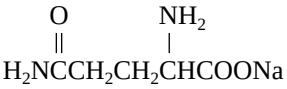
22. (a) Flour, cork, and jute are plant materials that are mainly cellulose; as these are main ingredients of linoleum, it may be classified as a polymer. All the ingredients are natural; all except the limestone dust are synthesized by living organisms and thus may be classified as organic (carbon-containing compounds). All matter is composed of chemicals, so the linoleum is also chemical.

(b) The linseed oil, a major ingredient, is a mixture of oils that are esters of fatty acids and alcohols. These ester linkages can be hydrolyzed by strong bases such as high pH cleaning agents, in saponification reactions.

(c) Advantages: easily decomposed, atoms in materials are recycled when decomposed, does not require nonrenewable resources.
Disadvantages: the linoleum floor is vulnerable to attack by bacteria or mould, can readily decompose if conditions such as moisture are not controlled, and it is not long-lasting or durable.

(d) You might want to consider such factors as:
is it a high-traffic area?
is it likely to remain damp for extended periods?
appearance
availability
cost

23. (a) 

(b) Yes. Carbon 2 is attached to 4 different groups or atoms: H, NH_2, COONa, and $CH_2CH_2C(O)NH_2$. It is, therefore, a chiral molecule.

(c) There is some evidence that a small portion of the population experiences mild reactions to MSG. These are not classified as allergies, but as a sensitivity or intolerance; they include: effects to the heart, respiratory tract, muscles, eyes, skin, gastrointestinal tract, circulation, and neurological functions. Drinking alcohol or exercising just before or after ingesting MSG may increase the intensity of the adverse reaction.

UNIT 1 PERFORMANCE TASK: CHEMISTRY IN A BATHTUB

(Page 148)

1 Research, Plan, and Synthesize an Ester

Experimental Design

(a) (Answers may vary. Sample answer) Ethyl butanoate is one ester which could be synthesized. It has a pineapple flavour.

(b) Butanoic acid + ethanol → ethyl butanoate
CH3CH2CH2COOH + CH3CH2OH Æ CH3CH2CH2COOCH2CH3 + H2O
Butanoic acid is heated with ethanol, in the presence of concentrated sulfuric acid as a catalyst, to produce ethyl butanoate. A water molecule is also produced in this condensation reaction, called esterification. As the ester has a low solubility in water, it can be extracted from the reaction mixture by adding the mixture to water and removing the layer of ester floating on the water surface.

Materials

(c) ethanol
butanoic acid
concentrated sulfuric acid
2 test tubes
hot-water bath (large beaker of water over hot plate)
hot plate
pipette and suction bulb
evaporating dish
eyedropper

Safety Precautions

Eye protection and a lab apron must be used at all times. Also, conduct experirment in a fume hood.

Procedure

(d)

1. Put on the lab apron and eye protection.
2. Prepare a hot-water bath by half-filling a large beaker (500 mL) with water and heating it on a hot plate until a gentle boil is reached.
3. In a test tube, place 2 mL of ethanol and 2 mL of butanoate.
4. Take the test tube to the fume hood, and add 1 mL of concentrated sulfuric acid. Concentrated sulfuric acid is extremely corrosive to the skin and must be handled with care.
5. Take the test tube to the lab bench and carefully place the tube in the hot-water bath, being careful not to point the tube at anyone.
6. Heat for about 5 min; remove the tube from the heat and let cool.
7. Pour the contents of the test tube into an evaporating dish half-filled with cold water.
8. Use an eyedropper to collect the ester floating on the surface of the water; place the ester in a clean test tube.
9. Dispose of remaining reaction mixture and water in the sink and flush with water.

3 Prepare a Product Information Package

(e) (Sample answer) Materials used: an alcohol of choice, a carboxylic acid of choice, citric acid, cornstarch, sodium hydrogen carbonate, vegetable oil of choice, Styrofoam box, silk ribbon. (Other suggestions: cotton bag, nylon string, Styrofoam cup or packing beads, jute rope, Saran wrap, glue, cellophane)

- Chemical names for each compound: ethanol, ethanoic acid (acetic acid, vinegar), 2-hydroxy-1,2,3-propane tricarboxylic acid (citric acid), $HOC(CH_2COOH)_2COOH$, sodium hydrogen carbonate (sodium bicarbonate).
- Each chemical by organic family: ethanol (alcohol), ethanoic acid (carboxylic acid), citric acid (carboxylic acid), cornstarch (carbohydrate, condensation polymer), sodium hydrogen carbonate, vegetable oil of choice (ester), Styrofoam (polystyrene, addition polymer), silk ribbon (protein, condensation polymer).
- Physical properties of each compound: ethanol (soluble in water, alcohol odour, relative high boiling point, liquid at room temperature), ethanoic acid (soluble in water, sour odour, relative high boiling point, less volatile than analogous alcohol, liquid at room temperature), citric acid (soluble in water, sour taste, relatively high melting point and boiling point, solid at room temperature), cornstarch (soluble in water, solid at room temperature), sodium hydrogen carbonate, vegetable oil of choice (insoluble in water, liquid at room temperature), Styrofoam (insoluble in water, lightweight, chemically unreactive), silk ribbon (insoluble in water, shrinks (denatures) when heated).
- (Sample answers)

Nonpolymers:
ethanol (The hydroxyl group renders this compound soluble in water; intermolecular hydrogen bonding accounts for its high boiling point.)
ethanoic acid (The hydroxyl group and carbonyl group on the carboxyl group renders this compound soluble in water; strong intermolecular hydrogen bonding of the two types of polar groups accounts for the high boiling point of this acid.)
citric acid (Each molecule of this acid contains three carboxyl groups and one hydroxyl group; the abundance of polar groups for hydrogen bonding accounts for the very high melting point of this acid, which is a solid at room temperature.)
Natural polymer:
cornstarch (Starch is a helical polymer of glucose monomers; the helical structure allows flexibility and mobility, and renders the starch molecule soluble in water.)
Synthetic polymer:
Styrofoam (Polystyrene is an addition polymer of styrene; long polymer chains, weak interchain attractions account for low rigidity.)

- The citric acid is a solid organic acid which, when dissolved in the bath water, will react with an inorganic base, the sodium hydrogen carbonate, to produce carbon dioxide as one of its products. The carbon dioxide produces the fizzing in the water. Safety concerns: ensure that the ester used is free of contaminants (e.g., concentrated acid) from its synthesis.
- Student choice, justified by definitions of terms.