ANDERSON JUNIOR COLLEGE

Preliminary Examinations 2012

CHEMISTRY **9647/01**

Higher 2 **19 September 2012**

Paper 1 Multiple Choice **1 hour**

Additional Materials: Multiple Choice Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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 Multiple Choice Answer Sheet.

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.

Multiple Choice Answer Sheet

Write your name, PDG and NRIC/FIN number, including the reference letter.

Shade the NRIC / FIN number.

Exam Title: JC 2 Prelim

Exam Details: H2 Chem / Paper 1

Date: 19/09/2012

This document consists of **17** printed pages.

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 first stage in the manufacture of nitric acid is the oxidation of ammonia by oxygen.

$$\boldsymbol{a}NH_3(g) + \boldsymbol{b}O_2(g) \longrightarrow \boldsymbol{c}NO(g) + \boldsymbol{d}H_2O(g)$$

What are the values for ***a***, ***b***, ***c*** and ***d***?

	a	***b***	***c***	***d***
A	4	5	4	6
B	4	6	4	5
C	5	6	5	4
D	6	5	6	4

2 The nickel–cadmium rechargeable battery is based on the following overall reaction.

$$Cd + 2NiOOH + 4H_2O \longrightarrow Cd(OH)_2 + 2Ni(OH)_2.H_2O$$

What is the oxidation number of nickel at the beginning and at the end of the reaction?

	Beginning	End
A	+1.5	+2
B	+2	+3
C	+3	+2
D	+3	+4

3 Which element has an equal number of paired and unpaired electrons in its orbitals with principal quantum number 2?

A Beryllium

B Carbon

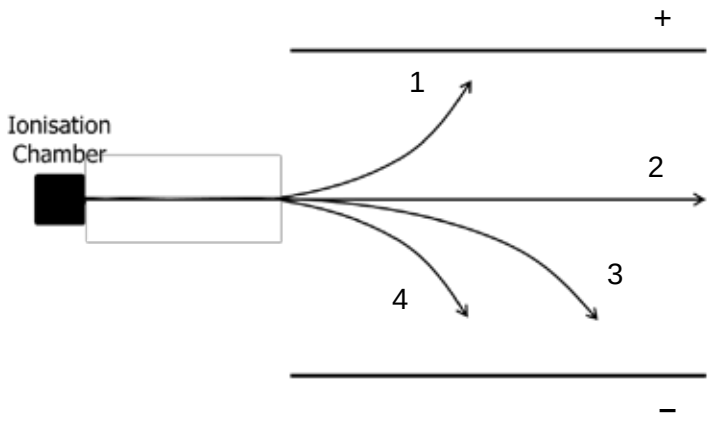
C Nitrogen

D Oxygen

4 Americium–241 is commonly used in smoke detectors. It works by emitting a constant stream of alpha particles which are similar to the nucleus of ^4He.

Strontium–90 is another radioactive substance which can be used as a tracer for medicinal or agriculture uses. On decaying, it emits beta particles which can be considered as electrons.

A small amount of Americium–241 and Strontium–90 are separately placed in an ionisation chamber to emit a constant stream of radiation and the emitted particles are passed through an electric field.



What would be the path of the emitted particles in an electric field?

	Americium–241 (a–particles)	Strontium–90 (b–particles)
A	1	2
B	1	3
C	4	1
D	3	1

5 Which of the following is **not** a feature in the corresponding ion?

	Ion	Feature
A	HF_2^-	Hydrogen bond
B	NO_2^-	Unpaired electron
C	CO_3^{2-}	Delocalised electrons
D	$C_6H_5O^-$	All bond angles are 120°

6 Two gas bulbs, **E** and **F**, are connected by a stopcock. Bulb **E** contains argon and bulb **F** contains oxygen gas. The pressure and volume of gas in each bulb at 25 °C is shown below.

	Bulb **E**	Bulb **F**
Volume / dm^3	v	7v
Pressure / kPa	p	5p

The stopcock is then opened and the gases were allowed to mix at 25 °C. Subsequently, the temperature of the mixture is raised and the final pressure is found to be 9p.

