Calibration Problems can be fun - sort of like working puzzles so I hope you enjoyed working the practice problem set.

Questions 42-55 apply only to the Research & Demonstration portion of the tests.

I hope you have tried to work the problems before you look at this SOLUTION SET.

Remember that my way of solving the problem IS NOT the ONLY way. There may be many ways to solve the same problem.

Try to work the problems in a way that seems logical to you. If you try to work a problem using a different method than the ones in the example solutions and do not get the answer on the answer sheet please FAX your work to me (979-845-6251) and I will find the error, if there is one, and I will FAX a correction back to you.

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Solutions to Problem Set

General Comments and Conversion Factors

Calibration is easy but it takes practice. The best way to get a feel for calibration is to go out and calibrate a few spray rigs because this makes the whole process real. Calibration is the process used to apply a ***specific amount*** to a ***known area*** usually while traveling at a certain ***speed***.

1) ***Determine the question being asked***. This is especially true when there is extra information that is not needed in a problem.

2) ***Determine what information you need to answer the question being asked***. I usually circle or rewrite the information that I need.

3) ***Be prepared to make conversions***. I have most often worked with small plots in research trials so we collected output in milliliters and mixed liters and measured chemicals in milliliters (liquid) or grams (dry) but we had to relate that back to gallons per acre and pounds a.i. per acre, etc.

4) Make any conversions necessary to work the problem.

5) Most if not all problems can be worked by using a ratio and proportion set up that reads 'A' is to 'B' as 'C' is to 'D', cross multiply, and divide. Place 'X' into the unknown spot.

$$\frac{A}{B} = \frac{C}{D} \quad \textit{if } C \textit{ is unknown then } \quad \frac{A}{B} = \frac{X}{D} \quad \textit{so } X = \frac{A \times D}{B}$$

6) Understand the difference between ***broadcast*** and ***banded*** acres

a.i. = active ingredient
GPM = gallons per minute
GPA = gallons per acre
MPH = miles per hour
1 mile = 5280 feet
1 MPH = 88 ft/min

Note: I never can remember 5280 feet so I multiply 88 ft/min X 60 minutes/hour to get 5280

1 acre = 43,560 square feet
1 gallon = 4 quarts = 8 pints = 128 ounces (liquid) = 3785 ml
1 foot = 12 inches
1 pound = 454 grams = 16 ounces (dry)
1 kilogram = 1000 grams = 1,000,000 mg
1 gram = 1000 mg = 1,000,000 ug
1 mg = 1000 ug
1 pound = 0.454 kg
1 kg = 2.2 lbs

CALIBRATION PRACTICE SOLUTIONS

1. To decrease the flow rate of a nozzle from ***0.4 gallons per minute*** at ***40 pounds per square inch*** to ***0.3 gallons per minute***, pressure must be decreased to _____ pounds per square inch.

Two ways to do the same thing: $\frac{GPM_1}{GPM_2} = \frac{\sqrt{psi_1}}{\sqrt{psi_2}}$ $\frac{(GPM_1)^2}{(GPM_2)^2} = \frac{psi_1}{psi_2}$

second way works on any calculator

$GPM_1 = 0.4$ $psi_1 = 40$ $(GPM_1)^2 = 0.16$
$GPM_2 = 0.3$ $psi_2 = X$ $(GPM_2)^2 = 0.09$ so

$$\frac{0.16}{0.09} = \frac{40}{X} \text{ so } X = \frac{(0.09)(40)}{0.16} \quad X = \textbf{\textit{22.5 pounds per square inch}}$$

2. How much adjuvant should be added to ***400 gallons*** of herbicide mixture if the adjuvant is used at ***0.25 percent*** concentration by volume? 0.25 % = 0.0025

400 gallons
X 0.0025 or
1.0 gallon

$$\frac{0.25 \text{ gal adjuvant}}{100 \text{ gal water}} \text{ as } \frac{X}{400 \text{ gal}}$$

$$X = \frac{(0.25)(400)}{(100)} \text{ so } X = \textbf{\textit{1 gallon adjuvant}}$$

3. If a herbicide label calls for ***3 pounds*** active ingredient per acre and a ***75%*** wettable powder is used, how much of the formulated product should be used per acre?

3 lb a.i./A
75% WP

$$\frac{3 \text{ lb a.i.}}{A} \times \frac{1 \text{ lb product}}{0.75 \text{ lb a.i.}} = \textbf{\textit{4 lb WP}}$$

4. A 4-gallon backpack sprayer has been calibrated to apply ***1 gallon per 1000 square feet*** of area. Using a Wettable Powder with ***50%*** active ingredient at ***10 pounds of active ingredient per acre***, how many ounces of the formulated product will be needed per 1000 square feet?

dry formulation 1 lb = 16 oz (10 lb) (16oz/lb) = 160 oz a.i./0.50 = 320 oz WP
1 acre = 43,560 sq.ft.

$$\frac{1000 \text{ sq.ft.}}{43{,}560 \text{ sq.ft.}} = \frac{X}{320 \text{ oz}} \quad X = \textbf{\textit{7.346 oz}}$$

5. A fenced yard that is ***200 feet*** wide and ***500 feet*** long needs a ***1 foot band*** on the inside and a ***1 foot band*** on the outside of the fence. How many square feet will be treated?

Add up the sides 200 + 200 + 500 + 500 = 1400
add band in and out 1 + 1 = 2

(1400 ft) (2 ft) = ***2,800 sq.ft.***

6. If a ***308-foot*** course is measured and an average of ***70 seconds*** is required to make a pass, what is the ground speed in miles per hour?

$$\frac{308 \text{ ft.}}{70 \text{ sec.}} \times \frac{60 \text{ sec.}}{\text{minute}} \times \frac{1 \text{ MPH}}{88 \text{ ft./min}} = \textbf{\textit{3 MPH}}$$

7. If a sprayer applying ***20 gallons per acre*** at ***5 miles per hour*** decreases it's speed to ***3 miles per hour*** with the pressure remaining constant, how many gallons are being applied per acre?

