HODDER Education

Chemistry review

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Volume 34, Number 2, November 2024

Answers

Practice exam questions

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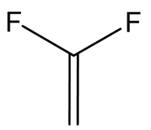
Check your answers to the questions in this issue.

Lithium and sustainable practice (pp. 2–5)

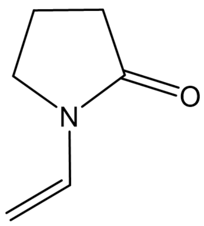
1 **a** **Addition polymerisation** involves unsaturated compounds (those containing a double or triple bond) forming a long chain through a series of addition reactions, in which a double bond becomes a single bond (or a triple bond becomes a double bond). With addition polymerisation the polymer has the same empirical formula as the monomer, as no atoms are lost in the process.

b **Condensation polymerisation** involves the elimination of a small molecule (such as water) as each monomer is added to the growing polymer chain via a condensation reaction.

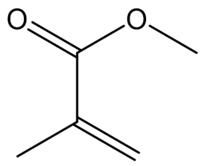
2



a) vinylidene fluoride
1,1-difluoroethene



b) N-vinyl-2-pyrrolidone
(1-ethenylpyrrolidin-2-one)



c) methyl methacrylate
(methyl 2-methylprop-2-enoate)

Dyeing without killing the environment (pp. 6–9)

1 **a** Light with a wavelength of 600 nm appears orange.

b Light with a wavelength of 600 nm has a frequency of **500 × 10^{12} s^{-1}** (or 500 THz).

$$\lambda = \frac{c}{\upsilon}$$

where λ = wavelength of light in metres (m)

c = the speed of light = 3.0×10^8 metres per second (m s^{-1})

υ = frequency in per seconds (s^{-1}) or hertz (Hz), 1 Hz = 1 s^{-1}

$\lambda = \frac{c}{\upsilon}$ can be rearranged to $\upsilon = \frac{c}{\lambda}$

$$\upsilon = \frac{3.0 \times 10^{8}\ \mathrm{m\ s^{-1}}}{600 \times 10^{-9}\ \mathrm{m}} = 5 \times 10^{14} = 500 \times 10^{12}\ \mathrm{s^{-1}}$$

c The energy of a photon with this frequency is **0.33×10^{-18} J**.

$E = h\upsilon$

where E = energy in joules (J)

h = Planck's constant = 6.626×10^{-34} J s

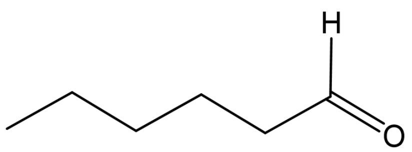
$E = 6.626 \times 10^{-34}$ J s $\times$ 500×10^{12} s^{-1}

E = 0.33×10^{-18} J

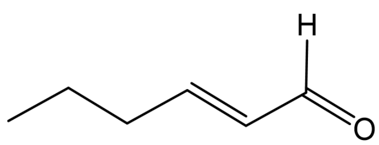
2 A dye that absorbs light with wavelengths in the range 400–620 nm would appear to be red, as only the wavelengths responsible for red visible light are not absorbed and are reflected back to our eyes.

Green, green grass (pp. 20–25)

1



Hexanal



(*E*)-2-hexenal

Infrared (IR) spectroscopy: Both compounds will have C–C, C–H and C=O vibrations. Additionally, (*E*)-hex-2-enal has a C=C bond, so its IR spectrum will contain a band in the 1640–1680 cm^{-1} region that will not be seen in the spectrum of hexanal. There will be a band in the IR spectrum of <u>both</u> compounds at around 1700 cm^{-1} due to C=O stretching.

Mass spectrometry: The mass spectra of the two compounds will be different from each other. In particular, hexanal, $C_6H_{12}O$, has a relative molecular mass (RMM) of 100. (*E*)-2-hexenal, $C_6H_{10}O$, has a RMM of 98. They will therefore have molecular ions 2 mass units apart.

^{13}C NMR spectroscopy: The best spectroscopic method for distinguishing between them would be the ^{13}C NMR spectrum, as the spectrum of (*E*)-hex-2-enal will contain two lines with chemical shifts in the region 130–160 ppm due to the two C= carbons, in addition to a line around 200 ppm (C=O) and the peaks in the 'saturated carbon' region ~50 ppm. There will be no signal anywhere between ~200 ppm (C=O) and ~50 ppm (saturated carbons) in the spectrum of hexanal. In addition to that, the ^{13}C NMR spectrum of hexanal will have 5 peaks in the 'saturated carbon' region around 50 ppm, while the spectrum of (*E*)-hex-2-enal will have 3 peaks in that region.

[1]H NMR spectroscopy: The [1]H NMR spectra of the two compounds will also differ, as the spectrum of (*E*)-hex-2-enal will contain two (split) signals with chemical shifts in the region 6–7 ppm due to the two HC=CH hydrogens – there will be no signal in this region in the spectrum of hexanal. There will be 3 split signals in the 'saturated' CH region 0–3 ppm in the spectrum of (*E*)-hex-2-enal, with 5 signals in this region for hexanal.

2 **a** With 2,4-dinitrophenylhydrazine, hexanal would give a yellow/orange precipitate. There would be no change with hexan-1-ol. Alternatives are available, such as Tollens' reagent.

b Add a piece of sodium metal to each. With hexan-1-ol there will be a gentle effervescence and evolution of hydrogen gas, but no reaction with hexyl acetate. PCl_5 could similarly be used as a test.

3 **a** Sodium borohydride, $NaBH_4$, would reduce hexanal to hexan-1-ol. Some other reducing agents, like lithium aluminium hydride, $LiAlH_4$, would also be suitable.

b Warm the hexan-1-ol with ethanoic acid and a trace of sulfuric acid catalyst.