AP Environmental Science
Summer Math Packet

Name:____

Ms. Escobedo
mescobedo@epsd.org

Email me with questions.

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AP. Environmental Science Summer Packet

The AP Environmental Science exam will require you to do mathematical calculations. Occasionally, these calculations maybe somewhat difficult, and you may find it possible to do them in your head; nonetheless, it is **mandatory** to show all work or all calculations on the free response section of the AP Environmental Science exam. This worksheet is designed to help you prepare for the type of calculations you may encounter on this years exam.

For each problem, show every step of your work, and indicate the cancellation of all units....NO CALCULATORS!!!

Scientific Notation - All students should be able to work comfortably with numbers in scientific notation.

- Place the following numbers into proper scientific notation

1. 5,284,400,000 ____
2. 0.00000612 ____
3. 200,000,000,000 ______________________________________
4. 0.0000000026 ____
5. 651,400 ____

- Complete the following calculations using scientific notation only. SHOW YOUR WORK

6. One hundred thousand divided by twelve thousand five hundred: Answer: ____________________

7. Two billion seven hundred fifty million times fifty thousand: Answer: _____________________

8. Six thousand divided by three hundred billion: Answer: ____________________

9. 420 million times 4 billion: Answer: ____________________

10. Two billion seven hundred fifty million divided by fifty thousand: Answer: _____________________

Unit Conversions: All AP Environmental Science students should be able to convert from one system of units to another. Given the following, complete problems 11-15. Show all of your work including canceling units.

1 hectacre = 2.47 acre   1 kilowatt hour = 3412 BTU   1000 kilogram = 1 metric ton

42 gallon crude oil = 1 barrel   1 barrel crude oil - 5.8×10^6 BTU

11. If the annual rate of forest clearing is 80,000 acres per day, how many hectares are being cleared per week?

Answer:___________________________________

12. If my refrigerator uses 300 watts when the motor is running, and the motor runs 30 minutes every hour, then how much energy does it use per day? How many BTUs of energy would that be equal to?

Answer:_____________________________________

13. Given a feedlot of about 2500 cows, if an individual cow produces about 40 liters of manure per day, how many kiloliters of manure would be produced in one month?

Answer:_____________________________________

14. How many BTUs of energy will one gallon of crude oil provide?

Answer: _____________________________________

15. Sixty-four thousand kilograms of solid waste is equivalent to how many metric tons?

Answer: ______________________________________

Percentages: All students should be able to work comfortable with percentages.

16. A coal fired power plant is 35% efficient. If one ton of coal contains 20 million Btu of energy, then how many Btu of waste heat are produced per ton of coal?

Answer:______________________________________

17. Calculate the percent growth rate for a country with a population of 5 million: in a year in which it had 100,000 births, 70,000 deaths, 30,000 immigrants, and 50,000 emigrants.

Answer: _____________________________________

18. If the concentration of iron in a water supply changes from 45ppm to 8 ppm in a ten-year period, what is the annual percent change of the iron concentration?

Answer: ____________________

19. If 25% of a natural area is to be developed, leaving 750 acres untouched, how many acres are to be developed?

Answer: ____________________

Energy The AP Environmental Science exam always has questions about energy use. Be prepared!!

20. Your house is 1000 sq ft, and you have a natural gas furnace. 60,000 BTUs of heat per square foot are required to heat your house for one winter season. How many BTUs of energy will be needed?

Answer: ____________________

21. If one cubic foot of natural gas supplies 1,000 BTUs of heat, how many cubic feet of natural gas will be needed for this one winter season?

Answer: ____________________

22. My new Subaru Forester gets 32 miles to the gallon of gas. I drive approximately 20,000 miles per year. How many gallons of gas do I use in a year?

Answer: ____________________

23. If one gallon of gasoline emits 20 pounds of CO_2, when burned in the internal combustion engine of my car, how much CO_2 does my Forester emit each year?

