

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CHEMISTRY

9729/01

Paper 1 Multiple Choice

23 September 2019

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, CT and NRIC / FIN on the Answer Sheet in the spaces provided.

There are **thirty** questions in 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.

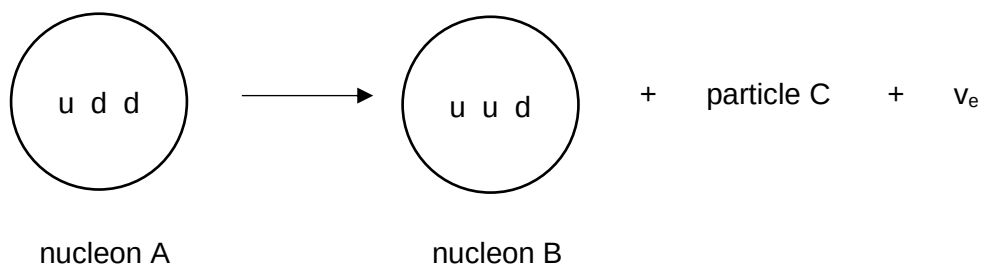
- 1 4th July 2012, the discovery of the Higgs boson validated the Standard Model of elementary particles, a widely accepted framework for understanding sub-atomic particles.

In the Standard Model, nucleons can be further divided into more basic particles, called quarks. Quarks occupy spaces and have charges; some positive, some negative.

The following table list the characteristics of some sub-atomic particles in the Standard Model.

Type of particle	Symbol	Size and polarity of electronic charge, e
Up quark	u	$+\frac{2}{3}$
Down quark	d	$-\frac{1}{3}$
electron	e	-1
neutrino	ν_e	0

In a radioactive reaction, the following process occurs in the nucleus of an atom.



Which of the following statements are correct?

- 1 The charge of nucleon B is +1.
- 2 Particle C is deflected towards the positive plate in an electric field.
- 3 The process can be described by $^{22}\text{Ne} \rightarrow ^{22}\text{Na}$.

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

- 2 An oxygen candle is used to provide an emergency supply of oxygen in spacecraft. It contains sodium chlorate in a chemical mixture. When ignited, the mixture burns at 600 °C. At this temperature, thermal decomposition of the sodium chlorate occurs, releasing oxygen gas and forming sodium chloride as the only products.

When sodium chlorate decomposes, 0.150 moles of oxygen gas and 0.100 mole of sodium chloride are formed.

What is the oxidation state of chlorine in the chlorate?

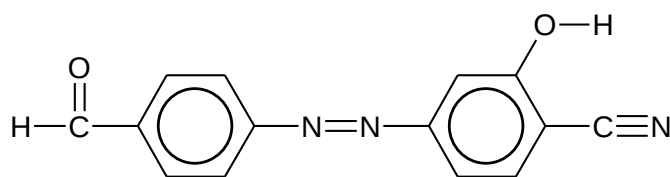
A +3 **B** +5 **C** +6 **D** +11

- 3 Cations with a high charge density can polarise adjacent anions. This results in ionic bonds with covalent character. However, if the oxidation state is high enough, a covalent bond will form instead.

Which of the following correctly lists the most ionic and the most covalent halide compounds?

	<u>Most ionic</u>	<u>Most covalent</u>
A	SnF ₂	PbCl ₄
B	PbF ₂	SnCl ₄
C	SnF ₄	PbCl ₂
D	PbF ₄	SnCl ₂

- 4 Compound Z has the following structure.



compound Z

Which bond angle is not present in a molecule of compound Z?

- A 105° B 109° C 120° D 180°
- 5 *Use of the Data Booklet is relevant to this question.*

A mass of 0.253 g of a volatile liquid is injected into a gas syringe at 97 °C. The initial reading of the gas syringe, before the injection of the liquid, is 5 cm³. The final reading, after complete vaporisation of the liquid, is 81 cm³. The temperature was kept constant at 97 °C.

