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|---|---|
| **Started on** | Sunday, 19 November 2023, 8:31 AM |
| **State** | Finished |
| **Completed on** | Sunday, 19 November 2023, 10:09 AM |
| **Time taken** | 1 hour 38 mins |
| **Grade** | **19.00** out of 35.00 (**54**%) |

**Question 1**

Correct

Mark 8.00 out of 8.00

**An industry is illegally discharging the effluent into a nearby stream. The stream water sample collected at the point of discharge (after instantaneous mixing) indicated the following: Ultimate BOD = 50 mg/L, temperature= 25 $^0$C, flow rate= 2 m$^3$/s and flow velocity = 1 m/s. Deoxygenation and reoxygenation constants at 20 $^0$C are 0.23 and 0.4 per day, respectively. Saturation DO at 25 $^0$C= 9.3 mg/L. Water quality studies indicated that the lowest DO obtained downstream from the point of discharge is 3 mg/L. Assume there are no other pollution sources discharging into the stream and the stream temperature remains the same after mixing. Answer the following questions.**

**A) Critical deficit in mg/L** 6.3 ✓ **(1 mark)**

**B) Reaeration constant at 25 $^0$C (per day, rounded off to 3 decimals)**

0.433 ✓ **(1 mark)**

**C) 3-Day BOD at 27 $^0$C (in mg/L, rounded off to 3 decimals) for the stream water sample collected at the point of discharge after instantaneous mixing**

30.695 ✓ **(2 marks)**

**D) The time of occurrence of the lowest DO after the wastewater discharge (in days, rounded off to 3 decimals)** 5.549 ✓ **(4 marks)**

$$D = \frac{k_1 L_0}{k_2 - k_1}\left(e^{-k_1 t} - e^{-k_2 t}\right) + D_0 e^{-k_2 t}$$

$$t = \frac{x}{u}$$

$$D_c = \frac{k_1}{k_2} L_0 e^{-k_1 t_c}$$

$$t_c = \frac{1}{k_2 - k_1} \ln\left[\frac{k_2}{k_1}\left(1 - D_0 \frac{k_2 - k_1}{k_1 L_0}\right)\right]$$

Your answer is correct.

**Question 2**

Correct

Mark 3.00 out of 3.00

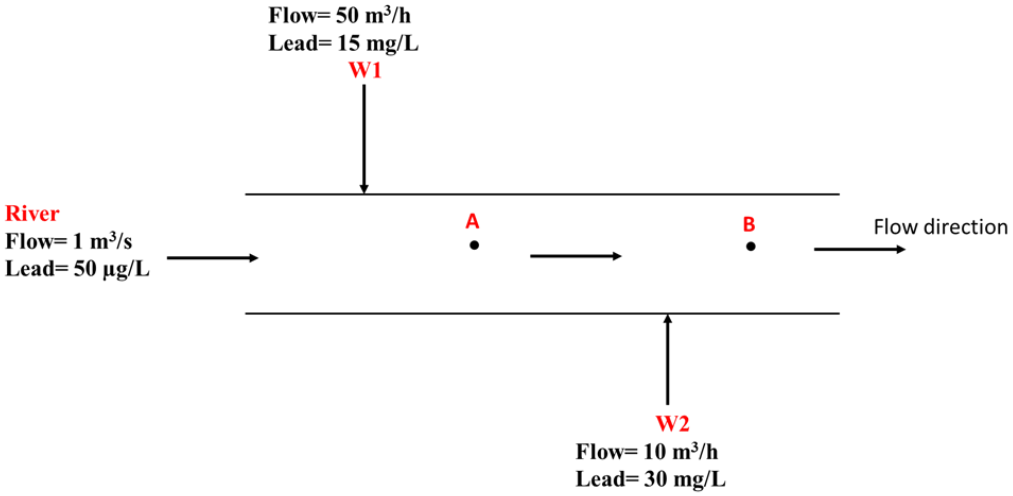
**Two wastewater effluents are discharged into a river as shown in the figure below.**

**Lead concentration at point A in mg/L (rounded off to 3 decimals)**

0.255 ✓ **(1.5 marks)**

**Lead concentration at point B in mg/L (rounded off to 3 decimals)**

0.332 ✓ **(1.5 marks)**




Your answer is correct.

