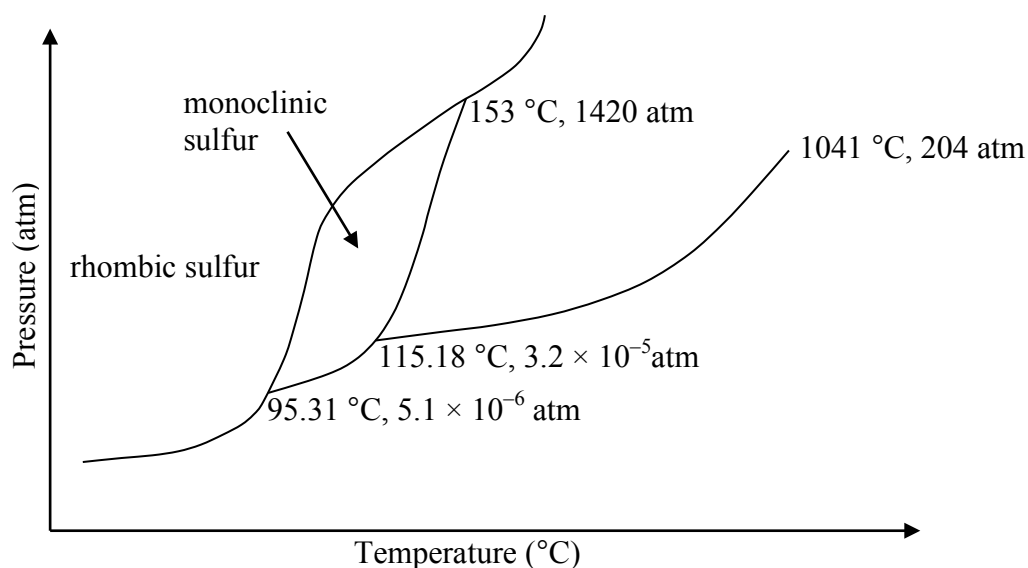


- The diagram below shows the phase diagram of sulfur. Note that 'rhombic' and 'monoclinic' refer to two different crystalline forms of the element.



Determine the number of triple points for sulfur and indicate which species are present at each of the triple points.

There are 3 triple points:

- rhombic, monoclinic and vapour (at 95.31 °C and 5.1×10^{-6} atm);
- monoclinic, liquid and vapour (at 115.18 °C and 3.2×10^{-5} atm);
- rhombic, monoclinic and liquid (at 153 °C and 1420 atm);

Which crystalline form of sulfur is predicted to be more dense? Briefly explain your answer.

The rhombic allotrope is denser. If you start in the monoclinic region and increase the pressure at constant temperature (i.e. draw a vertical line upwards) you move into the rhombic region. Rhombic is thus the more stable form at higher pressures, so must be denser.

“Plastic” sulfur is a tough elastic substance that is formed when molten sulfur (m.p. = 115.2 °C) is poured into cold water. On standing, it slowly crystallizes. Predict which crystalline form is formed at room temperature and pressure. Also, explain why “plastic” sulfur is not shown on the above phase diagram.

Rhombic sulfur is formed. Plastic sulfur is not shown as it is a metastable state and changes into a more stable state over time. Phase diagrams only show stable states that are in equilibrium with other stable states. There are no conditions of temperature and pressure in which plastic sulfur is in equilibrium with another state of sulfur, so it does not appear on the phase diagram.

Based on the information provided, it is reasonable to assume that plastic sulfur is a compound formed by reaction of water with sulfur or some form of sulfur involving water in its crystal structure. Arguing that, and that the phase diagram for sulfur only shows pure forms of sulfur, was also awarded full marks.