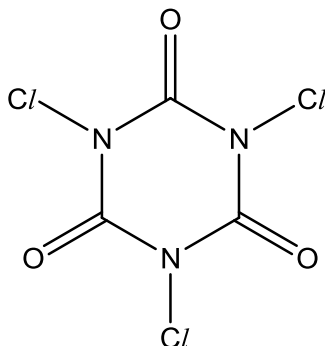


2015 H1 Chemistry Preliminary Examination

Paper 1 Workout Solutions

- 1 **Trichloroisocyanuric acid** is used commonly in swimming pools as a disinfectant. The recommended concentration level of the acid is 1.50 mg per litre.



Trichloroisocyanuric acid

How many moles of chlorine atoms are present in a 2.50×10^6 litre Olympic-sized pool?

Working:

3 atoms in 1 molecule of Trichloroisocyanuric acid

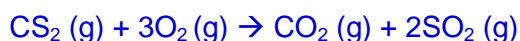
$$\text{No of moles of Trichloroisocyanuric acid in the pool} = \frac{2.50 \times 10^6 \times 1.50 \times 10^3}{12 \times 3 + 16 \times 3 + 35.5 \times 3 + 14 \times 3} = 16.1$$

No. of moles of chlorine atoms = $3 \times 16.1 = 48.3$ (Answer: B)

- 2 Carbon sulfide, CS_2 is a volatile flammable liquid used in the manufacture of cellophane. It combusts to form CO_2 and SO_2 .

What is the volume of gases produced after the complete combustion of 30 cm^3 of CS_2 ?

Working:

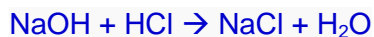


Volume of gas produced = $3 \times 30 = 90 \text{ cm}^3$ (Answer: C)

- 3 The active ingredient in antacids is calcium carbonate. To assess the percentage content of calcium carbonate in a tablet, a 0.50 g tablet was dissolved in 30 cm³ of 0.150 mol dm⁻³ hydrochloric acid. The resultant solution required 21.30 cm³ of 0.100 mol dm⁻³ sodium hydroxide for complete reaction.

What is the percentage mass of calcium carbonate in the antacid tablet?

Working:



$$\text{No. of moles of NaOH} = \frac{21.30}{1000} \times 0.1 = 2.13 \times 10^{-3}$$

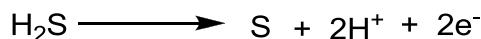
$$\text{No. of moles of HCl reacted with CaCO}_3 = \frac{30.00}{1000} \times 0.150 - 2.13 \times 10^{-3} = 2.37 \times 10^{-3}$$

$$\text{No. of moles of CaCO}_3 = 2.37 \times 10^{-3} \div 2 = 1.185 \times 10^{-3}$$

$$\text{Mass of CaCO}_3 = 1.185 \times 10^{-3} \times (40 + 12 + 16 \times 3) = 0.1185 \text{ g}$$

$$\% \text{ mass of CaCO}_3 = \frac{0.1185}{0.500} \times 100 = 23.7\% \text{ (Answer: A)}$$

- 4 720 cm³ of H₂S gas is passed through 40 cm³ of 0.500 mol dm⁻³ HNO₃. Yellow precipitate of S was produced after the complete reaction as shown in the following half equation.



Which of the following could be the nitrogen-containing product?

(Assume that all volumes are measured at room temperature and pressure conditions)

Working:

$$\text{No. of moles of H}_2\text{S} = \frac{720}{24000} = 0.03$$

$$\text{No. of moles of HNO}_3 = \frac{40}{1000} \times 0.500 = 0.02$$

$$\text{Mole ratio of H}_2\text{S: HNO}_3 = 3: 2$$

$$1 \text{ mole of H}_2\text{S lost 2 electrons} \rightarrow 3 \text{ moles of H}_2\text{S lost 6 electrons}$$

$$2 \text{ moles of HNO}_3 \text{ gains 6 electrons} \rightarrow 1 \text{ mole of HNO}_3 \text{ gain 3 electrons}$$

Original oxidation state of HNO₃:

$$(+1) + x + 3(-2) = 0$$

$$x = +5$$

Since HNO₃ gains 3 electrons, new oxidation state of N = +2 (Answer: B)

Compound	Oxidation State of N
A N ₂	0
B NO	+2
C NO ₂	+4
D NH ₃	-3

- 5 Barium carbonate is an insoluble salt composed of barium and carbonate ions. When the two ions are passed through an electric field, it was observed that the barium ions are deflected by an angle of -5.8° .