**Question 3**

Correct

Mark 1.00 out of 1.00

A telecom powder manufacturing industry is using a cyclone separator with cut size diameter 6.5 µm. The flow rate of cyclone is increased by 1.1 times due to change in production rate, while other parameters remained same. Estimate the new cut diameter (in µm) due to change in flow rate. [Roundoff answer to 1 decimal place]

$$\eta = \frac{D_p^2 \rho_p N v_c \pi}{9 \mu W_i}$$

6.2 ✓

One possible correct answer is: 6.1975068300963

Your answer is correct.

**Question 4**

Correct

Mark 1.00 out of 1.00

ESP has a measured efficiency of 92 percent. We wish to upgrade it to 96.5 percent. By how much must we increase the applied voltage? [Round off answer to 2 decimal place]

$$F_D = 3\pi v_t D_p \mu_g$$

$$Fe = 3Dp^2 \epsilon_0 E_0 E_p \pi \left(\frac{\epsilon}{\epsilon + 2}\right)$$

1.15 ✓

One possible correct answer is: 1.1520863701316

Your answer is correct.

**Question 5**

Incorrect

Mark 0.00 out of 5.00

A Power Station is using 10 compartments of bag house filters for removal of particles. Each compartment has 100 bags of diameter 26 cm and 9 m height. The effective surface area is 90% of the total surface area per bag. The flow rate of flue gas was measured as 45000 $m^3$/min. The pressure drop of newly installed baghouse was estimated as 1.773 in $H_2O$. The bags are operated until the pressure drops 3 times of initial value, at which time they are taken out of service and cleaned. The cleaning frequency is once per hour. One out of 10 compartments always kept out of service for cleaning. The flue gas has a particle concentration 10 g/$m^3$. The collection efficiency is 92 percent, and the filter cake is estimated to be 65 percent solids, with the balance being voids. Density of dust material is 2000 kg/$m^3$. Viscosity of flue gas $2.61\times10^{-5}$ (Pa.s) at 200 ºC. Note 1 in $H_2O$=248.843 N/$m^2$. Assume the resistance of filter material as negligible.

$$V_s = \frac{P_1 - P_3}{\mu[\alpha + \frac{VW}{kA}]}$$

(a) Estimate thickness of the cake (in mm) when the bags are taken out of service for cleaning. [Round off answer to one decimal place] **[Marks 3]**

19.2 ✗

One possible correct answer is: 3.2089096569043

(b) Also calculate the permeability of the cake (μm)$^2$. Just enter the value of k in the answer box [Round off answer to 2 decimal place] **[Marks 2]**

285.85 ✗

One possible correct answer is: 7.9699040543228

Your answer is incorrect.

**Question 6**

Incorrect

Mark 0.00 out of 2.00

Determine the concentration (in µg/m$^3$) of nitrogen dioxide 150 m downwind of Munirika flyover near IIT Delhi highway at 5:30 PM on an overcast winter day with slight incoming solar insolation and a wind speed of 4 m/s. The highway runs towards east-west and the wind is blowing perpendicular to the direction of flyover. The measured traffic flow is 6000 vehicles per hour. The emission rate per vehicle is 0.5 g/km. [Roundoff answer to 2 decimal place]

$$C = \frac{2E}{(2\pi)^{0.5} u \sigma_z} e^{[-0.5(\frac{H}{\sigma_z})]}$$

TABLE 6.1
**Key to stability categories**

| Surface wind speed (at 10 m), m/s | Day: Incoming solar radiation: Strong | Day: Incoming solar radiation: Moderate | Day: Incoming solar radiation: Slight | Night: Thinly overcast or ≥ 4/8 cloud | Night: Clear or ≤ 3/8 cloud |
|---|---|---|---|---|---|
| 0–2 | A | A–B | B | — | — |
| 2–3 | A–B | B | C | E | F |
| 3–5 | B | B–C | C | D | E |
| 5–6 | C | C–D | D | D | D |
| ≥ 6 | C | D | D | D | D |

*Source:* Ref. 7.

