

# Healthcare Math: Calculating IV Flow Rates



**Industry:** Healthcare

**Content Area:** Mathematics

**Core Topics:** Using formulas, converting time measurements, applying medical terms to math problems, rounding decimals

**Objective:** Students will be able to use a formula to calculate IV flow rates and perform time and rate calculations for IV medical orders.

**Materials included:**

- Instructor's notes
- Scenario: Registered Nurse (RN)
- Student worksheets
- Handouts
- Quiz
- Answer Keys

**Industry Overview:**

According to the U.S. Department of Labor, the healthcare industry is expected to generate over 20% of all new jobs created in the U.S. economy between 2012 and 2022.\* The healthcare industry is comprised of a vast array of jobs, ranging from nursing assistants to physicians. Mathematics and literacy skills are essential for students who plan to pursue a career in this field. Healthcare professionals, including nurses, must have the ability to use mathematical formulas to perform such tasks as calculating flow rates and administration times for intravenous (IV) medications and solutions.

\* Source: <http://www.bls.gov/news.release/ecopro.t06.htm>

## Instructor's notes:

- The purpose of this module is to help students develop and apply math skills in a healthcare workplace setting. The learning activities were designed to be incorporated throughout multiple instructional periods as math concepts are taught in a healthcare context.
- After completing the module, students should be able to:
  - Define the terms used in IV drug administration
  - Convert hours and minutes
  - Use a formula to calculate IV flow rates for medical orders
  - Calculate administration times and rates per hour for IV orders
- **Setting the stage:** Provide students with background information about the typical responsibilities of a registered nurse. You may want to have students use the occupational outlook handbook, O\*NET and/or other relevant websites to research the job responsibilities, educational/training requirements, salary, etc. for this position. In addition, you could have students view a YouTube video depicting the typical responsibilities of a registered Nurse (See links below)

Bureau of Labor Statistics – Occupational Outlook Handbook:

<http://www.bls.gov/ooh/>

Occupational Information Network (O\*NET)

<http://www.onetonline.org/link/summary/29-1141.00>

Life of a Registered Nurse:

[http://www.youtube.com/watch?v=NPh\\_Gtf51M0](http://www.youtube.com/watch?v=NPh_Gtf51M0)

- **For Activity 1:** As a class, discuss the common medical terms used in IV drug administration. Work examples of rounding decimals to the nearest whole number. Work examples of converting hours and minutes. Answers for the examples: 450 min., 3.75 hr., and 180 min. Have students complete **Worksheet 1**.
- **For Activity 2:** Have students watch the following YouTube video that covers the steps in setting up an IV drug set and the formula used to calculate the IV flow rate: <http://www.youtube.com/watch?v=KmyAksAo0RY> Introduce students to the flow rate formula and the steps to calculate the flow rate. Discuss the three main drop factors for IV drug administration. Work the scenario examples with students. Answer to the practice problem: 23 gtts/min. Have students complete **Worksheet 2**.
- **For Activity 3:** Explain and work the scenario examples with the class. Provide additional examples as needed. Answers for the examples: 60 gtts/min; Yes, the flow rate is correct; 1:00 p.m.; 125 mL/hr; 31gtts/min. Have students complete **Worksheet 3**.
- **Assessment: Quiz – Calculating IV flow rates**

## Workplace Scenario: Registered Nurse

You are a registered nurse working in an intensive care unit (ICU) at a local hospital. Part of your responsibility is to administer doctor prescribed medications to your patients. As you may know, medications are given in a variety of forms, including shots, tablets, capsules, and liquid. At times, the most effective way for patients to receive medications or fluids is through intravenous (IV) administration. The most common way to administer IV's is through the veins in the arm. As a nurse, you have to learn the meaning of the terms and the procedures required for IV administration.

### Activity 1: Task 1 – Understanding IV terms

The following abbreviations are commonly used in IV administration. Make sure you know what each term means before proceeding to task 2.