What would be the angle of defection for the carbonate ions?

Working:

$$\text{Angle of deflection} = k \times \left(\frac{\text{charge}}{\text{mass}} \right)$$

$$-5.8 = k \times \left(\frac{+2}{137} \right)$$

$$k = -397.3$$

$$\text{Angle of deflection} = (-397.3 \times \left(\frac{-2}{12 + 16 \times 3} \right)) = 13.2^\circ \text{ (Answer: C)}$$

- 6 The following data shows the successive ionisation energies of two elements.

Elements	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th
X	1060	1900	2920	4960	6280	21200	25430	29872
Y	1251	2298	3822	5159	6542	9362	11018	33604

Which of the following could be the compounds formed between X and Y?

Largest increase in IE for X: From 5th to 6th IE \rightarrow X is from Group 5

Largest increase in IE for Y: From 7th to 8th IE \rightarrow Y is from Group 7

Possible compounds formed: XY₃ or XY₅ (Answer: C)

- 7 Which of the two species when mixed together will give the most exothermic interactions?

	Type of solute- solvent interactions
A dichloromethane and propane	Pd – pd vs id – id
B tetrachloromethane and ethanol	Id – id vs hydrogen bonding
C propanal and propane	Pd – pd vs id-id
D propanal and dichloromethane	Pd – pd vs pd – pd (Answer: D)

8 Which of the following pairs contain one simple covalent and one giant covalent compound?

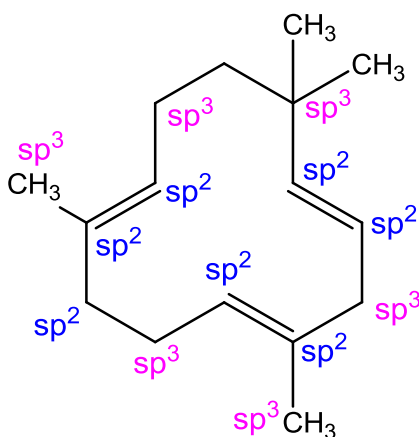
- A aluminium fluoride and silicon dioxide
- B sulfur dioxide and silicon
- C boron fluoride and silicon tetrachloride
- D sodium oxide and graphite

Answer: B

Type of structures

- Giant ionic compound & giant covalent compound
- Simple covalent compound & giant covalent compound
- Both are simple covalent compound
- Giant ionic compound & giant covalent compound

9 **Humulene** can be extracted from carnation flowers.



Humulene

How many $sp^2 - sp^3$ hybrid orbitals overlap are present in humulene?

Answer: C

10 Which of the following sequence gives the lattice energies in order of increasing magnitude?

Working:

Order of cationic charge: Ba^{2+} and $Mg^{2+} > Na^+$ and K^+

Order of anionic charge: S^{2-} and $O^{2-} > Br^-$ and I^-

→ L.E of BaS and MgO > L.E of NaBr and KI

Order of size: $Ba^{2+} > Mg^{2+}$ and $S^{2-} > O^{2-}$

→ L.E of MgO > L.E of BaS

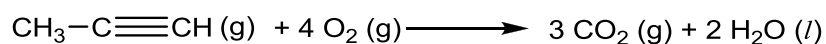
Order of size: $K^+ > Na^+$ and $I^- > Br^-$

→ L.E of NaBr > KI

→ Order: KI < NaBr < BaS < MgO (Answer: C)

11 The use of the Data Booklet is required for the following question.

The combustion of propyne is shown below.



What is the standard enthalpy change of combustion of propyne?

Working:

$$\text{Bond breaking} = 4(\text{C—H}) + (\text{C—C}) + (\text{C}\equiv\text{C}) + 4(\text{O=O})$$

$$= 4(410) + (350) + (840) + 4(496) = 4814$$

$$\text{Bond forming} = 6(\text{C=O}) + 4(\text{O—H})$$

$$= 6(740) + 4(460) = 6280$$

$$\Delta H = \text{Bond breaking} - \text{bond forming} = 4814 - 6280 = -1466 \text{ kJ mol}^{-1} \text{ (Answer: A)}$$

12 Which of the following is always an endothermic process?

Answer: D

- A Enthalpy change of combustion
- B Enthalpy change of formation
- C Enthalpy change of neutralisation
- D Lattice dissociation energy

