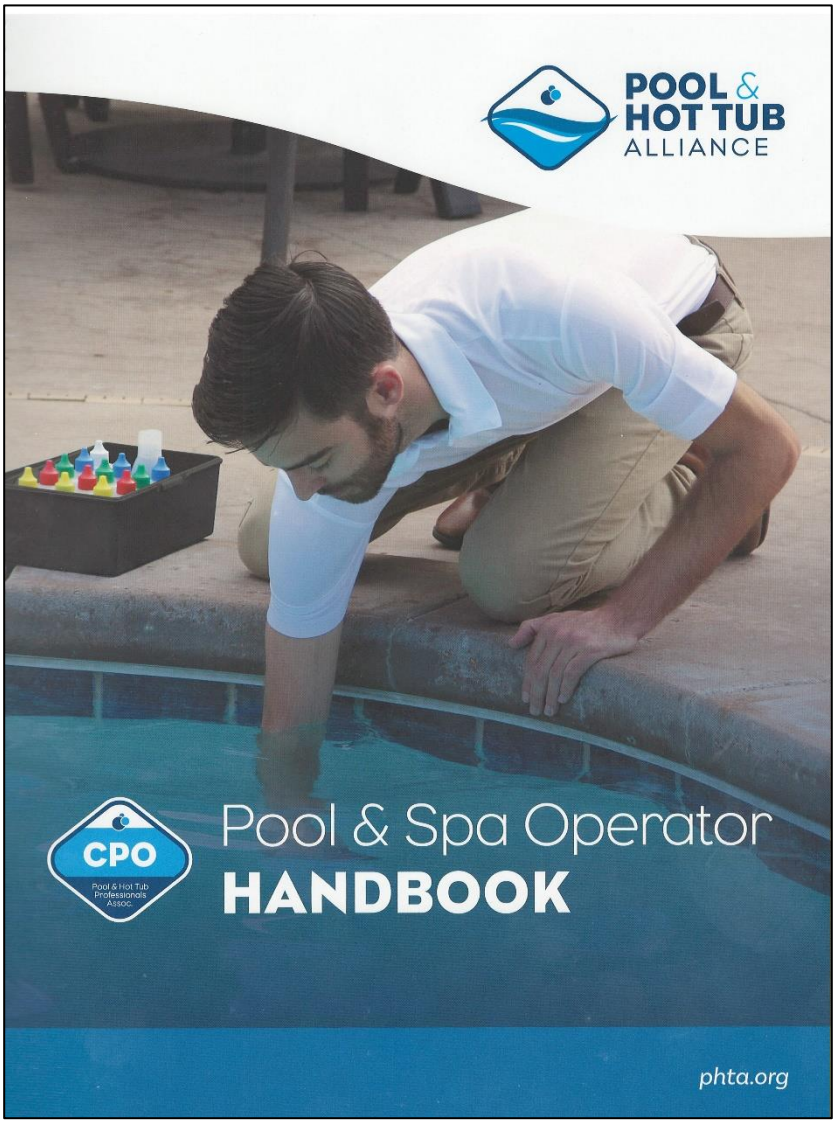
Certified Pool & Spa Operator Certification Course

2023-r3

Handout Packet



Presented by:

POOL & HOT TUB ALLIANCE
CPO INSTRUCTOR

cpo.TRAINING™
CERTIFIED POOL OPERATOR
A Passion for Healthy Water and Aquatic Education

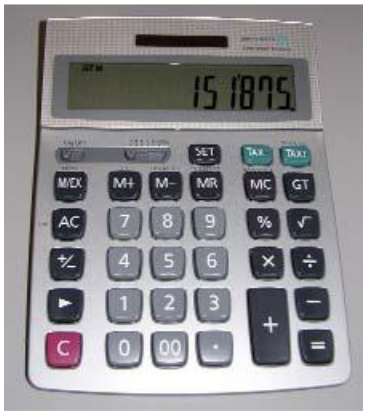
Class Agenda

2-DAY CERTIFIED POOL & SPA OPERATOR (CPO) COURSE

Day 1		Chapter	Topic
A.M.	8:00 – 8:45	-	Introduction and Housekeeping
	8:45 – 9:00	1	Pool & Spa Management
	9:00 – 9:15	2	Regulations & Guidelines
	9:15 – 10:15	3	Essential Calculations
	10:15 – 10:30	**-**	**Break**
	10:30 – 11:00	4	Pool Water Contamination
	11:00 – 12:00	5	Disinfection
	12:00 – 1:00	**-**	**LUNCH**
P.M.	1:00 – 1:45	6	Water Balance
	1:45 – 2:30	7	Pool & Spa Water Problems
	2:30 – 3:00	8	Chemical Testing
	3:00 – 3:15	**-**	**Break**
	3:15 – 3:45	9	Chemical Feed & Control
	3:45 – 4:30	10	Water Circulation
	4:30 – 5:00	11	Pool & Spa Filtration

