Math Diagnostic

* + This math paper will help you discover your weaknesses and strengths in the types of math found on the AP Environmental Science Exam. For students who need extra help, video tutorials are available for Review Worksheets #1-10. Go to: <https://youtu.be/QEczhWCrPGk>

Do your calculations here or on scratch paper but place your answers on the answer sheet.

## Part 1: Division

1. Divide 45.5 by 10
2. Divide 530.4 by 3.4
3. Divide 900 by 36,000
4. An old Honda Civic can go 348 miles on average before it runs out of gas. its tank holds 12 gallons of gas. What is the car’s mpg? (miles per gallon)
5. Find the average of the following numbers: 124, 456, and 785

## Part 2: Percentages

1. What is 45% of 1800?
2. A gas engine is 6% efficient. What portion of a 12-gallon tank of gas is wasted?
3. 667 BTUsIn a pasture of grass and other plants, the biomass of insects makes up 5000 kilograms. This is 5% of the total biomass of the pasture. What is the total biomass of the pasture? Set up the problem and solve below:

## Part 3: Scientific Notation

*Write the following numbers in scientific notation:*

1. 550,000,000,000
2. 15 million

*Solve:x 1092.3 x 1047 x 10133 x 102*

1. (2.96 x 10 7) **+** (1.0 x 10 7)
2. (2.96 x 10 7) **+** (1.0 x 10 8)
3. (6.0 x 10 6) **÷** (3.0 x 10 4)
4. (2 x 10 5) x (3 x 1010)
5. (8 x 10 12) **-** (1.2 x 10 12)

## Part 5: Percent Change

1. If cyanide in a stream next to a gold mine increases from 240 ppm to 360 ppm, what percent increase is this? Set up the problem below:
2. A toxin increases from 12 ppm to 48 ppm. What percent increase is this? Set up the problem below:

## Part 6: Metric Conversions

1. 1200 watts = \_\_\_\_\_\_\_\_\_\_\_\_ kw (kilowatts)
2. 500 km = \_\_\_\_\_\_\_\_\_\_\_\_\_ meter
3. 60 gram = \_\_\_\_\_\_\_\_\_\_\_\_\_\_ milligram
4. 14,000 milliliter = \_\_\_\_\_\_\_\_\_\_\_\_ liter
5. Convert 5 km2 to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ m2

## Part 7: Half-Life Calculations

These half-life problems require no formula or calculator. “Sketch” out the problem to solve.

1. A 50g sample of radioactive Iodine-131 has a half-life of 8.0 days.  After 32 days, how much is left?
2. A 48g sample of Germanium-66 is left undisturbed for 10 hours.  At the end of that period, only 3.0g remain.  What is the half-life of this material?

## Part 8: Basic Word Problems

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1. A Family of five recently replaced its 5-gallon-per-minute showerheads with water-saving 2-gallon per minute showerheads. Each member of the family averages 8 minutes in the shower per day.
	1. How many gallons will each person use each day?
	2. How many gallons will the entire family (5 people) save per day?
	3. In a 30-day period, how many fewer gallons of water will the family use with the new showerheads?
2. Burning one gallon of gasoline in a car releases approximately 20 pounds CO2 into the atmosphere.

One person drives 50,000 miles in a hybrid car that averages 50 miles per gallon (mpg), while another person drives 50,000 miles in an SUV that averages 20 mpg. Over the course of the 50,000 miles, how many fewer pounds of CO2 are released by the 50-mpg car than by the 20-mpg car?

1. Americans recycle about 35% of their solid waste (trash). If an average American generates about 2 kg of waste every day, how much of that waste is recycled per **year**?

## APES Math Diagnostic Answer Sheet

## Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period \_\_\_\_\_\_\_\_\_

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Division | 1 | 2 | 3 | 4 | 5 |
| Percentages | 6 | 7 | 8 |  |  |
| Scientific Notation | 9 | 10 | 11 | 12 | 13 |
|  | 14 | 15 |  |  |  |
| Percent Change  | 16 | 17 |  |  |  |
| Metric Conversions | 18 | 19 | 20 | 21 | 22 |
| Half Life | 23 | 24 |  |  |  |
| Word Problems | 25a | 25b | 25c | 26 | 27 |

Circle the topics in the first column that you need to review. You will practice these topics before you go on to harder problems this year. Be honest—this is to help you do well on math problems this year in AP Environmental Science

## APES Math Review #2 Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

## Division Per \_\_\_\_\_\_\_\_\_\_\_\_

Solve:

1. Divide 1,554 by 6 2. Divide 10,272 by 12

3. Divide 2000 by 40,000 4. Divide 5786.8 by 3.4

5. Divide 26.208 by 0.3 6. Divide 32 by 160

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7. If the total number of books checked out of the library at your high school is 14,400 and the student population is about 2400. How many books on average does each student have?

