Tips for Exams - Examples of Questions and Easy Ways to Answer Them

1 L of water = 1 kg

Here is a common type of question:

What is the net weight of a 3500 litre tank of water?

a) 7700 kg
b) 3500 kg
c) 35 tonnes
d) 77 tonnes

Remember that 1 litre of water weighs 1 kg, so 3500 litres of water will weigh 3500 kg.

$$\left(\frac{1\,L}{1\,kg}\right)\left(\frac{3500}{3500}\right) = \frac{3500\,L}{3500\,kg}$$

1 m^3 of water = 1000 L = 1000 kg = 1 metric tonne

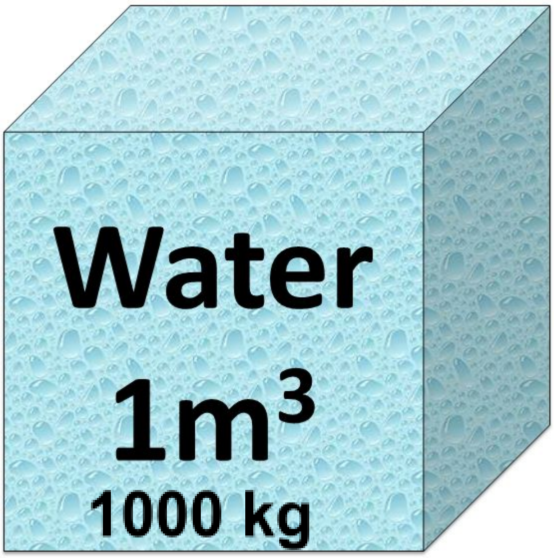
Along the same lines, here is another common question that you might see on an exam:

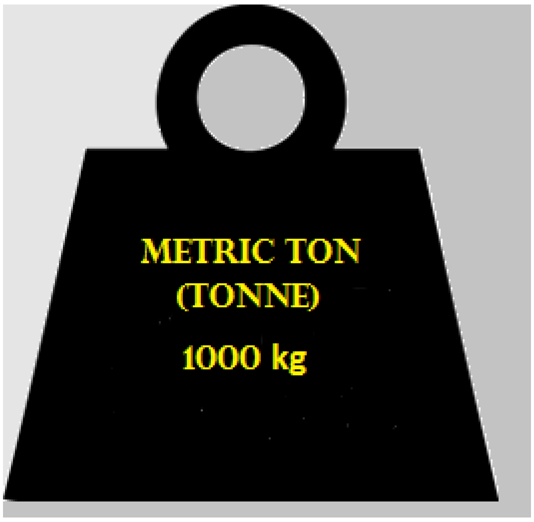
What is the weight in metric tonnes of one cubic metre of potable water?

a) 1.6
b) 2.2
c) 4.5
d) 1.0

Do you know the answer?

Remember that one cubic metre of water weighs 1000 kg.





Source: https://pediaa.com/difference-between-ton-and-metric-ton/

So, 1 cubic metre of water = 1000 kg = 1 metric tonne, therefore 1 cubic metre of water = 1 metric tonne.

One cubic metre of potable water, therefore, weighs 1.0 metric tonnes and the answer is d.

The Formula/Conversion Table You Receive When You Write Your Certification Exam

We will be referring to the Formula/Conversion Table that you are given when you write your certification exam document often and it is available here: http://surl.li/kcwsx or you can scan this QR code to get it:

A Quick Way to Estimate Degrees Celsius or Degrees Fahrenheit

The Formula/Conversion Table gives you this formula to convert degrees Celsius to degrees Fahrenheit:

$$\textbf{Degrees Fahrenheit} = (^{\circ}\mathrm{C})(1.8) + 32$$

and this formula to convert degrees Fahrenheit to degrees Celsius:

$$\textbf{Degrees Celsius} = \frac{(^{\circ}\mathrm{F} - 32)}{1.8}$$

However, since the questions are multiple-choice, you can usually find the correct answer by using a much simpler method:

To convert degrees Celsius to degrees Fahrenheit, multiply the Celsius temperature by 2 and add 30. (Multiplying the degrees Celsius by 2 instead of by 1.8 “compensates” for the addition of 30 instead of 32.)

To convert degrees Fahrenheit to degrees Celsius, divide the Fahrenheit temperature by 2 and subtract 15. (Dividing the degrees Fahrenheit by 2 instead of 1.8 “compensates” for the subtraction of 15 instead of approximately 17.78.)

Let's try this with a question:
35 degrees Celsius is equivalent to _______ degrees Fahrenheit.

a) 0
b) 95
c) 1.6
d) 55

We are converting from degrees Celsius to degrees Fahrenheit, so we are going to multiply the Celsius temperature by 2 and add 30:
(35)(2) + 30 = 70 + 30 = 100 The closest answer, by far, is 95 (choice b), so the answer is b.

