Calculation Refresher

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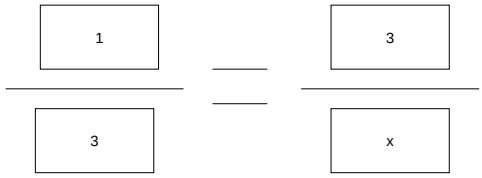
Speaker has nothing to disclose.

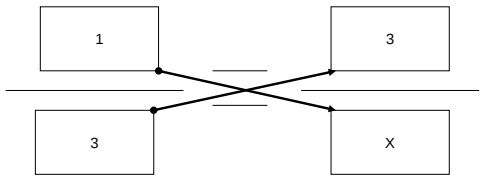
Ratio and Proportion Method

- A ratio is a relationship. 5mg / ml
- A proportion is an equation. 1:3 = 3:x
- Can be used to find an unknown value:
  - it has four terms, one of which is unknown (x)
  - units for each term need to be correct
  - cross multiplying is used to solve for "x"
- Word problems will be converted into a proportion (equation with four terms).



To solve for x:

- 1 / 3 = 3 / x We are trying to determine the value of x.
- We know the answer, because it is an easy example.
- How can we use the proportion calculation to get the answer?
- cross multiply: 1 X x = 3 X 3
- 1(x) = 3 X 3
- x = 9



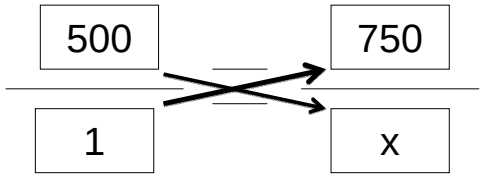
Word Problems

- In real life, we use calculations to solve "word problems".
- Often we are asked to provide a numeric answer to a verbal question.
- "E.D. needs an IM injection of (some drug) 750mg. I am sending a label to the printer. Can you get started in the IV hood?"

What is the Concentration of the Drug Product we will use?

- We convert the word problem into the proportion calculation
- The drug comes as a 500 mg/ml vial.
- We want a dose of 750mg.
- We will have to use more than one vial.
- Set up the proportion calculation.

$$\frac{500\text{mg}}{1\text{ml}} = \frac{750\text{mg}}{x\text{ ml}}$$



Cross Multiply

- 500 X x = 750 X 1
- 500 x = 750
- Divide both sides by 500 to solve for x.
- $\frac{500\,x}{500} = \frac{750}{500}$
- $x = \frac{750}{500}$ $\quad x = 1.5$
- Check the units. x is in ml, so x = 1.5 ml.

Let's Try Another Example

- "ICU wants a 30 mEq KCl rider. We will put it into 100 ml of normal saline. We will give it over 3 hours."
- Gather your ingredients:
  - 20 ml vial of concentrated (2 mEq/ml) KCl
  - 100 ml bag of normal saline (the "piggyback")
  - Normal saline is 0.9% sodium chloride in water.

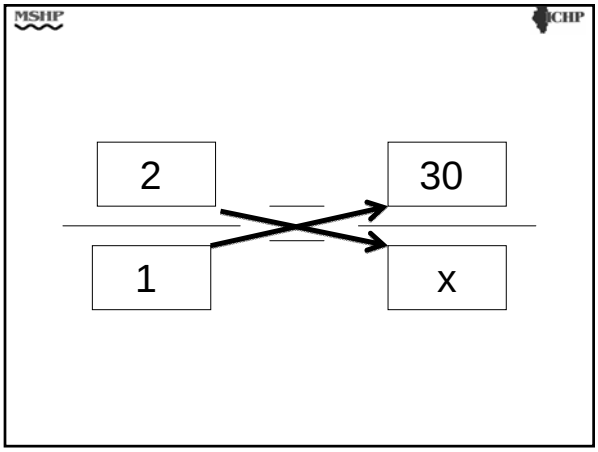
Word Problem Conversion

- Recognize that this is a proportion calculation.
- You have KCl in some concentration and you need to calculate how many ml to use.
- Your units are going to be mEq and ml.
- Calculations can use mcg, mg, gm, units, mmol, mEq, gram%, ml, liter, etc.

$$\frac{2\ \text{mEq}}{1\ \text{ml}} = \frac{30\ \text{mEq}}{x\ \text{ml}}$$

Solve for the amount of KCl

- We need to calculate how many ml of concentrated KCl solution is to be added to the 100ml bag of normal saline.
- Check the units. This means to be sure that both sides of the equation use the same units.
- The answer (x) is in ml.
- Leave the units off to make the proportion calculation less cluttered.



