A Level Christmas Chemistry Answers

$_{67}Ho$	$_{67}Ho$	$_{67}Ho$

The three gifts

1) **Gold**

Gold has a melting point of 1337K and a boiling point of 3243K. The atomic number of gold is 79.

a. With reference to bonding, explain why it has a high melting and boiling point.

Strong electrostatic forces of attraction between positively charged metal ions and delocalised electrons require a lot of energy to overcome.

DO NOT mention intermolecular forces, breaking of covalent bonds or attractions between oppositely charged ions. These are chemical errors resulting in no marks regardless of the rest of the answer.

b. Using subshell notation, write out the full electron configuration of gold.

Au: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}\ 5p^6\ 6s^1\ 4f^{14}\ 5d^{10}$

Abbreviated form: $[Xe]\ 6s^1\ 4f^{14}\ 5d^{10}$

At A Level, you are required to be able to recall the electron configuration of any of the first 36 elements. This question is a challenge as you are not required to know anything about the f-block apart from where it is in the periodic table. You may have been told that it holds a maximum of 14 electrons. You aren't required to learn the electron configuration of the f-block elements as they are somewhat more complicated than that seen in the s, p and d blocks but by the time you get to Ytterbium the 4f shell is filled.

Yb $[Xe]\ 4f^{14}\ 6s^2$

Lu $[Xe]\ 4f^{14}\ 5d^1\ 6s^2$

Hf $[Xe]\ 4f^{14}\ 5d^2\ 6s^2$

Gold is directly below copper so like copper an electron is promoted from the s-sublevel to the d-sublevel to fill it.

Cu $[Ar]\ 4s^1\ 3d^{10}$

c. Gold is found in compounds as ions with oxidation state +1 and +3. What is the electron configuration of these gold ions?

If this was a 3d element you would remove electrons from the highest occupied s-sublevel then the highest occupied d-sublevel. Apply the same logic here.

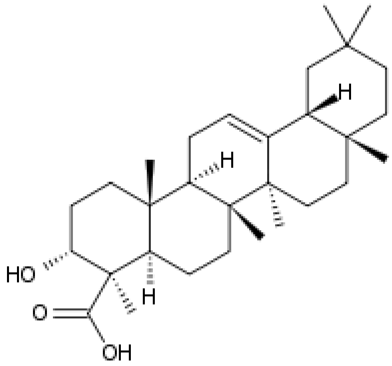
Au: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}\ 5p^6\ \mathit{6s^1\ 4f^{14}\ 5d^{10}}$

Au^+: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}\ 5p^6\ \mathit{4f^{14}\ 5d^{10}}$

Au^{3+}: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}\ 5p^6\ \mathit{4f^{14}\ 5d^8}$

2) Frankincense

Frankincense is a mixture of many compounds, including Boswellic acid. The structure of α-Boswellic acid is shown below.



https://en.wikipedia.org/wiki/Boswellic_acid

a. Which intermolecular forces are present in α-Boswellic acid?

Like all molecular species, α-Boswellic acid will have van der Waals forces between its molecules. It will also exhibit dipole-dipole attractions due to its asymmetrical C-O, C=O and O-H bonds. Any molecule with hydrogen covalently bonded to fluorine, oxygen or nitrogen is able to form hydrogen bonds provided that there is also a lone pair of electrons on the F, O or N atom. Therefore, this molecule will also be able to form hydrogen bonds with an adjacent neighbouring molecule. It has all three intermolecular forces.

b. Would you expect α-Boswellic acid to be soluble in water? Explain your answer.

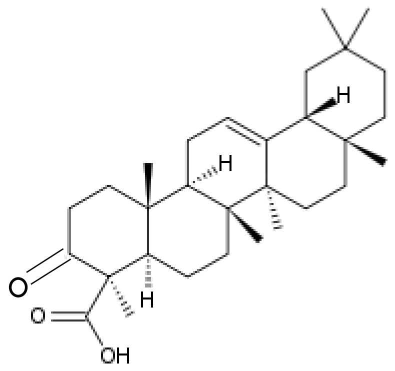
Molecules that have hydrogen bonding can form hydrogen bonds with water making them water soluble. In order to do this the molecules have to break the hydrogen bonds between water molecules. Also, the hydrogen bonds between the molecules being dissolved also have to be broken. Both of these processes require energy. However, when the molecules form hydrogen bonds with water energy is released and for small molecules the energy released is almost the same as the energy required to break the hydrogen bonds in the first place. The process of mixing the molecules also results in an increase in entropy which favours the process.

Molecules with hydrogen bonding but long non-polar chains or structures also need to break the hydrogen bonds between water molecules to dissolve. However, their non-polar structures can't form hydrogen bonds resulting in fewer hydrogen bonds being formed between the molecules and water. Less energy is released making the process energetically unfavourable.