Now, let's do that same question with the formula and see how close the answer is…

$$\textbf{Degrees Fahrenheit} = (^{o}C)(1.8) + 32$$

Degrees Fahrenheit = (35)(1.8) + 32
Degrees Fahrenheit = 95
The result is the exact number that is answer choice b. The estimate would work just as well since the answers are spaced quite far apart. If the answers were very close to each other, we might have needed to use the formula, but that tends to be unlikely on these tests.

In fact, you might have been able to answer the previous question without even using any calculations… normal body temperature in degrees Celsius is 37℃, which is close to 35℃, and you might have heard (for example, in movies and television shows) about people spiking fevers of around 104℉. Therefore, since 35℃ is a little less than 37℃, we can reason that the answer will be a little less than 104℉, and all of the other numbers are far too small.

You Can Almost Always Check Your Answer to a Math Question:

Often, there is more than one way to get to the answer. If you do the question a couple of different ways, do you get the same answer?

Every operation has an inverse operation, so you can often check your work by doing the inverse operation.

The inverse of addition is subtraction
The inverse of subtraction is addition
The inverse of multiplication is division
The inverse of division is multiplication

You can estimate the answer by rounding numbers and determining whether you get an answer that is close.

If you cannot think of another way to get to the answer and it is not a question for which doing the inverse operation would be helpful to check the answer, you can always do the question a second time without looking at your work from your previous attempt to see whether you get the same answer.

Tips to Help You Solve Word Problems

The first time you read the word problem, read it just like you would a story, do not try to figure out the math, just get a general sense of what is happening in the question.

Read the word problem a second time. This time, focus on what you need to find and the information you are given.

Make a strategy for how you will answer the question.

Do the math to answer the question - did you get an answer that is the same or close to one of the multiple-choice answers? If so, that is probably a good sign!

Check that your answer is reasonable.

Here is an example of a question that might seem very overwhelming when you first read it, but remember not to try to figure out the math the first time you read the question - just read it as you would a story and get an idea of what is happening in the question:
The electronic flow meter reads 137,892,900 gallons at 8:00 a.m. on Monday and 146,007,227 gallons at 8:00 a.m. on Tuesday. According to the scales, 122 lbs of chlorine was fed during that 24-hour period. Free chlorine readings entering the clearwell read 0.8 mg/L. What was the approximate chlorine demand of the raw water that day?

a) 2.6 mg/L
b) 1.0 mg/L
c) 3.2 mg/L
d) 4.1 mg/L

So, what is happening in the question?
An electronic flow meter is measuring the amount of water used during a 24-hour period, we know that an amount of chlorine was fed into the water, we have the free chlorine readings and want to know the approximate chlorine demand of the raw water that day.

Read the word problem a second time. This time, focus on what you need to find and the information that you are given.

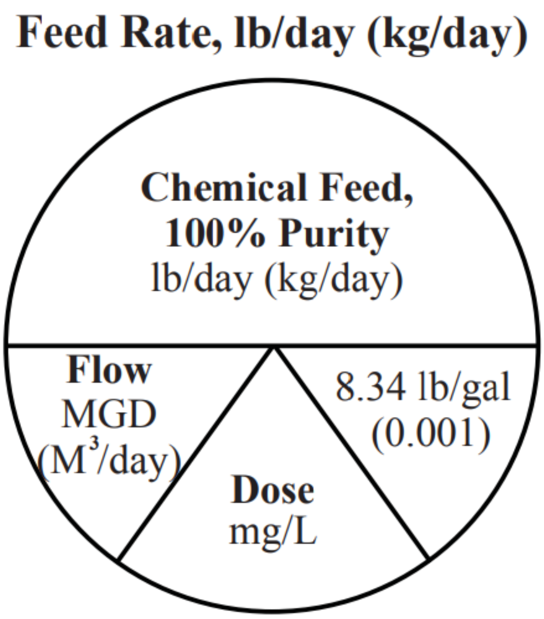
So, what do we need to find?
We need to find the approximate chlorine demand, in mg/L of the raw water that day.

What information are we given?

- We have the number of gallons that the electronic flow meter read at 8:00 a.m. on Monday and the number of gallons that the electronic flow meter read at 8:00 a.m. on Tuesday.
- We have that 122 lbs of chlorine was fed during the 24-hour period.
- We have that free chlorine readings entering the clearwell read 0.8 mg/L.

Plan how you will answer the question.

