

## **TEMASEK JUNIOR COLLEGE 2019 JC2 PRELIMINARY EXAMINATION**

1

**Higher 2** 

## **CHEMISTRY**

# 9729/01

18th September 2019 1 hour

Additional Materials: Multiple Choice Answer Sheet (OMS) Data Booklet

### **READ THESE INSTRUCTIONS FIRST**

Write in soft pencil.

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

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

1. Enter your NAME ( as in NRIC ). \_\_\_\_\_ . 2. Enter the SUBJECT TITLE. \_\_\_\_\_ Write your **name** 3. Enter the TEST NAME. \_\_\_\_ and Civics Group 4. Enter the CLASS. \_\_\_\_

	WRITE			SHA	DE A	PPRO	PRIA	TE BO	XES		
	IN	0	1	2	3	4	5	6	7	8	9
	DE	0	1	2	3	4	5	6	7	8	9
Write and shade	X N U	0	1	2	3	4	5	6	7	8	9
your index number		0	1	2	3	4	5	6	7	8	9
	B	0	1	2	3	4	5	6	1	8	9
	R	A	B	C	0	E	F	G	Н	1	

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 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.

The use of an approved scientific calculator is expected, where appropriate.

This document consists of <u>16</u> printed pages including the cover page.

1 The number of neutrons and nucleons for five particles are shown below. The letters of the particles do not correspond to the identity of the elements in the Periodic Table.

Particle	Neutrons	Nucleons
U	16	33
V-	18	35
S <sup>2-</sup>	16	32
T <sup>2+</sup>	17	34
Q <sup>3-</sup>	16	31

Which of the following sets consists of particles that are isoelectronic?

Α	U, S <sup>2-</sup> , T <sup>2+</sup>	В	U, S <sup>2-</sup> , Q <sup>3-</sup>
С	V <sup>-</sup> , S <sup>2-</sup> , Q <sup>3-</sup>	D	V <sup>-</sup> , T <sup>2+</sup> , Q <sup>3-</sup>

2 Methane was burned in an incorrectly adjusted burner. The methane was converted into a mixture of carbon dioxide and carbon monoxide in the ratio of 95 : 5, together with water vapour.

What will be the volume of oxygen consumed when x dm<sup>3</sup> of methane is burned?

**A** 
$$(x - \frac{0.05x}{2}) dm^3$$

**B** 
$$(x - 0.05x) dm^3$$

**C** 
$$(2x - \frac{0.05x}{2}) \text{ dm}^3$$

**D**  $(2x - 0.05x) dm^3$ 

- **3** Which of the following particles contains the most number of unpaired electrons?
  - A
     Na
     B
     P<sup>3-</sup>

     C
     V
     D
     Mn<sup>2+</sup>
- 4 *Nudic acid B* is an acidic antibiotic isolated from the culture medium of the basidiomycete *Tricholoma nudum* (Bull.) Fr.

What is the number of  $\sigma$  and  $\pi$  bonds present in the molecule?

- σ
   π

   A
   16
   5

   B
   13
   8

   C
   13
   5

   D
   10
   8
- 5 A pair of compounds have the following properties as described below.
  - (i) The first compound has a larger bond angle about the central atom than the second compound.
  - (ii) The second compound is more polar than the first compound.

Which pair of compounds fit the description above?

**A** 
$$BCl_3, ClO_2^-$$

**B** 
$$ICl_2^-$$
,  $CO_2$ 

- C HCN, XeF<sub>4</sub>
- $\mathbf{D} = \mathbf{C} l \mathbf{O}_2^{-}, \mathbf{C} \mathbf{O}_2$

- 6 In which of the following pairs is the melting point of the first member lower than that of the second member?
  - I diamond, silicon
  - II  $H_2O$ ,  $NH_3$
  - III SiC $l_4$ , A $l_2O_3$
  - IV  $Br_2$ , ICl
  - **A** I, II, III, IV
  - **B** I, III, IV
  - **C** III, IV
  - **D** I only
- **7** Gaseous  $Al_2Cl_6$  decomposes into gaseous  $AlCl_3$  in a 250 cm<sup>3</sup> closed reaction vessel maintained at a temperature of 500 K. The system reaches equilibrium with a total pressure of 1.16 x 10<sup>5</sup> Pa.

 $Al_2Cl_6(g) \longrightarrow 2AlCl_3(g)$ 

The average  $M_r$  of the equilibrium gas mixture in the vessel is found to be 214.9.

Which of the following statements are correct?

- 1 The bond angle in both molecules is 120°.
- 2 The mass of the gaseous mixture inside the reaction vessel is 1.50 g.
- **3** The following graphs depicts the correct behaviour of the two gases under standard conditions.



