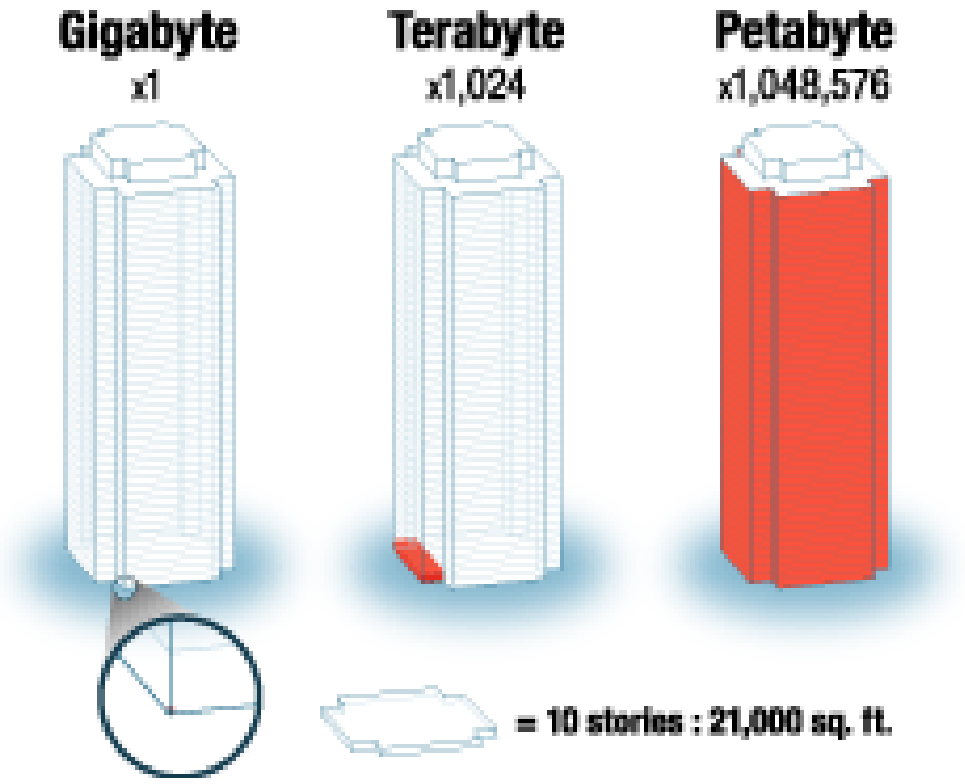
2013 Excellence in Mathematics Contest
Team Project

CHANDLER-GILBERT COMMUNITY COLLEGE



School Name:

Group Members:

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Reference Sheet

Formulas and Facts

You may need to use some of the following formulas and facts in working through this project. You may not need to use every formula or each fact.

$A = bh$ Area of a rectangle	$C = 2l + 2w$ Perimeter of a rectangle	$A = \pi r^2$ Area of a circle

$C = 2\pi r$ Circumference of a circle	$A = \frac{1}{2}bh$ Area of a triangle	$m = \frac{y_2 - y_1}{x_2 - x_1}$ Slope

12 inches = 1 foot	5280 feet = 1 mile	3 feet = 1 yard

16 ounces = 1 pound	2.54 centimeters = 1 inch	100¢ = $1

1 kilogram = 2.2 pounds	1 ton = 2000 pounds	1 gigabyte = 1000 megabytes

1 mile = 1609 meters	1 gallon = 3.8 liters	1 square mile = 640 acres

1 sq. yd. = 9 sq. ft	1 cu. ft. of water = 7.48 gallons	1 ml = 1 cu. cm.

$V = \pi r^2 h$ Volume of cylinder	$V = lwh$ Volume of rectangular prism	$V = \frac{4}{3}\pi r^3$ Volume of a sphere

Lateral SA = $2\pi \cdot r \cdot h$ Lateral surface area of cylinder	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Quadratic Formula	$\tan\theta = \frac{\sin\theta}{\cos\theta}$

TEAM PROJECT
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The Team Project is a group activity in which the students are presented an open ended, problem situation relating to a specific theme. The team members are to solve the problems and write a narrative about the theme which answers all the mathematical questions posed. Teams are graded on accuracy of mathematical content, clarity of explanations, and creativity in their narrative.

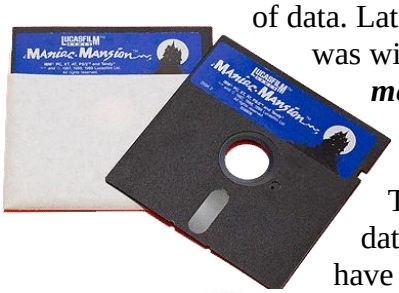
Part 1 – What is a Byte?

Before we discuss the answer to this question, we have to go back to the smallest unit of data that a computer uses. This is called a bit. The word "bit" comes from putting the words binary digit together. Computers convert all of its inputs, outputs, and processes to a binary system. This means that everything in a computer uses the symbols 0 or 1. A bit can be used to represent two states of information, such as "Yes or No", "On or Off", "0 or 1."

