Answers to Review Questions/5.5:

1. The melting point of ice decreases when pressure increases because when pressure is increased volume is decreased and the volume of water is less than ice. So it will be easier to change the state from solid to liquid, and therefore, the melting point decreases.
2. The critical temperature of a substance is the temperature at and above which vapor of the substance cannot be liquefied, no matter how much pressure is applied. Each substance has a single critical temperature. Critical temperature is different from boiling point. Unlike critical temperature, boiling point changes with changing pressure.
3. The boiling point increases with increased pressure up to the critical point, where the gas and liquid properties become identical. The boiling point cannot be increased beyond the critical point.
4. Boiling point is different from temperature at triple point.

Substance	Triple point temperature (°C)	P (kPa)	Boiling point at SP (°C)
Mercury	−39.0	1.65×10^{-7}	356.7
Water	0.01	0.6117	0.0
Zinc	419.50	0.065	907
CO_2	−56.60	517	−70

5. The critical temperature of water is 373.85 °C which is less than 374°C. Therefore, water cannot liquefy at and above 374°C.
6. **Given**: m = 10 g = 0.01kg, $L_{f, Cu}$ = 209000 J/kg

   $Q = mL_f = 0.01kg\times 209000\ J/kg = 2090\ J$
7. **Given**: m = 0.1kg, $L_{f,Al}$ = 376000 J/kg, $L_{v,Al}$ = 11,370 J/kg, c_{Al} =900 J/kg.°C , ΔT = 660.3 °C - 2,470 °C = -1809.7°C

   $Q = m L_{v,Al} + m c_{Al} \Delta T + m L_{f,Al}$
   $Q = 0.1kg\times[-11{,}370\ J/kg + 900\ J/kg.°C \times(-1809.7°C) - 376000\ J/kg]$
   $Q = -201610\ J$, the negative sign indicates heat released not added.
8. The diagram showing the phase diagram of CO_2 is given in students textbook.

   (a) The solid, liquid and vapor phases of CO_2 coexist in equilibrium at -56.7°C temperature and 5.1 atm pressure, which is the triple point.

   (b) The triple point of CO_2 is (5.1 atm, 56.7° C) means that liquid CO_2 cannot exist at pressures lower than 5.11 atm. Therefore, at 1 atm, solid CO_2 sublimes directly to the vapor while maintaining a temperature of −78.5°C, the normal sublimation temperature.

   (c) Carbon dioxide is a popular supercritical fluid and has a critical temperature

of 31.1° C and a critical pressure of 73.8 bars.

9. The freezing point of water at 1 atm is 0 °C. The phase of water at 1 atm and 0.01 °C is then solid. At 611.657 Pa pressure and 0.01°C temperature, water exists as solid (ice), liquid (water), and gas (water vapour). This is the triple point of water.