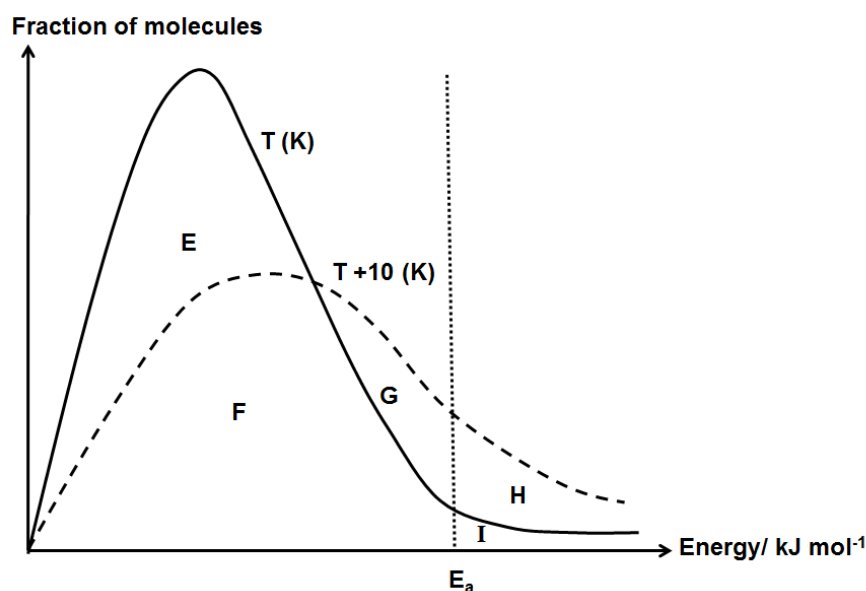
Always exothermic

Can be exothermic or endothermic

Can be exothermic or endothermic. SA-SB: $\approx -57.3 \text{ kJ mol}^{-1}$

Ionic bonds are broken so always endothermic

13



Which of the following shows the correct fraction of molecules with energy greater than activation energy, E_a , at the respective temperatures?

Answer: B

- 14 The rate of the reaction between **M** and **L** is shown below.

$$\text{Rate} = k [\text{M}][\text{L}]^2$$

When the concentration of **M** is doubled, the reaction proceeded at half of its original rate.

What was the corresponding change made to the concentration of **L**?

Working:

When concentration of M is doubled → Rate will double.

To cause it to proceed at half its original rate → L must be decreased by half. (Answer: C)

- 15 There are 39 known isotopes of radon (Rn) from ^{193}Rn to ^{231}Rn . The most stable isotope is ^{222}Rn with a half-life of 3.8 days.

How long will it take for ^{222}Rn to decrease to one-eighth of its original amount?

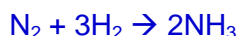
Working:

$$\frac{1}{2} \rightarrow \frac{1}{4} \rightarrow \frac{1}{8}$$

3 half-lives = $3.8 \times 3 = 11.4$ days (Answer: B)

- 16 A mixture of nitrogen, hydrogen and ammonia were reacting at dynamic equilibrium via the Haber Process. When 0.5 mole of hydrogen chloride was passed through the system, which of the following will occur?

Working:



When HCl is added to the system, it will react with NH_3 . Position of equilibrium shifts to the right to produce more NH_3 to replenish the loss.

Answer: C

- 17 Which of the following solutions when mixed together will form a buffer solution?

Answer: D

- A 0.5 mol of ethanoic acid and 0.5 mol of sodium hydroxide
- B 0.5 mol of sulfuric acid and 1.0 mol of ammonia
- C 1.0 mol of ethanoic acid and 2.0 of sodium hydroxide
- D 1.0 mol of sulfuric acid and 3.0 mol of ammonia

Type of solution

Basic salt: $\text{CH}_3\text{CO}_2^-\text{Na}^+$

Acidic salt: $(\text{NH}_4)_2\text{SO}_4$

Strong base: NaOH

Buffer: $(\text{NH}_4)_2\text{SO}_4$ and NH_3

- 18 Which of the following graph shows the correct pH trend of oxides of Period 3?

Working:

Compound	Na ₂ O	MgO	Al ₂ O ₃	SiO ₂	P ₄ O ₁₀	SO ₂
pH	14	9	7	7	3	2

Answer: A

- 19 **M** is an element in Period 3. Its oxide does not dissolve readily in water but spontaneously in aqueous sodium hydroxide. The molten oxide of **M** has a high electrical conductivity.

