Student Handout—Calculating Runoff Name_____

Square inches or cm are AREA measurements, as is an acre. But, if square inches are multiplied by another inch (or cm), the resulting unit is a CUBIC inch, which is a unit of volume, just like gallons, liters, etc. This volume unit is what is needed to calculate run off. Since cubic inches do not translate into gallons, we must convert inches to cm, cm to liters, then liters to gallons.

Example: **Conversions:**

1) 1 inch = 2.54 cm
2) 1 cubic inch = (2.54 cm)3
3) 1 cm3 = 1 ml
4) 1000 ml = 1 liter
5) 1 gallon = 3.8 liters
6) 1 foot = 12 inches

EXAMPLE of how to use conversion factors:

96 eggs =? dozen
We know that 12 eggs = 1 dozen
96 eggs x 1 dozen = In this step, the "eggs" unit will cancel out, leaving the "dozen" unit
1 = 12 eggs
96 dozen = 8 dozen
12

Data for Williams, Arizona:

Williams, AZ has an annual average rainfall of about 22.3 inches.
The average ground absorption rate is 50%.
The average shopping mall and surrounding parking areas is 25 acres.
1 acre = 43,560 feet (208 feet x 208 feet)

Converting

Step 1: Convert inches of rain into centimeters of rain

_____ inches per year of rain x 2.54 centimeters = _____cm of rain per year

Step 2: Converting acres into cm^2

acres x 43650 ft^2 x (conversion #6)^2 x (conversion #1)^2 = # cm^2

_____ acres x 43650 ft^2 /1acre x (12 inches/1ft)^2 x (2.54 cm/1 inch)^2 =

_____ cm^2

Step 3: Finding the volume in centimeter and in milliliters

Step 1 answer x Step 2 answer

_____ cm x _____ cm^2 = _____ cm^3, which is the same as milliliters.

Step 4: Converting cm^3 to liters

Step 3 answer x conversion 3 x conversion 4 = liters

_____ cm^3 x 1ml/cm^3 x 1 liter/1000 ml = _____ liters

Step 5: Converting liters to gallons

Step 4 answer x conversion 5 = # gallons

_____ liters x 1 gallon/3.8 liters = _____ gallons

Step 6: Finding the absorption amount

Step 5 answer x percent absorption = # gallons lost to runoff

_____ gallons x 50% absorption = _____ gallons

My Local Area Runoff

Step 1: Convert inches of rain into centimeters of rain

_____ inches per year of rain x 2.54 centimeters = _____cm of rain per year

Step 2: Converting acres into cm^2

acres x 43650 ft^2 x (conversion #6)^2 x (conversion #1)^2 = # cm^2

_____ acres x 43650 ft^2 /1acre x (12 inches/1ft)^2 x (2.54 cm/1 inch)^2 = _____ cm^2

Step 3: Finding the volume in centimeter and in milliliters

Step 1 answer x Step 2 answer

_____ cm x _____ cm^2 = _____ cm^3, which is the same as milliliters.

Step 4: Converting cm^3 to liters

Step 3 answer x conversion 3 x conversion 4 = liters

_____ cm^3 x 1ml/cm^3 x 1 liter/1000 ml = _____ liters

Step 5: Converting liters to gallons

Step 4 answer x conversion 5 = # gallons

_____ liters x 1 gallon/3.8 liters = _____ gallons

Step 6: Finding the absorption amount

Step 5 answer x percent absorption = # gallons lost to runoff

_____ gallons x 50% absorption = _____ gallons

Conclusion Questions:

Is your runoff greater or lesser than the runoff calculated in the example used in the Converting section of your worksheet? _____

How many malls can *you* think of that are located in your area? _____
Multiply this times the runoff amount and put that answer here:_____

Now, add in other shopping centers, businesses, roads, and GUESS how many MORE gallons are lost in this area: _____ (your answer may be different from other students)

Consider that most malls, shopping centers, office parks, etc., have empty stores or offices.

What could we do to reduce the number or area of parking lots and buildings? _____

_____

_____

What else could we do to increase the amount of water absorption from rainfall?