(GPA-1) (speed-1) = (GPA-2) (speed-2)
(20 gal/A) (5 MPH) = (X) (3 MPH)
X = ***33.33 gal/A***

8. All this is excess information (A herbicide label recommends an application rate of 15 to 30 gallons of carrier per acre. A 30-pound-per-square inch operating pressure, 4 miles per hour ground speed and a TeeJet 5880-3/4-2TOC10-BoomJet Nozzle set to cover a 25 foot spray width were selected.) This is a measured known quantity (If 448 ounces of water were collected from this system in 1 minute, calculate the flow rate in gallons per minute.) You only have to convert from ounces to gallons.

$$\frac{448 \text{ ounces}}{\text{minute}} \times \frac{1 \text{ gallon}}{128 \text{ ounces}} = \textbf{3.5 gallons per minute}$$

9. This part of the problem is theoretical (The herbicide label recommends an application rate of **20 gallons of carrier per acre**. The pressure is 30-pound-per-square inch operating pressure. The ground speed is **4 miles per hour**. The 20 foot spray boom has 12 (11003LP-SS) nozzles spaced **20 inches apart**.) You would expect this answer if the pressure was reading exactly correct and if the nozzles were new.

$$GPM = \frac{GPA \times speed \times swath}{5940} = \frac{20 \times 4 \times 20}{5940} = 0.269$$

This was actually measured (If **440 ounces** of water were collected from this system in **1 minute**) Answer the question - what was the average flow rate per nozzle in gallons per minute? Change ounces to gallons and divide by the number of nozzles.

$$\frac{440 \text{ ounces}}{(\text{minute})(\text{boom})} \times \frac{1 \text{ gallon}}{128 \text{ ounces}} \times \frac{\text{boom}}{12 \text{ nozzles}} = \textbf{0.286 gallons (minute)(nozzle)}$$

10. When calibrating your spray system the spray rig traveled **165 feet in 25 seconds** and each nozzle delivered **25 ounces per minute** and the spray boom contained **15 nozzles** spaced **20 inches** apart and produced a spray pattern that covered **25 feet**. Calculate the gallons per acre being applied by this spray system.

$$\frac{165 \text{ feet}}{25 \text{ seconds}} \times \frac{60 \text{ seconds}}{1 \text{ minute}} = \frac{396 \text{ feet}}{\text{minute}} \times 25 \text{ feet} = \frac{9900 \text{ feet sq.}}{\text{minute}}$$

$$\frac{43{,}560 \text{ feet sq./ acre}}{9900 \text{ feet sq. / minute}} = \frac{4.4 \text{ minutes}}{\text{acre}}$$

$$\frac{15 \text{ nozzles}}{\text{boom}} \times \frac{25 \text{ ounces}}{(\text{minute})(\text{nozzle})} \times \frac{1 \text{ gallon}}{128 \text{ ounces}} = \frac{2.93 \text{ gallons}}{\text{minute}}$$

$$\frac{4.4 \text{ minutes}}{\text{acre}} \times \frac{2.93 \text{ gallons}}{\text{minute}} = \frac{\textbf{12.9 gallons}}{\textbf{acre}}$$

Another way to work this problem is - - -

$$\frac{165 \text{ feet}}{25 \text{ seconds}} \times \frac{60 \text{ seconds}}{1 \text{ minute}} \times \frac{1 \text{ MPH}}{88 \text{ feet/min.}} = 4.5 \text{ MPH}$$

$$\frac{25 \text{ ounces}}{(\text{minute})(\text{nozzle})} \times \frac{1 \text{ gallon}}{128 \text{ ounces}} = \frac{0.1953 \text{ gallons}}{(\text{minute})(\text{nozzle})}$$

$$\text{GPM} = \frac{\text{GPA} \times \text{speed} \times \text{swath}}{5940} \quad \text{so} \quad 0.1953 = \frac{\text{GPA} \times 4.5 \times 20}{5940}$$

$$= \frac{0.1953 \times 5940}{4.5 \times 20} = \frac{\textbf{12.9 gallons}}{\textbf{acre}}$$

11. If your spray system applied **20 gallons per acre** and you have a **450-gallon tank** and need to spray a **50-foot width** to control weed along the roadside, how many miles of roadside could be sprayed?

$$\frac{450 \text{ gallons/tank}}{20 \text{ gallons/acre}} = \frac{22.5 \text{ acres}}{\text{tank}} \times \frac{43{,}560 \text{ sq. feet}}{\text{acre}} = 980{,}100 \text{ sq. feet}$$

$$\frac{980{,}100 \text{ sq. feet}}{50 \text{ feet}} = 19{,}602 \text{ feet} \times \frac{1 \text{ mile}}{5280 \text{ feet}} = \textbf{3.71 miles}$$

12. Calculate the flow rate in gallons per minute of a single swivel nozzle used to broadcast a herbicide at an application rate of **30 gallons per acre** if the speed of the sprayer is **5 miles per hour** and the nozzle spray width is **30 feet**. (30 feet × 12 inches/ft. = 360 in.)

$$\text{GPM} = \frac{\text{GPA} \times \text{speed} \times \text{swath}}{5940} = \frac{30 \times 5 \times 360}{5940} = \textbf{9.09 GPM}$$

13. You have a fenced pasture that is **900 feet wide** and **900 feet long** that needs a **2.0 foot** band on the **inside** and a **2.0 foot** band on the **outside** of the fence. How many square feet will be treated?
If each side is 900 feet long you have 900 feet X 4 sides = 3600 feet (total length).
2 feet on 2 sides = 4 foot wide treated band
3600 feet X 4 = **14,400 sq. feet**

or

consider two blocks one 2 feet longer and wider on each end or 904 feet and the other 2 feet shorter on each end or 896 ft. Then calculate the area of each block and find the difference.

904 X 904 = 817,216 and 896 X 896 = 802,816 so 817,216 - 802,816 = **14,400 sq. ft.**

14. A knapsack sprayer has been calibrated to apply 3-liters per 1000 square feet of area. If **5 ounces of active ingredient** will be needed per **1000 square feet** of ground area and the pesticide formulation is an 80% WP, how many pounds of active ingredient would be applied per acre?

Again you have information that you do not need to use. Many answers can be worked with ratio and proportion type math where you say A is to B as C is to D and then cross multiply and divide.

$\frac{5 \text{ ounces a.i.}}{1000 \text{ sq. feet}}$ as $\frac{X}{43{,}560 \text{ sq. ft./acre}}$ so (1000)(X) = (5)(43,560) or X = 217.8 ounces/acre

$\frac{217.8 \text{ ounces}}{\text{acre}} \times \frac{1 \text{ pound}}{16 \text{ ounces}}$ = **13.6 lb./A** This could be written as - - -

$\frac{217.8 \text{ ounces/acre}}{16 \text{ ounces/lb}}$ = **13.6 lb./A**

15. If **one gallon** of a surfactant is added to a **500-gallon** herbicide mixture, what is the percent concentration of the surfactant by volume?

To express a decimal number as percent move the decimal to the right two places (that is multiply by 100)

$\frac{1 \text{ gallon}}{500 \text{ gallons}}$ = 0.002 or **0.2 %**

16. If a **200-foot** course is measured and an average of **25 seconds** is required to make a pass, what is the ground speed in miles per hour?

