Marks 5

- Complete the following table. Give, as required, the formula, the systematic name and the principal ions present in a solution prepared by adding the substance to water. For the substances that do not form ions in solution, write N/A in this column.

FORMULA	SYSTEMATIC NAME	PRINCIPAL IONS IN WATER SOLUTION
	magnesium chloride	
	sodium chromate	
CO		
		$H^+(aq)$, $IO^-(aq)$
	iron(III) nitrate-6-wate	

- Electron configurations are governed by three rules: the 'Aufbau Principle', the 'Pauli Exclusion Principle' and 'Hund's Rule of Maximum Spin Multiplicity'. The ground state electron configurations of He, N and O have been written INCORRECTLY, as shown below. For each element, name the electron configuration rule that has been broken.

Element	Electronic configuration					Name of rule that has been broke
	1s	2s	2p	2p	2p	
He		↑↓				
N	↑↓	↑↓	↑↓	↑		
O	↑↓	↑↓	↑↑	↑		

Write the electron configuration of Fe^{2+}

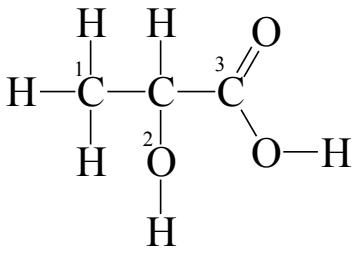
What property of iron makes it useful for biological systems?

5

- Draw the Lewis structures, showing all valence electrons for the following species. Indicate which of the molecules possess a dipole.

CH_3Cl	NO_2F	NCO^-
Dipole: YES / NO	Dipole: YES / NO	Dipole: YES / NO

	Marks
• The partial Lewis structure of lactic acid, the molecule that forms in muscle during exercise, is shown below. Complete the Lewis structure of lactic acid by drawing the non-bonded electron pairs around the relevant atoms.	**2**



Marks

- Complete the following table. Give, as required, the formula, the systematic name, the oxidation number of the underlined atom and, where indicated, the principal ions present in a solution prepared by adding the substance to water. **4**

FORMULA	SYSTEMATIC NAME	OXIDATION NUMBER	PRINCIPAL IONS IN WATER SOLUTION
$\underline{N}O_2$			N/A
$\underline{Pb}(CH_3CO_2)_2$			
			$Mg^{2+}(aq)$; $\underline{Cl}O_4^-(aq)$

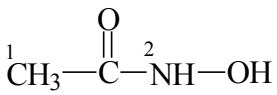
Write the full electron configuration of the As^{3+} ion.

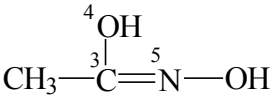
- Draw the Lewis structures, showing all valence electrons for the following species. Indicate which of the species have contributing resonance structures. **5**

HCO_3^-	COS	CN^-
Resonance: YES / NO	Resonance: YES / NO	Resonance: YES / NO

Marks 7

- Siderophores (from the Greek meaning 'iron carriers') are organic molecules produced by microorganisms to provide essential Fe^{3+} required for growth. The functional group (the group which binds Fe^{3+}) of siderophores is shown below as tautomers **I** and **II**. Complete the table below, relating to the molecular geometry about the specified atoms in **I** and **II**.

I 

II 

Atom	Geometric arrangement of the electron pairs around the atom	Hybridisation of atom	Geometry of bonding electron pairs around atom
^{1}C			
^{2}N			
^{3}C			
^{4}O			
^{5}N			

Desferal is a siderophore-based drug that is used in humans to treat iron-overload. One molecule of Desferal (molecular formula: $C_{25}H_{48}O_8N_6$) can bind one Fe^{3+} ion. A patient with iron-overload had an excess of 0.637 mM Fe^{3+} in his bloodstream. Assuming the patient has a total blood volume of 5.04 L, what mass of Desferal would be required to complex all of the excess Fe^{3+}?

