

CANDIDATE NAME		CLASS	19S
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ST ANDREW'S JUNIOR COLLEGE



JC2 Preliminary Examination

CHEMISTRY

9729/01

Paper 1 Multiple Choice

September 2020

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.

Write your name and class on the Answer Sheet in the spaces provided.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.

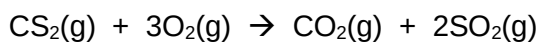
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer sheet.

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.

- 1 Carbon disulfide, CS_2 , burns in oxygen according to the following equation.



10 cm^3 of carbon disulfide was completely burnt in 50 cm^3 of oxygen. The resulting mixture was then treated with excess of aqueous sodium hydroxide.

All measurements of volume were made at the same temperature and pressure in which all the reactants and products were in the gaseous state.

What was the volume of the gas after burning and after adding $\text{NaOH}(\text{aq})$?

	volume of gas after burning / cm^3	volume of gas after adding $\text{NaOH}(\text{aq})$ / cm^3
A	30	10
B	30	20
C	50	20
D	50	40

- 2 1 mole of $\text{X}_2\text{O}_3^{2-}$ oxidised 68.1 dm^3 of sulfur dioxide gas to sulfate ions at standard temperature and pressure.

What is the final oxidation state of **X**?

- A** -2 **B** -1 **C** +1 **D** +2

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

Which species have the same number of unpaired electrons as chlorine atom?

- 1 Li^+
- 2 Mg^+
- 3 O^-
- 4 F^-

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

- 4 Hospitals require large amount of oxygen gas in the treatment of patients with respiratory symptoms. Oxygen is liquefied under pressure and stored in special cylinders. It vapourises when pressure is released.

Which statement best describes why oxygen gas liquefies under pressure?

- A High pressure lowers the kinetic energy of oxygen molecules, creating less disordered liquid state.
- B High pressure pushes the molecules closer for more effective intermolecular interactions.
- C High pressure causes the temperature of oxygen gas to increase above its boiling point.
- D High pressure decreases the total volume occupied by the oxygen molecules.

5 Which species contain a dative (co-ordinate) bond?

1 CO

2 CO_3^{2-}

3 N_2H_4

4 N_2O_4

A 2, 3 and 4

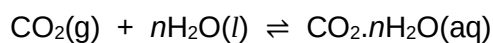
B 1 and 2 only

C 1 and 4 only

D 3 and 4 only

6 One proposed strategy to reduce the amount of greenhouse gases in the atmosphere is to capture carbon dioxide emissions from fossil fuel power plants and pump them into the deep ocean bed.

Under the extreme high pressure of the deep ocean bed, carbon dioxide would dissolve in water and stay out of the atmosphere.



What will be the signs of ΔH and ΔS for the forward reaction of this equilibrium at the deep ocean bed?

	ΔH	ΔS
A	–	–
B	–	+
C	+	–
D	+	+

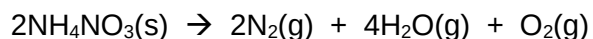
- 7 The table shows the charge and radius of each of six ions.

ion	J ⁺	L ⁺	M ²⁺	X ⁻	Y ⁻	Z ²⁻
radius / nm	0.14	0.18	0.16	0.14	0.18	0.16

The ionic solids JX, LY and MZ are of the same lattice type.

What is the correct order of their lattice energies, placing the **least** exothermic first?

- A JX, LY , MZ
- B JX, MZ, LY
- C LY, JX, MZ
- D LY, MZ, JX
- 8 Ammonium nitrate is commonly used in making of fertilisers.

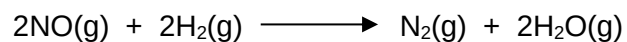


The decomposition of ammonium nitrate at 230°C give gases. It is a first-order reaction with a half-life of 10 min.