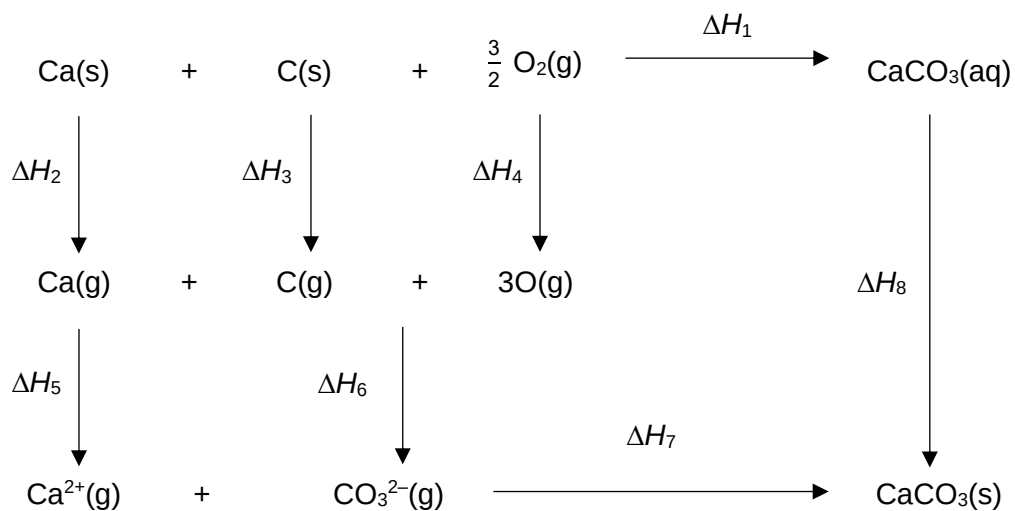
Atmospheric pressure is 1 atm.

What is the M_r of the volatile liquid?

- A 26 B 89 C 95 D 101

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

For the energy cycle given below, which enthalpy change is correctly stated?



All values are given in kJ mol^{-1} .

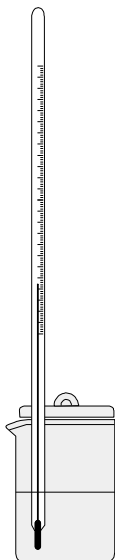
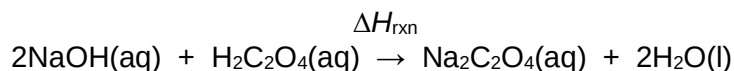
1 $\Delta H_7 = \Delta H_8 - \Delta H_{\text{hyd}}(\text{Ca}^{2+}) - \Delta H_{\text{hyd}}(\text{CO}_3^{2-})$

2 $\Delta H_5 = 1740$

3 $\Delta H_{\text{atm}}(\text{Ca}) = \Delta H_1 + \Delta H_8 - (\Delta H_3 + \Delta H_4 + \Delta H_5 + \Delta H_6 + \Delta H_7)$

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

- 7 The set-up shown is used to determine the enthalpy change of reaction for the neutralisation of oxalic acid, $\text{H}_2\text{C}_2\text{O}_4$, using a calibration method.



Experiment 1

- 50 cm³ of 2.0 mol dm⁻³ NaOH(aq) was added to 50 cm³ of 2.0 mol dm⁻³ HCl(aq).
- Temperature of solution rise by 10.0 °C.

Experiment 2

- 50 cm³ of 2.0 mol dm⁻³ NaOH(aq) was added to 50 cm³ of 2.0 mol dm⁻³ H₂C₂O₄(aq).
- Temperature of solution rise by 8.5 °C.

Using the results from experiments 1 and 2, and given standard enthalpy change of neutralisation is $-57.4 \text{ kJ mol}^{-1}$, what is the correct magnitude for the experimental value of ΔH_{rxn} in kJ mol^{-1} ?

A $\frac{57.4 \times 8.5 \times 2}{10}$

B $\frac{57.4 \times 8.5}{10 \times 2}$

C $\frac{57.4 \times 8.5}{10}$

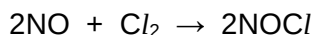
D $\frac{57.4 \times 10 \times 2}{8.5}$

- 8 For which of the following processes is the sign of $\Delta G^\ominus$ and $\Delta S^\ominus$ different?

