

## STUDY GUIDE FOR CHALLENGE EXAM

### I. Swimming Pool and Spa Definitions (COMAR 10.17.01.05)

- A. Private
- B. Public
  - 1. Limited Public-Use
  - 2. Recreational
  - 3. Semipublic
- C. Critical violations
- D. Major violations

### II. Disinfection (COMAR 10.17.01.44)

- A. Reason for sanitation (e.g. disease prevention)
- B. Types of disinfectants
  - 1. Chlorine
    - a) Definition of free, total and combined chlorine
    - b) Required chlorine disinfection levels per COMAR
    - c) Definition of chlorine demand
    - d) Types of chlorine and their effect on pH
      - (1) Sodium hypochlorite
      - (2) Calcium hypochlorite
      - (3) Lithium hypochlorite
    - e) Stabilizing chlorine (using cyanuric acid)
      - (1) Reasons for stabilization
      - (2) Required levels per COMAR
    - f) Chloramines
      - (1) Health concerns
      - (2) Reaching breakpoint and super chlorination
  - 2. Bromine
    - a) Disinfecting property of bromine
    - b) Required bromine disinfection levels per COMAR
  - 3. Other types of secondary disinfectants
    - a) Ozone
    - b) Ultra-violet
    - c) Copper and silver ions
  - 4. Types of chemical feeders
  - 5. How to dose or adjust chemicals

### III. Pool and Spa Chemistry (COMAR 10.17.01.45)

- A. pH
  - 1. Definition of pH
  - 2. Required pH levels per COMAR
  - 3. Effect of pH on disinfection levels
  - 4. Chemicals used to raise and lower pH
- B. Total Alkalinity
  - 1. Definition of total alkalinity

2. Required total alkalinity levels per COMAR
3. Relationship between total alkalinity and pH (pH bounce)
4. Chemicals used to raise and lower total alkalinity
- C. Langelier Saturation Index (LSI)
  1. Formula
  2. Required LSI levels per COMAR
  3. Purpose of chemical balancing
- D. Total Dissolved Solids (TDS)
  1. Definition and what contributes to TDS
  2. Required TDS levels per COMAR

#### **IV. Water Testing**

- A. Required test kits per COMAR
- B. Water testing techniques
  1. Chlorine
    - a) Free
    - b) Total
    - c) Combined
  2. Bromine
  3. pH
  4. Total alkalinity
  5. Calcium hardness
  6. Total dissolved solids
  7. Cyanuric acid
  8. Ozone
- C. False readings from bad reagents or really high / low chemical readings

#### **V. Pool and Spa Record Keeping Requirements**

- A. Recreational pool and public spa recording intervals
- B. Limited public-use pool and semi public pool recording intervals
- C. CPO responsibility and verification
- D. Entrapment hazard checklist

#### **VI. Filtration and Circulation of Pools and Spas**

- A. Types of filters
  1. Sand filters
  2. Diatomaceous earth filters
  3. Cartridge filters
- B. Cleaning procedures per COMAR
- C. When to backwash due to pressure differential
- D. Formula for pool / spa turnover rate
- E. Pool / Spa circulation and recirculation equipment
  1. Inlets and outlets
  2. Hair lint stainers and pumps
  3. Valves (labeling)
  4. Types of pressure gauges
    - a) Influent

- b) Effluent
- c) Vacuum or compound

5. Flow meters

F. Water Clarity

**VII. Pool and Spa Maintenance**

A. Pool vacuuming

- 1. Types of vacuums
- 2. Procedures

B. Pool lighting

- 1. Replacing underwater lights
- 2. Lighting requirements per COMAR

C. Filter room / chemical storage area

- 1. Ventilation
- 2. Requirements per COMAR
- 3. Pool data sheet
- 4. Lighting
- 5. Required signage