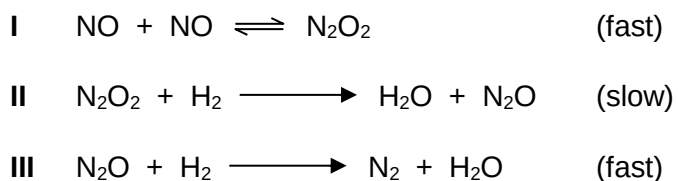
Explosion happens when the molar proportion of ammonium nitrate to gases is 1:14. How long would it take for ammonium nitrate to explode at 230°C?

- A 23 min
- B 35 min
- C 70 min
- D 80 min

- 9 The reaction of nitrogen monoxide and hydrogen gas,

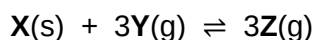


involves the following steps:



Which statements about the reaction are **correct**?

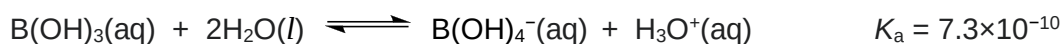
- 1 N_2O acts as the catalyst.
 - 2 The reaction is second order with respect to $[\text{NO}]$.
 - 3 The units of the rate constant is $\text{mol}^{-3} \text{dm}^9 \text{s}^{-1}$.
 - 4 When partial pressure of H_2 doubles, rate of reaction quadruples.
- A 1, 2 and 3
- B 1 and 3 only
- C 2 and 4 only
- D 2 only
- 10 Given that the K_p for the following equilibrium is 125 at 65°C ,



What is the mole ratio of **Y : Z** at equilibrium at 65°C ?

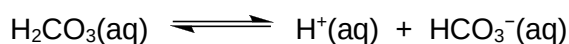
- A 1 : 1
- B 1 : 5
- C 25 : 1
- D 125 : 1

- 11** Boric acid, B(OH)_3 , is often used as an antiseptic and as a precursor to other chemical compounds. The following equilibrium illustrates the acidity of boric acid.



NaB(OH)_4 is a weak base. What is the pH of $0.20 \text{ mol dm}^{-3} \text{ NaB(OH)}_4(\text{aq})$?

- A** 9.1
B 9.4
C 11.2
D 13.3
- 12** Human plasma is buffered mainly by dissolved CO_2 , which reacts to form carbonic acid, H_2CO_3 .



Given that the pH of human plasma is 7.4 and the acid dissociation constant, K_a , of carbonic acid is $8 \times 10^{-7} \text{ mol dm}^{-3}$, which statements are correct?

- 1 The ratio of $[\text{HCO}_3^-]$ to $[\text{H}_2\text{CO}_3]$ in human plasma is 20 : 1.
 - 2 The human plasma has a maximum buffer capacity at around pH 6.
 - 3 This buffer system is more efficient in removing acid than base.
 - 4 This buffer system can be prepared by mixing suitable amounts of sodium hydrogencarbonate and sodium hydroxide.
- A** 1, 2 and 3
B 1 and 3 only
C 2 and 4 only
D 3 only

- 13** Values of two solubility products of copper carbonate, CuCO_3 , and neodymium carbonate, $\text{Nd}_2(\text{CO}_3)_3$ are given.

$$K_{\text{sp}} (\text{CuCO}_3) = 1 \times 10^{-10} \text{ mol}^2 \text{ dm}^{-6}$$

$$K_{\text{sp}} (\text{Nd}_2(\text{CO}_3)_3) = 1 \times 10^{-33} \text{ mol}^5 \text{ dm}^{-15}$$

Solid copper carbonate is shaken with water. The remaining solid is filtered off, leaving a saturated solution X.

Drops of dilute aqueous neodymium nitrate are added to X until neodymium carbonate just precipitates.

Which row of the table is correct?

