

PIONEER JUNIOR COLLEGE

JC2 PRELIMINARY EXAMINATION
HIGHER 2

CANDIDATE
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CHEMISTRY

9647/01

Paper 1 Multiple Choice

23 September 2016

1 hour

Additional Materials: Multiple Choice Answer Sheet
 Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

Write your name, Centre number and index number on the Answer Sheet in the spaces provided unless this has been done for you.

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

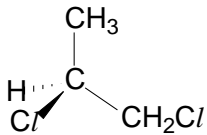
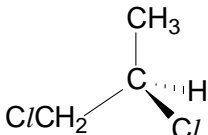
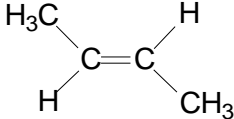
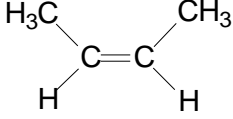
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

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.

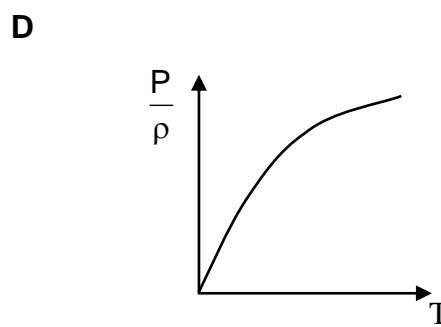
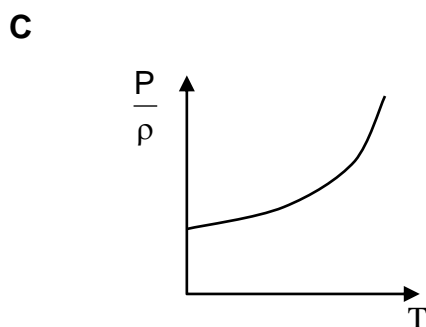
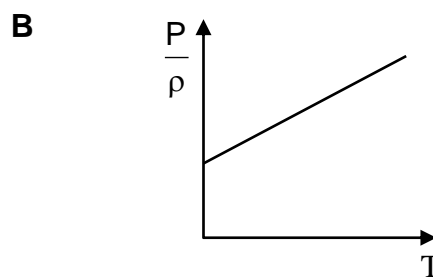
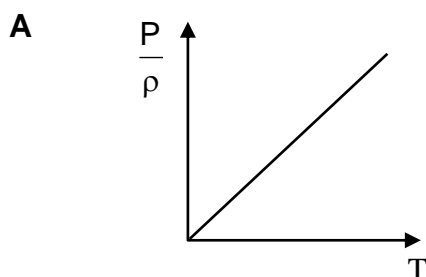
Section A

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

- 1 Which of the following quantities is equal to the Avogadro constant?
- A** the number of atoms in 24 dm³ of nitrogen gas at r.t.p. condition
B the number of molecules in 1 dm³ of oxygen at 273 K and 1 atm
C the number of electrons removed to form Ne⁺ ions from 6.02 x 10⁻²³ mol of Ne atoms
D the number of ions in 83.5 g of [Co(NH₃)₅Cl]Cl₂
- 2 Which of the following species has no unpaired electrons?
- A** Fe **B** Ge²⁺ **C** Si **D** Ti³⁺
- 3 Why is the molecule of BCl₃ planar, whereas the molecule of PH₃ is pyramidal?
- A** The repulsion between chlorine atoms is greater than that between hydrogen atoms.
B The covalent radius of chlorine is greater than that of hydrogen.
C The boron atom in BCl₃ has six electrons in its valence shell, whereas the phosphorus atom in PH₃ has eight.
D The boron atom has no d-orbitals available for bonding.
- 4 In which pair do the isomers have identical boiling points?
- A**  and 
- B**  and 
- C** CH₃CH₂CH₂CH₂OH and (CH₃)₂CHCH₂OH
- D** CH₃(CH₂)₄CH₃ and (CH₃)₂CHCH(CH₃)₂

