

PE Environmental Practice Problems

March 1, 2019 Errata

CHAPTER 1

Solution 3 (clarification)

Add middot between “ms” in denominator of last equation.

Problem 4

Water is impounded to a depth of 27 m behind a concrete dam. The face of the dam exposed to the water is vertical. Most nearly, what is the force of the water on the dam and what distance below the water line is the resultant force located?

- (A) 27 kN at 9 m
- (B) 47 kN at 27 m
- (C) 88 kN at 18 m
- (D) 270 kN at 18 m

Solution 4

Calculate the hydrostatic pressure on a vertical plane surface.

p = pressure, kN

ρ = density of water, 1000 kg/m³

g = acceleration of gravity, 9.81 m/s²

h = water depth, 27 m

$$\begin{aligned} p &= \frac{1}{2} \rho g (h_1 + h_2) \\ &= \left(\frac{1}{2} \right) \left(1000 \frac{\text{kg}}{\text{m}^3} \right) \left(9.81 \frac{\text{m}}{\text{s}^2} \right) (0 \text{ m} + 27 \text{ m}) \left(\frac{1 \text{ kN}}{1000 \frac{\text{kg} \cdot \text{m}}{\text{s}^2}} \right) \\ &= 132.5 \frac{\text{kN}}{\text{m}^2} \end{aligned}$$

Calculate the force acting on 1 m of width.

$$F = pA = \left(132.5 \frac{\text{kN}}{\text{m}^2} \right) (1 \text{ m}) (27 \text{ m}) = 3578 \text{ kN} \quad (3600 \text{ kN})$$

Calculate the location below the water surface of the resultant force.

h_R = location below water surface of resultant force, m

The answer is (D).

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CHAPTER 2

Problem 3

A tank is 3 m long and 3 m wide with a water depth of 3.5 m above the discharge outlet. The discharge outlet has a protruding pipe entrance with a 75 mm diameter. How much time is required to decrease the water depth to 0.5 m above the discharge outlet?

- (A) 0.76 min
- (B) 2.0 min
- (C) 22 min
- (D) 34 min

Solution 3

A_t = tank cross-sectional area, m²

$$A_t = (3 \text{ m})(3 \text{ m}) = 9 \text{ m}^2$$

D_o = discharge outlet diameter, 75 mm

A_o = discharge outlet area, m²

$$A_o = \frac{\pi D_o^2}{4} = \frac{\pi (75 \text{ mm})^2 \left(10^{-3} \frac{\text{m}}{\text{mm}}\right)^2}{4} = 0.0044 \text{ m}^2$$

[NCEES – Minor Losses in Pipe Fittings, Contractions, and Expansions]

C_d = coefficient of discharge, 0.8

t = time to empty tank, min

z = water depth at beginning and end, 3.5 m, 0.5 m

g = acceleration of gravity, 9.81 m/s²

$$\begin{aligned} t &= \frac{2A_t(\sqrt{z_1} - \sqrt{z_2})}{C_d A_o \sqrt{2g}} \\ &= \frac{(2)(9 \text{ m}^2)(\sqrt{3.5 \text{ m}} - \sqrt{0.5 \text{ m}})}{(0.8)(0.0044 \text{ m}^2) \sqrt{(2)\left(9.81 \frac{\text{m}}{\text{s}^2}\right)\left(60 \frac{\text{s}}{\text{min}}\right)}} \\ &= 22 \text{ min} \end{aligned}$$

The answer is (C).

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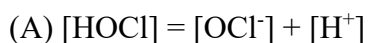
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CHAPTER 3

Problem 2

Replace entire problem statement with:

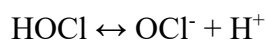
Chlorine gas reacts with water to form hypochlorous acid (HOCl). Which of the following statements is true regarding the dissociation of HOCl in water at equilibrium?



Solution 2

Replace entire problem solution with:

The equilibrium equation for the dissociation of HOCl is



At equilibrium, $[\text{OCl}^-] = [\text{H}^+]$

The answer is (D).

CHAPTER 5

Solution 8

Replace “1.18” with “1.22” in final equation result.

CHAPTER 7

Solution 8 (clarification)

In first sentence replace “an unconfined” with “a confined”.