8 The following information is given.

$$2Cr(s) + \frac{3}{2}O_2(g) \longrightarrow Cr_2O_3(s) \qquad \Delta H = -1120 \text{ kJ mol}^{-1}$$
$$3C(s) + Cr_2O_3(s) \longrightarrow 2Cr(s) + 3CO(g) \qquad \Delta H = +790 \text{ kJ mol}^{-1}$$

What is the standard enthalpy change of the following reaction, in kJ mol<sup>-1</sup>?

$$2C(s) + O_2(g) \longrightarrow 2CO(g)$$

- **A** -110
- **B** –220
- **C** -637
- **D** -1273
- **9** In this question, the symbol '<' means 'less positive than' or 'more negative than'.

Both mercury(I) sulfate,  $Hg_2SO_4$ , and cadmium(I) sulfate,  $Cd_2SO_4$ , are odourless white crystalline solids.  $Hg_2SO_4$  is sparingly soluble while  $Cd_2SO_4$  is very soluble in water. Both sulfates are used in industry for electrochemical and electrolytic processes.

 $\begin{array}{ll} \text{The following data is provided:} \\ \Delta \mathcal{H}_{\text{latt}}^{\,\, \Theta} \, \left(\text{Hg}_2 \text{SO}_4\right) &= -2127 \, \text{kJ mol}^{-1} \\ \Delta \mathcal{H}_{\text{hyd}}^{\,\, \Theta} \, \left(\text{Hg}^+\right) &= -625 \, \, \text{kJ mol}^{-1} \\ \Delta \mathcal{H}_{\text{hyd}}^{\,\, \Theta} \, \left(\text{SO}_4^{\,2-}\right) &= -1160 \, \text{kJ mol}^{-1} \end{array}$ 

Which of the following statements are correct?

- 1  $\Delta H_{soln}^{\circ}$  of Hg<sub>2</sub>SO<sub>4</sub> equals to a magnitude of 283 kJ mol<sup>-1</sup>.
- 2  $\Delta H_{latt}$   $^{\circ}$  of Hg<sub>2</sub>SO<sub>4</sub> is less exothermic than that of Cd<sub>2</sub>SO<sub>4</sub>.
- 3  $\Delta G_{soln}^{\circ}$  of Hg<sub>2</sub>SO<sub>4</sub> is <  $\Delta G_{soln}^{\circ}$  of Cd<sub>2</sub>SO<sub>4</sub>
- A 1 only
- **B** 1 and 2 only
- C 2 and 3 only
- **D** 1,2 and 3 only

**10** Three electrochemical cells are set up as shown below. The *e.m.f* in volts at standard conditions is shown on each voltmeter. The concentration of all the solutions are

1 mol dm<sup>-3</sup>. **X**, **Y** and **Z** are metal electrodes.



The *e.m.f* indicates the order of reactivity of the metals.

The order of the strongest to the weakest oxidising agent is :

- Α Z<sup>2+</sup>, Cu<sup>2+</sup>, X<sup>2+</sup>. Y<sup>2+</sup> Y<sup>2+</sup>. X<sup>2+</sup>, В Cu<sup>2+</sup>. Z<sup>2+</sup> С Cu<sup>2+</sup>, Z<sup>2+</sup>, Y<sup>2+</sup>. X<sup>2+</sup> D Ζ. Cu, Х. Υ
- **11** The standard reduction potentials,  $E^{\bullet}$ , for the electrode reactions NO<sub>3</sub><sup>-</sup>/NH<sub>4</sub><sup>+</sup> and NO<sub>3</sub><sup>-</sup>/NO<sub>2</sub> are +0.87 V and +0.81 V respectively.

Dilute HCl was added to separate beakers containing 1 mol dm<sup>-3</sup> NO<sub>3</sub><sup>-</sup>/NH<sub>4</sub><sup>+</sup> and 1 mol dm<sup>-3</sup> NO<sub>3</sub><sup>-</sup>/NO<sub>2</sub> until a pH of 5 was achieved.

Which of the following statements are correct for the two beakers?

- 1 The reducing abilities of  $NH_4^+$  and  $NO_2$  decreases.
- 2 NO<sub>2</sub> is a weaker reducing agent than  $NH_4^+$  at pH 5.
- **3** The oxidising ability of  $NO_3^-$  decreases.
- A 1 only
- B 3 only
- **C** 1 and 2 only
- **D** 1,2 and 3 only

12 Excess marble chips are added to 30 cm<sup>3</sup> of 1 mol dm<sup>-3</sup> of nitric acid at room temperature until no further reaction occurs.

