ST ANDREW'S JUNIOR COLLEGE

JC2 Preliminary Examinations

Chemistry
Higher 2 **9647/01**
Paper 1 Multiple Choice **19 September 2012**
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.

There are **40** questions on this paper. Answer all questions. For each question there are four possible answers A, B, C and D. Chose 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.

This document consists of **22** printed pages **including** this page.

Section A

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

1. Group **I** and Group **II** ionic hydrides react with water.

$H^- + H_2O \rightarrow OH^- + H_2$

In an experiment, 1 g of a sample of an ionic hydride is dissolved in excess H_2O. The resulting solution required 24.00 cm^3 of a 2.0 mol dm^{-3} HC*l* solution for complete neutralisation.

What is the formula of the hydride?

A LiH

B NaH

C MgH_2

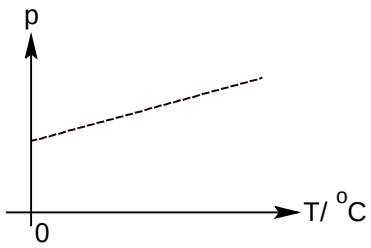
D CaH_2

2. Which species is oxidised and which species is reduced in the following reaction?

$4TiCr_2O_4 + 8Rb_2CO_3 + 7O_2 \rightarrow 8Rb_2CrO_4 + 2Ti_2O_3 + 8CO_2$

	Species oxidised	**Species reduced**
A	Chromium only	Carbonate ion only
B	Chromium only	Carbonate ion and oxygen
C	Chromium and titanium	Oxygen only
D	Chromium and titanium	Carbonate ion and oxygen

3. The graph below shows how pressure varies with temperature when 1 mole of helium is heated in an enclosed volume.

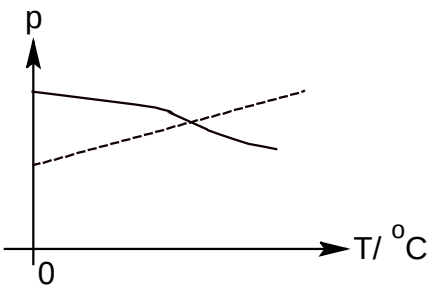


Similar relationship between pressure and temperature was examined for 1 mole of gaseous $\mathbf{XY}_2$ which dissociates according to the following equation.

$\mathbf{XY}_2\ (g) \rightleftharpoons \mathbf{X}\ (g) + \mathbf{Y}_2\ (g)\ \Delta H > 0$

Which graph best represents how pressure varies with temperature of the gas?

A



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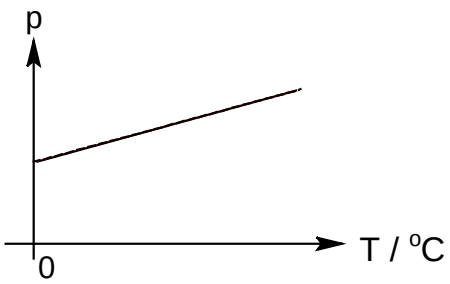

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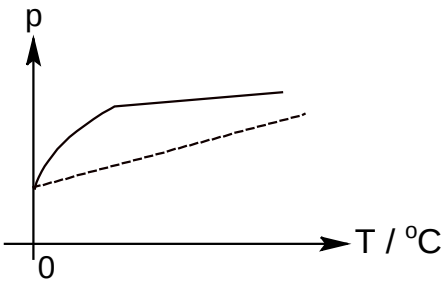

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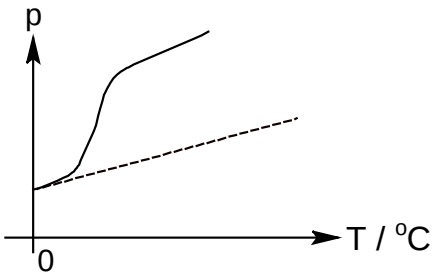


4. Which of the following particles has a half-filled p subshell after losing two electrons?

A Ga^-

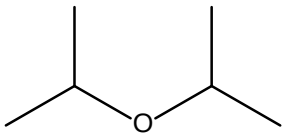
B As^{2+}

C Se^-

D Te^+

5. Which of the following isomers is likely to have the highest boiling point?

A



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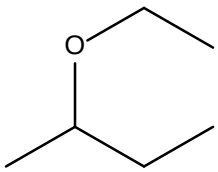

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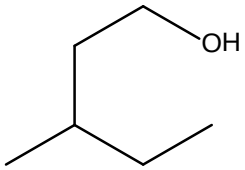

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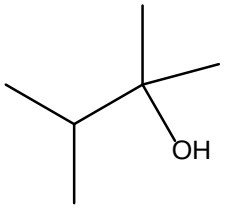


6. In which of the following reactions is the H–N–H bond angle in ammonia smaller than that in the product?

A $2NH_3(l) + 2Na(s) \rightarrow 2NaNH_2(s) + H_2(g)$

B $NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$

C $2NH_3(g) \rightarrow H_2N–NH_2(l) + H_2(g)$

D $2NH_3(g) + O_2(g) \rightarrow 2NH_2OH(l)$

7. When water vaporises, 51.6 kJ mol^{-1} of heat enthalpy is required. What is the entropy change when 54 g of water boils at 1 atm?

