Chemistry · Organic Chemistry

Phenols

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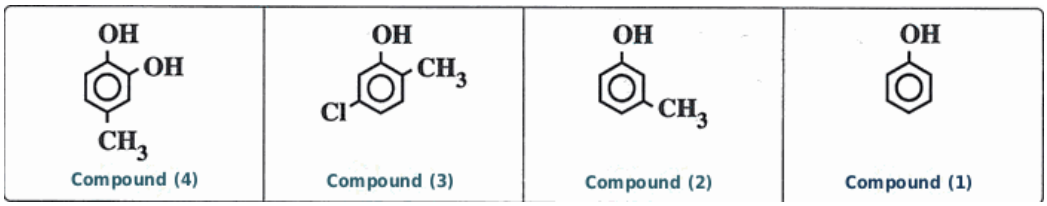
Multiple choice questions — 34 questions

1 The compound 1,2,3-trihydroxybenzene is .....

(A) glycerol. (B) pyrogallol. (C) catechol. (D) picric acid.

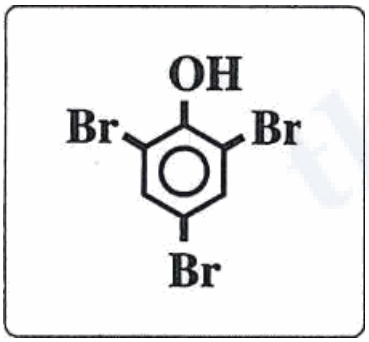
2 The following are the structural formulas of four phenolic compounds:

Which two compounds contain the same number of hydrogen atoms?



(A) (1) , (2). (B) (2) , (3). (C) (3) , (4). (D) (2) , (4).

3 What is the IUPAC name of the opposite compound?



(A) 2-Hydroxy-1,3,6-tribromobenzene. (B) 1-Hydroxy-2,4,6-tribromobenzene.

(C) 1,3,5-Tribromo-2-hydroxybenzene. (D) 1,3,6-Tribromo-2-hydroxybenzene.

4 The following table shows the molecular formulas of three compounds (X), (Y) and (Z):

(X): C_8H_{14} , (Y): C_5H_{10} , (Z): $C_6H_6O_3$

Which of the following is correct?

(A) (X): alkyne , (Y): cycloalkane , (Z): phenols.

(B) (X): alkene , (Y): cycloalkane , (Z): phenols.

(C) (X): alkyne , (Y): alkane , (Z): ethers.

(D) (X): alkane , (Y): alkene , (Z): ethers.

5 All of the following can be obtained by fractional distillation, except .....

(A) benzene from coal tar.
(B) phenol from coal tar.
(C) coal tar from coal.
(D) ethanol from the fermentation mixture.

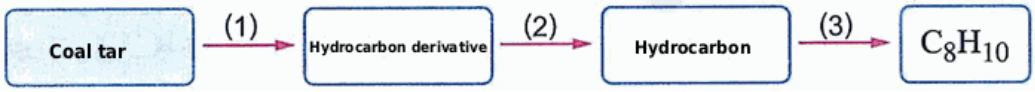
6 Aromatic benzene, anthracene and phenol have in common .....

(A) the functional group.
(B) the possibility of preparing them from coal tar.
(C) the number of pi bonds.
(D) the number of carbon atoms.

7 When coal is heated in the absence of air, a heavy black substance (X) is formed.
Which two substances can be obtained by the fractional distillation of substance (X)?

(A) Aromatic benzene and carbolic acid.
(B) Aromatic benzene and diethyl ether.
(C) Propane and butane.
(D) Butane and butene.

8 The following scheme shows some processes carried out under suitable conditions:
Which of the following represents each of processes (1), (2) and (3)?



(A) (1): fractional distillation , (2): hydrolysis , (3): substitution.
(B) (1): destructive distillation , (2): reduction , (3): addition.
(C) (1): fractional distillation , (2): reduction , (3): Friedel–Crafts.
(D) (1): destructive distillation , (2): elimination , (3): Friedel–Crafts.

9 When chlorobenzene is heated with NaOH(aq) under pressure at 300°C, ... is formed.

(A) an aromatic hydroxyl compound
(B) an aromatic aldehyde
(C) aromatic benzene
(D) chlorophenol

10 What are the products of the reaction of aqueous sodium hydroxide with each of ethyl bromide and chlorobenzene separately – under suitable conditions – respectively?

(A) Ethene and ortho-chlorophenol.
(B) Ethyl alcohol and ortho-chlorophenol.
(C) Ethyl alcohol and phenol.
(D) Ethanal and phenol.

11 A compound used as an insecticide can be obtained from chlorobenzene by the following chemical processes .....

(A) alkaline hydrolysis – removal of oxygen – addition.

(B) addition – alkaline hydrolysis – removal of oxygen.

(C) thermal decomposition – reduction – substitution.

(D) substitution – thermal decomposition – reduction.

12 In what physical state is phenol found at 25°C?

(A) Solid crystals.

(B) A clear liquid.

(C) A volatile vapour.

(D) A yellow liquid.

13 An organic substance (X) is found under ordinary conditions as crystals with a characteristic smell; its melting point is 43°C and it is slightly soluble in water. What is the organic substance (X)?

(A) Acetic acid.

(B) Benzene.

(C) Phenol.

(D) Ethylene glycol.