1. Find the number of millions of gallons of raw water that went through the water treatment plant that day.
2. Use this pie wheel to determine the dose in mg/L:



3. Subtract the chlorine reading from the chlorine fed to get the chlorine demand of the raw water.

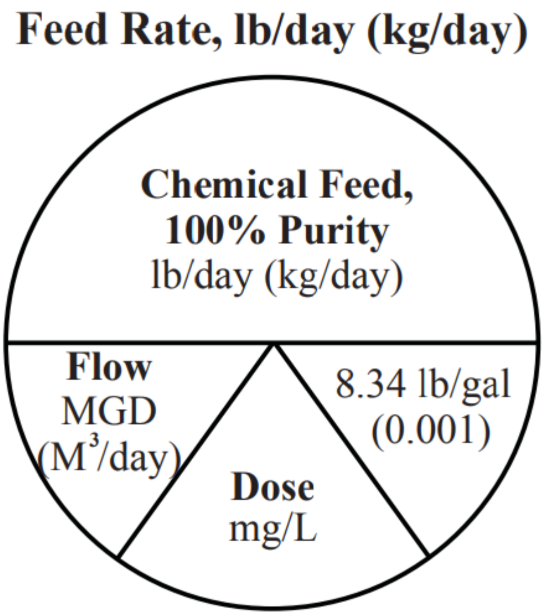
Let's do the math:

1. Find the number of millions of gallons of raw water that went through the water treatment plant that day.

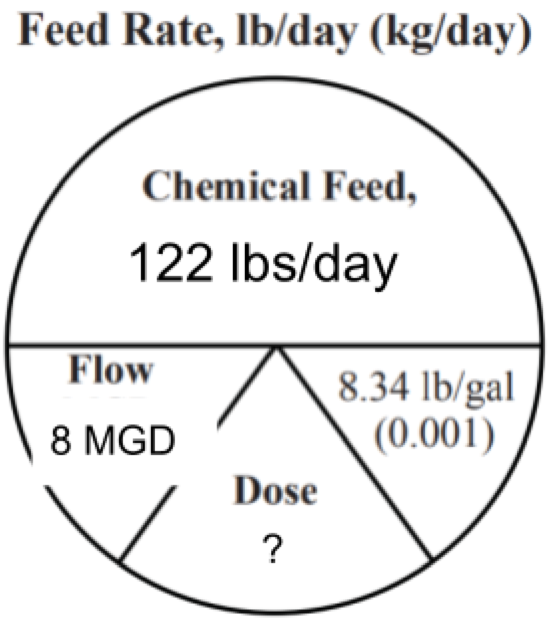
   146,007,227 gallons - 137,892,900 gallons = 8,114,327 gallons

   This is close enough to consider it 8 million gallons in one day (since it was a 24-hour period) (8 MGD).

2. Use this pie wheel to determine the dose in mg/L:



Plugging the values we have into the pie wheel, we get:



$$\frac{122\ lbs/day}{(8\ MGD)(8.34\ lb/gal)} = \text{dose}$$

$$\frac{122\ lbs/day}{66.72} = \text{dose}$$

1.83 mg/L ≈ dose

3. Subtract the chlorine reading from the chlorine fed to get the chlorine demand of the raw water.

Total chlorine - free chlorine = chlorine demand
1.83 mg/L - 0.8 mg/L = chlorine demand
1.0 mg/L ≈ chlorine demand
So, the answer would be b.

The ≈ Symbol

The ≈ symbol means approximately equal to. While it is used in this document, so that the work is formally correct, do not worry about putting it into your calculations.

How Many Digits Should You Keep?

Since the questions on the ABC standardized exams are multiple-choice questions and they do not tend to have options that are very close to each other, you should be fine if you round your numbers to one or two digits after the decimal point. In your work for many questions, you could even round your answers more than that if you would like. You might want to look at the possible answers to see how close they are, and judge how exact you are with your work accordingly.

Let's check that our answer is reasonable:
Feed Rate, lb/day = (Dosage, mg/L)(Flow, MGD)(8.34 lb/gal)
Let's plug in the dosage and the flow, perform the multiplication, and check that we get approximately 122 pounds:
Feed Rate, lb/day = (1.8 mg/L)(8 MGD)(8.34 lb/gal)
Feed Rate, lb/day ≈ 120 pounds, yes this is close, so our answer is probably correct!

Here is another question that involves chlorine:
How many lbs of HTH (65%) are required to treat 7 MG of water and satisfy a 2.8 ppm demand as well as a 0.6 ppm residual?

a) 198.5 lbs
b) 251.9 lbs
c) 288.7 lbs
d) 305.4 lbs

(Note that MG means millions of gallons, just as MGD means millions of gallons per day.)

What do we need to find?
We need to find the number of pounds of HTH (65%) that are required to treat 7 MG of water and satisfy a 2.8 ppm demand and a 0.6 ppm residual.

What information are we given?

- We have that the HTH concentration is 65%.
- We have that the amount of water we need to treat is 7 MG.
- We have that we need to satisfy a 2.8 ppm demand and a 0.6 ppm residual.

Plan how you will answer the question.

