ANDERSON JUNIOR COLLEGE

2017 JC 1 PROMOTIONAL EXAMINATION

CHEMISTRY

Higher 2

Paper 1 Multiple Choice

9729/01

29 September 2017

1 hour

Additional Materials: Multiple Choice Answer Sheet

Data Booklet

READ THESE INSTRUCTIONS FIRST

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

There are **thirty** 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.
The use of an approved scientific calculator is expected, where appropriate.

Multiple Choice Answer Sheet

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

Shade the NRIC / FIN number.

Exam Title: <u>JC1 PROMO</u>

Exam Details: <u>H2 Chemistry / Paper 1</u>

Date: <u>29/9/2017</u>

This document consists of **15** printed pages.

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

The ^{68}Ge isotope of the Group 14 element germanium is medically useful because it undergoes a natural radioactive process to give a gallium isotope, ^{68}Ga, which can be used to detect tumors. This transformation of germanium occurs when one of its electrons enters the nucleus, changing a proton into a neutron.

What do the isotopes ^{68}Ga and ^{68}Ge have in common?

A   Both isotopes have 37 neutrons in their nuclei.

B   Both isotopes have more electrons than protons.

C   Both isotopes have an outer electronic configuration $4s^2 4p^3$.

D   Both isotopes contain the same number of nucleons in their nuclei.

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

The graph shows the logarithm, lg, of the first eight ionisation energies of two elements in Periods 2 and 3.
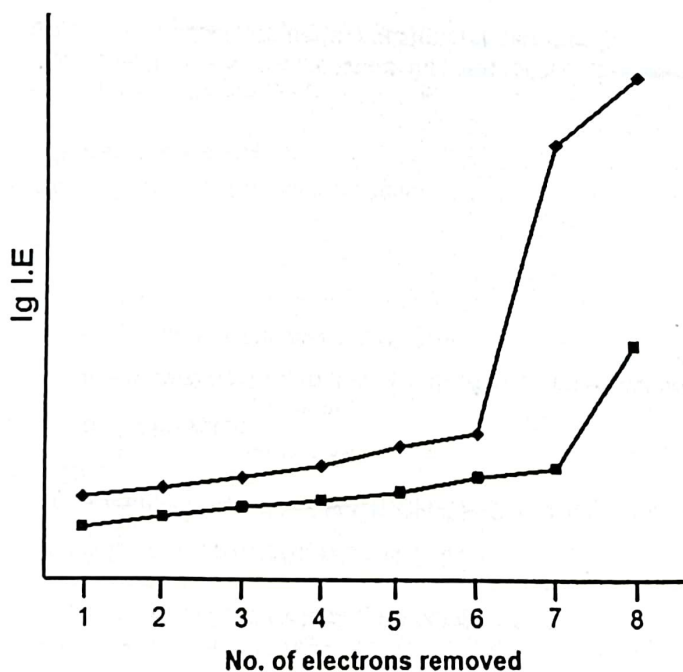
What is the most likely compound that will be formed between the two elements?

A OF_2 B OCl_2 C SF_2 D SCl_2

3   Which of the following corresponds to the configuration of the six electrons of highest energy for the ground state of a Group 16 element?

   A $1s^2 2s^2 2p^2$

   B $3p^6$

   C $3d^4 4s^2$

   D $4s^2 4p^4$

4   BH_3 and trimethylamine, $(CH_3)_3N$, react in a 1:1 ratio to give a white solid product.

   Which of the following statements are true about this reaction?

   1   Dative covalent bonds are formed during the reaction.

   2   The shape around boron changes from trigonal pyramidal to tetrahedral during the reaction.

   3   Hydrogen bonds are present in the product.

   A   1, 2 and 3

   B   1 and 2 only

   C   2 and 3 only

   D   1 only

5   The bond energies of the C–C and Si–Si bonds are shown below.

Bond	Bond energy / kJ mol⁻¹
C–C	350
Si–Si	222

   Which of the following explains the difference in the bond energies of these bonds?

   A   Silicon is more electronegative than carbon.

   B   The valence atomic orbital of silicon is larger than that of carbon.

