

CANDIDATE NAME	CT GROUP	11S
CENTRE NUMBER	INDEX NUMBER	
CHEMISTRY		9647/01
Paper 1 Multiple Choice		21 September 2012
		1 hour
Additional Materials: Multiple Choice Answer Sheet		

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Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

1.	Enter your NAME (as in NRIC).	← Write your name
2.	Enter the SUBJECT TITLE.	
3.	Enter the PAPER NUMBER.	Write your CT group
4.	Enter your CT GROUP.	
5.	Date.	NRIC / FIN
6. 7.	Enter your NRIC NUMBER or FIN NUMBER.	Write <u>and</u> Shade your NRIC or FIN number

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.

Section A

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

1 When iron is reacted with aqueous iron(III) ions, iron(II) ions are formed.

Assuming the reaction goes to completion, how many moles of Fe and of $Fe^{3+}(aq)$ would result in a mixture containing twice the number of moles of $Fe^{2+}(aq)$ compared to $Fe^{3+}(aq)$ once the reaction had taken place?

	moles of Fe	moles of Fe ³⁺ (aq)
Α	2	4
В	2	5
С	2	6
D	2	7

2 45 cm³ of 0.8 mol dm⁻³ of potassium iodide and 30 cm³ of 0.5 mol dm⁻³ of lead(II) nitrate were mixed together. The equation for the reaction that occurs is as shown.

$$2KI(aq) + Pb(NO_3)_2(aq) \rightarrow PbI_2(s) + 2KNO_3(aq)$$

What will be the approximate concentration of the iodide ions in the solution after the reaction has completed?

Α	0.006 mol dm ⁻³	С	0.133 mol dm ⁻³
в	0.080 mol dm ⁻³	D	0.280 mol dm ⁻³

³ Alpharadin®, containing the radioactive isotope $\frac{223}{88}$ Ra, is currently under clinical evaluation for the treatment of cancer. $\frac{223}{88}$ Ra decays to give only an element **X** and a high energy α -particle ($\frac{4}{2}$ He); the latter targets the cancer cells.

$$^{223}_{88}$$
Ra \rightarrow X + $^{4}_{2}$ He

Which row in the table correctly defines the chemical symbol for element ${\bf X}$ and the number of neutrons in its nucleus?

	chemical symbol for element X	number of neutrons
Α	Ро	135
В	Ро	219
С	Rn	133
D	Rn	219

4 The cylinder in a car engine has a volume of 0.500 dm³ when the piston is at the bottom of its stroke. At this point the pressure is reduced to 95.0 kPa and the reduced pressure causes the fuel/air mixture to move into the cylinder. At the top of its stroke, the piston has compressed the gases to 25 cm³.

Assuming that the temperature in the cylinder remains constant, what is the pressure of the gases (in kPa) when the piston is at the top of its stroke?

5 The dye alizarin only sticks fast to cotton when a 'mordant' is used. If an aluminium compound is used as a mordant under alkaline conditions, aluminium ions become bonded to the hydroxyl groups of cotton. Alizarin can bond with the aluminium ions, giving the structure below which dyes the cotton red.



Which statement is **incorrect**?

- **A** All the carbon atoms in alizarin are sp^2 hybridised.
- **B** The four oxygen atoms form coordinate bonds with the aluminium ion.
- **C** In the absence of a mordant, alizarin can bind to cotton via hydrogen bonding.
- **D** There is a decrease in the bond angles about the oxygen atoms of the cotton hydroxyl groups upon binding to aluminium ions.
- **6** The standard enthalpy change and standard entropy change of vaporisation of a compound are +23.35 kJ mol⁻¹ and +97.41 J K⁻¹ mol⁻¹ respectively.

What is the boiling point of the compound?