	$[\text{CO}_3^{2-}]$ in X / mol dm^{-3}	$[\text{Nd}^{3+}(\text{aq})]$ when $\text{Nd}_2(\text{CO}_3)_3$ just precipitates / mol dm^{-3}
A	1×10^{-5}	1×10^{-9}
B	1×10^{-5}	1×10^{-18}
C	5×10^{-11}	8×10^{-3}
D	5×10^{-11}	9×10^{-2}

- 14** Which statement about Period 3 elements and their oxides is **false**?

- A** The resultant pH of the oxides in water decrease across the period.
- B** The melting points of elements decrease across the period.
- C** The covalent character of oxides increase across the period.
- D** The maximum oxidation state of elements increases across the period.

- 15** Which property generally increases down Group 2?

- A** sum of the first and second ionisation energies
- B** reactivity of metal with cold water
- C** polarising power of the cation
- D** oxidising power of the cation

- 16** X_2 , Y_2 and Z_2 are bromine, chlorine and iodine but not necessarily in the order given while X^- , Y^- and Z^- are their corresponding halide ions.

The table below shows the observations of two experiments involving the addition of these halogens to separate aqueous solutions containing the halide ions, followed by the addition of an organic solvent.

Experiment	Reactions	Observations
1	$X_2(aq) + Y^-(aq)$	violet organic layer
2	$Z_2(aq) + X^-(aq)$	violet organic layer

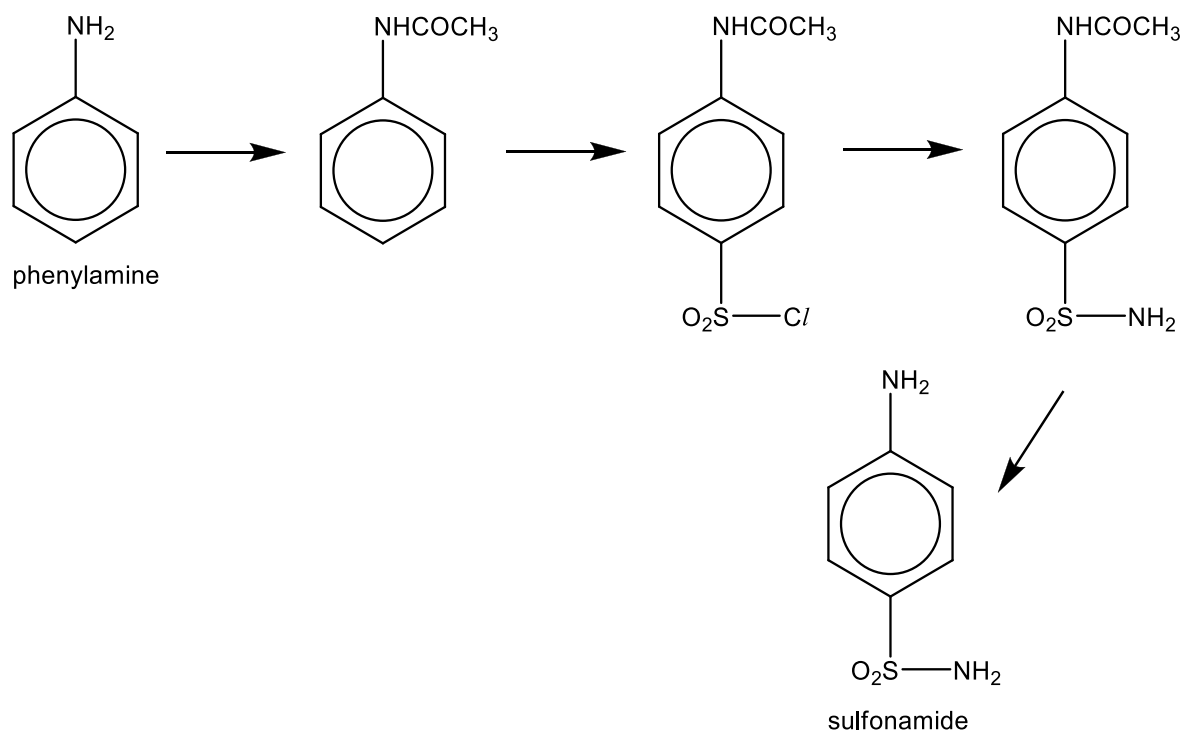
Which statement is correct?