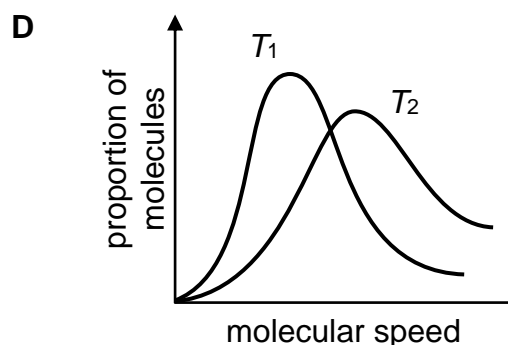
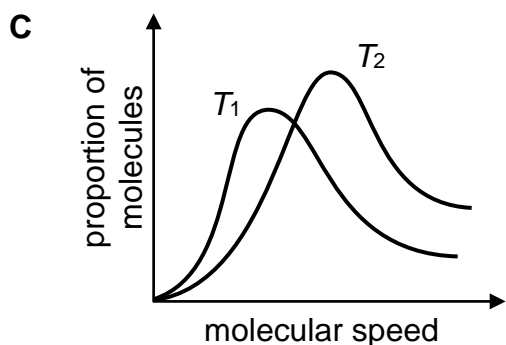
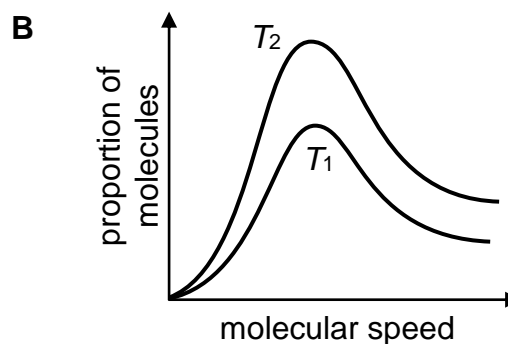
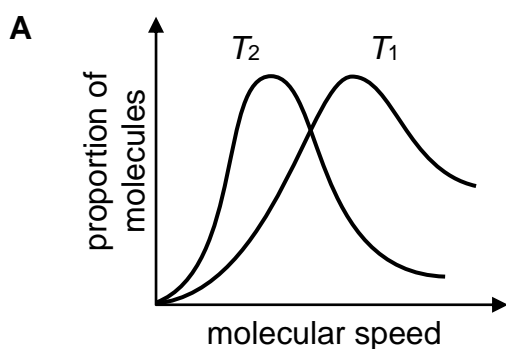
- 5 Which of the following shows a graph of $\frac{P}{\rho}$ against T for an ideal gas?

(P = pressure; ρ = density; T = temperature in $^{\circ}\text{C}$).



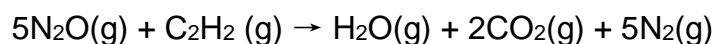
- 6 One mol of neon gas at temperature T_1 was added to another one mol of neon and the temperature was increased to T_2 .

Which of the following diagrams correctly represents the Boltzmann distribution of molecular speeds before and after the changes were made?



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

Dinitrogen oxide burns in ethyne to produce water vapour, carbon dioxide and nitrogen gas as the only products.



Given that the N=N and N=O bond energies in dinitrogen oxide are $+418 \text{ kJ mol}^{-1}$ and $+686 \text{ kJ mol}^{-1}$ respectively, what is the enthalpy change of the reaction?

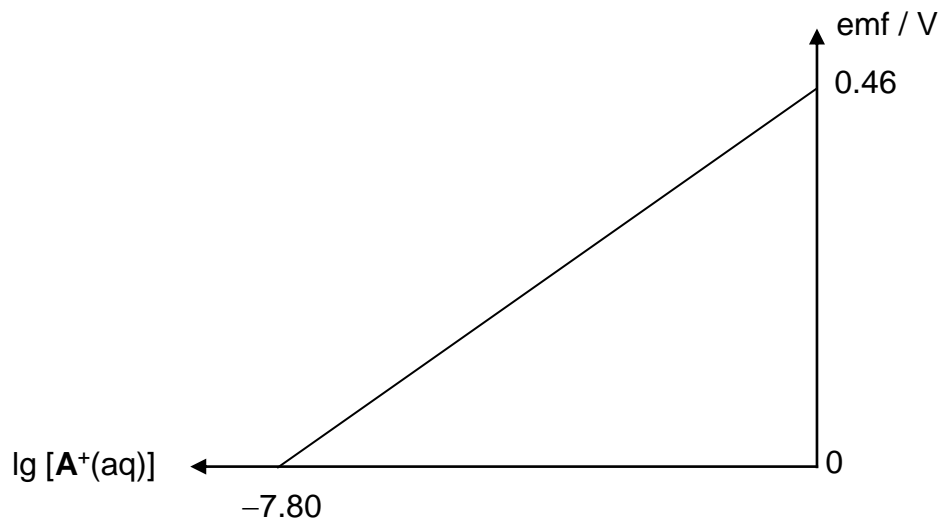
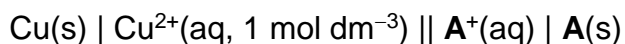
- A $+1670 \text{ kJ mol}^{-1}$
B $+1710 \text{ kJ mol}^{-1}$
C $-1670 \text{ kJ mol}^{-1}$
D $-1710 \text{ kJ mol}^{-1}$
- 8 Quarter-life, $t_{1/4}$, of a radioactive isotope is defined as the time taken for the sample to decay to $\frac{1}{4}$ its original amount.
- Potassium-argon dating is used to determine the age of a rock. ^{40}K is a radioactive isotope of potassium and it decays to ^{40}Ar with a constant $t_{1/4}$ of 2.50×10^9 years. A sample of moon rock was found to contain 6.25% of the original amount of ^{40}K .
- How old is the rock?
- A 2.50×10^9 years B 5.00×10^9 years
C 7.50×10^9 years D 1.00×10^{10} years
- 9 During electrolysis, 0.785 g of chromium is deposited on the cathode when 8690 C of electricity is passed into a chromium-containing electrolyte.