Solve the Proportion Calculation

- 2 X x = 30 x 1, 2 x = 30
- Divide both sides by 2.
- $\frac{2x}{2} = \frac{30}{2}$, x = 15
- Answer is in ml (of concentrated KCl)
- Finish the preparation. Put the 15ml of KCl into the 100ml bag of 0.9% NaCl.

Pharmacist Check

- Put a foil on the port used to inject the KCl solution.
- Leave the syringe used to withdraw the KCl drawn back to 15ml.
- Put syringe (without needle) next to the labeled IV bag.
- Leave the used vial of concentrated KCl next to the IV bag.

Calculate the Volume and Infusion Rate of the KCl rider?

- 15 ml KCl + 100 ml 0.9% NaCl = 115ml
- The order is to run the rider over 3 hours.
- The IV pump is programmed in ml / hour.
- Use a proportion calculation to calculate the IV pump rate.
- Infuse the 115 ml over 3 hours.

$$\frac{115\text{ml}}{3\text{ hours}} = \frac{X\text{ ml}}{1\text{ hour}}$$

IV Pump Rate?

- Check the units.
- The answer is in ml.
- This is the number that is “dialed” into the IV pump.
- Leave out the units for a clearer picture.
- Cross multiply: 115 x 1 = 3 X x.
- Divide both sides of the equation by 3
- x = 38

Bonus Questions

- Why do we run the KCl rider (piggyback) at 10 mEq per hour (30 mEq in 3 hours)?
- Answer: To avoid cardiac arrhythmias
- Why do we dilute KCl riders instead of giving KCl in a more concentrated form?
- Answer: To avoid vein irritation

Pediatric Antibiotic Syringe

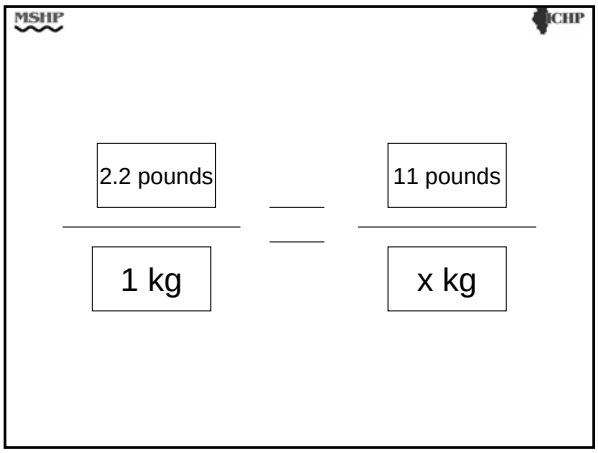
- “Pediatrics wants 80 mg / kg IV pip/tazo (Zosyn®) in a syringe.”
- Zosyn® comes in a powder form in a 2.25 gram vial. We dilute it with sterile water.
- The Zosyn® vial says to use 10 ml SWFI.
- We put pediatric IV drugs in a syringe with 6 ml total fluid to infuse on a syringe pump
- The patient weighs 11 lbs.