*Note:* The neutral class D should be assumed for overcast conditions during day or night.

TABLE 9-14
**Values of $a$, $c$, $d$, and $f$ for calculating $\sigma_y$ and $\sigma_z$**

| Stability class | $a$ | $x \leq 1$ km: $c$ | $x \leq 1$ km: $d$ | $x \leq 1$ km: $f$ | $x > 1$ km: $c$ | $x > 1$ km: $d$ | $x > 1$ km: $f$ |
|---|---|---|---|---|---|---|---|
| A | 213 | 440.8 | 1.941 | 9.27 | 459.7 | 2.094 | −9.6 |
| B | 156 | 100.6 | 1.149 | 3.3 | 108.2 | 1.098 | 2 |
| C | 104 | 61 | 0.911 | 0 | 61 | 0.911 | 0 |
| D | 68 | 33.2 | 0.725 | −1.7 | 44.5 | 0.516 | −13.0 |
| E | 50.5 | 22.8 | 0.678 | −1.3 | 55.4 | 0.305 | −34.0 |
| F | 34 | 14.35 | 0.74.0 | −0.35 | 62.6 | 0.18 | −48.6 |

(*Source:* Martin, 1976.)

The concentration of $NO_2$ (in µg/m$^3$) at given distance is

24.85 ✗

One possible correct answer is: 15.344397910988

Your answer is incorrect.

**Question 7**

Incorrect

Mark 0.00 out of 5.00

On a clear summer afternoon with strong solar insolation and a wind speed of 3 m/s at surface, the particulate concentration was found to be 1100 µg/m$^3$ at a point 1.2 km downwind and 0.5 km perpendicular to the plume centerline from a coal-fired power plant with heat emission 50 MW. Given the following parameters and conditions, determine the effective plume rise (in m) and particulate emission rate (in kg/s) of the power plant. Assume the stability class B.

The coefficient a, c, d and f for stability class B are given below. Use the appropriate Briggs equations of plume rise.

a=156; c=108.2; d=1.098; f=2

F=33 $\frac{m^4}{s^3}$

**Stack parameters:**

Height =220 m
Diameter =1.50 m
Exit velocity = 12.0 m/s
Temperature= 322 ºC

**Atmospheric conditions:**
Pressure = 100.0 kPa
Temperature = 28.0 ºC

**Formulae**

$$x_f = 2.16F^{0.4}H_s^{0.6}$$

$$x_f = 674^{0.4}$$

$$C_{(x,y,z)} = \frac{Q}{2\pi\sigma_y\sigma_z u_z} exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right]\left\{exp\left[-\frac{1}{2}\left(\frac{z-H}{\sigma_z}\right)^2\right] + exp\left[-\frac{1}{2}\left(\frac{z+H}{\sigma_z}\right)^2\right]\right\}$$

- $\Delta H = \frac{v_s d_s}{U}\left[1.5 + 2.68 \times 10^{-2}(P)\left(\frac{T_s - T_a}{T_s}\right)d_s\right]$
- $\Delta H(in\ m) = \frac{1.6F^{1/3}x_f^{2/3}}{U}$

$$\Delta H = \frac{1.6F^{1/3}x_f^{2/3}}{U}\left[0.4 + 0.64\frac{x}{x_f} + 2.2\left(\frac{x}{x_f}\right)^2\right]\left(1 + 0.8\frac{x}{x_f}\right)^{-2}$$

$$\Delta H(in\ m) = 2.4\left(\frac{F}{US}\right)^{1/3}$$

$$S = \frac{g}{T_a}\left(\frac{\Delta T_a}{\Delta Z} + 0.01^{\circ}C/m\right)$$

- $F\left(in\ \frac{m^4}{s^3}\right) = gV_s r_s^2\left(\frac{T_s - T_a}{T_s}\right)$