   C   Silicon has more electrons than carbon.

   D   The bond between the silicon atoms is a π bond.

6   Which of the following sets of compounds have molecules that are all non–polar?

   A O_2, $BeCl_2$, PCl_3

   B XeF_4, CCl_4, PF_5

   C CS_2, SF_4, SO_2

   D $AlCl_3$, SO_3, H_2S

7 In which pair of species does **I** have a larger bond angle about the central atom than **II**?

	I	II
A	NO_2^-	NO_2
B	OF_2	$BeCl_2$
C	PH_3	PF_3
D	SF_6	CCl_2F_2

8 Which of the following can be explained by hydrogen bonding?

1 The density of ice is lower than that of water at 0 °C.

2 The boiling point of pentan–1–ol, $CH_3CH_2CH_2CH_2CH_2OH$, is higher than butan–1–ol, $CH_3CH_2CH_2CH_2OH$.

3 The solubility of ethanol in water.

4 The dimerisation of ethanoic acid when it is dissolved in a non–polar solvent such as benzene.

A 1 and 4 only

B 1, 3 and 4 only

C 2 and 3 only

D 1, 2, 3 and 4

9 Which of the following graphs does **not** describe the relationship between volume and pressure for a fixed mass of an ideal gas under constant temperature?
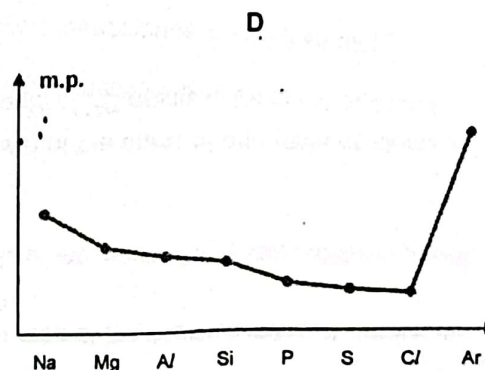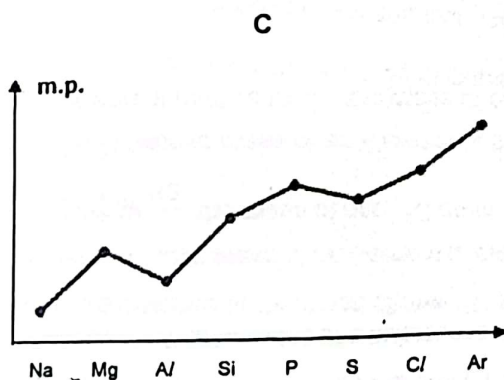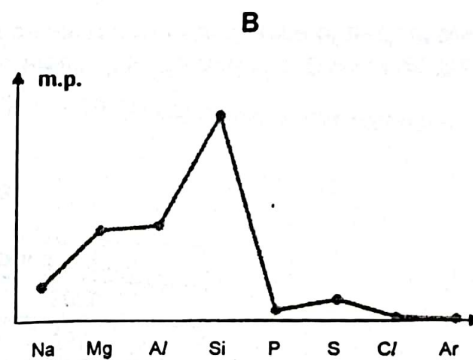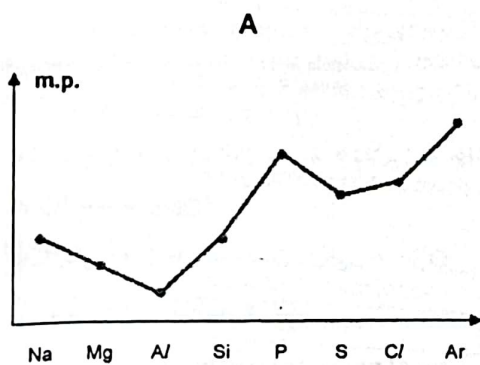
A