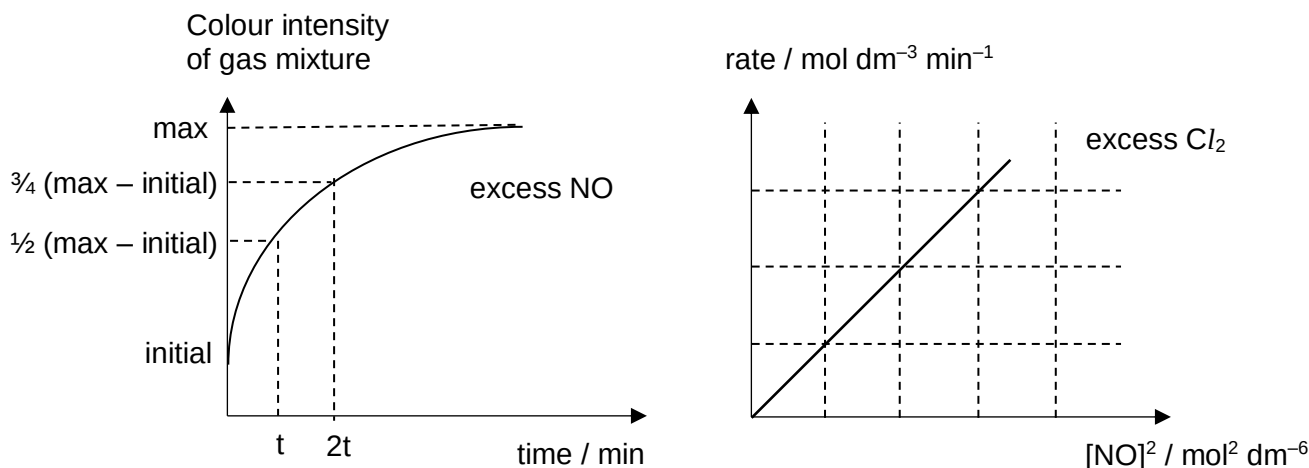
- 1 Addition of silicon chloride to water.
- 2 Bubbling chlorine gas into potassium iodide solution.
- 3 Thermal decomposition of magnesium carbonate.

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

- 9 Nitrosyl chloride, NOCl , is a yellow gas produced by the reaction of colourless nitrogen monoxide gas and chlorine gas.

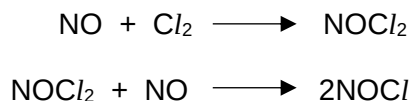


To investigate the kinetics of the production of nitrosyl chloride, experiments were carried out and the following graphs obtained.



Which of the following can be deduced from these results?

- 1 The reaction is first order with respect to Cl_2 .
- 2 A possible mechanism for the reaction is:



- 3 The rate constant has units of $\text{mol}^2 \text{dm}^{-6} \text{min}^{-1}$.

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

- 10 The decomposition of hydrogen peroxide in aqueous solution is a first order process.

If 10 % of the hydrogen peroxide in a solution of concentration 0.10 mol dm^{-3} decomposes in 5 minutes at a certain temperature, what is the concentration, in mol dm^{-3} , of a 1.00 mol dm^{-3} hydrogen peroxide solution after 5 minutes at the same temperature?

A 0.10 **B** 0.50 **C** 0.80 **D** 0.90

- 11** The pH of human blood is constant at about 7.40.

Which ion present in the human body will remove contaminating $\text{H}^+(\text{aq})$ ions from the blood to keep the pH constant?

- A** CO_3^{2-} **B** HCO_3^- **C** H_2PO_4^- **D** PO_4^{3-}

- 12** Values of three solubility products are given.

$$K_{\text{sp}} (\text{AgIO}_3) = 3.2 \times 10^{-8} \text{ mol}^2 \text{ dm}^{-6}$$

$$K_{\text{sp}} (\text{Ag}_2\text{CrO}_4) = 9.0 \times 10^{-12} \text{ mol}^3 \text{ dm}^{-9}$$

$$K_{\text{sp}} (\text{Ag}_3\text{AsO}_4) = 1.0 \times 10^{-22} \text{ mol}^4 \text{ dm}^{-12}$$

A conical flask contains 0.10 mol dm^{-3} potassium iodate(V), 0.10 mol dm^{-3} potassium chromate(VI) and 0.10 mol dm^{-3} potassium arsenate(V), all in solution together.

