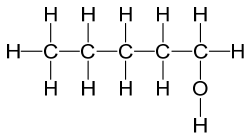
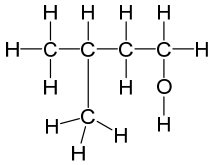
Answers to Hydroxy Compounds self-check questions

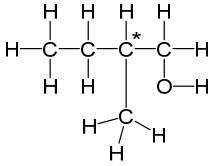
1 (a)



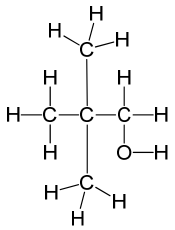
pentan-1-ol
primary (1°)



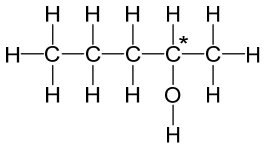
3-methylbutan-1-ol
primary (1°)



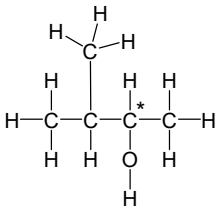
2-methylbutan-1-ol
primary (1°)



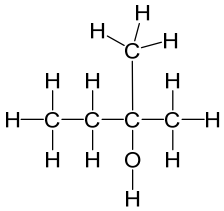
2,2-dimethylpropan-1-ol
primary (1°)



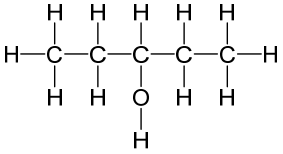
pentan-2-ol
secondary (2°)



3-methylbutan-2-ol
secondary (2°)



2-methylbutan-2-ol
tertiary (3°)



pentan-3-ol
secondary (2°)

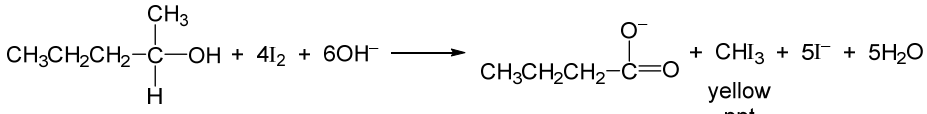
(b) pentan-1-ol, 3-methylbutan-1-ol, 2-methylbutan-1-ol

(Note: Pentan-3-ol is not accepted as it forms an alkene which can exhibit cis-trans isomerism.)

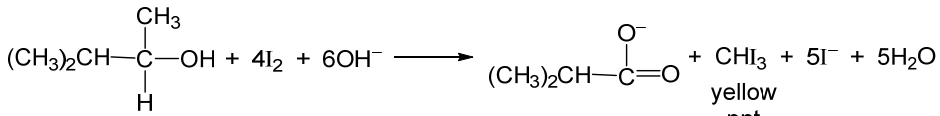
(c) 2,2-dimethylpropan-1-ol

(Note: For dehydration to occur, there must be a H atom and a –OH group on adjacent carbon atoms)

(d)



pentan-2-ol



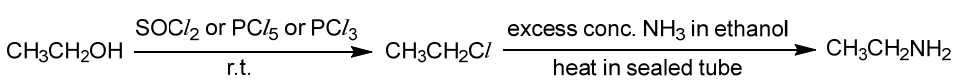
3-methylbutan-2-ol

(e) **(i)** 2-methylbutan-2-ol *(Note: 3° alcohols do not undergo oxidation)*

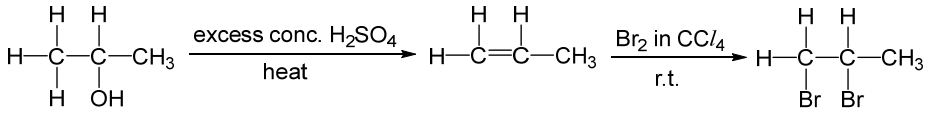
(ii) pentan–1–ol, 3–methylbutan–1–ol, 2–methylbutan–1–ol, 2,2–dimethylpropan–1–ol

(Note: Only carboxylic acids will react with $Na_2CO_3(aq)$ to form CO_2 gas)

2 **(a)**



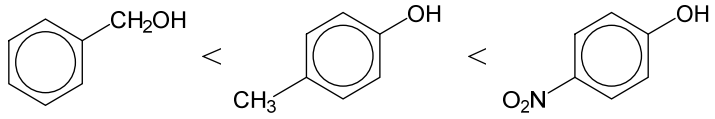
(b)



3

Relative acidity: alcohol < water < phenol

The relative acid strength depends on the relative stability of the respective conjugate bases, namely the alkoxide, hydroxide and phenoxide ions. **The more stable the conjugate base, the more acidic the compound.**

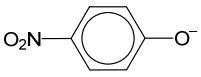
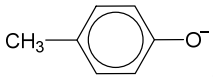
K_a values: 

Phenylmethanol is an <u>alcohol</u> while 4-methylphenol and 4-nitrophenol are <u>substituted phenols</u>.

