INDIAN INSTITUTE OF TECHNOLOGY PATNA
CE 102: Environmental Studies
Final Examination 2016-17 II: CB + CE + EE

Maximum Time: 120 Minutes **Maximum Marks: 40**

Instructions

- Answer must be *brief* and *to the point*.
- Make suitable assumptions wherever necessary.
- Numbers in the parenthesis at the end of each question indicate Maximum Marks.
- Use of notes/reference materials is *not* permitted.
- Use of mobile phone is *not* permitted. Sharing of calculator is *not* permitted.
- Write your name and roll number on the question paper in the space below before proceeding further. ***Do not forget to submit question paper along with answer book.***

Name: _____ **Roll No:** _____

Questions

1. Results are shown below from a routine water quality analysis being run on a water sample:

Cation	Concentration (mg/L)	Anion	Concentration (mg/L)
Na^+	30.0	Cl^-	60.0
K^+	5.0	HCO_3^-	45.0
Ca^{2+}	36.0	CO_3^{2-}	1.0
Mg^{2+}	12.0	SO_4^{2-}	60.0
Sr^{2+}	1.0	NO_3^-	2.0

(a) Estimate for the water sample: (i) total alkalinity, (ii) total hardness, (iii) calcium hardness, (iv) magnesium hardness, (v) carbonate hardness, (vi) non-carbonate hardness in mg/L as $CaCO_3$.

(b) Perform ion balance based on the analysis results and estimate and check the permissibility of the percent error induced in the analysis. Also, construct a representative bar diagram of the ion balance.

(03 + 03)

2. (a) Form the first principle i.e. classical mechanics approach, derive the following expression for the terminal settling velocity (v_t) of a particulate matter in air:

$$v_t = \frac{g}{18}\frac{(\rho_p - \rho_a)}{\mu} d_p^2$$

Here, ρ_p, ρ_a, d_p, μ and g are density of the settling particulate, density of air, diameter of the particulate, dynamic viscosity of air, and acceleration due to gravity, respectively. Clearly state the *assumptions* made while deriving the expression.

(b) Assuming an airborne particle with unit density (1 g/cm^3) and a diameter of 10 μm, estimate the terminal settling velocity in room air in cm/s. Assume: (i) density of room air as 1.2 kg/m^3, (ii) dynamic viscosity of room air as 1.85×10^{-5} kg/m.s.

(c) What type of settling you would assume for separation of (i) settleable solids in river water in primary sedimentation, (ii) colloidal solids in river water in secondary sedimentation, (iii) grits in wastewater in grit chamber, and (iv) organic suspended solids in wastewater in primary clarifier.

(03 + 01 + 02)

3. (a) 'Food web provides more stability to the ecosystem as compared to food chain'. Justify the statement with suitable example.

(b) 'Removal of apparent color from water is easy as compared to true color'. Justify the statement.

(c) Assuming ThOD is equivalent and synonymous with COD, estimate COD of 100 mg/L solution of potassium hydrogen phthalate (KHP) ($C_8H_5KO_4$).

(d) Explaining various forms of UV-irradiation, mention which form is generally used for disinfecting water/wastewater.

(e) What is 'seeding'? Why is seeding required for BOD determination of industrial wastewater?

(f) Drawing schematic diagram, explain the purpose and working of sanitary landfill.

(02 + 01 + 02 + 02 + 02 + 02)

..... ***continued on Page 2***

4. (a) Scientifically define: (i) particulate matter (PM), (ii) dust, (iii) fog, and (iv) fume.

(b) Define 'aerodynamic diameter' and 'Stokes diameter'. What are basis for development of the term 'aerodynamic diameter' with respect to PM as air pollutant?

(c) Calculate the aerodynamic diameter (d_{pa}) of an airborne particle having a Stokes diameter (d_{ps}) of 2.0 μm and a density of 2700 kg/m^3.

(d) The average daily concentration of SO_2 from a coal-fired thermal power plant is observed to be 415 μg/m^3 at 20°C and 1 atm. What is the equivalent concentration of SO_2 in percent by volume and parts per million?

(e) Drawing the schematic, explain the tri-modal distribution behavior of PM in the urban atmosphere.

(f) Explain how photochemical smog is formed by drawing schematic showing source of pollutants and reactions in the atmosphere.

(g) Why do oil companies now-a-days sell unleaded petrol through petrol pumps?

(02 + 03 + 01 + 02 + 03 + 02 + 01)

5. Draw separate schematic layout/flow diagram of drinking water treatment plant (WTP) for treatment of (i) surface water with considerable amount pollution, and (ii) ground water containing 10-20 mg/L of both iron and manganese showing typical sequence of following unit operations *as applicable* as individual block: chlorination, screening, coagulation, flocculation, filtration, primary sedimentation, secondary sedimentation, aeration. **(03)**

Some Useful Information

C: 12; H: 1; O: 16; N: 14; S: 32; Na: 23; K: 39; Ca: 40; Mg: 24; Sr: 88; Cl: 35.5