8. An electric bill for the month of February showed a total of 646 kWh (kilowatt hours) used by her family of four. How many kWh per capita (per person)?

9. The electric bill totaled $193.80 for that month. How much $ did each kwh cost?

10. A Honda Civic can go 348 miles on average before it runs out of gas. The tank holds 12 gallons of gas. What is the car’s mpg? (miles per gallon)

## APES Math Review #3 Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

## Percentages Review Period \_\_\_\_\_\_\_\_\_

Solve:

1. What is 35% of 700?
2. What is 25% of 50,000?
3. What percentage of 400 is 20?

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1. Twenty percent of a forest is cut down. The forest area is 35,000 hectares. How many hectares of trees are left?
2. 10% of a barrel of oil is turned into plastic. A barrel of oil contains 42 gallons. How many gallons are NOT turned into plastic?
3. Joshua trees in the Mojave Desert occupy 25% of a piece of land. The land has 450 hectares in total. How much land is made up of Joshua trees?
4. A water tank holds 500 gallons and is 35% full. How many gallons are in the tank?
5. A teenager drinks 480 Calories of soda. Soda Calories are from sugar. She also eats another 1920 Calories of other nutrients that day. What percentage of Calories were from sugar?

## APES Math Review #4 Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Scientific Notation Review Period \_\_\_\_\_\_\_\_\_\_\_\_

Express each of the following in standard form:

1. 5.2 x 103
2. 9.65 x 10-4
3. 8.5 x 10-2
4. 2.71 x 104

Express each of the following in scientific notation:

1. 78,000
2. 0.00053
3. 250
4. 0.00000016

Add the following:

1. (2 x 105) + (3 x 103) =
2. (3.27 x 104) + (9.8 x 103) =
3. (9.06 x 105) + ( 3.1 x 10-2) =

Subtract the following:

1. (9 x 1011) – (7 x 1010) =
2. (2.8 x 10-4) – (1 x 10-2) =
3. (9.9 x 103) – (3 x 102) =

Multiply and divide the following:

1. (2 x 10-3)(9 x 10-3) =
2. (2.8 x 10-6)(4 x 10-5)=
3. (7.1 x 10-5)(6 x 10-6)=
4. (7.1 x 106)/(2 x 101)=
5. (4 x 104)/(2 x 10-4)
6. (5.4 x 10-1)/(10 x 101) =

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1. A farmer cultivates 2.3 x 104 acres of land and leaves 5.3 x 103 acres untouched. How many acres does he/she own?
2. Farmers in certain state lose 2.3 x 102 kg of topsoil in a year on average. There are 4.5 x 103 farmers in this state. How much topsoil is lost in this state annually?
3. A new construction site releases dust particulates that measure 2 microns (2 x 10-6 meters). Six hundred thousand particles are released each hour. What is the total length of the particles released in an hour? In a day? In a year?
4. The density of Calcium Carbonate (CaCO3) in Coral reefs is 2 x 103 kg/m3. If the CaCO3 in a reef weights 4 x 108 kg, what is the volume?

## APES Math Review #5 Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Percent Change Per. \_\_\_\_\_\_\_\_\_\_\_

To find percent change: Ending amount – starting amount X 100
 starting amount

Or Difference X 100 Memorize this formula for the AP Exam!
 Starting #

If your result is a **positive number**, then you have a **% increase**.

If your result is a **negative number**, you have a **% decrease**.

Find each percent change to the nearest percent (you may round, if necessary). State if it is a percent increase or a decrease.

1) From 100 km to 125 km 2) From 25 hours to 20 hours

3) From 70 g to 75 g (round to nearest whole %) 4) From 3 inches to 10 inches (round)

5) From 45 m to 90 m 6) From 12 L to 6 L

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7) In 1987, the population of Black Footed Ferrets in the world was 18 individuals. By 1989 through captive breeding, the number rose to 120. What percent change is this? (round to nearest whole %)

8) The number of km2 of Wilderness area increased from 4.0 X 104 to 6.0 X 104 in a decade. What is the percent increase?

