Water Problems – Corrected & MBBS Teaching Version

These questions and answers are corrected, structured, and formatted for MBBS-level Community Medicine teaching.

Water Problems

Questions and Answers

A circular well of 10 meter diameter with 15 meter depth of water is to be chlorinated. Horrocks test shows blue color in 3rd cup onwards.  
 a) Calculate the quantity of bleaching powder (CaOCl2) required to disinfect the well?   
b) Enumerate four water borne diseases. (5 + 2 )

Solution:

a). Step 1: Finding the volume of the well water

Volume of water in the circular well = ᴫ\*r2 \*h\*1000

Where, = ᴫ= (22/7)=3.14

= ᴫ \* r2 \* h \*1000 r =radius = 5mt (half an diameter)

=3.14 \* 52 \* 15 \* 1000 h=height = 15 water column

= 3.14 \* 25 \* 15 \* 1000 Volume of water per 1 m3 = 1000 litres

=1,177,500

Volume of water in the well is = 1,177,500 liter

Step 2 : Finding the amount of bleaching powder requirement

3 rd cup is the earliest cup showing blue color

3 rd cup means – 3 level spoon (3 \* 2 gm) = 6gm of bleaching powder is required to disinfect 455 liter of water.

455 liter of water requires -6gm of bleaching powder

For 1177500 liter – How much bleaching powder is required?

= (6/455) \* 1177500 = 15,527.5 gm (roughly 15.5 kg)

15 kg 527 gm (to round up 15.5 kg) of bleaching powder is required to disinfect the well water.  
b). 1. Poliomyelitis 2. Hepatitis 3. Cholera 4. Typhoid

In a slum, there is a circular kutcha dug well which is measuring 4 meter in diameter. Depth of water is 10 meter.  
a) Calculate the amount of bleaching power required to disinfect the well? (In Horrocks test, 5th cup show blue color).   
b) Explain the actions of bleaching powder. (5 + 2 )

Solution:

Step 1: Finding the volume of the well water

Volume of water in the circular well = ᴫ \* r2 \* h \* 1000

Where, ᴫ=(22/7)=3.14

= ᴫ \* r2 \* h \* 1000 r=radius ( ½ of the diameter)=2 mt

= 3.14 \* 22 \* 10 \* 1000 h= height =10mt

= 3.14 \* 4 \* 10 \* 1000 Volume of water per 1 m3 = 1000 litres

=125,600

Volume of water in the well is 125,600 liter.

Step 2: Finding the amount of bleaching powder requirement

Earliest cup showing blue color is 5th cup. Fifth cup means 5 level spoon (5 \* 2 gm) = 10gm of bleaching powder is required to disinfect liter of water.

455 liter of water require – 10gm of bleaching powder

For 125,600 liter- how much bleaching powder is required?

=(10/455) \*125600  
 =2,760gm 2 kg 760gm of bleaching powder is required to disinfect the well.

## Actions of Bleaching Powder

When bleaching powder (CaOCl₂) is added to water, the following reactions occur:  
  
1. CaOCl₂ + H₂O → Ca(OH)₂ + Cl₂  
2. Cl₂ + H₂O → HOCl + HCl  
3. HOCl ⇌ H⁺ + OCl⁻  
  
Hypochlorous acid (HOCl) and hypochlorite ions (OCl⁻) have strong germicidal action. They kill pathogenic bacteria and viruses, control algae, and oxidize iron, manganese, and hydrogen sulphide.

When bleaching powder is added to water, hydrochloric and hypochlorous acid are formed.

Hydrochloric acid is neutralized by alkalinity of water

Hypochlorous acid ionizes to from hydrogen ions and hypochlorite ions CaOCI2 + H2O CaO (settled lime is discarded)+Hcl+HOCl (Active principle). H2O+Cl2HCl+HOCl HOClH+OCI

Hypochlorous acid and to a small extent hydrochloric acid by their germicidal action, kills pathogenic bacteria and viruses, controls algae, thus disinfects water.

Apart from germicidal action, it oxidizes iron manganese and hydrogen sulphide.

In a medical college hostel, there is a rectangular tank measuring 6 meter in length 4 meter in breadth, depth of water is 8 meter.   
a) How much bleaching powder is needed to disinfect the water? Horrocks test shows blue color in 4th cup.

b) Enumerate water borne viral diseases. (5 + 2)

Solution:  
a) Step 1: Finding the volume of water in the water tank

Volume of water in the rectangular tank = L \* b \* h \* 1000 = 6\*4\*8\*1000

Where, L = Length = 6mt, b = breadth = 4 mt, h = height = 8 mt Volume of water per 1 m3 = 1000 litres

Volume of water in the rectangular tank is 192,000 liter.