Which of the following could have been the electrolyte?

- A CrCl_2 B CrCl_3 C K_2CrO_3 D $\text{K}_2\text{Cr}_2\text{O}_7$

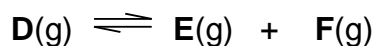
- 10 Use of the Data Booklet is relevant to this question.

The graph below shows the variation in electromotive force (emf) of the following electrochemical cell with $\lg [\text{A}^+(\text{aq})]$ at 298 K.



Which of the following statements is incorrect?

- A Cu(s) is the negative electrode.
 - B The direction of electron flow in the external circuit will be reversed when the concentration of $\text{A}^+(\text{aq})$ is $1.00 \times 10^{-7} \text{ mol dm}^{-3}$.
 - C The standard electrode potential of the $\text{A}^+(\text{aq}) \mid \text{A(s)}$ half-cell is +0.80 V.
 - D The emf of the given cell under standard conditions will be +0.46 V.
- 11 Gas **D** dissociates on heating to set up the equilibrium below:

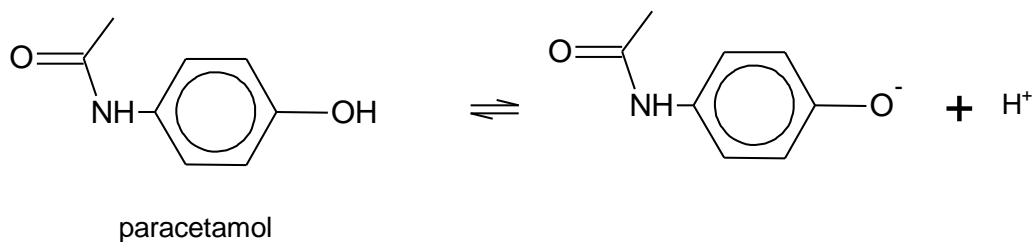


A quantity of **D** was heated at a constant pressure, p , at a certain temperature. The equilibrium partial pressure of **D** was found to be $\frac{1}{7}p$.

What is the equilibrium constant, K_p , at this temperature?

- A $\frac{6p}{7}$
- B $\frac{9p}{7}$
- C $\frac{36p}{7}$
- D $6p$

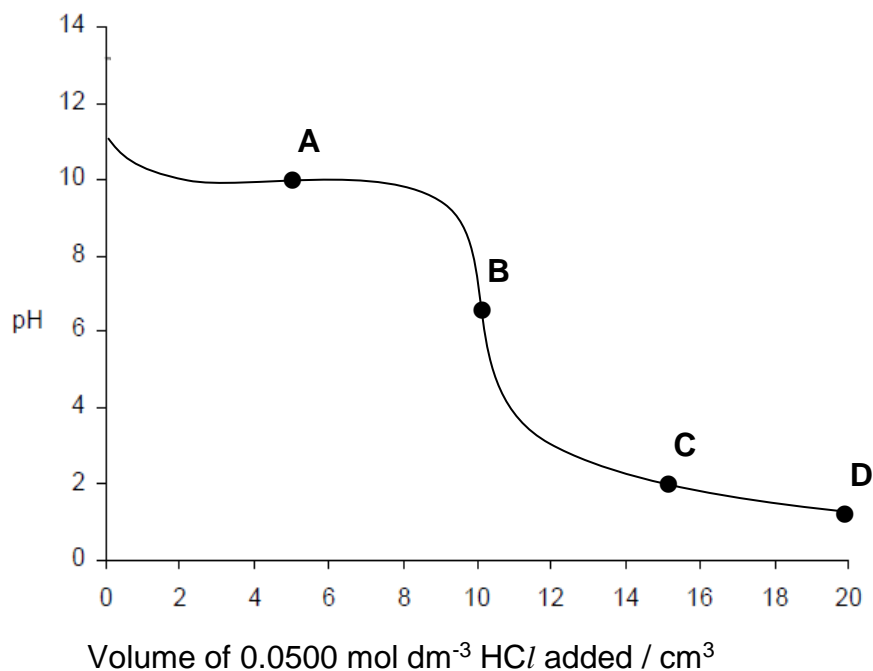
- 12 Paracetamol ($pK_a = 9.5$) is a widely used over-the-counter pain reliever and fever reducer. Its solubility in water is 12.78 mg cm^{-3} at 25°C . (M_r of Paracetamol = 151.0)



What is its pH in water at 25°C ?

- A 1.07
 B 5.29
 C 6.79
 D 8.71
- 13 The pH change when $0.0500 \text{ mol dm}^{-3} \text{ HCl}$ is added dropwise to 5.00 cm^3 of $0.100 \text{ mol dm}^{-3} \text{ CH}_3\text{NH}_2 (\text{aq})$ is shown in the graph below.

At which point on the graph is $\text{pH} = 14 - pK_b$, where K_b is the base dissociation constant of the weak base?



