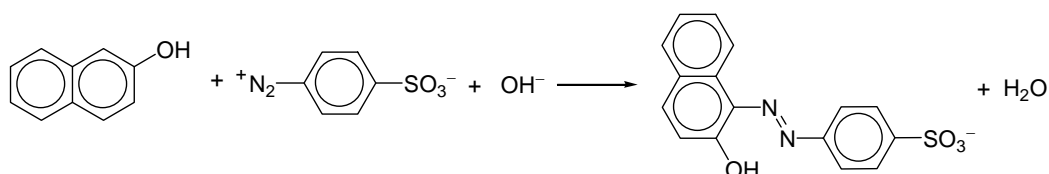
- A  B   
 C  D 

- 21  $\beta$ -naphthol is a crystalline solid that is widely used in the production of dyes.



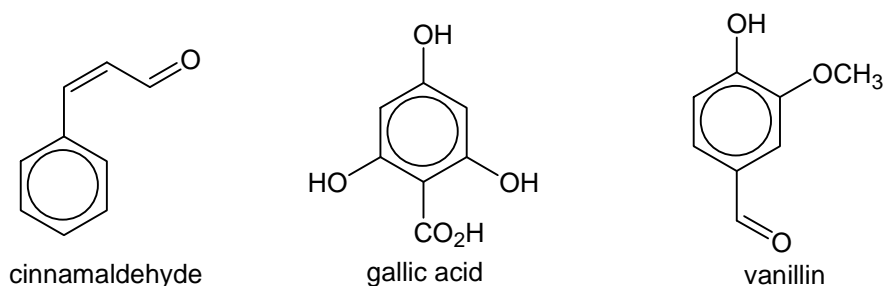
Which of the following is likely to be a property of  $\beta$ -naphthol?

- A Its  $pK_a$  is lower than that of phenol.  
 B It gives white fumes with  $\text{SOCl}_2$ .  
 C It reacts with carboxylic acid to form ester.  
 D It undergoes nucleophilic substitution in the reaction below.





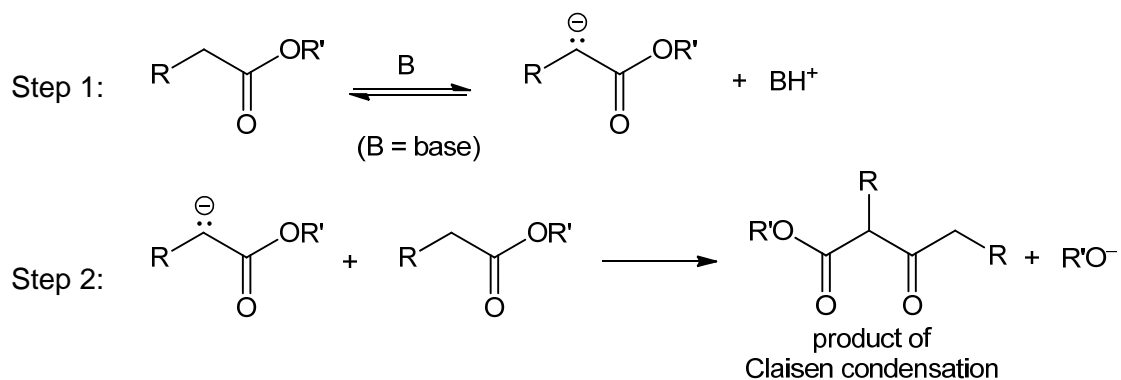
- 22 Cinnamaldehyde, gallic acid and vanillin are naturally occurring organic compounds found in plants.



The  $\text{CH}_3\text{O}$  group is inert and can be disregarded in this question.

Which set of reagents can be used to distinguish these three compounds?