1. We will determine the total dosage by finding the sum of the chlorine demand and the chlorine residual.
2. We will use this formula from the Formula/Conversion table to find the feed rate in pounds (it does not need to only be used to find the feed rate per day, it can be used to find the feed rate for any amount of water, as long as the Flow is replaced by the amount of water, in millions of gallons):

$$\textbf{Feed Rate, lb/day*} = \frac{(\text{Dosage, mg/L})(\text{Flow, MGD})(8.34 \text{ lb/gal})}{\text{Purity, \% expressed as a decimal}}$$

Let's do the math:

1. We will determine the total dosage by finding the sum of the chlorine demand and the chlorine residual.
   2.8 ppm + 0.6 ppm = 3.4 ppm (or 3.4 mg/L)

2. We will use this formula from the Formula/Conversion Table to find the feed rate in pounds per day:

$$\textbf{Feed Rate, lb/day*} = \frac{\text{(Dosage, mg/L)(Flow, MGD)(8.34 lb/gal)}}{\text{Purity, \% expressed as a decimal}}$$

   Feed = $\frac{(3.4\ mg/L)(7\ MG)(8.34\ lb/gal)}{0.65}$ ≈ 305.4 pounds

   So, the answer would be d.

Let's check that our answer is reasonable:
Let's use that same formula, but let's solve for the purity.

$\frac{(3.4\ mg/L)(7\ MG)(8.34\ lb/gal)}{x}$ ≈ 305.4 pounds

$\frac{198.5}{x}$ ≈ 305.4

Multiply each side by x to get the variable out of the denominator:
198.5 ≈ 305.4x

Divide each side by 305.4 to solve for x: $\frac{198.5}{305.4} \approx \frac{305.4x}{305.4}$

0.65 ≈ x We got the correct purity % expressed as a decimal, so our answer is most likely correct!

A Note Regarding the Steps for Solving Word Problems

Of course, you could continue to use the steps for solving word problems that were discussed in this document for word problems that involve fewer steps as well. However, in the interest of brevity, the formal steps will not appear in the remainder of the problems.

SASKATCHEWAN FIRST NATIONS WATER ASSOCIATION

When Given Answer Options that Are in Minutes and in Hours and Minutes, Check that They Are Different - Otherwise, You Can Eliminate Some Options!

It is likely that a question on the ABC standardized exam will relate to detention time. Here is one example:
The basin in the water treatment plant measures 60 feet long by 40 feet wide by 8 feet deep. The flow through this plant is 4.1 cubic feet per second. What is the detention time?

a) 1 hour 18 minutes
b) 144 minutes
c) 449 minutes
d) 2 hours 24 minutes

If we convert the answer options that are in hours and minutes to just minutes (remember 1 hour = 60 minutes, so we multiply the number of hours by 60 and then add the number of minutes), we get the following options:

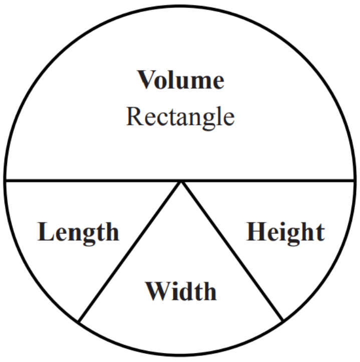
a) 78 minutes
b) 144 minutes
c) 449 minutes
d) 144 minutes

Wait a minute… answers b and d are the same, they are both equal to 144 minutes. Therefore, how could the answer be b or d? We can only choose one answer, and if b is correct then so would be d and vice versa! Therefore, we can eliminate the options that are obviously incorrect and we are just left with a. 78 minutes or c. 449 minutes.

Next, we are going to calculate the volume of the basin. We will use this formula from the Formula/Conversion Table:

Volume of Rectangular Tank* = (Length)(Width)(Height) The star means that there is a Pie Wheel Format for this equation that is available at the end of this document. It is this:

Volume of Rectangular Tank



It means that to find the volume of a rectangular tank we can multiply the length by the width by the height, to find the length we can divide the volume by the product of the width and the height, to find the width we can divide the volume by the product of the length and the height, and to find the height we can divide the volume by the product of the length and the height.

Math Terms Reminder

Product = Answer to a multiplication question
Quotient = Answer to a division question
Sum = Answer to an addition question
Difference = Answer to a subtraction question

We want the volume and we have the length, the width, and the height, so we multiply them together (note that, even if we did not know which dimension was the length, which was the width, and which was the height, as long as we had the three dimensions and we knew that it was a rectangular tank, we could multiply the three dimensions together to get the volume): Volume = (60 ft)(40 ft)(8 ft) = 19,200 ft^3

We know that the flow is 4.1 cubic feet per second, so we divide the total volume by the flow and get $\frac{19{,}200\ ft^3}{4.1\ ft^3/s} \approx$ 4682.93 seconds, but we need this in minutes. We know that there are 60 seconds in each minute, so we divide the number of seconds by 60 to get the number of minutes: 4682.93 seconds ÷ 60 seconds/minute ≈ 78 minutes. So, the answer is a.