Day 2		Chapter	Topic
A.M.	8:00 – 8:30	-	Internet– National, State and Local codes
	8:30 – 9:00	12	Heating & Air Circulation
	9:00 – 9:30	13	Spa & Therapy Operation
	9:30 – 10:15	14	Facility Safety
	10:15 – 10:30		**Break**
	10:30 – 10:45	15	Keeping Records
	10:45 – 11:00	16	Maintenance Systems
	11:00 – 11:15	17	Trouble Shooting
	11:15 – 11:30	18	Renovation & Design, ADA Revision of 2010
	11:30– 12:30	**-**	**LUNCH**
P.M.	12:30– 1:30		Review, Questions, Exam Instructions
	1:30 – 4:00		Exam

BASIC MATH SKILLS TEST



Calculator Functions

+ = Add
- = Subtract or Takeaway
± = Divide
x = Multiply
= Represents equals

This basic math skills test is design to help you test your basic math knowledge that you will be required to perform as a CPO® graduate. This is also your chance to make sure that you are familiar with using a calculator. Complete this test before you move on to the next section. The answers to these basic math questions are found on the next page but try not to look until you have completed all the questions. Your CPO® instructor may ask to see your answers to these questions at the beginning of your CPO® course. Simply circle your answer choice.

1. **Add:** 2.32 + 71.4 + 0.003 =
   (a) 73.75
   (b) 94.9
   (c) 9.49
   (d) 73.723

2. **Add:** 7.4 + 0.7 + 1.7 + 1.9 =
   (a) 11.5
   (b) 11.7
   (c) 12.1
   (d) 11.9

3. **Subtract:** 7,527 - 149 =
   (a) 7,378
   (b) 7,478
   (c) 7,388
   (d) 7,488

4. **Subtract:** 11. 7 - 12.1 =
   (a) +0.4
   (b) +1.1
   (c) -0.4
   (d) +0.4

5. **Add and Subtract:**
   7.2 + 0.9 + 1.8 + 1.6 - 12.2 =
   (a) +0.7
   (b) +23.7
   (c) -1.7
   (d) -0.7

6. **Multiply:** 300 x 7.48 =
   (a) 2,144
   (b) 2,244
   (c) 40.106
   (d) 292.52

7. **Multiply:** 25 x 75 =
   (a) 1875
   (b) 2875
   (c) 18,750
   (d) 187.5

8. **Divide:** 200,000 ± 10,000 =
   (a) 2000
   (b) 200
   (c) 20
   (d) 40

9. Divide: 75,000 ÷ 10,000 =

(a) 7.5
(b) 7.0
(c) 75
(d) 10

10. You have a pool that is 60 feet in length and 30 feet in width. How many square feet of surface area does this pool have:

(a) 2,800 square feet
(b) 3,600 square feet
(c) 6,000 square feet
(d) 1,800 square feet

11. The volume of your pool is 328,637 gallons. What is the volume rounded to the nearest thousand?

(a) 328
(b) 329
(c) 329,000
(d) 328,000

12. The current chlorine reading in your pool is 1.5 ppm. You want to raise it to 3.0 ppm. How many more ppm of chlorine do you need to add?

(a) 4.5 ppm
(b) 3.0 ppm
(c) 1.5 ppm
(d) 2.0 ppm

13. How many cubic yards of concrete are needed to make a cement floor of a spa that 9 feet x 12 feet and 6 inches thick?

(a) 2
(b) 4
(c) 18
(d) 54

14. Your pool slopes from 3.5 feet to 6.5 feet. What is the average depth of this pool?

(a) 10 feet
(b) 5 feet
(c) 22.75 feet
(d) 3 feet

15. There is a leak in your pool and it loses 2.5 inches of water each day. It takes 1235 gallons for each inch of water in your 60 feet x 30 feet pool. How many gallons do you need to add to your pool each day?