B

C

D
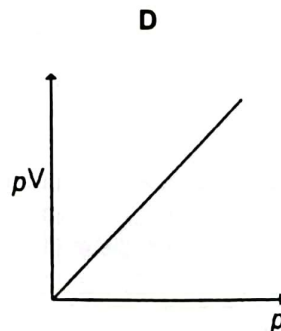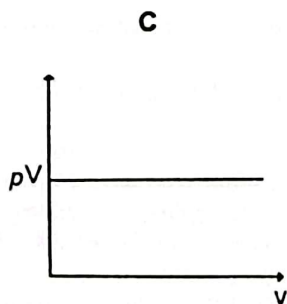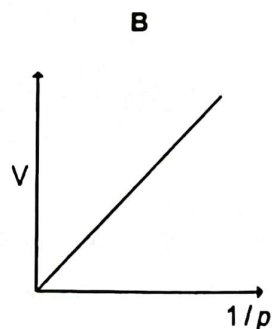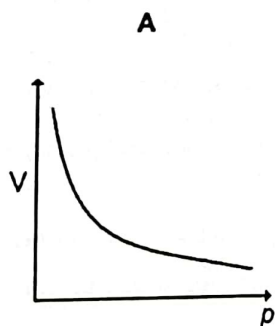
10 3 dm³ of helium at a pressure of 5 kPa and 2 dm³ of argon at a pressure of 3 kPa are introduced into a 1.5 dm³ vessel at the same temperature.

What is the total pressure in the vessel?

A 5 kPa

B 8 kPa

C 11.5 kPa

D 14 kPa

11 Which graph best shows the variation of melting point of the third period elements?

12 Two properties of a Period 3 element are as follows.

property 1   has an oxide that has a different effect from its chloride on litmus solution

property 2   has a giant structure

Which element has the two stated properties?

1   aluminium
2   phosphorus
3   silicon
4   sodium

A   1, 3 and 4 only
B   1 and 3 only
C   1 and 4 only
D   2 and 4 only

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

What changes occur in the magnitudes of:

(i)   the reducing power of the element
(ii)   the enthalpy change of hydration of the cation

as Group 2 is descended?

	reducing power	*enthalpy change of hydration*
A	increases	decreases
B	increases	increases
C	decreases	decreases
D	decreases	increases

14 What are the trends in the stated properties as Group 2 is descended from magnesium to barium?

|	*decomposition temperature of the carbonate*	*polarising effect on anion*
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

15 Aqueous chlorine is added to aqueous sodium bromide and the mixture is shaken with an equal volume of trichloroethane.

Which observation would be made?

A	B	C	D
purple	red–brown	colourless / purple	colourless / red–brown
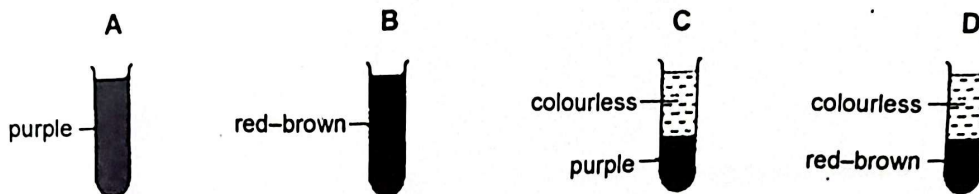
16 Which statement about *relative molecular mass* and *relative atomic mass* is correct?

A   *Relative molecular mass* has the unit $g\ mol^{-1}$.

B   *Relative molecular mass* of a substance is the ratio of the average mass of a molecule of the substance to the mass of one ^{12}C atom.

C   *Relative atomic mass* of an element is the ratio of the mass of one atom of the element relative to $\frac{1}{12}$ the mass of one ^{12}C atom.

D   *Relative atomic mass* of an element is the ratio of the mass of one mole of atoms of the element relative to $\frac{1}{12}$ the mass of one mole of ^{12}C atoms.

17 Which of the following is a redox reaction?

A $CaCO_3 \longrightarrow CaO + CO_2$

B $2CrO_4^{2-} + 2H^+ \longrightarrow Cr_2O_7^{2-} + H_2O$

C $N_2O_4 \longrightarrow 2NO_2$

D $4Ti^{3+} + O_2 + 2H_2O \longrightarrow 4TiO^{2+} + 4H^+$

18 The element sulfur has three naturally occurring isotopes, ^{32}S, ^{33}S and ^{34}S. Given that the relative atomic mass of sulfur is 32.094, what could be the relative abundance of each of the three isotopes?

