Question 38 **(17 marks)**

Caffeine is an organic molecule found in tea, coffee and energy drinks. It is a stimulant that also can be taken in tablet form. Pure caffeine is a white odourless powder that tastes bitter and contains carbon, hydrogen, nitrogen and oxygen.

A 2.55 g sample of caffeine was combusted to produce 4.623 g of carbon dioxide and 1.18 g of water. A second, 3.33 g sample of caffeine was treated to convert all of the nitrogen to 1.17 g of ammonia.

(a) Determine the empirical formula of caffeine. (13 marks)

Empirical formula

A third, 1.05 g sample of caffeine was converted to the gaseous phase. Measurement showed that 100.0 mL of the gas exerted 370 kPa pressure at a temperature of 550 °C.

(b) Calculate the molar mass of caffeine. (2 marks)

(c) From your answers to part (a) and part (b), determine the molecular formula of caffeine, showing clearly how this was determined. (2 marks)