What is the temperature of the gases in the mixture that gives a pressure of 9p?

A 50 °C **B** 596 °C **C** 50 K **D** 596 K

7 Solutions of hydrogencarbonates can react with acids as follows.

$HCO_3^-(aq) + H^+(aq) \longrightarrow H_2O(l) + CO_2(g)$ $\Delta H^\ominus = +12.7$ kJ mol^{-1}

Given the following enthalpy changes:

species	ΔH_f^q / kJ mol^{-1}
$H_2O(l)$	–285.8
$CO_2(g)$	–393.5
$HCO_3^-(aq)$	–692.0

What is the standard enthalpy change of formation of $H^+(aq)$?

A –25.4 kJ mol^{-1} **B** 0.0 kJ mol^{-1} **C** +25.4 kJ mol^{-1} **D** +1384 kJ mol^{-1}

8 The Gibbs free energy change of a system determines whether a reaction is spontaneous, while the equilibrium constant indicates the extent of reaction.

What does the following pair of values for a reaction system indicate?

	values
ΔG_f^q	–50.8
K_c	5.80×10^8

A No reaction

B Position of equilibrium lies to the left

C Some extent of reaction

D Reaction goes to completion

9 The electrolysis of a highly concentrated aqueous solution of potassium hydroxide was carried out using an iron anode and a platinum cathode. After a current was passed through the cell for some time, 360 cm^3 of gas was collected at the cathode (measured at r.t.p.) while there was a loss of mass of 0.279 g at the anode.

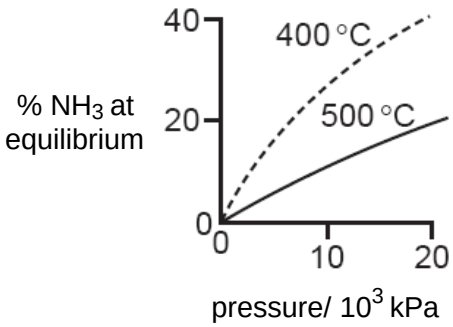
Which of the following ions is a likely product at the anode?

A Fe^{2+} **B** Fe^{3+} **C** FeO_4^{4-} **D** FeO_4^{2-}

10 The percentage of ammonia obtainable, if equilibrium was established during the Haber process, is plotted against the operating pressure for two temperatures, 400 °C and 500 °C.

Which diagram correctly represents the two graphs?

A



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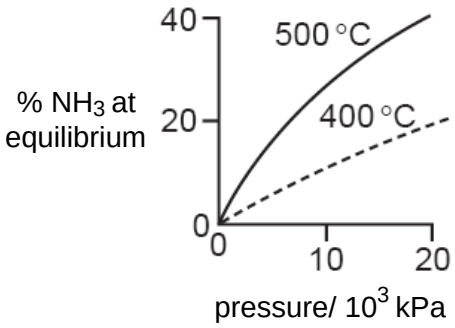

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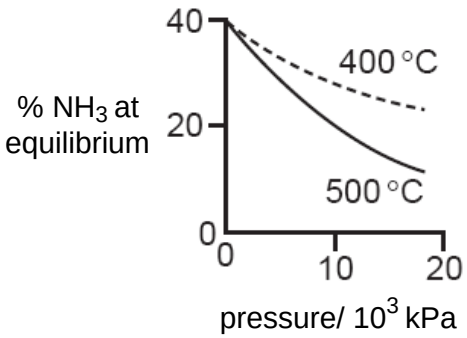

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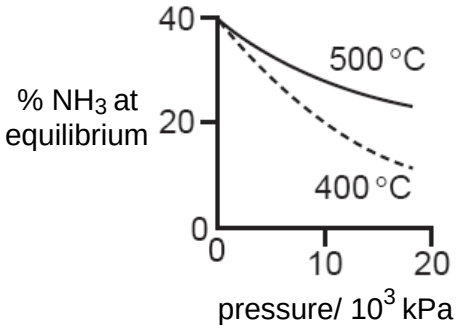


11 Water dissociates into H^+ and OH^- as shown.

$$H_2O \rightleftharpoons H^+ + OH^-$$

At 25 °C, the equilibrium $[H^+]$ is 10^{-7} mol dm^{-3}; $[H_2O]$ = 55.6 mol dm^{-3}.