Drops of aqueous silver nitrate were added incrementally until the first precipitate appears.

What is the concentration of silver ions, in mol dm^{-3} , present?

- A** 9.5×10^{-6}
B 3.2×10^{-7}
C 1.0×10^{-7}
D 3.3×10^{-8}

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

Free energy change of a reduction half-equation is related to the standard electrode potential by the equation.

$$\Delta G^\ominus = -nFE^\ominus$$

The free energy, $-\Delta G^\ominus/F$, for the reduction of uranium species are given in the table.

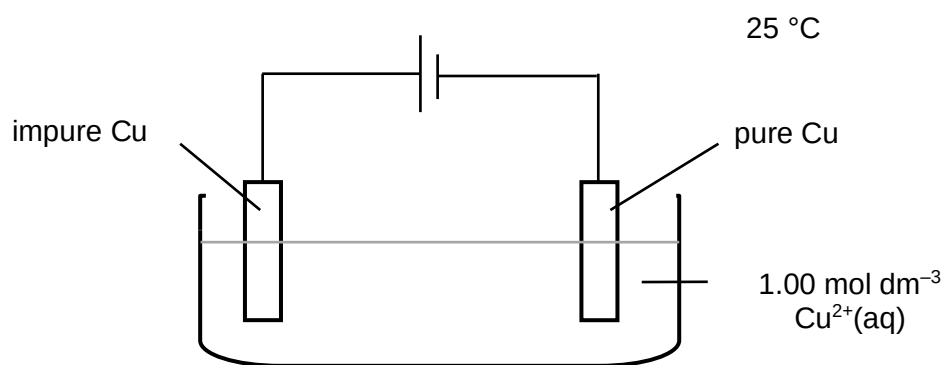
half-equation	$-\Delta G^\ominus/F$ (V)
$\text{UO}_2^{2+} + \text{e}^- \rightleftharpoons \text{UO}_2^+$	+0.16
$\text{UO}_2^+ + 4\text{H}^+ + \text{e}^- \rightleftharpoons \text{U}^{4+} + 2\text{H}_2\text{O}$	+0.27
$\text{U}^{4+} + \text{e}^- \rightleftharpoons \text{U}^{3+}$	-0.52
$\text{U}^{3+} + 3\text{e}^- \rightleftharpoons \text{U}$	-4.98

Units of $-\Delta G^\ominus/F$ are in voltage, V.

Excess magnesium powder was added to 1.0 mol dm^{-3} solution of UO_2^{2+} at 25°C . What is the stable species of uranium formed?

- A** U **B** U^{3+} **C** U^{4+} **D** UO_2^{2+}

- 14** An electrolytic cell is set up for the purification of a mass of impure copper as shown.



The sample of impure Cu is known to contain nickel and silver as minor impurities.

Which of the following factor, when used in a larger quantity, results in more pure copper deposit on the cathode?

- A** concentration of Cu²⁺ electrolyte
 - B** current
 - C** mass of impure Cu
 - D** surface area of pure Cu
- 15** In addition to the Group 2 elements, several elements behave similarly in forming only cations with +2 charge.

On losing two electrons, which of the following element acts as the strongest reducing agent?

- | | | | |
|-------------|-------------|-------------|-------------|
| A Cd | B Ni | C Sr | D Zn |
|-------------|-------------|-------------|-------------|

- 16** Transition metal ions can react in a number of different ways. Listed are three different reactions of transition metal ions with relevant observations.

Which observation is due to ligand exchange only?