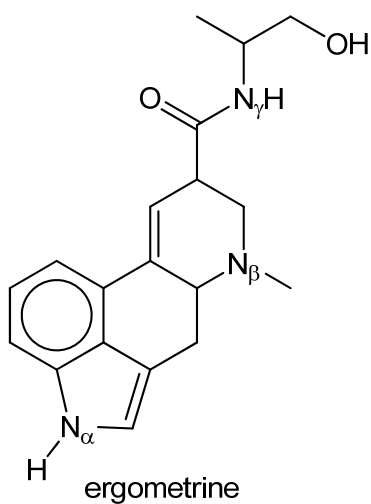
- A** Aqueous bromine and aqueous sodium hydrogencarbonate
- B** Aqueous bromine and Tollens' reagent
- C** Fehling's solution and neutral iron(III) chloride
- D** Fehling's solution and hot acidified potassium manganate(VII)
- 23 Two esters can react via Claisen condensation in the presence of a strong base. The two steps of this reaction are shown below.



Which compound will be formed when  $\text{CH}_3\text{CH}_2\text{OCOCH}_3$  undergoes Claisen condensation?

- A**  $\text{CH}_3-\text{C}(=\text{O})-\text{CH}(\text{CH}_3)-\text{O}-\text{C}(=\text{O})-\text{CH}_3$
- B**  $\text{CH}_3-\text{C}(=\text{O})-\text{CH}_2-\text{C}(=\text{O})-\text{O}-\text{CH}_2\text{CH}_3$
- C**  $\text{CH}_3\text{O}-\text{C}(=\text{O})-\text{CH}(\text{CH}_3)-\text{C}(=\text{O})-\text{CH}_2\text{CH}_3$
- D**  $\text{CH}_3-\text{C}(=\text{O})-\text{CH}_2-\text{CH}_2-\text{C}(=\text{O})-\text{OCH}_3$

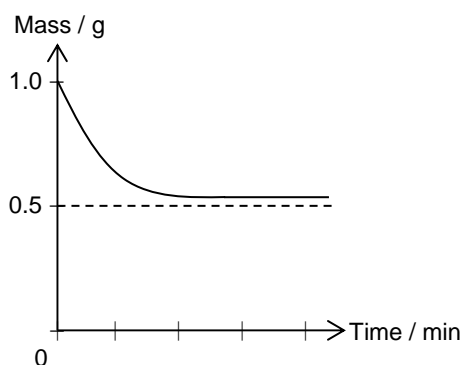
24 Ergometrine is a drug used in obstetrics to treat heavy bleeding after childbirth.



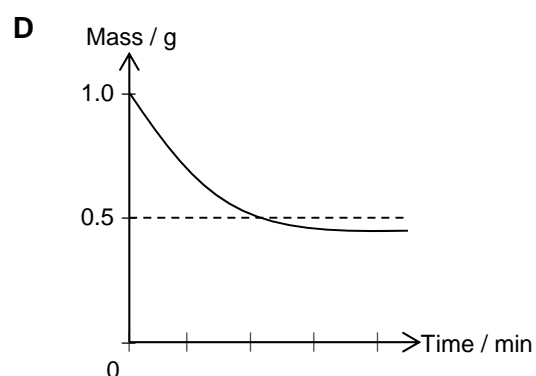
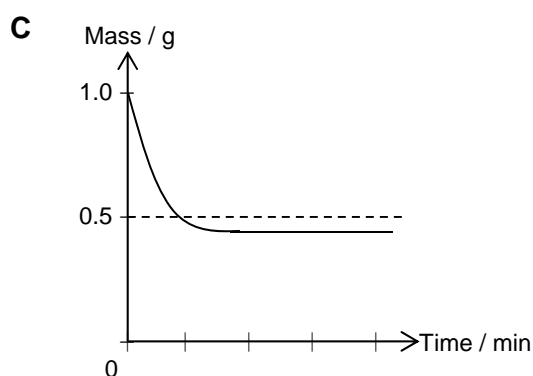
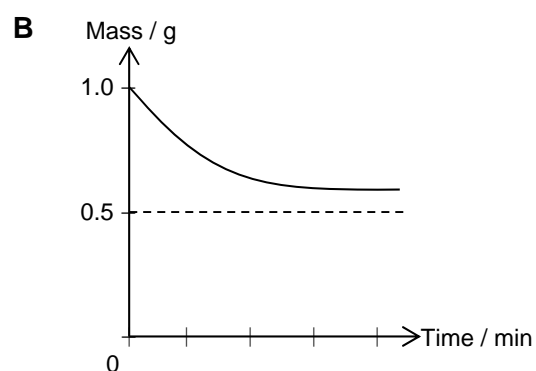
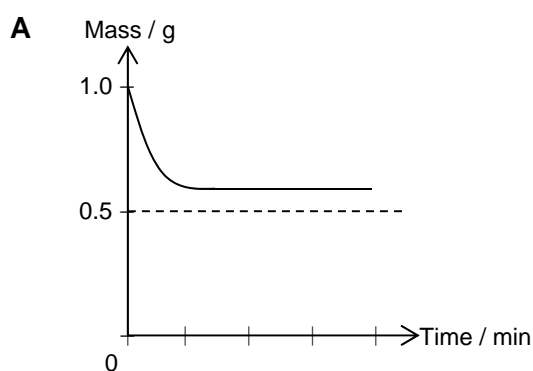
Which statement about ergometrine is correct?