What is the order of increasing numerical value of pH, pK_a and pK_w for this equilibrium at this temperature?

	smallest		*largest*
A	pH	pK_w	pK_a
B	pH	pK_a	pK_w
C	pK_w	pK_a	pH
D	pK_a	pK_w	pH

12 Bromocresol green is an acid–base indicator with a pH range of 3.8 to 5.4. The acidic colour of the indicator is yellow and the alkaline colour is blue.

Two drops of the indicator are added to each of the four aqueous solutions listed below.

Which solution has its colour **not** correctly stated?

A	Aqueous solution of $MgCl_2$	blue
B	Equal proportions of sodium ethanoate and ethanoic acid [pK_a of ethanoic acid = 4.7]	green
C	Dilute HCl of concentration 3.0 x 10^{-5} mol dm^{-3}	yellow
D	Aluminium oxide in aqueous solution	blue

13 Lead is the final product formed by a series of changes in which the rate–determining step is the radioactive decay of uranium–238. The radioactive decay is a first order reaction with a half–life of 4.5 x 10^9 years.

What would be the age of a rock sample, originally lead–free, in which the molar proportion of uranium to lead is now 1:3?

A 2.25 x 10^9 years

B 4.5 x 10^9 years

C 9.0 x 10^9 years

D 13.5 x 10^9 years

14 $Na_2S_2O_3$ reacts with dilute HC*l* to give a pale yellow precipitate. If 1 cm^3 of 0.1 mol dm^{-3} HC*l* is added to 10 cm^3 of 0.02 mol dm^{-3} $Na_2S_2O_3$ the precipitate forms slowly. If the experiment is repeated with 1 cm^3 of 0.1 mol dm^{-3} HC*l* and 10 cm^3 of 0.05 mol dm^{-3} $Na_2S_2O_3$ the precipitate forms more quickly.

Which of the following helps to explain this observation?

A The activation energy of the reaction is lower when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.

B The reaction proceeds by a different pathway when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.

C The collisions between reactant particles are more violent when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.

D The reactant particles collide more frequently when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.

15 Consecutive elements **G**, **H** and **I** are in the third period of the Periodic Table. Element **H** has the highest first ionisation energy and the lowest melting point.

What could be the identities of **G**, **H** and **I**?

A Aluminium, silicon, phosphorus

B Magnesium, aluminium, silicon

C Silicon, phosphorus, sulfur

D Sodium, magnesium, aluminium

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

A 5.00 g sample of an anhydrous Group II metal nitrate loses 3.29 g in mass when heated strongly.

Which metal is present?

A Magnesium

B Calcium

C Strontium

D Barium

17 Which suggestion concerning the element astatine (proton number 85) is consistent with its position in Group VII?

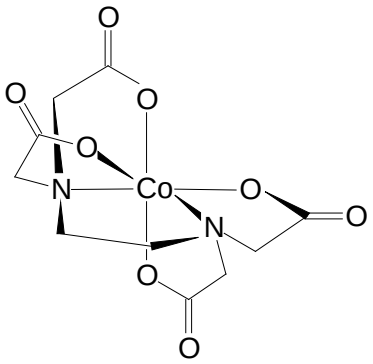
A The element is a solid at room temperature and pressure.

B Hydrogen astatide is more stable to heat than hydrogen iodide.

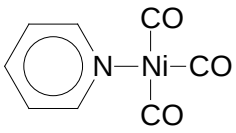
C Silver astatide is soluble in aqueous ammonia.

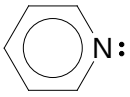
D Hydrogen astatide is a weak acid.

18 The structures of two complexes are as shown.



[Co(edta)] $^-$



$[Ni(CO)_3(py)]$ where py = 

Which of the following statements is **correct**?

A Both complexes contain two different ligands.

B Co in the complex has four unpaired d–electrons.

C The oxidation number of Co in the complex is +2.

D The electronic configuration of nickel in the complex is [Ar] $3d^7$.