- A** Reaction of $X_2(aq)$ with $Z^-(aq)$ would produce a different observation from experiments 1 and 2.
- B** Displacement took place in both experiments 1 and 2.
- C** X^- is a weaker reducing agent than both Y^- and Z^- .
- D** H-X bond is weaker than H-Y and H-Z bond.

Q17 and 18 will make reference to the structure of sulfonamide and its synthesis.

17 Sulfonamides are one of the earliest antimicrobial drugs developed in the laboratory.

The following scheme shows a synthesis of sulfonamide from phenylamine.



Which reactions are involved in the above synthesis?

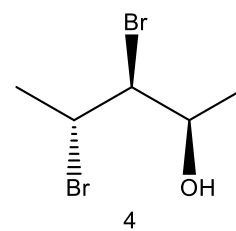
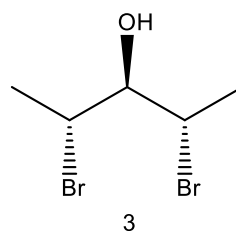
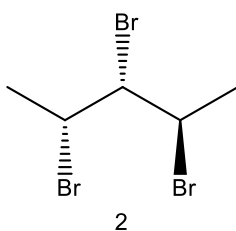
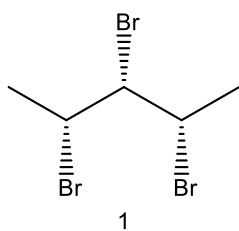
- 1 Oxidation
 - 2 Hydrolysis
 - 3 Elimination
 - 4 Substitution
- A** 1 and 3
- B** 2 and 3
- C** 2 and 4
- D** 4 only

18 Which bond angles are present in sulfonamide?

- 1 105°
- 2 107°
- 3 109.5°
- 4 120°

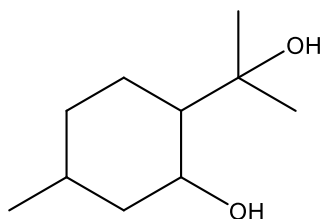
- A 2, 3 and 4
- B 2 and 3 only
- C 1 and 3 only
- D 1 only

19 Which molecules are optically **inactive**?



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

- 20 Citriodiol is an active ingredient in insect repellent extracted from the lemon eucalyptus tree. It has the following structure.



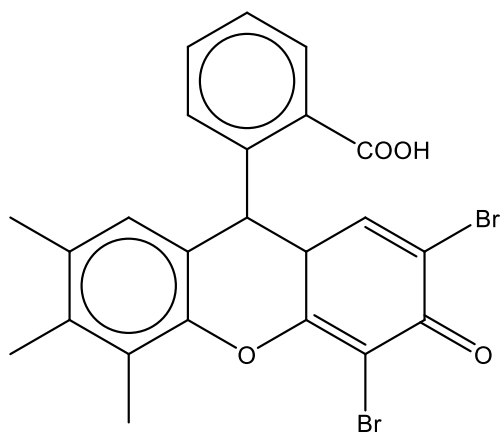
citriodiol

Citriodiol is heated under reflux with acidified potassium dichromate (VII) to form compound **E**.

Which reagent reacts with **both** citriodiol and compound **E**?

- A aqueous sodium bromide
- B 2,4-dinitrophenylhydrazine
- C warm alkaline aqueous iodine
- D hot concentrated sulfuric acid

- 21** The classic red colour from many lipsticks are obtained from pigments and dyes, such as the compound eosin. Eosin reacts with proteins on the skin to produce a deep red colour.



eosin

Eosin was reduced separately by LiAlH_4 and by $\text{H}_2 + \text{Pt}$.

What is the number of hydrogen atoms added to each molecule of eosin?