Abbreviation	Meaning
IV	Intravenous
gtt	Drop
gtts	Drops
h or hr	Hour
mL	milliliter
min	minute
gtts/min	Drops per minute

### Activity 1: Task 2 – Rounding drops

When calculating the IV flow rate, the number of drops (gtts) are always rounded to the nearest whole number. Look at the following examples:

12.38 The number you should round is to the left of the decimal point. Underline this number. Now, look at the first number to the right of the decimal point. Since this number is less than 5, the number you are rounding stays the same. Answer: 12 gtts.

12.53 In this example, the first number to the right of the decimal point is 5 or larger, so you will round up. Answer: 13 gtts.

### Activity 1: Task 3 – Converting hours and minutes

Another important skill used in calculating IV flow rates is converting between hours and minutes. Some IV drugs are delivered slowly over several hours, while others are administered rapidly for several minutes. The directions for administering IV medications must be followed precisely in order to be safe and effective for the patient.

Since you know that 1 hour = 60 minutes, you can convert hours to minutes by multiplying by 60. That is: **# of hours x 60 = # of minutes**. For example, to convert 4.25 hours into minutes, you would multiply by 60:  $4.25 \times 60 = 255$  minutes

If you want to convert minutes to hours, you would divide by 60. **# of minutes ÷ 60 = # of hours**. For example, to convert 330 minutes into hours, you would divide by 60:  $330 \div 60 = 5.5$  hours

7.5 hours = \_\_\_\_\_ minutes      225 minutes = \_\_\_\_\_ hours      3 hours = \_\_\_\_\_ minutes

Complete **Worksheet 1** to practice the skills in this activity.

**Worksheet 1: IV terms, rounding and converting time units**      Name: \_\_\_\_\_

**Directions:** Write the correct abbreviation for each term or definition.

<b>Term/Definition</b>	<b>Abbreviation</b>
Hour	
Drops	
Milliliters	
Intravenous	
Drops per minute	

**Directions:** Round each drop to the nearest whole number and use the correct unit abbreviation in the answer.

1. 123.8 drops = \_\_\_\_\_
2. 0.82 drops = \_\_\_\_\_
3. 15.25 drops = \_\_\_\_\_
4. 24.9 drops = \_\_\_\_\_
5. 35.35 drops = \_\_\_\_\_

**Directions:** Convert each of the following as indicated.

<b>Time in Hours</b>	<b>= Time in Minutes</b>
6 hours	
15 ½ hours	
24 hours	
12 ¼ hours	
<b>Time in Minutes</b>	<b>= Time in Hours</b>
525 minutes	

## Activity 2: The IV flow rate formula

In order to calculate the IV flow rate, you must know the total volume to be infused, the time in minutes, and the drop factor. The **drop factor** is the rate at which medicine flows through the IV line into the body. The three main drop factors for IV administration sets are:

**Blood drip factor – 10 gtts/mL**  
**Standard drip factor – 15 gtts/mL**  
**Microdrip factor – 60 gtts/mL**

The formula for calculating IV flow rates is:

$$\frac{\text{Total volume (mL)}}{\text{time (in minutes)}} \times \text{drop factor (gtts/mL)} = \text{gtts/min (flow rate)}$$

As a nurse, you always follow these five steps to calculate the IV flow rate.

- Step 1: Write the formula with the information you are given
- Step 2: Convert hours to minutes, unless time is given in minutes
- Step 3: Divide the total volume by the time in minutes
- Step 4: Multiple the answer in step 3 by the drop factor
- Step 5: Round to the nearest whole number and write your answer in the form of gtts/min.