Options Can Be Eliminated When their Units Do Not Make Sense

Sometimes, it is easy to eliminate an option because its units do not make sense,

Here is an example of this:
Water is flowing through a completely filled 10-inch line at 4 cuft/sec. What is the velocity?

a) 0.4 fps
b) 7.3 fps
c) 2.5 fps
d) 4.0 cuft/sec

Velocity is always a linear measurement divided by a unit of time (like when you are travelling 100 km/h on the highway). Therefore, option d can be eliminated because it is in cubic units divided by a unit of time.

Since we want to find the Velocity, we have the line's diameter in inches, and we want the final units to be fps (or ft/sec), we will use this formula:

$$\textbf{Velocity, ft/sec} = \frac{\text{Flow Rate, ft}^3\text{/sec}}{\text{Area, ft}^2}$$

There are 12 inches in a foot, so the diameter of the line is $\frac{10}{12}$ feet, which is equal to $\frac{5}{6}$ feet. We know that the formula for the area of a circle is $\textbf{Area of Circle*} = (0.785)(\text{Diameter}^2)$ so, we plug in the diameter in feet and we get Area of Circle = $(0.785)(\frac{5}{6})^2 = (0.785)(\frac{25}{36}) \approx 0.55$ ft^2.

We plug the flow rate and the area into the equation and get:
Velocity, ft/sec = $\frac{4\ ft^3/s}{0.55\ ft^2} \approx 7.27$ fps, which rounds to 7.3 fps, so the answer is b.

Here is another question where we can use this technique:
The water treatment plant treats 9.5 MGD through the use of six (6) filters, each measuring 20 ft wide by 20 ft long. What is their filtration rate?

a) 16.50 gpm/sqft
b) 1.77 gpm/sqft
c) 2.75 gpm/sqft
d) 4.76 gpm/q/ft

What are gpm/q/ft? Nobody knows! We can, therefore, eliminate option d.

Next, let's figure out the total number of square feet of filters at this water treatment plant. There are 6 filters and they each have the same dimensions. Each filter measures 20 ft wide by 20 ft long. Therefore, the area of each filter is (20)(20) = 400 ft^2, and since there are 6 of these filters, we can multiply this area by 6: (6)(400 ft^2) = 2400 ft^2.
Now, let's convert from MGD to gpm. Fortunately, there is a conversion for this in the Conversion Factors in the Formula/Conversion Table:

1 million US gallons per day .... = 694 gpm

(9.5)(694) = 6593 gpm
Now, we divide the gallons per minute by the square feet of filters to get the gpm/sqft:
6593 gpm/2400ft^2 ≈ 2.75 gpm/sqft, so the answer is c.

Here is yet another question where we can use this technique:
25 MGD is equivalent to ______________________.

a) 1122 gpm and 1560 cu/ft of water
b) 36000 gpm and 187 cuft/sec
c) 17362 gpm and 38.75 cuft/sec
d) 15600 gpm and 466.7 cuft/sec

The units for the second part of option a are cu/ft of water? That makes no sense, there is never cubic/feet, it is cubic feet, so we know that a is not the correct answer.

Options Can Also Be Eliminated When They Are Supposed to Express the Same Value in Two Different Units, and the Values Are Not Actually Equal

We are continuing the previous question… from the Conversion Factors in the Formula/Conversion Table document, we can see that 1 million US gallons per day is equal to 694 gpm and 1.55 ft^3/sec. If we want, we can multiply the number of cuft/sec by 694/1.55 (≈ 447.74) to get the gpm to determine whether all of the answers are even possible: (187 cuft/sec)(447.74 gpm/ft^3/sec) = 83,727.38 gpm, so b is not possible. (38.75 cuft/sec)(447.74 gpm/ft^3/sec) ≈ 17,349.93 gpm, so c is close enough to be possible (there can be small differences due to rounding). (466.7 cuft/sec)(447.74 gpm/ft^3/sec) ≈ 208,960.26 gpm, so d is not possible. Therefore, c is the only answer that is even possible, but let's check our answer:
(25 MGD)(694) = 17,350 gpm - okay, close enough
(25 MGD)(1.55) = 38.75 cuft/sec - yes
Therefore, the answer is c.

Here is another question where we can put this technique to use:
The flow through a water plant is 5.25 MGD. Jar tests have indicated that the desired dosage of lime is 150 mg/L. What would be the correct lime feeder setting per day and per minute?

a) 3294.0 lbs a day/2.29 lbs a minute
b) 6567.8 lbs a day/4.56 lbs a minute
c) 4930.9 lbs a day/3.42 lbs a minute
d) 6587.8 lbs a day/274.5 lbs a minute

We can see that the numbers of lbs a day in option b and option d are close (6567.8 lbs a day and 6587.8 lbs a day, respectively). However, their numbers of lbs a minute are not close at all (4.56 lbs a minute and 274.5 lbs a minute, respectively), so one must be incorrect. We know that there are 60 minutes in each hour and 24 hours in each day, so we can multiply 60 by 24 and get the number of minutes in a day: (60 minutes/hr)(24 hrs/day) = 1440 minutes/day (1440 minutes in a day). Therefore, if we multiply the number of lbs a minute by 1440, we should get the number of lbs a day. (274.5 lbs/min)(1440 min/day) = 395,280 lbs/day, so this is the one that must be incorrect. Let's check the other one too: (4.56 lbs/min)(1440 min/day) = 6566.4 lbs/day yes, that is close enough.