14 Which of the following compounds is the most acidic?

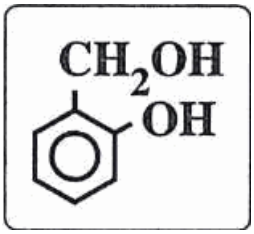
(A) C_2H_6

(B) C_6H_5OH

(C) C_2H_5OH

(D) C_2H_2

15 Which of the following does not describe the properties of 1 mol of the opposite compound?



(A) It reacts with 2 mol of potassium metal.

(B) It reacts with 2 mol of potassium hydroxide.

(C) It reacts with 1 mol of hydrochloric acid.

(D) It is affected by acidified potassium permanganate solution.

16 What substances are needed to obtain potassium phenoxide from chlorobenzene under suitable reaction conditions?

(A) Excess potassium hydroxide solution only.

(B) Excess potassium metal.

(C) Soda lime only.

(D) Hydrogen, platinum, phenol.

---

17 All of the following substances react with sodium hydroxide solution, except .....

(A) aluminium chloride.

(B) iron(III) chloride.

(C) phenol.

(D) ethylene.

---

18 Which of the following compounds cannot be nitrated directly?

(A) Toluene.

(B) Phenol.

(C) Acetic acid.

(D) Benzoic acid.

---

19 The yellow colour of the seagull's beak is due to it containing .....



Seagull

(A) picric acid.

(B) silver sulphide.

(C) iron(II) chloride.

(D) sodium ethoxide.

---

20 Which of the following gives the final product of the nitration and chlorination of phenol, each separately?

(A) Nitration: trinitrophenol , chlorination: meta-chlorophenol

(B) Nitration: meta-nitrophenol , chlorination: gammexane

(C) Nitration: picric acid , chlorination: gammexane

(D) Nitration: picric acid , chlorination: trichlorophenol

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21 What is the least number of chemical processes needed to convert the simplest alkyne into an antiseptic used to treat burns?

(A) 2 (B) 3 (C) 4 (D) 5

22 The compound C_6H_5Cl is converted into 1-chloro-2-nitrobenzene by .....

(A) nitration only.

(B) hydrolysis in an alkaline medium then nitration.

(C) hydrolysis in an alkaline medium then reduction then nitration then halogenation.

(D) hydrolysis in an alkaline medium then reduction then halogenation then nitration.

23 Four organic compounds:

Compound (W): can be oxidized and reduced.

Compound (X): can react by addition and substitution.

Compound (Y): an antiseptic used to treat burns.

Compound (Z): is hydrolysed in an acidic medium forming two isomers.

Which of the following gives the molecular formulas of these compounds?

(A) (W): C_4H_9O , (X): C_7H_8 , (Y): $C_6H_3N_3O_7$, (Z): $C_6H_{12}O_6$

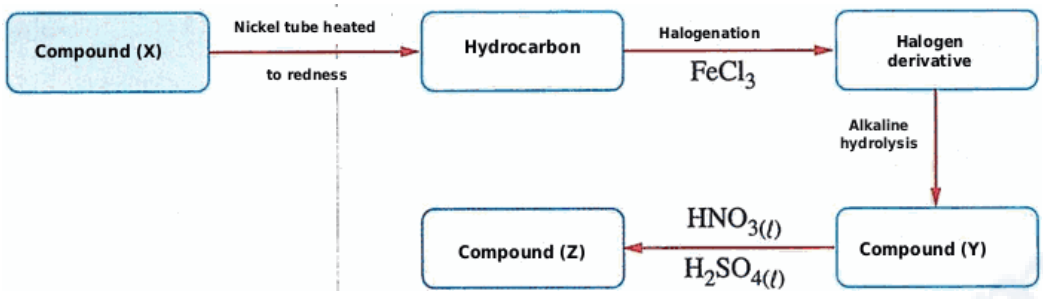
(B) (W): C_4H_8O , (X): C_6H_6 , (Y): $C_6H_3N_3O_7$, (Z): $C_{12}H_{22}O_{11}$

(C) (W): C_6H_6O , (X): $C_6H_5NO_2$, (Y): $C_3H_5N_3O_9$, (Z): $C_6H_{12}O_6$

(D) (W): C_3H_6O , (X): C_2H_5Br , (Y): $C_3H_5N_3O_9$, (Z): $C_{12}H_{22}O_{11}$

24 The reactions shown in the following scheme take place under suitable reaction conditions.

Which of the following describes the properties of each of compounds (X), (Y) and (Z)?



(A) (X): unsaturated , (Y): solid at room temperature , (Z): insecticide

(B) (X): can be polymerized , (Y): reacts with NaOH , (Z): used to dilate the arteries

(C) (X): can be reduced , (Y): reacts with HCl , (Z): aldehyde

(D) (X): chemically active , (Y): corrosive to the skin , (Z): antiseptic

25 Three compounds are used in making explosives.

Compound (X): one of the hydrocarbons.

Compound (Y): a hydroxyl derivative of an aliphatic hydrocarbon.

Compound (Z): a derivative of an aromatic hydrocarbon.

Which of the following describes compounds (X), (Y) and (Z)?

(A) (X): prepared by reforming , (Y): miscible with water , (Z): prepared by the alkaline hydrolysis of a halobenzene

(B) (X): dissolves in water , (Y): prepared by the alkaline hydrolysis of a halobenzene , (Z): prepared by reforming

(C) (X): prepared by the alkaline hydrolysis of a halobenzene , (Y): prepared by reforming , (Z): does not dissolve in water

(D) (X): immiscible with water , (Y): prepared by the alkaline hydrolysis of a halobenzene , (Z): prepared by reforming

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26 Which of the following monomers takes part in polymerization reactions that form water molecules?