How would the experiment be different if it is now repeated with 50  $cm^3$  of 0.5 mol dm<sup>-3</sup> of nitric acid at the same temperature?

	Rate of reaction	Amount of products
Α	Faster	Lesser
в	Faster	More
С	Slower	More
D	Slower	Lesser

**13** CO and H<sub>2</sub> were placed in a reactor fitted with a movable piston and the following equilibrium is established.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

Which of the following best explains what happens when some argon gas is added to the mixture at constant volume and temperature?

- A The position of equilibrium will not shift as the partial pressure of all gaseous reactants and products remain constant.
- **B** The position of equilibrium will not shift as argon does not react with any substance in the mixture.
- **C** The position of equilibrium will shift to the right to decrease total pressure.
- **D** The position of equilibrium will shift to the left to increase total pressure.

14 A solution of 1 mol dm<sup>-3</sup> of weak acid is diluted with large excess of water at 25 °C. Which of the following graph correctly shows how the pH of the solution varies with volume of mixture, V?

8



15 Zn<sup>2+</sup> ions combine with hexacyanoferrate(III), [Fe(CN)<sub>6</sub>]<sup>3-</sup>, to produce a sparingly soluble salt, Zn<sub>3</sub>[Fe(CN)<sub>6</sub>]<sub>2</sub>.

Given than the  $K_{\text{sp}}$  value for the salt is  $\bm{W},$  what is the concentration of the anion at equilibrium?



**16** A solution of cysteine in its *fully protonated* form is titrated against a standard solution of potassium hydroxide. The structure of *fully protonated* cysteine is shown below and its 3 pK<sub>a</sub> values are 1.9, 8.1 and 10.3.



Which of the following indicator(s) can be used to detect the isoelectric point of the cysteine?

	Indicator	Working range
1	Bromocresol Green	3.7 – 5.7
2	Methyl Red	4.1 – 6.1
3	Bromothymol Blue	6.0 - 8.0
4	Phenol Red	6.9 - 8.9

Α	1 and 2	В	2 and 3	С	3 and 4	D	1 only
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17 X, Y and Z are elements in Period 3 of the Periodic Table.

The results of some experiments carried out on respective chlorides and oxides of these elements are shown in the table below.

Element	Addition of H <sub>2</sub> O(I) to the oxides	Colour of universal indicator upon addition of H <sub>2</sub> O(I) to chlorides	Addition of HC <i>l</i> to the oxides	
X	no reaction	orange	forms chloride salt	
Y	forms hydroxide	green	forms chloride salt	
Z	no reaction	red	no reaction	

Which of the following is correct?

- **A X** is A*l* and **Y** is Na.
- **B** X is Si and Y is Mg
- **C Y** is Al and **Z** is **P**.
- **D Y** is Na and **Z** is Al.

**18** CaCO<sub>3</sub> decomposes at 825°C to produce  $CO_2$  and the metal oxide.

BaSO<sub>4</sub> decomposes at 1580 °C to produce SO<sub>2</sub> and the metal oxide.

Which one of the following statements correctly explains the greater thermal stability of  $BaSO_4$ ?

- 1 The CO<sub>2</sub> molecule is smaller than SO<sub>2</sub>.
- 2 The  $CO_3^{2-}$  ions are more easily polarised than  $SO_4^{2-}$ .
- **3** The charge density of  $Ca^{2+}$  is greater than that of  $Ba^{2+}$ .
- 4 The lattice energy of  $CaCO_3$  is more exothermic than  $CaSO_4$ .
- A 2 only
- B 3 only
- C 1 and 3 are correct.
- D 2 and 4 are correct.
- **19** A reaction scheme starting from aqueous copper(II) sulfate solution is shown below. Both **P** and **Q** are copper-containing species.



Copper complex with Isoxazole Schiff base

Which one of the following statements is incorrect?

- A The copper complex with isoxazole schiff base has a coordination number of 4.
- **B** The copper centre in the complex with isoxazole schiff base has an oxidation state of +2.
- **C Q** is a deep blue solution containing  $[Cu(NH_3)_4(H_2O)_2]SO_4$ .
- **D Q** undergoes reduction in reaction **III**.

**20** An alkane **X** with the molecular formula C<sub>4</sub>H<sub>10</sub> reacts with chlorine gas in the presence of light to form two monochlorinated alkanes **Y** and **Z** in the molar ratio of 9:1.

	X	Z
Α	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> Cl
В	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>	CH <sub>3</sub> CH <sub>2</sub> CHC/CH <sub>3</sub>
С	CH <sub>3</sub> CH(CH <sub>3</sub> )CH <sub>3</sub>	CH <sub>3</sub> CC/(CH <sub>3</sub> )CH <sub>3</sub>
D	CH <sub>3</sub> CH(CH <sub>3</sub> )CH <sub>3</sub>	CH <sub>3</sub> CH(CH <sub>3</sub> )CH <sub>2</sub> Cl

What are the structures of X and Z?