Problem 12

Replace answer options with:

(A) 5.6 min

(B) 18 min

(C) 26 min

(D) 47 min

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Solution 12

In first sentence and in first calculation, replace “36 cm/hr” with “14 cm/hr”.

In first and last calculation, replace “14.17 in/hr” with “5.51 in/hr”.

In answer to last calculation, replace “34 min” with “18 min”.

CHAPTER 8

Problem 3

For answer option (D), after “together or” insert “I,”.

Solution 3

After “filter the water or” insert “disinfect and”.

CHAPTER 10

Solution 6 (clarification)

Note: Solution is correct as printed in the book.

Replace calculation with

$$\begin{aligned}\theta &= \frac{\theta_c^d Y (N_0 - N_e)}{X_N (1 + \theta_c^d k_d)} \\ X_N &= (0.17) \left(3200 \frac{\text{mg}}{\text{L}} \right) = 544 \text{ mg/L} \\ \theta_c^d &= (130 \text{ h}) \left(\frac{1 \text{ d}}{24 \text{ h}} \right) = 5.42 \text{ d} \\ \theta &= \frac{(5.42 \text{ d}) \left(0.2 \frac{\text{g}}{\text{g}} \right) \left(112 \frac{\text{mg}}{\text{L}} - 5 \frac{\text{mg}}{\text{L}} \right) \left(24 \frac{\text{h}}{\text{d}} \right)}{\left(544 \frac{\text{mg}}{\text{L}} \right) (1 + (5.42 \text{ d})(0.045 \text{ d}^{-1}))} \\ &= 4.1 \text{ h} \quad (4.0 \text{ h})\end{aligned}$$

Problem 18

In third sentence, replace “factor” with “ratio”.

Solution 18

In first sentence and in definition table, replace “factor” with “ratio”.

In definition table and calculation, replace “*F*” with “*R*”.

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CHAPTER 11

Problem 4

In fourth sentence replace “pressure” with “temperature”.

CHAPTER 12

Solution 2

In final calculation replace “ $((100^{\circ}\text{C} - 20^{\circ}\text{C}) + 273^{\circ})$ ” with “ $((100^{\circ}\text{C} + 273^{\circ}) - (20^{\circ}\text{C} + 273^{\circ}))$ ”.

In final answer, replace “ 3×10^8 ” with “ 7×10^7 ”.

In “*The answer is*”, replace “**D**” with “**B**”.

CHAPTER 15

Solution 3 (clarification)

Replace “total” with “average” in the first sentence.

Solution 5 Solution (clarification)

In first calculation, replace $\frac{1.04 \text{ m}^2}{2.76 \text{ m}}$ with “0.38 m”.

Solution 6

In calculation, replace “QA” with “Q/A”.

CHAPTER 17

Problem 5

Change second sentence to “...1.0 m diameter tanks with a total daily media volume...”

Problem 15

Change the fifth sentence to “The inlet velocity gradient is 40/s and the outlet velocity gradient is 20/s.”

Solution 16 (clarification)

Note: Solution is correct as printed in the book.

Add the following clarifying text at the beginning of the solution: “The flocculation tank depth matches the sedimentation basin depth of 3.5 m. Paddles rotating perpendicular to flow turn in a cross section of 3.5 m x 3.5 m. The standard clearance between the paddle tip and the sides and bottom of the flocculation tank is 0.3 m.”

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CHAPTER 19

Problem 3

In second sentence, replace “65%” with “35%”.

In last sentence, insert “thickening and” before “dewatering”.

CHAPTER 22

Problem 3

Replace the first and second sentences in the problem statement with:

“A raindrop falls at a velocity of 4.6 m/s. The raindrop diameter remains constant but the fall velocity increases to 5.2 m/s.”

CHAPTER 23

Problem 7

In the table under the concentration heading, replace ‘0.21’ with “0.021”.

Solution 7

In calculation for I_{O_3} , replace “210” with “21” and “194” with “19”.

Replace the last sentence with “Carbon monoxide has the highest AQI value at 101.”

Change the correct answer option from “A” to “B”.

Problem 8

In the table under the concentration heading, replace ‘0.21’ with “0.021”.

Change answer option (B) from “121” to “101”.

