



State Water Resources Control Board

GRADE V OPERATOR CERTIFICATION EXAMINATION
INFORMATION AND SAMPLE QUESTIONS

The Grade V examination contains questions regarding the following subjects: safety practices, hazards encountered during operations, sampling and analysis of wastewater constituents, operation and maintenance procedures in preliminary, primary and secondary treatment unit processes, anaerobic sludge digestion and disinfection. It also includes operation and maintenance of wastewater stabilization ponds and state regulations regarding the classification of wastewater treatment plants and operator certification. Questions may deal with sludge handling and evaluation of wastewater unit processes as well as overall plant performance. In addition, the Grade V examination includes questions on process control, activated sludge process modifications and tertiary treatment, requirements and practices for water reclamation and reuse, supervision/management responsibilities such as energy management, safety program development, operator training and budget development and control. Examinees will be asked to write essay answers to some questions.

The Grade V examination contains some of the most complex mathematical questions asked at Grades I-IV. Examinees may be asked to write essay answers and calculate problems including heat value/gas generation from an anaerobic digester, BOD/nitrogenous BOD calculations, effects of process adjustments/changes, polymer usage/dose, efficiency and loading of solids thickening processes, disinfection options/dose/residual/cost, use/calculation of process control variables, hydraulic or organic loading rates, pumping efficiency/cost, nitrification and effects on plant operations and infiltration and inflow. The examinee should be familiar with typical calculations related to the subject matter listed in paragraph 1. Examinees must work out the math problems. Answers to math questions that are not supported by calculations will NOT receive credit.

Examinees are given 4 hours to complete the examination. The question format is as follows:

Table with 3 columns: Question Type, Symbol, and Points. Includes rows for Multiple Choice Questions, Math Problems, Mandatory Essay Question, Essay Questions (Work 4 of 6), and TOTAL POINTS.

The following are examples of the types of questions that you would find on the Grade V certification examination (see attached key for answers).

Multiple Choice Questions

1. Which one of the following statements is TRUE regarding polymers?
 - a. Alum is frequently used along with an anionic polymer when dewatering anaerobically digested sludge using a belt press.
 - b. Cationic polymers are high-molecular-weight organic compounds carrying a negative charge.
 - c. A dry polymer is always a better choice for application in centrifuges than any liquid polymer solution.
 - d. Because of its viscosity, a Mannich polymer may be difficult to pump.
 - e. All liquid polymer solutions are harmless and need not require the examination of their MSDS sheets.

2. When using alum to remove suspended solids from a secondary effluent, an important consideration is:
 - a. The concentration of phosphorus in the secondary effluent.
 - b. The consumption of alkalinity by the alum with a resultant decrease in the pH of that wastewater.
 - c. Staining of concrete or other surfaces.
 - d. The heat generated when the alum is mixed too rapidly.
 - e. The toxic effect of aluminum in the secondary effluent.

3. Which one of the following statements is TRUE regarding the various modifications of the activated sludge process?
 - a. An MCRT of 5 to 10 days is typical for the oxidation ditch.
 - b. Step-aeration (also called step-feed) involves decreasing the air being fed along the length of the aeration tank.
 - c. Typical hydraulic detention times in the contact tank of the contact stabilization process need only be 0.5 to 1.0 hour.
 - d. F to M ratios of 0.03 to .1 are appropriate for the step-aeration mode of the activated sludge process.
 - e. Pure oxygen activated sludge floc often has a large population of rotifers.

4. When adding anhydrous ammonia to a sour primary anaerobic digester, _____ is an important consideration because if it is too high, digester “poisoning” may result.
 - a. The concentration of hydrogen sulfide in the digester gas.
 - b. The pH in the digesting sludge.
 - c. The concentration of free copper ion in the digesting sludge.
 - d. The ferrous and ferric ion concentration in the digesting sludge.
 - e. Dissolved sulfide concentration.