19 Platinum(IV) chloride combines with ammonia to form compounds in which the coordination number of platinum is 6. A formula unit of one of the compounds contains a cation and only one chloride ion.

What is the formula of this compound?

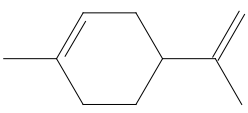
A $Pt(NH_3)_6Cl_4$

B $Pt(NH_3)_5Cl_4$

C $Pt(NH_3)_4Cl_4$

D $Pt(NH_3)_3Cl_4$

20 Limonene occurs in oil of lemons and is used to flavour some citrus drinks. The structure of limonene is shown below.



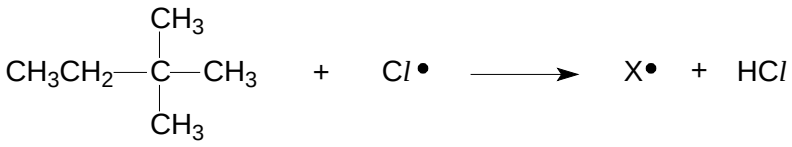
limonene

How many optical isomers will be formed when limonene is reacted with cold acidified potassium manganate(VII)?

A 2 **B** 4 **C** 16 **D** 32

21 When heated with chlorine, 2,2–dimethylbutane undergoes free radical substitution.

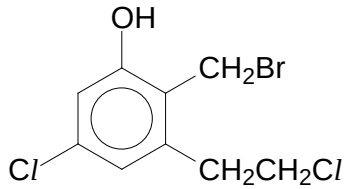
In a propagation step, the free radical X• is formed.



How many different forms of X• are possible?

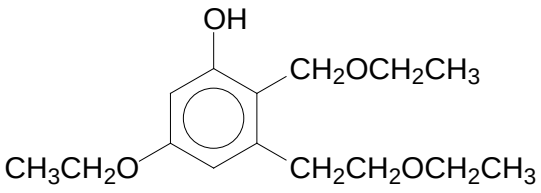
A 1 **B** 2 **C** 3 **D** 4

22 A compound has the following structure.



Which of the following is obtained when alcoholic sodium ethoxide is added to this compound?

A



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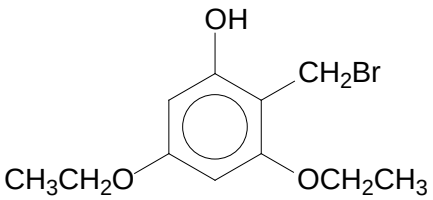

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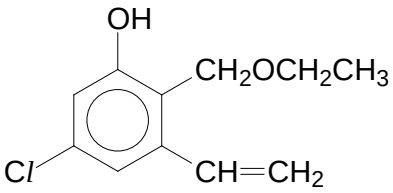

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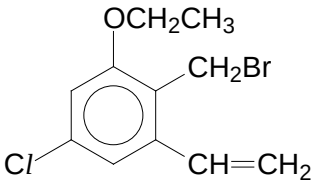


23 *Use of the Data Booklet is relevant to this question.*

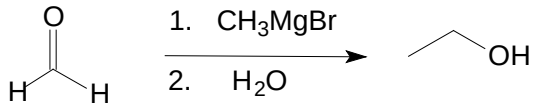
2.76 g of ethanol were mixed with an excess of aqueous acidified potassium dichromate(VI). The reaction mixture was then boiled under reflux for one hour. The organic product was then collected by distillation.

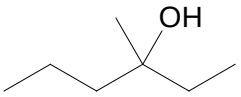
The yield of product was 75.0 %.

What mass of product was collected?

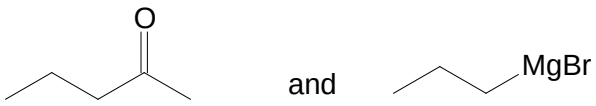
A 1.98 g **B** 2.07 g **C** 2.70 g **D** 4.80 g

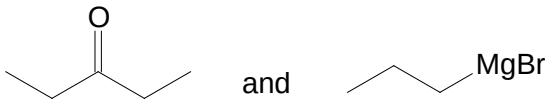
24 The 'Grignard Reaction' is the addition of an organomagnesium halide, R–MgX (Grignard reagent) to a carbonyl compound to form an alcohol. For example, the reaction with methanal leads to the formation of a primary alcohol as shown.