The next unit of data is the byte which is equivalent to 8 bits. A byte can represent $2^8 = 256$ states of information such as numbers or a combination of numbers and letters. One byte could be equal to one character. Ten bytes could be equal to a word. One hundred bytes would equal an average sentence.

As you are probably well aware, units of data that a computer uses are represented with terms such as kilobyte, megabyte, gigabyte, terabyte, etc.

In the 1970's and 1980's, computer data was saved to 5-¼-inch floppy disks that could initially hold 100 ***kilobytes*** of data. Later in the 1980's and into the 1990's, the standard way to save data was with the 3-½ inch disk (that wasn't as floppy). It could hold 1.44 ***megabytes*** of data. Now, we have flash drives (a.k.a thumb drives or jump drives) that can hold several ***gigabytes*** of data. We also have portable disk drives that can hold up to several ***terabytes*** of data. These prefixes (kilo, mega, giga, and tera) tell us how many bytes of data the storage device can hold. Traditionally, the prefixes have the following meanings:



- kilo – one thousand
- mega – one million
- giga – one billion
- tera – one trillion

These prefixes give you some idea of the size of these storage devices. But to really wrap our heads around the amount of data that can be stored is a challenge. The goal of this project is to help you to make sense of these quantities.

Part 2 – How Much Data?

As mentioned in Part 1, computers use the binary system and so the actual data storage sizes are based on powers of 2. For example, one byte is equivalent to $2^3 = 8$ bits.

1. Please consider the table and extend the pattern to complete the table. Note that you may need to be flexible in expressing an equivalent number when dealing with the very large numbers. That is, not everything has to be based on 1 byte.

Name	Equivalent Number
1 byte	$2^0 = 1$ byte
1 kilobyte	$2^{10} = 1{,}024$ bytes
1 megabyte	$2^{20} = 1{,}048{,}576$ bytes
1 gigabyte	2^{30} bytes = 1,024 megabytes
1 terabyte	
1 petabyte	
1 exabyte	
1 zetabyte	
1 yottabyte	
1 brontobyte	

Source: www.whatsabyte.com

2. An average 10 megapixel JPEG image will be about 4.5 megabytes. How many pictures can you store on a 1 gigabyte storage device?

3. How many pictures can you store on a 1 terabyte storage device?

Part 3 – Music Downloads

While music file size depends on the length of the song, a typical size is 4 megabytes. In this part of the project, we will determine the time needed to download music files as a way to make sense of the size of the storage device.

1. How many music files (assuming each is 4 megabytes in size) will fit on a 8 gigabyte storage device?

2. Apple iTunes is reported to be able to download music at a rate of 128 kbps (kilobytes per second). How long will it take to fill the 8 gigabyte storage device (use your results from #1 above).

3. Complete the following table showing the length of time needed to download a given number of songs (assuming each is 4 megabytes in size).

Number of Songs	Time Needed to Download
0	0
5	

10	
15	
20	
25	
30	

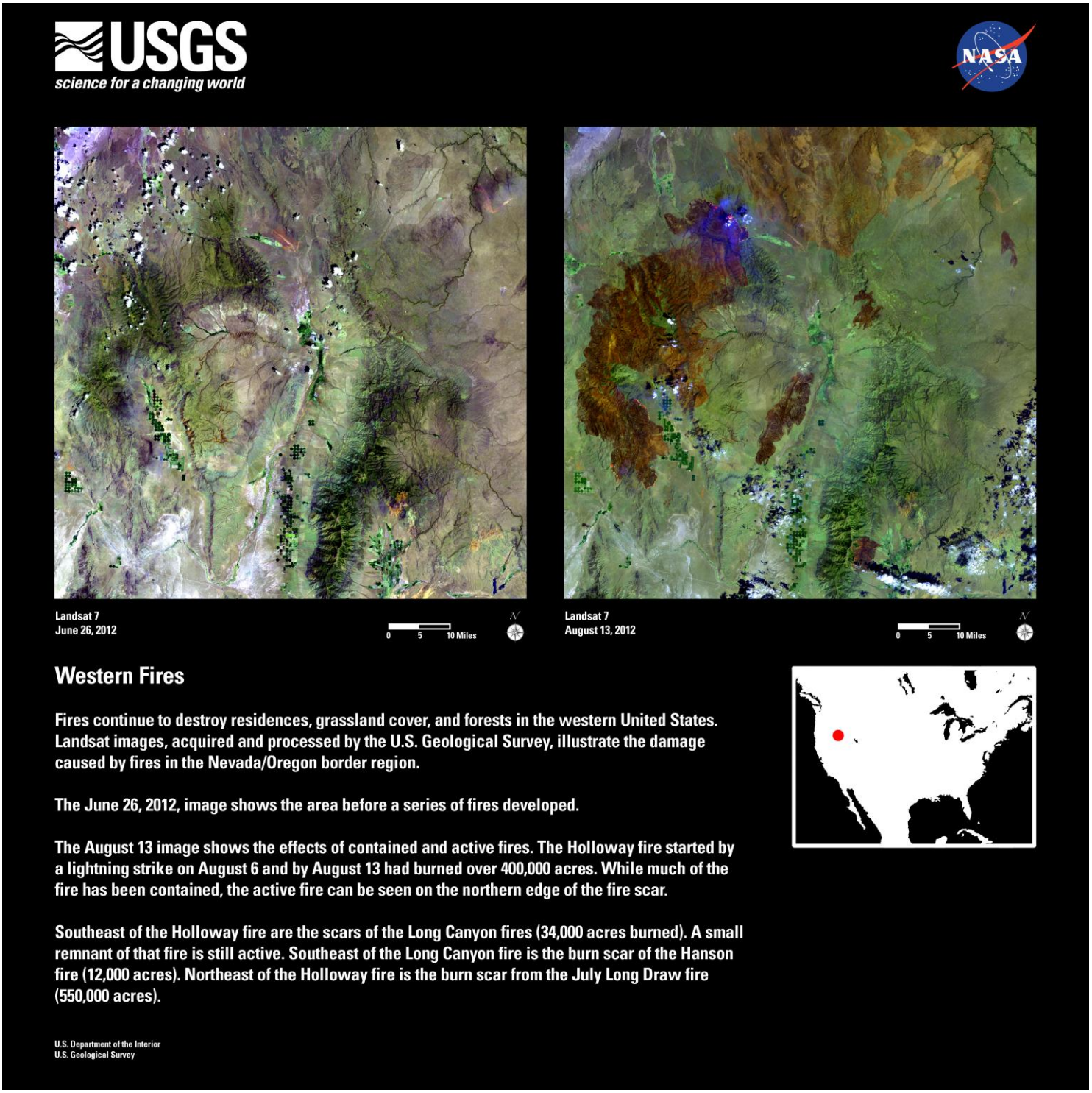
4. Create a graph showing the relationship between the number of songs downloaded and the length of time needed to download the songs. Write an explanation for why you chose to design the graph in the way that you did. Specifically explain the choice of which quantity to place on which axis.

