NONE

Collection System Math - Practice Problems
Answer Key

The Division of Water Quality
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PRACTICE PROBLEMS 8.1: Wet Well Capacity

1. What is the gallon capacity of a wet well 10 ft long, 10 ft wide, and 8 ft deep?

Volume = (10 ft)(10 ft)(8 ft)

Volume = $(800\ ft^3)(7.48\ \frac{gal}{ft^3})$

ANS 5,984 gals

2. A wet well is 12 ft long, 10 ft wide, and contains water to a depth of 6 ft. How many gallons of water does it contain?

Volume = (12 ft)(10 ft)(6 ft)

Volume = $(720\ ft^3)(7.48\ \frac{gal}{ft^3})$

ANS 5,386 gals

3. What is the cubic feet capacity of a wet well 8 ft by 8 ft with a maximum depth of 6 ft?

Volume = (8 ft)(8 ft)(6 ft)

ANS 384 ft^3

4. The maximum capacity of a wet well is 4787 gallons. If the wet well is 10 ft long and 8 ft wide, what is the maximum depth of water in the wet well?

$$\text{Volume} = \frac{4{,}787 \text{ gal}}{7.48 \frac{\text{gal}}{\text{ft}^3}}$$

$$\text{Volume} = 640 \text{ ft}^3$$

$$\text{Depth} = \frac{640 \text{ ft}^3}{(10 \text{ ft})(8 \text{ ft})}$$

ANS 8 ft

5. A wet well is 8 ft long and 6 ft wide. If the wet well contains water to a depth of 2.8 ft, what is the volume of water in the wet well, in gallons?

$$\text{Volume} = (8 \text{ ft})(6 \text{ ft})(2.8 \text{ ft})$$

$$\text{Volume} = (134.4 \text{ ft}^3)\left(7.48 \frac{\text{gal}}{\text{ft}^3}\right)$$

ANS 1,005 gal

PRACTICE PROBLEMS 8.2: Wet Well Pumping Rate

1. A wet well is 8 ft by 8 ft. During a 5-minute pumping test, with no influent to the well, a pump lowers the water level 1.6 ft. What is the pumping rate in gpm?

$$\text{Volume} = (8\text{ ft})(8\text{ ft})(1.6\text{ ft})$$

$$\text{Volume} = (102.4\text{ ft}^3)\left(7.48\ \frac{\text{gal}}{\text{ft}^3}\right)$$

$$\text{Rate} = \frac{766\text{ gal}}{5\text{ min}}$$

ANS 153 gpm

2. A wet well is 10 ft by 12 ft. During a 3-minute pumping test, a pump lowers the water level 1.1 ft. What is the gpm pumping rate? (Assume no influent to the well during the pumping test.)

$$\text{Volume} = (10\text{ ft})(12\text{ ft})(1.1\text{ ft})$$

$$\text{Volume} = (132\text{ ft}^3)\left(7.48\ \frac{\text{gal}}{\text{ft}^3}\right)$$

$$\text{Rate} = \frac{987\text{ gal}}{3\text{ min}}$$

ANS 329 gpm

3. The water level in a wet well drops 19 inches during a 3-minute pumping test. There was no influent to the wet well during the pumping test. If the wet well is 8 ft by 6 ft, what is the pumping rate in gpm?

$$\text{Volume} = (8\text{ ft})(6\text{ ft})\left(\frac{19\text{ inches}}{12\text{ in/ft}}\right)$$

$$\text{Volume} = (76\text{ ft}^3)\left(7.48\ \frac{\text{gal}}{\text{ft}^3}\right)$$

$$\text{Rate} = \frac{568\text{ gal}}{3\text{ min}}$$

ANS 189 gpm

4. During a period when there is no pumping from the wet well, the water level rises 0.7 ft in one minute. If the wet well is 8 ft long and 7 ft wide, what is the gpm flow rate of wastewater entering the wet well?

$$\text{Rate} = (8\ \text{ft})(7\ \text{ft})\left(0.7\ \frac{\text{ft}}{\text{min}}\right)$$

$$\text{Rate} = \left(39.2\ \frac{\text{ft}^3}{\text{min}}\right)\left(7.48\ \frac{\text{gal}}{\text{ft}^3}\right)$$

ANS 293 gpm

PRACTICE PROBLEMS 8.3: Screenings Removed

1. A total of 62 gallons of screenings are removed from the wastewater flow during a 24-hour period. What is the screenings removal reported as cu ft/day? (Round to the nearest tenth.)