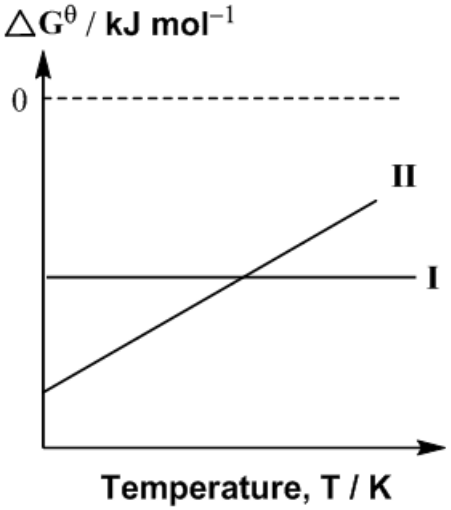
A + 138 J K^{-1}

B + 415 J K^{-1}

C + 516 J K^{-1}

D + 1548 J K^{-1}

8. Ellingham diagrams are plots of ΔG against temperature, T. An Ellingham diagram for two reactions involving the oxidation of S and SO_2 is as shown below:



Given that, $\Delta G = \Delta H - T\Delta S$, which of the following correctly shows the two reactions corresponding to reactions **I** and **II** in the above Ellingham diagram?

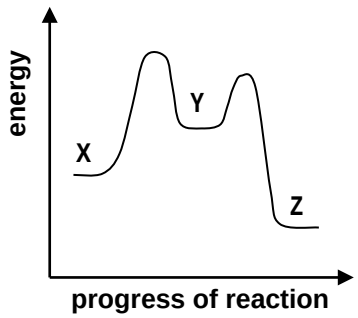
	I	**II**
A	$2S + 3O_2$ à $2SO_3$	$2SO_2 + O_2$ à $2SO_3$
B	$2SO_2 + O_2$ à $2SO_3$	$S + O_2$ à SO_2
C	$S + O_2$ à SO_2	$2S + 3O_2$ à $2SO_3$
D	$2SO_2 + O_2$ à $2SO_3$	$2S + 3O_2$ à $2SO_3$

9. In the conversion of compound **X** into compound **Z**, it was found that the reaction proceeded according to the rate equation below:

Rate = k [**X**]

The intermediate **Y** can be isolated. Which reaction profile fits these data?

A



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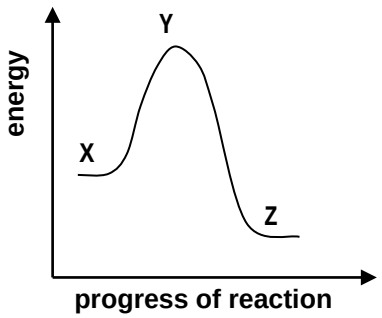
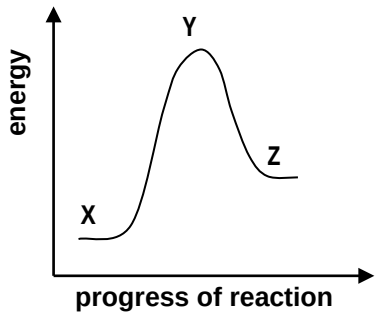