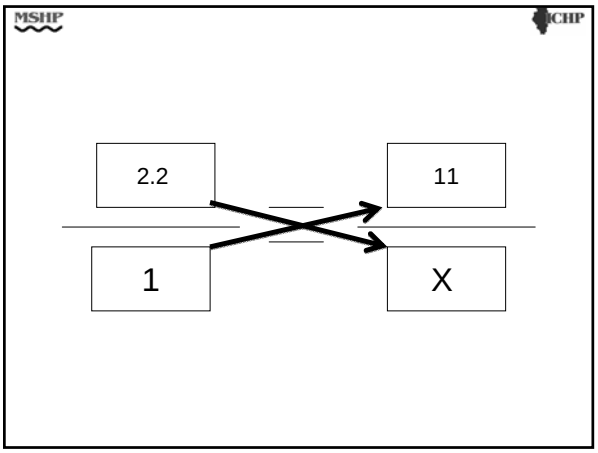
Proportion Calculations

- The patient’s mass in kg
- The mg / kg dose of pip/tazo
- The concentration of reconstituted pip/tazo
- The dose of drug in ml of pip/tazo

The Patient’s Mass in kg

- There are 2.2 pounds per kg.
- The patient weighs 11 pounds.
- What units are in the equation?
- What are the units in the answer?



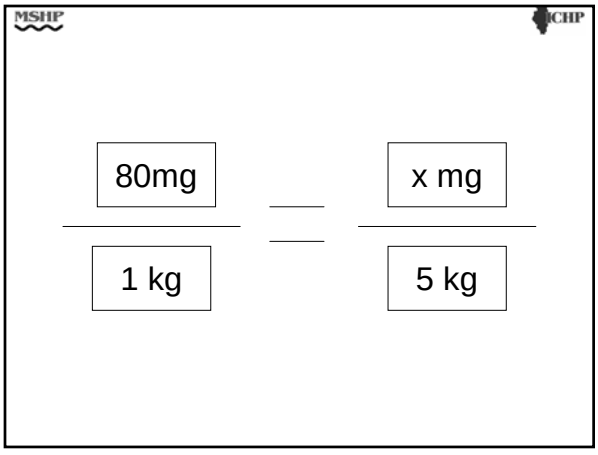


Cross Multiply

- 2.2 X x =1 X 11
- 2.2x = 11
- Simplify the side of the equation with the x by dividing BOTH sides by the number next to the x (2.2)
- $\frac{2.2x}{2.2} = \frac{11}{2.2}$
- x = 5, So the patient weighs 5 kg.

The mg / kg Dose

- The dose is 80 mg / kg.
- The patient's mass is 5 kg.
- We need the dose in mg.
- Set up the proportion calculation.
- Check the units.
- The answer is in mg.

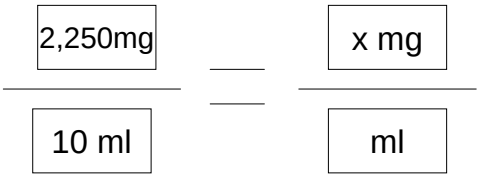


Calculate the dose in mg

- Cross multiply
- 80 X 5 = 1 X x
- 400 = x
- The dose is 400mg.

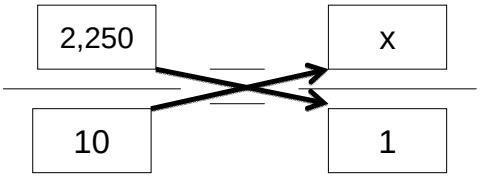
Units of pip/tazo per vial

- The label says 2.25 grams per vial.
- We need to calculate in mg, not grams
- There are 1000 mg/gm. Multiply 2.25 x 1000 to convert gm to mg.
- So, another way to state the amount of pip/tazo is 2,250 mg per vial.
- We reconstitute the vial with 10 ml of SWFI. Calculate mg/ml pip/tazo.



Managing the Equation

- Make sure the units are correct.
  - The units in the numerators (top) should be the same.
  - The units in the denominators (bottom) should be the same.
- Make a mental note of the units for x. This will always be part of the answer.
- Now leave out the units for calculations.

