Fractional Distillation Activity: Student Worksheet

Name _____ Class _____

**Use the* Petroleum *poster to answer the questions below. Focus on the section titled "Refining Process"* (located inside, top centre, under the poster heading).

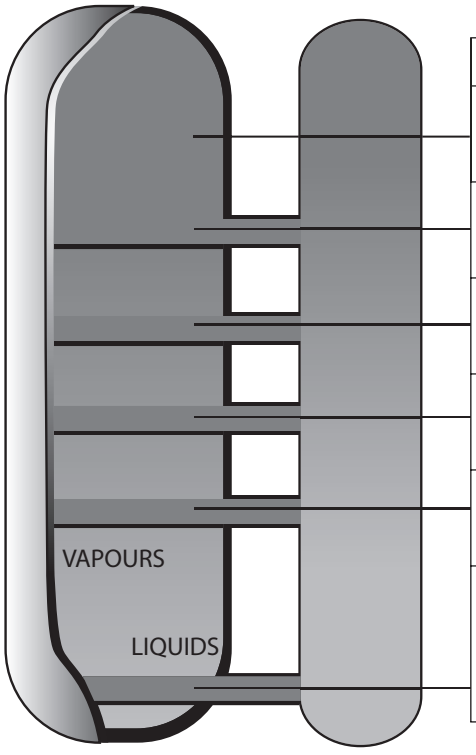
1. What is crude oil?

2. What are some products that the petroleum industry manufactures from crude oil?

3. What is the name of the piece of equipment used in the oil and gas industry to separate the hydrocarbon components of crude oil?

4. The list below shows common crude oil fractions that result from fractional distillation. Place the hydrocarbons in order in the distillation tower and match them to their boiling points.

Crude Oil Fractions:	*Boiling Points:*
Gas (C_1- C_3)	*300-370°C*
Lubricating oil (C_{17}- C_{25})	*<40°C*
Kerosene (C_{12}- C_{16})	*200-250°C*
Naptha & Gasoline (C_4- C_{11})	*>375°C*
Residuals & Asphalt (>C_{25})	*40-200°C*
Gas oil & Diesel (C_{16}- C_{18})	*250-300°C*



FRACTIONATING TOWER

Hydrocarbon	Boiling Point

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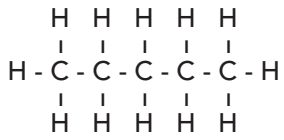
5. Choose two crude oil fractions from the tower on the previous page. Choose a precise number of carbons within the range, write the chemical formula and draw the structure of your compound.

Crude Oil Fraction	# of Carbons	Chemical Formula	Structural Diagram
Example: naptha & gasoline	5	C_5H_{12}	
1)			
2)			

6. The refinery gases that have (highest/lowest) boiling points, such as _____ _____, are removed from the distillation tower. They undergo _____ _____ _____to create these two products: _____ _____ and _____ _____ .

7. The refinery sludges that have (highest/lowest) boiling points are typically referred to as the _____ _____ . These fractions are refined to create products such as _____ .

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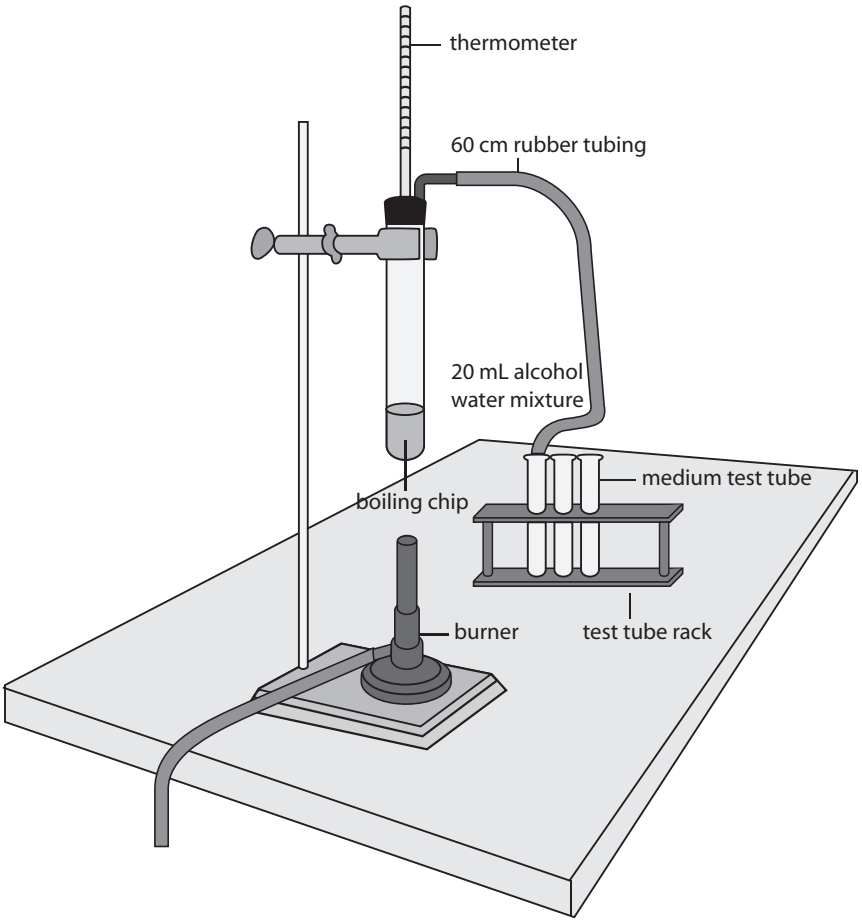
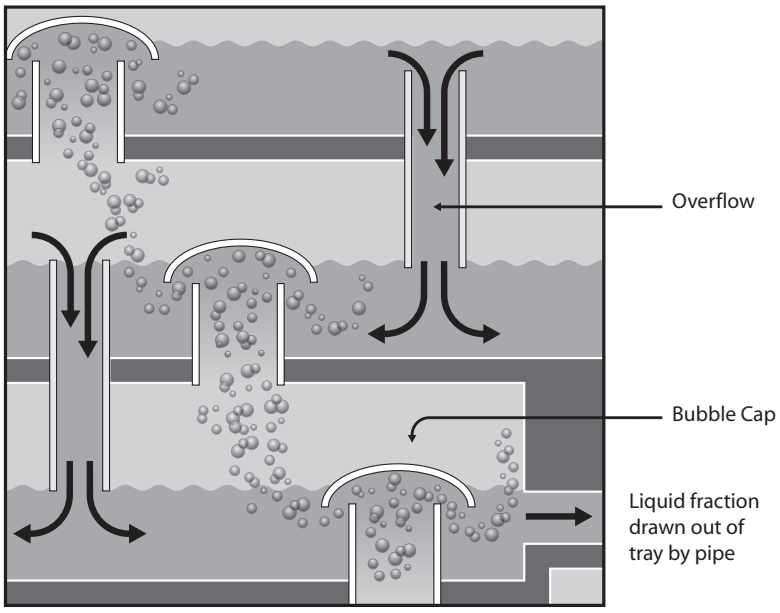
Lab Worksheet & Questions:
Perform fractional distillation using a mixture of alcohol and water.