	LiAlH_4	$\text{H}_2 + \text{Pt}$
A	2	2
B	2	4
C	4	6
D	6	6

- 22** Alkanes can undergo free radical substitution with liquid bromine to produce mono-substituted bromoalkanes.

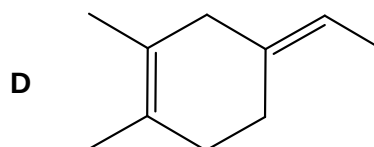
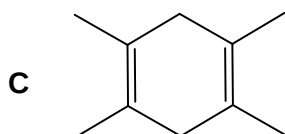
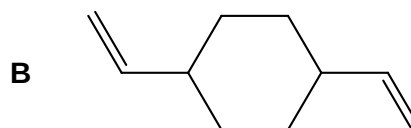
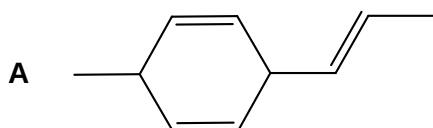
Which row gives the correct number of mono-substituted bromoalkanes produced and their relative proportions when 2,4-dimethylpentane reacts with bromine?

	number of mono-substituted bromoalkanes	relative proportions
A	3	1 : 1 : 6
B	3	2 : 3 : 3
C	4	1 : 1 : 6 : 6
D	4	1 : 2 : 3 : 3

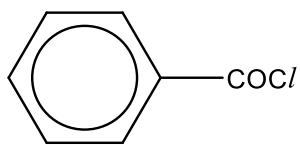
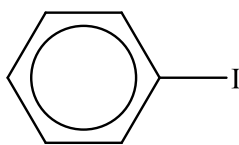
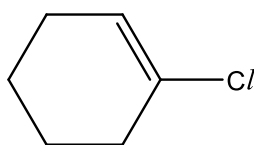
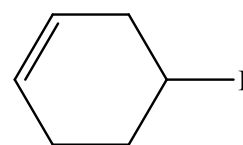
- 23** Alkene **G** was heated with excess acidified $\text{KMnO}_4(\text{aq})$. The resultant solution was cooled and separated into two test-tubes. Two reagents were added separately to each test-tube, with the observations recorded in the table below.

Reagent	Observations
Na_2CO_3	Effervescence. Gas evolved gave white precipitate with $\text{Ca}(\text{OH})_2(\text{aq})$.
2,4-DNPH	Orange precipitate formed.

What is the structure of alkene **G**?



- 24 Equal amounts of **P**, **Q**, **R** and **S** are added separately to four test-tubes containing equal concentrations of ethanolic silver nitrate solution in a heated water bath.

**P****Q****R****S**

Which option is correct?

	number of test-tubes with no precipitate	colour of the precipitate which forms the fastest
A	2	yellow
B	2	white
C	1	yellow
D	1	white

- 25 Carbonyl compounds undergo nucleophilic addition reaction with HCN.

What is the hybridisation state of the reactive carbon in the organic reactant, intermediate and product during the reaction?

	hybridisation state of carbon in		
	reactant	intermediate	product
A	sp^2	sp^2	sp^2
B	sp^2	sp^3	sp^2
C	sp^2	sp^3	sp^3
D	sp^3	sp^2	sp^3

- 26** Diester **T** has the molecular formula $C_7H_{12}O_4$.

One of the products from acid hydrolysis of **T** produces no effervescence when heated with acidified $KMnO_4(aq)$.

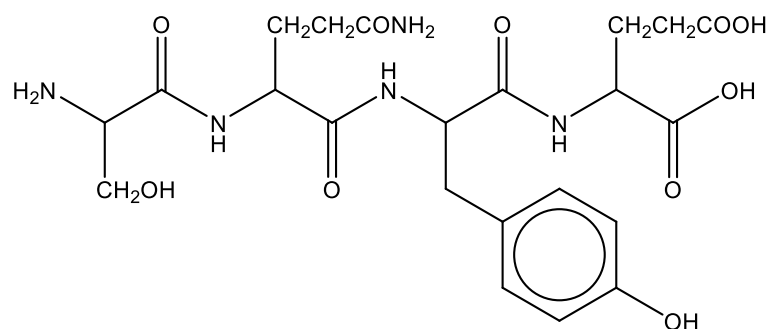
Which of the following structures can be compound **T**?