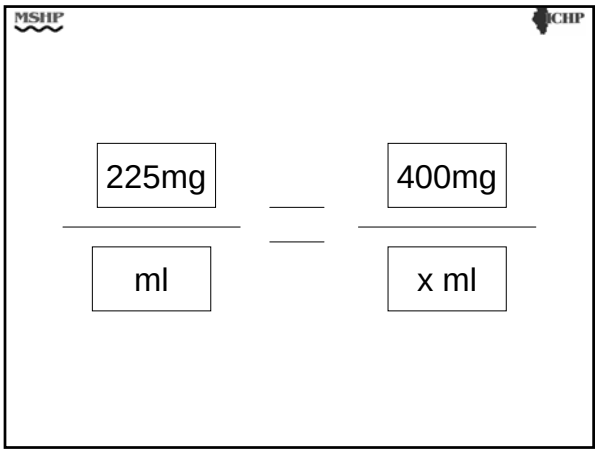


Reconstituted pip/tazo

- 2,250 X 1 = 10 X x
- 2,250 = 10x
- Simplify by dividing both sides by 10.
- $\frac{2,250}{10} = \frac{10x}{10}$
- 225 = x x = 225 mg
- The proper units for concentration are 225mg/ml.

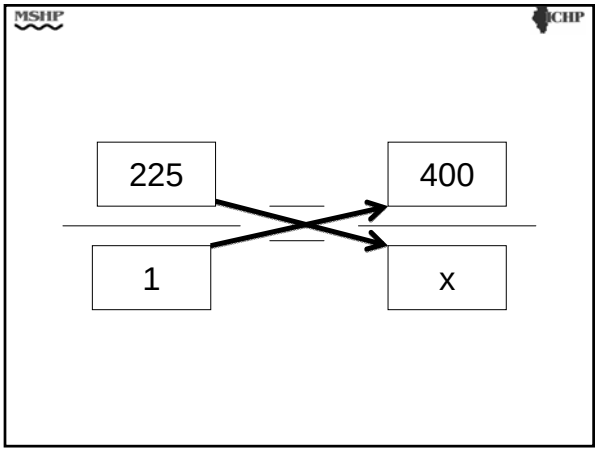
Dose of pip/tazo in ml

- The concentration of the reconstituted pip/tazo is 225 mg per ml.
- The dose is 400 mg.
- Calculate the dose in ml.



Now Cross-multiply

- Check the units
- Answer is going to be in ml.
- Leave off the units for clarity



Dose of pip/tazo in ml

- 225 X x = 1 X 400
- 225x = 400
- Divide both sides by 225 to isolate the x by itself.
- $\frac{225x}{225} = \frac{400}{225}$
- X = 1.8; Answer is in ml.

Dilute the Dose into 6 ml

- Our pediatric IV syringes are componded with a total volume of 6 ml.
- Subtract the volume of pip/tazo from 6 ml.
- This is the volume of SWFI or NS or D5W to add to the syringe with the pip/tazo.
- 6 ml – 1.8 ml = 4.2 ml
- Add 4.2 ml to make a total volume of 6 ml.

Review

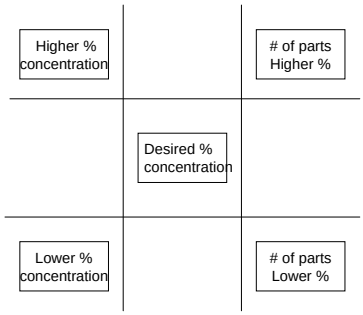
- Translate the word problem into a proportional calculation.
- Set up the equation.
- Make sure the units will cancel.
- Cross-multiply (without the units).
- Divide to eliminate the term with the x.

PART 2
A second technique - alligation

- Used when there are two liquids of <u>different</u> concentrations to be mixed to make a liquid with a concentration <u>between</u> the two.
- The concentration is in percent (%).
- The amount of each liquid is called a part.
- Add the parts to total the number of parts.

Setting Up the Alligation

- Looks like a tic-tac-toe board
- 5 terms:
  - Three boxes for liquid concentrations in %
  - Two boxes for amount of liquid in parts
- Subtraction used to determine # of individual parts
- The units won't make Algebraic sense.