5. Which one of the following statements is TRUE regarding the BOD test?
- a. Some NPDES permits specify that only CBOD is to be reported on a wastewater plant's final effluent. The letters CBOD refer to complete BOD (i.e. the total BOD).
 - b. Phenylarsineoxide (PAO) is typically added to destroy nitrifying bacteria when running this test.
 - c. Dechlorinated secondary effluents need not be seeded when set up for the BOD test.
 - d. Nitrate ions interfere with this test.
 - e. Nitrogenous BOD (NBOD) results from the oxygen demand exerted by certain bacteria as they oxidize ammonia to nitrate ions.
6. Which of the following statements is TRUE regarding anaerobic digesters?
- a. Methane formers thrive in a pH range of 6.5 to 6.7.
 - b. A typical gas analysis of a healthy anaerobic digester would show: 60% methane, 39% carbon dioxide, and about 1.0% hydrogen sulfide.
 - c. Much of the alkalinity in an anaerobic digester results from the reaction of ammonia, water and carbon dioxide digester start-up.
 - d. Most "high rate" anaerobic digesters operate in the thermophilic temperature range. When adding lime to a sour anaerobic digester it's best to add an excess amount.
7. Regarding trickling filter operation which one of the following statements is TRUE?
- a. Series operation is appropriate for winter operation of two-stage trickling filters.
 - b. Psychoda flies are more of a problem in low rate trickling filters than in high rate trickling filters.
 - c. Dosing a trickling filter with 10-20 mg/L of chlorine is a common method of reducing filter ponding.
 - d. Decreasing the recirculation rate and letting a trickling filter dry out is a common method of controlling filter flies.
 - e. It is commonly known that plastic media in roughing filters is no longer desirable because toxic plasticizer residues inhibit slime growth.
8. A DAF thickener has effluent solids of 55 mg/L and float solids of 2.0%. Solids loading is in the normal range. This data likely indicates:
- a. This unit is operating normally.
 - b. Too low a air to solids ratio.
 - c. Float blanket too thick.
 - d. Flight speed too fast.
 - e. Flight speed too slow.

MATH PROBLEMS

9. Given the information below estimate the heat value of the gas produced from an anaerobic digester in units of BTUs per day. PURE METHANE has a net heat value of 932 BTUs per standard cubic foot. Assume gas produced is measured at standard conditions.

Raw sludge pumping schedule	7.0 min/30 min
Sludge pumping rate	75 gpm
Raw sludge % TS	4.2%
Raw sludge % VS	73.0%
Digester Sludge % VS	58%
Gas Production	11.5 ft ³ /day/Lb VS destroyed
Percent CO ₂ ...(by volume)	35.5%
Other Gases...(by volume)	1.0%

10. Liquid alum (9.1% Aluminum) is being used to remove phosphorus from an activated sludge effluent. Seven and one-half (7.5) mg/L of aluminum is required to give adequate removal of the phosphorus in this effluent. Calculate the daily cost of liquid alum given the following information:

Plant flow	1.8 MGD
Specific Gravity of Liq Alum	1.32
Percent Alum (wt/wt)	49%
Liquid alum	\$1.62 per gallon

11. A DAF thickener used to thicken WAS has been operated 24 hours/day and 7 days/week. All the WAS is pumped to the thickener. In order to save on energy and labor you plan to switch to one 8-hour shift per day and 7 days/week. Use the data below to calculate the solids loading rate (lbs/ft²/hour) to DAF unit.

DAF Dimensions: 12.5 ft. wide x 38 ft. long x 6.5 ft. liquid depth

Plant Flow	4.2 MGD
Total Aeration Basin Vol	1.55 MG
Total Final Clarifier Vol	0.60 MG
Pri. Effluent BOD	135 mg/L
Pri. Effluent SS	92 mg/L
Final Effluent SS	22 mg/L
MLSS	3250 mg/L
WAS	9100 mg/L
Target (Optimum) MCRT	5.5 days

