(g) $CH_3CH_2CH_2CH_2OH + (O) \rightarrow CH_3CH_2CH_2CHO + H_2O$

$$CH_3CH_2\underset{\substack{|\\ OH}}{C}HCH_3 + (O) \rightarrow CH_3CH_2\underset{\substack{\|\\ O}}{C}CH_3 + H_2O$$

$$CH_3\overset{\substack{CH_3\\ |}}{\underset{\substack{|\\ OH}}{C}}CH_3 + (O) \rightarrow \text{ no reaction}$$

(h) 1°, 2°, and 3° alcohols all undergo halogenation reactions, the OH group being substituted with the halogen atom. 1° and 2° alcohols undergo controlled oxidation to aldehydes and ketones respectively, but 3° alcohols do not.

INVESTIGATION 1.5.2 TRENDS IN PROPERTIES OF ALCOHOLS

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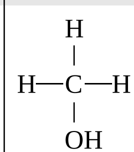
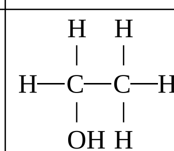
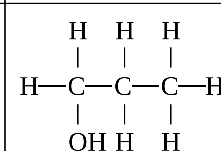
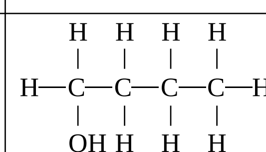
Question

(a)–(c)

Name	Structural Formula	b.p. (°C)	m.p. (°C)	Solubility	Diagram
methanol	CH_3OH	65	–94	w, al, eth, ace, bz, chl	 methanol
ethanol	C_2H_5OH	78	–117	w, al, eth, ace, bz	 ethanol
1-propanol	C_3H_7OH	97	–126	w, al, eth, ace, bz	 1-propanol
1-butanol	C_4H_9OH	117	–89	w, al, eth, ace, bz	 1-butanol

KEY:
w: soluble in water;
al: soluble in ethanol;
eth: soluble in diethyl ether;
ace: soluble in acetone;
bz: soluble in benzene;
chl: soluble in chloroform

Analysis

(d) Boiling points of alcohols increase with increasing length of hydrocarbon chain. Melting points decrease with increasing length of hydrocarbon chain for the first three alcohols. *n*-butanol is less soluble in water than are the first three alcohols.

Synthesis

(e) The properties of primary alcohols are a combination of the properties of its polar OH group and its nonpolar hydrocarbon component. Molecular models show the increasing length of the nonpolar component and corresponding trends in properties.

INVESTIGATION 1.7.1 PROPERTIES OF CARBOXYLIC ACIDS

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Question

(a) (Sample answers) How does the length of the hydrocarbon chain in a carboxylic acid affect its melting and boiling points, its solubility, and its reactions with bases and oxidizing agents?

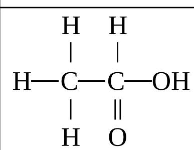
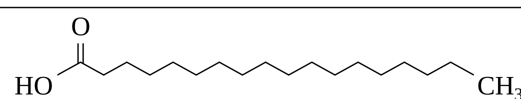
What are the similarities and differences in several properties of two carboxylic acids of different molecular size?

Prediction

(b) (Sample answer) Stearic acid has a much longer hydrocarbon chain than does acetic acid; thus, stearic acid is more nonpolar than acetic acid and will be less soluble in a polar solvent such as water, and more soluble in a nonpolar solvent such as vegetable oil. Stearic acid will also have a higher melting point because its long hydrocarbon chain allows additional intermolecular forces of attraction (van der Waals). Acetic acid will react readily with the base, but stearic acid will react less readily because it is less soluble in the aqueous solution of the base. Neither acid will react with the potassium permanganate because the carboxyl group does not readily gain oxygen atoms or lose hydrogen atoms.

Evidence

(c) and (d)

Property	Acetic acid	Stearic acid
IUPAC name	ethanoic acid	octadecanoic acid
structural diagram	 ethanoic acid	 stearic acid
molar mass	60.05 g/mol	284.50 g/mol
solubility	soluble in water (also al, ace, bz)	soluble in oil (also eth, ace, chl)
reaction with base	reacts with base	does not readily react
reaction with $KMnO_4$	no reaction	no reaction

KEY:
w: soluble in water;
al: soluble in ethanol;
eth: soluble in diethyl ether;
ace: soluble in acetone;
bz: soluble in benzene;
chl: soluble in chloroform

Analysis

(e) Both acids contain the polar carboxyl group; in addition, stearic acid has a long hydrocarbon group with stronger van der Waals attractions than in the shorter ethanoic acid.