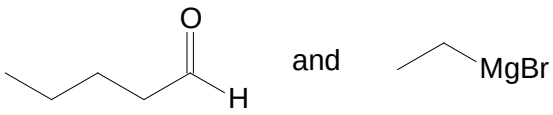


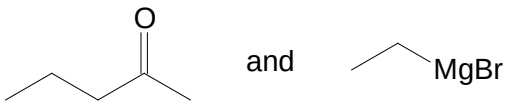
Which of the following pairs of reagents could be used to produce 

?

A 

B 

C 

D 

25 Which of the following, in aqueous solutions of equal concentration, is arranged in order of **decreasing** pH value?

A CH_3CH_2OH, C_6H_5OH, CH_3CO_2H, $ClCH_2CO_2H$, CH_3COCl

B CH_3CH_2OH, C_6H_5OH, $ClCH_2CO_2H$, CH_3CO_2H, CH_3COCl

C CH_3COCl, $ClCH_2CO_2H$, CH_3CO_2H, C_6H_5OH, CH_3CH_2OH

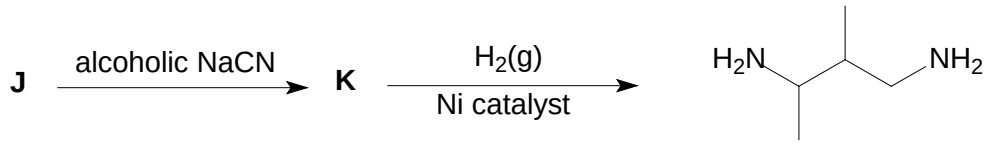
D CH_3COCl, CH_3CH_2OH, C_6H_5OH, CH_3CO_2H, $ClCH_2CO_2H$

26 Two isomers, **L** and **M**, $C_6H_{12}O$, react with alkaline aqueous iodine to form a yellow precipitate. However, unlike **L**, **M** can also react with both PCl_5 and ethanoyl chloride. **M** undergoes oxidation to form two compounds, both of which also form a yellow precipitate with alkaline aqueous iodine.

Which combination could **L** and **M** be?

	L	**M**
A	$(CH_3)_2CHCOCH_2CH_3$	$CH_3CH{=}CHC(OH)(CH_3)_2$
B	$CH_3COCH(CH_3)CH_2CH_3$	$CH_3CH{=}C(CH_3)CH(OH)CH_3$
C	$CH_3COCH_2CH(CH_3)_2$	$(CH_3)_2C{=}CHCH(OH)CH_3$
D	$(CH_3)_2CHCOCH_2CH_3$	$(CH_3)_2C{=}C(CH_3)CH_2OH$

27 The reaction scheme below outlines the production of 3–amino–2–methylbutylamine from compound **J**.



3-amino-2-methylbutylamine

Which compound could **J** be?

A $(CH_3)_2C(Br)CHBrCH_3$

B $CH_3CH(Br)CHBrCH_3$

C $CH_3CH(NH_2)C(CH_3)_2Br$

D $CH_3CH(NH_2)CHBrCH_3$

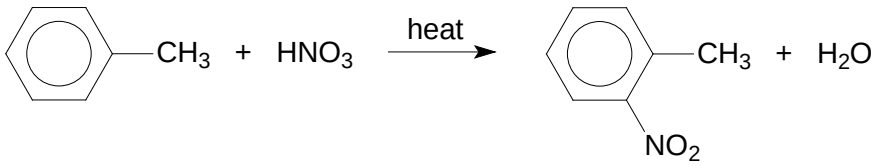
28 The reaction conditions for four different transformations are given below.

Which transformation has a set of conditions that is **not** correct?