B



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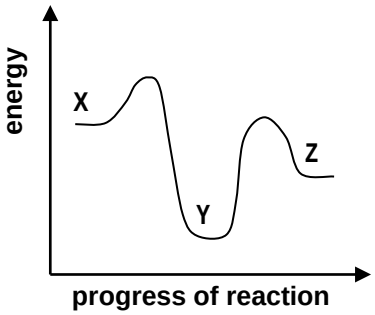
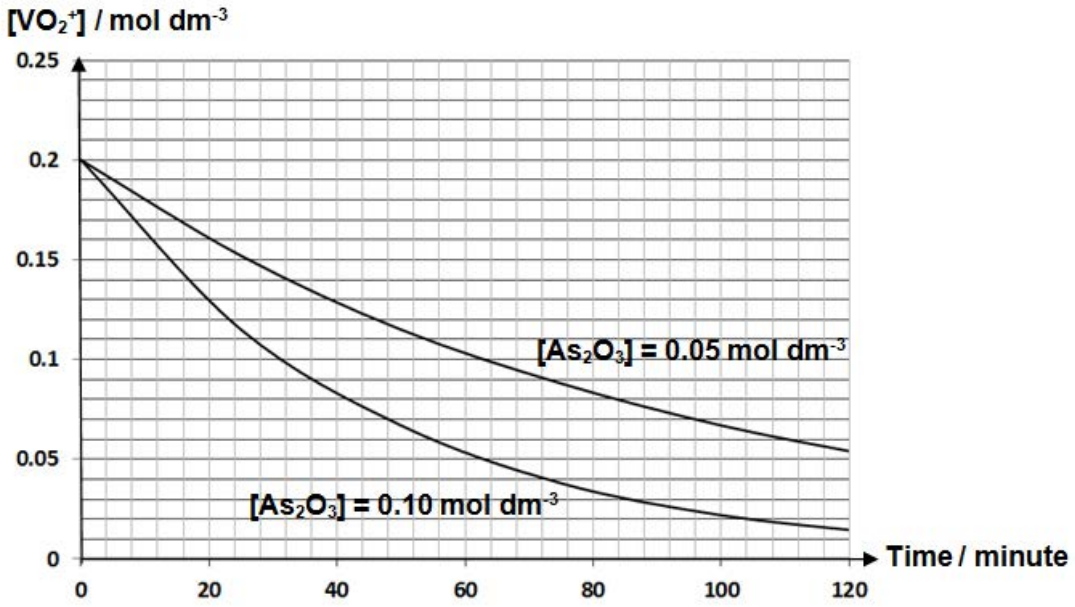


10. A solution of vanadium (V) ions in 1 mol dm^{-3} H_2SO_4 slowly oxidises arsenic (III) oxide to arsenic (V) oxide, according to the following equation.

$As_2O_3 + 4\ VO_2^+ + 4\ H^+ \rightarrow As_2O_5 + 4\ VO^{2+} + 2\ H_2O$

To find the rate equation for the above reaction, two experiments were carried out, starting with different concentrations of arsenic (III) oxide and the concentration of VO_2^+ was monitored.



The rate equation is most likely to be

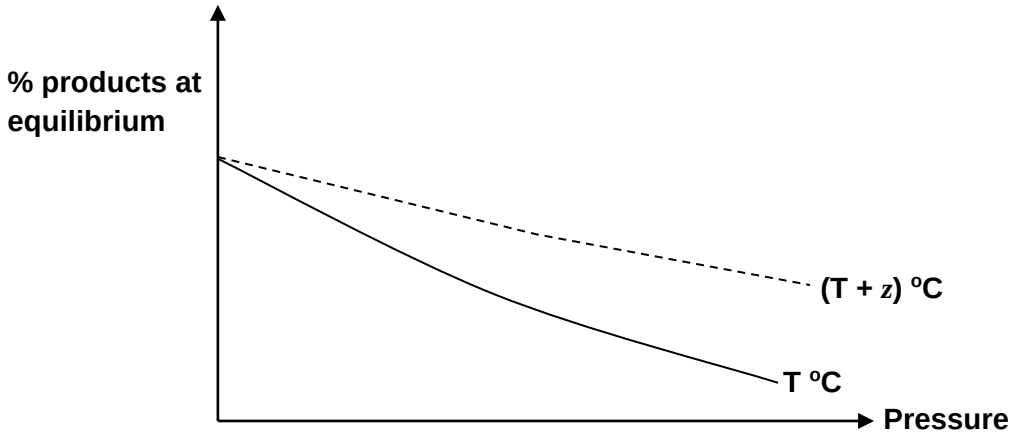
A rate = $k\ [As_2O_3][VO_2^+]$

B rate = $k\ [As_2O_3][VO_2^+]^2$

C rate = $k\ [As_2O_3]^2[VO_2^+]$

D rate = $k\ [As_2O_3]$

11. The graphs below show the variation of the percentage of gaseous products present at equlibrium, with pressure and two temperatures, **T ºC** and (**T + *z***) **ºC**.



Which one of the following systems could the graphs represent?