Let's use the Conversion Factors from the Formula/Conversion Table to convert from gallons to litres to convert MGD to millions of litres per day:

1 gallon (US) .... = 3.785 L

(5.25 MGD)(3.785 litres/gallon) ≈ 19.87 million litres per day
150 mg/L is the desired dosage of lime, so let's multiply the 19.87 million litres per day by this dosage:
(19.87 million L)(150 mg/L) = 2980.5 million milligrams

Next, we need to convert milligrams to kilograms and then kilograms to pounds:
2980.5 million milligrams ÷ 1 million = 2980.5 kg

Let's find the number of pounds of lime required per day by converting the kilograms to pounds:
2980.5 kg ÷ 0.454 kg/lb ≈ 6565 pounds
This is quite close to answer b and to answer d, but we know that answer d cannot be correct because of its number of pounds per minute. Therefore, we know that the answer is b.

Two Notes About Converting Units

If you multiply by a conversion factor to change the units from “a” to “b” (a and b represent any units that could be converted), then you can always divide by that same conversion factor to change the units from “b” to “a”. Vice versa, if you divide by a conversion factor to change the units from “a” to “b”, then you can also multiply by that same conversion factor to change the units from “b” to “a”.

If you are converting a measurement from smaller units to larger units, you should end up with a smaller number because there will be fewer, larger units. If you are converting a measurement from larger units to smaller units, you should end up with a larger number because there will be more, smaller units.

For example, if you were converting kilograms to pounds, you should end up with more of them because 1 pound is lighter than 1 kilogram. If you were converting pounds to kilograms, you should end up with fewer of them because 1 kilogram is heavier than 1 pound.

If you were converting litres to U.S. gallons, you should end up with fewer of them because 1 U.S. gallon (or any gallon for that matter) is larger than 1 litre. If you were converting U.S. gallons to litres, you should end up with more of them because 1 litre is smaller than 1 U.S. gallon (or any gallon for that matter).

This is a quick way to check whether your answer is reasonable after you convert units.

Sometimes, Word Problems Have Extra Information That Is Not Needed - Do Not Let It Confuse You!

Here is an example of a question with extra information that is not needed:
The treatment facility treats 100,000 cuft of water a day and operates for 18 hours a day. How much water do they treat a day expressed in MGD?

a) 0.75 MGD
b) 1.80 MGD
c) 2.92 MGD
d) 5.75 MGD

We are told that the treatment facility operates for 18 hours a day - will we use the number 18 in any of the equations? No! We know that the treatment facility treats 100,000 cuft of water a day and we want to find the amount of water they treat a day expressed in MGD - it does not matter how many hours a day the treatment facility operates because this is all based on the day, none of it is based on the hours of operation! Therefore, all we need to do is convert 100,000 cuft of water into millions of gallons of water, since they are both per day. Again, we use the Conversion Factors from the Formula/Conversion Table:

1 cubic foot of water .... = 7.48 gal

(100,000)(7.48) = 748,000

$\frac{748,000}{1,000,000}$ = 0.748 This answer is reasonable because 748,000 is a little less than one million.

This is approximately 0.75 million, so the answer is a.

It Is Easy to Write Similar Questions to Practice Answering Them

To write similar questions to practice answering them, simply change the values. You might not have multiple-choice answers to choose from, but you have a similar math question to solve. Another option is to change the values, solve the question, and then turn the question into a multiple-choice question by writing the correct answer and three other options as possible answers. Have a colleague do the same, and then exchange papers to answer each other's questions.

However, there are also many websites on which you can find practice questions and practice tests. Some of them can be found on SFNWA's website here: https://sfnwa.ca/basic-information in the answer to the question "How can someone prepare for the water systems operator exams?"

There is the Long Way Around, and There Is Often A Quicker Way - It Is Alright to Take Shortcuts in Math As Long As They Always Work!

Here is a more difficult type of question that you might see on an ABC standardized exam, but one for which we will find a simple solution:

If water flowing in a 150 mm (6 inch) pipe is discharged into a 100 mm (4 inch) diameter pipe, the velocity will:

a) remain the same
b) increase approximately twice
c) decrease approximately twice
d) increase four times

What would your first instinct be? What do you think the answer is?

Thinking logically about the question, if the same volume of water had to move through a pipe with a smaller diameter, would it have to go faster or slower?
If the same volume of water had to move through a pipe with a smaller diameter, it would have to go faster.