A $CF_3CH_2Cl + Br_2 \xrightarrow{\text{uv light}} CF_3CHBrCl + HBr$

B $CH_2{=}CHCH{=}CH_2 + 11[O] \xrightarrow[\text{heat}]{KMnO_4,\ H^+} 4CO_2 + 3H_2O$

C



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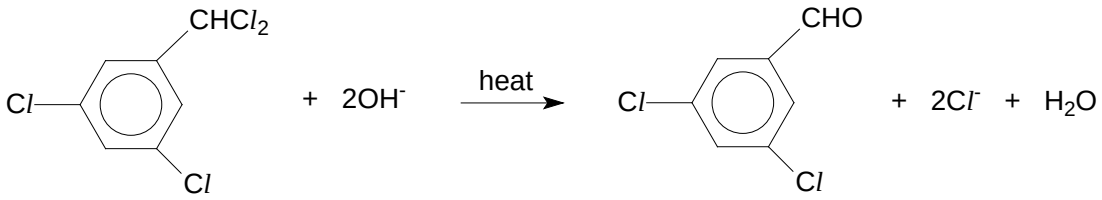
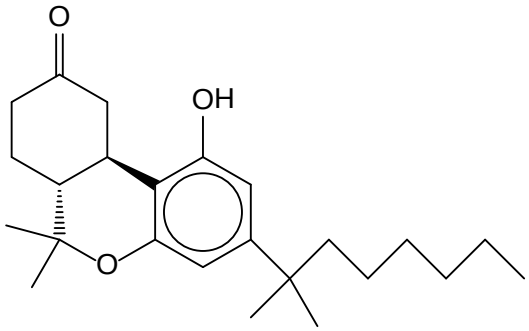
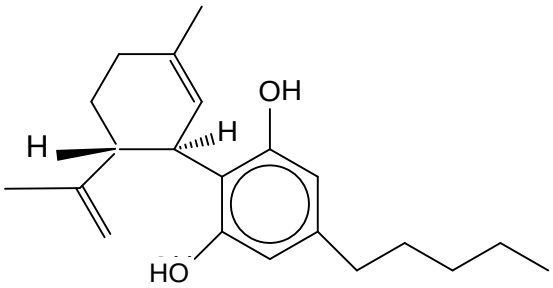


29 Cannabinoids are active chemicals in the Cannabis plant that cause drug–like effects throughout the body including the central nervous system and the immune system.

Nabilone, a synthetic cannabinoid, has therapeutic use as adjunct analgesic for neuropathic pain while *Cannabidiol*, a naturally occurring cannabinoid in the plant, is effective as a typical antipsychotics in treating schizophrenia.



Nabilone



Cannabidiol

Which reagent would **not** react with **either** of these two cannabinoids?

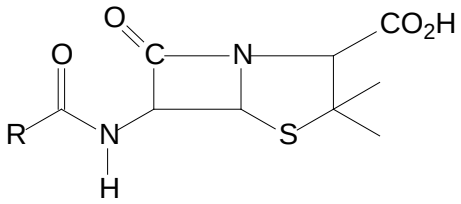
A An aqueous solution of ammoniacal silver nitrate

B Alkaline potassium manganate(VII) solution

C 2,4-dinitrophenylhydrazine

D Aqueous bromine

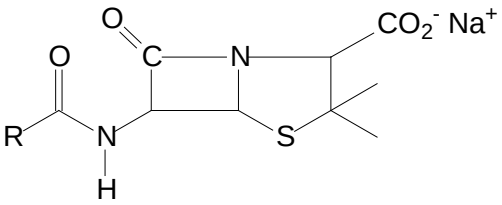
30 Penicillin is widely used to kill bacteria. The general structure of a penicillin molecule is given below.



R = an aryl group

What is produced when penicillin is boiled with excess aqueous sodium hydroxide?