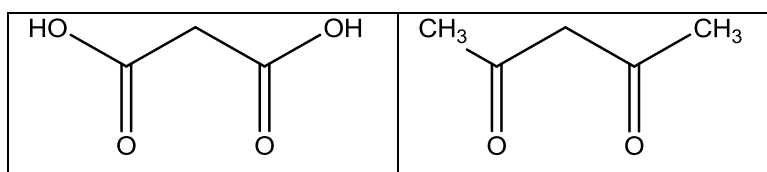
Which of the following statement about **M** is **not** true?

Working: **M** is Aluminium

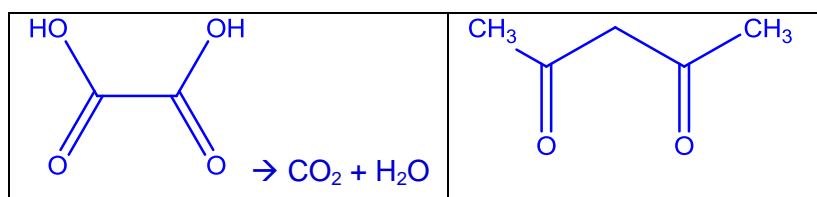
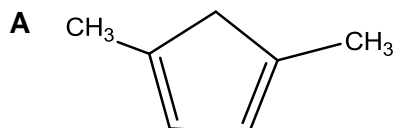
(Answer: A)

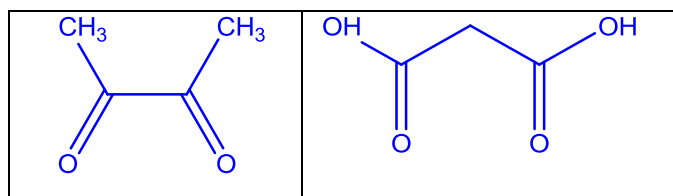
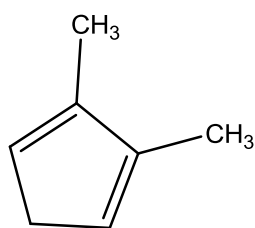
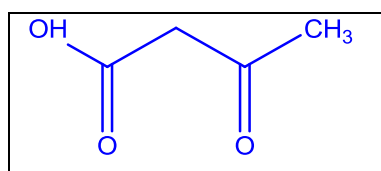
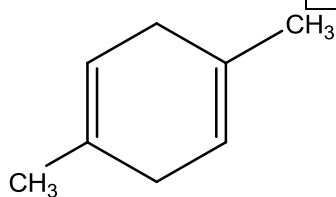
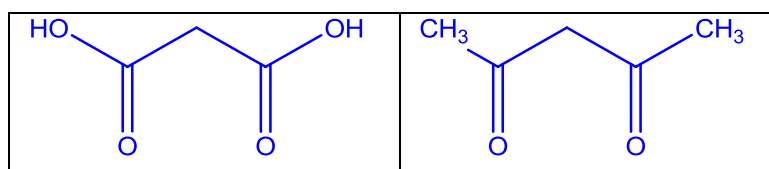
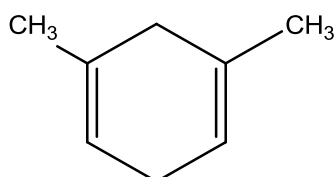
- A** **M** exist as a giant covalent structure.
 Al exist as a giant metallic structure.
- B** The oxide of **M** dissolves in aqueous hydrochloric acid.
 Al₂O₃ is amphoteric.
- C** The aqueous solution of the chloride of **M** reacts has a pH of 3.
 AlCl₃ hydrolyses in water to form an acidic solution.
- D** The chloride of **M** is able to dimerise through dative bonds.
 AlCl₃ dimerises via dative bonds to form Al₂Cl₆.

- 20 An organic compound when reacted with hot acidified potassium manganate (VII) forms only the following products.



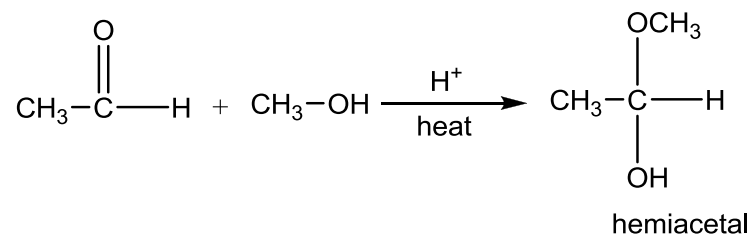
Which of the following could be the organic compound?