- 1** When a yellow solution of ammonium vanadate(V) is added to zinc powder, the solution changes colour eventually to violet as vanadium(II) ions are made.
- 2** When a purple solution of chromium(III) sulfate is warmed, a green solution containing $[\text{Cr}(\text{H}_2\text{O})_5\text{SO}_4]^+$ is made.
- 3** When a pink solution of cobalt(II) ions is added to tartrate ions, $^-\text{OOCCH}_2(\text{OH})\text{CH}_2(\text{OH})\text{COO}^-$, followed by hydrogen peroxide solution, a green solution of $[\text{Co}(\text{OOCCH}_2(\text{OH})\text{CH}_2(\text{OH})\text{COO})_3]^{3-}$ is made which eventually returns to a pink solution again.

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

- 17** An aqueous solution containing both potassium chloride and potassium iodide is treated with an excess of aqueous silver nitrate. The precipitate formed is filtered off and washed with distilled water. The precipitate is then shaken with aqueous ammonia and filtered off again.

Which ion is present in the final filtrate?

- A** chloride
- B** iodide
- C** potassium
- D** silver

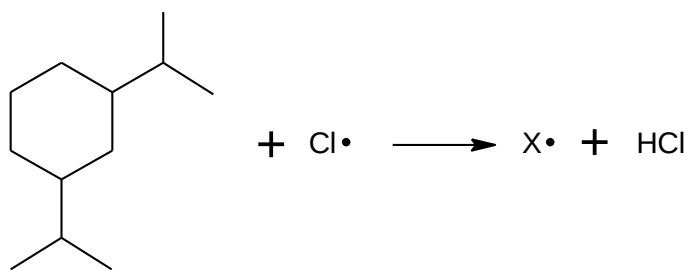
18 An organic molecule has

- the composition, by mass, C, 40%; H, 6.7%; O, 53.3%,
- the ability to rotate plane polarised light,
- no cyclic structure.

What is the smallest number of carbon atoms this molecule can have?

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

19 When heated with chlorine, the hydrocarbon 1,3-diisopropylcyclohexane undergoes free radical substitution. In a propagation step, the free radical $X\cdot$ is formed by the loss of one hydrogen atom.



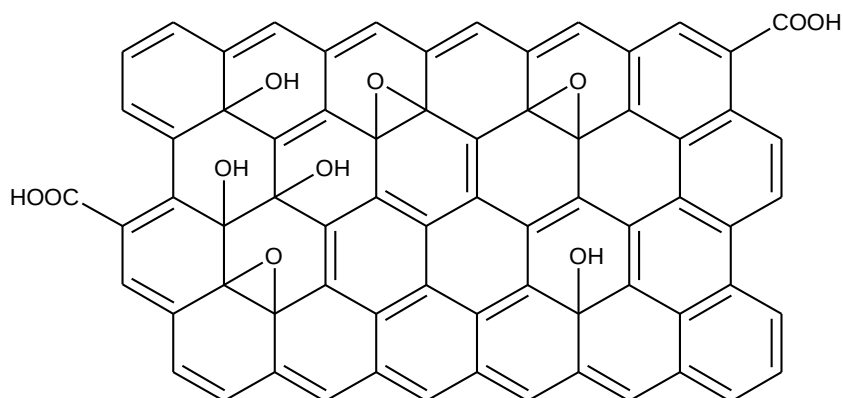
1,3-diisopropylcyclohexane

How many different forms of $X\cdot$ are theoretically possible?

- A** 6 **B** 7 **C** 8 **D** 9

- 20** A. Geim and K. Novoselov shared the 2010 Nobel prize for the discovery and characterisation of graphene, which is a single layer of graphite. A graphene sheet is 100 times stronger than steel, and conducts heat and electricity efficiently.

More recently, oxygen atoms have been added to graphene in order to modify its physical properties. A graphene sheet is normally non-polar and impermeable to all gases and liquids. A graphene oxide layer, however, will allow water molecules to pass through.