A $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ $DH = - 92\ kJ\ mol^{-1}$

B $3O_2(g) + 4NH_3(g) \rightleftharpoons 2N_2(g) + 6H_2O(g)$ $DH = - 1248\ kJ\ mol^{-1}$

C $2N_2(g) + O_2(g) \rightleftharpoons 2N_2O\ (g)$ $DH = + 82\ kJ\ mol^{-1}$

D $CO_2(g) + C(s) \rightleftharpoons 2CO\ (g)$ $DH = + 173\ kJ\ mol^{-1}$

12. Solutions **E**, **F**, **G** and **H** contain a strong monobasic acid, a weak monobasic acid **HX**, a strong base and a salt of **HX**, but not necessarily in the same order. The concentration and pH for each solution are shown below.

Solution	Concentration /mol dm^{-3}	pH
E	1.0	4.0
F	1.0	9.4
G	0.01	12.0
H	0.01	2.0

Which one of the following statements is **false**?

A **E** contains a weak acid while **H** contains a strong acid.

B Mixing 10 cm^3 of **E** and 50 cm^3 of **G** produces a buffer solution.

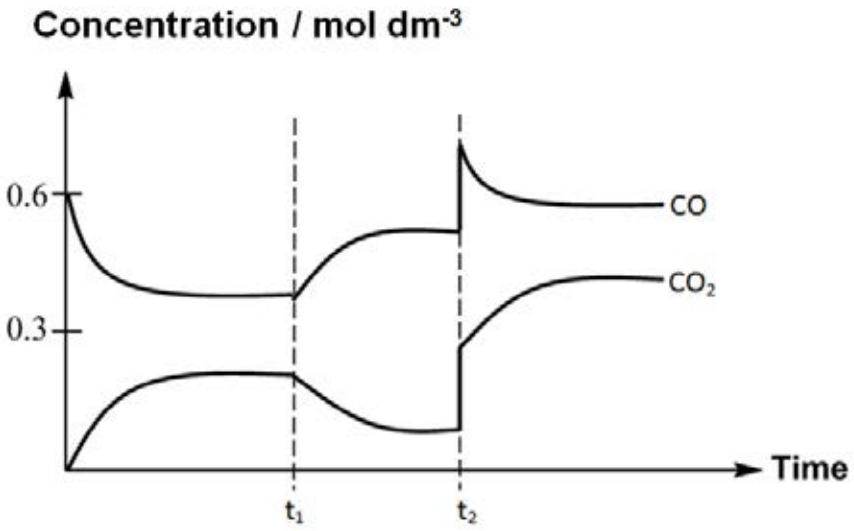
C Mixing 10 cm^3 of **E** and 50 cm^3 of **H** produces a buffer solution.

D Mixing 10 cm^3 of **F** and 1 dm^3 of **H** produces an acidic solution.

13. At a temperature T K, 0.60 mol dm^{-3} of CO and 0.30 mol dm^{-3} of O_2 were introduced into a 5 dm^3 vessel and allowed to reach equilibrium.

$2\,CO\,(g) + O_2\,(g) \rightleftharpoons 2CO_2\,(g)$ $\quad\quad \Delta H < 0$

The graph below shows the changes in the concentration of CO and CO_2 in the system with time. A change was made to the system at time, t_1 and t_2.

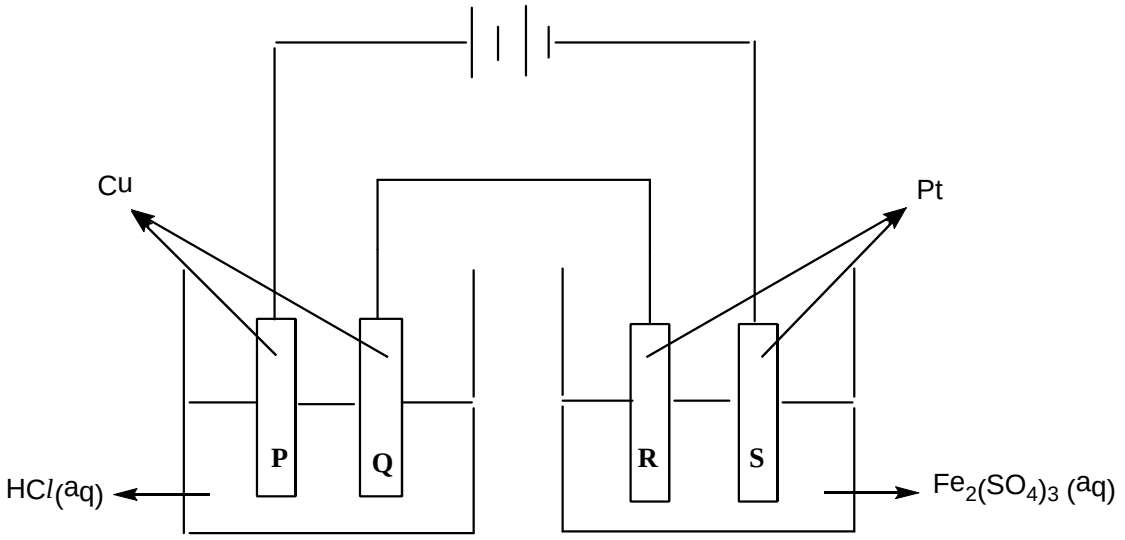


What were the changes made at time, t_1 and t_2?