Step 2: Calculating the bleaching powder demand  
4th cup means,4 level spoon (4 \* 2) = 8 gm of bleaching powder is required to disinfect 455 liter of water.

455 liter of water requires – 8 gm of bleaching powder For 192,000 liter- How much bleaching powder is required?

=(8/455)\* 192000 = 3,375.82 gm

3.38 kg bleaching powder is required for disinfect of tank water  
b) Poliomyelitis

Hepatitis A

Rota Virus

A swimming pool having 100 meter length, 60 meter breadth, with 10 meter depth of the water is to be disinfecting the swimming pool. Horrocks test show blue color in 4th cup.   
a) Calculate the amount of bleaching powder.   
b) What measures you advise for swimming pool sanitation.

Solution: (5 + 2 )

Step 1: Finding the volume of water I the swimming pool

Volume of water in swimming pool = L \* b \* h \* 1000 = 100 \* 60 \* 10 \* 1000

Where, L = length = 100 mt, b = breadth = 60 mt, h =height = 10 mt

= 60,000,000

= 60, 00,000 Volume of water per 1 m3 = 1000 litres

Volume of water in the swimming pool is 60,000,000 liter

Step 2: Finding the amount of bleaching powder required

4 th cup is the earliest cup showing blue color in Horrocks test indicates that, 4 level spoon ( 4 \* 2 ) = 8 gm of bleaching powder is required to disinfect 455 liter of water

455 liter of water requires – 8 gm of bleaching powder   
For 60,000,000 liter – How much bleaching powder is required?

= (8/455)\*60000000 = 1,054,945 gm

1054 kg 945 gm (roughly 1055) kg of bleaching powder is required to disinfect the swimming pool.

Step 3: Maintaining swimming pool sanitation

People suffering from skin disease, sore eye, nasal or ear discharge, upper respiratory, GI infections and any communicable disease should not be allowed to swim.

Swimmers are instructed to empty the bladder, bowel and to take bath before entering the pool.

Surrounding environment of the pool should be maintained well.

Swimming pools should have continuous filtration, daily water testing, and periodic super-chlorination. Regular maintenance ensures microbiological safety.

Pool water is frequently tested for any contamination. 25 sqft area is provided per swimmer.

## Breakpoint Chlorination

Breakpoint chlorination is the point at which the chlorine demand of water is completely satisfied, and any further addition of chlorine results in the presence of free residual chlorine. This ensures the safety of drinking water.

Solution:

Step 1: Finding the volume of water in the square tank

Volume of water in square tank = L \* b \* h \* 1000 == 8 \* 8 \* 10 \* 1000 = 640,000

Where, L=length = 8mt, b = breadth = 8mt, h=height of water = 10mt

1000 = volume of water per 1 m 3

Volume of water in the tank is 640,000 liter

Step 2: Finding the amount of bleaching powder requirement

6th cup is the earliest cup showing blue color in Horrocks test indicates that 6 level spoon (6 \* 2 gm) = 12 gm of bleaching powder is required to disinfect 455 liter of water.

455 liter of water require – 12 gm of bleaching powder

For 640,000 liter – How much bleaching powder is required?

= (12/455) \* 640000

= 16,879 gm

## Breakpoint Chlorination

Breakpoint chlorination is the point at which the chlorine demand of water is completely satisfied, and any further addition of chlorine results in the presence of free residual chlorine. This ensures the safety of drinking water.

Overhead tank with 1000 Liter of water in your house has to be disinfected. Bleaching powder demand was found to be 2g. / 453 liters of water  
a) Calculate the amount of bleaching powder required to disinfect the tank.  
b) How much contact period is required? (5 + 2 )

Solution:

Calculation the required bleaching powder

The bleaching powder demand is 2 gm, which indicates that 2 gm of bleaching powder is required to disinfect 455 liter of water.

455 liter of water requires—2 gm of bleaching powder   
for 1000liter—how much bleaching powder is required?

= (2/455)\* 1000 = 4.39 gm

4.39 gm of bleaching powder is required to disinfect the tank water. Freshly prepared Starch-iodine solution is used as indicator Recommended contact period is 1 hour after mixing bleaching powder and before use.