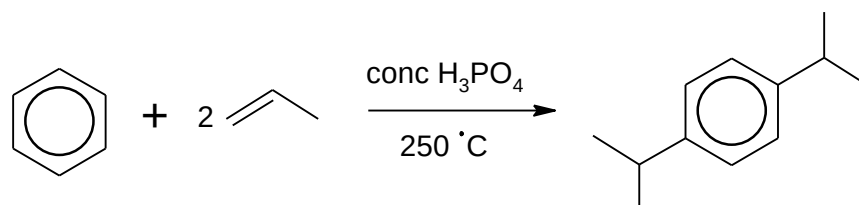


example of a graphene oxide layer

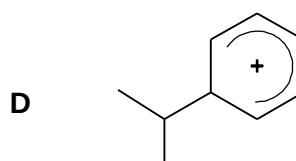
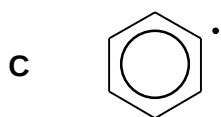
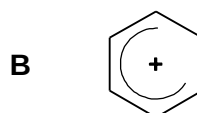
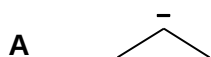
Which of the following statement is incorrect?

- A** A graphene sheet is insoluble in water.
- B** A graphene sheet is very strong as overlapping p-orbitals on the carbon atoms strengthens the C–C bonds.
- C** All carbon atoms in a graphene oxide layer are on the same plane.
- D** There are σ bonds formed by $2sp^2$ – $2sp^3$ overlap in a graphene oxide layer.

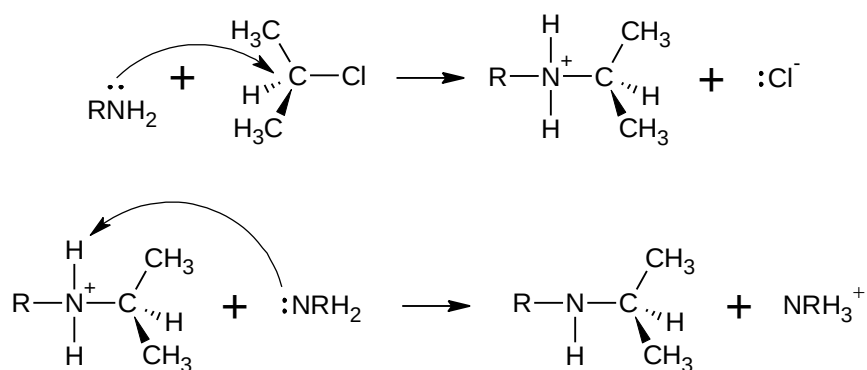
- 21** The following industrial reaction involves benzene and propene.



Which of the following intermediate is likely formed in this reaction.



- 22** Amines can react in various ways in organic reactions: as nucleophiles, Brønsted bases and oxidising and reducing agent.



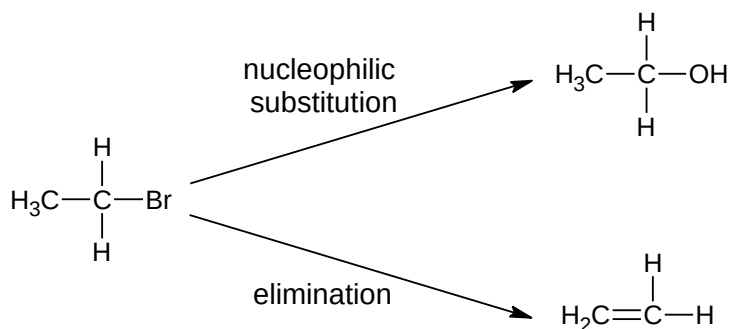
In the reaction mechanism shown, what are the ways in which amines react as?

- 1 Nucleophile
- 2 Brønsted base
- 3 Oxidising agent

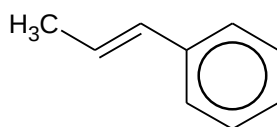
- A** 1, 2 and 3 **B** 1 and 2 only **C** 2 and 3 only **D** 1 only

- 23** A halogenoalkane can react with hydroxide ions, OH^- , in two ways,

- to form an alcohol in a nucleophilic substitution reaction, or
- to form an alkene in an elimination reaction.



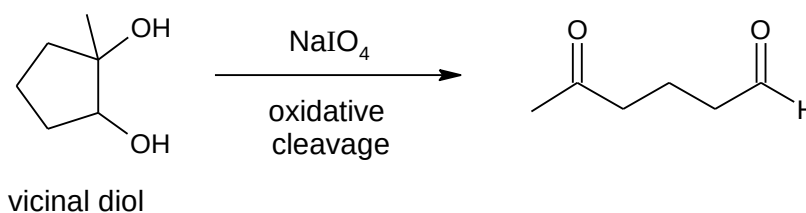
Compound H has the structure shown.