A −272.8 °C **B** −33.3 °C **C** 0.240 °C **D** 239.7 °C

7 The conversion of carbon dioxide and water to glucose and oxygen is not energetically feasible.

 $6CO_2(g) + 6H_2O(l) \rightarrow C_6H_{12}O_6(aq) + 6O_2(g)$ $\Delta G = +2867 \text{ kJ mol}^{-1}$

In plants, this reaction may be coupled to the hydrolysis of adenosine triphosphate (ATP) to adenosine diphosphate (ADP) and the oxidation of the NADPH cofactor to NADP⁺. The overall reaction may be represented by:

Given the ΔG values for the following reactions:

 $\begin{array}{ll} \text{ATP}(\text{aq}) \ + \ \text{H}_2\text{O}(l) \ \rightarrow \ \text{ADP}(\text{aq}) \ + \ \text{P}_i(\text{aq}) \\ \text{NADP}^+(\text{aq}) \ + \ \text{H}_2\text{O}(l) \ \rightarrow \ \text{NADPH}(\text{aq}) \ + \ \text{H}^+(\text{aq}) \ + \ \frac{1}{2}\text{O}_2(\text{g}) \end{array} \qquad \begin{array}{ll} \Delta G = -30.5 \ \text{kJ} \ \text{mol}^{-1} \\ \Delta G = +220 \ \text{kJ} \ \text{mol}^{-1} \end{array}$

What is ΔG_{rxn} ?

Α	−6056 kJ mol ⁻¹	С	+2617 kJ mol ⁻¹
В	-322 kJ mol ⁻¹	D	+4958 kJ mol ⁻¹

8 The rate information below was obtained for the reaction $P + Q \rightarrow$ products.

[P] / mol dm ⁻³	[Q] / mol dm ⁻³	Rate / mol dm ⁻³ s ⁻¹
0.01	0.05	1.9×10^{-4}
0.02	0.05	3.9×10^{-4}
0.02	0.01	4.0×10^{-4}

If the rate constant doubles for each 10 °C rise in temperature, which set of conditions will give the greatest rate of reaction?

	[P] / mol dm ⁻³	[Q] / mol dm ⁻³	Temperature / °C
Α	0.1	0.2	40
В	0.2	0.2	30
С	0.3	0.1	30
D	0.4	0.4	20

9 In a microbial electrolytic cell, CO₂ and H₂O, are converted by electrochemically active bacteria into CH₄ and O₂.

The electrode reactions are:

Anode: $2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e^-$ Cathode: $CO_2(g) + 8H^+(aq) + 8e^- \rightarrow CH_4(g) + 2H_2O(l)$

If the process is 80% efficient, how many hours are needed to produce 1 dm³ of methane gas (at r.t.p.) when a current of 0.50 A is passed through the cell?

Α	100×96500×8	С	$0.50\!\times\!100\!\times\!24\!\times\!3600$
	$\overline{0.50\!\times\!80\!\times\!24\!\times\!3600}$		80×96500×8
В	80×96500×8	D	$0.50\!\times\!80\!\times\!24\!\times\!3600$
	$0.50 \times 100 \times 24 \times 3600$		100×96500×8

10 The current dominant method for the industrial production of hydrogen is by steam reforming of methane from natural gas. Two reactions are involved, both being in equilibrium in closed systems:

Reaction 1	$CH_4(g) + H_2O(g) = CO(g) + 3H_2(g)$	ΔH = +210 kJ mol ⁻¹
Reaction 1	$CH_4(g) + H_2O(g) = CO(g) + 3H_2(g)$	ΔH = +210 kJ mol

Reaction 2	$CO(g) + H_2O(g) = CO_2(g) + H_2(g)$	$\Delta H = -42 \text{ kJ mol}^{-1}$
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Which statement about Reactions 1 and 2 is correct?

- A Increasing the pressure increases the equilibrium constant for **Reaction 2**.
- **B** Increasing the temperature increases the equilibrium constant for **Reaction 1**.
- **C** Addition of a catalyst increases both the yield and rate of production of hydrogen gas.
- D Increasing the temperature decreases the rate constant for the forward reaction in **Reaction 2**.
- 11 What is the pH of the resultant solution when 100 cm³ of 0.10 mol dm⁻³ of aqueous NH₃ and 80 cm³ of 0.15 mol dm⁻³ aqueous NH₄C*l* are mixed at 25 °C? (p K_b of NH₃ = 4.75)

A 9.07 **B** 9.17 **C** 9.32 **D** 9.35

12 The numerical value of the solubility product, K_{sp} , of silver chromate(VI), Ag₂CrO₄, is 2.5×10^{-22} at 25 °C.

Which statement about silver chromate(VI) is correct?

