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1 a) $HCOOH$ → Methanoic acid.
$HOOCCH_2CH_2CH_2COOH$ → Pentan-1,5-dioic acid
$CH_3CH_2CH_2COOH$ → Butanoic acid
HO_2C-CO_2H → Ethanedioic acid
$CH_3(CH_2)_4COOH$ → Hexanoic acid.
$CH_3CH=CHCH_2CH_2COOH$ → Hex-4-eneoic acid.

b) i) PHYSICAL APPEARANCE: All simple aliphatic carboxylic acids from C_1 to C_{10} are liquids at room temperature. Most of the others are solids at room temperature. Now, below the room temperature, acetic acid (glacial ethanoic acid which is an anhydrous carboxylic acid) freezes to an ice-like solid.

ii) SOLUBILITY: Solubility of these acids in water decreases with an increase in relative molecular mass as the compound is said to become more hydrocarbon in nature hence, covalent. All carboxylic acids are soluble in organic solvents. In water, lower molecular mass carboxylic acids with up to 4 carbon atoms have the ability to form hydrogen bonds with the H_2O molecules hence are soluble.

iii) BOILING POINTS: This increases with increasing relative molecular mass. Aromatic carboxylic acids which are crystalline solids have higher melting points than their aliphatic counterparts of comparable relative molecular mass.

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3. a) FROM CO (Carbon (II) oxide): Formic acid (methanoic acid) is form by adding CO ~~to hot~~ under pressure to hot aqueous solution of NaOH. The free carboxylic acid liberated does so by careful reaction with H_2SO_4

$$CO + NaOH \longrightarrow HCOONa \xrightarrow{H_2SO_4} HCOOH + NaHSO_4.$$

b) FROM ETHANAL: Ethanoic acid is obtained commercially by the liquid phase air-oxidation of 5% solution of ethanal (which is obtained from ethylene) to ethanoic acid using manganite (II) ethanoate catalyst.

$$CH_3CHO + O_2 \xrightarrow{(CH_3COO)_2Mn} CH_3COOH.$$

4. a) OXIDATION OF PRIMARY ALCOHOLS and ALDEHYDES using the usual oxidizing agents eg $K_2Cr_2O_7$ or $KMnO_4$.

$$RCH_2OH \xrightarrow{[O]} RCOOH$$

$$RCHO \xrightarrow{[O]} RCOOH$$

b) CARBONATION OF GRIGNARD REAGENT: Aliphatic carboxylic acids are obtained by bubbling CO_2 into the Grignard reagent and then hydrolyzing with dilute acid.

$$RMgBr + CO_2 \longrightarrow RCOOMgBr \xrightarrow{H^+OH} RCOOH + MgBrOH$$

While preparing benzoic acid the reagent is added to solid CO_2 which also serves as a coolant to the reaction mixture.

4.

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5 a) Reduction To Primary School:

$$CH_3CH_2CH_2COOH \xrightarrow{LiAlH_4} CH_3CH_2CH_2CH_2OH + H_2O.$$

b. Decarboxylation:

$$CH_3CH_2CH_2COONa + NaOH \xrightarrow{fuse} CH_3CH_2CH_3 + Na_2C$$

OR

c. $$2CH_3CH_2COONa + 2H_2O \xrightarrow{electrolysis} \underbrace{CH_3C(CH_2)_2CH_3 + CO_2}_{anode} + \underbrace{2NaOH}_{cath} +$$

c. Esterification:

$$CH_3CH_2COOH + CH_3CH_2CH_2OH \xrightarrow{H^+} CH_3CH_2COO + CH_3CH_2$$
$$+ H_2O.$$