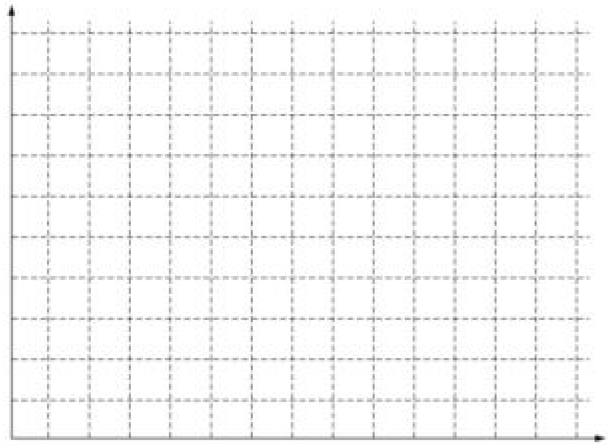
Answer: ____________________

<u>Free Response Questions</u> – At least one of the FRQs on the exam will be mostly math and there may be a smaller amount of math in one or more of the other three FRQs. Be Prepared!! Show all your work, include units, and circle your final answer. **No calculators!**

24. A certain fictional country called Industria is tracking its population data. In 1855, the first year vital statistics were reported for the country, the population was 1.6 million, with a crude birth rate of 43 per 1,000. At that time the population of Industria was growing quite slowly, because of the high death rate of 41 per 1,000. In 1875 the population began to grow very rapidly as the birth rate remained at its 1855 level, while the crude death rate dropped dramatically to 20 per 1,000. Population growth continued to increase in the small country into the late 1800's, even though birth rates began to decline slowly.

In 1895 the crude birth rate had dropped to 37, and the death rate to 12 per 1,000. In that year (1895) a complete census revealed that the population of Industria had grown to 2.5 million By 1950 population growth gradually began to decline as the death rate remained at its 1895 level, while the birth rate continued to decline to 22 per 1,000. In 1977 vital statistics revealed that the death rate was 10 per 1,000, and that population growth had slowed even more to an annual rate of 0.4%. By 1990 Industria had reduced its birth rate to that of its now constant, low death rate, and the population transition was complete.

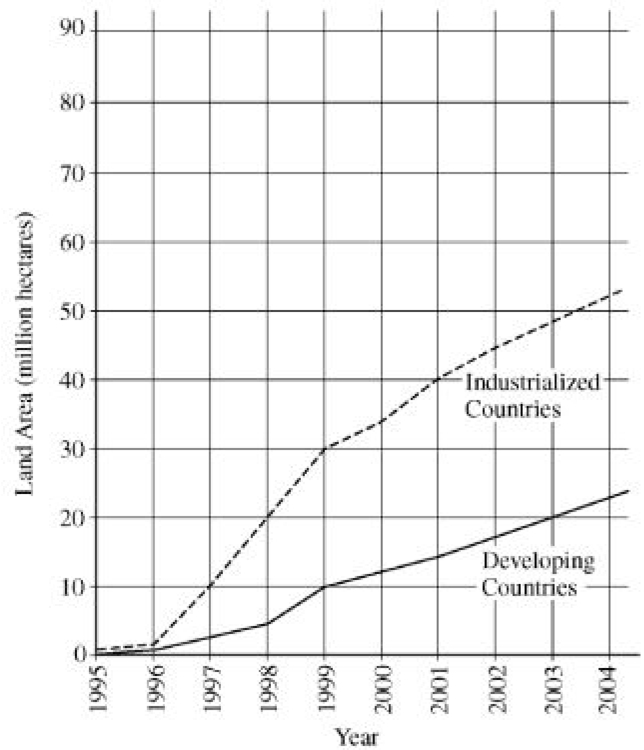
(a) On the axes below, plot the crude birth-rate data from 1855 to 1990. Now plot the crude death-rate data on the same axes. Clearly label the axes and the curves.



(b) What was the annual growth rate of Industria in 1950 ? What was the birth rate in Industria in 1977?

(c) Determine what the population size of Industria would have been in 1951 if the population had continued to grow at the annual rate of growth recorded for Industria in 1895.