(A) Ethene.

(B) Carbolic acid.

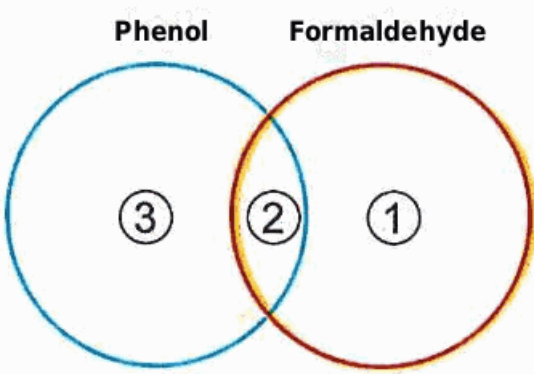
(C) Vinyl chloride.

(D) Tetrafluoroethene.

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27 The opposite Venn diagram represents formaldehyde and phenol.

Which of the following represents the preparation methods (1) and (3) and the substance (2) produced by their reaction together?



(A) (1): reduction of a secondary alcohol , (2): PVC , (3): hydrolysis of an aromatic halogen compound

(B) (1): reduction of a primary alcohol , (2): copolymer , (3): hydrolysis of an aromatic halogen compound

(C) (1): oxidation of a primary alcohol , (2): copolymer , (3): coal tar

(D) (1): oxidation of a secondary alcohol , (2): PVC , (3): coal tar

---

28 From the opposite table:

Compound (X): C_2H_4O , compound (Y): C_6H_6O

Which of the following describes compounds (X) and (Y)?

(A) (X): unstable compound , (Y): takes part in addition polymerization.

(B) (X): stable compound , (Y): cannot be nitrated.

(C) (X): unstable compound , (Y): one of the resins.

(D) (X): stable compound , (Y): its functional group is easily removed.

---

29 Several successive chemical reactions are needed to convert the molecular formula $C_7H_5O_2Na$ into the aromatic compound (X) used in making Bakelite.

What type is the last chemical reaction that produces compound (X)?

(A) Condensation polymerization.

(B) Substitution.

(C) Elimination.

(D) Addition.

---

30 $FeCl_3$ solution was added to each of the aqueous solutions of sodium hydroxide, phenol and ammonium thiocyanate.

Which of the following gives the observations from the experiment?

(A) Sodium hydroxide: greenish-white ppt , phenol: red solution , ammonium thiocyanate: blood-red ppt

(B) Sodium hydroxide: greenish-white ppt , phenol: colourless solution , ammonium thiocyanate: blood-red ppt

(C) Sodium hydroxide: reddish-brown gelatinous ppt , phenol: violet solution , ammonium thiocyanate: colourless solution

(D) Sodium hydroxide: reddish-brown gelatinous ppt , phenol: violet solution , ammonium thiocyanate: blood-red solution

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31 The following three compounds all contain a hydroxyl group:

Compound (1): its colour turns violet when $FeCl_3$ solution is added to it.

Compound (2): is a secondary alcohol.

Compound (3): is oxidized forming a carboxylic acid.

Which of the following represents these compounds?

(A) (1): C_6H_5OH , (2): $(CH_3)_3COH$, (3): $(CH_3)_2CHOH$

(B) (1): $C_6H_5CH_2OH$, (2): $(CH_3)_3COH$, (3): $(CH_3)_2CHCH_2OH$

(C) (1): C_6H_5OH , (2): $(CH_3)_2CHOH$, (3): $(CH_3)_2CHCH_2OH$

(D) (1): $C_6H_5CH_2OH$, (2): $(CH_3)_2CHOH$, (3): $(CH_3)_2CHOH$

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32 Phenol and ethanol can be distinguished by each of the following, except .....

(A) bromine water.

(B) sodium metal.

(C) litmus indicator.

(D) iron(III) chloride solution.

---

33 All of the following are properties of phenol, except that it .....

(A) is more acidic than ethanol.

(B) does not react with HX

(C) reacts with sodium bicarbonate.

(D) reacts with sodium hydroxide.

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34 What mass of bromine is needed to convert 2 g of phenol into tribromophenol?

[Br = 80 , C = 12 , O = 16 , H = 1]

(A) 4 g

(B) 6 g

(C) 10.2 g

(D) 20.44 g

Essay questions — 10 questions

1 How can you distinguish between heptene and phenol by one practical experiment?

2 Compound (X) has a pOH value of zero and is used in preparing:

• the organic compound (Y), slightly soluble in water, which in turn is used in preparing picric acid.

• the reddish-brown inorganic compound (Z), which does not dissolve in water.

(1) Does compound (Y) react with HCl? Explain.

(2) Write the symbolic equation for preparing compound (Z) using compound (X).

3 The aromatic compound (X) is used to disinfect and treat burns.

Write the symbolic equation for preparing compound (X).

4 Show by symbolic equations how to obtain phenol from the simplest aromatic hydrocarbon.

5 An organic compound (X) has the molecular formula CH_2O:

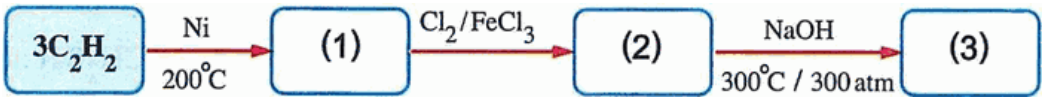
(1) Draw the structural formula of compound (X), stating the homologous series it belongs to.

(2) State one use of the polymer in whose manufacture compound (X) is used.

