Supporting information

Teaching and assessing systems thinking in first-year chemistry

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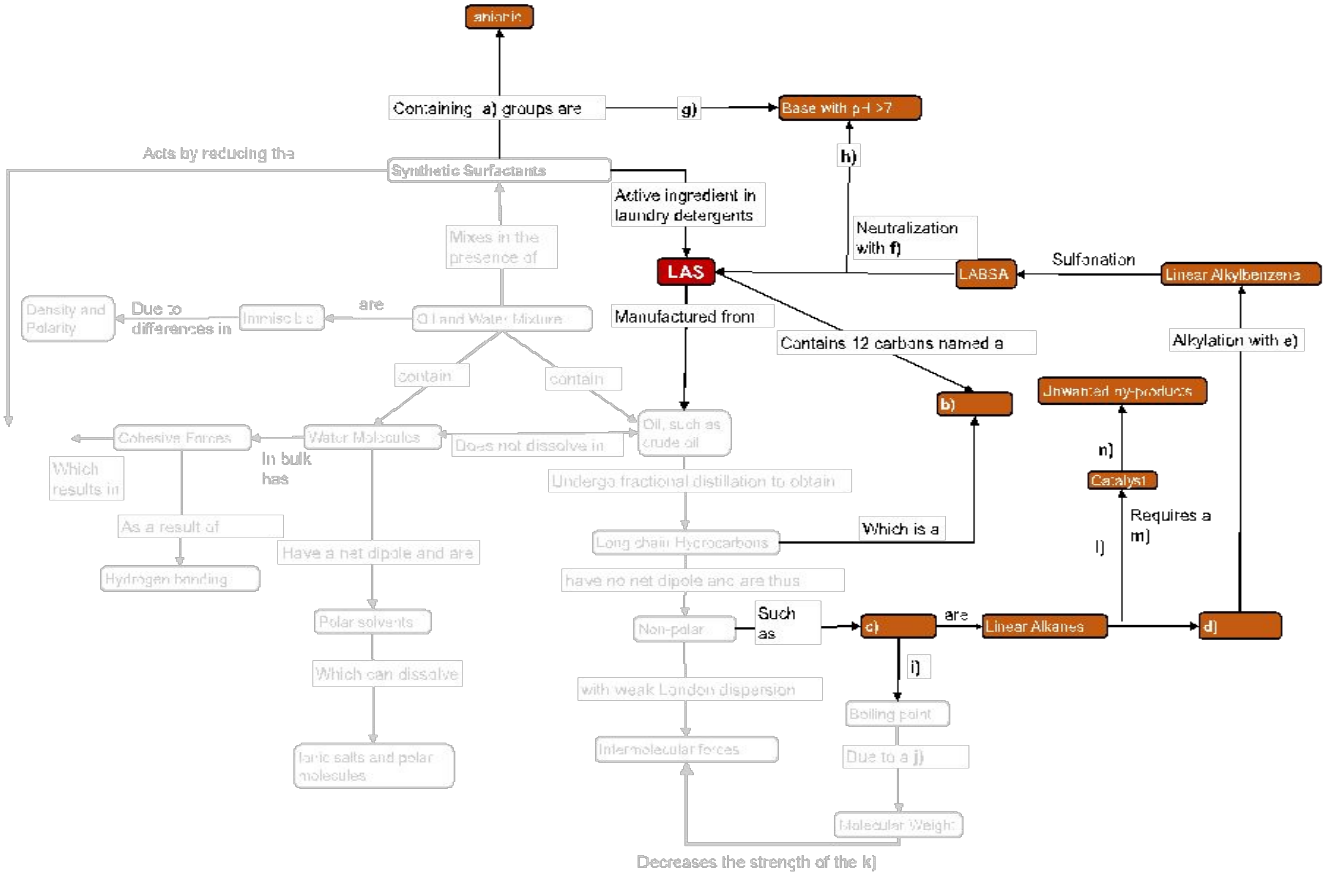
Practical Activity 1

Economic Subsystem

Description
In this practical activity, you have to answer questions that involve some of the concepts on the economic subsystem as seen on the expanded concept map.



Expanded Concept Map: Economic Subsystem

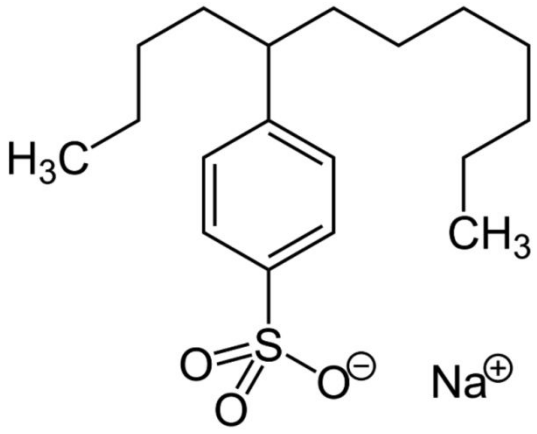
Instructions
In your economic subsystem group, work together to answer the following questions. The group presenter must share their screens so that each member can discuss the questions that are being shared over blackboard collaborate, however, each group member must complete the answers to the activity questions on their ClickUp during the practical activity.