_____

_____

Explain why urban areas are more likely to have a water shortage than farmlands, even though farms use about the same amount of water.

_____

_____

_____

How would the absorption rate be different if we had a different type of soil? Be specific.

_____

_____

What else could we do as a society to decrease the amount of land we use for building, while still not compromising the need to grow as populations increase?

Student Handout—Calculating Runoff Answer Key

Square inches or cm are AREA measurements, as is an acre. But, if square inches are multiplied by another inch (or cm), the resulting unit is a CUBIC inch, which is a unit of volume, just like gallons, liters, etc. This volume unit is what is needed to calculate run off. Since cubic inches do not translate into gallons, we must convert inches to cm, cm to liters, then liters to gallons.

Example: **Conversions:**

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EXAMPLE of how to use conversion factors:

96 eggs =? dozen
We know that 12 eggs = 1 dozen
96 eggs x 1 dozen = In this step, the "eggs" unit will cancel out, leaving the "dozen" unit
1 = 12 eggs

$\frac{96}{12}$ dozen = 8 dozen

Data for Williams, Arizona:

Williams, AZ has an annual average rainfall of about 22.3 inches.
The average ground absorption rate is 50%.
The average shopping mall and surrounding parking areas is 25 acres.
1 acre = 43,560 feet (208 feet x 208 feet)

Converting

Answers using Williams data

Step 1: Convert inches of rain into centimeters of rain

_____22.3_____ inches per year of rain x 2.54 centimeters =

_____56.64_____cm of rain per year

Step 2: Converting acres into cm^2

acres x 43650 ft^2 x (conversion #6)^2 x (conversion #1)^2 = # cm^2

_____25____ acres x 43650 ft^2 /1acre x (12 inches/1ft)^2 x (2.54 cm/1 inch)^2 =

_____33,261,300_____ cm^2

Step 3: Finding the volume in centimeter and in milliliters

Step 1 answer x Step 2 answer

_____56.6_____ cm x ____33,261,300_____ cm^2 = _____1,882,572.6_____ cm^3, which is the same as milliliters.

Step 4: Converting cm^3 to liters

Step 3 answer x conversion 3 x conversion 4 = liters

_____1,882,572.6___ cm^3 x 1ml/cm^3 x 1 liter/1000 ml = _____1882.5726_____ liters

Step 5: Converting liters to gallons

Step 4 answer x conversion 5 = # gallons

_____1882.5726____ liters x 1 gallon/3.8 liters = _____495.4138__ gallons

Step 6: Finding the absorption amount

Step 5 answer x percent absorption = # gallons lost to runoff

___495.4138_____ gallons x 50% absorption = _____247.7069____ gallons lost to runoff

My Local Area Runoff **Answers will vary upon your location**

Step 1: Convert inches of rain into centimeters of rain

_____ inches per year of rain x 2.54 centimeters = _____cm of rain per year

Step 2: Converting acres into cm^2

acres x 43650 ft^2 x (conversion #6)^2 x (conversion #1)^2 = # cm^2

_____ acres x 43650 ft^2 /1acre x (12 inches/1ft)^2 x (2.54 cm/1 inch)^2 = _____ cm^2

Step 3: Finding the volume in centimeter and in milliliters

Step 1 answer x Step 2 answer

_____ cm x _____ cm^2 = _____ cm^3, which is the same as milliliters.

Step 4: Converting cm^3 to liters

Step 3 answer x conversion 3 x conversion 4 = liters

_____ cm^3 x 1ml/cm^3 x 1 liter/1000 ml = _____ liters

Step 5: Converting liters to gallons

Step 4 answer x conversion 5 = # gallons

_____ liters x 1 gallon/3.8 liters = _____ gallons

Step 6: Finding the absorption amount

Step 5 answer x percent absorption = # gallons lost to runoff

_____ gallons x 50% absorption = _____ gallons

Conclusion Questions: **Answers will vary due to your location.**

Is your runoff greater or lesser than the runoff calculated in the example used in the Converting section of your worksheet? _____

How many malls can *you* think of that are located in your area? _____
Multiply this times the runoff amount and put that answer here:_____

Now, add in other shopping centers, businesses, roads, and GUESS how many MORE gallons are lost in this area: _____ (your answer may be different from other students)

Consider that most malls, shopping centers, office parks, etc., have empty stores or offices.