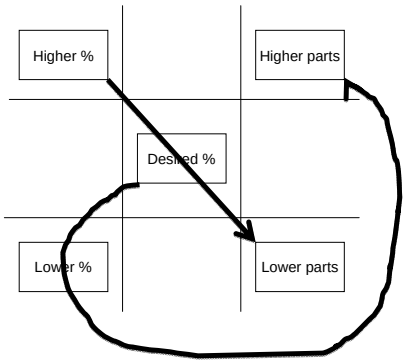


Practice with %

- "one half" = 50%. So is 0.5, ½, 1:2
- To convert a number to %, multiply x 100.
- 0.5 x 100 = 50%
- 1:200 = 1/200 = 0.005 Use your calculator.
- 0.005 x 100 = 0.5%

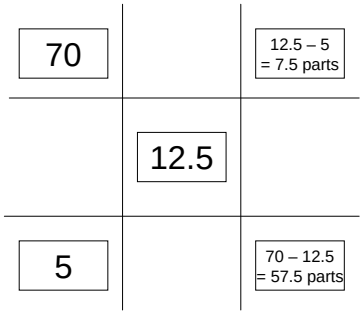
Order for Subtracting

- Higher % - Desired % = # of parts of the Lower % liquid
- % - % = parts
- Desired % - Lower % = # of parts of the Higher % liquid



Dextrose Alligation Problem

- "We need to make a liter of D12.5W."
- We have D70W and D5W.
- D70W is 70% dextrose in water.
- 70% means 70 grams / 100 ml.
- Also called "gram %"
- D5W is 5% dextrose in water.
- 5% means 5 grams / 100 ml

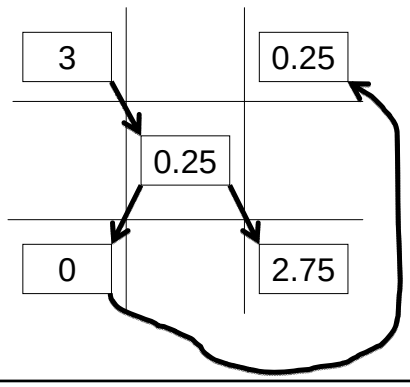


Calculating the Volumes

- 57.5 parts + 7.5 parts = 65 parts total.
- 57.5 / 65 = 0.88 (88%)
- 7.5 / 65 = 0.12 (12%)
- 88% of 1 liter = 88% of 1,000 ml = 880 ml
- 12% of 1 liter = 12% of 1,000 ml = 120 ml
- (Hint – Solve these using proportion calculations.)

Try An Example Using 0%

- "E.D. wants half strength Dakin's Solution"
- sodium hypochlorite topical
- Confusing units: For Dakin's Solution, "full strength" = ½%. So, "half strength" = ¼%
- ¼% = 0.25%
- We have water for irrigation (0%) and 3% sodium hypochlorite (Clorox®)



Calculating the Volume

- 2.75 + 0.25 = 3
- 2.75 (parts of water) + 0.25 (parts of bleach solution) = 3 (parts of desired strength Dakins solution)
- 2.75 / 3 = 0.92 (92%) water
  - Made this way, Dakins is mostly water.
- 0.25 / 3 = 0.08 (8%) bleach
  - Clorox® is very concentrated. A poison.

How to make 500 ml

- 2.75 / 3 = 0.92 (Use a calculator)
- (Remember: 0.92 = 92%)
- 0.92 x 500ml = 458 ml water
- 0.25 / 3 = 0.08 (Same thing as 8%)
- 0.08 x 500ml = 42 ml 3% sodium hypochlorite - Clorox®
- Carefully pour 42 ml bleach into 458 ml of water for irrigation.

PART 3 - TPN Example

- Total Parenteral Nutrition (TPN)
- Using proportion calculations to make TPN
- TPN orders use a mixture of units.
- Some units refer to only part of the final mixture.
- The technician needs each ingredient converted into ml to make the TPN.

TPN Orders

- 96 kg patient
- Total volume of TPN = 2,000 ml
- 20% lipid: 183 ml
- 15% amino acid: 0.5 gm / kg
- D70W: Use enough to make 75% of non-protein (lipid + carbohydrate) calories
- Electrolytes, vitamins, trace elements, etc.
  - Assume that these total 100 ml.