D. Temperature

- 1. Pool
- 2. Spa
- 3. Therapy pool

E. Calculating gallonage

F. Purpose of flocculants

G. Purpose of algicides

**VIII. Pool and Spa Safety and Chemical Storage**

A. Pool and spa safety

- 1. Requirements for safety equipment
  - a) Public pools and spas
  - b) Semi public pools
- 2. Lifeguard requirements
- 3. Emergency telephone
- 4. Depth and no diving markers (COMAR and ANSI)
- 5. Glass containers
- 6. Suction entrapment hazards (missing, cracked or broken suction outlet covers)
- 7. Conditions that require immediate pool closures (critical violations)
- 8. Accident prevention
- 9. Lifeline requirements

# BREAKPOINT SUPERCHLORINATION

STEP 1:  $\frac{\text{TOTAL CHLORINE} - \text{FREE CHLORINE}}{10} = \text{COMBINED CHLORINE}$

STEP 2:  $\text{COMBINED CHLORINE} \times 10 = \text{DESIRED FREE CHLORINE LEVEL}$

STEP 3:  $\text{DESIRED LEVEL} - \text{EXISTING FREE CHLORINE} = \text{ADJUSTMENT (C1)}$

| (A) AMOUNT OF CHEMICAL (PRODUCT LABEL) | (B) ACTUAL POOL VOLUME                                | (C) DESIRED CHEMICAL CHANGE                  | TOTAL      |
|----------------------------------------|-------------------------------------------------------|----------------------------------------------|------------|
|                                        | (B1)<br>_____<br>GALLONS                              | (C1)<br>_____<br>PPM                         |            |
|                                        | (B2) (PRODUCT LABEL)<br>÷<br><u>10,000</u><br>GALLONS | (C2) (PRODUCT LABEL)<br>÷<br><u>1</u><br>PPM |            |
| (A)<br>_____                           | (B3)<br>X _____                                       | (C3)<br>X _____                              | =<br>_____ |

NOTE: DIVIDE DOWN THEN MULTIPLY ACROSS

# DOSAGES REQUIRED TO TREAT 10,000 GALLONS

| INCREASE FREE AVAILABLE CHLORINE       | 1 PPM             |
|----------------------------------------|-------------------|
| CHLORINE GAS                           | 1.3 OUNCES        |
| CALCIUM HYPOCHLORITE 67%               | 2.0 OUNCES        |
| SODIUM HYPOCHLORITE 12%                | 10.7 FLUID OUNCES |
| LITHIUM HYPOCHLORITE                   | 3.8 OUNCES        |
| TRICHLOR                               | 1.5 OUNCES        |
| DICHLOR 56%                            | 2.4 OUNCES        |
| DICHLOR 62%                            | 2.1 OUNCES        |
| NEUTRALIZE FREE AVAILABLE CHLORINE     | 1PPM              |
| SODIUM THIOSULFATE                     | 2.6 OUNCES        |
| SODIUM SULFITE                         | 2.4 OUNCES        |
| INCREASE TOTAL ALKALINITY              | 10 PPM            |
| SODIUM BICARBONATE                     | 1.4 POUNDS        |
| SODIUM CARBONATE                       | 14.0 OUNCES       |
| SODIUM SESQUICARBONATE                 | 1.25 POUNDS       |
| DECREASE TOTAL ALKALINITY              | 10 PPM            |
| HYDOCHLORIC ACID (MURIATIC ACID) 31.4% | 26.0 FLUID OUNCES |
| SODIUM BISULFATE                       | 2.1 POUNDS        |
| INCREASE pH                            | .2 PPM            |
| SODIUM CARBONATE                       | 6.0 OUNCES        |
| SODIUM HYDROXIDE 50%                   | 5.5 FLUID OUNCES  |
| DECREASE pH                            | .2 PPM            |
| HYDROCHLORIC ACID (MURIATIC ACID)      | 12.0 FLUID OUNCES |
| SODIUM BISULFATE                       | 1.0 POUNDS        |
| CARBON DIOXIDE (CO2)                   | 4.0 OUNCES        |
| INCREASE CALCIUM HARDNESS              | 10 PPM            |
| CALCIUM CHLORIDE 100%                  | 0.9 POUNDS        |
| CALCIUM CHLORIDE 77%                   | 1.2 POUNDS        |
| INCREASE STABLIZER                     | 10 PPM            |
| CYANURIC ACID                          | 13.0 OUNCES       |

