

Physical States

The physical states at which some alkanes exist at room temperature and atmospheric pressure are found in **Table 5**. Alkanes that have the lowest molecular mass—those with one to four carbon atoms—are gases. **Natural gas** is a fossil fuel composed primarily of alkanes containing one to four carbon atoms. These alkanes are gases because they are very small molecules. Therefore, they have weak London dispersion forces between them and are not held together tightly. Larger alkanes are liquids. Gasoline and kerosene consist mostly of liquid alkanes. Stronger London dispersion forces hold these molecules close enough together to form liquids. Alkanes that have a very high molecular mass are solids, corresponding to a greater increase in London dispersion forces. Paraffin wax contains solid alkanes. It can be used in candles, as shown in **Figure 6**.

Boiling Points

The boiling points of alkanes, also shown in **Table 5**, increase with molecular mass. As London dispersion forces increase, more energy is required to pull the molecules apart. This property is used in the separation of petroleum, a major source of alkanes. **Petroleum** is a complex mixture of different hydrocarbons that varies greatly in composition. The hydrocarbon molecules in petroleum contain from 1 to more than 50 carbon atoms. This range allows the separation of petroleum into different portions that have different boiling point ranges, as shown in **Table 6**. In *fractional distillation*, components of a mixture are separated on the basis of boiling point, by condensation of vapor in a fractionating column. **Figure 7** shows an example of refinery towers in which the process takes place. During its fractional distillation, petroleum is heated to about 370°C. Nearly all components of the petroleum are vaporized at this temperature. As the vapors rise in the fractionating column, or tower, they are gradually cooled. Alkanes that have higher boiling points have higher condensation temperatures and condense for collection lower in the tower. For example, lubricating oils, which have higher condensation temperatures than gasoline has, are collected lower in the fractionating tower.

TABLE 6 Petroleum Fractions

Fraction	Size range of molecules	Boiling-point range (°C)
Gasoline	C ₄ –C ₁₂	up to 200
Kerosene	C ₁₀ –C ₁₄	180–290
Middle distillate, such as heating oil, gas-turbine fuel, diesel	C ₁₂ –C ₂₀	185–345
Wide-cut gas oil, such as lubricating oil, waxes	C ₂₀ –C ₃₆	345–540
Asphalt	above C ₃₆	residues



FIGURE 6 Paraffin wax, used in candles, contains solid alkanes. Molecules of paraffin wax contain 26 to 30 carbon atoms.

FIGURE 7 Fractional distillation takes place in petroleum refinery towers.