Therefore, we can eliminate two of the choices:
If water flowing in a 150 mm (6 inch) pipe is discharged into a 100 mm (4 inch) diameter pipe, the velocity will:

~~a) remain the same~~
b) increase approximately twice
~~c) decrease approximately twice~~
d) increase four times

Now, how do we determine whether the answer is b or d? Can you figure it out?

From the Formula/Conversion Table, one could use any of these formulas for velocity:

$$\textbf{Velocity, ft/sec} = \frac{\text{Flow Rate, ft}^3\text{/sec}}{\text{Area, ft}^2}$$

$$\textbf{Velocity, ft/sec} = \frac{\text{Distance, ft}}{\text{Time, sec}}$$

$$\textbf{Velocity, m/sec} = \frac{\text{Flow Rate, m}^3\text{/sec}}{\text{Area, m}^2}$$

$$\textbf{Velocity, m/sec} = \frac{\text{Distance, m}}{\text{Time, sec}}$$

There are four different formulas for velocity, how do we know which one to choose? We know that we have the diameters of the pipes in both millimetres and inches, so we could convert inches to feet and use one of the top two formulas or we could convert millimetres to metres and use one of the bottom two formulas. Wait a second… we do not have the velocity and we do not have the flow rate… and we do not have the velocity, we do not have the distance, and we do not have the time… so we would have two or three unknowns no matter which formula we use! To use a formula to solve for an unknown, we generally need to have only one unknown!

What can we figure out? Well, we do not know the value of the flow rate, but we know that the flow rate will be the same regardless of which pipe the water is flowing through, because the water flows at the same rate. Let’s use the first formula to figure this out…

$$\textbf{Velocity, ft/sec} = \frac{\text{Flow Rate, ft}^3\text{/sec}}{\text{Area, ft}^2}$$

Now, to compare the velocities of the water when it is flowing through the pipes with the two different diameters, we can set up a fraction with the flow rate being the same for both, so we will call it f, for flow rate. Since we want to know how the velocity changed, we will divide the velocity of the pipe the water is flowing into (the one with a diameter of 4 inches) by the velocity of the pipe the water is flowing from (the one with a diameter of 6 inches):

$$\frac{\dfrac{f}{Area\ of\ the\ pipe\ with\ a\ 4\ inch\ diameter,\ ft^2}}{\dfrac{f}{Area\ of\ the\ pipe\ with\ a\ 6\ inch\ diameter,\ ft^2}}$$

from school, you might remember that the saying for dividing fractions is “flip and multiply” (we multiply the numerator by the reciprocal of the denominator). So, let’s do that:

$$\frac{f}{Area\ of\ the\ pipe\ with\ a\ 4\ inch\ diameter,\ ft^2} \times \frac{Area\ of\ the\ pipe\ with\ a\ 6\ inch\ diameter,\ ft^2}{f}$$

You might also remember that we can cross simplify, so we would get:

$$\frac{\cancel{f}}{Area\ of\ the\ pipe\ with\ a\ 4\ inch\ diameter,\ ft^2} \times \frac{Area\ of\ the\ pipe\ with\ a\ 6\ inch\ diameter,\ ft^2}{\cancel{f}}$$

Which gives us:

$\frac{Area\ of\ the\ pipe\ with\ a\ 6\ inch\ diameter,\ ft^2}{Area\ of\ the\ pipe\ with\ a\ 4\ inch\ diameter,\ ft^2}$ Okay, so now we just need to find the areas of the pipes, in square feet, and divide them…

We can use either of these formulas to find the area of a circle:

Area of Circle* = (0.785)(Diameter^2)

Area of Circle = (3.14)(Radius^2)

We need to convert the diameters of the pipes from inches to feet, square that, and then multiply by 0.785…

Let’s convert the 6-inch diameter to feet first:

$\frac{6\ inches}{12\ inches/ft}$ = 6 ~~inches~~ ($\frac{1\ foot}{\cancel{12\ inches}}$) = $\frac{6}{12}$ ft = ½ ft

Let's convert the 4-inch diameter to feet:

$\frac{4\ inches}{12\ inches/ft}$ = 4 ~~inches~~ ($\frac{1\ foot}{12\ \cancel{inches}}$) = $\frac{4}{12}$ ft = ⅓ ft

Next, we divide the area of the pipe with the 6-inch diameter by the area of the pipe with the 4-inch diameter:

$\frac{Area\ of\ the\ pipe\ with\ a\ 6\ inch\ diameter,\ ft^2}{Area\ of\ the\ pipe\ with\ a\ 4\ inch\ diameter,\ ft^2}$ = $\frac{(\frac{1}{2}\ ft)^2(0.785)}{(\frac{1}{3}\ ft)^2(0.785)}$ = $\frac{(\frac{1}{2}\ ft)^2(0.785)}{(\frac{1}{3}\ ft)^2(0.785)}$ $\frac{0.25\ \cancel{ft^2}}{0.11\ \cancel{ft^2}}$ = 2.27

So, the velocity will be a little more than double, and the answer is b.