B**C****D**

Answer: D

21 Ketones and aldehydes undergo the following reaction to form hemiacetal.



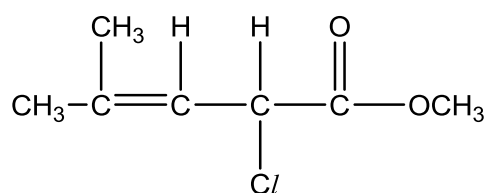
Which of the following describes the reaction above?

Working:

Answer: C

Unsaturated C=O bond is covered to saturated O-C-O bond through addition.

22 Which of the following reagents will give a positive colour change with compound **W**?



Compound **W**

Answer: C

- A hydrogen bromide gas
- B 2,4- dinitrophenylhydrazine
- C bromine in tetrachloromethane
- D aqueous alkaline iodine

Adds to C=C but no colour change observed.

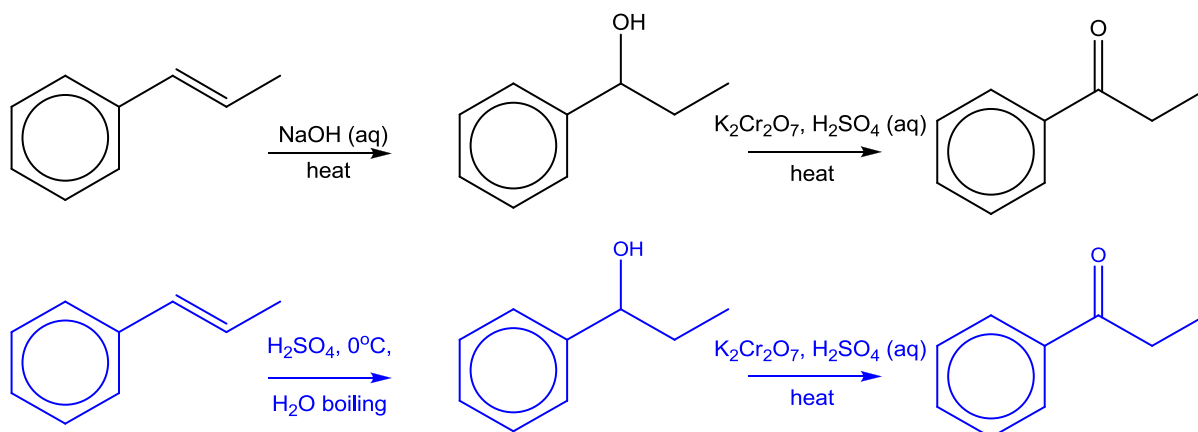
No carbonyl group present → no orange ppt.

Adds to C=C → reddish brown Br₂ decolourised.

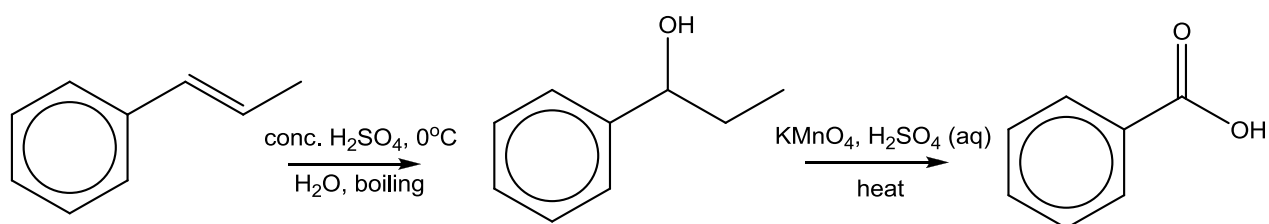
No methyl alcohol or methyl ketone → no yellow ppt.