Solution 8

In calculation for I_{O_3} , replace “210” with “21” and “194” with “19”.

Replace the last two sentences with “The highest AQI value is for carbon monoxide at 101. Therefore, the AQI value for the day is 101.”

The correct answer option is “B”, not “C”.

Problem 9

In the table under the concentration heading, replace ‘0.21’ with “0.021”.

Change B, C, and D answer options to:

(B) unhealthy for sensitive groups

(C) unhealthy

(D) very unhealthy

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Solution 9

In calculation for I_{O_3} , replace “210” with “21” and “194” with “19”.

Replace the last sentence with “The highest AQI value is 101, so the descriptor is ‘unhealthy for sensitive groups.’”

CHAPTER 25

Solution 2 (clarification)

In calculation, replace “total pressure, atm” with “1.0 atm”.

Problem 10

Change the first sentence to “...the mass of water vapor in 100 kg of dry air at 1 atm and 20°C?”

Solution 10

In second calculation, replace “0.0146” with “0.0146 g water vapor/g dry air”.

Delete “kg” and “g” from m_a and m_v definitions.

Inside parentheses in last calculation, units for 0.0146 should be g/g.

CHAPTER 26

Problem 6

Delete “0.18 ppmv and” from the first sentence.

Replace the third sentence with “The SO_2 concentration in the air at the stack is $380 \text{ g}/10^6 \text{ m}^3$.”

Solution 6

Delete “(given at SO_2 concentration of 0.18 ppmv)”

Replace the sentence before the last calculation with “The SO_2 concentration in the air at 18°C is”

CHAPTER 27

Problem 2

In the second sentence, replace “4.6 m/s” with “6.1 m/s”.

Solution 2

In paragraph following first calculation, delete “location of maximum ground level concentration” and replace with “standard deviation”.

Problem 3

Change answer option (A) to from 2.2×10^4 to “ 5.5×10^3 ”.

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Solution 3

In second and third paragraphs, replace “ $x = 400 \text{ m}$ ” with “ $x = 18 \text{ km}$ ”.

In third paragraph, replace “ $\sigma_y = 25 \text{ m}$ ” with “ $\sigma_y = 100 \text{ m}$ ”.

In last calculation replace “ 25 m ” with “ 100 m ” and “ 2.2×10^4 ” with “ 5.5×10^3 ”.

Problem 8

Delete “neutral to” from fourth sentence.

Solution 8

Delete “neutral to” from first paragraph.

Problem 11

Delete “neutral to” from third sentence.

In the last sentence, after “concentration” insert “downwind of the power plant”.

Solution 11

In definition of terms, delete “downwind distance, x ”.

Delete “neutral to” from paragraph after calculation.

Problem 13

Delete “neutral to” from fourth sentence.

Solution 13

Delete “neutral to” from first paragraph.

Problem 14

Delete “neutral to” third fourth sentence.

Solution 14

Delete “neutral to” from first paragraph.

CHAPTER 30

Solution 4

Replace first sentence after first calculation with “1 mol of HCl gas at 25°C occupies 24.5 L.”

In second calculation, replace “22.4” with “24.5” and “1.29” with “1.18”.

In third calculation, replace “1.29” with “1.18” and “1003” with “918”. Leave parenthetical as “(1000 kg/d)”.

Problem 6

In table, replace “daily mass HCl removed” with “daily mass dry lime”.

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Problem 19

Replace the last sentence with “The mass of carbon dioxide that will be emitted by the automobile in 1 week is most nearly”

Solution 25 (clarification)

In sentence after “Fabric Filtration” reference, change “60 s/m” to “60 s/min”.

Problem 26

For answer option (B), replace “33” with “6”.

Solution 26

In first table and in final calculation, for W , replace 1.12 with 0.12.

In second table and in final calculation, for air density, replace 1.644 with 1.1644.

In final calculation, replace 0.000042 with 0.000006 (both places) and replace 42 with 6.

In the final calculation, the term “ 1.865×10^{-5} ” should have units of “kg/m.s”.

Replace “The answer is (C).” with “The answer is (B).”

CHAPTER 40

Problem 13

Change answer option (B) from “ 2.1×10^6 ” to “ 2.4×10^6 ” and change answer option (C) from “ 2.4×10^6 ” to “ 3.1×10^6 ”.