ANSWER:

THIS QUESTION CONTINUES ON THE NEXT PAGE

Marks

- Complete the following table. Give, as required, the formula, the systematic name, the oxidation number of the underlined atom and, where indicated, the number of *d* electrons for the element in this oxidation state. **5**

FORMULA	SYSTEMATIC NAME	OXIDATION NUMBER	NUMBER OF *d* ELECTRONS
$\underline{S}O_3$			
$K\underline{Mn}O_4$			
$\underline{Co}Cl_2 \cdot 6H_2O$			
	ammonium sulfate		

- Draw the Lewis structures, showing all valence electrons for the following species. Indicate which of the species have contributing resonance structures. **4**

NO_3^-	CO_2	N_2H_2
Resonance: YES / NO	Resonance: YES / NO	Resonance: YES / NO

- A sample of carboxypeptidase (an enzyme) was purified and found on analysis to contain 0.191% by weight of zinc. What is the *minimum* molecular weight of the enzyme if we assume it is a monomer? **2**

Answer:

- Draw the Lewis structures, showing all valence electrons for the following species. Indicate which of the species have contributing resonance structures.

4

NCO^-	COF_2	NO_3^-
Resonance: YES / NO	Resonance: YES / NO	Resonance: YES / NO

- Draw the Lewis structures, showing all valence electrons for the following species. **3**

CH_3^-	CH_3^+

Indicate which of these species you expect will be more stable and explain why.

	Answer:

- Complete the following table, giving either the systematic name or the molecular formula as required.

Marks 2

Formula	Systematic name
SO_2	
$CoCl_2 \cdot 6H_2O$	
	silver chromate
	potassium hydrogencarbonate

- The intense yellow light emitted from a sodium street lamp has a wavelength of $\lambda = 590$ nm. The light is emitted when an electron moves from a 3*p* to a 3*s* orbital. What is the energy of (a) one photon and (b) one mole of photons of this light? **5**

(a) Answer:	(b) Answer:

Sketch the shape of a 3*s* and a 3*p* orbital and label any spherical nodes that may be present.

3*s* orbital	3*p* orbital

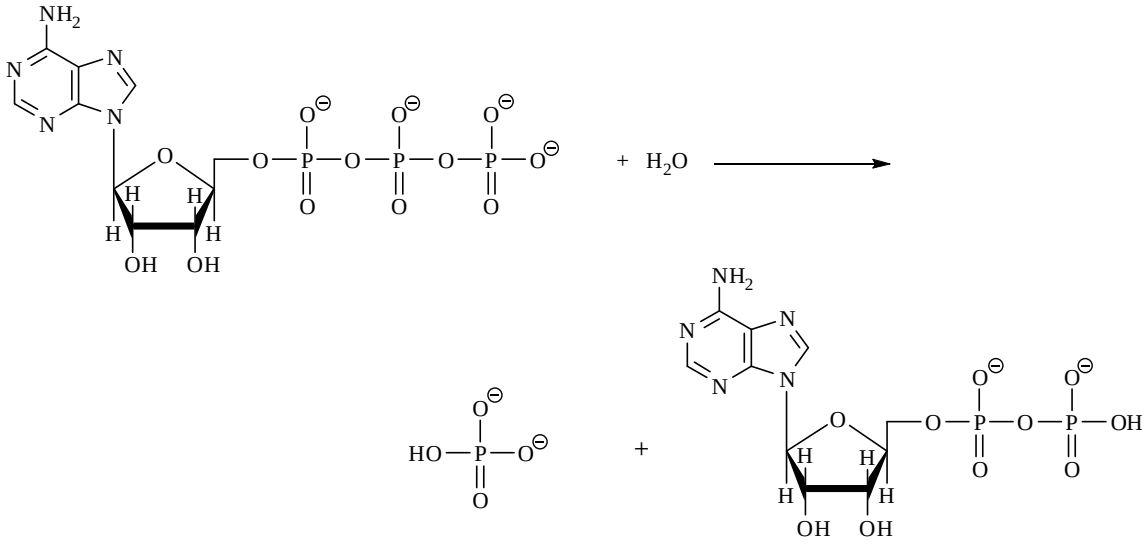
What does a node represent?

Marks

- Consider the σ-bond of a hydrogen molecule and the π-bond of ethylene ($H_2C=CH_2$). Sketch the shapes of the molecular orbitals of these bonds and the shapes of the atomic orbitals from which they arise. **2**

hydrogen	ethylene

- ATP is used as an energy source in the body. Hydrolysis releases ADP, HPO_4^{2-} and energy, according to the equation: **2**



Suggest **two** reasons why this reaction is a good energy source.