- **A** The units of K_{sp} of silver chromate(VI) are mol² dm⁻⁶.
- **B** The solubility of silver chromate(VI) is 3.97×10^{-8} mol dm⁻³.
- **C** Addition of hydrochloric acid will decrease the solubility of silver chromate(VI).
- **D** Addition of hydrochloric acid will decrease the numerical value of K_{sp} of silver chromate(VI).

13 The graph below shows the variation in the melting points for eight consecutive elements in the Periodic Table, all with atomic number below 20.



What statement is correct?

- A Element **F** does not conduct electricity.
- **B** Element **D** burns with a brilliant yellow flame.
- **C** Element **H** does not react with air at room temperature.
- **D** Element **C** is a gas which is chemically inert at room temperature.
- 14 Which property about X, Y and Z will give the trend shown below?



15 Group II iodate(V) compounds undergo thermal decomposition to yield products as shown by the equation below.

 $2M(IO_3)_2(s) \rightarrow 2MO(s) + 2I_2(g) + 5O_2(g)$

The three graphs given below show the change in mass when 2.00 g each of three Group II iodate(V) compounds were heated separately at a temperature T $^{\circ}$ C.



Which three Group II iodate(V) compounds give rise to these graphs?

	<u>Graph 1</u>	<u>Graph 2</u>	<u>Graph 3</u>
Α	Sr(IO ₃) ₂	Ba(IO ₃) ₂	Ca(IO ₃) ₂
В	Mg(IO ₃) ₂	Ba(IO ₃) ₂	Sr(IO ₃) ₂
С	Ca(IO ₃) ₂	Mg(IO ₃) ₂	$Ba(IO_3)_2$
D	Ca(IO ₃) ₂	Mg(IO ₃) ₂	Sr(IO ₃) ₂

- 16 Which observation about bromine or its compounds is correct?
 - A When aqueous silver nitrate is added to aqueous sodium bromide, a yellow precipitate is observed.
 - **B** When aqueous sodium chloride is added to aqueous bromine, the orange solution is decolourised.
 - **C** When sodium bromide is treated with concentrated sulfuric acid, a gas that turns moist starch paper black is evolved.
 - **D** When sodium bromide is treated with concentrated sulfuric acid, a gas that turns moist blue litmus paper red is evolved.

17 A partial spectrochemical series with ligands arranged in order of decreasing field strength is given below.

ethylenediamine (en) > $H_2NCH_2CO_2^{-}$ (gly⁻) > $C_2O_4^{2^-}$

Stronger field ligands are known to give rise to a larger energy gap between the two sets of d-orbitals in a transition metal complex.

The figure below shows a colour wheel with approximate wavelength values (in nm) for different colour light. As wavelength decreases, the energy of the light increases.



An aqueous solution containing the [Co(gly)₃] complex is violet.

Which combination could be the colours of $[Co(C_2O_4)_3]^{3-}(aq)$ and $[Co(en)_3]^{3+}(aq)$?

	[Co(C ₂ O ₄) ₃] ³⁻ (aq)	[Co(en) ₃] ³⁺ (aq)
Α	green	yellow
В	yellow	orange
С	red	blue
D	blue	green

18 Use of the Data Booklet is relevant to this question.

Which set of reagents, when added in the order shown below, would convert $Fe^{3+}(aq)$ to $[Fe(CN)_6]^{3-}(aq)$?

	Fe ³⁺ (aq) Step 1	Fe ²⁺ (aq) Step 2	X Step 3	[Fe(CN) ₆] ^{3–} (aq)
	Step 1	Step 2	Step 3	
A	Zn(s)	CN⁻(aq)	SO ₂ (g)	
В	I⁻(aq)	CN⁻(aq)	$Cl_2(g)$	
С	H ₂ O ₂ (aq)	I⁻(aq)	CN⁻(aq)	
D	Ag(s)	I⁻(aq)	CN⁻(aq)	

- **19** How many isomers of C_7H_7Cl contain a benzene ring in the structure?
 - **A** 2 **B** 4 **C** 6 **D** 8
- 20 Cyclohexane undergoes substitution with chlorine gas.