23 Which of the following shows the correct synthetic pathway?

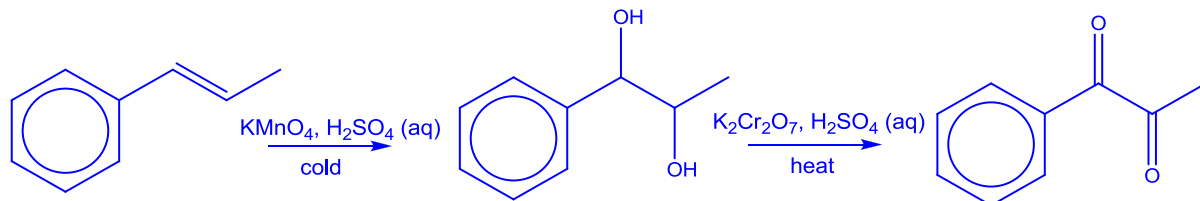
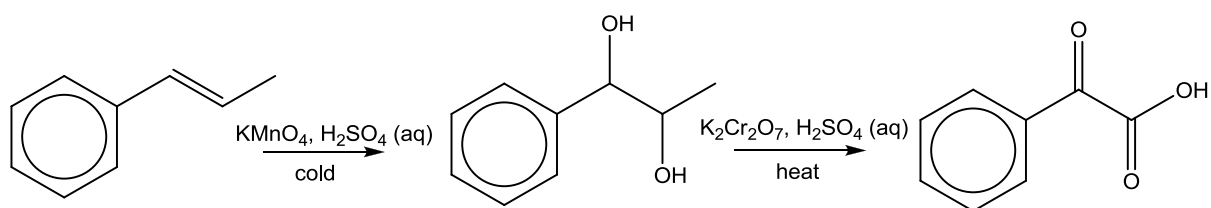
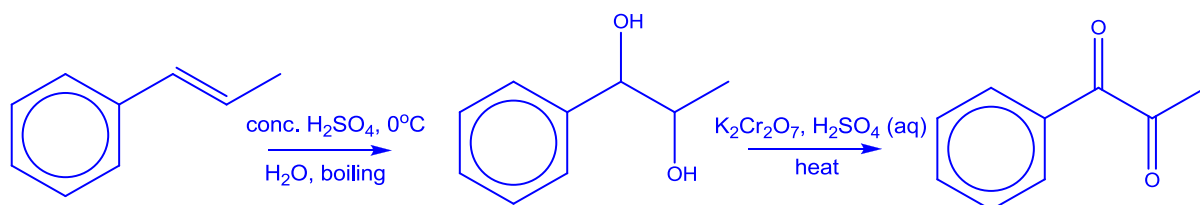
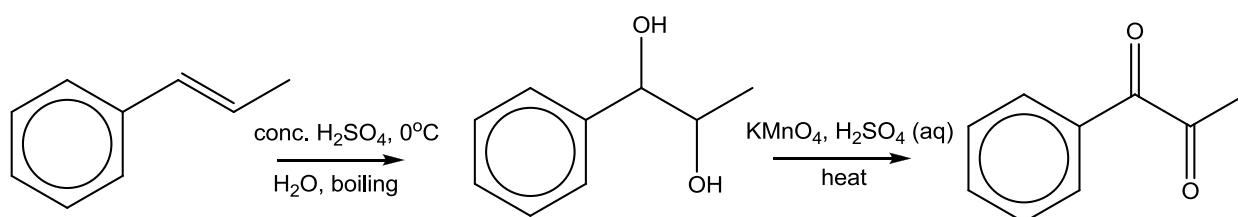
A



B

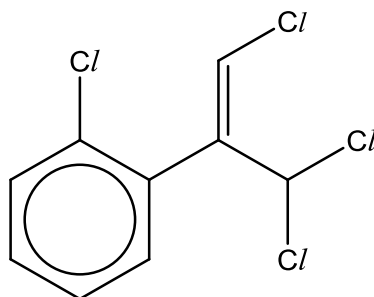


Answer: B

C**D**

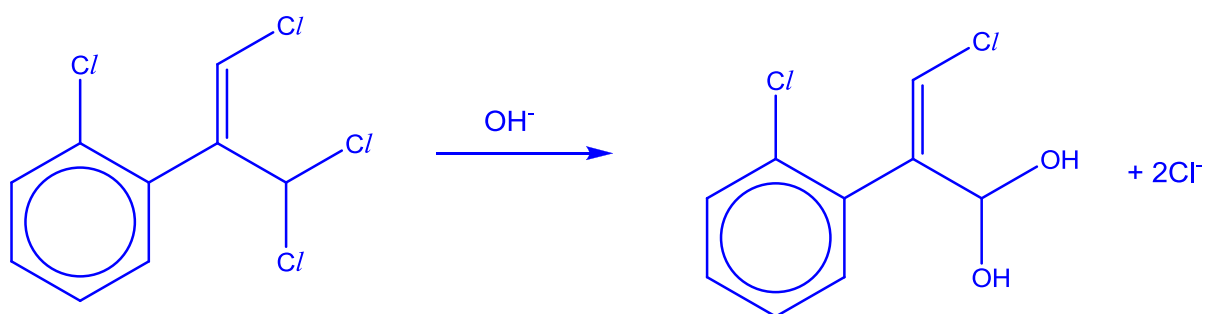
- 24** Compound **T** was reacted with hot sodium hydroxide. When the solution is cooled and acidified, dilute silver nitrate was added to the resultant mixture.