25. The major issues in modern agriculture include the use of genetically modified (GM) crops and the implementation of sustainable agricultural practices. The following graph shows the increase in the use of GM crops in both developing and industrialized countries from 1995 to 2004.



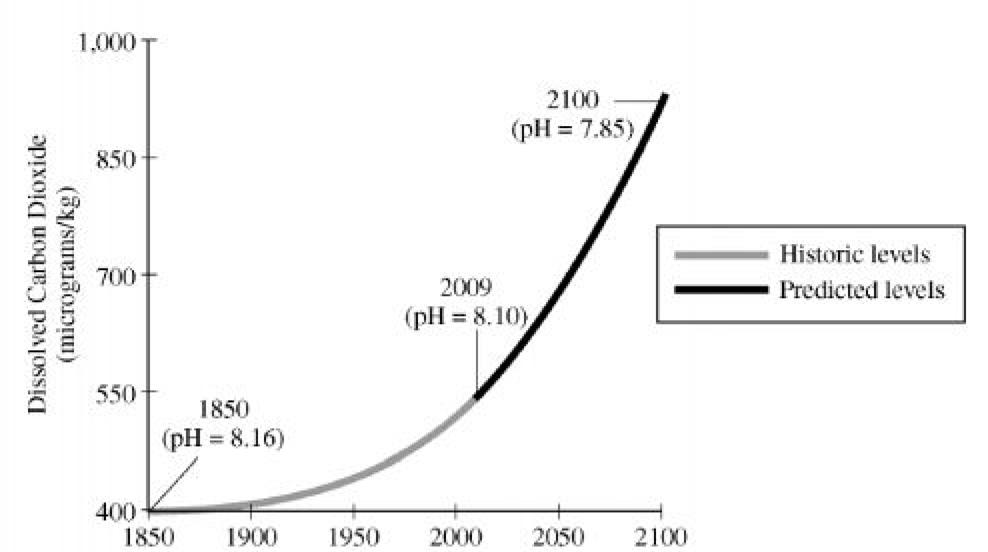
(a) Reply to the following questions based on the data in the graph above.

(i) Calculate the increase in the area of land used for growing GM crops in developing countries from 1999 to 2003. Express your answer as a percentage of the 1999 value.

(ii) Calculate the annual rate of increase in land area used for growing GM crops in industrialized countries from 1997 to 1999.

(iii) Using the rate you calculated in part (ii), project the area of land that would have been expected to be used for GM crops in industrialized countries in 2004.

26. Coral reefs are produced when corals acquire calcium ions (Ca^{2+}) and carbonate ions ($CO_3^{\ 2-}$) from seawater and deposit solid $CaCO_3$ to form their exoskeletons. Scientists are concerned that relatively rapid decreases in ocean water pH will hinder the deposition of $CaCO_3$. The graph below shows the amount of CO_2 dissolved in ocean water and ocean water pH (shown in parentheses) since 1850 and the predicted changes through 2100.



(a) In order to model the effects of ocean acidification on coral reefs, some simplifying assumptions can be made. Use the assumptions in the table below to perform the calculations that follow.

Assume that the total global area of corals growing in reefs is 2.5×10^{11} m^2 .
Assume that corals grow only vertically and that the average vertical growth rate of corals is 3 mm/year.
Assume that the average density of $CaCO_3$ in corals is 2×10^3 kg/m^3 .

(i) Calculate the current annual global increase in volume, in m3 , of $CaCO_3$ in coral reefs. Show all steps in your calculation.

(ii) Calculate the current annual global increase in mass, in kg, of $CaCO_3$ in coral reefs. Show all steps in your calculation.

(iii) Because of ocean acidification, it is expected that in 2050 the mass of $CaCO_3$ deposited annually in coral reefs will be 20 percent less than is deposited currently. Calculate how much less $CaCO_3$, in kg, is expected to be deposited in 2050 than would be deposited if ocean water pH were to remain at its current value.

27. The Fremont School District uses oil to heat school buildings. Go Green! is a new project the district will implement. The superintendent has declared that the district will dedicate itself to reducing its carbon footprint. In addition to taking serious energy-conservation measures, the district is planning to help offset its carbon dioxide emissions by raising money to help conserve a portion of a large tract of forest land adjacent to the high school campus.