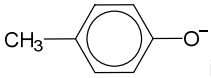
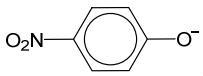
Phenols are more acidic than alcohols.

- The p-orbital containing the lone pair of electrons on the oxygen atom of the phenoxide ions <u>overlaps</u> with the π electron cloud of the benzene ring and the <u>lone pair of electrons is delocalised</u> into the ring.
- This results in the <u>delocalisation of negative charge on oxygen</u> into the ring, i.e. <u>dispersal</u> of the negative charge over the ring.
- The phenoxide ion is <u>resonance–stabilised and more stable</u> than alkoxide ion and the equilibrium position for the acid dissociation of phenol <u>lies more to the right</u>.
- Hence, phenols have <u>larger K_a</u> value than alcohols.

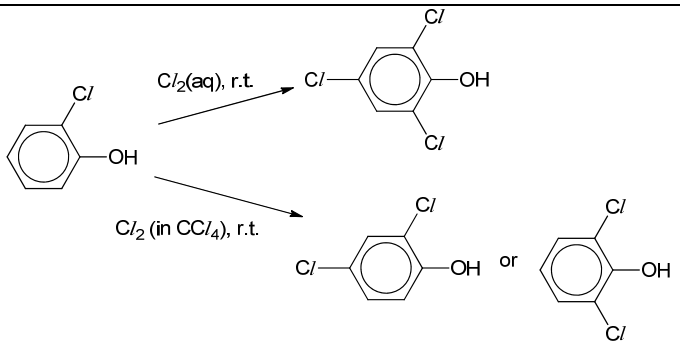
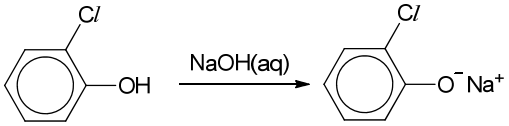
4-methylphenol is less acidic than 4-nitrophenol.

- Presence of electron-withdrawing group, $-NO_2$, on the benzene ring <u>disperses</u> the negative charge on the oxygen atom.
- Thus  is <u>more stable</u> than  .
- The equilibrium position for the acid dissociation of 4-nitrophenol <u>lies more to the right</u>.
- 4-nitrophenol has a <u>larger K_a</u> value.

OR

- Presence of electron-donating group, $-CH_3$, on the benzene ring <u>intensifies</u> the negative charge on the oxygen atom.
- Thus  is <u>less stable</u> than  .
- The equilibrium position for the acid dissociation of 4-methylphenol <u>lies more to the left</u>.
- 4-methylphenol has a <u>smaller K_a</u> value.

4 (Ans: C)

A	
B	no reaction *(Note: Phenols do not undergo dehydration when heated with conc. H_2SO_4.)*
C	Acid-base reaction occurs. 
D	No reaction. *(Note: Phenols do not undergo oxidation reaction.)*

5 (Ans: A)

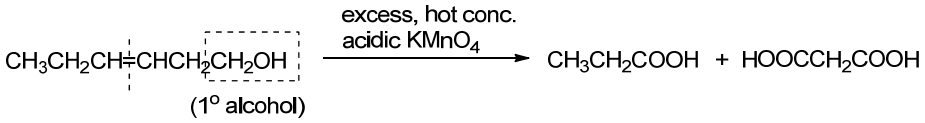
$ROH + Na(s) \longrightarrow RO^-Na^+ + ½\ H_2(g)$

For $C_6H_{12}O_6$, there is <u>one</u> degree of unsaturation.
Since there are no C=C bonds, the compound must have <u>one C=O bond</u>.
The remaining O atoms must be in -OH groups ⇒ There are a total of <u>5 -OH groups</u>.

mole ratio of -OH : Na : H_2 = <u>1 : 1 : ½</u>
Hence, 1 mol of sugar (with 5 -OH groups) will react with <u>5 mol of Na</u> to form <u>5/2 mol of H_2</u>.