This is why the alcohols become less water soluble as the chain length increases.

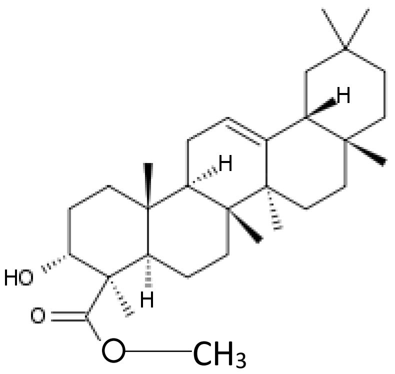
c. Draw the structure of the main organic product that you would expect to see if α-Boswellic acid is subjected to the following conditions.

i. Heat under reflux with potassium dichromate(VII) dissolved in dilute sulfuric acid.



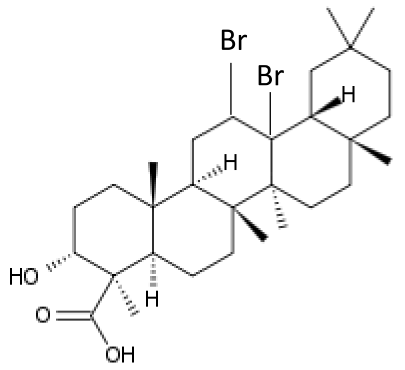
The secondary alcohol group will oxidise to a ketone.

ii. Heat with methanol and concentrated sulfuric acid in the absence of water.



The carboxylic acid functional group will form a methyl ester.

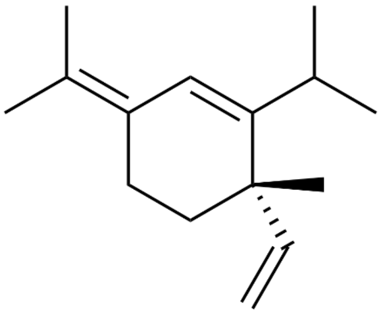
iii. Addition of bromine at room temperature.



The double bond is lost and bromine atoms bond to the carbon atoms.

3) Myrrh

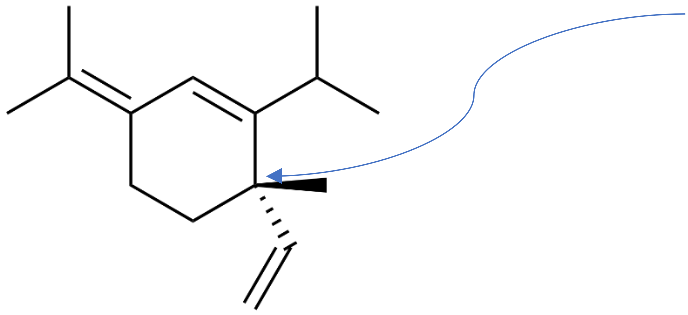
Myrrh resin is rich in organic compounds. These include the group of naturally occurring organic compounds called the elemenes. The compound below is α-elemene.



https://upload.wikimedia.org/wikipedia/commons/thumb/2/22/Alpha-elemene.svg/945px-Alpha-elemene.svg.png

a) Would you expect α-elemene to be optically active? Explain your answer.

The molecule has one chiral carbon atom (see below). This would give rise to optical isomers.

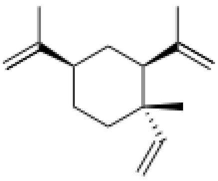


b) Draw three non-aromatic positional isomers of α-elemene.

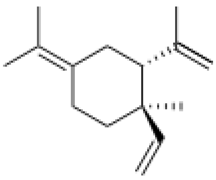
Positional isomers have the same carbon chain structure so the only movable structure is the double bond. Any of them can be but it is not permitted to have two double bonds directly next to each other, there must be at least one single C-C bond between two C=C bonds. The question specifically asks for non-aromatic isomers so they can't all be placed in the hexagonal structure in the middle of the molecule as this would give it aromaticity.

Examples of correct molecules below.

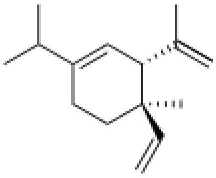
β-elemene



γ-elemene



δ-elemene



https://en.wikipedia.org/wiki/Elemene

BEST WISHES FOR CHRISTMAS 2018.

FOLLOW ME ON SOCIAL MEDIA FOR STUDY TIPS AND INFORMATION ON NEW RESOURCES FOR 2019.

www.onlinechemistrytutor.net

info@onlinechemistrytutor.net

Facebook: https://www.facebook.com/onlinechemistrytutor.net

Twitter: https://twitter.com/Onlinechemtutor