- 14 Which of the following statements explains the observations that magnesium hydroxide dissolves in ammonium chloride, but not in aqueous sodium chloride?
- A The ammonium ion changes the solubility product of $\text{Mg}(\text{OH})_2$.
 - B NH_4^+ ion is first formed, and then acts through a common ion effect.
 - C NH_4Cl dissociates less fully than NaCl .
 - D The NH_4^+ ion acts as an acid.

- 15 A saturated solution of $\text{Ca}(\text{OH})_2$ is found to have a pH of 12.3 at 25 °C.

Which of the following statements is incorrect?

- A The K_{sp} of $\text{Ca}(\text{OH})_2$ is $4 \times 10^{-6} \text{ mol}^3 \text{ dm}^{-9}$.
 - B The solubility of $\text{Ca}(\text{OH})_2$ would increase when temperature is raised to 35 °C.
 - C The solubility of $\text{Ca}(\text{OH})_2$ will decrease when solid Na_2O is added.
 - D The pH of the solution would increase when $\text{Ca}(\text{NO}_3)_2$ is added
- 16 *Use of the Data Booklet is relevant to this question.*

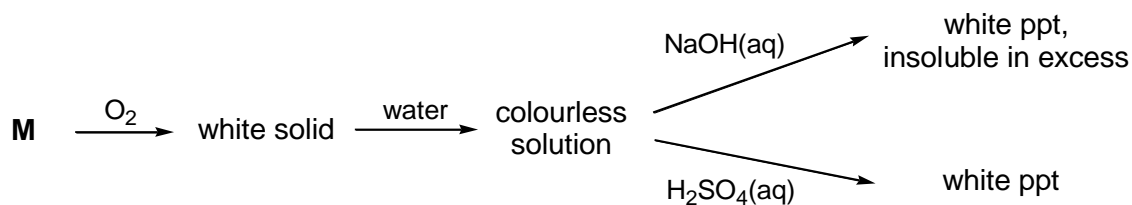
Natural water in reservoirs often contains very finely divided solid particles of between 1 and 100 nm in diameter which have negative charges on their surface.

One stage in the water purification process consists of adding salt solutions containing high charge-density cations which will neutralise the negative charges and cause the solid particles to join together and be precipitated out.

Which compound, in aqueous solution, would be the most effective in precipitating the finely divided solid particles?

- A AlCl_3
- B MgCl_2
- C SiCl_4
- D PCl_3

17



Based on the information above, what could element **M** be?

- A aluminium
- B calcium
- C potassium
- D silicon

18 HCl is stable to heat, but HI decomposes into its elements when heated.

What is the reason for this difference?

- A HI is a stronger reducing agent than HCl .
- B $\text{Cl}-\text{Cl}$ bond is stronger than $\text{I}-\text{I}$ bond.
- C $\text{H}-\text{Cl}$ bond is stronger than $\text{H}-\text{I}$ bond.
- D HI is more volatile than HCl .

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

Which of the following solutions would result in a colour change when left to stand in the atmosphere?

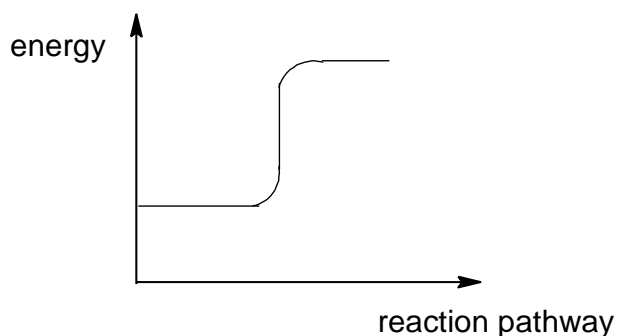
- A an acidified solution of cobalt(II) nitrate
- B a solution of potassium hexacyanoferrate(III)
- C an acidified solution of tin(II) chloride
- D an acidified solution of vanadium(II) sulfate

- 20 Adding concentrated $\text{HCl}(\text{aq})$ to $\text{CuSO}_4(\text{aq})$ causes the colour of the solution to change from blue to green.

Which of the following row correctly shows the number of d-electrons and the energy gap between the d-orbitals, before and after the reaction?

	number of d-electrons	energy gap between the d-orbitals
A	changes	changes
B	changes	remains the same
C	remains the same	changes
D	remains the same	remains the same

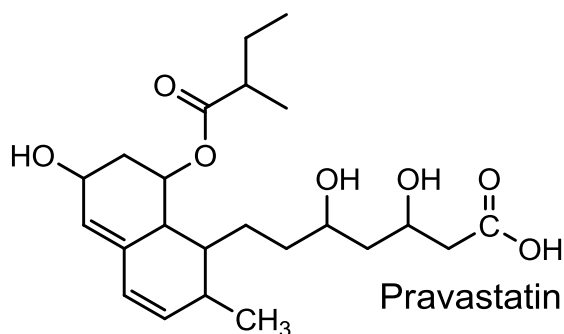
- 21 In the reaction of methane with chlorine in the presence of light, the following energy level diagram (for single reaction step) is obtained.



To which of the following steps does this diagram apply?

