Marks 5

- Carbon monoxide is a poisonous gas that may be obtained from incomplete combustion. Draw the Lewis structure of carbon monoxide and add the labels *lone pair,* σ*-bond,* π*-bond* as appropriate.

On the atoms below, draw and label the orbitals (atomic and/or hybridised) that give rise to the bonds and lone pairs on carbon monoxide and clearly show which orbitals overlap with each other and the type of bond that results.

C O

THE REMAINDER OF THIS PAGE IS FOR ROUGH WORKING ONLY.

• In the spaces provided, briefly explain the meaning of the following terms.	**Marks**
Ionic bonding	**1**

THE REMAINDER OF THIS PAGE IS FOR ROUGH WORKING ONLY.

	Marks
• Silicon and carbon are both in Group 14 and form dioxides. Carbon dioxide is a gas at room temperature while silicon dioxide (sand) is a solid with a high melting point. Describe the bonding in these two materials and explain the differences in properties they show.	**3**

Marks 3

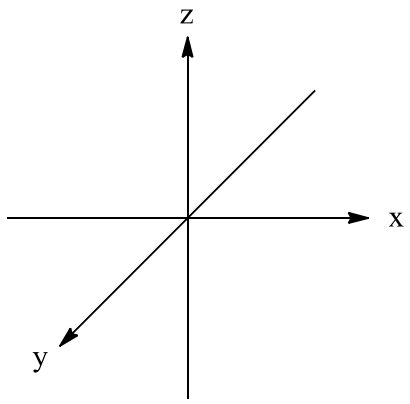
- Complete the following table, include resonance structures if appropriate. The central atom is underlined.

Formula	$\underline{P}Cl_5$	$\underline{S}OCl_2$	$H\underline{C}OO^-$
Lewis structure			

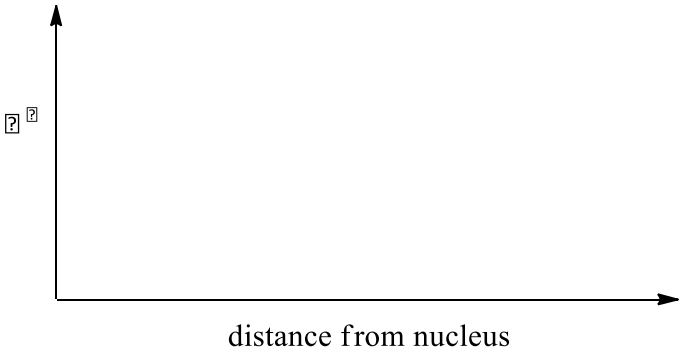
THE REMAINDER OF THIS PAGE IS FOR ROUGH WORKING ONLY.

Marks 4

- Sketch the shape of a $3p_x$ orbital.



Sketch the radial probability (ψ^2) of an electron in a $3p_x$ orbital.



Sketch the shape of the σ orbital formed by overlap of a $3p_x$ orbital and an *s* orbital. Clearly show the position of the two nuclei.

- 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

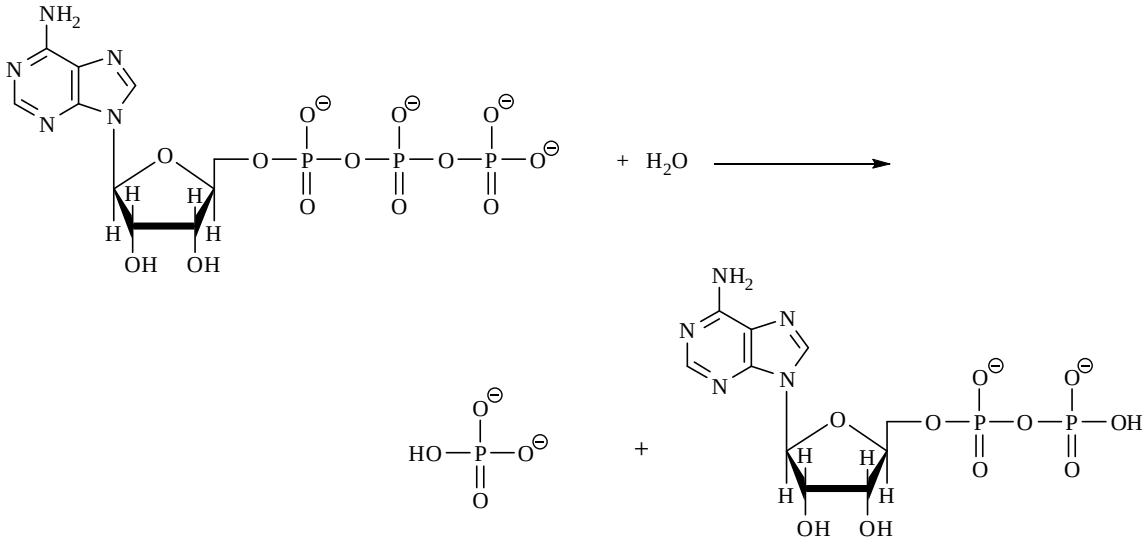
What does a node represent?

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.

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

Marks 2

Formula	Systematic name
$NaHSO_4$	
	arsenic(III) chloride
$CrCl_3 \cdot 6H_2O$	
	silver dichromate

- Like most medicines, the platinum complex, cisplatin, *cis*-$[PtCl_2(NH_3)_2]$, is both effective and toxic. What is cisplatin used to treat? **4**

What does the cisplatin react with in the body to cause most of the toxicity?

Draw a graph showing the relationship between overall health and the level of platinum in the body of a healthy person.

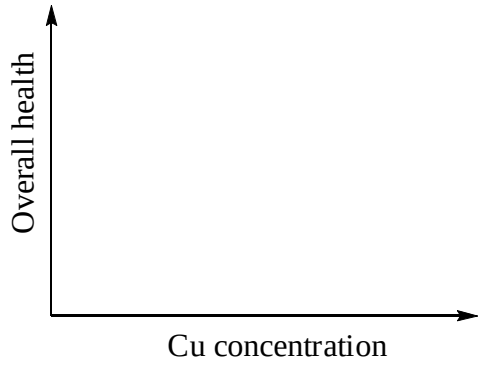
- Complete the following table, giving either the systematic name or the molecular formula as required.

Marks 2

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

- Copper is an essential element in human biology, deficiencies leading to blood disorders. Excess copper can occur in cases of poisoning or in Wilson's disease. Draw a graph showing the relationship between overall health and the level of copper in the body and identify the 'healthy' range.

4



Describe one biological function of copper.

Suggest one approach for treating an excess level of copper.

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
$\underline{C}O_2$			
$Na_2\underline{Cr}O_4$			
$\underline{Fe}Cl_3 \cdot 3H_2O$			
	potassium sulfate		

- 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.

- 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