What is a possible by-product for this reaction?



21 Vitamin D is a group of fat-soluble prohormones. It plays an important role in regulating calcium level in blood and is needed for bone growth. The structure of one major form of vitamin D, vitamin D₂ (or calciferol) is shown below.



Which statement is correct when vitamin D_2 is made to react with excess hot acidified $\mathsf{KMnO}_4?$

- **A** A triketone is produced.
- **B** Four organic products are produced.
- **C** One mole of carbon dioxide is produced for every mole of Vitamin D₂.
- **D** Each of the products, when isolated, produce effervescence with aqueous sodium carbonate.

22 Two isomers, $CH_3CH=CHCl$ and $ClCH_2CH=CH_2$, are warmed separately with ethanolic AgNO₃. Only the second compound gives a precipitate.

Which statement is not a possible explanation for this observation?

- **A** C-Cl bond in $CH_3CH=CHCl$ is shorter.
- **B** The carbon bonded to C*l* is less electron deficient for CH₃CH=CHC*l*.
- **C** The geometry about the carbon bonded to Cl in $CH_3CH=CHCl$ is planar.
- **D** C-Cl in $CH_3CH=CHCl$ possesses double bond character due to overlap between the p orbital of Cl and the pi cloud of C=C.
- **23** 4-Nitrochlorobenzene reacts with ethoxide ion via a mechanism shown below:



What is the mechanism?

- A Electrophilic addition
- **B** Electrophilic substitution
- **C** Nucleophilic addition
- **D** Nucleophilic substitution
- 24 Ferulic acid is an abundant phytochemical found in plant cell walls.



Assume that CH₃O- group is inert. Which statement about ferulic acid is correct?

- A Ferulic acid can only undergo electrophilic addition with aqueous bromine.
- **B** Ferulic acid forms an ester with ethanoic acid when heated with concentrated sulfuric acid.
- **C** One mole of ferulic acid can react with only one mole of phosphorous pentachloride.
- **D** Ferulic acid reacts with lithium aluminium hydride to form a product that does not exhibit geometric isomerism.

 $RCl + FeCl_3 \rightarrow R^+ + FeCl_4^-$

Which of the following correctly shows the sequence of reactions to convert benzene to compound \mathbf{X} ?







Compound Z

Which combination could be X and Y?





27 Aldehydes and ketones undergo addition in the presence of a strong base.

A reaction involving propanal, CH₃CH₂CHO, and barium hydroxide is shown below:



Which product could be formed when barium hydroxide is added to a mixture of ethanal, CH_3CHO , and propanone, CH_3COCH_3 ?



28 Which reagents can be used to distinguish between the 2 structural isomers?





- A H₂ and Ni
- B Aqueous Br₂
- **C** Hot dilute HC*l*
- **D** Hot acidified K₂Cr₂O₇

- 14
- **29** A reaction scheme using phenylethanone is given below. Which reaction does **not** take place?



30 A student treated a sample of a protein fragment by boiling with aqueous sodium hydroxide under reflux for several hours. He then carried out electrophoresis of the resulting mixture at pH 6.00. The diagrams below show the appearance of the electrophoresis gel at the start and at the end of electrophoresis.



The table below shows the isoelectric points of some amino acids:

Aspartic acid	2.77
Alanine	6.00
Arginine	10.76

What deduction can be made from the experiment?

- A Aspartic acid may be one of the amino acids in the protein fragment.
- **B** Alanine may be one of the amino acids in the protein fragment.
- **C** Arginine is not one of the amino acids in the protein fragment.
- **D** The sample is a dipeptide.