6 From the following scheme:

(1) Replace the numbers shown in the scheme by the formulas of the suitable compounds.

(2) What is the name of the method used to prepare compound (1)?



7 From the following table: 2-propanol , catechol , picric acid , 1-propanol , 2-methyl-2-propanol , 2-methyl-1-propanol

Choose only one compound that represents:

(1) an alcohol whose oxidation produces a ketone.

(2) an alcohol whose oxidation produces an aldehyde.

(3) a disubstituted derivative of benzene.

(4) a tetrasubstituted derivative of benzene.

8 (X), (Y) and (Z) are three compounds, each containing an (–OH) group:

• Compound (X): the (–OH) group is attached to an alkyl group.

• Compound (Y): the (–OH) group is attached to a phenyl group.

• Compound (Z): inorganic.

(1) State the IUPAC names of compounds (X) and (Y) "given that each is the simplest member of its homologous series".

(2) Which of compounds (X) and (Y) reacts with compound (Z)?

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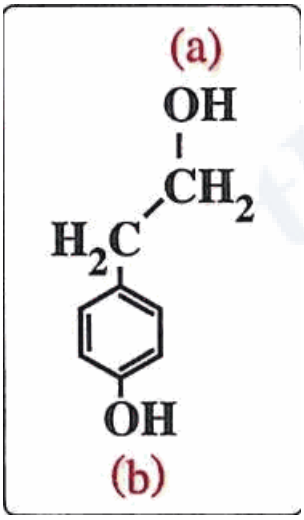
9 From the opposite compound:

(1) Which of the hydroxyl groups (a) or (b) reacts with sodium hydroxide?

(2) Show by chemical equations what happens to this compound when the following is added to it:

(a) sodium hydroxide solution.

(b) conc. hydrochloric acid in the presence of $ZnCl_2$



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10 Arrange the following steps, writing the equations of the reactions, to obtain phenol from calcium carbide:

• Hydrolysis in an alkaline medium. • Halogenation. • Dropping water. • Cyclic polymerization.

Past exam questions — 20 questions

1 (A), (B) and (C) are three organic acids that do not contain a carboxyl group: (Sample exam 2026)

(A): a weak solid acid with a characteristic smell at room temperature.

(B): can be prepared by the substitution reaction of benzene with one of the mineral acids.

(C): used as an antiseptic in treating burns.

Which of the following describes the previous acids?

(A) Acid (A) can be prepared from acid (B) by complete oxidation in the presence of a dehydrating agent.

(B) Acid (B) can be prepared from acid (A) by adding conc. nitric acid in the presence of sulphuric acid.

(C) Acid (C) can be prepared from acid (B) by adding conc. nitric acid and conc. sulphuric acid.

(D) Acid (B) can be prepared from acid (A) by adding zinc and heating, then conc. sulphuric acid.

---

2 Which of the following is correct for the order of the processes needed to obtain 1,2-dimethylcyclohexane from a compound of molecular formula C_6H_6O? (Sample exam 2026)

(A) Neutralization – fractional distillation – catalytic reforming – reduction.

(B) Heating with zinc – alkylation – Friedel-Crafts reaction – oxidation.

(C) Neutralization – alkylation – dehydration – Friedel-Crafts reaction.

(D) Heating with zinc – alkylation – Friedel-Crafts reaction – hydrogenation.

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3 Given that: (Sample exam 2026)

Compound (A): an organic acid that reacts with oxygen-containing mineral acids and does not react with halogen acids.

Compound (B): follows the formula $C_nH_{2n}O$ and is oxidized to an acid used in making insecticides and perfumes.

Which of the following represents the use of the compound produced by the reaction of (A) and (B) in an acidic or basic medium?

(A) Making explosives.

(B) Electrical appliances.

(C) Making antiseptics.

(D) Making heart valves.

---

4 All of the following can be used to distinguish between ethyl alcohol and phenol, except ..... (Sample exam 2026)

(A) bromine water.
(B) sodium.
(C) $FeCl_3$ solution
(D) acidified potassium permanganate.

5 The opposite table shows the observations or the role of iron(III) chloride when it is added to the organic compounds (X) and (Y). (Sample exam 2026)

(X): gives a violet colour.

(Y): a catalyst in its preparation.

Which of the following is correct for these compounds?

(A) (X): salicylic acid , (Y): carbolic acid.
(B) (X): carbolic acid , (Y): halobenzene.
(C) (X): oil of wintergreen , (Y): salicylic acid.
(D) (X): halobenzene , (Y): oil of wintergreen.

6 The following scheme shows a method of preparing an organic compound: (Sample exam 2026)

Which of the following represents the product (D)?



(A) Trinitrotoluene.
(B) Trinitroglycerol.
(C) Picric acid.
(D) Dacron fibres.

7 Which of the following represents the processes needed to obtain a polymer used in electrical appliances? (Sample exam 2026)

(A) Alkaline hydrolysis of 1-chloroheptane – polymerization with formaldehyde.
(B) Oxidation of ortho-hydroxytoluene – polymerization with ethylene glycol.
(C) Alkaline hydrolysis of 1-chloroheptane – oxidation – polymerization with ethylene glycol.
(D) Catalytic reforming of 1-chlorohexane – alkaline hydrolysis – polymerization with formaldehyde.

8 Compound (A) is produced by the fractional distillation of coal tar; the following processes were carried out on it in order, under the suitable conditions for each: (Sample exam 2026)
(substitution reaction with chlorine - reaction with sodium hydroxide - nitration)
Which of the following represents a use of the compound produced by these processes?