$$\text{Rate} = \frac{62 \frac{\text{gal}}{\text{day}}}{7.48 \frac{\text{gal}}{\text{ft}^3}}$$

ANS 8.3 $\frac{\text{ft}^3}{\text{day}}$

2. During one week a total of 271 gallons of screenings were removed from the wastewater screens. What was the average screenings removal in cu ft/day? (Round to the nearest tenth.)

$$\text{Rate} = \frac{271 \frac{\text{gal}}{\text{wk}}}{7.48 \frac{\text{gal}}{\text{ft}^3} \cdot 7 \frac{\text{day}}{\text{wk}}}$$

ANS 5.2 $\frac{\text{ft}^3}{\text{day}}$

3. The flow at a treatment plant is 2.72 MGD. If a total of 4.7 cu ft of screenings are removed during a 24-hour period, what is the screenings removal reported as cu ft/MG? (Round to the nearest tenth.)

$$\text{Rate} = \frac{4.7 \frac{\text{ft}^3}{\text{day}}}{2.72 \frac{\text{MG}}{\text{day}}}$$

ANS 1.7 $\frac{\text{ft}^3}{\text{MG}}$

4. On a particular day, a treatment plant receives a flow of 4.6 MGD. If 78 gallons of screenings are removed that day, what is the screenings removal expressed as cu ft/MG? (Round to the nearest tenth.)

$$\text{Rate} = \frac{78 \ \frac{\text{gal}}{\text{day}}}{7.48 \ \frac{\text{gal}}{\text{ft}^3} \cdot 4.6 \ \frac{\text{MG}}{\text{day}}}$$

ANS 2.3 $\frac{\text{ft}^3}{\text{MG}}$

5. A total of 45 gallons of screenings are removed from the treatment plant during a 24-hour period. If the treatment plant received a flow of 2,170,000 gpd, what is the screenings removal expressed as cu ft/MG? (Round to the nearest tenth.)

$$\text{Rate} = \frac{45 \ \frac{\text{gal}}{\text{day}}}{\left(7.48 \ \frac{\text{gal}}{\text{ft}^3}\right)\left(\frac{2{,}170{,}000 \ \frac{\text{gal}}{\text{day}}}{1{,}000{,}000 \ \frac{\text{gal}}{\text{MG}}}\right)}$$

ANS 2.8 $\frac{\text{ft}^3}{\text{MG}}$

PRACTICE PROBLEMS 8.4: Screenings Pit Capacity

1. A screenings pit has a capacity of 500 cu ft. (The pit is actually larger than 500 cu ft to accommodate soil for covering.) If an average of 2.8 cu ft of screenings are removed daily from the wastewater flow, in how many days will the pit be full?

$$\text{Days} = \frac{500 \text{ ft}^3}{2.8 \frac{\text{ft}^3}{\text{day}}}$$

ANS 179 days

2. A screenings pit has a capacity of 8 cu yds available for screenings. If the plant removes an average of 1.4 cu ft of screenings per day, in how many days will the pit be filled?

$$\text{Days} = \frac{8 \text{ yd}^3 \cdot 27 \frac{\text{ft}^3}{\text{yd}^3}}{1.4 \frac{\text{ft}^3}{\text{day}}}$$

ANS 154 days

3. A plant has been averaging a screenings removal of 2.1 cu ft/MG. If the average daily flow is 2.7 MGD, how many days will it take to fill a screenings pit with an available capacity of 290 cu ft?

$$\text{Rate} = (2.1 \frac{\text{ft}^3}{\text{MG}})(2.7 \frac{\text{MG}}{\text{day}})$$

$$\text{Days} = \frac{290 \text{ ft}^3}{5.7 \frac{\text{ft}^3}{\text{day}}}$$

ANS 51 days

4. Suppose you want to use a screenings pit for 120 days. If the screenings removal rate is 3.4 cu ft/day, what is the required screenings pit capacity in cu ft? (Calculate only the capacity for screenings. An additional capacity will be required for cover material.)

$$\text{Volume} = \left(3.4 \frac{ft^3}{day}\right) \cdot (120\ day)$$

ANS 408 ft^3

PRACTICE PROBLEMS 8.5: Grit Channel Velocity

1. A grit channel is 3 ft wide, with water flowing to a depth of 19 inches. If the flow meter indicates a flow rate of 1750 gpm, what is the velocity of flow through the channel in ft/sec? (Round to the nearest tenth.)