**Example:** 1500 mL IV Saline is ordered over 12 hours. Using a drop factor of 15 gtts/mL, how many drops per minute (gtts/min) need to be delivered?

$$\frac{1500 \text{ (mL)}}{12 \times 60} \times 15 \text{ (gtts/mL)} = 31 \text{ gtts/min (flow rate)}$$

- Step 1: Write the formula with the given information.
- Step 2: Convert the hours to minutes:  $12 \times 60 = 720$  minutes
- Step 3: Divide the total volume by the time in minutes:  $1500 \div 720 = 2.0833$
- Step 4: Multiply the answer in step 3 by the drop factor:  $2.0833 \times 15 = 31.2495$
- Step 5: Round to the nearest whole number and write your answer in the correct form: 31 gtts/min

Note: Since you are multiplying 2 fractions, you might find it easier to cancel first. For example, in the

above problem:  $\frac{1500}{12 \times 60} \times 15 = \frac{1500}{48} = 31.25 = \underline{31 \text{ gtts/min}}$

Try this practice problem: 2500 mL of a solution is ordered to be administered over 36 hours. Using a drop factor of 20 gtts/mL, what is the flow rate? \_\_\_\_\_

**Directions:** Identify the drops per milliliter (gtts/mL) for the 3 main drop factors.

Microdrip factor = \_\_\_\_\_

Standard drip factor = \_\_\_\_\_

Blood drip factor = \_\_\_\_\_

**Directions:** Use the formula and follow the steps to calculate the IV flow rate for each of the following

$$\frac{\text{Total volume (mL)}}{\text{time (in minutes)}} \times \text{drop factor (gtts/mL)} = \text{gtts/min (flow rate)}$$

1. 500 mL to run over 6 hours. The drop factor is 20 gtts/mL.
2. 1000 mL to be delivered over 12 hours. The drop factor is 15 gtts/mL.
3. 650 mL to infuse over 4 hours. The drop factor is 10 gtts/mL.
4. 100 mL to be delivered over 40 minutes. The drop factor is 20 gtts/mL.
5. 250 mL to infuse over 2 hours. The drop factor is 15 gtts/mL.
6. 2000 mL to run over 24 hours. The drop factor is 60 gtts/mL.
7. 1200 mL to run over 12 hours using a microdrip infusion set.
8. 50 mL to be infused in 30 minutes with a drop factor of 15 gtts/mL.
9. 650 mL to infuse in 10 hours with a blood drip factor.
10. 750 mL to run over 5 hours using IV tubing with a drop factor of 20 gtts/mL.

### Activity 3: IV calculations for medical orders

In the hospital, you receive medical orders for your patients throughout the day. After reading the orders, you use the formula to calculate the correct IV flow rate for the medications. Many of these orders contain abbreviations. The chart below contains some of the most common IV solutions.

Solution	Description
D <sub>5</sub> W	5% Dextrose Water
2/3D & 1/3S	3.3% Dextrose/ 0.3% saline
NS Normal Saline	0.9% NaCl
Half-Normal Saline	0.45% NaCl
D <sub>5</sub> 1 -2.NS	5% Dextrose/0.5% NaCl
LR	Lactated Ringer

This morning, you received the following order for your patient. Order: 480 mL D<sub>5</sub>W to infuse IV over 8 hours using tubing with a drop factor of 60 gtts/mL. After selecting the correct IV set, you calculate the flow rate. The flow rate is: \_\_\_\_\_

Once you have set up the IV for the patient, you manually verify the gtts/min by counting the drops for 15 seconds and then multiplying this number by 4, because 15 seconds x 4 = 60 seconds (1 minute). You count 15 drops in 15 seconds. 15 x 4 = 60 gtts/min. Is the IV flow correct? \_\_\_\_\_

At times, you receive IV orders with the rate of milliliters per hour (mL/hr) instead of the total infusion time. You can use this rate to calculate the IV flow rate. For example:

Order: 1000 mL to infuse at 200 mL/hr with a drop factor of 15 gtts/mL.

$$\frac{200 \text{ mL}}{1 \times 60} \times 15 = \frac{200}{4} = \underline{50 \text{ gtts/min}}$$

If you need to know the total infusion time for the above problem, you can use a proportion to find the hours:

$$\frac{200 \text{ mL}}{1 \text{ hr}} = \frac{1000 \text{ mL}}{x \text{ hrs}} \quad \text{Cross multiply and solve for } x. \quad 200x = 1000 \quad x = \underline{5 \text{ hours}}$$