ESSAY QUESTION

12. The control and calculation of RAS flow rates are important considerations in the operation of activated sludge wastewater treatment plants. Most commonly the operator either sets the return rate (Q_r) at a constant flow or as a constant percentage of flow.
- (a) Identify two effects that each of these approaches will have on plant operations. Assume that a normal diurnal variation in both wastewater flow and strength.
- (b) The so-called "solids balance approach" (shown below) may be used to mathematically estimate Q_r . What two assumptions are made in deriving this formula?

$$[Q_r + Q] \times \text{MLSS Conc.} = Q_r \times \text{RAS Conc.}$$

- (c) Using the information given below and the "solids balance" equation, calculate SVI and Q_r comment on these values:

Q.....2.0 MGD
MLSS.....2350 mg/L
RAS.....7350 mg/L
SV₃₀.....320 mLs/g

13. Your supervisor has been asked to evaluate the use of liquid chlorine versus sodium hypochlorite. He has requested your input. Prepare a memo for your supervisor in which you identify FIVE factors that should be considered when comparing the use of chlorine with sodium hypochlorite. Briefly discuss each of these factors. Where possible indicate which chemical has the advantage when a particular factor is discussed.

ANSWER KEY

GRADE V

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|------|------|--------------------------------|
| 1. D | 5. E | 9. 21,500,000 BTUs/day |
| 2. B | 6. C | 10. \$372/day |
| 3. C | 7. B | 11. 2.6 Lbs/hr/ft ² |
| 4. B | 8. D | |

THINGS TO KEEP IN MIND

1. A one-page “Formulas and Equivalents” sheet is included in the front of each examination (see attachment).
2. All multiple choice questions have only one right answer.
3. On the math problems, including the multiple choice math, show all your work so that you might receive partial credit.
4. There are some sections (math on the Grade III) where you have to choose which problems to answer. Read through these sections and decide which problems you want to answer before you begin.
5. When the instructions say to work 7 out of the 8 problems, do not waste time working 8 of these problems – there is no extra credit for extra problems answered.
6. On the math and essay problems, if you only know part of an answer, by all means put it down! **SHOW YOUR WORK.**
7. **REMEMBER:** In order to pass, you must achieve an overall score of at least 70%. Also be aware that you are required, in addition, to score at least 50% on the math section of the examination to pass.

STATE WATER RESOURCES CONTROL BOARD OPERATOR CERTIFICATION EXAMINATION

EQUIVALENTS

1 acre = 43,560 square feet

1 cubic foot of water = 7.48 gallons

1 gallon = 8.34 pounds

1 day = 1,440 minutes = 86,400 seconds

1 million gallons/day = 694 gallons/minute = 1.547 cubic feet/second = 3.069 acre-feet/day

1% = 10,000 mg/L

$\pi = 3.14$

1 in. mercury = 1.133 feet of water

1 psi = 2.31 feet of water

1 HP = 0.746 Kw = 550 ft-lb/sec = 33,000 ft-lb/min

FORMULAS

Area of a rectangle = Length x Width

Area of a circle = $\frac{\pi}{4} \times \text{Diameter}^2 = 0.785 \times \text{Diameter}^2$

Volume of rectangular tank or circular tank with uniform depth = Area x Depth

Volume of cone = $\frac{1}{3} \times \text{Base Area} \times \text{Depth}$

Circumference = $\pi \times \text{Diameter}$

Velocity = $\frac{\text{Flow}}{\text{Area}}$

Detention time = $\frac{\text{Volume}}{\text{Flow}}$

Pounds/day = 8.34 x Flow, mgd x Concentration, mg/L

F/M = $\frac{\text{Pounds of BOD applied per day}}{\text{Pounds of MLVSS under aeration}}$

MCRT = $\frac{\text{Pounds of MLSS in secondary system (aeration tank + clarifier)}}{\text{Pounds of MLSS leaving secondary system per day (effluent + WAS)}}$

Water HP = $\frac{\text{Flow, gpm} \times \text{Total Head, ft}}{3960 \frac{\text{gpm} \cdot \text{ft}}{\text{HP}}}$

Brake HP = Power to electric motor x Motor efficiency