Total questions
6

Total Points
20

Question 1 (Matching- 5 marks)

The structure of Linear alkylbenzene sulfonate is shown below (LAS). Answer the following questions to relate the chemical properties and chemical behaviour of LAS to the economic subsystem.

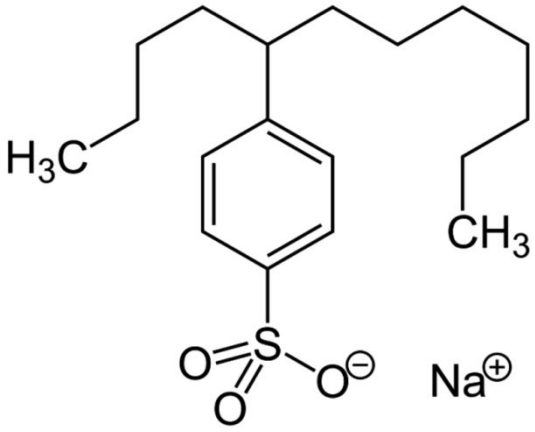


Match the characteristics stated on the left with the chemical name/concept stated on the right of this question. Use the expanded concept map to ensure your answers match the letters a) to f) ***Choose from the following concepts Dodecane, Kerosene, Alkenes, Benzene, Sulfonate, Sodium Hydroxide***

Question	**Answer**
The functional group that makes LAS a synthetic surfactant (a) on the concept map	
Long-chain hydrocarbon in LAS (b) on the concept map	
Obtained after the fractional distillation of crude oil (c) on the concept map	
Olefins with the functional group……...are unsaturated (d) on the concept map	
Is an aromatic, but also carcinogenic reactant used in the industrial manufacture of LAS (e) on the concept map	
LAS is manufactured by neutralization with ..... (f) on the concept map	

Question 2 (Matching- 6 marks)

The structure of LAS is provided below. Answer the following questions to relate the chemical properties and chemical behaviour of LAS to the economic subsystem.



Match the names/chemical concepts stated on the left with the chemical characteristics indicated on the right of this question. Use the concept map where necessary. Choose from the following:

A. Strong base
B. Has trigonal planar carbons with a large energy barrier to rotation
C. Conjugate base
D. Collected higher up in the fractional distillation column in comparison to crude oil
E. Has tetrahedral carbons with free rotation around sigma bonds and is insoluble in water
F. Aromatic, planar with bond angles of 120 degrees, all carbons are sp2 hybridized

Question	**Answer**
Sulfonate illustrated as g) on the expanded concept map	
Dodecane	
Kerosene	
Alkene	
Benzene	
Sodium Hydroxide as illustrated as h) on the expanded concept map.	

Question 3 (Jumbled sentence- 5 marks)

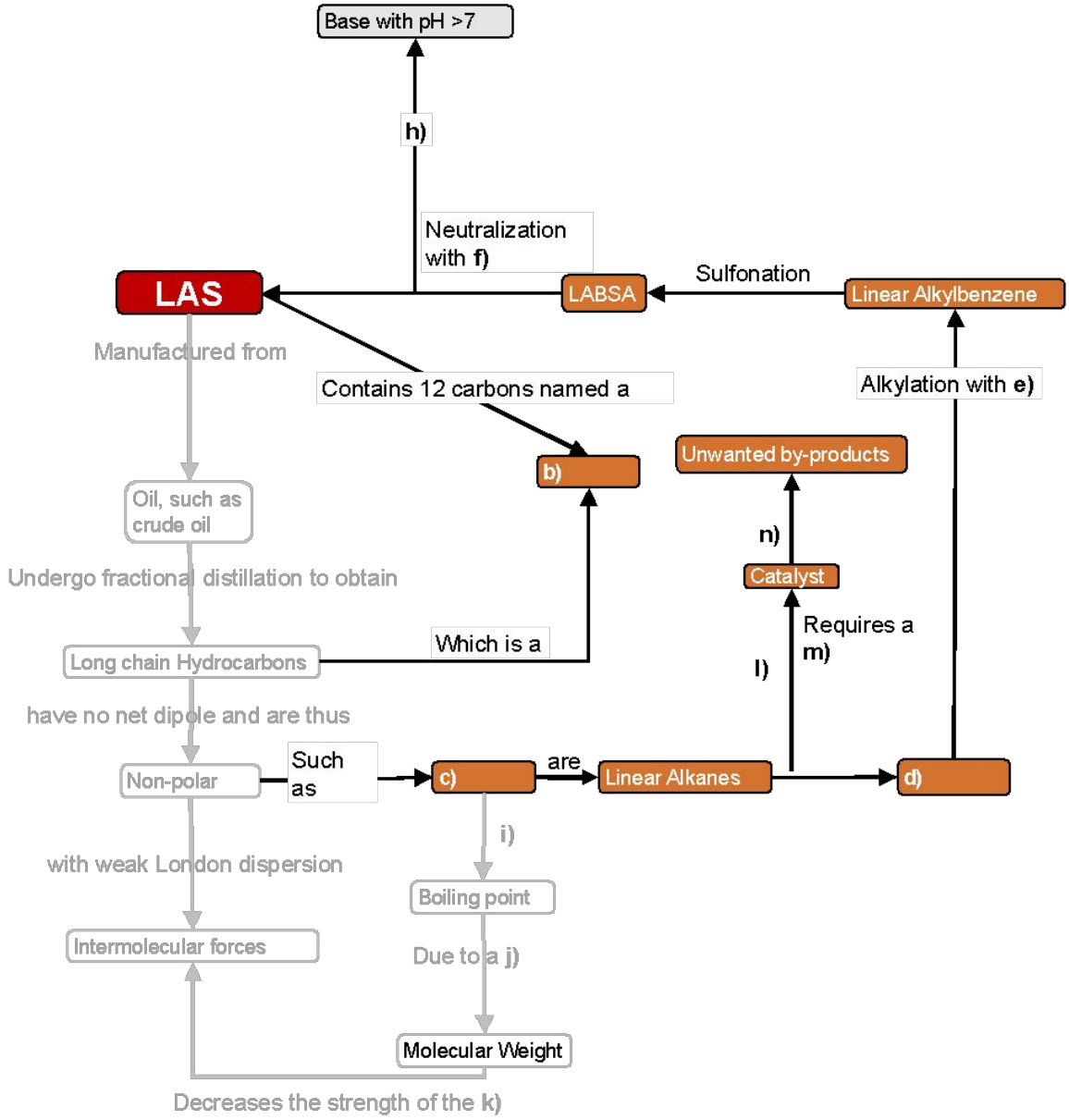
Choose the correct answer from the dropdown list about the primary feedstock used for the manufacturing of linear alkylbenzene sulfonate.