	t_1	t_2
A	A catalyst was added	Volume of the system is increased
B	The temperature was increased	Volume of the system is decreased
C	More CO_2 was added	An inert gas was added at constant volume
D	The temperature was decreased	More O_2 was added

14. *Use of the data booklet is relevant to this question*.

Two cells are connected in series as shown in the diagram where **P**, **Q**, **R** and **S** are electrodes. Which of the following correctly shows the products formed at each electrode?



	P	Q	R	S
A	Cu^{2+}	H_2	O_2	Fe^{2+}
B	O_2	Cu	SO_2	H_2
C	Cl_2	H_2	O_2	Fe
D	Cu^{2+}	Cu	SO_2	Fe^{2+}

15. *Use of the data booklet is relevant to this question*.

Ladles are often made from sterling silver. Which aqueous solution should **not** be stirred with a silver ladle because a reaction could occur?

A KC*l*

B $(NH_4)_2S_4O_6$

C Na_2SO_4

D $PbBr_4$

16. The oxide and chloride of an element **F** are separately mixed with water. The two resulting solutions have the same effect on methyl orange and can also be used to dissolve BeO. What is element **F**?

A Magnesium
B Aluminium
C Silicon
D Phosphorus

17. Which of the following statements about the elements strontium and barium is correct?

A The elements react with cold water liberating hydrogen gas.
B Aqueous solutions of their chlorides have a pH greater than 7.
C The hydroxide of barium is less stable to heat.
D The enthalpy change of hydration of the cations becomes less endothermic from strontium to barium.

18. Which statement is likely to be true for astatine which is below iodine in group VII of the Periodic Table?

A Potassium astatide and hot dilute sulfuric acid react to form astatine.
B Silver astatide reacts with excess dilute aqueous ammonia to form a soluble complex.
C Sodium astatide and hot concentrated phosphoric acid react to form white fumes of hydrogen astatide.
D Hydrogen astatide is stable to heat.

19. Transition metals such as iron are often used as a catalyst in reactions such as the Haber process. Which of the following statements best explains the role of transition metals in this use?

A Transition metals have good electrical conductivity as both 4s and 3d electrons are involved in metallic bonding.

B Transition metals have available and partially filled 3d orbitals for adsorption of reactant molecules.

C Transition metals form coloured ions due to the absorption of energy in the visible light region to promote an electron from a lower to a higher energy 3d orbital.

D Transition metals can exhibit variable oxidation states due to the close proximity in energy between the 3d and 4s electrons.

20. **X** is a transition metal. In aqueous solution, it forms the coloured complex ion, $[\mathbf{X}(H_2O)_6]^{4+}$. On oxidation of $[\mathbf{X}(H_2O)_6]^{4+}$ to $[\mathbf{X}(H_2O)_6]^{5+}$, the solution turned colourless. Which of the following is the electronic configuration of the transition metal **X**?

A [Ar] $3d^2\ 4s^2$

B [Ar] $3d^3\ 4s^2$

C [Ar] $3d^5\ 4s^1$

D Ar] $3d^{10}\ 4s^2$

21. How many cyclic hydrocarbons are there with the molecular formula C_4H_6?

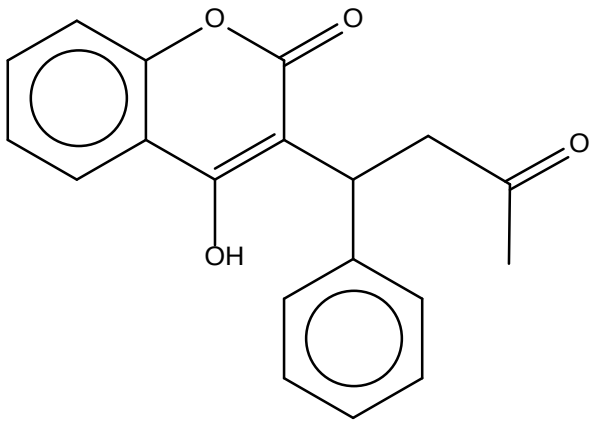
A 3

B 4

C 5

D 6

22. Warfarin is used as a pesticide against rodents. The structural formula of warfarin is given below.



Which of the following reactants will **not** react with warfarin?