- A**  $pK_b$  of the labelled three nitrogen atoms in increasing order is  $N_\beta < N_\alpha < N_\gamma$ .
- B** It reacts with both dilute NaOH and dilute HCl at room temperature.
- C** It forms orange precipitate with 2,4-dinitrophenylhydrazine.
- D** One mole of ergometrine reacts with 3 moles of  $\text{CH}_3\text{COCl}$ .

- 25 The graph represents the change in mass that occurs when 1.0 g of powdered calcium carbonate,  $\text{CaCO}_3$ , is heated at a temperature,  $T$ .



Which graph would be obtained by heating 1.0 g of powdered magnesium carbonate,  $\text{MgCO}_3$ , at the same temperature,  $T$ ?



- 26 What chlorine-containing products are formed when chlorine is bubbled into hot aqueous sodium hydroxide?
- A**  $\text{NaClO}$  only
- B**  $\text{NaClO}_3$  only
- C**  $\text{NaCl}$  and  $\text{NaClO}$
- D**  $\text{NaCl}$  and  $\text{NaClO}_3$

27 Which statement concerning the Period 3 elements, sodium to chlorine, is correct?

- A Chlorine has the largest anion.
- B Aluminium has the highest melting point.
- C Chlorine exhibits the most number of different oxidation states.
- D Phosphorus reacts most vigorously with water.

28 Element **X** is one of the first five elements in Period 3 of the Periodic Table. The following four statements were made about the properties of element **X** or its compounds.

Three statements are correct descriptions and one is false.

Which statement does **not** fit with the other three?

- A The oxide of **X** dissolves in excess dilute NaOH(aq).
- B **X** exhibits only one possible oxidation number in its chloride, which is not a solid at room temperature.
- C The oxide of **X** has a very high melting point.
- D The chloride of **X** reacts with water to give an acidic solution with pH 1.

29 Which property of the first row transition elements does **not** remain relatively constant?

- |                           |                               |
|---------------------------|-------------------------------|
| A atomic radius           | B melting point               |
| C first ionisation energy | D ionic radius of the +2 ions |

30 Aqueous platinum(IV) chloride reacts with ammonia to form compounds in which the coordination number of platinum is 6. When dissolved in water, 1 mol of such compound gave 3 mol of ions.

What is the formula of this compound?

- |   |   |
|---|---|
| A $\text{Pt}(\text{NH}_3)_2\text{Cl}_4$ | B $\text{Pt}(\text{NH}_3)_3\text{Cl}_4$ |
| C $\text{Pt}(\text{NH}_3)_4\text{Cl}_4$ | D $\text{Pt}(\text{NH}_3)_6\text{Cl}_4$ |

## 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 that you consider to be correct).

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

<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
<b>1, 2 and 3</b> are correct	<b>1 and 2</b> only are correct	<b>2 and 3</b> only are correct	<b>1</b> only is correct

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

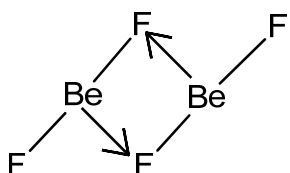
**31** Which statements about one mole of a metal are always correct?

- 1** It contains the same number of atoms as one mole of hydrogen atoms.
- 2** It contains the same number of atoms as that in 12 grams of  $^{12}\text{C}$ .
- 3** It is liberated by one mole of electrons.