$$\text{Area} = (3\text{ ft})\left(\frac{19\text{ inches}}{12\text{ in/ft}}\right)$$

$$\text{Rate} = \frac{1{,}750\ \frac{\text{gal}}{\text{min}}}{\left(7.48\ \frac{\text{gal}}{\text{ft}^3}\right)\cdot\left(60\ \frac{\text{s}}{\text{min}}\right)}$$

$$\text{Velocity} = \frac{3.9\ \frac{\text{ft}^3}{\text{s}}}{4.75\ \text{ft}^2}$$

ANS 0.8 $\frac{\text{ft}}{\text{s}}$

2. A stick in a grit channel travels 25 ft in 31 seconds. What is the estimated velocity in the channel in ft/sec? (Round to the nearest tenth.)

$$\text{Velocity} = \frac{25\text{ ft}}{31\text{ sec}}$$

ANS 0.8 $\frac{\text{ft}}{\text{s}}$

3. The total flow through both channels of a grit channel is 4.1 cfs. If each channel is 2 ft wide and water is flowing to a depth of 13 inches, what is the velocity of flow through the channel in ft/sec? (Round to the nearest tenth.)

$$\text{Area} = (2)(2\text{ft})\left(\frac{13\text{ inches}}{12\text{ in/ft}}\right)$$

$$\text{Rate} = 4.1\ \frac{\text{ft}^3}{\text{s}}$$

$$\text{Velocity} = \frac{4.1\ \frac{\text{ft}^3}{\text{s}}}{4.33\ \text{ft}^2}$$

ANS 0.9 $\frac{\text{ft}}{\text{s}}$

4. A stick is placed in a grit channel and flows 35 ft in 31 seconds. What is the estimated velocity in the channel in ft/sec? (Round to the nearest tenth.)

$$\text{Velocity} = \frac{35 \text{ ft}}{31 \text{ sec}}$$

ANS 1.1 $\frac{\text{ft}}{\text{s}}$

5. The depth of water in a grit channel is 15 inches. The channel is 32 inches wide. If the flow meter indicates a flow of 1120 gpm, what is the velocity of flow through the channel in ft/sec? (Round to the nearest tenth.)

$$\text{Area} = \left(\frac{15 \text{ inches}}{12 \text{ in/ft}}\right)\left(\frac{32 \text{ inches}}{12 \text{ in/ft}}\right)$$

$$\text{Rate} = \frac{1{,}120 \frac{\text{gal}}{\text{min}}}{\left(7.48 \frac{\text{gal}}{\text{ft}^3}\right)\left(60 \frac{\text{s}}{\text{min}}\right)}$$

$$\text{Velocity} = \frac{2.50 \frac{\text{ft}^3}{\text{s}}}{3.33 \text{ ft}^2}$$

ANS 0.7 $\frac{\text{ft}}{\text{s}}$

PRACTICE PROBLEMS 8.6: Grit Removal

1. A treatment plant removes 11 cu ft of grit in one day. If the plant flow was 7 MGD, what is this removal expressed as cu ft/MG?

$$\text{Rate} = \frac{11 \ \frac{ft^3}{day}}{7 \ \frac{MG}{day}}$$

ANS 1.6 $\frac{ft^3}{MG}$

2. The total daily grit removal for a plant is 240 gallons. If the plant flow is 10.3 MGD, how many cubic feet of grit are removed per MG flow? (Round to the nearest tenth.)

$$\text{Rate} = \frac{240 \ \frac{gal}{day}}{7.48 \ \frac{gal}{ft^3}}$$

$$\text{Rate} = \frac{32.09 \ \frac{ft^3}{day}}{10.3 \ \frac{MG}{day}}$$

ANS 3.1 $\frac{ft^3}{MG}$

3. The average grit removal at a particular treatment plant is 2.8 cu ft/MG. If the monthly average daily flow is 3.6 MGD, how many cu yds of grit would be removed from the wastewater flow during one month? (Assume the month has 30 days.)

$$\text{Rate} = (2.8 \ \frac{ft^3}{MG})(3.6 \ \frac{MG}{day})$$

$$\text{Volume} = (10.08 \ \frac{ft^3}{day})(30 \ day)$$

$$\text{Volume} = \frac{302.4 \ ft^3}{27 \ \frac{ft^3}{yd^3}}$$

ANS 11.2 yd^3

4. The monthly average grit removal is 2.1 cu ft/MG. If the average daily flow for the month is 4,120,000 gpd, how many cu yds must be available for grit disposal if the disposal pit is to have a 90-day capacity? (Calculate only the volume required for grit, not cover material.)