A   94.0% ^{32}S, 1.0% ^{33}S, 5.0% ^{34}S

B   94.9% ^{32}S, 0.8% ^{33}S, 4.3% ^{34}S

C   96.0% ^{32}S, 0.8% ^{33}S, 3.2% ^{34}S

D   96.5% ^{32}S, 2.2% ^{33}S, 1.3% ^{34}S

19 Aspirin, $CH_3CO_2C_6H_4CO_2H$, can be prepared by an acylation reaction between 2–hydroxybenzenecarboxylic acid, $HOC_6H_4CO_2H$, and ethanoic anhydride, $(CH_3CO)_2O$, as shown in the following equation.

$$HOC_6H_4CO_2H + (CH_3CO)_2O \longrightarrow CH_3CO_2C_6H_4CO_2H + CH_3CO_2H$$
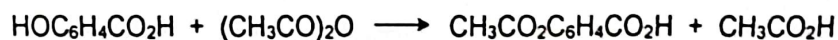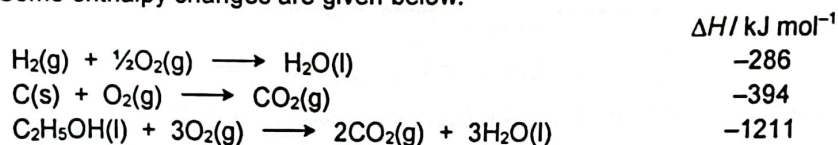
Given that the typical yield of pure aspirin is 75%, what is the mass of $(CH_3CO)_2O$ required to prepare 5 g of pure aspirin?

[M_r: $(CH_3CO)_2O$, 102.0 ; $CH_3CO_2C_6H_4CO_2H$, 180.0]

A   2.13 g   B   2.83 g   C   3.78 g   D   5.11 g

20 Some enthalpy changes are given below.

		ΔH / kJ mol^{-1}
$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(l)$		−286
$C(s) + O_2(g) \longrightarrow CO_2(g)$		−394
$C_2H_5OH(l) + 3O_2(g) \longrightarrow 2CO_2(g) + 3H_2O(l)$		−1211

What is the enthalpy change of formation of ethanol, $C_2H_5OH(l)$?

A   −435 kJ mol^{-1}

B   −2857 kJ mol^{-1}

C   +435 kJ mol^{-1}

D   +531 kJ mol^{-1}

21 A student conducted an experiment to determine the enthalpy change of solution of $MgSO_4$ in water. 9.00 g of solid $MgSO_4$ was added to 150 g of water and the temperature of the solution rose by 11 °C.

The specific heat capacity of water is 4.18 J g^{-1} K^{-1}.

What is the enthalpy change of solution of $MgSO_4$?

A   −5.54 kJ mol^{-1}

B   −92.3 kJ mol^{-1}

C   −97.8 kJ mol^{-1}

D   −143 kJ mol^{-1}

22 In a Science experiment, a student mixed solid NH_4SCN with solid $Ba(OH)_2$ in a beaker. She observed that the temperature dropped and a gas was produced.

$$2NH_4SCN(s) + Ba(OH)_2(s) \longrightarrow Ba(SCN)_2(aq) + 2NH_3(g) + 2H_2O(l)$$

What are the correct signs for ΔG, ΔH and ΔS for the above reaction?

	ΔG	ΔH	ΔS
A	+	−	−
B	+	+	+
C	−	−	+
D	−	+	+

23 According to Trouton's rule, a wide range of liquids give approximately the same standard entropy change of vaporisation.

The table shows the boiling points of two such liquids.

	boiling point / °C
carbon tetrachloride	76.7
decane	174

The standard enthalpy change of vaporisation for carbon tetrachloride is $+30.0$ kJ mol^{-1}.

Based on the information given above, what is the standard enthalpy change of vaporisation for decane?

A $+23.5$ kJ mol^{-1}

B $+30.0$ kJ mol^{-1}

C $+38.3$ kJ mol^{-1}

D $+68.1$ kJ mol^{-1}

24 Consider the reaction $W + X \rightleftharpoons Y + Z$.

Which of the following statements is **incorrect** when a catalyst is added to the reaction mixture?