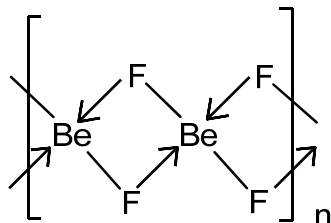
**32** Beryllium is the first member of Group II and forms covalent compounds which are said to be electron deficient. In many ways, beryllium resembles aluminium.

Which of the following are possible?

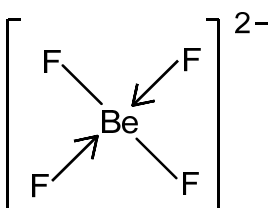
**1**



**2**



**3**



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

<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
<b>1, 2 and 3 are correct</b>	<b>1 and 2 only are correct</b>	<b>2 and 3 only are correct</b>	<b>1 only is correct</b>

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

- 33** When  $25.0 \text{ cm}^3$  of a  $0.100 \text{ mol dm}^{-3}$  strong monobasic acid was titrated against  $0.200 \text{ mol dm}^{-3}$  of a weak base **X**,  $12.50 \text{ cm}^3$  of the base was required to completely neutralise the acid.

Which statement is correct for this experiment?

- 1** Bromocresol green ( $pK_{\text{in}} = 4.7$ ) is a suitable indicator for this titration.
- 2** 1 mole of **X** reacts with 1 mole of the monobasic acid.
- 3** A solution of maximum buffering capacity was formed when  $6.25 \text{ cm}^3$  of the base was added.

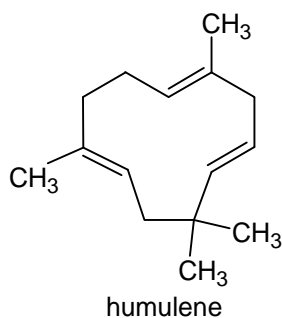
- 34** *The use of the Data Booklet is relevant to this question.*

Electrolysis of a solution of  $\text{M}^{n+}(\text{aq})$  led to the deposition of **M** atoms at the cathode.  $5.00 \times 10^{-3} \text{ mol}$  of **M** is deposited when 965 C of electricity are passed through the solution.

What could  $\text{M}^{n+}$  be?

- 1**  $\text{Sn}^{2+}$
- 2**  $\text{Cr}^{2+}$
- 3**  $\text{Ag}^+$

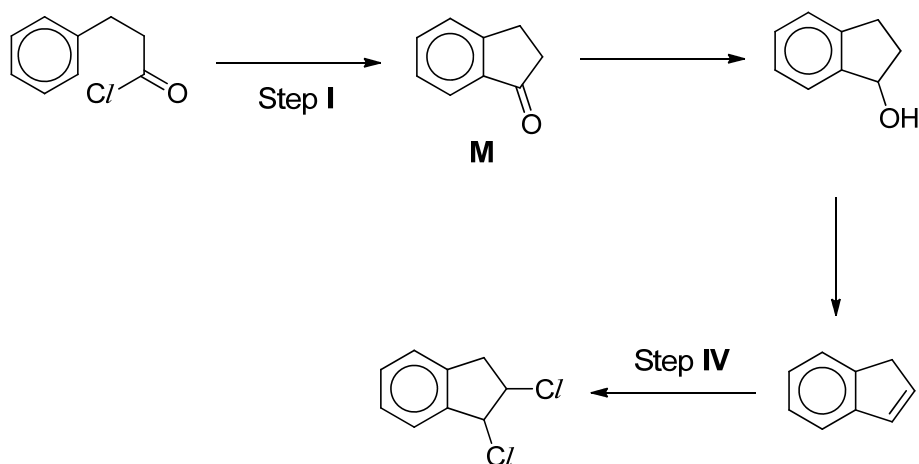
35 Humulene can be extracted from carnation flowers.



Which products are obtained from the reaction of humulene with hot acidified concentrated  $\text{KMnO}_4$ ?

- 1  $\text{CH}_3\text{COCH}_2\text{CH}_2\text{CO}_2\text{H}$
- 2  $\text{CH}_3\text{COCH}_2\text{CO}_2\text{H}$
- 3  $\text{HO}_2\text{CCH}_2\text{C}(\text{CH}_3)_2\text{CO}_2\text{H}$

36 Consider the following reaction scheme.



Which of the following statements about this reaction scheme are correct?