A



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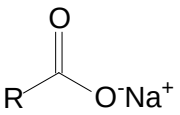

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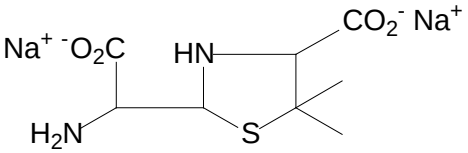

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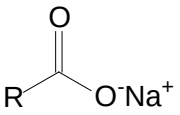
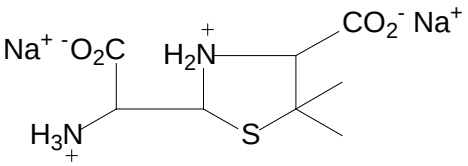
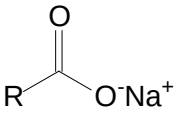


and



D



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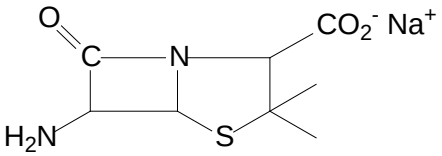


Section B

For each of the question 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

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 Sodium hydrogensulfide, NaSH, is used to remove hair from animal hides.

Which statements about the SH^- ion are correct?

1 It contains 18 electrons.

2 3 lone pairs of electrons surround the sulfur atom.

3 Sulfur has an oxidation state of +2.

32 Which physical properties are due to hydrogen bonding between molecules?

1 Water has a higher boiling point than H_2S.

2 Ice floats on water.

3 The H–O–H bond angle in water is approximately 104°.

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

An electrochemical cell is set up using a $Fe^{2+}(aq)|Fe(s)$ half–cell and a $VO_2^+(aq),VO^{2+}(aq)|Pt(s)$ half–cell.

Which of the following gives a correct effect on the $E^{\ominus}_{cell}$ and a correct explanation for the effect when each of the changes is made to the cell separately?

	Change	Effect on $E^{\ominus}_{cell}$	Explanation
1	Add KCN(aq) to the $Fe^{2+}(aq)|Fe(s)$ half–cell	Increases	Concentration of $Fe^{2+}(aq)$ decreases
2	Add water to the $VO_2^+(aq),VO^{2+}(aq)|Pt(s)$ half–cell	Decreases	Concentration of water increases
3	Increase temperature of the $Fe^{2+}(aq)|Fe(s)$ half–cell	No change	Temperature change does not affect $E^{\ominus}$

34 Which of the following processes will result in an increase in entropy?

1 The sublimation of solid carbon dioxide.

2 The decomposition of dinitrogen tetraoxide.

3 The formation of calcium carbonate from calcium oxide and carbon dioxide.

35 **X**, **Y** and **Z** are elements in the same period of the Periodic Table. The oxide of **X** is amphoteric, the oxide of **Y** is basic and the oxide of **Z** is acidic.

What is the correct order of trend for these elements?

1 Proton number: **Y** < **X** < **Z**

2 Atomic radius: **Z** < **X** < **Y**

3 Melting point: **X** < **Z** < **Y**

36 A student observed the reactions when sodium chloride and sodium iodide were each reacted separately with concentrated sulfuric acid and concentrated phosphoric acid. The observations were recorded in the table.

	Sodium chloride	*Sodium iodide*
conc. H_2SO_4	steamy fumes formed	purple fumes formed
conc. H_3PO_4	steamy fumes formed	steamy fumes formed

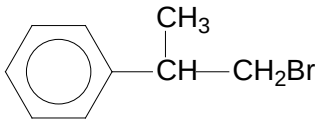
Which of the following deductions can be made from these observations?

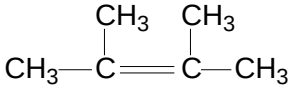
1 Concentrated sulfuric acid is a stronger oxidising agent than iodine.