Materials:
Safety goggles
Lab apron
Lab gloves
Bunsen burner
Ring stand & clamp
1 graduated cylinder
3 medium test tubes
Test tube rack
Boiling chips
Metal pan
Paper strips – approx. 5 cm x 1 cm
2-hole stopper
Glass tubing with 90° bend
Rubber tubing (60 cm)
Thermometer
alcohol + water mixture (20 mL):
- 10 mL isopropyl (rubbing) alcohol (or 2-propanol)
- 10 mL distilled water

Stirring rod
Grease pencil/marker
Stop watch
Matches
Sugar
Graph paper
Scoopula



Inside Fractionating Tower



Procedure:

1. Put on safety equipment and gather lab materials.
2. Set up a modified distillation apparatus as shown in the image above.
3. Label the 3 test tubes (1, 2, & 3) using the grease pencil.
4. Place the rubber tubing into test tube 1.
5. Add 20 mL of alcohol-water mixture and 1 boiling chip to the graduated cylinder.
6. Record initial temperature of the mixture. Assign a group member to record temperatures every minute in the time-temperature table.

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7. Carefully light the Bunsen burner. (Ensure rubber tubing and test tube stand are not too close to the heat as they will melt/burn.) Set to low flame height.
8. Heat the mixture.
9. Record the temperature at which the mixture begins to boil. Place a mark (e.g. B or *) on the time-temperature table to represent this state change.
10. Watch for a sudden rise in temperature then use gloves to switch the tubing into test tube 2.
11. Continue heating. When temperature reaches 98°C, use gloves to move the tubing into test tube 3.
12. Continue heating until you have distilled the majority of the fluid and only a few mL of the initial mixture remains in the graduated cylinder.
13. Turn off Bunsen burner.
14. You have completed the fractional distillation of the alcohol-water mixture and should have three fractions of the original mixture to analyze.
15. Analyze the fractions on the basis of odour, flammability, & solubility.

    Odour:
    a) Use wafting technique to determine if there is any difference in the odour of your fractions. Record observations in observation table.

    Flammability:
    a) Dip paper strip halfway into test tube 1.
    b) Place the moistened strip in metal pan.
    c) Ignite the moist end with the match.
    d) Describe how easily it ignites. Record in observation table.

    Solubility:
    a) Place a small scoopula of sugar into each test tube. (The amount will vary depending on the quantity of liquid collected.)
    b) Swirl.
    c) Does the sugar dissolve? Record observations in the observation table.
16. Clean up lab bench and complete analysis questions.

Time-Temperature Table

Time (minutes)	Temperature (°C)
0 (Initial Temperature)	
1	
2	
3	
4	
5	
6	
7	
8	
9	

10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

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Observation Table:

	Fraction 1	Fraction 2	Fraction 3
Odour			
Flammability			
Solubility			

Analysis:

1. What property of the liquids allowed you to separate the fractions?

_____

_____

_____

2. Which component of crude oil separated in the fractional distillation tower are represented by your fractions?

_____

_____

_____

3. Given that your initial mixture was a combination of 50% alcohol and 50% water, what fraction did each test tube contain?

   i. Test tube 1 _____

   ii. Test tube 2 _____

   iii. Test tube 3_____

   iv. On a separate piece of graph paper, graph the changes in temperature over time. Explain any rapid rises in temperature and/or periods where temperatures remained constant.

4. What are some methods that could be used to further refine and separate the contents of test tube 2?

_____

_____

_____