What is the mass of the precipitate formed given that 0.10 mol of compound **T** is used?



Compound **T**

Working:



Mass of $\text{AgCl} = 2 \times 0.10 \times (108 + 35.5) = 28.7\text{g}$ (Answer: B)

- 25 Which of the following will react with sodium metal to produce 1 mol of hydrogen gas?

Working:

1 OH reacts to form $\frac{1}{2} \text{H}_2$

Answer: B

- 26 Which of the following shows the correct trend in electronegativity?

Working:

Electronegativity decreases down a group.

Electronegativity increases across a period.

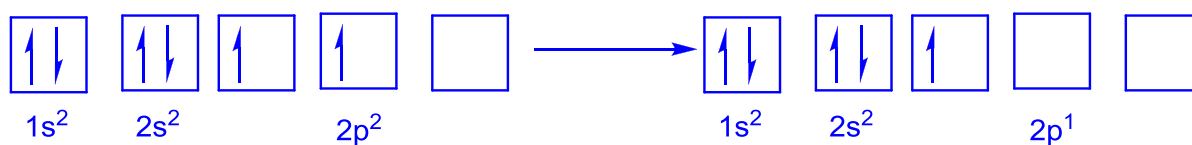
Answer: D (1 only)

- 1 $\text{F} > \text{Cl} > \text{Br}$
- 2 $\text{S} > \text{Cl} > \text{K}$
- 3 $\text{Na} > \text{Mg} > \text{Al}$

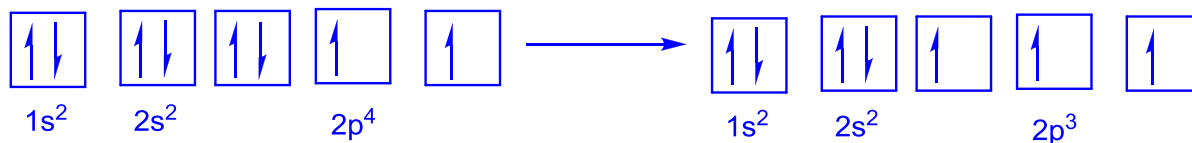
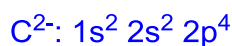
- 27 Which of the following particles would, on losing an electron, have a half-filled set of p orbitals?

- 1 N^+

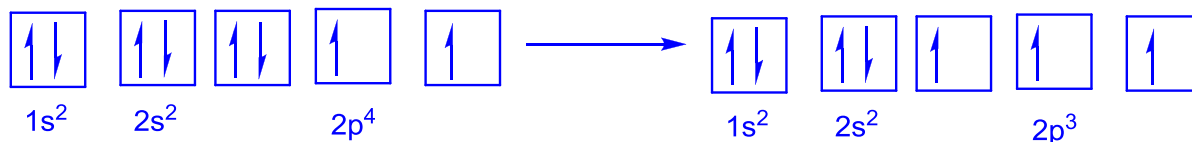
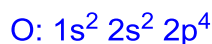
N^+ : $1s^2 2s^2 2p^2$



2 C^{2-}



3 O



Answer: C (2 and 3)

28 Poly(tetrafluoroethene) is a polymer used as a coating in non-stick kitchen utensils. One of the steps in the reaction is shown below.



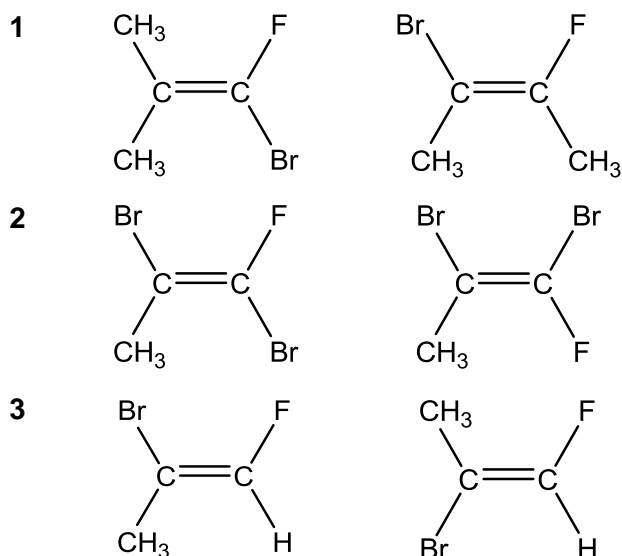
Which of the following conditions will result in a shift of the equilibrium to the left?

