Question 1:

The change in concentration of reactants or products per unit time. [2 marks]

Derivation of integrated rate equation for first-order reaction:

Rate = $-d[A]/dt = k[A]$

$d[A]/[A] = -k\,dt$

Integrating both sides: $\ln[A]_o/[A]_t = kt$ or $\ln[A]_t = \ln[A]_o - kt$ [5 marks]

Calculation of half-life:

$t_{1/2} = 0.693/k = 0.693/0.0693 = 10$ minutes [3 marks]

Question 2:

(a)

First law: The mass of a substance deposited at an electrode during electrolysis is directly proportional to the quantity of electricity passed.

Second law: The masses of different substances deposited by the same quantity of electricity are proportional to their equivalent weights.

(b)

Quantity of electricity = Current × Time = 2 A × 30 × 60 s = 3600 C

Number of moles of electrons = 3600 C / 96500 C mol^{-1} = 0.0373 mol

Since $Cu^{2+} + 2e^- \rightarrow Cu$, 2 moles of electrons deposit 1 mole of copper

Moles of copper deposited = 0.0373 mol / 2 = 0.01865 mol

Mass of copper deposited = 0.01865 mol × 63.5 g/mol = 1.18 g

Question 3:

(a)

Carbon undergoes sp^3 hybridization in methane

The 2s and three 2p orbitals of carbon mix to form four equivalent sp^3 hybrid orbitals

These hybrid orbitals are oriented tetrahedrally at an angle of 109.5°

Each sp^3 hybrid orbital of carbon overlaps with the 1s orbital of hydrogen to form four equivalent C-H sigma bonds

This gives methane a tetrahedral geometry

(b)

Lewis structure shows phosphorus with five bonds to chlorine atoms and no lone pairs

According to VSEPR theory, the electron pair arrangement is trigonal bipyramidal

The five electron pairs around phosphorus repel each other to minimize repulsion

Three chlorine atoms lie in the equatorial plane at 120° angles

Two chlorine atoms lie at the axial positions at 180° to each other

The molecular geometry is trigonal bipyramidal with bond angles of 120° (equatorial) and 90° (between axial and equatorial)