- A** $CH_3CO_2CH_2CH_2OCOCH_2CH_3$
- B** $CH_3CH_2CO_2CH_2CO_2CH_2CH_3$
- C** $CH_3OCOCH_2CH_2CO_2CH_2CH_3$
- D** $CH_3CH_2OCOCH_2CO_2CH_2CH_3$
- 27** The internal combustion engine catalytically removes harmful compounds.

Which statement about the catalytic removal of these compounds is **incorrect**?

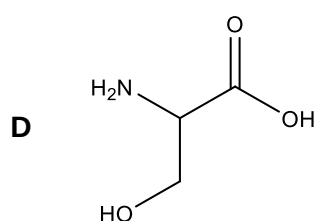
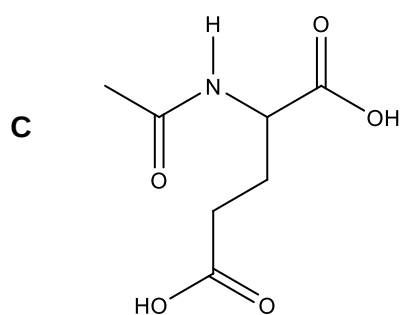
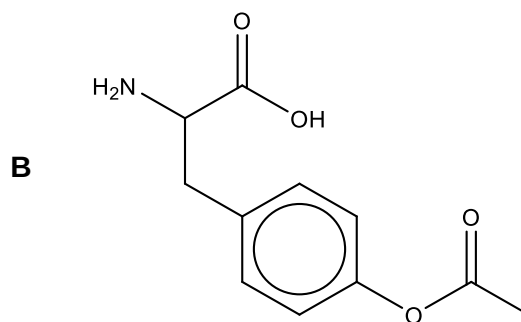
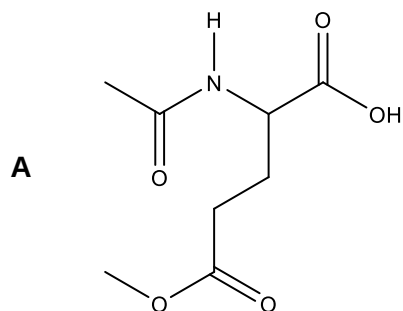
- A** Carbon monoxide is oxidised.
- B** Unburnt hydrocarbon is oxidised.
- C** Water is produced.
- D** Nitrogen dioxide is produced.

28 The diagram shows the structure of a tetrapeptide, **J**.



J is heated with aqueous NaOH under reflux, followed by careful acidification. Each product is isolated and warmed separately with excess ethanoyl chloride in an inert solvent, to produce compound **L**.

Which is a possible structure of **L**?



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

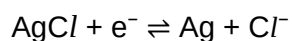
Which pair of compounds has d-block elements (Ti, V, Cr and Mn) with the same electronic configuration?

- 1 TiCl_3
- 2 $(\text{NH}_4)_3\text{VO}_4$
- 3 $\text{Cr}_2(\text{SO}_4)_3$
- 4 MnO_2

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

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

The half equation involved in the AgCl / Ag reference electrode is



The reduction potential of $\text{V}^{3+} / \text{V}^{2+}$ half-cell is -0.46 V when it is measured using the AgCl / Ag reference electrode at standard conditions.

What is the reduction potential of AgCl / Ag electrode when it is measured with the standard hydrogen electrode?

- A** $+0.80\text{V}$
- B** $+0.20\text{V}$
- C** -0.26V
- D** -0.76V