CHAPTER 42

Solution 8 (clarification)

The last term in the calculation should be $\left(\frac{32 \text{ g O}_2}{12 \text{ g C}} \right)$

CHAPTER 45

Problem 3

Change the value for answer option (B) from “2.0” to “1.5”.

Solution 3

In first paragraph after first calculation, replace NCEES reference with [\[Properties of Water\]](#).

In table of parameters, for dynamic viscosity change “ 1.00×10^{-3} ” to “ 1.41×10^{-3} ” and “0.00067” to “0.00094”.

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In the second calculation, replace “0.00067” with “0.00094” and “0.029” with “0.020”.

In the last calculation, replace “0.029” with “0.020” and “2.0 ft/day” with “1.44 ft/day (1.5 ft/day)”.

CHAPTER 46

Problem 8

After second sentence add “The soil organic carbon fraction is 148 mg/kg.”

CHAPTER 48

Problem 6

In the second to the last sentence replace “administered” with “absorbed”.

Solution 9

In definition of terms replace “EF = exposure frequency (assume 100%)” with “exposure frequency

$$= \frac{350 \frac{\text{days}}{\text{yr}}}{365 \frac{\text{days}}{\text{yr}}} = 0.96$$

In calculation for CDI, replace “1” with “0.96” and replace “0.00348” with “0.00334”.

In calculation for HI, replace “0.00348” with “0.00334” and replace “3.48 (3.5)” with “3.3”

In the last paragraph, replace “3.5” with “3.3”.

Solution 10

In definition of terms replace “EF = exposure frequency (assume 100%)” with “exposure frequency

$$= \frac{350 \frac{\text{days}}{\text{yr}}}{365 \frac{\text{days}}{\text{yr}}} = 0.96$$

In calculation for CDI, replace “1” with “0.96” and replace “0.0543” with “0.0521”.

In calculation for HI, replace “0.0543” with “0.0521” and replace “0.905 (0.9)” with “0.868 (9.0)”.

Problem 11

In the sentence after the table, insert “female” before “adult”.

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Problem 12

Replace “commonly applied” with “EPA”. For answer options (A) and (D), replace “1 million” with “10,000”.

Solution 12

Replace the first sentence with “The EPA considers an acceptable risk for carcinogens to be within the range of 10^{-4} (1 in 10,000) to 10^{-6} (1 in 1 million)”. Replace “ 1×10^6 ” with “ 1×10^4 ”. Leave “ 4.7×10^4 ” and “2200” unchanged. [[NCEES Handbook - Carcinogens](#)]

CHAPTER 49

Problem 3

In the fourth sentence, replace “ 10^{-3} ” with “ 10^{-13} ”.

Solution 16

Sentence should read “Substitute K_{La} for k .”

CHAPTER 56

Solution 8

First sentence, replace “air” with “water”.

Calculation for herbicide 2, replace “46%” with “44%” in the numerator.

CHAPTER 57

Problem 8

Delete “and intensity” from the second sentence.

Solution 8

After “use” in the second sentence delete “this equation” and insert “a form of this equation modified for sound power”.

In the calculation, replace “SPL” with “ L_W ” and replace “ P ” and “ P_0 ” with “ W ” and “ W_0 ”.

Problem 9

Delete the second sentence.

Solution 9

In the calculation, replace “ P ” with “ W ” (two places).

Problem 10

In the second sentence, delete “power and” and change the “ W ” to “ W/m^2 ”.

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Solution 10

After “use” in the second sentence delete “this equation” and insert “a form of this equation modified for sound intensity”.

In the second sentence, change “W” to “W/m²”.

Problem 11

Change answer option (C) from “7 yr” to “8 yr”.

CHAPTER 59

Problem 2

Replace “top three positions” in in first sentence with “first, second, and third place”.

Problem 5

Insert “or” after “they will be a resident,” in third sentence.

Solution 14

The second term in the equation should be “...+ (277 – 332)²(0.5) +...”

CHAPTER 62

Solution 2

In the calculation, replace “22.1806” with “19.8416” and “\$1,794,001” with “\$1,786,980”.

CHAPTER 65

Solution 2

In first sentence, replace “guidance in” with “guidance is”.