Could there not be a much simpler way of solving this problem? Yes! There is! We can simply square the diameter of the pipe the water is coming from and divide that by the square of the diameter of the pipe the water is flowing into, and the diameters can be in any units as long as they are in the same units. So, we could have simply calculated $\frac{6^2}{4^2}$ = $\frac{36}{16}$ = 2.25.

How do we know that this simplified method will always work?
Let's look at the formula we used after we had crossed out the flow rate (remember that we could do that because the flow rate would be the same):

$\frac{Area\ of\ the\ pipe\ with\ a\ 6\ inch\ diameter,\ ft^2}{Area\ of\ the\ pipe\ with\ a\ 4\ inch\ diameter,\ ft^2}$ We can calculate the area of a circle with its diameter in any units, we just need the units in the numerator to be the same as the units in the denominator so that the ratio makes sense.

$\frac{(diameter\ of\ the\ first\ pipe)^2(0.785)}{(diameter\ of\ the\ second\ pipe)^2(0.785)}$ We can simplify this expression by cancelling out what is the same in the numerator and in the denominator:

$\frac{(diameter\ of\ the\ first\ pipe)^2\cancel{(0.785)}}{(diameter\ of\ the\ second\ pipe)^2\cancel{(0.785)}}$ We are, therefore, just left with

$\frac{(diameter\ of\ the\ first\ pipe)^2}{(diameter\ of\ the\ second\ pipe)^2}$ and you can remember that when you have a question like this, you just square the diameter of the pipe the water is coming from and divide that by the square of the diameter of the pipe the water is flowing into, as long as the units of the diameters are the same!

Questions For You - Find the Answers and Check Your Answers

1. What is the net weight of a 5000 litre tank of water?
   a) 10 000 kg
   b) 5000 kg
   c) 50 tonnes
   d) 100 tonnes

2. What is the weight in grams of one cubic centimetre of water?
   a) 1.6
   b) 2.2
   c) 4.5
   d) 1.0

3. 53 degrees Fahrenheit is equivalent to _______ degrees Celsius.
   a) -10
   b) 5
   c) 12
   d) 67

4. Chlorine is added at a rate of 10 lb/day to a flow of 300 gpm. If the chlorine residual in the system is 1.5 mg/L, what is the chlorine demand?
   a) 2.8 mg/L
   b) 1.3 mg/L
   c) 3.4 mg/L
   d) 4.6 mg/L

5. How many lbs of HTH (65%) are required to treat a storage tank with 0.5 MG of water if the dose is 10 ppm?
   a) 14.6 lbs
   b) 41.6 lbs
   c) 61.4 lbs
   d) 64.1 lbs

6. What is the detention time in hours for a flow of 2,200,000 gal/day through a tank that measures 50 ft long, 40 ft wide and 30 ft tall?
Hint - You might need this conversion factor:

1 cubic foot of water .... = 7.48 gal

a) 1.4 hours
b) 1.9 hours
c) 4.1 hours
d) 4.9 hours

7. If a flow of 1,200,000 gpd were flowing through an 18-inch pipe, what is the velocity in ft/sec?
Hint - You might need this conversion factor:

1 million US gallons per day .... = 694 gpm
= 1.55 ft^3/sec

a) 0.01 fps
b) 0.05 fps
c) 1.05 fps
d) 5.01 fps

8. The water treatment plant treats 1 MGD through the use of one filter that measures 20 ft by 25 ft. What is their filtration rate?
a) 15.38 gpm/q/ft
b) 1.39 gpm/sqft
c) 2.62 gpm/sqft
d) 4.48 gpm/sqft

9. 3 MGD is equivalent to ________________________.
a) 2082 gpm and 4.65 cuft/sec
b) 20820 gpm and 4.65 cuft/sec
c) 2082 gpm and 0.47 cuft/sec
d) 20820 gpm and 46.5 cu/ft of water

10. The flow through a water plant is 2.2 MGD. Jar tests have indicated that the desired dosage of lime is 120 mg/L. What would be the correct lime feeder setting per day and per minute?

a) 2201.0 lbs a day/1.53 lbs a minute
b) 4820.8 lbs a day/6.70 lbs a minute
c) 5134.7 lbs a day/3.57 lbs a minute
d) 3482.4 lbs a day/2.42 lbs a minute

11. The treatment facility treats 250,000 cuft of water a day and operates for 12 hours a day. How much water do they treat a day expressed in MGD?
    a) 0.87 MGD
    b) 1.87 MGD
    c) 0.16 MGD
    d) 0.94 MGD

12. If water flowing in an 80 mm (3.1 inch) pipe is discharged into a 130 mm (5.1 inch) diameter pipe, the velocity will:
    a) decrease to approximately three-quarters of what it was
    b) increase approximately three times
    c) decrease to approximately one-third of what it was
    d) remain the same

Answers:

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