(A) An insecticide. (B) An artery dilator. (C) An explosive. (D) Bakelite polymer.

---

9 (A , B) are organic hydroxyl compounds; the O–H bond in compound (A) is longer and weaker than that in compound (B). (Sample exam 2026)
Which of the following is correct?

(A) Both (A) and (B) react with NaOH

(B) Both (A) and (B) react with HCl acid

(C) (A) reacts with sodium hydroxide, while (B) does not.

(D) Both compounds (A) and (B) can be detected by $FeCl_3$ solution

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10 The following compounds are hydrocarbon derivatives: (2nd session 2024)
(X): an acidic compound that reacts with bromine water.
(Y): a compound that can be oxidized and dissolves in water.
(Z): a compound with the same number of carbon atoms as compound (Y) and a higher boiling point than (Y).
So the previous compounds are .....

(A) (X): carboxylic acid , (Y): phenol , (Z): primary alcohol.

(B) (X): alcohol , (Y): carboxylic acid , (Z): phenol.

(C) (X): phenol , (Y): monohydric alcohol , (Z): dihydric alcohol.

(D) (X): phenol , (Y): tertiary alcohol , (Z): dihydric alcohol.

---

11 From the following table: solubility in water at 25°C (1st session 2023)
(A): dissolves , (B): does not dissolve , (C): slightly soluble.
So compounds (A), (B) and (C) are .....

(A) (A): ethene , (B): benzene , (C): carbolic acid.

(B) (A): ethene , (B): carbolic acid , (C): cyclohexane.

(C) (A): isopropyl alcohol , (B): ethene , (C): carbolic acid.

(D) (A): ethyl alcohol , (B): acetic acid , (C): cyclohexane.

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12 On the hydrolysis of a benzene halide in a basic medium, then nitration of the product, each of the following is formed, except ..... (1st session 2022)

(A) nitrobenzene.
(B) an acidic polynitro compound.
(C) an explosive substance.
(D) an antiseptic substance.

13 (A) and (B) are hydrocarbon derivatives that share some chemical properties, such that: (1st session 2021)

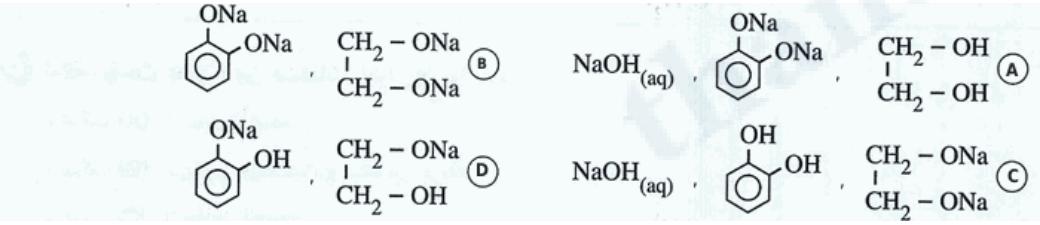
(A): can be used as a fuel. (B): is used in preparing a type of plastic.

So (A) and (B) are .....

(A) (A): alcohol , (B): alkyl halide.
(B) (A): phenol , (B): acid.
(C) (A): ester , (B): aldehyde.
(D) (A): alcohol , (B): phenol.

14 When excess caustic soda is added to a mixture of (1 mol) of ethylene glycol and (1 mol) of catechol. (1st session 2023)

The compounds present in the solution are .....



15 (A) is an organic compound and (B) an inorganic compound. When compound (C) is added to compound (A), a violet colour forms, and when compound (C) is added to compound (B), a reddish-brown ppt forms. (1st session 2021)

Which of the following choices is correct?

(A) (B): sodium iodide , (A): an acid salt.
(B) (C): an acid salt , (A): a basic compound.
(C) (B): an alkaline compound , (A): an acidic compound.
(D) (B): a solution of a gas in water , (A): a liquid substance.

16 Iron(III) chloride was added to each of the organic hydroxyl compounds (A) and (B) separately. (2nd session 2021)

A violet colour formed with compound (A), and compound (B) was not affected.

Which of the following is correct regarding the bond energies?

(A) (O–H) of compound (A) is greater than (O–H) of compound (B).

(B) (O–H) of compound (A) is less than (O–H) of compound (B).

(C) (C–O) of compound (B) is greater than (C–O) of compound (A).

(D) (C–O) of compound (B) equals (C–O) of compound (A).

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17 Compound (X) is aliphatic with the formula $(C_nH_nO_2)$ and compound (Y) is aromatic with the formula $(C_nH_{2n+2}O_2)$. Each was put in a test tube; sodium hydroxide was added to compound (X), and hydrochloric acid was added to compound (Y). (1st session 2024)

Which of the following choices is correct?

(A) No reaction occurs with compound (X), and a dichloro compound forms with compound (Y).

(B) A disodium salt forms with compound (X) and a dichloro compound with compound (Y).

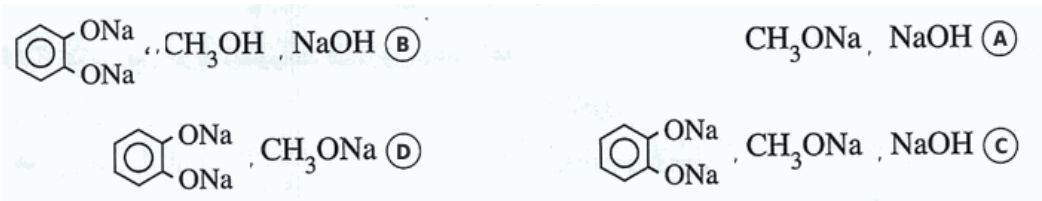
(C) No reaction occurs with compound (X) and no reaction occurs with compound (Y).