What could we do to reduce the number or area of parking lots and buildings?

What else could we do to increase the amount of water absorption from rainfall?

Explain why urban areas are more likely to have a water shortage than farmlands, even though farms use about the same amount of water.

How would the absorption rate be different if we had a different type of soil? Be specific.

What else could we do as a society to decrease the amount of land we use for building, while still not compromising the need to grow as populations increase?

Name_____ **Homework—My House**

You will need to measure the base of your house and any driveways, storage building, etc., that would keep water from soaking into your ground. Then you need to measure the total size of your lot. If you live in a multifamily dwelling (example: an apartment), approximate the size of the land in the complex that would be your yard.) Then you need to calculate how much of an acre your yard would be.

My House Runoff

Step 1: Convert inches of rain into centimeters of rain

_____ inches per year of rain x 2.54 centimeters = _____cm of rain per year

Step 2: Converting acres into cm^2

acres x 43650 ft^2 x (conversion #6)^2 x (conversion #1)^2 = # cm^2

_____ acres x 43650 ft^2 /1acre x (12 inches/1ft)^2 x (2.54 cm/1 inch)^2 =

_____ cm^2

Step 3: Finding the volume in centimeter and in milliliters

Step 1 answer x Step 2 answer

_____ cm x _____ cm^2 = _____ cm^3, which is the same as milliliters.

Step 4: Converting cm^3 to liters

Step 3 answer x conversion 3 x conversion 4 = liters

_____ cm^3 x 1ml/cm^3 x 1 liter/1000 ml = _____ liters

Step 5: Converting liters to gallons

Step 4 answer x conversion 5 = # gallons

_____ liters x 1 gallon/3.8 liters = _____ gallons

Step 6: Finding the absorption amount

Step 5 answer x percent absorption = # gallons lost to runoff

_____ gallons x 50% absorption = _____ gallons

Is your runoff greater or lesser than the runoff calculated in the My Local Area Runoff section of your worksheet? _____

Homework—My House **Answer Key**

You will need to measure the base of your house and any driveways, storage building, etc., that would keep water from soaking into your ground. Then you need to measure the total size of your lot. If you live in a multifamily dwelling (example: an apartment), approximate the size of the land in the complex that would be your yard.) Then you need to calculate how much of an acre your yard would be.

My House Runoff **Answers will vary due to location**

Step 1: Convert inches of rain into centimeters of rain

_____ inches per year of rain x 2.54 centimeters = _____cm of rain per year

Step 2: Converting acres into cm^2

acres x 43650 ft^2 x (conversion #6)^2 x (conversion #1)^2 = # cm^2

_____ acres x 43650 ft^2 /1acre x (12 inches/1ft)^2 x (2.54 cm/1 inch)^2 =

_____ cm^2

Step 3: Finding the volume in centimeter and in milliliters

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_____ cm x _____ cm^2 = _____ cm^3, which is the same as milliliters.

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Step 6: Finding the absorption amount

Step 5 answer x percent absorption = # gallons lost to runoff

_____ gallons x 50% absorption = _____ gallons

Is your runoff greater or lesser than the runoff calculated in the My Local Area Runoff section of your worksheet? _____

Asssessment Essay Questions Name_____

1. In a short paragraph (5-8 sentences) compare your home location to that of Williams, Arizona. Which environment has more rain? Which environment has more gallons lost to runoff? What are some ways that runoff could be decreased in both environments? Why is it important to have more water becoming part of our groundwater?

2. Describe the invention that you and your partner designed (or another classmate designed that you think it a better idea) to decrease the amount of runoff from a residential or commercial site. Be sure to explain how it would work to reclaim and conserve water.