Amino Acid Dose

- Dose = 0.5 gm / kg
- Patient weighs 96 kg
- Set up the proportion calculation
- 0.5 / 1 = x / 96
- Check units; answer is in gm.
- We need to know ml, not gm!

$$\frac{0.5}{1} = \frac{x}{96}$$

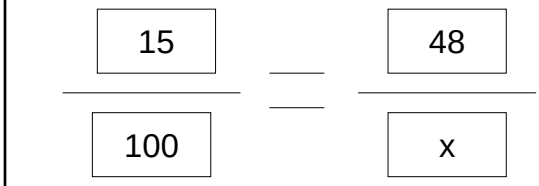
$$\frac{0.5}{1} = \frac{x}{96}$$

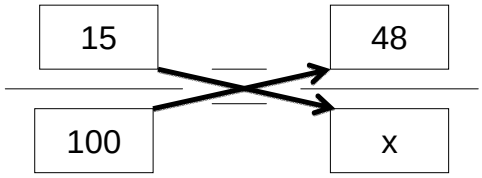
Grams of Amino Acid

- 0.5 x 96 = 1 X x
- 0.5 x 96 = x
- 48 = x
- Answer is in gm.
- We want ml.

Volume of Amino Acid

- 15% amino acid = 15 gm / 100ml
- Dose = 48 gm
- Set up the proportion calculation
- 15 / 100 = 48 / x
- Check units; answer is in ml





ml of Amino Acid

- 15 X x = 48 X 100
- 15x = 4,800
- Get rid of 15 by dividing both sides by 15
- $\frac{15x}{15} = \frac{4,800}{15}$
- x = 320
- Answer is in ml.

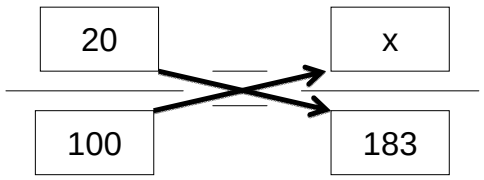
Carbohydrate Calories

- Dose = 75% of non-protein calories
- The sum of the lipid + carbohydrate calories is the non-protein calories
- We don't count the calories from the amino acids because we want them to be incorporated into new tissue (healing).
- Lipids provide 9 calories per gram.
- Carbohydrates provide 4 calories per gram

How Many Lipid Calories?

- 20% lipid emulsion = 20 grams / 100ml
- Dose is 183 ml of lipid
- Set up the proportion calculation.
- 20 / 100 = x / 183
- Check units; answer is in gm

$$\frac{20}{100} = \frac{x}{183}$$



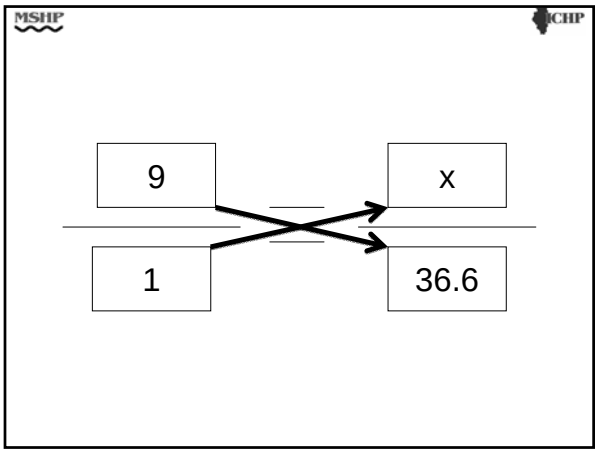
gm of Lipid

- 20 X 183 = 100 X x
- 3,660 = 100x
- Get rid of 100 - divide both sides by 100.
- $\frac{3{,}660}{100} = \frac{100x}{100}$
- 36.6 = x
- Answer is in gm