$\frac{200 \text{ feet}}{25 \text{ seconds}} \times \frac{60 \text{ seconds}}{1 \text{ minute}} \times \frac{1 \text{ MPH}}{88 \text{ feet/min.}}$ = **5.45 MPH**

17. If a herbicide label calls for **2 pounds per acre** of active material and a **75% wettable powder** is used, how much wettable powder should be used per acre? (Just divide the lb. a.i. by the % expressed as a decimal)

$$\frac{2 \text{ lb a.i.}}{\text{acre}} \times \frac{1 \text{ lb. formulated}}{0.75 \text{ lb. a.i.}} = \frac{\textbf{2.67 lb. formulated}}{\textbf{acre}}$$

18. A sprayer with a tank capacity of **300 gallons** is calibrated for an application rate of **30 gallons per acre**. An **85% wettable powder** herbicide is to be applied. The label recommends applying **3 pounds of *active ingredient* per acre**. How many pounds of herbicide product (i.e. the 85WP) should be added to the spray tank?

$$\frac{300 \text{ gallons}}{\text{tank}} \times \frac{\text{acre}}{30 \text{ gallons}} = \frac{10 \text{ acres}}{\text{tank}} \times \frac{3 \text{ pounds a.i.}}{\text{acre}} = \frac{30 \text{ lbs. a.i.}}{\text{tank}}$$

$$\frac{30 \text{ lb a.i.}}{\text{tank}} \times \frac{1 \text{ lb. formulated}}{0.85 \text{ lb. a.i.}} = \frac{\textbf{35.3 lb. formulated}}{\textbf{tank}}$$

19. If **30 gallons per acre** are being applied in a **6-foot swath** and the boom is raised to cover a **9-foot** swath with everything else remaining constant, how many gallons per acre are being applied? (When you raise the boom you spread the spray over a larger area and therefore spray less per acre.) Use the formula (GPA1)(swath1) = (GPA2)(swath2)

(30)(6) = (GPA2)(9) so GPA2 = 180/9 = **20 gallons per acre**

20. If a sprayer applying **30 gallons per acre** at **2 miles per hour** increases speed to **3.5 miles per hour** with the pressure remaining constant, how many gallons are being applied?

(When you increase the speed you spread the spray over a larger area and therefore spray less per acre.) Use the formula (GPA1)(speed1) = (GPA2)(speed2)

(30)(2) = (GPA2)(3.5) so GPA2 = 60/3.5 = **17.14 gallons per acre**

21. In order to increase the flow rate of an 8003LP-SS nozzle from **0.3 gallons per minute** at **15 pounds per square inch** to **0.4 gallons per minute**, pressure must be increased to _____ pounds per square inch. (In order to double the output you must increase the pressure by 4X)

$$\frac{(GPM1)^2}{(GPM2)^2} = \frac{PSI1}{PSI2} \quad \text{so} \quad \frac{(0.3)^2}{(0.4)^2} = \frac{15}{PSI2}$$

$$\frac{(0.09)}{(0.16)} = \frac{15}{PSI2} \quad \text{so} \quad PSI2 = \frac{(0.16)15}{(0.09)} = \textbf{26.7 psi}$$

22. If a pesticide label states: use **2.5 pounds of product** per **100 gallons** of water, how many pounds of product should be added to **500 gallons** of water? (Use a simple ratio)

$$\frac{\text{2.5 pounds}}{\text{100 gallons}} \text{ as } \frac{\text{X}}{\text{500 gallons}} \text{ so . . . .}$$

(100)(X) = (2.5)(500) or X = 1250/100 pounds and X = **12.5 pounds**

23. How many acres can be treated from a spray tank holding **400 gallons** if the rate of application is **20 gallons per acre**?

$$\frac{\text{400 gallons}}{\text{tank}} \times \frac{\text{acre}}{\text{20 gallons}} = \frac{\textbf{20 acres}}{\textbf{tank}}$$

24. For a spray rig that delivers **15 gallons per acre** (GPA) and has a **300 gallon tank**, how many pounds of a pesticide (product) must be added to the tank if the recommended rate is **1 pound (product) per acre**?

$$\frac{\text{300 gallons}}{\text{tank}} \times \frac{\text{acre}}{\text{15 gallons}} = \frac{\text{20 acres}}{\text{tank}} \times \frac{\text{1 pounds product}}{\text{acre}} = \frac{\textbf{20 lbs. product}}{\textbf{tank}}$$

25. How many gallons of a **70% emulsifiable concentrate** are needed to make **50 gallons** of **2% active ingredient spray**? NOTE: (volume1)(concentration1) = (volume2)(concentration2)

(X)(70 %) = (50 gallons)(2 %) so 100/70 = **1.43 gallons**

26. If a pesticide label says 4EC there are 4 pounds of active ingredient per gallon of formulation. In order to apply 1 pound of active ingredient **per acre** 1 quart of formulation is mixed into each **20 gallons of spray mix**. How many gallons of the spray mix will be needed to treat 10 acres?

$$\frac{\text{20 gallons mix}}{\text{acre}} \times \frac{\text{10 acre}}{} = \textbf{200 gallons mix}$$

27. If an applicators spray equipment travels **88 feet** in **20 seconds**, what is the speed in miles per hour (MPH)?

$$\frac{\text{88 feet}}{\text{20 seconds}} \times \frac{\text{60 seconds}}{\text{1 minute}} \times \frac{\text{1 MPH}}{\text{88 feet/min.}} = \textbf{3.0 MPH}$$

28. Calculate the swath width in feet (FT.) if the spray equipment has 12 nozzles on 20 inch (IN.) spacings.

$$\frac{12 \text{ nozzles}}{} \times \frac{20 \text{ inch spacing}}{} \times \frac{1 \text{ foot}}{12 \text{ inch}} = \textbf{20 feet}$$

29. Nozzle discharge rate and calibration of the sprayer should be performed with clean water before pesticide has been loaded.

A. **True** (this way you are not contaminated)
B. False

30. What will the application rate be in gallons per acre (GPA) if ***25 ounces per nozzle*** are delivered from a boom with ***20 nozzles*** at ***12 inch spacing*** in the ***time*** required to travel ***340 feet***?

(340 ft) (1 ft) = 340 sq.ft.

$$\frac{25 \text{ oz}}{340 \text{ sq.ft.}} \text{ as } \frac{X}{43{,}560 \text{ sq.ft/A}} \quad X = 3202.94 \text{ oz/A}$$

so

$$\frac{3202.94 \text{ oz}}{A} \times \frac{1 \text{ gallon}}{128 \text{ oz}} = \textbf{\textit{25 gallon/A}}$$

31. How many square feet would a hand sprayer holding one gallon treat if ***4 ounces*** of the spray mix are used to treat ***100 square feet***? 1 gallon = 128 oz

$$\frac{4 \text{ oz}}{100 \text{ sq.ft.}} \text{ as } \frac{128 \text{ oz}}{X} \quad X = \frac{(128 \text{ oz})(100 \text{ sq.ft})}{(4 \text{ oz})} \quad X = \textbf{\textit{3,200 sq.ft.}}$$

32. A sprayer with a ***500 gallon tank*** capacity is calibrated to apply ***20 gallons per acre***. DE PESTO herbicide will be used to control broadleaf weeds at a rate of ***2 pounds a.i. per acre***. How many gallons of DE PESTO - ***4EC*** herbicide should be added to the tank?