A The catalyst alters the mechanism of the reaction.

B The addition of a catalyst lowers the activation energy of the forward reaction but not that of the reverse reaction.

C The enthalpy change of reaction remains unchanged.

D The catalyst does not alter the proportion of **W**, **X**, **Y** or **Z** at equilibrium.

25 The following mechanism is proposed for the exothermic gas–phase reaction:

$$P + 2Q \longrightarrow PQ_2$$

Step 1 $\quad P + Q \xrightarrow{slow} PQ$

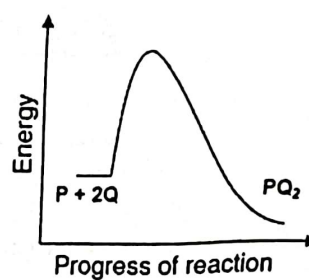Step 2 $\quad PQ + Q \xrightarrow{fast} PQ_2$
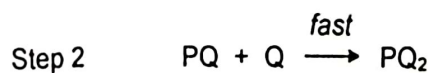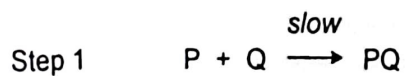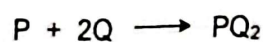
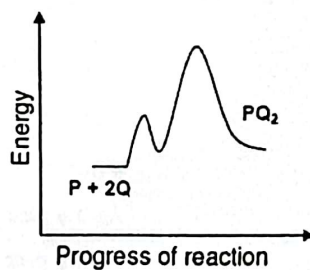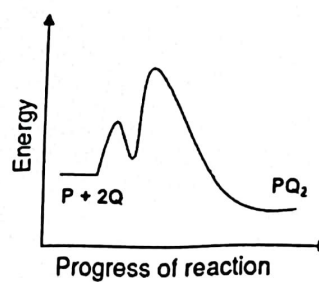Which diagram represents the reaction profile for this mechanism?
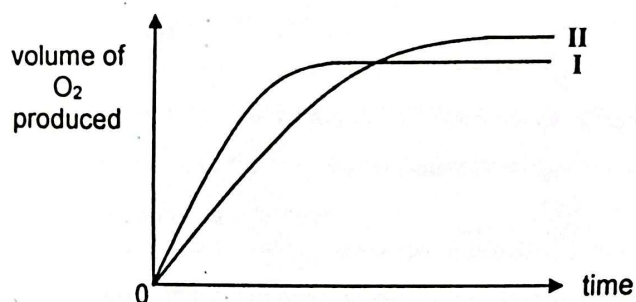
A
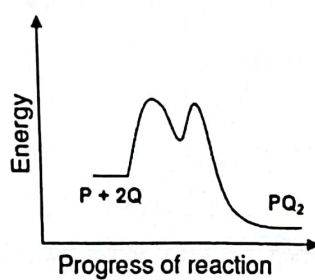
B

C

D

26 In the diagram below, curve **I** was obtained by observing the decomposition of 100 cm³ of 1.0 mol dm^{-3} hydrogen peroxide, catalysed by manganese(IV) oxide.

Which alteration to the original experimental conditions, when carried out separately, would produce curve **II**?

1   adding water

2   using less manganese(IV) oxide

3   adding some 0.1 mol dm^{-3} hydrogen peroxide

A   1 and 2 only

B   2 only

C   3 only

D   1, 2 and 3

27 The diagram shows a catalytic converter used in car exhaust systems.
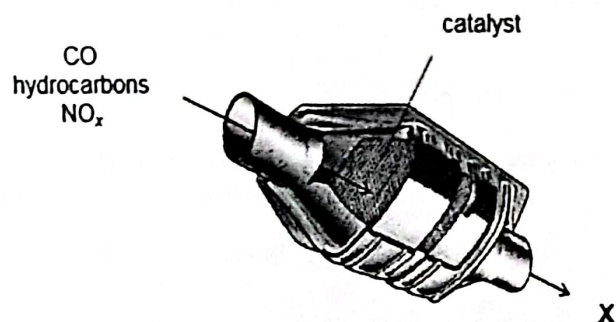
Which of the following statements are correct regarding the processes that occur in the catalytic converter?

