Student worksheet and test

The Chemistry of Coffee · worksheet

Name: _____ Date: _____

1. **First guess.** Which molecule do coffee and energy drinks have in common? _____ How sure are you? 1 2 3 4 5
2. **Smell test.** Jar 1: _____ Jar 2: _____ Jar 3: _____ Jar 4: _____ I think jar ____ holds only caffeine dissolved in water
3. **Label.** ____ mg per 100 ml × ____ ml ÷ 100 = ____ mg in the can. Does the coffee cup give a number? yes / no
4. **Count the atoms.** C ____ H ____ N ____ O ____ Formula: _____ Total atoms: ____
5. **Rotate to reveal.** Atoms I named correctly from the back: ____ out of 24. The hardest element to name was ____
6. **3D meets 2D.** The ring with five atoms contains ____ nitrogens; the ring with six atoms contains ____ nitrogens.
7. **Exhibit D.** Which groups give the strongest IR bands? _____ Why four ^{1}H NMR signals for ten hydrogens? _____ Which peak is the molecular ion (the whole molecule)? ____
8. **From memory.** Sketch the two rings and mark N and O:

   (a) Formula: _____ (b) Why does caffeine not smell of coffee? _____ (c) Why does the can carry a warning and the cup not? _____ (d) Coffee is a substance / a mixture
9. **The verdict.** Our conclusion is _____ because _____. One limitation is _____. How sure am I now? 1 2 3 4 5

Five-question test (+3 extension questions) · before and after the lesson

Optional, and not counted in the 45 minutes: allow 3–5 minutes before the lesson and 3–5 after it, or give the second test at the start of the next lesson. Tick one answer.

1. The formula of caffeine is ☐ $C_6H_{12}O_6$ ☐ $C_8H_{10}N_4O_2$ ☐ C_2H_5OH
2. Pure caffeine ☐ smells of coffee ☐ smells sweet ☐ has no smell
3. A cup of coffee is ☐ one substance ☐ a mixture of many substances
4. How many nitrogen atoms are in one caffeine molecule? ☐ 1 ☐ 2 ☐ 4
5. In the EU, which must state its caffeine content on the label when it has more than 150 mg per litre? ☐ an energy drink ☐ coffee

Extension questions (ages 17+ and undergraduates; answer in two or three sentences):

6. All four nitrogen atoms in caffeine are the same element. Why are they not all equivalent?
   _____
7. Caffeine has two C=O groups in the same ring system. Why should the strong bands in its carbonyl region not be read as “one peak for each C=O bond”? _____
8. Why does a caffeine crystal change polarised light in a way that one isolated caffeine molecule cannot?
   _____