(a) Use the assumptions below to answer the questions that follow. For each calculation, show all work.

The biomass of the forest increases at an annual rate of 2.7×10^5 kg/ha.
The forest biomass is 50 percent carbon by mass.
Each year the district uses 3.0×10^5 gallons of fuel oil for heating and hot water.
10 kg of CO_2 is produced when 1 gallon of fuel oil is burned.
1.0 kg of CO_2 contains 0.27 kg of carbon.
The cost of putting 1 ha of the forest into conservancy is $12,000.

(i) Calculate the mass of carbon, in kg, that is accumulated and stored in 1.0 ha of forest in one year.

(ii) Calculate the mass of carbon, in kg, that is emitted by the school as a result of its fuel-oil consumption in one year.

(iii) Calculate the number of hectares of forest the school district needs to conserve in order to offset the carbon released in one year by the school burning its fuel oil.

(iv) Calculate the amount of money the school district must raise for the conservation project.

28. Like many communities, Fremont has a combined sewer system that collects both sewage and storm water. When storm water runs into storm drains that connect to the city's sanitary sewer system, the storm water and sewage flow together to the Fremont Wastewater Treatment Plant (FWTP). During a major storm event, however, the combined volume of storm water and sewage may exceed the plant's capacity, and the overflow bypasses the FWTP. The untreated overflow is discharged into Fremont Creek along with the treated waste. Recently parts of Fremont received 5 cm of rain in 60 minutes. The storm caused widespread flooding in the northeast section of town. Especially hard hit was the Shoppes at Fremont shopping center. Use the data from the table below to answer the questions that follow. Show all calculations.

Fremont Water Data
The shopping center's parking lot is 200 meters long and 100 meters wide.
Fremont has an area of 10 km^2 .
Impervious surfaces cover 20 percent of Fremont's area.
The FWTP has the capacity to treat 5,000 m^3 of domestic sewage per day.
The FWTP has the capacity to treat 10,000 m^3 of combined sewage and storm water per day.

(a) **Calculate** the volume of water (in m^3) that runs off the Shoppes at Fremont parking lot after a 5 cm rainfall event. Assume that all the water that falls on the parking lot runs off.

(b) **Calculate** the volume of storm-water runoff (in m^3) generated in all of Fremont by the 5 cm rainfall event. Assume that only the impervious surfaces generate runoff.

(c) Assume that all the runoff that you calculated in part (b) is captured by the storm sewers in one day. Calculate the volume of untreated water (in m^3) that bypasses the plant as a result of the storm. (Note that the plant still receives 5,000 m^3 of domestic sewage per day.)

29. Iron ores are rocks from which metallic iron can be extracted for steel production. This process involves several steps. Iron ore is first mined and then turned into pig iron in a blast furnace, and some rock waste such as silicon dioxide is separated out. In the final step, the pig iron is refined into steel using a process that includes reacting the molten pig iron with oxygen to remove impurities.

(a) Use the data below to respond to the following. For each calculation, show all your work.

Global Iron and Steel Data
1.6 billion tons of iron ore are used yearly to make pig iron.
1.2 billion tons of pig iron are produced each year.
Iron ore reserves are estimated to be 800 billion tons.
95% of iron ore that is mined is used in steel production.

(i) Calculate the weight (in tons) of rock waste produced globally each year when iron ore is converted to pig iron.

(ii) Calculate the weight (in tons) of pig iron that could be produced if all of the estimated global iron ore reserves were used for pig iron production.

(iii) Calculate the weight (in tons) of the current global iron ore reserves that would be used to make steel if the current trends continue.

Both iron ore and coal are mined for use in the manufacture of steel. It is estimated that for every ton of steel recycled, 1.25 fewer tons of iron ore and 0.7 fewer tons of coal must be mined. About 80 million tons of steel are recycled every year in North America.

(b) Calculate the weight (in tons) of coal that is conserved each year in North America by recycling steel.