Which of the following halogenoalkane and solvent pair, when reacted with OH^- , will give the best yield for compound H?

	halogenoalkane	solvent
A	<chem>CC(Br)Cc1ccccc1</chem>	<chem>CC(C)(C)O</chem>
B	<chem>CC(C)CC(Br)c1ccccc1</chem>	<chem>CC(C)(C)O</chem>
C	<chem>CC(Br)Cc1ccccc1</chem>	<chem>O</chem>
D	<chem>CC(C)CC(Br)c1ccccc1</chem>	<chem>O</chem>

- 24** Vicinal diols are organic compounds where there are two –OH groups on adjacent carbons. On treatment with sodium periodate, NaIO_4 , the carbon-carbon bond between the two diols is cleaved to form aldehydes or ketones.



A vicinal diol, D, which contains six carbon atoms, reacts with NaIO_4 to form compounds E and F.

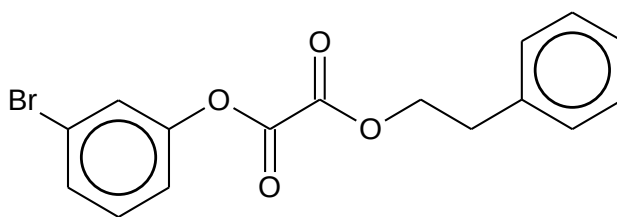
Compound E gives a yellow precipitate with alkaline aqueous iodine.

Compound F gives a red-brown precipitate with alkaline Cu^{2+} solution.

What is the organic product formed when D is warmed with acidified $\text{K}_2\text{Cr}_2\text{O}_7$?

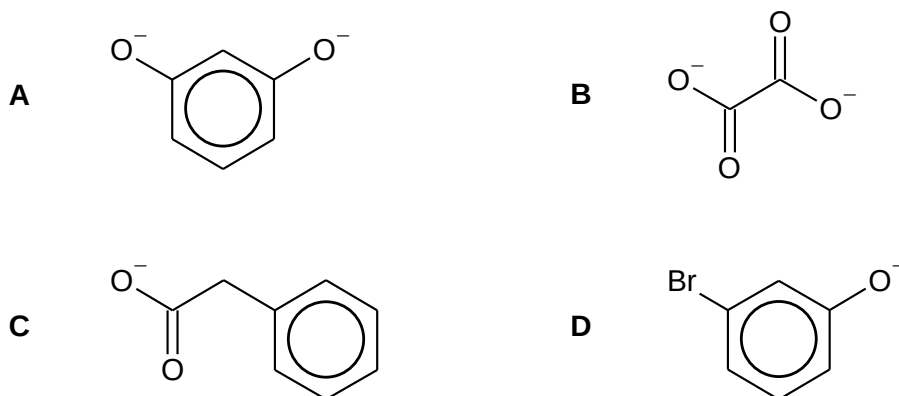
- A** $\text{HOOCCH}_2\text{CH}_2\text{CH}_2\text{COCH}_3$
- B** $\text{CH}_3\text{CH}(\text{OH})\text{COCH}_2\text{CH}_2\text{CH}_3$
- C** $(\text{CH}_3)_2\text{C}(\text{OH})\text{COCH}_2\text{CH}_3$
- D** $\text{HOCCOC}(\text{CH}_3)_3$
- 25** Which liquid is the best conductor of electricity?
- A** aqueous pyruvic acid, $\text{CH}_3\text{COCO}_2\text{H}$ with a concentration of 1 mol dm^{-3}
- B** aqueous propanoic acid, $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$ with a concentration of 1 mol dm^{-3}
- C** aqueous ethanoic acid, $\text{CH}_3\text{CO}_2\text{H}$ with a concentration of 1 mol dm^{-3}
- D** pure ethanoic acid

- 26 Compound K reacts with hot alkaline aqueous manganate(VII).