If you begin the above IV at 8 a.m., what time will the infusion end? \_\_\_\_\_

Sometimes you may need to calculate the rate of milliliters per hour (mL/hr) of an infusion. You can find this rate by dividing the total volume by the total infusion time. Calculate the mL/hr for the following order: 1000 mL D<sub>5</sub>W with 0.45% NS to infuse in 8 hours using tubing with a drop factor of

15 gtts/mL. 1000 ÷ 8 = \_\_\_\_\_ mL/hr

What is the flow rate for the above order? \_\_\_\_\_ gtts/min.

**Worksheet 3: IV calculations for medical orders**

**Name:** \_\_\_\_\_

During your 12 hour shift in the ICU today, you receive the following IV medical orders that you must set up and administer to your patients.

Dr. Smith ordered 500 mL D<sub>5</sub> ½ NS to infuse in 6 h; drop factor: 20 gtts/mL. What is the flow rate?

**(1)** \_\_\_\_\_

Dr. Amad ordered 1000 ml D<sub>5</sub>W with 10 mEq KCL to infuse at 100 mL/h using tubing with a drop factor of 20 gtts/mL. The infusion was started at 6:30 a.m. What is the total infusion time?

**(2)** \_\_\_\_\_ What time will the infusion end? **(3)** \_\_\_\_\_ What is the flow rate?

**(4)** \_\_\_\_\_

Dr. James ordered 3 L NS IV to infuse at 125 mL/h with a drop factor of 15 gtts/mL

What is the flow rate? **(5)** \_\_\_\_\_

Dr. Juan ordered 1000 D<sub>5</sub>W to run over 10 h with microdrip tubing. What is the flow rate?

**(6)** \_\_\_\_\_

Dr. John ordered 1000 mL of 0.9% NS to infuse in 12 hours with a drop factor of 20 gtts/mL. What is the flow rate? **(7)** \_\_\_\_\_. What is the rate of mL/hr for this infusion?**(8)** \_\_\_\_\_

Dr. Sam ordered 250 mL D<sub>5</sub>W to infuse in 4 hours using blood drip tubing. What is the flow rate?

**(9)** \_\_\_\_\_

Dr. Barry ordered 500 mL of blood plasma over 4 hours at a blood drop rate of 10 gtts/mL. What is the flow rate? **(10)** \_\_\_\_\_

Dr. Patel ordered 3000 mL 0.45% NaCl IV for 24 h with a drop factor of 15 gtts/mL. What is the flow rate? **(11)** \_\_\_\_\_. What is the rate of mL/hr for this infusion? **(12)** \_\_\_\_\_. When there is 1000 mL left in the IV bag, how much time is remaining for the infusion? **(13)** \_\_\_\_\_

Dr. Leslie ordered 2500 mL of NS to infuse over 20 hours with a drop factor of 20 gtts/mL. What is the rate of mL/hr for this infusion? **(14)** \_\_\_\_\_ What is the IV flow rate? **(15)** \_\_\_\_\_



**Quiz: IV calculations for medication orders**

**Name:** \_\_\_\_\_

You have been given the following IV orders during your shift today.

Ordered: 100 mL gentamicin over 30 minutes using IV tubing with a drop factor of 15 gtts/mL

What is the flow rate? **(1)** \_\_\_\_\_

Ordered: 850 mL D<sub>5</sub>/0.45% NS to infuse in 6 hours. Drop factor: 15 gtts/mL

What is the flow rate? **(2)** \_\_\_\_\_ What is the rate of mL/hr? **(3)** \_\_\_\_\_

Ordered: 500 mL of D<sub>5</sub>W to infuse in 8 hours using microdrip tubing

What is the flow rate? **(4)** \_\_\_\_\_

Ordered: 40 mEq KCL in 100 mL over 40 minutes using tubing with a drop factor of 20 gtts/mL