9) A 2500-hectare piece of wild chaparral was bought by a developer to turn into homes. The developer built homes on 1000 hectares and left the rest untouched. What was the percent decline in wild chaparral? (Hint: you need to find the decline in wild chaparral, NOT the percent developed—so, subtract first)

10) A carmaker improved the mpg of a model of car from 22 to 32. What percent change is this? (round to nearest whole %)

11) Between 1950 and 2000, global meat production increased from 52 billion kilograms to 240 billion kilograms. During this period, the global human population increased from 2.6 billion to 6.0 billion.

 a. Calculate the per capita meat production in 1950 and 2000

b. Use the values from part a to calculate the change in global per capital meat production during this 50-year period as a percentage of the 1950 value.

## APES Math Review #6 Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

## Metric Conversions Period \_\_\_\_\_\_\_\_\_\_

The table below has the most common conversions used in this class and on the AP exam. **You will need to memorize this table**.
To convert to a larger unit, move To convert to a smaller unit, move

the decimal point to the left or divide the decimal point to the right or multiply

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|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Giga (G) 109**  | **Mega (M) 106** | **Kilo (k) 103** | **Basic Unit (gram g, liter l, meter m, Joule J, Watt W)** | **Centi (c) 10-2** | **milli (m) 10-3** | **micro or micron (µ) 10-6** | **nano (n) 10-9** |

When you convert to a SMALLER unit, the answer must be a LARGER number
When you convert to a LARGER unit, the answer must be a SMALLER number

Examples:

1 x 103 meters (m) = 1 kilometer (km) -–the answer requires a larger unit, so the answer must be a smaller number (1 is smaller than 103)

1 meter (m) = 1 x 10-3 kilometer (km)—the answer requires a larger unit so the answer must be a smaller number (10-3)

Example problem: Convert 20 g to mg.

g is a basic unit. mg is 10-3 on our chart. This tells us we need to move the decimal 3 places. Since we are converting to a smaller unit, the answer must be larger so move the decimal 3 spaces to the right and fill in with zeros. That way our number of 20,000 is larger than 20.

20g = 20,000 mg

Example problem: A home uses 15,000 kW power per year. How many Megawatts is this?

Because we go from 103 to 106, we increase by 103. We need to move the decimal 3 spaces. Since we are converting to a larger unit, we need to move the decimal to the left and make the number smaller.

15,000 kW = 15 MW

1. 1 nm= \_\_\_\_\_\_\_\_\_\_\_\_\_\_ m
2. 1.5 kg = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ g
3. 19.42 ml = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ l
4. 18.7 microns = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ nm
5. 25 J = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_kJ
6. 60 W = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ kW
7. 496.2 nl = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_µl
8. 93.1 ml = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_µl
9. A piece of particulate matter measure 2.5 microns. How many nanometers is this?
10. Mrs. Schertz drove 570 km from Santa Clarita, CA to Sacramento, CA. How many meters was this?
11. The Valencia Reclamation Plant reclaims 5.68 million liters of wastewater each day. How many Megaliters is this?
12. An iPad has 64 Gigabytes of memory. How many bytes is this?
13. A lightbulb is rated at 100 watts. It is on for 5 hours/day on average. How many kWh does this lightbulb use each month? (30 days)

When converting area (such as km2), simplify it and then convert.

Example: 1 km2 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ m2

Simplify to: 1 km X 1 km

Then convert: 1000m X 1000m = 1,000,000 m2

1. Convert 5 km2 to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ m2
2. Calculate the area in cm of a table that is 2m2

1. A shopping center’s parking lot is 200 meters long and 100 meters wide. How many km2 is this?
2. 5 cm of rain lands on this parking lot during a storm. Calculate the volume of storm water runoff this surface generates.

## APES Math Review #7 Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

## Half Life Problems Per \_\_\_\_\_\_\_

These half-life problems require no formula or calculator. “Sketch” out the problem to solve.

1. Radon has a half-life of 3.8 days.  After 7.6 days, 6g remain.  What was the mass of the original sample?
2. The half-life of Cs-137 is 30.2 years.  If the initial mass of the sample is 100g, how much will remain after 120.8 years?