The effective plume rise (in m) is **[Marks 2]** [Round off answer to two decimal place]

6.098 ✗

One possible correct answer is: 258.30519721851

The emission rate (in kg/s) is **[Marks 3]** [Round off answer to two decimal place]

0.26 ✗

One possible correct answer is: 2.6715137652352

Your answer is incorrect.

**Question 8**

Incorrect

Mark 0.00 out of 1.00

A pesticide plant is using baghouse filter for controlling particles of 1 µm diameter. How many number of bags will be required. The gas flow rate is 40 $m^3$/s if each bag is 15 cm in diameter and 13 m in length. One tenth of the bags are taken out of operation for cleaning. The manufacturer's recommended air to cloth ratio is 0.03 m/s. [Round off your answer to nearest whole number/integer]

1306 ✗

One possible correct answer is: 239

Your answer is incorrect.

**Question 9**

Incorrect

Mark 0.00 out of 2.00

Determine the face velocity (m/s) of gas through the adsorption bed and thickness (in m) of adsorption bed for the following system to ensure an $SO_2$ breakthrough time not less than 7 h?

Gas flow rate = 2.2 $m^3$/s

Gas temperature = 25.0 ºC

Gas pressure = 105.0 kPa

Flue gas density=1.1 kg/$m^3$

Bed density as packed = 390 kg/$m^3$

Inlet pollutant concentration = 4500 ppm

Langmuir parameters: a = 400; b = 900

Width of adsorption zone = 0.03 m

Bed diameter=3.0 m

**Formula:**

$$v_f = \frac{Q_g(1 + b * C)}{aA_c\rho_g\rho_s}$$

Face velocity (in m/s) × $10^{-5}$ **[Mark 1]** [Enter only value roundoff to one decimal place]

0.9 ✗

One possible correct answer is: 2.5081316225145

Thickness of adsorption bed (in m) **[Mark 1]** [Roundoff answer to 2 decimal place]

0.26 ✗

One possible correct answer is: 0.66204916887366

Your answer is incorrect.

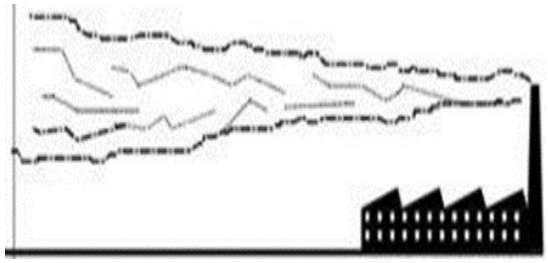
**Question 10**

Correct

Mark 2.00 out of 2.00

Match the following.

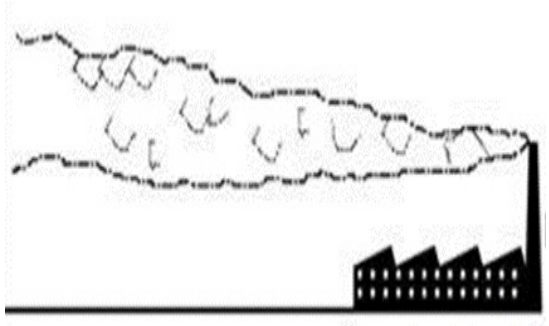
Entrainment zone in the atmosphere is a — Stable layer ✓