$$\frac{500 \text{ gal}}{\text{tank}} \times \frac{\text{acre}}{20 \text{ gal.}} \times \frac{2 \text{ lb}}{\text{acre}} \times \frac{1 \text{ gallon EC}}{4 \text{ lb}} = \textbf{\textit{12.5 gal EC}}$$

33. If an applicator's spray equipment travels ***150 feet*** in ***30 seconds***, what is the speed in miles per hour (MPH)?

$$\frac{150 \text{ ft.}}{30 \text{ sec.}} \times \frac{60 \text{ sec.}}{\text{minute}} \times \frac{1 \text{ MPH}}{88 \text{ ft./min}} = \textbf{\textit{3.41 MPH}}$$

34. Calculate the swath width in feet (FT.) if the spray equipment has ***10 nozzles*** on ***18 inch*** (IN.) spacings.
1 foot = 12 inches

$$\text{swath} = \frac{(10 \text{ noz})(18 \text{ in})}{} \times \frac{1 \text{ ft}}{12 \text{ in}} = \textbf{\textit{15 feet}}$$

35. What will the application rate be in gallons per acre (GPA) if ***5 gallons*** are used to treat an area ***300 feet*** long and ***20 feet*** wide? area = (length) (width) = (300 ft) (20 feet) = 6,000 sq.ft.

$$\frac{5 \text{ gallons}}{6{,}000 \text{ sq.ft.}} \text{ as } \frac{X}{43{,}560 \text{ sq.ft.}} \text{ so } X = \frac{(43{,}560 \text{ sq.ft.})(5 \text{ gal})}{(6{,}000 \text{ sq.ft.})} \quad X = \textbf{\textit{36.3 gal}}$$

36. If the label on a ***65%*** wettable powder states; use ***3 pounds*** of active ingredient ***per acre***, how many pounds of the product are needed to treat one acre?

$$\frac{3 \text{ lb a.i./A}}{65\% \text{ WP}} \quad \frac{3 \text{ lb a.i.}}{\text{A}} \times \frac{1 \text{ lb product}}{0.65 \text{ lb a.i.}} = \textbf{\textit{4.62 lb WP}}$$

37. How many gallons per acre (GPA) (broadcast rate) is applied by a spray rig that travels at ***4 miles per hour*** (MPH), delivers ***36 ounces per minute per nozzle***, and has a nozzle spacing of ***18 inches*** (IN.)?
(36 oz/min)/(128 oz/gallon) = 0.28 gallon/min (GPM)

$$\frac{GPM}{(per\ nozzle)} = \frac{GPA \times MPH \times W}{5940} \qquad GPA = \frac{(GPM)(5940)}{(MPH)(W)}$$

$$GPA = \frac{(0.28)(5940)}{(4)(18)} = \textbf{\textit{23.1 gal/A}}$$

It is OK to use a formula if you know and understand it.
But you can work it out without a formula. (18 in)/(12 in/ft) = 1.5 ft
(4 MPH)(88 ft/min/MPH) = (352 ft/min) (1.5 ft) = 528 sq.ft./min

$$\frac{43{,}560 \text{ sq.ft./acre}}{528 \text{ sq.ft.}} \text{ as } \frac{X}{1 \text{ min}} \text{ so } X = \frac{82.5 \text{ min}}{\text{acre}} \times \frac{0.28 \text{ gal}}{\text{min}} \quad X = \textbf{\textit{23.1 gal/A}}$$

38. For a spray rig that delivers ***10 gallons per acre*** (GPA) and has a ***400 gallon tank***, how many gallons of a ***4 pounds a.i. per gallon*** pesticide must be added to treat ***40 acres*** at a rate of ***1 pound a.i. per acre***?

(400 gal/tank) / (10 gal/A) = 40 A / tank
(40 A / tank) (1 lb / A) = (40 lb / tank)
(40 lb / tank) / (4 lb / gal EC) = (10 gal EC / tank)

39. You plan to walk ***3 MPH*** while applying chemicals along a roadside. If you take an average of ***42 steps per 100 feet***, how many steps must you take per minute?

(3 MPH) (88 ft/min /MPH) = 264 ft/min

$$\frac{42 \text{ steps}}{100 \text{ feet}} \times \frac{264 \text{ ft}}{\text{min}} = \frac{\textbf{\textit{110.9 steps}}}{\textbf{\textit{min}}}$$

40. You have a hand-held four nozzle boom sprayer with a ***20 inch nozzle spacing***. The 8002 nozzles are emitting ***0.2 GPM*** and you plan to walk ***2.5 MPH*** while taking 45 steps per 100 feet when making the application. How many beats per minute should be set on your metronome?

(2.5 MPH) (88 ft/min /MPH) = 220 ft/min

$$\frac{45 \text{ steps}}{100 \text{ feet}} \times \frac{220 \text{ ft}}{\text{min}} = \frac{\textbf{\textit{99 steps}}}{\textbf{\textit{min}}}$$

41. Using any information you need from problem 40, calculate how many gallons you will apply per acre.

$$\frac{GPM}{(per\ nozzle)} = \frac{GPA \times MPH \times W}{5940} \qquad GPA = \frac{(GPM)\ (5940)}{(MPH)\ (W)}$$

$$GPA = \frac{(0.20)\ (5940)}{(2.5)\ (20)} = \textbf{\textit{23.76 gal/A}}$$

County Agents be sure to practice the following problems:

42. You are helping a producer calibrate his sprayer prior to applying a herbicide. He has just purchased a new set of nozzle tips that have an average output of ***0.3 gallons per minute per nozzle***. The boom contains ***12 nozzles spaced 20 inches*** apart. You have determined the correct gear and throttle settings to travel at a speed of ***4 MPH*** while spraying. How many **gallons** of *spray solution* are being applied **per acre** on a *broadcast basis*?

The question is, how many gallons of *spray solution* are being applied per acre?
output = 0.3 GPM
speed = 4 MPH
nozzle spacing = 20 inches

As far as formulas go, this one from the Tee Jet catalog is useful to get the job done fast. I'll use this formula and then just work the problem logically. You actually do not need to use formulas to do calibration problems, they just serve to save time if you understand the process and want to hurry. Formulas can get people into a lot of trouble if they are used improperly.

$$\frac{GPM}{(per\ nozzle)} = \frac{GPA \times MPH \times W}{5940}$$

Note that when this formula is used the W is the spray width or swath in ***inches***. Correct units are a must ! ! ! (20 inches is 1.667 feet using 1.667 for W would give you a very wrong answer.) W and GPM must match - - - both must be the value for 1 nozzle or for the whole boom. The answers can really be crazy if the swath for the whole boom spray pattern is used with the output of one nozzle or the output of the whole boom is used with the swath of only one nozzle. If the above problem had said that the 12 nozzle boom produced a 20 foot spray pattern, you would have to figure how many inches were covered by one nozzle.