- A $\cdot\text{CH}_3 + \cdot\text{CH}_3 \longrightarrow \text{C}_2\text{H}_6$
- B $\text{CH}_4 + \cdot\text{Cl} \longrightarrow \text{CH}_3\text{Cl} + \cdot\text{H}$
- C $\cdot\text{CH}_3 + \text{Cl}_2 \longrightarrow \text{CH}_3\text{Cl} + \cdot\text{Cl}$
- D $\text{Cl}_2 \longrightarrow \cdot\text{Cl} + \cdot\text{Cl}$

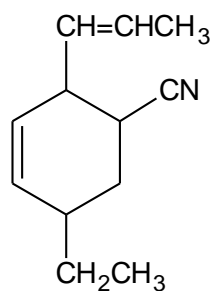
- 22 The cholesterol-lowering agents called statins, such as pravastatin, are among the most widely prescribed drugs in the world.



How many chiral centres are present in the product when pravastatin was treated with H_2 , Ni catalyst at 200°C ?

- A 6 B 7 C 8 D 9

23

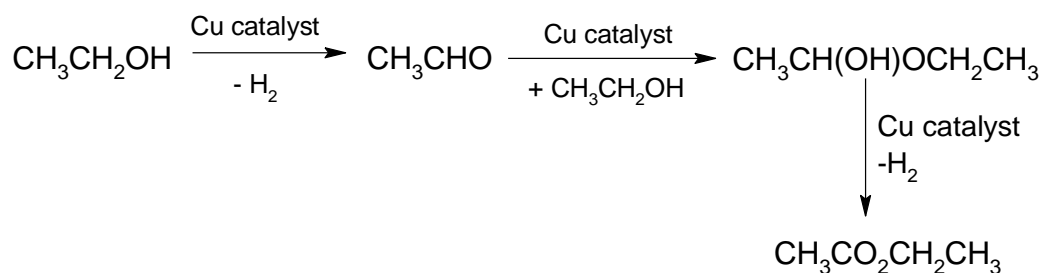


compound **P**

Which of the following statements about compound **P** is incorrect?

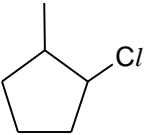
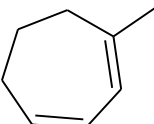
- A There is only one sp hybridised carbon atom in a molecule of **P**.
 B A molecule of **P** contains four π bonds.
 C After **P** reacts with HCl(g) , all but one carbon atom in the product formed are sp^3 hybridised.
 D After **P** reacts with LiAlH_4 , all the carbon atoms in the product formed are sp^3 hybridised.

- 24 Industrially, ethyl ethanoate may be prepared from cheap, low-grade ethanol as follows:



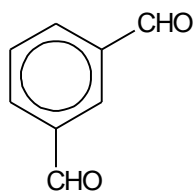
Which process is included in the above reaction sequence?

- A disproportionation
 B electrophilic addition
 C nucleophilic addition
 D reduction
- 25 Which process will **not** give a good yield of $\text{CH}_3\text{CO}(\text{CH}_2)_3\text{CO}_2\text{H}$?

- A  $\xrightarrow[\text{heat}]{\text{KOH in ethanol}}$ $\xrightarrow{\text{hot KMnO}_4 (\text{aq}), \text{H}_3\text{O}^+}$
- B $\text{H}_2\text{NCO}(\text{CH}_2)_3\text{CHClCH}_3 \xrightarrow[\text{heat}]{\text{KOH(aq)}} \xrightarrow{\text{hot KMnO}_4 (\text{aq}), \text{H}_3\text{O}^+}$
- C $\text{CH}_3\text{CH}(\text{OH})(\text{CH}_2)_3\text{CH}_2\text{Cl} \xrightarrow[\text{heat}]{\text{NaOH in ethanol}} \xrightarrow{\text{hot KMnO}_4 (\text{aq}), \text{H}_3\text{O}^+}$
- D  $\xrightarrow{\text{hot KMnO}_4 (\text{aq}), \text{H}_3\text{O}^+}$

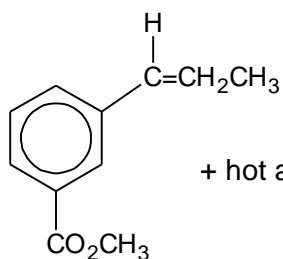
26 Which of the following reactions would **not** produce 1,3-dicarboxylic acid?