 — Week lapse ✓

ELR>DALR>MALR — Absolutely unstable ✓

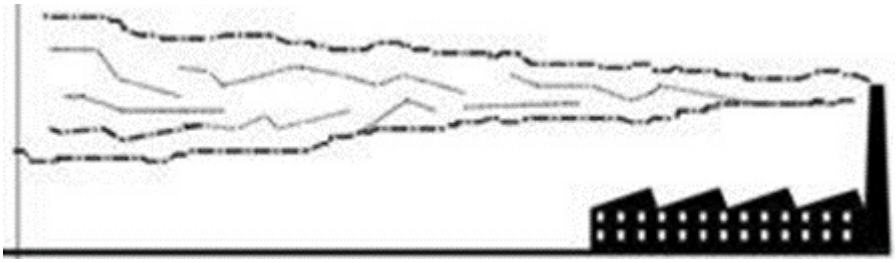
A stable layer after sunset is — Nocturnal boundary layer ✓

DALR>ELR>MALR — Conditionally unstable ✓

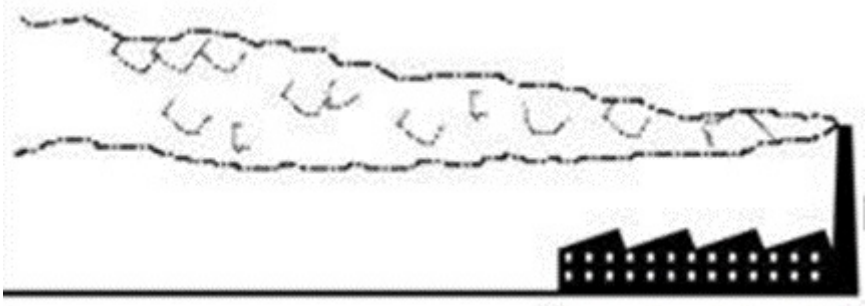
 — Lapse above and inversion below ✓

Your answer is correct.

The correct answer is: Entrainment zone in the atmosphere is a → Stable layer,

 → Week lapse,

ELR>DALR>MALR → Absolutely unstable, A stable layer after sunset is → Nocturnal boundary layer, DALR>ELR>MALR → Conditionally unstable,

