

11.2 REFINING PETROLEUM

PRACTICE

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Understanding Concepts

1. The fraction might be kerosene, light gas oil, or fuel oil.
2. A minimum temperature of 450°C is required.

Making Connections

3. In winter, gasoline is blended with a higher percentage of substances with low boiling points — so it will vaporize more easily in cold temperatures.
4. H_2S gas is often present in hydrocarbon gases from drilled wells. Humans are amazingly sensitive to the smell of this gas — we can detect the “rotten egg” odour at concentrations of only 2-3 parts per billion. The gas is extremely toxic; mice and rats have an LC50 (concentration lethal to 50% of test animals) of about 700 ppm. The maximum workplace exposure concentration is 10 ppm in air. Humans can suffer collapse, coma, and death after only one or two breaths of hydrogen sulfide at high concentration. A complication is that the gas numbs the sense of smell, so a victim may assume the gas is gone because the odour can no longer be detected. The gas is also explosive, when mixed with air, at relatively low temperatures (ignition at 260°C).

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Understanding Concepts

Note: Students should know at this point that the alkanes from pentane up are liquids at room conditions, and smaller alkanes are gases.

5. $\text{C}_{14}\text{H}_{30(l)} + \text{H}_{2(g)} \rightarrow \text{C}_8\text{H}_{18(l)} + \text{C}_6\text{H}_{12(l)}$
6. $\text{C}_4\text{H}_{8(g)} + \text{C}_5\text{H}_{12(l)} \rightarrow \text{C}_9\text{H}_{20(l)}$ (nonane)

Making Connections

7. Electric cars are an attractive alternative to gasoline power. They are silent, simple, and nonpolluting (at least directly — generating electricity can be polluting). The serious disadvantage is range and speed; no battery currently available can match the performance of the internal combustion engine. Fuel cells to power the electric motor are being developed and tested but are not yet (in 2001) practical technology as they are too expensive and not dependable.

SECTION 11.2 QUESTIONS

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Understanding Concepts

1. Petroleum is the underground liquid mix of organic compounds, also called crude oil.
2. To the best of our current knowledge, petroleum requires many millions of years to form, so from our point of view it is a finite resource.
3. The three processes in refining petroleum are: fractional distillation to separate mixture fractions according to boiling points; cracking to break larger molecules into smaller ones; and reforming to combine smaller molecules into larger ones.
4. Petroleum fractions are complex mixtures. The fraction called gasoline has thousands of different hydrocarbons with anywhere from 5 to 12 carbon atoms per molecule.
5. Refining produces jet fuels, heating fuels, lubricants, waxes, tars, and asphalts, as well as gasoline.
6. The larger a hydrocarbon's molecules, the higher the boiling point of the substance. This is because larger molecules have stronger London forces.

Making Connections

7. A few things that would not work/exist if hydrocarbons disappeared:
Automobiles, airplanes, ships, trains — so everything perishable we import from other places (farther than a day away on a mule) would disappear.
Electricity would be in short supply — so no television, vacuum cleaners, or stereos. Since the home furnace would not work either, the lack of television might not be the biggest concern — especially in winter.
There would be no plastics, few pharmaceuticals, no cosmetics, no deodorants, and a much narrower selection of cleaners.

11.3 COMBUSTION OF HYDROCARBONS

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Understanding Concepts

1. The major use of hydrocarbons (by amount) is for fuels. Some minor uses (by amount) are for making plastics, pharmaceuticals, chemicals and cleaners.
2. $2 \text{C}_{14}\text{H}_{30(l)} + 43 \text{O}_{2(g)} \rightarrow 28 \text{CO}_{2(g)} + 30 \text{H}_2\text{O}_{(g)}$
3. The substance has molecules with 4 C atoms and 10 H atoms, so it must be butane, $\text{C}_4\text{H}_{10(g)}$.
4. The benefit of fossil fuel combustion is nothing less than our level of civilization. The disadvantage is that the resource is finite, and someday we are likely to run out.

Making Connections

5. (a) Jet fuel fires outside are fought primarily with chemical foams, which cover and smother the liquid fuel, and trap most of the vapour. Jet fuel vapour is heavier than air, which actually makes it much more dangerous, because the flammable vapour will stay near the ground and not disperse into the atmosphere.
(b) Inside passenger aircraft, dry-chemical fire extinguishers must be used, because the passengers must remain able to breathe (releasing oxygen masks in such an event is definitely not a good idea).
(c) Students will find that all airports have some materials for firefighting. The question is whether they are adequate, especially at small, uncontrolled airports.

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Reflecting

6. Without hydrocarbons, there would be a dramatic drop in new clothing available, and most common consumer items (anything made of/with or packaged in plastic). That might be noticed fairly soon. Possibly the increased amount of cycling and walking would be noticed early (no fossil fuels). More likely, though, is that the most immediate problem would be a lack of food, which is harvested on and transported from farms to markets and processing plants by vehicles that use fossil fuels (tractors, trucks, ships, trains, planes). More long-term effects would include injury or death from exposure.

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Understanding Concepts

7. The greenhouse effect is essential. Without it the planet would be permanently frozen, with an average surface temperature of about -19°C instead of the actual average value of about 15°C . The concern is that a small increase in the effect can influence climate conditions, creating problems for people and other living things.
8. Carbon dioxide is absorbed by plants, and released by decomposition, as a cycle in the biosphere.
9. If global warming effects become significant, Canada's biomes would change noticeably. The prairies might become too dry for agriculture, for example.