The 5940 comes from all of the conversion factors that are needed along the way to change from values measured to the values needed. You would use each of these factors in the process of working the problem without a formula.

$$\frac{1\ hour}{60\ minutes} \times \frac{5280\ feet}{1\ mile} \times \frac{1\ foot}{12\ inches} \times \frac{1\ acre}{43560\ sq.\ ft.}$$

$$GPA = \frac{GPM\ (per\ nozzle) \times 5940}{MPH \times W} =$$

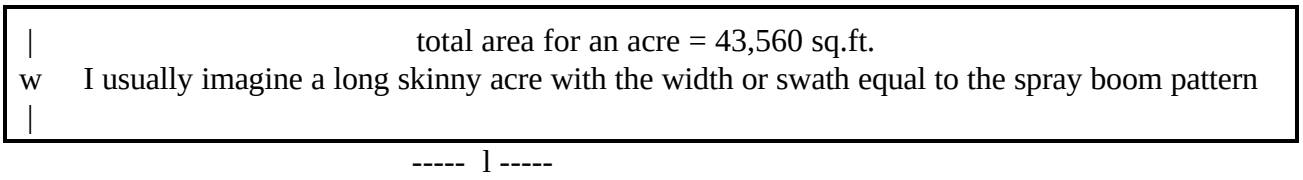
$$= \frac{5280}{31363200} = \frac{1}{5940}$$

When calculating GPA, MPH, or W if GPM is known the elements of the formula must be rearranged.

$$GPA = \frac{0.3 \times 5940}{4 \times 20} = 22.3$$

Now let's do the same

problem just logically answering a series of small questions along the way.
An acre is a specific area (A) and as an area it has length (l) and width (w) (so A = l X w).



We have 12 nozzles on the boom spaced 20 inches apart and we need the swath in feet.

$$\frac{12\ nozzles}{boom} \times \frac{20\ inches}{nozzle} \times \frac{1\ foot}{12\ inches} = \frac{20\ feet}{boom}$$

So the swath (width) is 20 feet. Area = l x w so length = area/width or 43560 sq.ft./20 ft.= 2178 feet

How long will it take to treat one acre (how long will it take to drive 2178 feet)?
Length/speed = minutes per acre Since 1 MPH = 88 ft/min then 4 MPH = 352 ft/min.

$$\frac{2178\ feet}{acre} \times \frac{minute}{352\ feet} = \frac{6.19\ minutes}{acre}$$

You could have combined these two steps and multiplied width by speed to get square feet per minute (20 feet X 352 feet/min = 7040 sq.ft./min) and then divided sq. ft./min into sq. ft./ acre to get min./acre.

$$\frac{43560\ sq.\ feet}{acre} \times \frac{minute}{7040\ sq.\ feet} = \frac{6.19\ minutes}{acre}$$ Same thing!!

Each of the 12 nozzles has an output of 0.3 gallons per minute per nozzle. So the boom output is 12 X 0.3 GPM = 3.6 gallons per minute.

$$\frac{3.6\ gallons}{minute} \times \frac{6.19\ minute}{acre} = \frac{22.3\ gallons}{acre}$$

So I have shown two different ways to do this problem and get the correct answer. There are probably other ways to do the same thing and if you do something correct and get the correct answer that is just as good as any way that I would use. The second method here may take up a little more space but you use conversion factors and common sense without the need of a formula.

43. The producer in Problem 42 plans to spray a pasture with Depesto 75WP to control grassburs and broadleaf weeds in his pasture. Depesto 75WP contains 75% of the active ingredient pestoff. The label states that pestoff should be applied at a rate of 1.5 pound a.i. per acre. How many pounds of Depesto 75WP should be added to each 100 gallons of water in the spray tank in order to apply the correct amount of pestoff per acre?

The question is, how many pounds of Depesto 75WP should be added to each 100 gallons of water?

Depesto 75WP is the formulated product, formulated as a 75% wettable powder. The active ingredient in Depesto is pestoff and the active ingredient pestoff is used at 1.5 pounds per acre.
Here you need to use the GPA from problem 42 which was 22.3 gallons per acre. The first thing you must determine is how many acres are being treated with 100 gallons of spray mix. At some point you will do each of the following: a) divide 100 gallons by 22.3 gallons to get acres per tank, b) multiply acres by the rate per acre to get the total amount of pesticide needed, c) divide by 0.75 to determine the amount of formulated product you need to have the correct amount of active ingredient. I will do it a couple of ways but you may come up with other ways of doing it. One way is to just be sure that all of the units cancel and the answer is pounds per tank.

$$\frac{100\ gallons}{tank} \times \frac{acre}{22.3\ gallons} \times \frac{1.5\ lbs.\ a.i.}{acre} \times \frac{1.0\ lb.\ formulated}{0.75\ lb.\ a.i.} = \frac{8.97\ lbs.\ formulated}{tank}$$

Or you can do the same thing in a number of small steps and see the individual answers as you go.
(Note: rounding off will cause answers to vary some)

$$\frac{100\ gallons}{tank} \times \frac{acre}{22.3\ gallons} = \frac{4.48\ acres}{tank}$$

$$\frac{4.48\ acres}{tank} \times \frac{1.5\ lbs.\ a.i.}{acre} = \frac{6.72\ lbs.\ a.i.}{tank}$$

$$\frac{6.72\ lbs.\ a.i.}{tank} \times \frac{1.0\ lb.\ formulated}{0.75\ lb.\ a.i.} = \frac{8.96\ lbs.\ formulated}{tank}$$

Another way is to start by figuring the amount of formulated product that you need per acre and then set up a ratio between the amount in 22.3 gallons and the amount needed in 100 gallons. You read this ‘A’ is to ‘B’ as ‘X’ is to ‘D’, cross multiply and solve for the unknown ’X’.

$$\frac{1.5\ lbs.\ a.i.}{acre} \times \frac{1.0\ lb.\ formulated}{0.75\ lb.\ a.i.} = \frac{2.0\ lbs.\ formulated}{acre}$$

$$\frac{2\ lbs.\ Depesto}{22.3\ gallons} = \frac{X\ lb.}{100\ gallons} \quad so \quad X = \frac{2\ lbs.\ Depesto \times 100\ gallons}{22.3\ gallons} = 8.97\ lbs\ Depesto$$

44. You are spraying "Depesto" insecticide in 18-inch bands over 40-inch rows, with the pressure gauge set at

40 pounds per square inch and the speed at 4 miles per hour. How would you increase the application rate without changing tractor speed or pressure? (Be specific and give an example of what you would do.)
[NOTE: There is no problem to work here.]