Lipid Calories

- Dose = 36.6 gm of lipid
- There are 9 Calories per gm of lipid.
- Set up the proportion calculation.
- 9 / 1 = x / 36.6
- Check units; answer is in Calories

$$\frac{9}{1} = \frac{x}{36.6}$$



Calories of Lipid

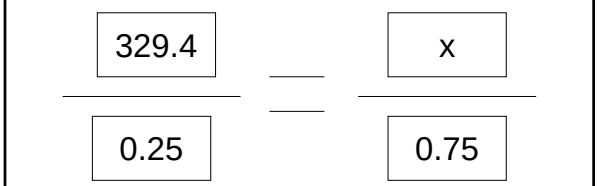
- 9 x 36.6 = 1 X x
- 329.4 = x
- Answer is in Calories (lipid calories)
- By knowing this, we can calculate the total number of (non-protein) Calories.
- The orders for carbohydrate Calories were associated with lipid Calories.

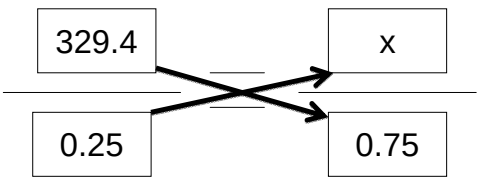
Total Non-Protein Calories

- lipid Calories = 329.4 Calories
- carbohydrate Calories + lipid Calories = non-protein Calories (n-p C)
- carbohydrate Calories = 75% of n-p C.
- lipid Calories = 100%-75% = 25% of n-pC
- 329.4 lipid Calories = 25% of all n-p C.
- 25% = 0.25

n-p C from Carbohydrates

- 329.4 lipid Calories = 0.25 total n-p C
- What are the n-p C from carbohydrate?
- Set up the proportion calculation
- 329.4/0.25 = x / 0.75
- Check units; answer is in Calories
- Note: We do not have to calculate all of the n-p Calories; We only want the Carbs.



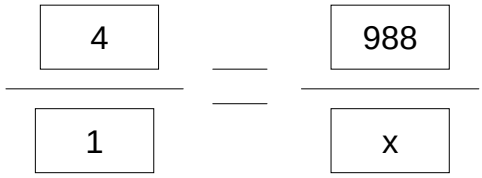


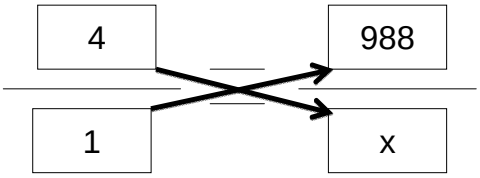
n-p Calories from Carbohydrate

- 329.4 X 0.75 = 0.25 X x
- 247 = 0.25 x
- Get rid of the 0.25 by dividing both sides by 0.25
- $\frac{247}{0.25} = \frac{0.25\ x}{0.25}$
- 988 Calories = n-p C from carbohydrate

Grams of Dextrose

- 988 Calories from carbohydrates (sugar)
- 4 Calories per gram of dextrose (sugar)
- Set up the proportion calculation
- 4 / 1 = 988 / x
- Check units; answer is in gm