A



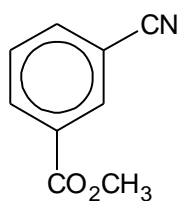
+ Fehling's solution followed by acidification

B



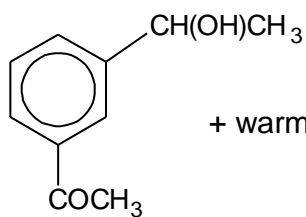
+ hot acidified potassium manganate(VII)

C



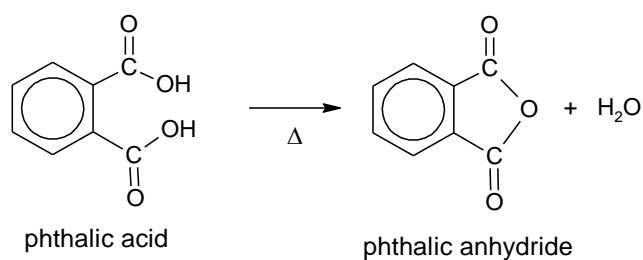
+ aq H_2SO_4 , heat

D

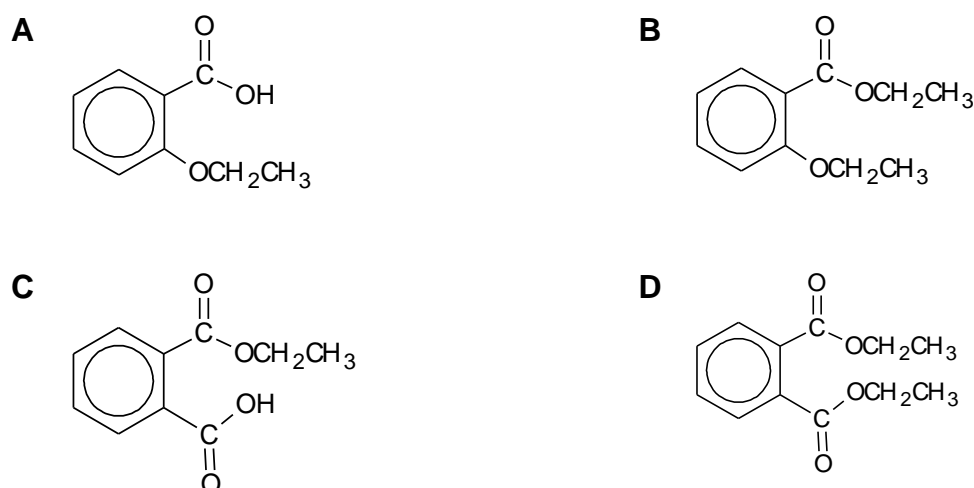


+ warm, alkaline aqueous iodine followed by acidification

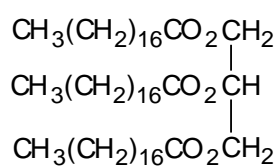
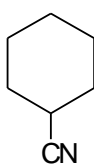
- 27 When heated strongly, phthalic acid undergoes condensation reaction to form phthalic anhydride.



On reaction with water, the anhydride gives phthalic acid. What would be formed when phthalic anhydride reacts with ethanol instead of water?



- 28 Experiments are carried out on three compounds **Q**, **R**, and **S**.

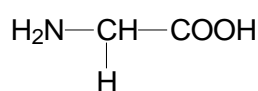
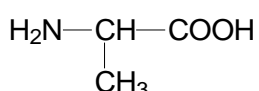
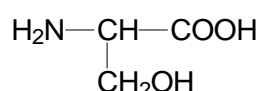
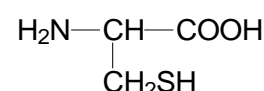
**Q****R****S**

A sample of 0.01 mol of each compound is heated under reflux with 50 cm³ of 1 mol dm⁻³ aqueous NaOH (in excess) until hydrolysis is completed and any ammonia gas produced was expelled from the solution. The excess NaOH was then titrated in each case and was found to require 20 cm³, 30 cm³ and 40 cm³ of 1 mol dm⁻³ HCl for neutralisation.

Which sequence of compounds matches these results?

	20 cm ³	30 cm ³	40 cm ³
A	Q	R	S
B	Q	S	R
C	R	S	Q
D	S	R	Q

- 29** Why are amides, RCONH_2 , less basic than amines, RNH_2 ?
- A** Amides form zwitterion in which the nitrogen atom carries a positive charge.
 - B** Amides have a resonance structure involving the movement of a pair of electrons from the nitrogen atom to the oxygen atom.
 - C** Electrons on the nitrogen atom move on the C-N bond giving it some double bond character so that it is more difficult to break.
 - D** The amide carbonyl group withdraws electrons from the NH_2 group to make the hydrogen atoms more acidic.
- 30** Silk fibroin is a type of fibrous protein made up almost entirely of β -pleated sheets. The main amino acids found in silk fibroin are alanine, glycine, serine and cysteine. The structures of these amino acids are given below.

*glycine**alanine**serine**cysteine*

Which of the following statements about the type of interactions present in silk fibroin is incorrect?

- A** The β -pleated sheets are held together by hydrogen bonding.
- B** There are van der Waals' forces between glycine and alanine in the protein.
- C** There are disulfide linkages present in silk fibroin.
- D** Serine forms ionic bonds with another serine amino acid in the protein.

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 that you consider to be correct).

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

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

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

- 31** A 0.0200 mol sample of an oxochloride of **T**, TOCl_y required 10.00 cm³ of 0.400 mol dm⁻³ acidified potassium manganate(VII) for oxidation to TO_3^- ions.

Which of the following statements are correct?