1. Carbon-14 has a half-life of 5730 years.  Consider a sample of fossilized wood that when alive would have contained 96kg of C-14.  It now contains 3000g.  How old is the sample?
2. A 48g sample of Germanium-66 is left undisturbed for 10 hours.  At the end of that period, only 3.0g remain.  What is the half-life of this material?

1. With a half-life of 28.8 years, how long will it take 1g of strontium-90 to decay to 250mg?

1. Uranium-235 has a half-life of 700 million years. 600kg is stored as a spent fuel-rod at a nuclear power plant. How many billion years will it take to decay to 75kg?

##  APES Math Review #8 Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Word Problems: Dishwasher Period \_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Word Problems**: You will be required to set-up math problems on the free-response section of the AP Environmental Science Exam. You must write out the set-up EVEN IF you can do it in your head. No set-up = no points. You have room below to set up each problem and solve.

The Edwards family needs to buy a dishwasher. The new energy-efficient machines use less water and energy, but that they are more expensive. A traditional dishwasher costs $200 whereas the water-efficient machine costs $300.

1. If the average family washes 5 loads of dishes per week, how many loads does the family wash per year?
2. The traditional machine uses 20 L of water per load of dishes, and the efficient machine uses 7 L. How many liters would the efficient dishwasher save per year?
3. The average cost of water in the United States is $1.00 for every 1000 L. How much money would you save each year by using the more efficient dishwasher?
4. How many years would you have to own the more efficient dishwasher before you would save money on water compared with the traditional machine? Round to the nearest year.
5. The federal standard for energy use in dishwashers is 400 kWh/year. An energy efficient dishwasher will save 40% of that energy use. How much energy will an energy efficient dishwasher use in a year?
6. If the cost of electricity is $0.20/kWh, how much money will you save per year owning the energy efficient dishwasher?
7. Disregarding the cost savings for water use (#4), how many years would you have to own the more efficient dishwasher before you would save money on energy compared with the traditional machine? Round to the nearest year.

## APES Math Review #9 Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

## Word Problems: Avocado Trees Period \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Some members of a community garden in California want to plant an orchard to earn some extra income. After researching, they decided to plant avocado trees. Avocado saplings (baby trees) cost $20 each. It takes 3 years for avocado trees to reach maturity and bear fruit, but after they do, each tree will produce $125 worth of fruit. The community garden is made of 50 members and their goal is to sell $250 per capita each year.

1. Calculate the total number of trees that **all** the garden members will need in total in their orchard to meet the goal.
2. Calculate the cost to buy **all** the avocado trees.
3. Each avocado tree needs 40 L of water per day during the dry season (120 days per year) and 2 L of water per day during the rainy season (200 days per year). The community garden must buy water from the water agency at $0.01 per liter. Calculate how much it will cost per year to water **each tree.**
4. Calculate the cost of the water for **all** the trees each year.
5. After subtracting the cost of water, calculate the profit will each person make each year.

In another section of the community garden, some members raise chickens, not only for their eggs, but for the manure to fertilize the avocado trees. Each chicken produces 50 kg of manure per year and the garden’s chicken coop holds 25 chickens.

1. Calculate the mass of the manure produced per year by the chicken coop.
2. Manure can be worked into the soil at about 2kg/m2. Calculate the area that can be fertilized by the chickens’ manure.
3. Each avocado tree needs 10 m2 of space to grow. Calculate the number of avocado trees that the manure from the chicken coop can fertilize.

## APES Math Review #10 Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Word Problems: Corn Period \_\_\_\_\_\_\_\_\_\_\_\_

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On average 1 kg of corn contains 3 x 103 kcal and a single hectare can produce 1.2 x 104 kg of corn per year.

1. The US grows corn on 96 **million** hectares of corn each year. How many kg of corn is produced each year in the US?
2. How much kcals of corn are produced in a hectare of land each year?
3. How many kcals of corn is produced in the US each year? (Hint: use your answer from #2)
4. Thirteen percent of the US corn crop is exported to other countries. How many kg is exported? (Hint: use your answer from #1)
5. If a person ate **half** of their 2,000 kCal/day diet from corn and corn products, approximately how many people can a single hectare of corn feed in 30 days? (Round to the nearest whole person)