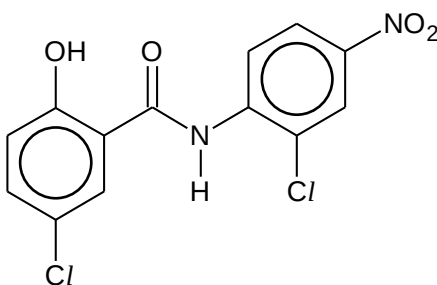


compound K

Which of the following compound is formed?



- 27 Niclosamide is an essential medicine used in the treatment of tapeworm infestations.

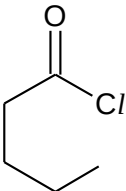
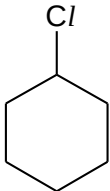
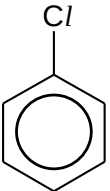


niclosamide

Which of the following reducing agent does not react with niclosamide?

- A** H_2 with Ni metal
- B** LiAlH_4 in dry ether
- C** NaBH_4 in ethanol
- D** Sn in concentrated HCl

- 28** One mole of each of the following compounds was boiled with NaOH (aq) for two minutes, and then dilute HNO₃ (aq) and AgNO₃ (aq) were added. The appearance of the precipitate was recorded.

P	Q	R
		
Thick fluffy mass of white precipitate formed.	Some white precipitate formed.	No precipitate observed.

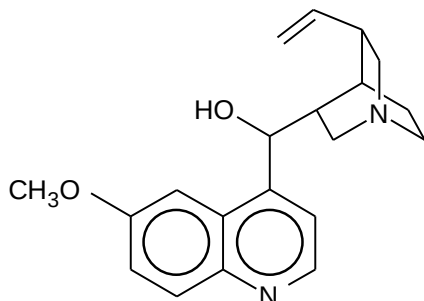
Which of the following statements explain the observations?

- 1 Lone pairs of electrons of Cl in P overlap with π -electrons of the C=O group, electrons delocalised with C=O group disperse the partial positive charge.
- 2 Cl atom causes the C–Cl bond to have a partial positive charge on the carbon atom.
- 3 The π -electron cloud in the aromatic ring of R repels OH[–] nucleophiles.

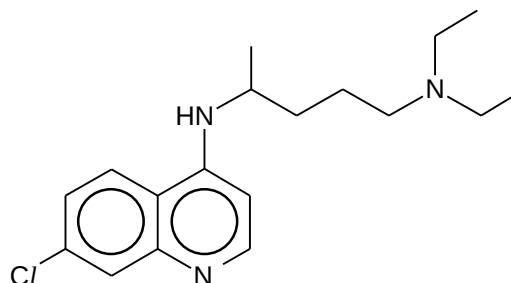
A 1, 2 and 3 **B** 1 and 2 only **C** 2 and 3 only **D** 3 only

- 29** *Jesuit's bark* was brought to Europe from South America by missionaries and proved useful in the treatment of malaria. Quinine, the active compound, is found in the bark of the cinchona tree and used originally by natives of Peru and Bolivia to treat shivering in cold weather.

Nowadays, a similar alkaloid, chloroquine is commonly used for the treatment of malaria.



quinine



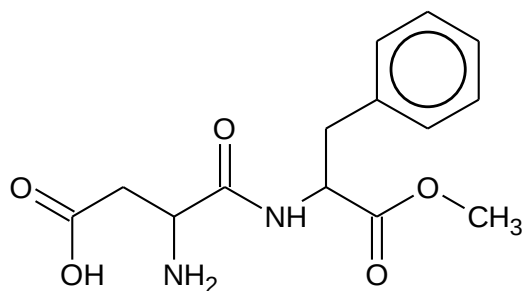
chloroquine

Which reagents react with both quinine and chloroquine?

- 1 aluminium oxide
- 2 aqueous bromine
- 3 ethanoyl chloride

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

- 30 Coca-Cola® No Sugar is a sugar and calorie free drink developed to taste like Coca-Cola classic. It uses the artificial sweetener aspartame.



aspartame

Aspartame has pK_a values of 3.2 and 7.9.

Given that Coca-Cola® No Sugar has a pH of 2.5, what is the structure of the major species of aspartame present?