$$\text{Rate} = 2.1 \ \frac{ft^3}{MG}$$

$$\text{Volume} = \left(2.1 \ \frac{ft}{MG}\right) \cdot \left(\frac{4{,}120{,}000 \ \frac{gal}{day}}{1{,}000{,}000 \ \frac{gal}{MG}}\right) (90 \ day)$$

$$\text{Volume} = \frac{778.68 \ ft^3}{27 \ \frac{ft^3}{yd^3}}$$

ANS 29 yd^3

PRACTICE PROBLEMS 8.7: Flow Measurement

1. A grit channel 2.5 ft wide has water flowing to a depth of 15 inches. If the velocity through the channel is 0.9 fps, what is the cfs flow rate through the channel? (Round to the nearest tenth.)

$$\text{Area} = (2.5\ \text{ft})\left(\frac{15\ \text{inches}}{12\ \text{in/ft}}\right)$$

$$\text{Velocity} = (3.1\ \text{ft}^2)\left(0.9\ \frac{\text{ft}}{\text{s}}\right)$$

ANS 2.8 $\frac{\text{ft}^3}{\text{s}}$

2. A grit channel 2 ft wide has water flowing at a velocity of 1.2 fps. If the depth of water is 16 inches, what is the gpd flow rate through the channel? (Assume the flow is steady and continuous.)

$$\text{Area} = (2\ \text{ft})\left(\frac{16\ \text{inches}}{12\ \text{in/ft}}\right)$$

$$\text{Velocity} = (2.7\ \text{ft}^2)\left(1.2\ \frac{\text{ft}}{\text{s}}\right)\left(7.48\ \frac{\text{gal}}{\text{ft}^3}\right)$$

$$\text{Velocity} = (23.9\ \frac{\text{gal}}{\text{s}})(60\ \frac{\text{s}}{\text{min}})(1440\ \frac{\text{min}}{\text{day}})$$ ANS 2,068,070 gpd

3. A grit channel 34 inches wide has water flowing to a depth of 9 inches. If the velocity of the water is 0.85 fps, what is the cfs flow in the channel? (Round to the nearest tenth.)

$$\text{Area} = \left(\frac{34\ \text{inches}}{12\ \text{in/ft}}\right)\left(\frac{9\ \text{inches}}{12\ \text{in/ft}}\right)$$

$$\text{Velocity} = (2.1\ \text{ft}^2)\left(0.85\ \frac{\text{ft}}{\text{s}}\right)$$

ANS 1.8 $\frac{\text{ft}^3}{\text{s}}$

4. Using the table given below, determine the cfs flow rate through a rectangular weir with end contractions if the feet of head indicated at the staff gage is 0.12 ft and the length of the weir crest is 2 ft.

Head ft	LENGTH OF WEIR CREST IN FEET					
	1		1-1/2		2	
	cfs	MGD	cfs	MGD	cfs	MGD
0.11	.119	.077	.178	.116	.241	.155
0.12	.135	.087	.204	.132	.273	.177
0.13	.152	.098	.230	.149	.308	.199
0.14	.169	.110	.256	.166	.343	.222

ANS 0.273 $\frac{\text{ft}^3}{\text{s}}$

DISCHARGE OF 6-INCH PARSHALL FLUME							
Head ft	cfs	gps	MGD	Head ft	cfs	gps	MGD
0.31	.3238	2.422	.2092	0.41	.5036	3.767	.3255
0.32	.3404	2.547	.2200	0.42	.5231	3.913	.3381
0.33	.3574	2.673	.2310	0.43	.5429	4.062	.3509
0.34	.3746	2.803	.2421	0.44	.5630	4.212	.3639
0.35	.3922	2.934	.2535	0.45	.5834	4.364	.3770
0.36	.4100	3.068	.2650	0.46	.6040	4.518	.3904
0.37	.4282	3.203	.2767	0.47	.6249	4.675	.4038
0.38	.4466	3.341	.2886	0.48	.6460	4.833	.4175
0.39	.4653	3.481	.3007	0.49	.6674	4.993	.4313
0.40	.4843	3.623	.3130	0.50	.6890	5.155	.4453

5. The head measured at the upstream gage on a 6-inch Parshall flume is 0.33 ft. What is the MGD flow through the channel? (Assume there are no submergence conditions in the channel.)

ANS 0.2310 MGD

6. What is the cfs flow through a 6-inch Parshall flume if the upstream gage indicates a depth of 0.39 ft? (Assume no submergence condition exists.)