(a) 494 gallons
(b) 37,050 gallons
(c) 4,500 gallons
(d) 3,087.5 gallons

16. The diameter of a spa is 24 feet. What is the radius?

(a) 6 feet
(b) 18 feet
(c) 12 feet
(d) 24 feet

Answers:

1.	d	2.	b
3.	a	4.	c
5.	d	6.	b
7.	a	8.	c
9.	a	10.	d
11.	c	12.	c
13.	a	14.	b
15.	d	16.	c

CALCULATION FORMULAS

AMOUNT CONVERSIONS	
Ounces to Pounds	Ounces ÷ 16 **= Pounds**
Fluid Ounces to Gallons	Fluid Ounces ÷ 128 **= Gallons**

DISTANCE CONVERSIONS	
Yards to Feet	Yards **X** 3 **= Feet**
Meters to Feet	Meters **X** 3.28 **= Feet**

SURFACE AREA	
Rectangle or Square	Length **X** Width **= Square Feet**
Circle (πr^2)	Radius **X** Radius **X** 3.14 **= Square Feet** (Radius = Diameter ÷ 2)

POOL WATER VOLUME	
Average Depth	(Shallow + Deep) ÷ 2
Water Volume	Surface Area **X** Avg. Depth **X** 7.5

TURNOVER & FLOW RATE	
Turnover Rate (TOR in Hours)	Water Volume ÷ Flow Rate ÷ 60
Flow Rate (FR in GPM)	Water Volume ÷ TOR ÷ 60

FILTER SIZING	
Filter Area (FA in Sq. Ft.)	Flow Rate ÷ Filter Media Rate
Filter Media Rate (FMR)	Flow Rate ÷ Filter Area
Flow Rate (FR in GPM)	Filter Area **X** FMR

HEATER SIZING	
BTU	Water Volume **X** 8.33 **X** Temp. Rise
Time to reach Temp. (in Hours) (Assuming no heat loss in plumbing or pool)	BTUs ÷ (Heater Rating **X** Efficiency Rating)
Cost (Natural Gas: 1 Therm = 100,000 BTUs)	Time **X** Heater Rating ÷ 100,000 **X** Therm Rate

Langelier
SATURATION INDEX

SI = pH + Tf + Cf + Af - TDSf

- pH: pH as Measured
- Tf: Temp Factor
- Cf: Calcium Factor
- Af: Total Carbonate Alkalinity Factor
- TDSf: Total Dissolved Solids Factor

Saturation Index Factors

Temperature		Calcium Hardness Expressed as CaCO3		Total Carbonate Alkalinity		Total Dissolved Solids	
Temp °F	Tf	ppm	Cf	ppm	Af	ppm	TDSf
32	0.0	25	1.0	25	1.4	< 800	12.1
37	0.1	50	1.3	50	1.7	801-1,500	12.2
46	0.2	75	1.5	75	1.9	1,501-2900	12.3
53	0.3	100	1.6	100	2.0	2901-5,500	12.4
60	0.4	125	1.7	125	2.1	> 5,500	12.5
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		

If an actual measurement is not found in the chart, use the next greatest value.

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SATURATION INDEX WORKSHEET

	Value	Factor	New Value	Factor
pH				
Temperature				
Calcium Hardness				
Carbonate Alkalinity				
Sub-Total				
Total Dissolved Solids				
Saturation Index				

	Value	Factor	New Value	Factor
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Saturation Index				

Water Chemistry Guidelines

The Balance

Parameter	Min.	Ideal	Max.	Pool Type
pH	7.2	7.4 - 7.6	7.8	All Types
Total Alkalinity (ppm)	60	80 – 100*	180	All Types
		100 –120**		
Calcium Hardness (ppm)	150	200 - 400	1,000	Pools
	100	150 - 250	800	Spas
Total Dissolved Solids (ppm)	NA	NA	1,500 over start-up***	All Types
Cyanuric Acid (ppm)	0	30 – 50	100	Outdoor Pools
	0	0	0	Indoor Pool/Spa
Temperature	78º F	80.5º F	82º F	Competition Pools
	-	-	104º F	Spas
	-	Personal Preference	104º F	Other Pools

* For calcium hypochlorite, lithium hypochlorite, or sodium hypochlorite

** For sodium dichlor, trichlor, chlorine gas, BCDMH

*** Start-up includes the TDS contribution of salt found in chlorine generating systems

The Disinfectant

Parameter	Min.	Ideal	Max.	Pool Type
Free Chlorine (ppm)	1.0	2.0 - 4.0	5.0	Pools
	2.0	3.0 - 5.0	10.0	Spas
Total Bromine (ppm)	2.0	4.0 - 6.0	10.0	All Types

The Contaminants

Contaminant	Min.	Ideal	Max.	Pool Type
Combined Chlorine (ppm)	0	0	0.2	Pools
	0	0	0.5	Spas
Heavy Metals	None	None	None	All Types
Visible Algae	None	None	None	All Types
Bacteria	None	None	Local Code	All Types

