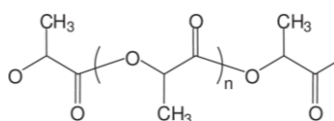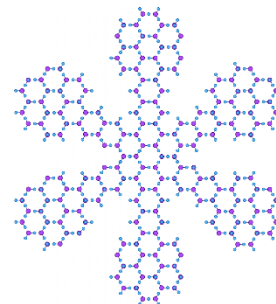## Mince Pies and MCQs – festive chemistry quiz

1. A typical snowflake has a mass of around 3 mg. Within the ice crystals, each water molecule forms hydrogen bonds with four other water molecules. Approximately how many hydrogen bonds are there in a snowflake?

    A. 1×10^{20}
    B. 4×10^{20}
    C. 2.5×10^{19}
    D. 6.7×10^{-4}

2. The polymer polylactic acid, shown opposite, is often used to make biodegradable artificial snow. What is the M_r of the monomer used to make polylactic acid?

    A. 74
    B. 72
    C. 88
    D. 90

3. Cinnamaldehyde is the main chemical responsible for the scent and flavour of cinnamon. The structure of cinnamaldehyde is shown. If cinnamon bark contains 85% cinnamaldehyde, what mass of bromine will react with 5 grams of cinnamon bark (without presence of heat, a catalyst or UV light)?
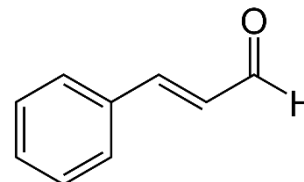
    A. 2.57 g
    B. 5.14 g
    C. 20.58 g
    D. 4.25 g

4. What is the relative atomic mass of a sample of Holmium (to 2 decimal places) given the information about isotopic composition shown in the table?

Isotope	^{163}Ho	^{165}Ho	^{166}Ho
Percentage composition	4.12	95.8	0.08

    A. 164.97
    B. 164.91
    C. 164.92
    D. 166.11

5. A 4.5 kg turkey is heated in a gas oven. The oven burns 57 grams of methane during cooking and the efficiency of heat transfer is 28%. If the turkey increases in temperature by 70°C and the enthalpy of combustion for methane is 890 kJmol^{-1}, what is the specific heat capacity of the turkey in Jg^{-1}K^{-1}?
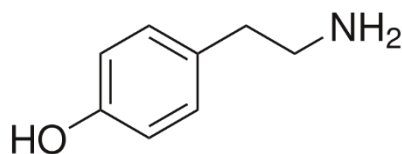
A. 2.82
B. 35.9
C. 18.0
D. 4.51

6. Which of these compounds would **not** give either a red or green result in a flame test?

A. Barium chloride
B. Lithium nitrate
C. Magnesium sulfate
D. Strontium chloride

7. Tyramine is a toxic chemical found in mistletoe. Its structure is shown below. Which of these reagents will **not** react with tyramine?

A. Aqueous sodium hydroxide
B. Dilute aqueous hydrochloric acid
C. Acidified potassium dichromate under reflux
D. Aqueous bromine

8. Allyl isothiocyanate is the compound responsible for the bitter taste of sprouts. The skeletal formula is shown below. Which statement about this compound is **not** true?

A. It contains equal numbers of carbon and hydrogen atoms
B. The C-N=C bond angle is around 118°
C. It contains three π bonds
D. It is unsaturated
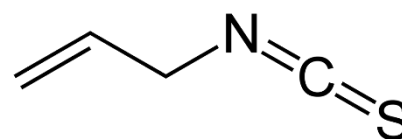
BONUS QUESTION:

Make a Christmas word, song title or message using only element symbols.

Example: FRaNKInCeNSe

ckchemistry.co.uk

Answers

1. B
   First calculate the moles of water in a snowflake: 3×10^{-3} / 18 = 0.0001667 mol. Multiply by 6.02×10^{23} to get the number of molecules, then multiply by 4 to get the number of hydrogen bonds.

2. D
   The structure of the monomer, lactic acid, is shown. It is a condensation polymer that is formed from a carboxylic acid group bonding with an alcohol group, so the molecular formula of the monomer is $C_3H_6O_3$ and the M_r is 90.
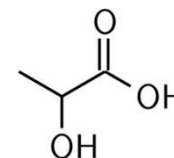
3. B
   There is one C=C bond that will react with one bromine molecule (Br_2). 5 g cinnamon bark contain 4.25g cinnamaldehyde, which has a molecular formula of C_9H_8O and M_r = 132.
   Moles of cinnamaldehyde = 4.25/132 = 0.0322 mol. It reacts with bromine in a 1:1 ratio (the benzene ring does not react without a catalyst) so the mass of bromine that reacts = 0.0322 x 159.8 = 5.15 g

4. C
   This should be a straightforward relative atomic mass calculation, but you need to be careful about the 0.08%! The calculation is:
   (163 x 4.12 + 165 x 95.8 + 166 x 0.08) / 100 = 164.9184 => 164.92 to 2 D.P.

5. A
   Moles of methane burned = 57 / 16 = 3.5625 mol
   kJ released = 890 x 3.5625 = 3170.625 kJ
   28% of energy is transferred to the turkey = 887.775 kJ
   Specific heat capacity in $Jg^{-1}K^{-1}$ = $\dfrac{887775\ J}{4500\ g \times 70\ K}$ = 2.82 $Jg^{-1}K^{-1}$ (to 3SF)

6. C
   This might not be required by your A Level course! Barium gives a green flame, lithium is red and strontium is also red. Magnesium gives off UV light but no visible colour.

7. C
   You need most of your organic knowledge for this! -OH attached to a benzene ring is phenol, which is a weak acid and so will react with sodium hydroxide. $-NH_2$ is an amine which is a base and will react with acid. Phenol is reactive enough that it will react with bromine water (unlike benzene) but there are no primary or secondary alcohols – the -OH group on phenol cannot be oxidised.

8. A
   The molecular formula is C_4H_5NS. Around the nitrogen atom there are two bonds (one double, one single) and one lone pair. The angle is based on trigonal planar but the bond angle would be reduced by the lone pair from 120 to about 117.5. Every double bond contains one π bond and one σ bond. It contains a C=C bond so is unsaturated.