(D) A disodium salt forms with compound (X), and no reaction occurs with compound (Y).

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18 When a piece of sodium is added to an aqueous solution of a mixture of catechol and methanol, (2nd session 2023)

the compounds present in the solution are .....



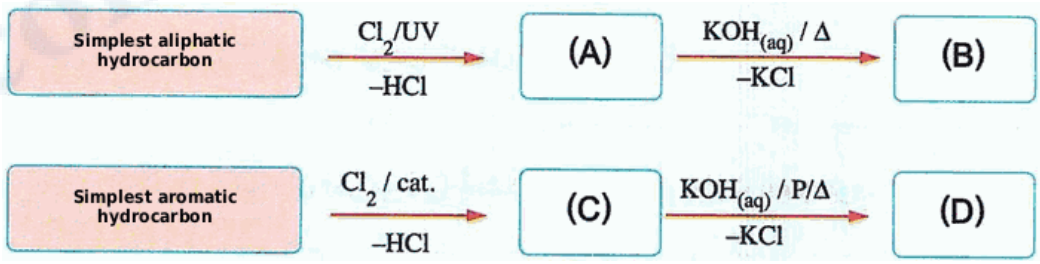
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19 From the following schemes: (1st session 2023)

Deduce:

(1) The reduction product of each of (B) and (D).

(2) The effect of adding hydrochloric acid to each of (B) and (D) separately.

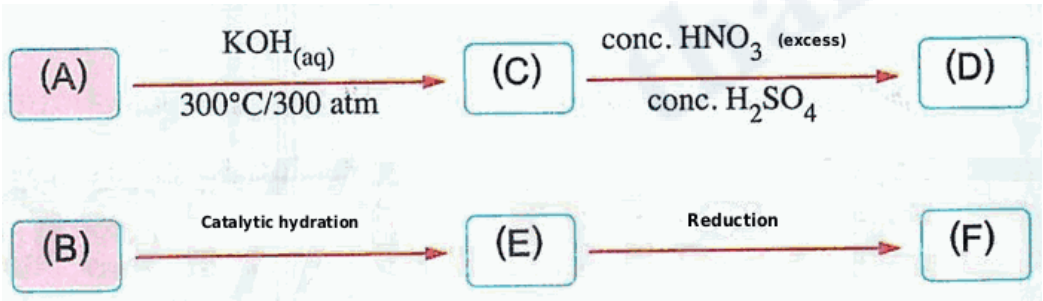


20 From the following reaction schemes, which take place under suitable conditions: (2nd session 2023)

Given that:

- (D) is used in treating burns.
- (F) is used in mouth and teeth sterilizing solutions.

Deduce the names of compounds (A), (B), (C) and (E).



Answer key and solutions

Multiple choice questions

1 B	2 D	3 C	4 A	5 C	6 B	7 A	8 C	9 A	10 C
11 A	12 A	13 C	14 B	15 B	16 A	17 D	18 C	19 A	20 D
21 C	22 A	23 B	24 D	25 A	26 B	27 C	28 C	29 B	30 D
31 C	32 B	33 C	34 C						

1 **Answer (B)**

1,2,3-Trihydroxybenzene is pyrogallol.

2 **Answer (D)**

(1) C_6H_6O , (2) C_7H_8O , (3) C_7H_7ClO , (4) $C_7H_8O_2$

Compounds (2) and (4) each have 8 hydrogen atoms.

3 **Answer (C)**

We choose the lowest numbers for the positions of the groups: (1,2,3,5) is lower than (1,2,4,6)

And the groups are written in alphabetical order (bromo before hydroxy): 1,3,5-tribromo-2-hydroxybenzene.

4 **Answer (A)**

(X) C_8H_{14} follows C_nH_{2n-2}: an alkyne.

(Y) C_5H_{10} follows C_nH_{2n}: it can be a cycloalkane.

(Z) $C_6H_6O_3$: trihydroxybenzene (phenols).

5 **Answer (C)**

Coal tar is obtained from coal by destructive distillation, not fractional distillation.

6 **Answer (B)**

Benzene, anthracene and phenol can all be obtained from coal tar.

7 **Answer (A)**

(X) is coal tar; by its fractional distillation we obtain aromatic benzene and carbolic acid (phenol).

8 **Answer (C)**

(1) Fractional distillation of coal tar gives phenol.

(2) Reduction of phenol by zinc gives benzene.

(3) The Friedel–Crafts reaction of benzene gives ethylbenzene C_8H_{10}

9 **Answer (A)**

$C_6H_5Cl + NaOH \rightarrow C_6H_5OH + NaCl$

Phenol is an aromatic hydroxyl compound.

10 **Answer (C)**

$C_2H_5Br + NaOH \rightarrow C_2H_5OH + NaBr$

$C_6H_5Cl + NaOH \rightarrow C_6H_5OH + NaCl$ (under suitable reaction conditions)

11 **Answer (A)**

Chlorobenzene → alkaline hydrolysis → phenol.

Phenol → removal of oxygen (by zinc) → benzene.

Benzene + Cl_2 → addition → gammexane (an insecticide).

12 **Answer (A)**

Phenol at 25°C is solid crystals (its melting point is 43°C).