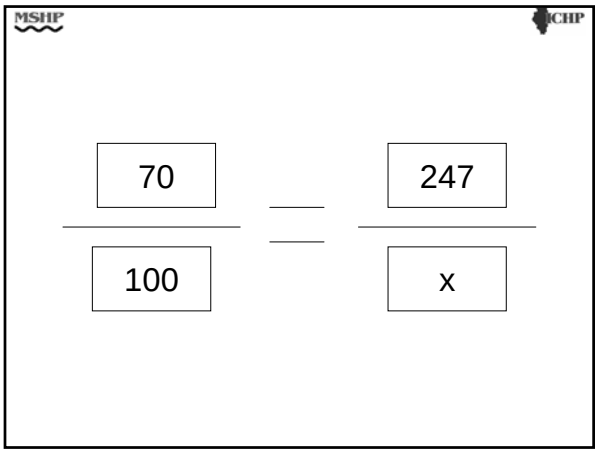


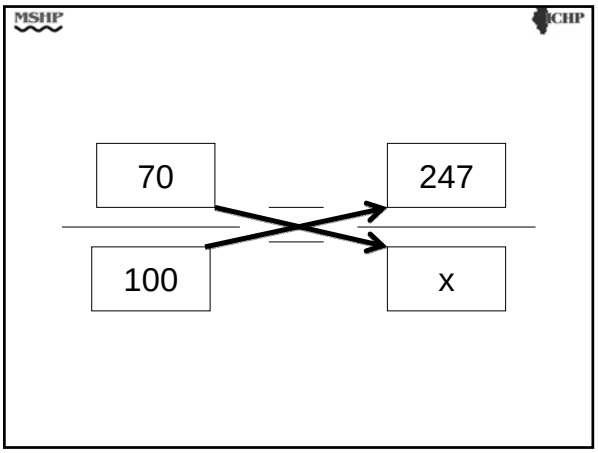
Grams of Dextrose

- 4 X x = 1 x 988
- 4x = 988
- Get rid of the 4 by dividing both sides by 4
- $\frac{4x}{4} = \frac{988}{4}$
- X = 247 gm = carbohydrate
- We are going to get it from D70W

Volume of D70W

- Dose = 247 gm dextrose
- Product is D70W; 70% dexrose in water
- 70 gm dextrose / 100 ml water
- Set up the proportion calculation
- 70 / 100 = 247 / x
- Check units; answer is in ml





ml of D70W

- 70 X x = 100 X 247
- 70x = 24,700
- Get rid of 70 by dividing both sides by 70
- $\frac{70x}{70} = \frac{24,700}{70}$
- x = 353 ml

Sterile Water for Injection

- Total volume of TPN = 2,000 ml
- Lipid = 183 ml
- Amino Acids = 320 ml
- Dextrose = 352 ml
- Electrolytes, vitamins, trace elements, etc. = 100 ml
- 2,000 – (183 + 320 + 352 + 100) = 2,000 – 952 = 1,048ml water

Helpful References

- Pharmacy Calculations, 2nd Edition
  - Mary F. Powers and Janet B. Wakelin
  - Morton Publishing Company, Englewood, CO
  - (Easy to understand. Separate section on Institutional Pharmacy, 250 pages)
- Reference Guide For Pharmaceutical Calculations – 3rd Edition
  - Manan Shroff, RXEXAM® (365 practice ?s)

PRACTICE PROBLEMS FOR CALCULATIONS REFRESHER
121-000-09-016-L04-T

And Answer Key

1. "Please make a one liter I.V. of D5NS with 10 mEq/l potassium chloride." The Pharmacy carries liters of D5NS and vials of concentrated KCl (2mEq/ml). **You would do the following:**
    a. Add 20ml KCl to one liter of D5NS
    b. Add 10ml KCl to one liter of D5NS
    c. Add 5ml KCl to one liter of D5NS
    d. Cannot be made with above ingredients

2. "A 20kg child in Pediatrics needs 50mg/kg ampicillin/sulbactam (Unasyn®) [a/s] every 6 hours." **What is the dose (mg)?**
    a. 0.4
    b. 2.5
    c. 1,000
    d. 1

3. A reconstituted vial of a/s contains 150mg/ml. **How many ml of a/s will you withdraw when preparing a dose of 750mg?**
    a. 5ml
    b. 7.5ml
    c. 112.5 ml
    d. 0.2ml

4. "Please make 250ml of hypertonic saline (3% sodium chloride in water)" The Pharmacy carries liters of NS (0.9% sodium chloride in water) and vials of concentrated sodium chloride (23.4% sodium chloride in water). **You would combine:**
    a. 217.5 ml NS with 32.5 ml concentrated sodium chloride
    b. 240 ml NS with 10 ml concentrated sodium chloride
    c. 227 ml NS with 23 ml concentrated sodium chloride
    d. 175 ml NS with 75 ml concentrated sodium chloride

The correct answers are:
1(c)

2(c)

3(a)

4(c)