Chemical Dosages for 10,000 Gallons

Dosages to Treat	10,000 Gallons		
Chemical	**Desired Change**		
Increase Chlorine	**1 ppm**	**5 ppm**	**10 ppm**
Chlorine Gas	1.3 oz	6.7 oz	13 oz
Calcium Hypochlorite (67%)*	2 oz	10 oz	1.3 lb
Sodium Hypochlorite (12%)	10.7 fl.oz.	1.7 qtrs.	3.3 qtrs.'
Lithium Hypochlorite	3.8 oz	1.2 lbs	2.4 lbs
DiChlor (62%)	2.1 oz	10.75 oz	1.3 lbs
DiChlor (56%)	2.4 oz	12 oz	1.4 lbs
TriChlor	1.5 oz	7.5 oz	14 oz

Increase Total Alkalinity	10 ppm	30 ppm	50 ppm
Sodium Bicarbonate	1.4 lbs	4.2 lbs	7.0 lbs
Sodium Carbonate	14 oz	2.6 lbs	4.4 lbs
Sodium Sesquicarbonate	1.25 lbs	3.75 lbs	6.25 lbs

Decrease Total Alkalinity	10 ppm	30 ppm	50 ppm
Muriatic Acid (31.4%)	26 fl.oz.	2.4 qtrs.	1 gal
Sodium Bisulfate	2.1 lbs	6.4 lbs	10.5 lbs

Increase Calcium Hardness	10 ppm	30 ppm	50 ppm
Calcium Chloride (100%)	.9 lbs	2.8 lbs	4.6 lbs
Calcium Chloride (77%)	1.2 lbs	3.6 lbs	6.0 lbs

Increase Stabilizer	10 ppm	30 ppm	50 ppm
Cyanuric Acid	13 oz	2.5 lbs	4.1 lbs

Neutralize Chlorine	1 ppm	5 ppm	10 ppm
Sodium Thiosulfate	2.6 oz	13 oz	1.6 lbs
Sodium Sulfite	2.4 oz	12 oz	1.5 lbs

Chemical amounts have been rounded off for convenience. Always follow the instructions on the manufacturer's label for exact amounts.

* **Other** calcium hypochlorite products are available from 47% to 78%. Remember to follow the label directions for dosage amounts.

(Pool & Hot Tub Alliance, 2023 Pool & Spa Handbook, Appendix B-2)

Chemical Adjustment Worksheet

A – Amount	B – BIG		C – Change		Total
(from dosage chart or other source)	**B-1** Actual Gals		**C-1** Actual Chg		
		Divide		Divide	
	B-2 Label Gals		**C-2** Label Chg		
	Times		Times		
				Divide ? **oz**? (16) or **fl. oz**? (128)	
				Final Answer	

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Breakpoint Super-Chlorination Worksheet

Step One: Determine the amount of Combined Chlorine (CC = TC – FC)

Step Two: Calculate the Breakpoint Chlorination (BPC) amount (CC x 10)

Step Three: Determine the desired change amount (DC) (BPC – FC)

	Total Chlorine		Free Chlorine		Combine Chlorine
Step One		-		=	
Step Two	**Multiply by 10**				
Step Three	**Subtract the Free Chlorine**				-
Use this number in the C-1 (desired change) blank in the Chemical Adjustment Worksheet					