Here is an example of having too much information and not really needing to use any of it. If you have read the books or tested it out empirically, you know that for small changes in output per acre you could slow down to spray more or speed up to spray less per acre. Or, again for small changes, you could increase pressure to apply more or decrease the pressure to apply less per acre. BUT the question says "without changing tractor speed or pressure". The best way to make a significant change in output is to change the nozzles; but, it is not enough to simply say change the nozzle. You must say 'in order to increase the application rate the nozzle tips must be changed to a kind that applies more GPM at a given pressure.

Examples: You could change from 8002 to 8004 nozzle tips to double the output.
You could change from a standard 8002 to an 8002LP which applies a higher volume at a lower pressure.

Many other examples are possible as long as the output is increased. (Look on appropriate pages of a Tee Jet catalog for other examples.)

45. Depesto pesticide contains 2 pounds of the active ingredient "pestoff" per gallon, which is 29 % a.i. per gallon. How many pints of the 29 % pesticide would you use per acre if the recommended rate is 3/4 pound of active ingredient per acre on a broadcast basis? Show your work.

The question is, how many pints of Depesto would you use per acre?

First change 3/4 pound to 0.75 pound. Change the gallon to 8 pints and then set up a ratio that reads 'A' is to 'B' as 'C' is to 'X', cross multiply, and divide.

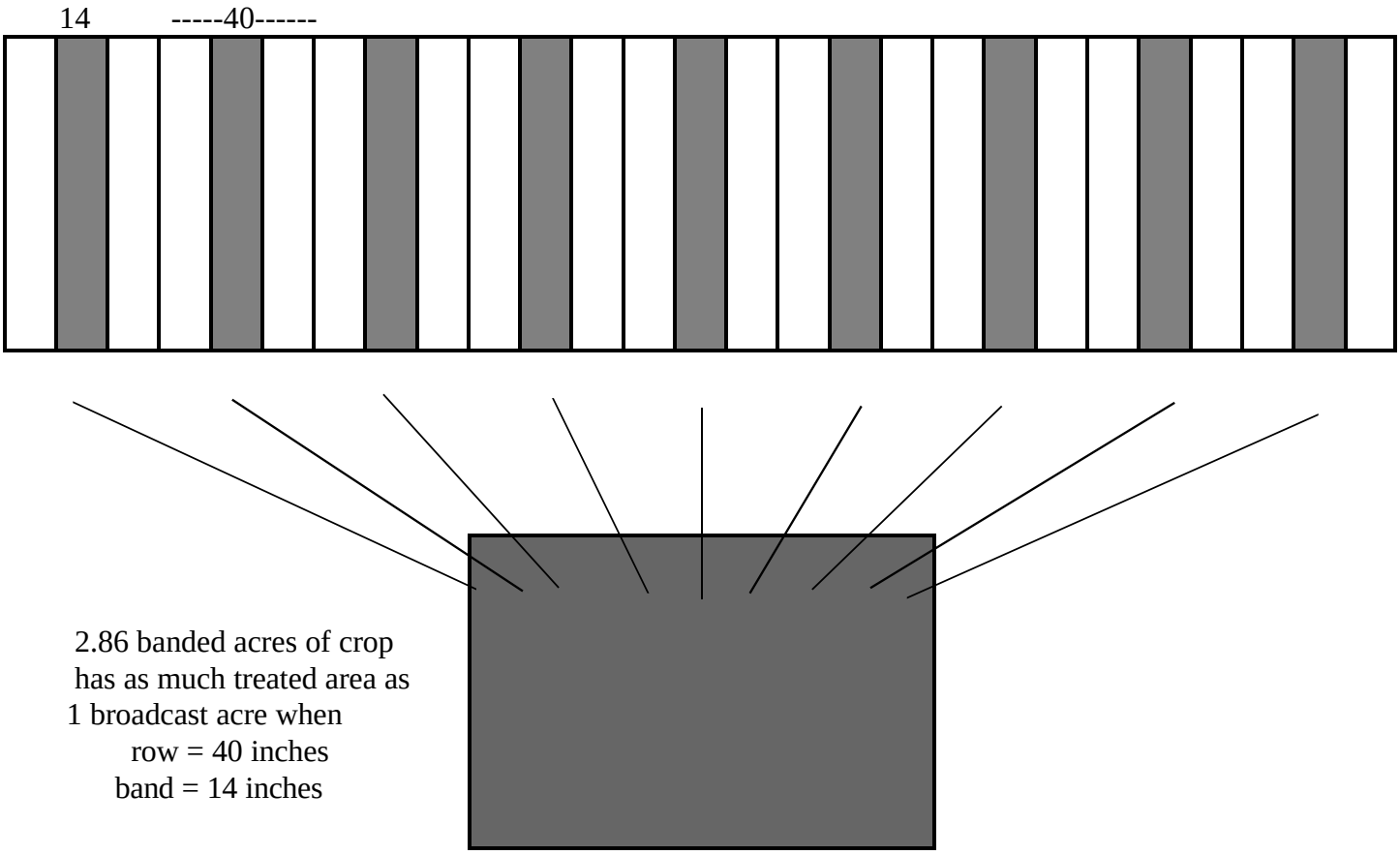
$$\frac{2\ lbs.\ a.i.}{8\ pints} = \frac{0.75\ lb.\ a.i.}{X\ pints} \quad so \quad X = \frac{8\ pints. \times 0.75\ lbs.}{2\ lbs.} = 3\ pints$$

Another way to do it would be to figure the pounds per pint and divide lbs./A by lbs./pt. to get pints per acre.

$$\frac{\frac{0.75\ lb.\ a.i.}{acre}}{\frac{0.25\ lb.\ a.i.}{1\ pint}} \quad or \quad \frac{0.75\ lb.\ a.i.}{acre} X \frac{1\ pint}{0.25\ lb.\ a.i.} = \frac{3\ pints}{acre}$$

46. COUNTER 15G material is 15% active ingredient. The application rate reads 5 lbs. COUNTER per 10,000 linear feet of row in 14-inch bands centered on 40-inch rows. How many pounds of the 15G COUNTER

would you apply per crop acre while banding? Show your work.



The question is, how many pounds of the 15G COUNTER would you apply per crop acre while banding? Be sure to remember you are working with the formulated product and you are banding. You can figure this (A) for a broadcast acre and then correct for banding or (B) for the banded acre directly.

The row width divided by the band tells you how many acres of crop would be banded before one acre of surface had been treated. Here 40/14 = 2.86 so 2.86 acres of banded crop includes 1 acre of treated land. To determine what % of an acre is actually being treated, divide the part by the whole (i.e. 14/40 = 0.35 or 35 % of the land area is being treated). These values will be used later. In either case the 14 inches and the 40 inches can be changed to feet by dividing each by 12 inches/foot to get 1.167 ft. or 3.33 ft.