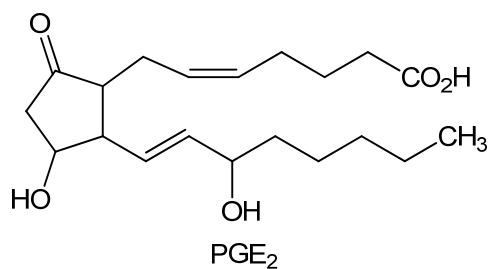
- 1 Step I requires a catalyst.
- 2 Compound **M** is a planar molecule.
- 3 Step IV is a substitution reaction.

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

<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
<b>1, 2 and 3</b> are correct	<b>1 and 2</b> only are correct	<b>2 and 3</b> only are correct	<b>1</b> only is correct

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

**37** PGE<sub>2</sub> is a prostaglandin that has pharmacological activity.

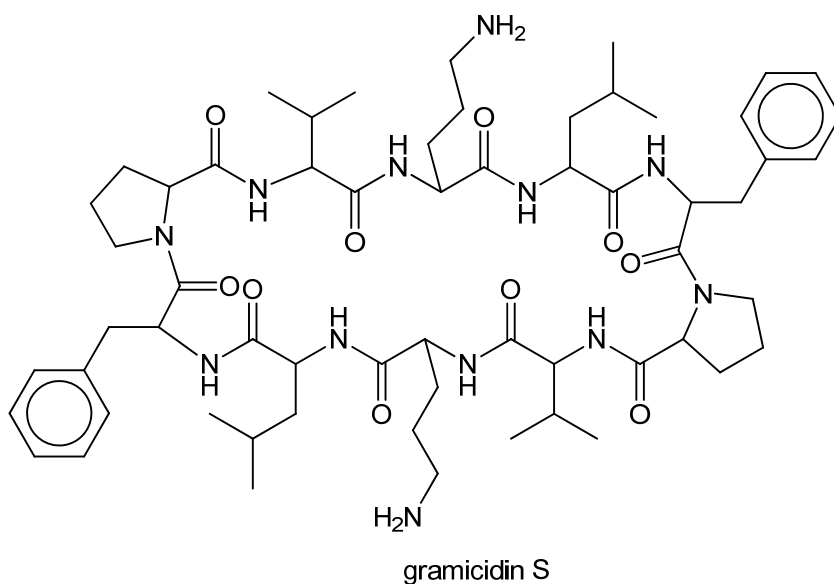


What is the correct number of hydrogen atoms incorporated per molecule of PGE<sub>2</sub> when PGE<sub>2</sub> is reacted with each of the following reducing agents?

	Reducing agent	Number of hydrogen atoms incorporated per molecule of PGE <sub>2</sub>
<b>1</b>	H <sub>2</sub> / Ni	6
<b>2</b>	LiAlH <sub>4</sub> in dry ether	4
<b>3</b>	NaBH <sub>4</sub> in ethanol	4



- 38 The cyclic peptide gramicidin S can act as an antibiotic.



Which statements about gramicidin S are correct?

- 1 It is made up of 5 different amino acids.
  - 2 1 mole of gramicidin S reacts with 10 moles of hot dilute HCl.
  - 3 Its three-dimensional structure can be stabilised by ionic interaction.
- 39 Which of the following are trends across Period 3 of the Periodic Table?
- 1 The electronegativity of the elements increases.
  - 2 The oxides of the elements change from ionic to covalent.
  - 3 The electrical conductivity of the elements decreases.
- 40 Prussian blue,  $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$ , is a dark blue pigment often used in painting and dyeing.

It can be synthesised in the laboratory by mixing iron(III) chloride,  $\text{FeCl}_3$ , with potassium ferrocyanide,  $\text{K}_4[\text{Fe}(\text{CN})_6]$ .

Based on the information given above, which conclusions can be made about Prussian blue?

- 1 The percentage by mass of iron in Prussian blue is 45.5%.
- 2 A redox reaction has taken place in the formation of Prussian blue.
- 3 Prussian blue absorbs blue light strongly.

**The End**