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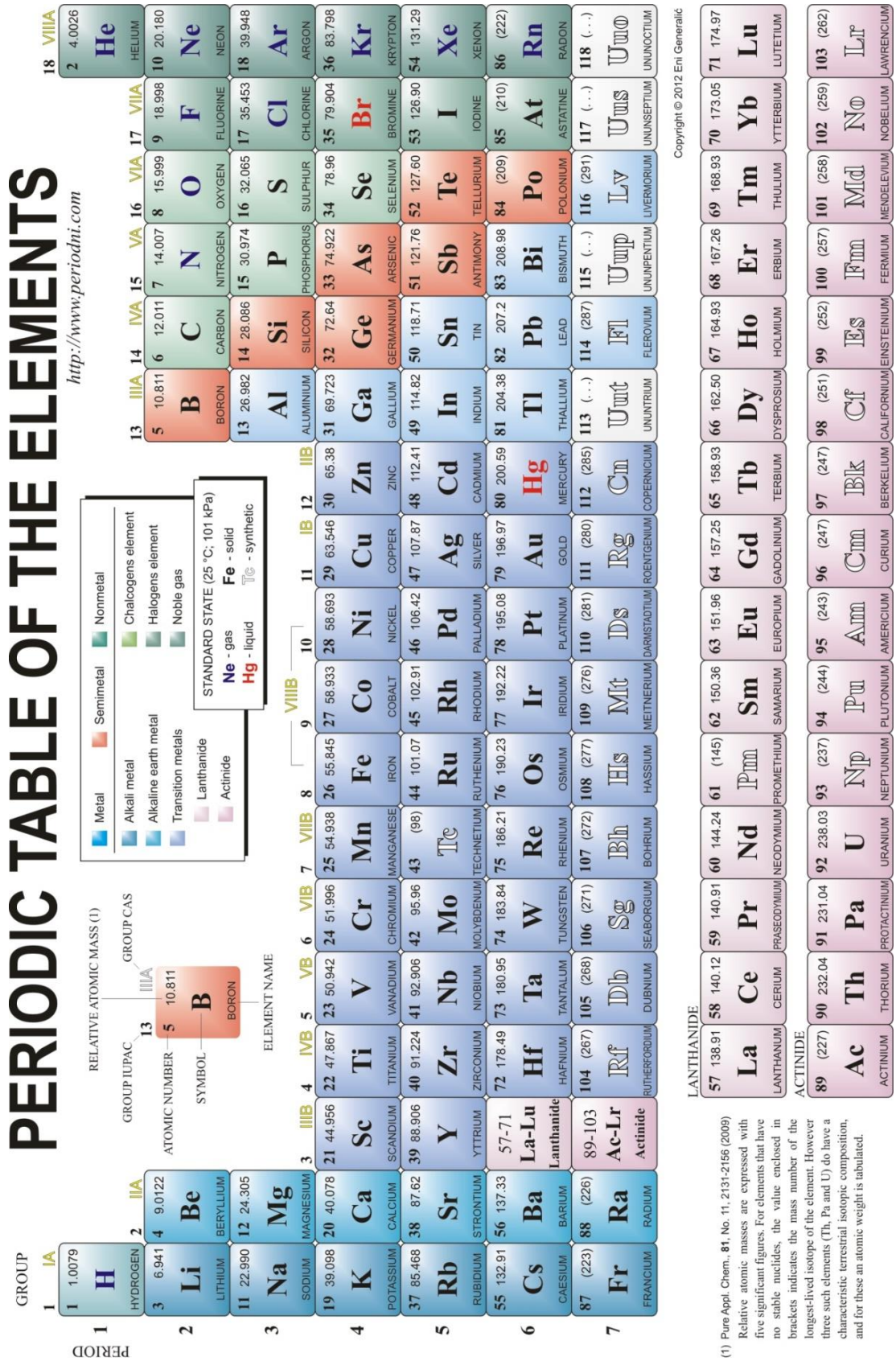
Step One		-		=	
Step Two	**Multiply by 10**				
Step Three	**Subtract the Free Chlorine**				-
Use this number in the C-1 (desired change) blank in the Chemical Adjustment Worksheet					

Chemical Adjustment Worksheet					
A – Amount (from dosage chart or other source)	**B – BIG**		**C – Change**		**Total**
	B-1 Actual Gals		**C-1** Actual Chg		
		Divide		Divide	
	B-2 Label Gals		**C-2** Label Chg		
	Times		Times		
				Divide ? **oz**? (16) or **fl. oz**? (128)	
				Final Answer	

The following pages contain additional information which is not in or explicitly stated in the

Pool & Spa Operator Handbook™



(1) Pure Appl. Chem., **81**, No. 11, 2131-2156 (2009)
Relative atomic masses are expressed with five significant figures. For elements that have no stable nuclides, the value enclosed in brackets indicates the mass number of the longest-lived isotope of the element. However three such elements (Th, Pa and U) do have a characteristic terrestrial isotopic composition, and for these an atomic weight is tabulated.

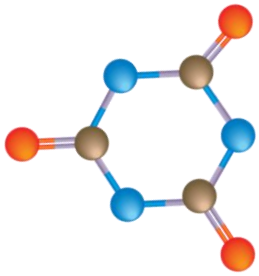
Element	Atomic Weight
Carbon	12.01
Nitrogen	14.01
Oxygen	16
Sodium	22.99
Chlorine	35.45

Atomic Weights
Of Organic Chlorine

Cyanuric Acid

$C_3N_3O_3$

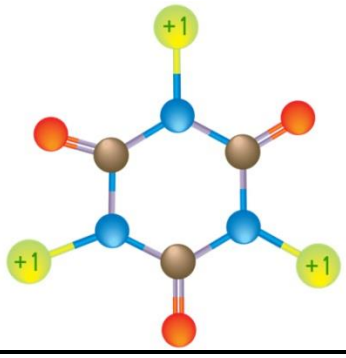
Carbon	36.03
Nitrogen	42.03
Oxygen	48
Total	**126.06**