What is the flow rate? **(5)** \_\_\_\_\_

Ordered: 3000 mL NS over 24 h using tubing with a drop factor of 10 gtts/mL

What is the flow rate? **(6)** \_\_\_\_\_ What is the rate of mL/hr? **(7)** \_\_\_\_\_

Ordered: 750 mL of NS to infuse over 5 hours IV using tubing with a drop factor of 10 gtts/mL

What is the flow rate? **(8)** \_\_\_\_\_ What is the rate of mL/hr? **(9)** \_\_\_\_\_

Ordered: 1000 mL of D<sub>5</sub> ½ NS to infuse IV at 200 mL/hr via tubing with a drop factor 20.

What is the flow rate? **(10)** \_\_\_\_\_ What is the total infusion time? **(11)** \_\_\_\_\_

Ordered: 1000 mL of D<sub>5</sub>W at 50 mL/hr with a drop factor of 10 gtts/mL to be started at 5:30

a.m. What is the flow rate? **(12)** \_\_\_\_\_ What is the total infusion time? **(13)** \_\_\_\_\_

What time will the infusion end? **(14)** \_\_\_\_\_

Ordered: 2000 mL of D<sub>5</sub> ½ NS to run over 24. The drop factor is 20 gtts/mL.

What is the flow rate? **(15)** \_\_\_\_\_

**Directions:** Write the correct abbreviation for each term or definition.

Term/Definition	Abbreviation
Hour	h or hr
Drops	gtts
Milliliters	mL
Intravenous	IV
Drops per minute	gtts/min

**Directions:** Round each drop to the nearest whole number and use the correct unit abbreviation in the answer.

- 123.8 drops = 124
- 0.82 drops = 1
- 15.25 drops = 15
- 24.9 drops = 25
- 35.35 drops = 35

**Directions:** Convert each of the following as indicated.

Time in Hours	= Time in Minutes
6 hours	360 minutes
15 ½ hours	930 minutes
24 hours	1440 minutes
12 ¼ hours	735 minutes
Time in Minutes	= Time in Hours
525 minutes	8.75 hours

## Worksheet 2: Using the IV flow rate formula

## Answer Key

**Directions:** Identify the drops per milliliter (gtts/mL) for the 3 main drop factors.

Microdrip factor = 60 gtts/mL

Standard drip factor = 15 gtts/mL

Blood drip factor = 10 gtts/mL

**Directions:** Use the formula and follow the steps to calculate the IV flow rate for each of the following

$$\frac{\text{Total volume (mL)}}{\text{time (in minutes)}} \times \text{drop factor (gtts/mL)} = \text{gtts/min (flow rate)}$$

1. 500 mL to run over 6 hours. The drop factor is 20 gtts/mL. 28 gtts/min
2. 1000 mL to be delivered over 12 hours. The drop factor is 15 gtts/mL. 21 gtts/min
3. 650 mL to infuse over 4 hours. The drop factor is 10 gtts/mL. 27 gtts/min
4. 100 mL to be delivered over 40 minutes. The drop factor is 20 gtts/mL. 150 gtts/min
5. 250 mL to infuse over 2 hours. The drop factor is 15 gtts/mL. 31 gtts/min
6. 2000 mL to run over 24 hours. The drop factor is 60 gtts/mL. 83 gtts/min
7. 1200 mL to run over 12 hours using a microdrip infusion set. 100 gtts/min
8. 50 mL to be infused in 30 minutes with a drop factor of 15 gtts/mL. 25 gtts/min
9. 650 mL to infuse in 10 hours with a blood drip factor. 11 gtts/min
10. 750 mL to run over 5 hours using IV tubing with a drop factor of 20 gtts/mL. 50 gtts/min

### Worksheet 3: IV calculations for medical orders

### Answer Key

During your 12 hour shift in the ICU today, you receive the following IV medication orders that you must set up and administer to your patients.

Dr. Smith ordered 500 mL D<sub>5</sub> ½ NS to infuse in 6 h; drop factor: 20 gtts/mL. What is the flow rate?