Sasol and other industries that manufacture Linear alkylbenzene sulfonate depend on **[a]** as a major feedstock. Usually, 75% of the alkanes which are extracted from kerosene are used in the production of Linear alkylbenzene. Kerosene has a boiling point between 175 °C and 325 °C. However, the boiling point of kerosene is **[b]** *(refer to i) on the expanded concept map)* in comparison to the boiling points of other fractions such as diesel, oil, waxes, and bitumen. Kerosene has fewer carbons in the chain, which, therefore **[c]** *(refer to j) on the expanded concept map)* its molecular weight and the strength of the **[d]** *(refer to k) on the expanded concept map)* intermolecular forces. Hence, less energy is required to disrupt attractive **[e]** forces for evaporation to occur.

Drop-down List of Answers
LAB
LABSA
crude oil
lower
higher
increases
decreases
dipole-dipole
london dispersion
intermolecular
intramolecular

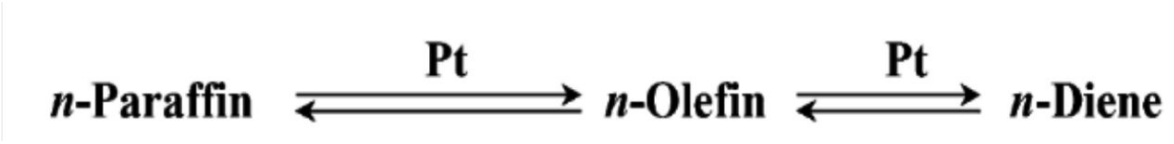
Question 4 (Hot spot image- 2 points)

Click on the block (concept) in the image below that influences the activation energy of a reaction and could therefore reduce the reaction time requires for synthesis in the industrial manufacturing process.



Question 5 (Multiple-choice- 2 marks)

Select the correct answer for the following paragraph that also describes this diagram shown below, the letters l) to n) is illustrated on the expanded concept map:



To obtain olefins (alkenes) from linear paraffin (alkanes), a/an l) reaction should occur with a/an m) platinum catalyst to obtain high yields of olefins with high selectivity to n) unwanted by-products (dienes).

A. Hydrogenation, unmodified, reduce
B. Hydrogenation, modified, increase
C. Dehydrogenation, modified, reduce
D. Dehydrogenation, unmodified, reduce

Question 6 (Jumbled sentence- 0 marks, enrichment)

Think about the following concepts and discuss in your group whether these concepts belong to the social, economic, or environmental subsystem.

- Heavy metals can potentially be within the **[a]** subsystem
- Platinum Exports can potentially be within the **[b]** subsystem
- Job creation can potentially be within the **[c]** subsystem
- Greenhouse gasses can potentially be within the **[d]** subsystem
- Carcinogenic can potentially be within the **[e]** subsystem
- Chemical waste can potentially be within the **[f]** subsystem
- Health risks can potentially be within the **[g]** subsystem
- Oil spills can potentially be within the **[h]** subsystem
- Fossil fuels can potentially be within the **[i]** subsystem
- Global warming can potentially be within the **[j]** subsystem

For further enrichment the following in your subsystem group:

1. How you would link these concepts to other concepts in the economic subsystem?

2. What would your linking words be on the arrows when you connect two or three concepts in the economic subsystem?