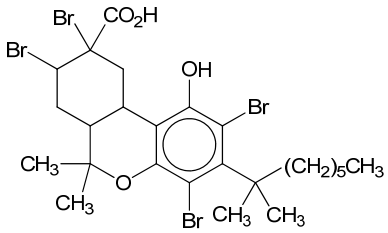
6 (Ans: D)

Oxidative cleavage of the C=C bond and oxidation of the 1° alcohol occurs.

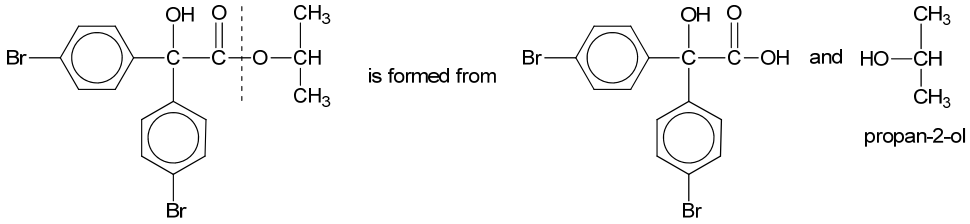


7 (Ans: D)

A Incorrect. The phenol group undergoes electrophilic <u>substitution</u> with dilute nitric acid.
B Incorrect. Only the $-CO_2H$ group reacts with ethanol to form <u>one</u> ester.
C Incorrect. The phenol group <u>does not undergo oxidation</u> reaction.
D Correct. The alkene group can undergo <u>electrophilic addition</u> and the phenol group can undergo <u>electrophilic substitution</u> with Br_2(aq) to form the following compound as one of the possible product.



8 (Ans: D)



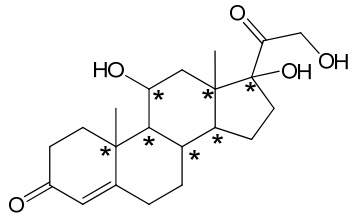
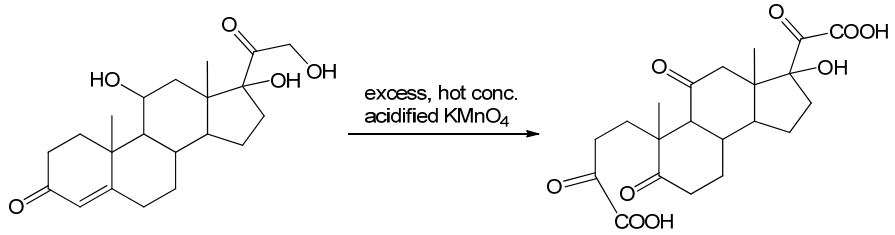
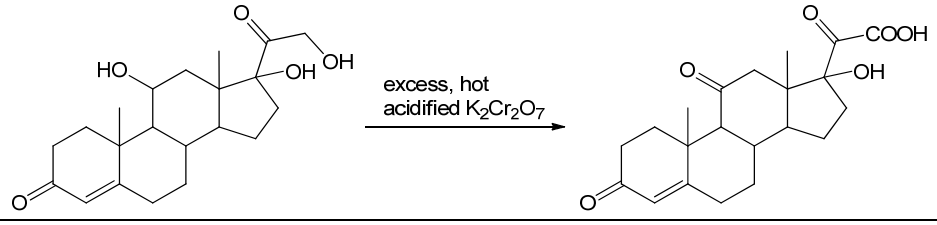
9 (Ans: 1,2)

1 Correct. The four primary (1°) alcohol groups can undergo oxidation with hot acidified $KMnO_4$(aq).

2 Correct. The four alcohol groups can undergo redox reaction with Na(s).

3 Incorrect. Both the molecular and empirical formulae are $C_5H_{12}O_4$.

10 (Ans: 1,2)

1	Correct. 
2	Correct: Oxidation of the alcohol groups (1° and 2°) and oxidative cleavage of the alkene group will occur to yield the following compound with two carboxylic acid groups: 
3	Incorrect. Oxidation of the alcohol groups (1° and 2°) will occur to yield a product with only three carbonyl groups. 

11 (Ans: 1,2)

1 Correct. The phenol group is acidic.

2 Correct. The compound has a chiral carbon and is able to exhibit enantiomerism. Each of its enantiomers is optically active.

3 Incorrect. There are no $-CO_2H$ groups present to react with ethanol to form ester.