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Answers

Practice exam questions

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Check your answers to the questions in this issue.

Stick your nose in a book (pp. 2–6)

1 Ether, (primary) alcohol, phenol

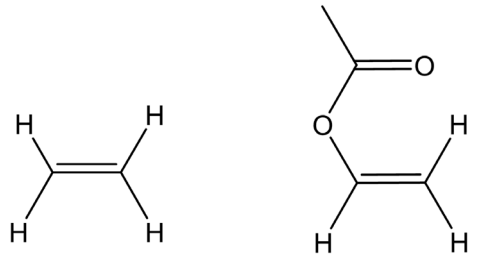
2 **a** With 2,4-dinitrophenylhydrazine, the aldehyde group in vanillin would give a yellow/orange precipitate, while there would be no change with guaiacol. Alternatives are available, such as Tollens' reagent (ammoniacal silver nitrate), which would be reduced by the aldehyde group in vanillin to give a silver mirror.

b Mass spectra: Vanillin has the molecular formula $C_8H_8O_3$, corresponding to a molecular mass of 152. Guaiacol has the molecular formula $C_7H_8O_2$, corresponding to a molecular mass of 124, so the molecules can be distinguished by the masses of the molecular ions.

Infrared spectrum: The presence of an aldehyde group in vanillin means that there will be a C=O stretching peak around 1700 cm^{-1}, which is not seen in the spectrum of guaiacol.

NMR spectrum: The –CH=O group present in vanillin, but not in guaiacol, will give peaks in the ^1H NMR spectrum in the region 9–10 ppm, and in the ^{13}C NMR spectrum around 200 ppm.

3



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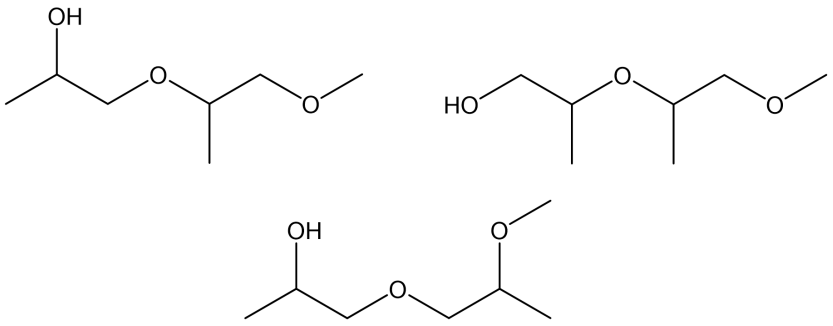


It's only rocket science (pp. 8–9)

1 **a** The molar mass of carbon dioxide (CO_2) is: 12 + (2 × 16) = 44 g mol^{-1}

Therefore, 700 g of CO_2 is equivalent to 16 moles:

$$\frac{700\text{ g}}{44\text{ g mol}^{-1}} = 15.9\text{ mol} \approx \mathbf{16\text{ moles}}$$

b $2LiOH(s) + CO_2(g) \rightarrow Li_2CO_3(s) + H_2O(g)$

The molar mass of LiOH is: 7 + 16 + 1 = 24 g mol^{-1}

As 2 moles of lithium hydroxide are required to capture 1 mole of carbon dioxide, we would need 2 × 16 = 32 moles of LiOH to capture 16 moles of CO_2.

This amount would have a mass of: 32 × 24 = 768 g

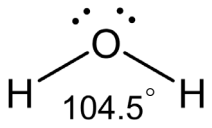
c The minimum mass of LiOH to scrub the air for 7 days for 3 astronauts would be:

7 × 3 × 768 = 16128 g = 16.128 kg

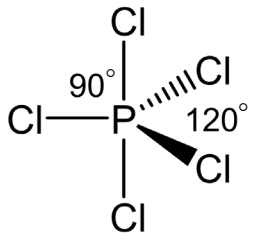
2 LiOH has a molar mass of 24 g mol^{-1}, whereas NaOH and KOH have molar masses of 40 and 56 g mol^{-1} respectively. Keeping the mass of a spacecraft as low as possible is important because the heavier it is, the more fuel is required to provide the thrust for it to be launched.

Molecular geometry (pp. 10–11)

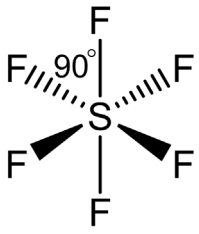
1 **a** Water (H_2O): bent



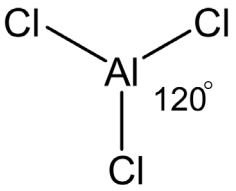
b Phosphorus pentachloride (PCl_5): trigonal bipyramidal



c Sulfur hexafluoride (SF_6): octahedral



d Aluminium chloride ($AlCl_3$): trigonal planar



Thallium: friend or foe? (pp. 12–13)

1 $Fe_4[Fe(CN)_6]$

+3 +2 +2 −3

2 **a** 1.38 angstroms

b 510 picometres

3 **a** Tl_2SO_4

b CH_3COOTl

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