2 Concentrated sulfuric acid is a weaker oxidising agent than chlorine.

3 Concentrated phosphoric acid is a stronger oxidising agent than concentrated sulfuric acid.

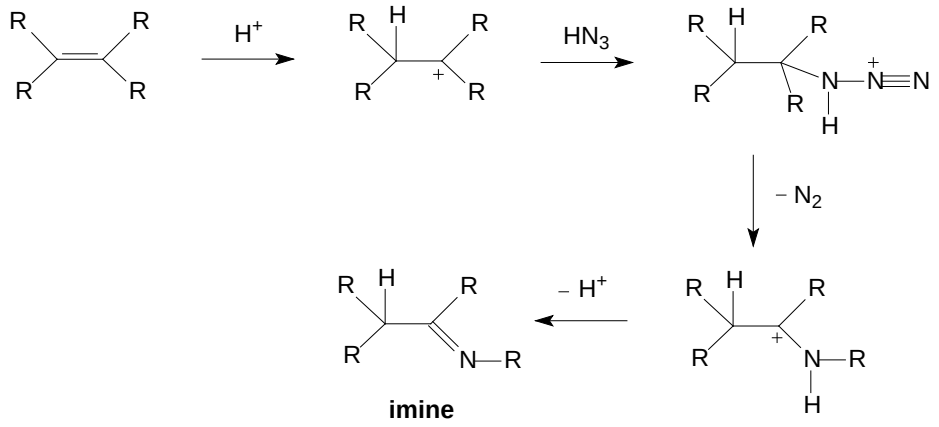
37 Which of the following reactions will form a product that rotates plane–polarised light?

1  heated under reflux with aqueous KOH

2  with cold alkaline $KMnO_4$(aq)

3 CH_3COCH_3 with HCN in trace amounts of a base at 10 ^oC.

38 The following route shows the acid–catalysed reaction of an alkene with hydrogen azide, HN_3, to form an imine.



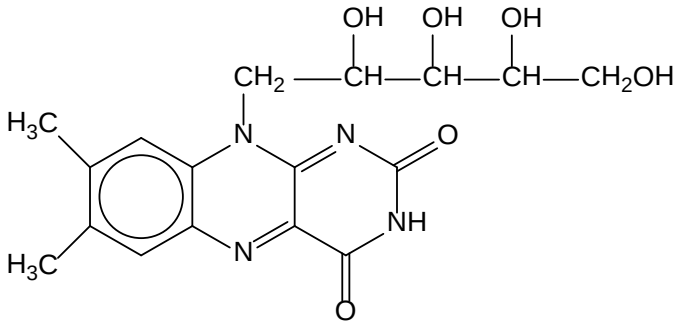
Which of the following types of reaction occur in the synthesis of imine?

1 Elimination

2 Electrophilic addition

3 Nucleophilic substitution

39 Milk, red meat, liver and egg white are sources of Vitamin B_2.



Vitamin B_2

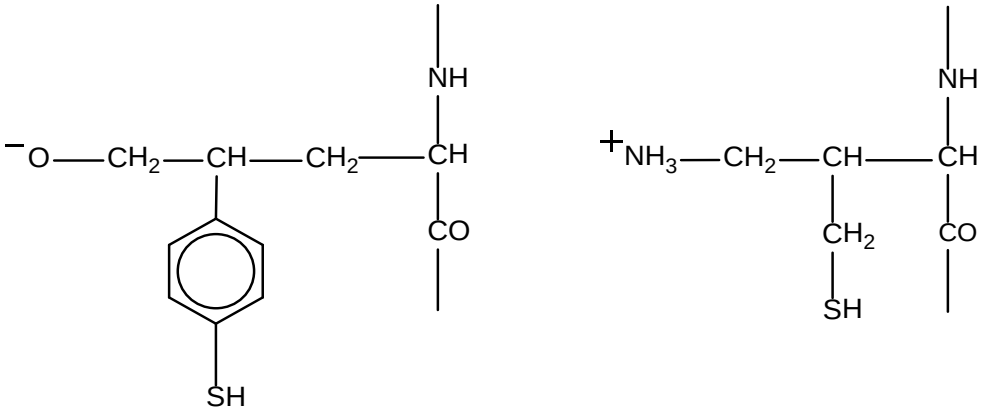
Which of the following statements about Vitamin B_2 are **incorrect**?

1 It is soluble in water.

2 1 mol of Vitamin B_2 reacts with excess metallic sodium to produce 4 mol of hydrogen gas.

3 A yellow precipitate is formed when acidified 2,4–DNPH is added to Vitamin B_2.

40 The diagram below shows two segments of a protein molecule.



Which of the following, when added to the protein, will cause the interactions which exist between the two segments to be broken?

1 hot water

2 0.100 mol dm^{-3} sodium hydroxide

3 0.100 mol dm^{-3} lead(II) nitrate