A. Broadcast: Use the actually treated area 10,000 ft X 1,167 ft = 11,670 sq.ft. Set up a ratio that reads 'A' is to 'B' as 'X' is to 'D' , fill in the items we know, cross multiply, and solve for 'X'.

$$\frac{5\ lbs.}{11670\ sq.ft.} = \frac{X\ lbs}{43560\ sq.ft.} \quad so \quad X = \frac{5\ lbs. \times 43560\ sq.ft.}{11670\ sq.ft.} = 18.7\ lbs.$$

Since only 35 % of the area is treated 18.7 lbs X 0.35 = 6.5 lbs on one acre of banded crop.

B. Banded crop acre: Use the row width to figure the area (this area is the land that is driven over and includes both treated (35 %) and untreated (65 %) strips. 10,000 ft. X 3.33 ft. = 33,300 sq.ft. Set up a ratio in a similar

way but now solving for X will be the pounds applied on a banded crop acre with no correction needed.

$$\frac{5\ lbs.}{33300\ sq.ft.} = \frac{X\ lbs}{43560\ sq.ft.} \quad so \quad X = \frac{5\ lbs. \times 43560\ sq.ft.}{33300\ sq.ft.} = 6.5\ lbs.$$

In actual practice, I like to figure the broadcast amount and then correct for the banding because if you were spraying and filling a tank, the tank is filled as though you were treating broadcast acres. When you band you use less pesticide over-all but you spread it out by placement. That part of the land that is treated while banding receives a rate equivalent to the treated land that is sprayed broadcast.

(NOTE: ***If*** you had been asked, how much ***active ingredient*** was being applied *to an acre of crop while banding* you would multiply the amount of formulated material used by the percent active ingredient.)
(6.5 lbs formulated product) X (0.15) = (0.975 pounds active ingredient)

47. Recommendations for Depesto 4EC Fungicide calls for 0.8 pound active ingredient per acre. You have 5 gallons of the 4EC formulation containing *4 pounds of active ingredient per gallon*. Your sprayer holds *500 gallons*; it is calibrated to apply *40 gallons per acre* and cannot be changed. How much 4E is needed per tankful to apply the 0.8 pound a.i. per acre? Show your work.

The question is, how much 4E is needed per tankful?
You will need to know _____ acres treated per tank and then _____ pounds needed per tank

$$\frac{500\ \text{gallons/tank}}{40\ \text{gallons/acre}} = \frac{12.5\ \text{acres}}{\text{tank}} \times \frac{0.8\ \text{lbs.}}{\text{acre}} = \frac{10\ \text{lbs}}{\text{tank}} \times \frac{\text{gallon}}{4\ \text{lbs}} = 2.5\ \text{gallons/tank}$$

48. The Depesto 10G nematicide label reads "apply Depesto at the rate of 100 lbs. per 15,000 linear feet of row in 14-inch bands centered on 40-inch rows." How many pounds of the active ingredient is being applied per crop acre while banding? Show your work.

The question is how many *pounds* of the *active ingredient* is being applied *per crop acre while banding*?

This is similar to 46 except that you will figure the amount of active ingredient per acre of banded crop.
15,000 ft. X 1.167 ft. = 17,505 sq.ft. and 15,000 ft. X 3.333 ft. = 49,995 sq.ft.
(100 lbs formulated product) X (0.10) = (10 pounds active ingredient)

A. Broadcast

$$\frac{10\ lbs.}{17505\ sq.ft.} = \frac{X\ lbs}{43560\ sq.ft.} \quad so \quad X = \frac{10\ lbs. \times 43560\ sq.ft.}{17505\ sq.ft.} = 24.9\ lbs.$$

Since only 35 % of the area is treated 24.9 lbs X 0.35 = 8.7 lbs on one acre of banded crop.

B. Banded acre of crop

$$\frac{10\ lbs.}{49995\ sq.ft.} = \frac{X\ lbs}{43560\ sq.ft.} \quad so \quad X = \frac{10\ lbs. \times 43560\ sq.ft.}{49995\ sq.ft.} = 8.7\ lbs.$$

49. The Depesto 3E nematicide contains *3 pounds of active ingredient per gallon*. How many fluid ounces of the nematicide would you use for one thousand linear feet of row in 20-inch bands over 40-inch rows, at the rate of *4 pounds active ingredient per acre* on a *broadcast basis*? Show your work.

The question is, how many *fluid ounces* would you use for 1000 linear feet of row?
(This is a liquid formulation we are looking for fluid ounces)

You know how much is applied to 1 acre so once again setting up a ratio will do the job.
3 lb/gallon = 3 lb/128 ounces or 1 lb/42.67 oz. or 4 lb/171 oz.
20 /12 = 1.667 and 40/12 = 3.333
1000 ft. X 1.67 ft. = 1667 sq.ft. and 1000 ft. X 3.333 ft. = 3333 sq.ft.

A. Broadcast

$$\frac{171\ oz.}{43560\ sq.ft.} = \frac{X\ oz.}{1667\ sq.ft.} \quad so \quad X = \frac{171\ oz. \times 1667\ sq.ft.}{43560\ sq.ft.} = 6.5\ oz.$$

B. Crop acre while banding. If the broadcast rate if 171 fluid ounces per acre, and you are banding 20-inch bands over 40-inch rows, then 171 (20/40) = 85.5 fluid ounces are applied to a banded acre.

$$\frac{85.5\ oz.}{43560\ sq.ft.} = \frac{X\ oz.}{3333\ sq.ft.} \quad so \quad X = \frac{85.5\ oz. \times 3333\ sq.ft.}{43560\ sq.ft.} = 6.5\ oz.$$

50. Depesto insecticide also comes in an 8% active ingredient granular formulation. It is sold only in 50 pound bags. How many bags per acre would be needed to apply 4.0 pounds active ingredient per acre on a broadcast basis? Show your work.

$$\frac{Pounds\ Active\ Ingredient\ per\ Acre}{Percent\ Active\ Ingredient\ in\ Formulated\ Product} = Pounds\ of\ Pesticide\ Product\ per\ Acre$$

$$\frac{4\ lbs.\ a.i.\ per\ Acre}{0.08\ a.i.\ in\ Formulated\ Product} = 50\ lbs.\ Product\ per\ Acre$$

As it turns out, there is 4 lbs. of the active ingredient in a 50 lb. Bag of the formulated product. If the number of pounds of product had not been 50 you could divide the value calculated by 50 to get the number of bags. This might be written a different way but you would be doing the same thing (see below).
You can go back and forth, either way you see that one bag is required in this problem.

$$\frac{4.0\ lbs.a.i.}{acre} \ X \ \frac{1\ lb.\ formulated}{0.08\ lb.a.i.} = \frac{50\ lbs.\ formulated}{acre}$$

$$\frac{50\ lbs.\ formulated}{bag} \ X \ \frac{0.08\ lb.a.i.}{1.0\ lb.\ formulated} = \frac{4.0\ lbs.\ a.i.}{bag}$$

51. A person weighs 150 pounds. Technical atrazine has an oral LD_{50} of 3090. How many milligrams of atrazine per kilogram is needed to reach the LD_{50} for this person? Show your work.