(1) 28 gtts/min

Dr. Amad ordered 1000 ml D<sub>5</sub>W with 10 mEq KCL to infuse at 100 mL/h using tubing with a drop factor of 20 gtts/mL. The infusion was started at 6:30 a.m. What is the total infusion time? (2) 10 hrs

What time will the infusion end? (3) 4:30 p.m. What is the flow rate? (4) 33 gtts/min

Dr. James ordered 3 L NS IV to infuse at 125 mL/h with a drop factor of 15 gtts/mL

What is the flow rate? (5) 31 gtts/min

Dr. Juan ordered 1000 D<sub>5</sub>W to run over 10 h with microdrip tubing. What is the flow rate?

(6) 17 gtts/min

Dr. John ordered 1000 mL of 0.9% NS to infuse in 12 hours with a drop factor of 20 gtts/mL. What is the flow rate? (7) 28 gtts/min What is the rate of mL/hr for this infusion? (8) 83 mL/hr

Dr. Sam ordered 250 mL D<sub>5</sub>W to infuse in 4 hours using blood drip tubing. What is the flow rate?

(9) 10 gtts/min

Dr. Barry ordered 500 mL of blood plasma over 4 hours at a blood drop rate of 10 gtts/mL. What is the flow rate? (10) 21 gtts/min

Dr. Patel ordered 3000 mL 0.45% NaC1 IV for 24 h with a drop factor of 15 gtts/mL. What is the flow rate? (11) 31 gtts/min. What is the rate of mL/hr for this infusion? (12) 125 mL/hr. At the end of your shift, there is 1000 mL left in the patient's IV bag, how much time is remaining for this infusion?

(13) 8 hours remaining

Dr. Leslie ordered 2500 mL of NS to infuse over 20 hours with a drop factor of 20 gtts/mL. What is the rate of mL/hr for this infusion? (14) 125 mL/hr What is the IV flow rate? (15) 42 gtts/min

## Quiz: IV calculations for medical orders

## Answer Key

You have been given the following IV orders during your shift today.

Ordered: 100 mL gentamicin over 30 minutes using IV tubing with a drop factor of 15 gtts/mL

What is the flow rate? **(1) 50 gtts/min**

Ordered: 850 mL D<sub>5</sub>/0.45% NS to infuse in 6 hours. Drop factor: 15 gtts/mL

What is the flow rate? **(2) 36 gtts/min** What is the rate of mL/hr? **(3) 142 mL/hr**

Ordered: 500 mL of D<sub>5</sub>W to infuse in 8 hours using microdrip tubing

What is the flow rate? **(4) 63 gtts/min**

Ordered: 40 mEq KCL in 100 mL over 40 minutes using tubing with a drop factor of 20 gtts/mL

What is the flow rate? **(5) 50 gtts/min**

Ordered: 3000 mL NS over 24 h using tubing with a drop factor of 10 gtts/mL

What is the flow rate? **(6) 21 gtts/min** What is the rate of mL/hr? **(7) 125 mL/hr**

Ordered: 750 mL of NS to infuse over 5 hours IV using tubing with a drop factor of 10 gtts/mL

What is the flow rate? **(8) 25 gtts/min** What is the rate of mL/hr? **(9) 150 mL/hr**

Ordered: 1000 mL of D<sub>5</sub> ½ NS to infuse IV at 200 mL/hr via tubing with a drop factor 20.

What is the flow rate? **(10) 67 gtts/min** What is the total infusion time? **(11) 5 hrs**

Ordered: 1000 mL of D<sub>5</sub>W at 50 mL/hr with a drop factor of 10 gtts/mL to be started at 5:30

a.m. What is the flow rate? **(12) 8 gtts/min** What is the total infusion time? **(13) 20 hrs**

What time will the infusion end? **(14) 1:30 a.m.**

Ordered: 2000 mL of D<sub>5</sub> ½ NS to run over 24. The drop factor is 20 gtts/mL.

What is the flow rate? **(15) 28 gtts/min**