TriChlor

$C_3N_3O_3Cl_3$

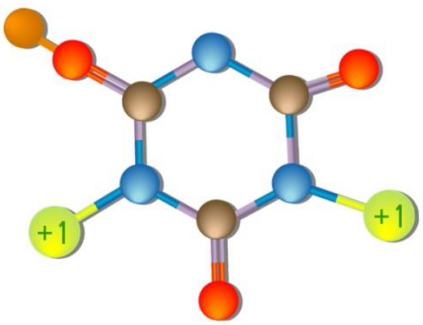
CYA	126.06
Chlorine (3)	106.35
Total	**232.41**
%Chlor	**45.76%**
%CYA	54.24%



DiChlor

$NaCl_2C_3N_3O_3$

CYA	126.06
Sodium (1)	22.99
Sub-Total	149.05
Chlorine (2)	70.9
Total	**219.95**
%Chlor	**32.23%**
%CYA	57.31%
%Sodium	10.45%



Cyanuric Acid

(Chlorine Stabilizer / Pool Water Conditioner)

Cyanuric acid (CYA) is used in pool water to protect the chlorine disinfectant from the sun's UV. It does this by forming a weak molecular bond with the disinfectant, thus keeping it in the water longer. This bond, however, **does slow down** the killing rate of the chlorine disinfectant.

To ensure there is enough active chlorine disinfectant to keep a healthy swimming pool and to prevent algae when using CYA, the measured FC level should be at least **7.5 percent** of the amount of CYA. For example: if the CYA level is 50ppm then the measured residual FC should be at least 3.75 (4ppm).

High levels of CYA -- i.e., 100, 200 and higher -- will require impractical high levels of chlorine disinfectant to prevent algae and to ensure the inactivation of harmful bacteria and other pathogens that may be introduced into the swimming pool. When CYA levels are this high, then supplemental chemicals (algaecides, oxidizers, phosphate removers, etc.) can be used to help prevent algae and to help keep the pool safe and healthy.

Table 5 is the guideline that shows the amount of chlorine disinfectant needed as the CYA levels go up, given an equivalent killing rate. These chlorine/CYA ratios should be followed to maintain a healthy pool.

Chlorine / CYA Chart				
	Free available Chlorine (ppm)			
CYA (ppm)	**Minimum** (≈7.5% of CYA)	**Target** (≈11.5% of CYA)	**Shock/Algae** (≈40% of CYA)	**Yellow Algae Kill** (≈60% of CYA)
0	.07[1]	.1[1]	.7[1]	2[1]
10	1[1]	1.5[1]	5	7
20	2	3	10	13
30	2	4	12	18
40	3	5	16	24
50	4	6	20	30[2]
60	5	7	24	35[2]
70	5	8	28[2]	41[2]
80	6	9	31[2]	46[2]
90	7	10	35[2]	52[2]
100	7	12	39[2]	58[2]
120	9	14	47[2]	68[2]

Table 5

[1]A minimum FC level is needed as a "reserve" for usage so in practice at least 2 ppm FC is required even at low CYA levels. The table above shows the amount needed for disinfecting chlorine for equivalent killing power (rates), but does not take into account the amount needed in reserve to prevent getting used up as this varies by pool.

[2]The shock levels shown have equivalent disinfecting chlorine amounts (in a column) but at high CYA levels it may be impractical to use such high FC levels. A partial drain/refill to lower the CYA level is usually what is needed, or one can shock at a lower level but will take longer to kill the algae.

ACKNOWLEDGMENT: The chlorine/CYA chart was developed by Ben Powell of 'The Pool Forum' and Richard Falk of 'Trouble Free Pool'.

Universal Dosage Formula

$$\text{Pounds} = \left(\frac{\text{Pool Gallons} \times \textbf{PPM change}}{120{,}000}\right) \times \text{Multiplier}$$