- | | | |
|---|---------------------------------|--|
| 1 | decreasing temperature | POE shift left to favour exothermic reaction
POE shift left to favour less moles of gas
POE shift right to replenish HCl |
| 2 | increasing pressure | |
| 3 | adding aqueous sodium hydroxide | |

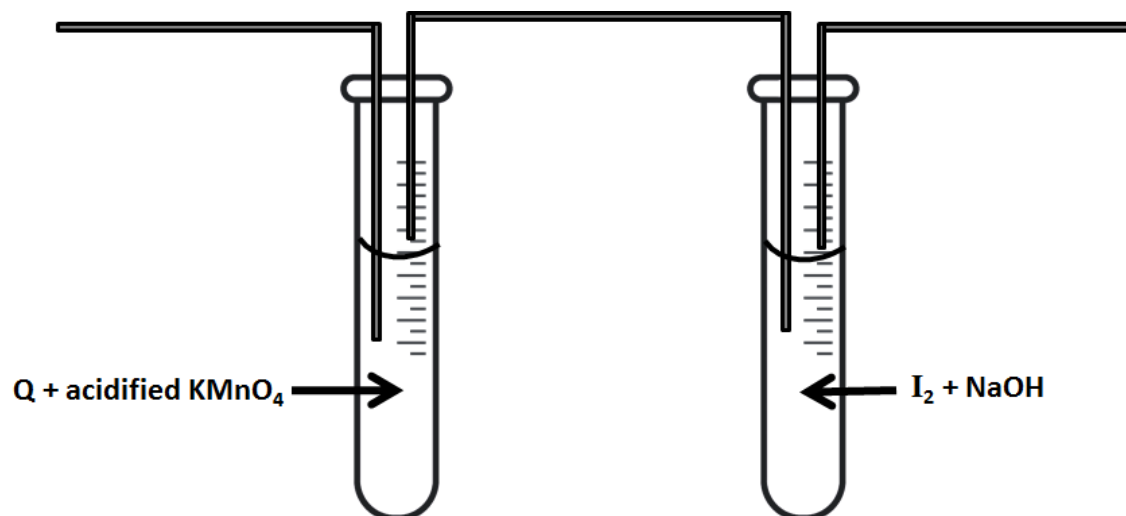
Answer: B (1 and 2)

29 Which of the following pairs illustrate cis-trans isomerism?

Answer: C (2 and 3)

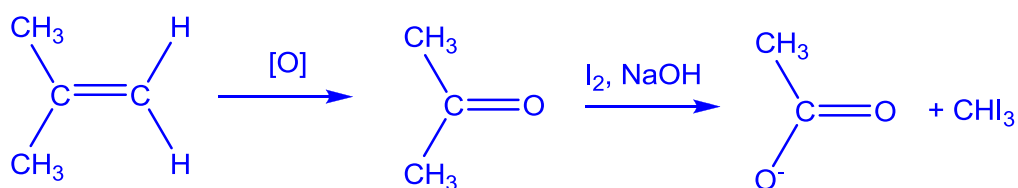


- 30 When the apparatus below was used with compound **Q**, a yellow precipitate was formed at the right hand test tube.

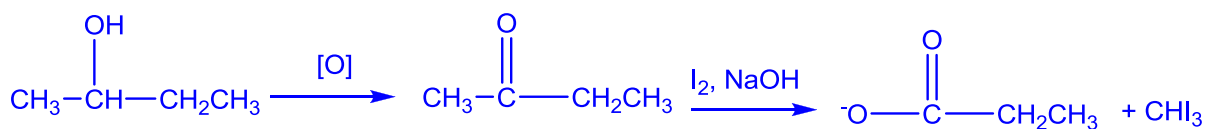


Which of the following could be compound **Q**?

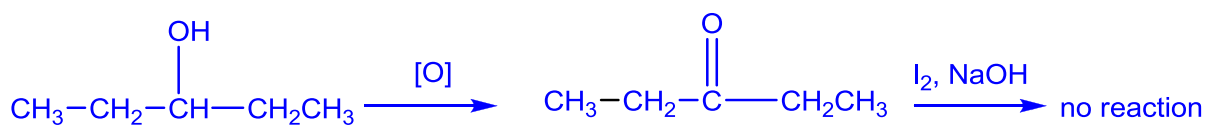
- 1 $(\text{CH}_3)_2\text{C}=\text{CH}_2$



- 2 $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CH}_3$



- 3 $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_2\text{CH}_3$



Answer: B (1 and 2)

END