13 **Answer (C)**

Crystals with a characteristic smell, melting at 43°C, slightly soluble in water: phenol.

14 **Answer (B)**

Phenol is more acidic than alcohols and hydrocarbons.

15 **Answer (B)**

The compound has an alcoholic OH and a phenolic OH.

Only the phenolic OH reacts with KOH, so 1 mol of it reacts with 1 mol of KOH, not 2 mol

16 **Answer (A)**

$C_6H_5Cl + KOH \rightarrow C_6H_5OH + KCl$

$C_6H_5OH + KOH \rightarrow C_6H_5OK + H_2O$

So only excess KOH solution is needed.

17 **Answer (D)**

Ethylene is a hydrocarbon that does not react with sodium hydroxide.

18 **Answer (C)**

Acetic acid is an aliphatic compound with no benzene ring, so it cannot be nitrated directly.

19 **Answer (A)**

Picric acid is yellow.

20 **Answer (D)**

Nitration of phenol gives picric acid (2,4,6-trinitrophenol).

Chlorination of phenol gives trichlorophenol.

21 **Answer (C)**

Ethyne → cyclic polymerization → benzene.

Benzene → halogenation → chlorobenzene.

Chlorobenzene → alkaline hydrolysis → phenol.

Phenol → nitration → picric acid (an antiseptic for burns).

The number of processes is 4

22 **Answer (A)**

The chlorine atom in chlorobenzene directs the entering group to the ortho and para positions.

So its direct nitration gives 1-chloro-2-nitrobenzene.

23 **Answer (B)**

(W) C_4H_8O (an aldehyde or ketone) is oxidized and reduced.

(X) C_6H_6, benzene, reacts by addition and substitution.

(Y) $C_6H_3N_3O_7$ is picric acid.

(Z) $C_{12}H_{22}O_{11}$, sucrose, is hydrolysed to glucose and fructose (two isomers).

24 **Answer (D)**

(X) ethyne → benzene → chlorobenzene → (Y) phenol → (Z) picric acid.

Ethyne is chemically active, phenol is corrosive to the skin, and picric acid is an antiseptic.

25 **Answer (A)**

(X) Toluene is prepared by reforming (TNT).

(Y) Glycerol is miscible with water (nitroglycerin).

(Z) Phenol is prepared by the alkaline hydrolysis of a halobenzene (picric acid).

26 **Answer (B)**

Phenol (carbolic acid) polymerizes by condensation with formaldehyde, forming Bakelite and water molecules.

27 **Answer (C)**

(1) Formaldehyde is prepared by the oxidation of a primary alcohol (methanol).
(2) Their reaction gives Bakelite (a copolymer).
(3) Phenol is prepared from coal tar.

28 **Answer (C)**

(X) C_2H_4O may be the unstable vinyl alcohol (it changes into ethanal).
(Y) C_6H_6O is phenol, used in making resins.

29 **Answer (B)**

$C_7H_5O_2Na$ (sodium benzoate) → benzene → chlorobenzene → phenol.
The last reaction is the hydrolysis of chlorobenzene, a substitution reaction (replacing Cl by OH).

30 **Answer (D)**

$FeCl_3 + 3NaOH \rightarrow Fe(OH)_3 + 3NaCl$: a reddish-brown gelatinous ppt.
$FeCl_3$ with phenol: violet colour.
$FeCl_3 + 3NH_4SCN \rightleftharpoons Fe(SCN)_3 + 3NH_4Cl$: blood-red solution.

31 **Answer (C)**

(1) Phenol C_6H_5OH gives a violet colour with $FeCl_3$
(2) $(CH_3)_2CHOH$ is a secondary alcohol.
(3) $(CH_3)_2CHCH_2OH$ is a primary alcohol that is oxidized to a carboxylic acid.

32 **Answer (B)**

Phenol and ethanol both react with sodium metal, giving off hydrogen, so they cannot be distinguished by it.

33 **Answer (C)**

Phenol is a very weak acid that does not react with sodium bicarbonate.

34 **Answer (C)**

$C_6H_5OH + 3Br_2 \rightarrow C_6H_2Br_3OH + 3HBr$
94 g of phenol needs $3 \times 160 = 480$ g of bromine
Mass of bromine = $2 \times 480 \div 94 \approx 10.2$ g

Essay questions

1 **Model answer**

Bromine water is added to each of them:

Heptene: the colour of bromine water disappears.

Phenol: a white precipitate forms.

2 **Model answer**

Compound (X): sodium hydroxide , compound (Y): phenol , compound (Z): iron(III) hydroxide.

(1) Phenol does not react with HCl because the (C – O) bond between the carbon atom of the benzene ring and the oxygen atom of the hydroxyl group is short, which makes it stronger, so the hydroxyl group cannot be removed from phenol.

(2) $FeCl_3(aq) + 3NaOH(aq) \rightarrow 3NaCl(aq) + Fe(OH)_3(s)$

3 **Model answer**

The aromatic compound (X): picric acid.

$C_6H_5OH + 3HNO_3 \rightarrow C_6H_2(NO_2)_3OH + 3H_2O$ (in the presence of conc. H_2SO_4)

4 **Model answer**

$C_6H_6 + Cl_2 \rightarrow C_6H_5Cl + HCl$ (in the presence of $FeCl_3$)

$C_6H_5Cl + NaOH \rightarrow C_6H_5OH + NaCl$ (at 300°C and 300 atm)

5 **Model answer**

(1) H–CHO (formaldehyde), one of the aldehydes.

(2) Making ashtrays or electrical appliances (Bakelite).