Chemical	Multiplier		Weight in 1lb DE Scoop
Alkalinity – Down			
Muriatic Acid (**quarts**)	.96		N/A
Sodium Bisulfate (Dry Acid)	2.55		4.6 lbs.
Alkalinity – Up			
Sodium Bicarb (Baking Soda)	1.68		3.9 lbs.
Sodium Carbonate (Soda Ash)	1.06		4 lbs.
Chlorine		**Amount Needed to Equal ACC of 1 lb. of Cl_2 gas**	
Sodium Hypochlorite - Bleach (Liquid 12%, **gallon**)	1	1 **gallon**	N/A
TriChlor (90%)	1.09	1.1 lbs. (≈ 2 tabs)	3.5 lbs.
Sodium DiChlor (56%)	1.81	1.8 lbs.	3.3 lbs.
Calcium Hypochlorite (65%)	1.55	1.5 lbs.	2.9 lbs.
Calcium - Calcium Chloride (77%)	1.44		3 lbs.
Stabilizer - Cyanuric Acid	1		2.4 lbs.
Salt	1		3.8 lbs.
Borate (5 mol, pentahydrate)	6.74		
(10 mol, decahydrate)	9.09		
Boric Acid	5.7		

$$\text{PPM} = \frac{\text{Pounds X 120,000}}{\text{Pool Gallons/Multiplier}}$$

$$\text{Pool Gallons} = \frac{\text{Pounds X 120,000}}{\text{PPM/Multiplier}}$$

Equivalents of Common Pool Chemicals

Chemical Name	Equivalent to 1 lb. of Cl_2 Gas	Weight in a 1 lb. DE Scoop	Price per Pound 06-2013 / 01-2023
Sodium Hypochlorite (Bleach)	1 Gallon 12% Trade Grade	N/A	$2.86/Gallon **$5.66**
Sodium DiChlor (56%)	1.8 lbs.	3.3 lbs.	$2.15 / **$5.12**
TriChlor 3" Tabs (90%)	1.1 lbs. (≈ 2 tabs)	N/A	$1.88 / **$4.10**
TriChlor (Granular) (90%)	1.1 lbs.	3.5 lbs.	$2.38 / **$6.00**
Calcium Hypochlorite (65%)	1.5 lbs.	2.9 lbs.	$1.63 / **$2.72**
D.E.		1 lb.	$0.33 / **$0.54**
Cyanuric Acid (Chlorine Stabilizer)		2.4 lbs.	$0.85 / **$1.44**
Salt		3.8 lbs.	$0.15 / **$0.28**
Sodium Bicarbonate (Baking Soda)		3.9 lbs.	$0.45 / **$0.64**
Sodium Carbonate (Soda Ash)		4 lbs.	$0.44 / **$0.44**
Potassium Monopersulfate		4.3 lbs.	$3.34 / **$5.04**
Sodium Bromide		5.2 lbs.	$3.96 / **$5.44**
Muriatic Acid (Liquid Acid)		N/A	$4.18/Gallon **$7.50**
Sodium Bisulfate (Dry Acid)	**Equivalent to 1 quart. Muriatic Acid (TA)** ≈ 2.5 pounds	4.6 lbs.	$1.40 / **$1.53**
Boric Acid			**$0.96**

pH of Common Pool Water Chemicals

Chemical	pH
Sodium Carbonate (Soda Ash)	≈ 12.3 or higher
Sodium Hypochlorite (Liquid Chlorine, Bleach)	9-13
Calcium Hypochlorite (Cal Hypo)	8.5-11
Sodium Tetraborate Pentahydrate (Endure)	9.1-9.2
Calcium Chloride	8-9
Sodium Bicarbonate (Baking Soda, BiCarb)	8.3
Sodium Bromide	6.5-8
DiChlor	6.8-7.1
Boric Acid	5.1
Cyanuric Acid (Chlorine Stabilizer, Conditioner)	3-4
TriChlor	2.7-2.9
Potassium Monopersulfate	2-2.3
Sodium Bisulfate (Dry Acid)	1.4
Muriatic Acid	< 1

Adding Chlorine Compounds to The Swimming Pool

When chlorine compounds are added to a swimming pool to disinfect and oxidize the water, the active chlorine (HOCl) gets used up and the other elements of the compound will build up. When the active chlorine does its job and gets used/consumed, it converts to chloride, i.e. salt which also builds up in the pool water.

The following chart shows the rate of build-up of salt and other chemicals per 10ppm of chlorine added to a swimming pool using the various chlorine compounds.

Chlorine Compound (10 ppm)	**Salt** Build-Up (in ppm)	**Chemical** Build-Up (in ppm)
Sodium Hypochlorite (10 ppm)	**16.4 ppm**	
TriChlor (10ppm)	**8.2 ppm**	Cyanuric Acid **6.1 ppm**
DiChlor (10ppm)	**8.2 ppm**	Cyanuric Acid **9.1 ppm**
Calcium Hypochlorite (10ppm)	**8.2 ppm**	Calcium Hardness **7 ppm**

ACKNOWLEDGMENT: These ratios are published online at the forum: TroubleFreePool.com. by Richard Falk, aka "ChemGeek". He has also published them on various other forums and articles that he has written.