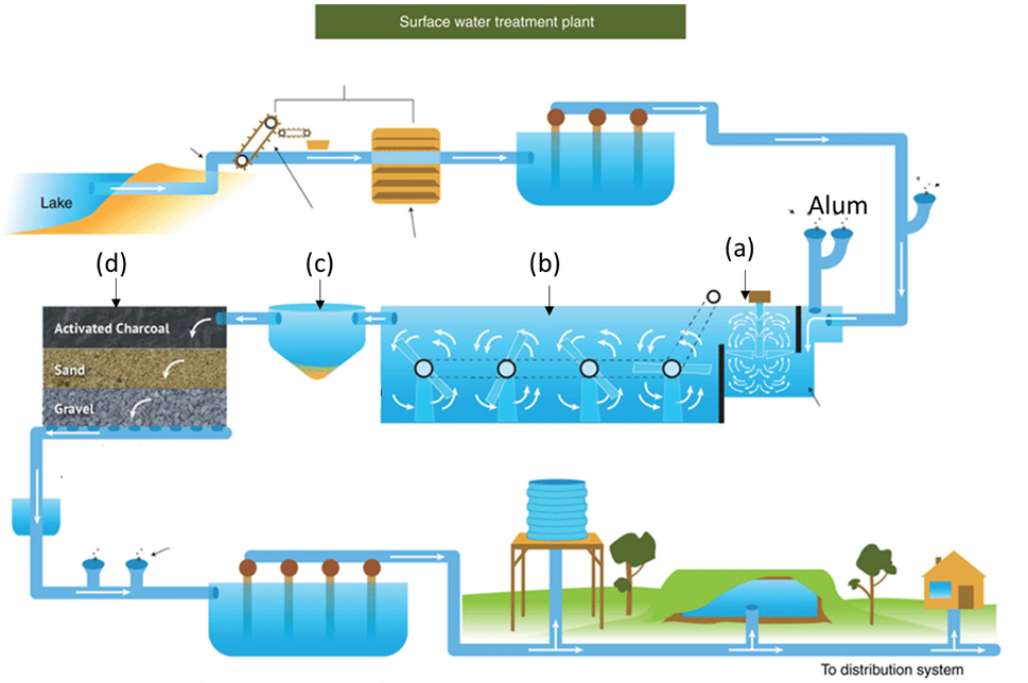
 → Lapse above and inversion below

**Question 11**

Correct

Mark 2.00 out of 2.00

**Label the treatment processes of the water treatment plant shown in the diagram.**




(d) Filtration ✓

(b) Flocculation ✓

(a) Coagulation ✓

(c) Sedimentation ✓

Your answer is correct.

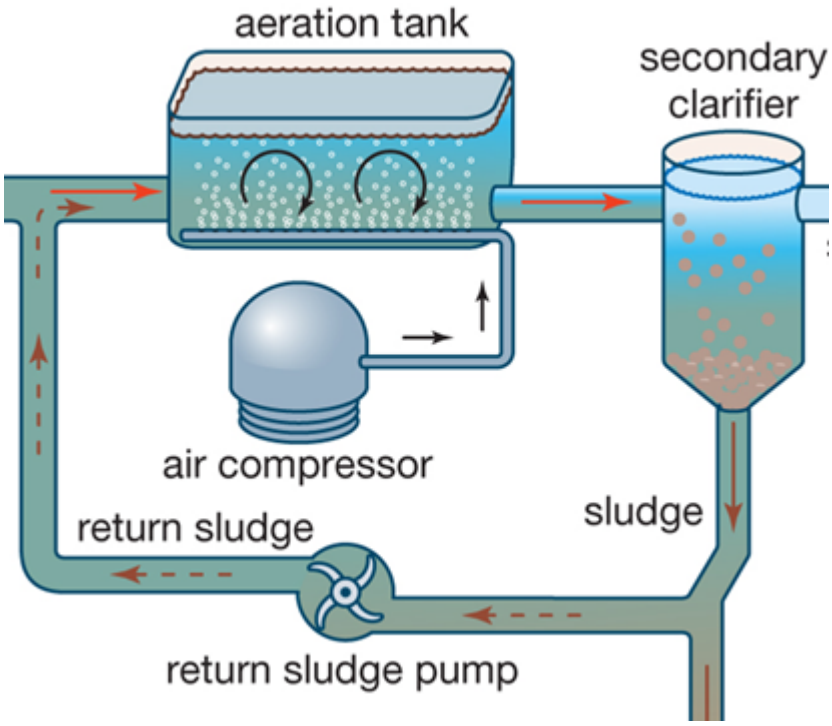
The correct answer is: (d) → Filtration, (b) → Flocculation, (a) → Coagulation, (c) → Sedimentation

**Question 12**

Correct

Mark 1.00 out of 1.00

**Identify the wastewater treatment unit shown in the diagram.**




Select one:

- a. Activated sludge process ✓
- b. Sequencing batch reactor
- c. Anaerobic digestion unit
- d. Oil and grease remover
- e. Upflow anaerobic sludge blanket reactor

Your answer is correct.

The correct answer is: Activated sludge process

**Question 13**

Incorrect

Mark 0.00 out of 1.00

**Which of the following treatment unit(s) do(es) NOT remove TDS? There is no partial marking.**

Select one or more:

- a. Reverse osmosis
- b. Distillation ✗
- c. Precipitation
- d. Lime-soda ash process

Your answer is incorrect.

The correct answers are: Lime-soda ash process, Precipitation

**Question 14**

Correct

Mark 1.00 out of 1.00

**Select the unit(s) used for sludge treatment in a wastewater treatment plant. There is no partial marking.**

Select one or more:

- [ ] a. Trickling filter
- [x] b. Anaerobic digester ✓
- [ ] c. Grit chamber
- [ ] d. Sequencing batch reactor

Your answer is correct.

The correct answer is: Anaerobic digester

◄ Quiz 3

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