- 1** 5 mol TOCl_y react with 1 mol MnO_4^- .
- 2** The change in oxidation state of **T** in the reaction is +1.
- 3** The value of y in TOCl_y is 2.

- 32** The ion U^{5+} has 38 electrons and 46 neutrons.

Which of the following statements are correct?

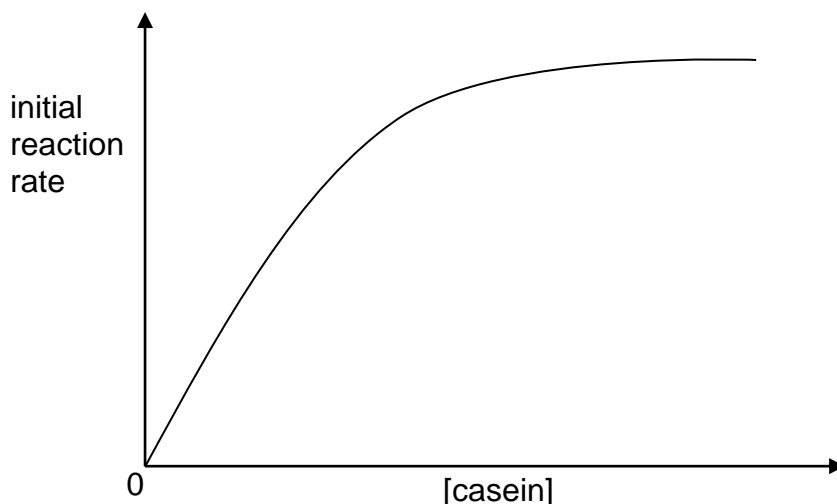
- 1** In an electric field, the ion U^{5+} will be deflected to the same extent as the yttrium ion, $^{89}\text{Y}^{5+}$.
- 2** The electronic configuration of U^{5+} is $[\text{Kr}] 4d^2$.
- 3** The third ionisation energy of element **U** is significantly higher than its second ionisation energy.

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

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

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

- 33** The graph shows the results of an investigation of the initial rate of hydrolysis of casein by the enzyme trypsin. In the experiments, the initial concentration of casein was varied but that of trypsin was kept constant.



Which conclusions can be deduced from these results?

- 1** When [casein] is low, the rate is first order with respect to [casein].
 - 2** When [casein] is high, the rate is dependent of [trypsin].
 - 3** When [casein] is high, the rate is dependent of [casein].
- 34** Button cells are tiny cells used to power small electronic devices such as wrist watches and calculators. One such cell consists of lithium electrode and a paste of manganese(IV) oxide electrode dipped in an organic electrolyte. The e.m.f. produced by the cell is 3.00 V. In discharging the cell, LiMnO_2 will be formed.

Which of the following statements about the Li- MnO_2 cell are correct?

- 1** Electrons flow from the lithium electrode to the manganese(IV) oxide electrode.
- 2** The equation for the reaction at the cathode is $\text{MnO}_2 + \text{e}^- \rightarrow \text{MnO}_2^-$.
- 3** Water is added to manganese(IV) oxide to form the paste.

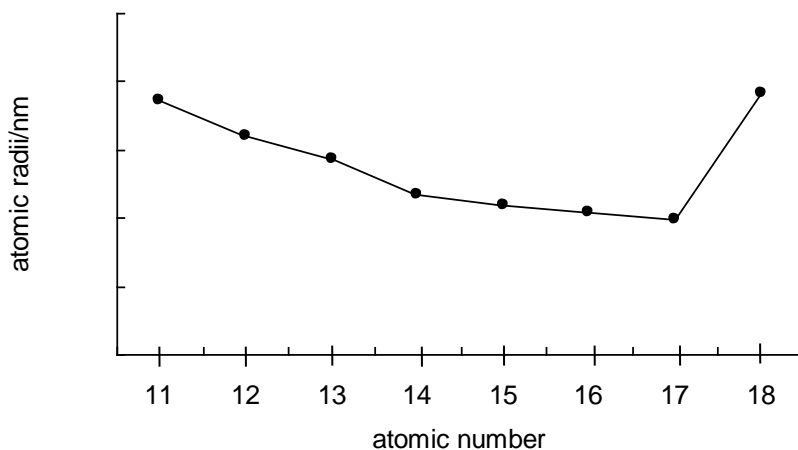
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

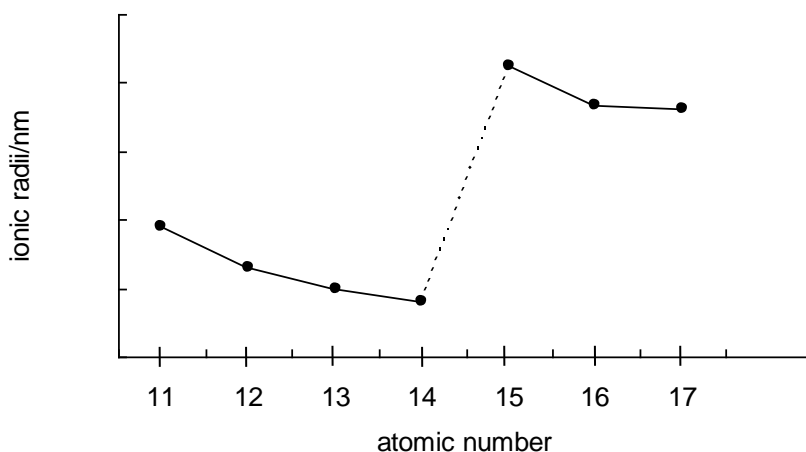
No other combination of statements is used as a correct response.