6 **Model answer**

(1) (1): C_6H_6 , (2): C_6H_5Cl , (3): C_6H_5OH

(2) Trimerization (cyclic polymerization).

7 **Model answer**

(1) 2-Propanol.

(2) 1-Propanol or 2-methyl-1-propanol.

(3) Catechol.

(4) Picric acid.

8 **Model answer**

(1) Compound (X): methanol , compound (Y): hydroxybenzene or phenol.

(2) Compound (Y) (phenol) reacts with compound (Z) (NaOH).

9 **Model answer**

(1) Hydroxyl group (b).

(2) (a) $HO–C_6H_4–CH_2CH_2OH + NaOH \rightarrow NaO–C_6H_4–CH_2CH_2OH + H_2O$

(b) $HO–C_6H_4–CH_2CH_2OH + HCl \rightarrow HO–C_6H_4–CH_2CH_2Cl + H_2O$ (in the presence of $ZnCl_2$)

10 **Model answer**

The order: dropping water → cyclic polymerization → halogenation → hydrolysis in an alkaline medium.

$CaC_2 + 2H_2O \rightarrow C_2H_2 + Ca(OH)_2$

$3C_2H_2 \rightarrow C_6H_6$ (a nickel tube heated to redness)

$C_6H_6 + Cl_2 \rightarrow C_6H_5Cl + HCl$ (in the presence of $FeCl_3$)

$C_6H_5Cl + NaOH \rightarrow C_6H_5OH + NaCl$ (at 300°C and 300 atm)

Past exam questions

1	2	3	4	5	6	7	8	9	10
D	D	B	B	B	C	D	C	C	C
11	12	13	14	15	16	17	18	19	20
C	A	D	A	C	B	C	C	—	—

1 **Answer (D)**

(A) phenol, (B) benzenesulphonic acid, (C) picric acid.

Phenol heated with zinc gives benzene, and benzene with conc. H_2SO_4 gives benzenesulphonic acid (B).

2 **Answer (D)**

Phenol C_6H_6O heated with zinc gives benzene.

Alkylation (Friedel-Crafts) twice gives ortho-xylene, and hydrogenation gives 1,2-dimethylcyclohexane.

3 **Answer (B)**

(A) phenol (it reacts with HNO_3 and H_2SO_4 and does not react with HX).

(B) formaldehyde HCHO

Their reaction gives Bakelite, used in electrical appliances.

4 **Answer (B)**

Both ethyl alcohol and phenol react with sodium, giving off hydrogen.

So they cannot be distinguished by sodium.

5 **Answer (B)**

(X) Phenol (carbolic acid) gives a violet colour with $FeCl_3$

(Y) Halobenzene is prepared by the halogenation of benzene in the presence of $FeCl_3$ as a catalyst.

6 **Answer (C)**

Carbolic acid + conc. HNO_3 (B) in the presence of conc. H_2SO_4 → 2,4,6-trinitrophenol (picric acid).

7 **Answer (D)**

The polymer is Bakelite (phenol + formaldehyde).

1-Chlorohexane → (catalytic reforming) chlorobenzene → (alkaline hydrolysis) phenol → polymerization with formaldehyde.

8 **Answer (C)**

Benzene → (chlorination) chlorobenzene → (NaOH) phenol → (nitration) picric acid.

Picric acid is an explosive.

9 **Answer (C)**

(A) is a phenol, (B) an alcohol.

Phenol reacts with NaOH, and the alcohol does not.

10 **Answer (C)**

(X) is acidic and reacts with bromine water: a phenol.

(Y) is oxidized and dissolves in water: a monohydric alcohol.

(Z) has the same number of carbon atoms and a higher boiling point: a dihydric alcohol.

11 **Answer (C)**

Isopropyl alcohol dissolves in water.

Ethene is a hydrocarbon that does not dissolve in water.

Carbolic acid (phenol) is slightly soluble.

12 **Answer (A)**

Hydrolysis of a benzene halide gives phenol.

Nitration of phenol gives picric acid: acidic, polynitro, explosive and antiseptic.

Nitrobenzene is not formed.

13 **Answer (D)**

(A) an alcohol used as a fuel , (B) a phenol used in preparing Bakelite.

They share the presence of the hydroxyl group.

14 **Answer (A)**

Catechol (a phenol) reacts with caustic soda, and its two OH groups change into ONa

Ethylene glycol (an alcohol) does not react with NaOH, and excess NaOH remains in the solution.

15 **Answer (C)**

(C) is iron(III) chloride; it gives a violet colour with phenol (A), which is an acidic compound.

And it gives a reddish-brown ppt of $Fe(OH)_3$ with alkalis, so compound (B) is alkaline.

16 **Answer (B)**

(A) is a phenol and (B) an alcohol.

Phenol is more acidic than the alcohol, so its O–H bond is weaker.

17 **Answer (C)**

The aliphatic dihydroxy compound (an alcohol) does not react with NaOH

The aromatic dihydroxy compound (a phenol) does not react with HCl

18 **Answer (C)**

Sodium reacts with water forming NaOH

And reacts with methanol forming CH_3ONa

And catechol reacts, and its two OH groups change into ONa

19 **Model answer**

(1) The reduction product of (B): it cannot be reduced (methanol).

The reduction product of (D): benzene C_6H_6 (by reducing phenol).

(2) (B): methyl chloride CH_3Cl is formed

(D): no reaction takes place.

20 **Model answer**

(A): chlorobenzene , (B): ethyne.

(C): phenol , (E): ethanal.