**ALWAYS READ CHEMICAL LABELS FOR EXACT AMOUNTS NEEDED TO MAKE  
CHEMICAL ADJUSTMENTS**

## CHEMICAL ADJUSTMENT WORKSHEET

| (B) AMOUNT OF CHEMICAL (PRODUCT LABEL) | (B) ACTUAL POOL VOLUME                     | (C) DESIRED CHEMICAL CHANGE            | TOTAL      |
|----------------------------------------|--------------------------------------------|----------------------------------------|------------|
|                                        | (B1)<br>_____<br>GALLONS                   | (C1)<br>_____<br>PPM                   |            |
|                                        | (B2) (PRODUCT LABEL)<br>÷ _____<br>GALLONS | (C2) (PRODUCT LABEL)<br>÷ _____<br>PPM |            |
| (A)<br>_____                           | (B3)<br>X _____                            | (C3)<br>X _____                        | =<br>_____ |

NOTE: DIVIDE DOWN THEN MULTIPLY ACROSS

## CHEMICAL ADJUSTMENT WORKSHEET

| (C) AMOUNT OF CHEMICAL (PRODUCT LABEL) | (B) ACTUAL POOL VOLUME                     | (C) DESIRED CHEMICAL CHANGE            | TOTAL      |
|----------------------------------------|--------------------------------------------|----------------------------------------|------------|
|                                        | (B1)<br>_____<br>GALLONS                   | (C1)<br>_____<br>PPM                   |            |
|                                        | (B2) (PRODUCT LABEL)<br>÷ _____<br>GALLONS | (C2) (PRODUCT LABEL)<br>÷ _____<br>PPM |            |
| (A)<br>_____                           | (B3)<br>X _____                            | (C3)<br>X _____                        | =<br>_____ |

NOTE: DIVIDE DOWN THEN MULTIPLY ACROSS

## SATURATION INDEX

| TEMPERATURE |     | CALCIUM HARDNESS |     | ALKALINITY |     |
|-------------|-----|------------------|-----|------------|-----|
| °F          | TF  | PPM              | CF  | PPM        | AF  |
| 32          | 0.0 | 25               | 1.0 | 25         | 1.4 |
| 37          | 0.1 | 50               | 1.3 | 50         | 1.7 |
| 46          | 0.2 | 75               | 1.5 | 75         | 1.9 |
| 53          | 0.3 | 100              | 1.6 | 100        | 2.0 |
| 60          | 0.4 | 125              | 1.7 | 125        | 2.1 |
| 66          | 0.5 | 150              | 1.8 | 150        | 2.2 |
| 76          | 0.6 | 200              | 1.9 | 200        | 2.3 |
| 84          | 0.7 | 250              | 2.0 | 250        | 2.4 |
| 94          | 0.8 | 300              | 2.1 | 300        | 2.5 |
| 105         | 0.9 | 400              | 2.2 | 400        | 2.6 |
| 800         |     |                  | 2.5 | 800        | 2.9 |

NOTE: If your tested value is not listed above go to the next highest value (ex. 85 °F would have a TF of 0.8)

#### TOTAL DISSOLVED SOLIDS FACTORS

| LESS THAN 1,000 PPM | 1,000 PPM OR GREATER |
|---------------------|----------------------|
| 12.1                | 12.2                 |

**pH** + **TF** + **CF** + **AF** - **TDSF** = **SI**  
 as tested      Temp      Calcium      Alkalinity      TDS      Saturation  
                          Factor      Factor      Factor      Factor      Index

\_\_\_\_\_ + \_\_\_\_\_ + \_\_\_\_\_ - \_\_\_\_\_ = \_\_\_\_\_

\_\_\_\_\_ + \_\_\_\_\_ + \_\_\_\_\_ - \_\_\_\_\_ = \_\_\_\_\_

\_\_\_\_\_ + \_\_\_\_\_ + \_\_\_\_\_ - \_\_\_\_\_ = \_\_\_\_\_