**21** Ergosterol is a compound present in ergot and many other fungi. A steroid alcohol, it is converted to vitamin D<sub>2</sub> when irradiated with ultraviolet light.



Ergosterol

How many possible stereoisomers exist for Ergosterol?

**A**  $2^8$  **B**  $2^9$  **C**  $2^{10}$  **D**  $2^{11}$ 

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**22** A mixture of propyne and propadiene is produced as side products during the cracking of propane. Propyne exists in equilibrium with propadiene.

 $\begin{array}{c} H-C \equiv C-CH_3 \rightleftharpoons H_2C = C = CH_2 \\ Propyne & Propadiene \end{array}$ 

Which of the following statements is incorrect?

- **A** Propyne contains a  $\sigma$  bond formed by 1s-2sp overlap.
- **B** Propadiene contains a  $\pi$  bond formed by 2p-2p overlap.
- **C** Both propyne and propadiene contain sp hydridised carbons.
- **D** Propyne has a longer C-C single bond compared to propane.
- **23** The reaction conditions for four different transformations are given below. Which transformation will give the desired product?



Conc. HNO<sub>3</sub> NO<sub>2</sub>
Conc. HCI Heat
NH<sub>2</sub>



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24 The primary application of hexabromocyclododecane (HBCD) is in polystyrene foam used as thermal insulation in the building industry. Usage of HBCD is under concern due to its toxicity. As HBCD has a number of possible stereoisomers, the substance poses a difficult problem for manufacture and regulation.



Which statements about HBCD are correct?

- 1 The stereoisomers of HBCD have similar chemical and biological properties.
- 2 The empirical formula of HBCD is  $C_2H_3Br$ .
- 3 The molecule is planar.
- **A** 2 only **B** 3 only **C** 2 and 3 only **D** 1, 2 and 3
- 25 Compound **G** has the following structure.



Which of the statement is correct about the following reactions with 1 mole of compound  $\mathbf{G}$ ?

	Reagent	Result
Α	excess sodium metal	3 moles of H <sub>2</sub> produced
в	hot acidified potassium dichromate(VI)	green solution was obtained
С	aqueous sodium hydroxide	anion in the product has a charge of 2
D	excess propanoyl chloride	2 moles of HC <i>l</i> produced

[Turn Over]

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

Reduction of **Y** with lithium aluminum hydride produces **Z** with a relative molecular mass 12 less than **Y**, i.e.  $M_r(Z) = M_r(Y) - 12$ .

Which of the following could be compound **Y**?

- 1 CH<sub>2</sub>=CHCO<sub>2</sub>H
- 2 CH<sub>3</sub>CH<sub>2</sub>COCO<sub>2</sub>H
- 3 CH<sub>3</sub>CH<sub>2</sub>CONH<sub>2</sub>
- **A** 1 only **B** 2 only **C** 1 and 2 **D** 1, 2 and 3
- 27 Which of the following will **not** yield a final organic product containing deuterium?  $(D = {}^{2}H)$ 
  - A CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>CHO <u>DCN, trace</u> amount of NaCN
  - **B**  $CH_3CH_2CH_2COCl$   $D_2O$
  - **C**  $CH_3CH_2CH_2CON(CH_3)_2 \xrightarrow{DCl, D_2O}{heat}$
  - **D**  $CH_3CH_2CH_2CN$   $\xrightarrow{NaOD, D_2O}_{heat}$



**28** Consider the following four compounds:

Which of the following shows the compounds arranged in order of increasing  $pK_b$  value?

- **A** 3, 4, 1, 2
- **B** 2, 1, 4, 3
- **C** 2, 1, 3, 4
- **D** 1, 2, 4, 3
- **29** A peptide contains seven amino acid residues. When it is partially hydrolysed, the following dipeptide and tripeptide fragments are produced.

gly-ser, ala-met, gly-ala-gly, ser-lys, met-gly-ala

What could be the structure of this peptide?

- A ala-met-gly-ala-gly-ser-lys
- B gly-ser-lys-ala-met-gly-ala
- C gly-ala-gly-ser-lys-ala-met
- D met-gly-ala-gly-ser-lys-ala

**30** The aldol condensation reaction is commonly used in synthetic organic chemistry to obtain a carbonyl compound. In the first step, a carbonyl compound reacts with a strong base at the  $\alpha$  carbon to form a nucleophile.



Which of the following is **not** a possible product when butanone and ethanal reacts with a strong base?



butanone

ethanal