A Alkaline aqueous iodine

B Acidified potassium manganate (VII)

C Ethanoyl chloride

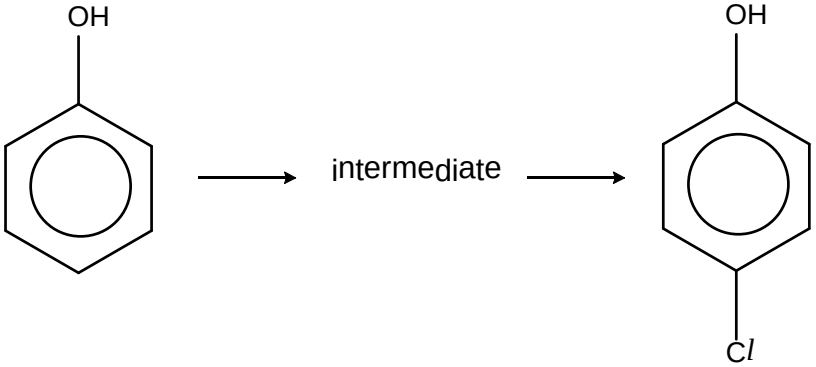
D Neutral $FeCl_3$

23. In which of the following reactions would the intermediate behave as a nucleophile?

Reaction 1: CH_3CH_2CHO à intermediate à $CH_3CH_2CH(OH)(CN)$

Reaction 2: $C(CH_3)_3Cl$ à intermediate à $C(CH_3)_3NH_2$

Reaction 3:



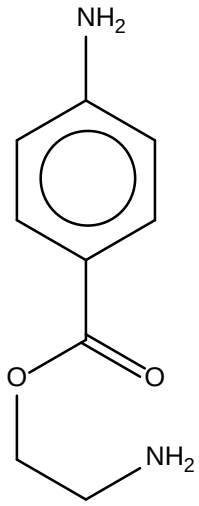
A Reaction 1

B Reactions 1 and 2

C Reaction 2

D Reactions 2 and 3

24. Which of the following reaction scheme is able to prepare compound **G** from methylbenzene?



Compound **G**

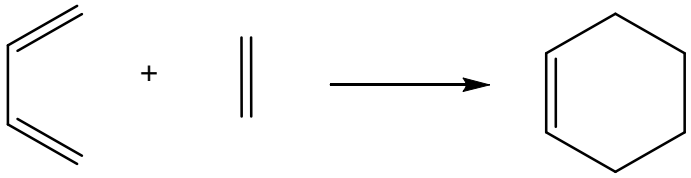
A Nitration, Side-chain oxidation, Condensation

B Nitration, Reduction, Side-chain oxidation, Condensation

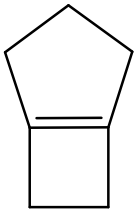
C Side-chain oxidation, Condensation, Nitration

D Side-chain oxidation, Condensation, Nitration, Reduction

25. Diels-Alder reaction is a conjugate addition reaction which is best exemplified by the reaction below.



Which of the following pairs of starting materials will give the following compound **H**?



Compound H

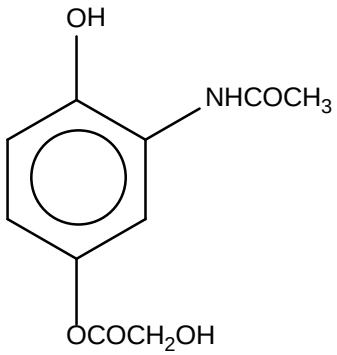
A Cyclopentene and ethene

B Cyclobutene and ethene

C Cyclopentadiene and ethene

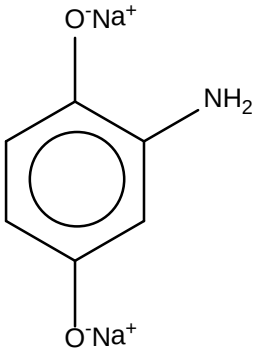
D Cyclobutadiene and ethene

26. Which of the following compounds is formed when compound **M** is dissolved in aqueous sodium hydroxide under standard conditions?