Incompatible Chemicals

Incompatible Chemicals	Result
Calcium Chloride (Hardness Increaser) **AND** Sodium Bicarbonate (BiCarb) OR Sodium Carbonate (Soda Ash)	Calcium Chloride and bicarb or soda ash should not be added at the same time or even within a few hours of each other. A white precipitate will form, clouding the water and may cause scaling
TriChlor **AND** Cal Hypo	Explosion and Fire (by themselves)
Chlorine – Any kind **AND** Iron	Stain and discolored water. Iron above .5ppm will rapidly destroy the chlorine.
Polymer water Clarifier **AND** Sequestering agent	Cloudiness that may not go away or filter out
Phosphate Remover **AND** Sequestering Agent	Cloudiness
Phosphate Remover **AND** High level of calcium or magnesium	Cloudiness and a precipitate that may scale

RECREATIONAL WATER ILLNESSES AT A GLANCE

PATHOGAN	TYPE	METHOD OF TRANSMISSION	SYMTOMS	REAL WORLD OCCURRENCE	CHLORINATION TIME (1PPM FAC)
Cryptosporidium	Parasite	Swallowing contaminated water. Very contagious, through people-to-people contact.	Dehydration, weight loss, stomach cramps, fever, nausea, vomiting. No treatment.	In 2008, several pools and water parks in the Dallas/Ft. Worth area were contaminated and closed. Hundreds of people were sick, one died	About 255 hours (10.6 days)
E.coli	Bacteria	Swallowing contaminated water.	Severe bloody diarrhea, abdominal cramps, kidney failure. Antibiotics available.	In 1998, 26 children fell ill from an outbreak in a Marietta, Georgia wading pool. Seven had kidney failure; one died.	Less than one minute
Giadiasis	One-celled parasite	Swallowing contaminated water. Cysts can survive in cold water for months.	Diarrhea, gas, greasy stools, stomach cramps, upset stomach, nausea. Prescription drugs available.	In 2003, 55 people were struck at a country club in Milton, Massachusetts. The source believed to be the children's swimming pool.	About 45 minutes
Hepatitis	A Virus	Swallowing water contaminated with feces infected with virus.	Jaundice, fatigue, stomach pain, loss of appetite, nausea, diarrhea, fever. No real treatment. Vaccine available.	The public pools at a campground in Louisiana were the source of a multistate outbreak in 1989. 20 people were infected.	About 16 minutes
Legionnaires' Disease	Bacterium Legionella pneumophila	Breathing mists from hot tubs infected with the bacteria. Not contagious.	Fever, chills, cough, muscle aches, headache, fatigue, diarrhea, kidney malfunction. Legionnaire's treatable.	Over 120 people became ill after attending a conference at the Playboy Mansion in L.A. in February 2011. Legionella pneumophila bacteria was found in the grotto spa	Less than one minute
Naegleria Infection	Microscopic amoeba	Enters through the nose and travels to brain and spinal cord. Feeds on brain tissue. Very rare infections.	Causes primary amebic meningoencephalitis (PAM), a brain inflammation. Drugs available, high fatality rate.	In 1978, a 9-year-old girl in San Francisco was infected in a hot springs pool; she was one of only three known survivors of this disease.	Less than one minute
Norovirus Gastroenteritis	Virus	Swallowing water contaminated with feces infected with virus. Very contagious.	Nausea, vomiting, diarrhea, stomach cramping, fever, chills, muscle aches, fatigue. Most recover in 1-2 days.	In 2004, 53 people fell ill at a swim club in Vermont.	About 30 minutes to an hour
Pseudomonas Dermatitis (Hot tub rash)	Bacteria, Pseudomonas Aeruginosa	Direct skin contact with contaminated water. Usually in hot tubs but also in pools.	Itchy skin, red rash, blisters around hair follicles. Clears up on its own in a few days.	Nine cases were documented at a hotel pool and spa in Bangor, Maine. In January 2009, this bacterium was found in the blood of a Brazilian Model – both hands and feet were amputated – she died	Less than one minute
Salmonellosis	Bacteria, Salmonella	Swallowing water contaminated with bacteria.	Diarrhea, fever, cramps. Antibiotics if infection spreads to intestines; no necessary treatment otherwise.	Three cases were documented at a park pool in 1995.	Less than one minute
Shigellosis Shigella	Bacteria, Shigella	Swallowing water contaminated with bacteria.	Bloody diarrhea, fever, cramps. Antibiotics-though forms of shigella have become resistant.	An un-chlorinated wading pool in Dubuque, Iowa, caused at least 69 cases in 2001	Less than one minute

Courtesy Aquatics International Magazine