1 Platinum, palladium and rhodium catalyse the redox reactions in the catalytic converter.

2 Only the hydrocarbons form temporary weak bonds with the catalyst at the surface.

3 Carbon monoxide and hydrocarbons react together.

4 Mixture X contains carbon dioxide, nitrogen and water vapour.

A 1 and 3 only

B 3 and 4 only

C 1 and 4 only

D 1, 2, 3 and 4

28 The graph shows the result of an investigation of the initial rate of hydrolysis of hydrogen peroxide by the enzyme catalase, which is found in the liver of mammals. In the experiments, the initial concentration of hydrogen peroxide was varied, but that of catalase was kept constant.
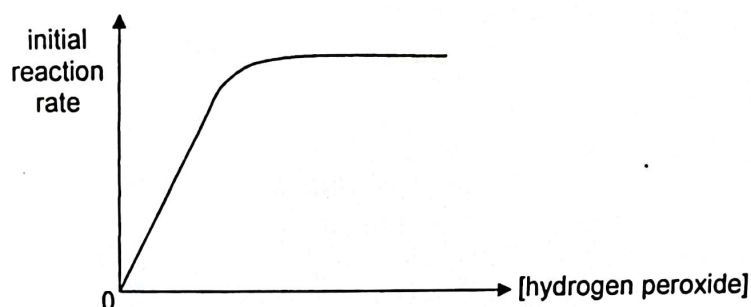
What conclusions can be drawn from these results?

1 When [hydrogen peroxide] is high, the rate is independent of [catalase].

2 When [hydrogen peroxide] is high, all the active sites in the enzyme molecules are occupied by hydrogen peroxide molecules.

3 When [hydrogen peroxide] is low, the reaction is first order with respect to hydrogen peroxide.

A 2 only

B 1 and 3 only

C 2 and 3 only

D 1, 2 and 3

29 Two diatomic gases, X_2 and Y_2, react as follows.

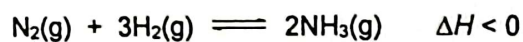$$X_2(g) + Y_2(g) \rightleftharpoons 2XY(g)$$
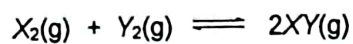
A mixture containing 0.5 moles each of X_2 and Y_2 is heated in a closed container and the reaction allowed to reach equilibrium. The graph shows how the number of moles of each gas varies with time.
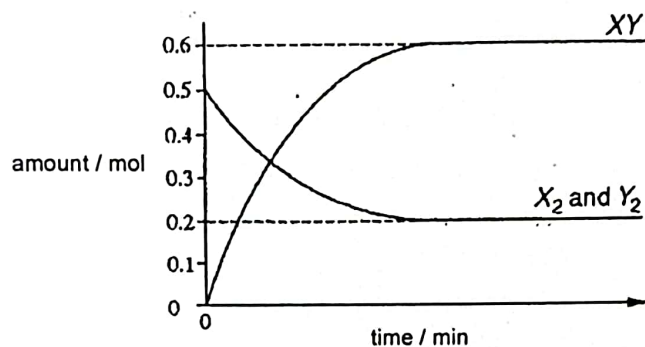
What is the value of the equilibrium constant, K_c, for this reaction?

A   1.5   B   3   C   9   D   18

30 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.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H < 0$$

Which diagram correctly represents the two graphs?

A

% NH$_3$ at equilibrium

40 — 400 °C
20 — 500 °C
0
0   10   20
pressure/ 10^3 kPa

B

% NH$_3$ at equilibrium

40 — 500 °C
20 — 400 °C
0
0   10   20
pressure/ 10^3 kPa

C

% NH$_3$ at equilibrium

40 — 400 °C
20 —
500 °C
0
0   10   20
pressure/ 10^3 kPa

D

% NH$_3$ at equilibrium

40 — 500 °C
20 —
400 °C
0
0   10   20
pressure/ 10^3 kPa