Compound M

A



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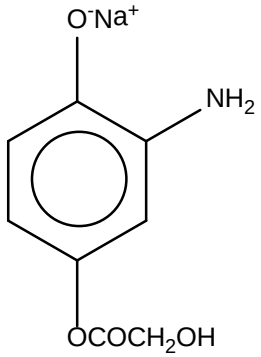
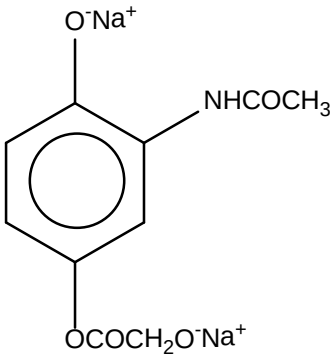


B



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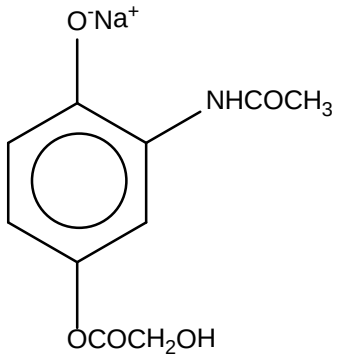


27. In which sequence is it correctly stated that the value of pK_b **decreases** continuously?

A $CH_3CH_2CONHCH_3$, $CH_3CH_2NH_2$, $CH_2ClCH_2NH_2$, $C_6H_5NH_2$

B $CH_3CH_2CONHCH_3$, $C_6H_5NH_2$, $CH_2ClCH_2NH_2$, $CH_3CH_2NH_2$

C $CH_3CH_2NH_2$, $CH_2ClCH_2NH_2$, $C_6H_5NH_2$, $CH_3CH_2CONHCH_3$

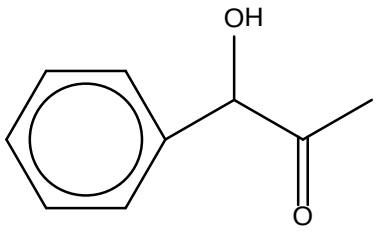
D $CH_2ClCH_2NH_2$, $CH_3CH_2NH_2$, $C_6H_5NH_2$, $CH_3CH_2CONHCH_3$

28. Compound **J** exhibits the following characteristics:

- 1 mol of **J** reacts with excess sodium metal to form 1 mol of hydrogen gas.
- Yellow precipitate is formed when **J** reacts with aqueous alkaline iodine.
- Orange precipitate is formed when **J** reacts with 2,4-DNPH, but no reaction with alkaline silver diammine solution.
- **J** rotates plane-polarised light.

What could compound **J** be?

A



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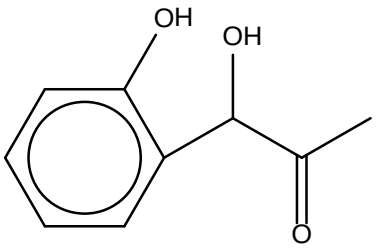
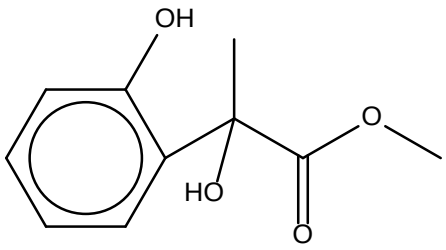


B



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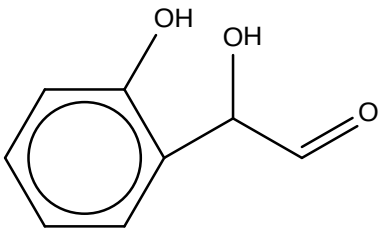


29. Which one of the following alcohols will give the most number of products when it is heated with concentrated H_2SO_4 at 170°C?

A $CH_3CH_2CH_2OH$

B $C(CH_3)_3OH$

C $CH_3CH_2CH(OH)CH_3$

D $CH_3CH_2C(CH_3)_2OH$

30. Polypeptides can be enzymatically hydrolysed to form shorter peptide chains. When a nanopeptide was hydrolysed by enzymes, the following tripeptides were obtained.

gly-ala-leu
tyr-ser-leu
leu-gly-tyr
lys-gly-ala
ser-leu-gly

Which of the following could this nanopeptide be?

A lys-gly-ala-leu-gly-tyr-ser-leu-gly
B gly-ala-leu-gly-tyr-ser-leu-gly-tyr
C lys-gly-ala-tyr-ser-leu-gly-tyr-ser
D gly-ala-leu-gly-ser-tyr-leu-gly-tyr

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. For the elements **R** and **S** with atomic number 14 and 15 respectively, which of the following statements are true?

1 The fifth ionisation energy of **R** is higher than that of **S**.
2 They can form **R**C*l*$_4$ and **S**C*l*$_3$ respectively.
3 The atomic radius of **R** is smaller than that of **S**.