35 Which of the following graphs correctly represents the variation in the specified property of the elements in Period 3?

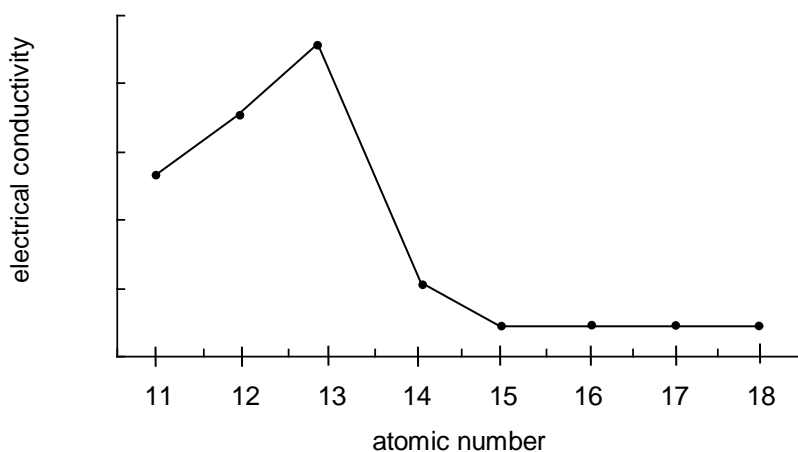
1



2



3



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

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

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

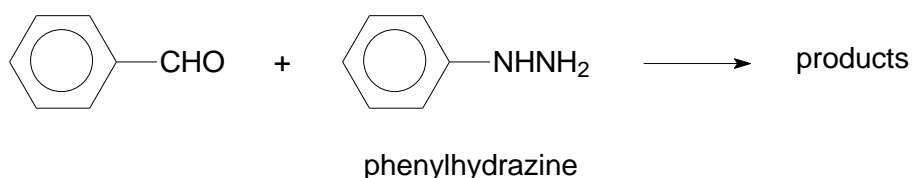
36 For the reaction,



which of the following statements are likely to be correct?

- 1** The reaction involves an electrophilic attack by $\text{CH}_3\text{CH}_2\text{O}^-$.
- 2** The rate determining step involves the formation of a carbocation.
- 3** The reaction will take place more rapidly when X is I than when X is Cl.

37 The reaction of phenylhydrazine is similar to that of 2,4-dinitrophenylhydrazine.



Which changes in bonding occur in the reactants and products during the reaction above?

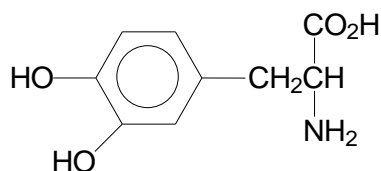
	Bond broken	Bond formed
1	C–H	C–C
2	N–H	O–H
3	C=O	C=N

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

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

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

- 38** *Dopamine* is a neurotransmitter found in many animals, including vertebrates and invertebrates.



Dopamine

Which of the following statements are **correct**?

- 1** 1 mole of *dopamine* reacts with 3 moles of acyl chloride
- 2** 1 mole of *dopamine* reacts with 1.5 moles of Br₂(aq).
- 3** 1 mole of *dopamine* reacts with 3 moles of Na₂CO₃.

- 39** Compound **V**, with molecular formula C₆H₁₂, was reacted with acidified potassium manganate(VII) and the resultant mixture obtained was colourless. The mixture was thereafter distilled to form distillate **W** and residual solution **X**.

Distillate **W** is able to form a yellow precipitate with alkaline aqueous iodine. Residual solution **X** reacts with sodium carbonate to form a colourless gas.

Which of the following statements are **true**?

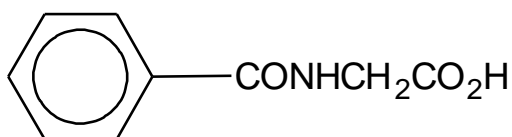
- 1** Compound **V** will decolourise aqueous bromine.
- 2** Distillate **W** can form an orange precipitate with 2,4-dinitrophenylhydrazine.
- 3** Residual solution **X** can form white fumes with PCl₅.

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

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

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

40 Benzoylglycine (hippuric acid) was first isolated from stallions' urine.



Benzoylglycine

Which properties does this compound possess?

- 1** It can be hydrolysed to produce an amino acid.
- 2** It can be made by reacting benzoyl chloride with aminoethanoic acid.
- 3** It can be neutralised by reaction with cold aqueous sodium hydroxide.

End of Paper