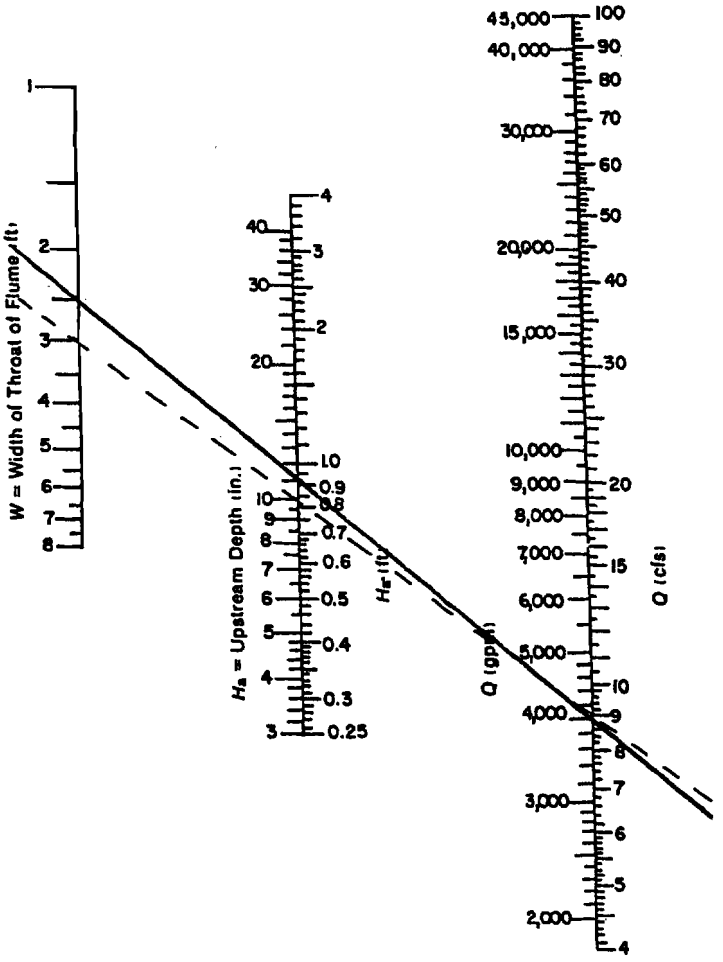
ANS 0.4653 $\frac{ft^3}{s}$

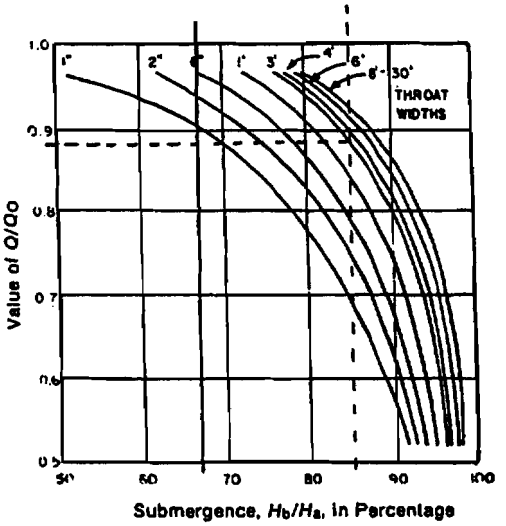
7. The head measured at the upstream gage of a 6-inch Parshall flume is 0.48 ft. What is the gpm flow through the flume? (Assume no submergence condition exists.)

Rate = $(4.833\ \frac{gal}{s}) \cdot (60\ \frac{s}{min})$

ANS 290 gpm

PRACTICE PROBLEMS 8.7: Flow Measurement Calculations Cont'd





8. What is the cfs flow through a Parshall flume with a throat width of 2.5 ft if the water depth at the upstream gage is 0.9 ft? The downstream depth (H_b) is 0.6 ft.

From Chart

$Q \cong 8.6 \frac{ft^3}{s}$

$\frac{H_b}{H_a} = \frac{0.6\ ft}{0.9\ ft} = 0.67$

From Chart

$\frac{Q}{Q_D} \cong 1$

ANS $8.6 \frac{ft^3}{s}$

9. What is the cfs flow through a Parshall flume with a throat width of 3 ft if the water depth at the upstream gage is 10 in.? The downstream depth (H_b) is 8.5 in.

From Chart

$Q \cong 9 \frac{ft^3}{s}$

$\frac{H_b}{H_a} = \frac{8.5\ in}{10\ in} = 0.85$

From Chart

$\frac{Q}{Q_D} \cong 0.88$

ANS $7.9 \frac{ft^3}{s}$

$Q_D \cong (0.88)(9 \frac{ft^3}{s})$