32. For the following chlorine-containing species,
ICl_2^-, ClF_3, ClO_3^-
Which of the following statements is correct?

1 All atoms achieve stable octet configuration.
2 ICl_2^- is linear, ClF_3 is T-shaped while ClO_3^- is trigonal pyramidal.
3 The bond angles increase in the order of ClF_3 , ClO_3^- , ICl_2^-

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. When a few drops of calcium nitrate solution is added to a saturated calcium hydroxide solution, a white precipitate is observed. Which of the following provides the correct explanation?

1 $[Ca^{2+}]$ and $[OH^-]$ are high enough such that the ionic product exceeds the K_{sp}.

2 The precipitate is formed because of the common ion, NO_3^- , and its effect on the equilibrium.

3 The K_{sp} has decreased due to the addition of calcium nitrate.

34. When a current of 2.05 A was passed through **J**$(NO_3)_3$ (aq) for 1 hour and 13 minutes, 1.73 g of metal **J** was deposited at the cathode. Which of the following statements about the above electrolysis are correct?

1 **J** is iron.

2 A colourless gas, which turned acidified $KMnO_4$ from purple to colourless, was evolved at the anode.

3 Increasing the $[NO_3^-]$ decreased the rate of formation of **J**.

35. Which of the following can act as ligands?

1 BF_4^-

2 $CH_3CH_2NH_2$

3 H_2S

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.

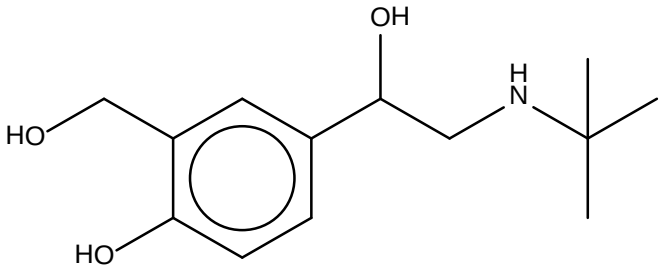
36. In black and white photographic film, light converts silver chloride into metallic silver. After the film has been produced, the unreacted silver chloride is removed by reaction with sodium thiosulfate. Given that the function of the thiosulfate ion is similar to that of ammonia, what are the functions of the thiosulfate ion?

1 To oxidise the chloride ions to chlorine.

2 To form complexes with silver ions.

3 To lower the concentration of silver ions.

37. Salbutamol is used in the treatment of asthma.



Salbutamol

Which of the following statements about salbutamol are correct?

1 It reacts with $SOCl_2$ to form a product with three C*l* atoms.

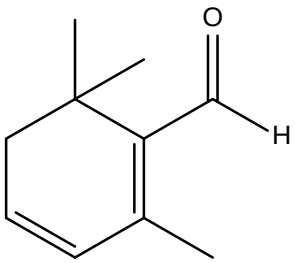
2 It has one chiral carbon.

3 One mole of salbutamol reacts with four moles of ethanoyl chloride.

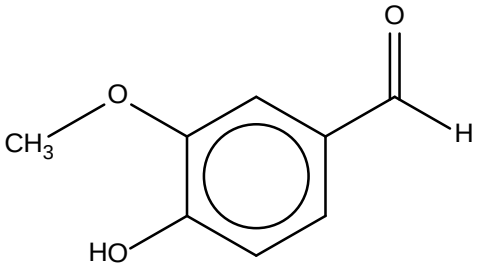
A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

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

38. Saffron and vanilla beans are often used to flavour foods. Safranal and vanillin are organic molecules which are responsible for the aromas of saffron and vanilla beans respectively.



Safranal



Vanillin

Which of the following reagents show identical observations when reacted with both compounds?

1 Aqueous bromine
2 Ammonical silver nitrate
3 Acidified potassium dichromate (VI)

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.

39. Which of the following statements are true for all amino acids from natural sources?

1 They can undergo condensation with one another to form peptide linkages.
2 They can exist as zwitterions which have high melting points.
3 When placed in buffer solutions with pH lower than their isoelectric points, amino acids will move towards the negative plate when electricity is applied.

40. Collagen is the main component of connective tissues in our body. The more common amino acids in collagen are listed in the table below.

Amino acid	**R-group**
Glycine	-H
Alanine	$-CH_3$
Glutamic acid	$-CH_2CH_2COOH$
Arginine	$-CH_2CH_2CH_2NHC(NH_2)=NH$
Aspartic acid	$-CH_2COOH$

Which of the following statements about collagen are true?

1 pH changes will denature collagen.
2 Hydrogen bonds are responsible for forming the secondary and tertiary structures in collagen.
3 The R-groups of alanine and arginine interact with each other through induced dipole-induced dipole interactions.

~~~ END ~~~