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

Α	В	С	D
1, 2 and 3 are	1 and 2 only	2 and 3 only	1 only is
correct	are correct	are correct	correct

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

- **31** Which statements are correct for any chemical reaction?
 - 1 Increasing the concentration of any reactant leads to an increase in reaction rate.
 - 2 The addition of a suitable catalyst would increase the reaction rate.
 - **3** The rate constant of a reaction is dependent on the activation energy and temperature.
- **32** The standard reduction potentials of the calomel reference electrode and the AgC*l*/Ag reference electrode are shown below:

Calomel electrode:	$\frac{1}{2}$ Hg ₂ Cl ₂ + e ⁻ = Hg + Cl ⁻	$E^{\ominus} = +0.27 \text{ V}$
AgCl/Ag electrode:	$AgCl + e^- = Ag + Cl^-$	<i>E</i> [⊖] = +0.22 V

A half-cell containing M^{2+}/M has a reduction potential of -0.46 V with respect to a calomel electrode.

Which statements are correct?

- 1 The reduction potential of the calomel electrode with respect to the AgCl/Ag electrode is +0.05 V.
- 2 The reduction potential of the M^{2+}/M half-cell with respect to the AgCl/Ag electrode is -0.41 V.
- **3** The reduction potential of the M^{2+}/M half-cell with respect to the standard hydrogen electrode is -0.19 V.
- 33 Which statements about the oxides and chlorides of the Period 3 elements are correct?
 - 1 When one mole of PCl_5 is reacted completely with water, the resulting solution requires eight molar equivalents of NaOH for neutralisation.
 - **2** A solution of $MgCl_2$ is slightly acidic in water.
 - **3** Both Al_2O_3 and $AlCl_3$ react with water to give the colourless complex ion $[Al(OH)_4]^-$.

34 Use of the Data Booklet is relevant to this question.

Which statements about Group II elements from magnesium to barium are correct?

- 1 Their reactivity increases down the group.
- 2 The solubility of their hydroxides increases down the group.
- 3 The melting point of their oxides decreases down the group.
- **35** Astatine is below iodine in Group VII of the Periodic Table. Based on the properties of the halogens, which statements are correct?
 - 1 Silver astatide is insoluble in aqueous ammonia.
 - **2** Astatine is a stronger oxidising agent than iodine.
 - **3** Hydrogen astatide is an ionic compound.
- 36 The diagram below shows an experimental set-up for preparation of the organic compounds.



Which preparations could this apparatus be used for?

- 1 ethanal from ethanol, sodium dichromate(VI) and dilute sulfuric acid
- 2 benzoic acid from methylbenzene, potassium managanate(VII) and dilute sulfuric acid
- **3** 1,2-dibromoethane from ethene and bromine
- **37** What could produce a gaseous product when heated with aqueous sodium hydroxide and potassium manganate(VII)?
 - 1 CH₃CH=CH₂
 - 2 CH₃CONH₂
 - **3** CH₃CO₂⁻NH₄⁺

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

A	В	С	D
1, 2 and 3 are	1 and 2 only	2 and 3 only	1 only is
correct	are correct	are correct	correct

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

38 Diazepam is a tranquilizer, commonly known as valium.



Which statements about diazepam are correct?

- 1 It is hydrolysed by hot aqueous sodium hydroxide.
- 2 It reacts with dilute acids at room temperature.
- **3** It gives an orange precipitate with 2,4–dinitrophenylhydrazine.
- **39** Equal amounts of two organic compounds, **P** and **Q**, were added to water and the pH values of both solutions were determined. It was found that the pH of the aqueous solution of **P** is higher.

Which pairs of compounds could be **P** and **Q**?

	Р	Q
1	CH ₃ CH ₂ OH	CH_3CO_2H
2	$CH_3CH_2NH_2$	$C_6H_5NH_2$
3	C ₆ H₅O⁻Na⁺	C ₆ H₅CO ₂ [−] Na ⁺

40 Which statements regarding the section of a polypeptide chain shown below are correct?



- 1 It is made up of 4 different amino acids.
- 2 The major types of interaction with other polypeptide chains are dispersion forces, hydrogen bonding and ionic interactions.
- 3 There is one chiral carbon present.