The question is, how many milligrams (mg) per kilogram (kg) is equal to the **LD_{50}** ?
Since the units for an oral LD_{50} is mg/kg, the answer is **3090**.

You may see this expressed differently in some places because a mg/kg is also a part per million (ppm) a µg/g is also a ppm. So you could see mg/kg, ug/g, or ppm and they would all be the same thing.

52. How many grams of atrazine (see problem 51) are needed to reach the LD_{50} for the 150 pound person? Show your work. (If you want to go farther with this 1 teaspoon = 5 grams, 3 teaspoons = 1 Tablespoon, 16 tablespoons = 1 cup).

The question is, how many grams of atrazine (see problem 51) are needed to reach the LD_{50} for a 150 pound person? You need to determine the persons weight in kg., determine the mg. of atrazine for an LD_{50} dose, then change mg. to grams.

$$\frac{150\ lb.}{person} \ X \ \frac{1\ kg.}{2.2\ lbs.} \ X \ \frac{3090\ mg.}{1\ kg.} \ X \ \frac{1\ g.}{1000\ mg.} = 210.7\ grams$$

This can also be done with a series of ratio problems as noted before:

$$\frac{2.2\ lb.}{1\ kg.} = \frac{150\ lb.}{X\ kg.} \quad so \quad X = \frac{1\ kg. \times 150\ lb.}{2.2\ lb.} = 68.2\ kg.$$

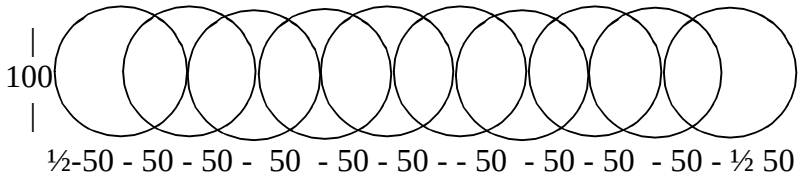
$$\frac{3090\ mg.}{1\ kg.} = \frac{X\ mg.}{68.2\ kg.} \quad so \quad X = \frac{3090\ mg. \times 68.2\ kg.}{1\ kg.} = 210{,}738\ mg.$$

$$\frac{210{,}738\ mg.}{dose} = \frac{1000\ mg.}{1.0\ g.} \quad so \quad X = \frac{210{,}738\ mg. \times 1.0\ g.}{1000\ mg.} = 210.7\ g$$

(If you want to go farther with this 1 teaspoon = 5 grams, 3 teaspoons = 1 Tablespoon, 16 tablespoons = 1 cup. This was for fun. It is interesting to see just how much is being talked about in some instances. The MCL in water is 3 ppb or 3 µg/liter.)

$$\frac{210.7\ \text{grams}}{\text{dose}} \times \frac{1\ \text{teaspoon}}{5\ \text{grams}} \times \frac{1\ \text{tablespoon}}{3\ \text{teaspoons}} \times \frac{1\ \text{cup}}{16\ \text{tablespoon}} = 0.88\ \text{cup}$$

You are planning an experiment using chemigation. Depesto is a preemergence herbicide that comes in a 65% wettable powder. It is being studied to be registered for use through overhead sprinkler systems. The instructions say "mix the 65% WP in sufficient water to make a slurry, inject into the sprinkler system for a period of 3 minutes. Use at the rate of 3/4 pound formulated material per acre on a broadcast basis." (For this to work correctly there should be a method to keep the slurry suspended.) The sprinkler system contains 10 sprinkler heads. The heads are 50 feet apart. The pattern from each sprinkler head overlaps to the next sprinkler head. (Although this is big, imagine it to be like 10 overlapping nozzles on a spray boom - same principles)



53. Using the information provided and assuming uniform coverage by the system, how many acres are covered by the sprinkler system in one set? Show your work.

These sprinkler patterns are similar to overlapping fan nozzles in that they overlap to produce a full pattern. The circles at the beginning and the end are each a ½ pattern since they do not overlap. The radius of each circle is 50 feet since the sprinkler heads are 50 feet apart therefore:
10 sprinkler heads X 50 feet = 500 feet long. 2 X 50 feet = 100 feet across
area = length X width = 500 ft. X 100 ft. = 50,000 sq.ft.

50,000 sq.ft./43,560 sq.ft. = 1.15 acres

54. Using the information provided, since the material is only 65% active ingredient, how much active material is applied to each field acre? Show your work.

rate = 3/4 pound formulated material (65% wettable powder) per acre on a broadcast basis.

$$\frac{0.75\ lb.\ (F)}{acre} \times \frac{0.65\ lb.\ a.i.}{1.0\ lb.\ (F)} = \frac{0.49\ lb.\ a.i.}{acre}$$

55. Using the information provided, at the rate of 3/4 pound Depesto 65WP per acre, how much of this material would be used for each sprinkler set? Show your work. (F = formulated product)
1 sprinkler set is 1.15 acres so:

$$\frac{1.15\ acre}{set} \times \frac{0.75\ lb.\ (F)}{acre} = \frac{0.86\ lb.\ Depesto}{set}$$

CALIBRATION PRACTICE
KEY

1. 22.5 psi
2. 1 gallon
3. 4 pounds
4. 7.35 ounces
5. 2,800 square feet
6. 3 MPH
7. 33.3 gallons per acre
8. 3.5 gallons per minute
9. 0.286 gallons per minute
10. 12.89 gallons per acre
11. 3.7 miles
12. 9.09 gallons per minute
13. 14,400 square feet
14. 13.6 pounds a.i. per acre
15. 0.2 %
16. 5.45 MPH
17. 2.67 pounds WP per acre
18. 35.3 pounds
19. 20 GPA
20. 17.14 GPA
21. 26.7 psi
22. 12.5 pounds
23. 20 acres
24. 20 pounds
25. 1.42 gallon
26. 200 gallons
27. 3 MPH
28. 20 feet
29. True
30. gallons per acre
31. 3,200 square feet
32. 12.5 gallons
33. 3.4 MPH
34. 15 feet
35. 36.3 GPA
36. 4.6 pounds
37. 23 GPA
38. 10 gallons
39. 111 steps per minute
40. 99 steps per minute
41. 23.76 GPA
42. 22.3 GPA
43. 8.97 pounds
44. Increase the application rate by changing the nozzle tips from for example 8002 to 8003.
45. 3 pints per acre
46. 6.5 pounds per crop acre while banding
47. 2.5 gallons per tankful
48. 8.7 pounds of the active ingredient per crop acre while banding
49. 6.38 fluid ounces
50. 1 bag
51. 3090 milligrams of atrazine per kilogram
52. 210 grams of atrazine are needed to reach the LD_{50} for the 150 pound person (42 teaspoons or 14 Tablespoons or 0.877 cups)
53. 1.147 acres
54. 0.4875 pounds a.i. per field acre
55. 0.86 pound per set