

1. Draw a picture to show the electrical double layer of a negatively charged colloid, the potential change with the distance, the names of these layers and their potentials (15%). Furthermore, by what mechanism does addition of an electrolyte such as NaCl bring about the destabilization of colloids in water? (5%) What are the main forces during this process? (5%)
2. A sealed radioactive source used for physics demonstrations in 2000 contained 10 microcuries of cobalt-60. Given a half-life of 1900 days for cobalt-60, what would be the source strength in 2053? (10%)
3. In a precipitation-dissolution reaction, the base-10 logarithmic equilibrium constant for the dissolution of limestone ($\text{CaCO}_3(\text{s})$) is -8.3. What is the equilibrium concentration of calcium ions in water when the carbonate ion (CO_3^{2-}) concentration is 10^{-6} M? (10%)
4. Draw the chemical structure of trichloroethylene and determine the oxidation states of all carbon atoms. (5%)
5. What is meant by the pE of an aqueous solution? What does a low (negative) pE value imply about the solution? What species determine the pE value in aerated water? (5%)
6. What are the main sources of Arsenic in the environment? What are their common ionic forms and metal-organic forms? Which form is the most toxic? (5%)
7. Define the term "soil-plant barrier", and use it to explain why cadmium (Cd) can be easily accumulated in the rice, but not for copper (Cu) (10%).
8. Describe (or illustrate) how to use the inductively coupled plasma (ICP) for quantifying heavy metals in soils? The preliminary or digestion process of soil samples before the ICP measurement and basic principle of ICP need to be included (10%)
9. Draw the structure of pentachlorophenol. What is its main use as a compound? What are the possible dioxin congeners that could be produced during its production, use and disposal? What are possible routes of pentachlorophenol and its byproducts entering into the aquatic environment (10%)?
10. List at least two criteria air pollutants (指標空氣污染物) in "Air Quality Standard (空氣品質標準)" of Taiwan's EPA (環保署). In addition, please explain "空氣污染指標 (Air Quality Index, AQI)" (10%)