5. Create a formula that could be used to determine the length of time (L) needed to download a given number of songs (S).

6. How long it would take to download enough songs to fill a 1 terabyte storage device.

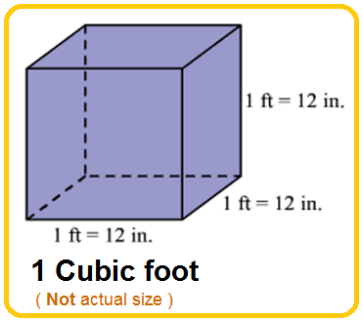
Part 4 – Making Sense of the Petabyte

The United States Geological Survey office in Sioux Falls, SD has a special department called the Earth Resources Observation and Science (EROS) Center. They "provide science and imagery to better understand our Earth." For example, EROS takes satellite images showing the effects of wildfires in the western United States.



On the EROS website (eros.usgs.gov), they share high resolution photos that allow for interactivity. EROS has many, many high quality images and need to store them on high-capacity storage devices. Their storage devices are at the petabyte level of capacity and they currently have around 4 petabytes worth of digital images. This part of the project is designed to help us to understand how large this really is!

1. Suppose that we represent a single byte of data using a cube that is 1 foot by 1 foot by 1 foot. That is, each of these cubes contains one byte of data. How many times could we fill the Grand Canyon with a 1 petabyte quantity of these cubes (each cube representing 1 byte of data)? According to the National Park Service, the Grand Canyon has a volume of 5.45 trillion cubic yards.



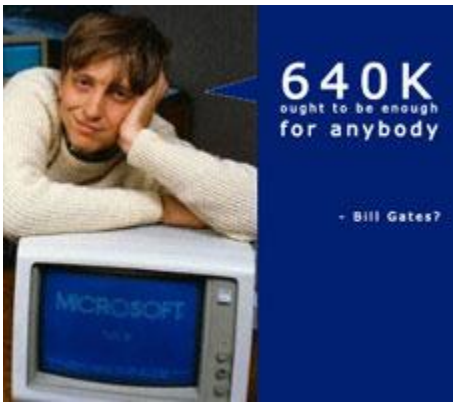
Part 5 – A Very Large Sugar Bowl?

Assume that a sugar cube is a perfect cube with dimensions1.25 cm ×1.25 cm ×1.25 cm (www.webstaurantstore.com/dixie-crystals-fine-sugar-cubes-1-pound-box/99929001.html) . Also, assume that a sugar cube contains 725,000 sugar crystals (www.chsugar.com/familyfun/sugart.html).

1. What is the volume of a single sugar crystal?

2. On January 2, 2013, the Louisville Cardinals played the Florida Gators in the 79th Sugar Bowl football game held in the Superdome in New Orleans, LA. This stadium has a volume of 3,500,000 m^3 (en.structurae.de/structures/data/index.cfm?id=s0000384). Suppose a byte of data is represented by a single sugar crystal. How many times could the Superdome be filled with sugar crystals if we had 4 petabytes worth of sugar crystals (now that's a big sugar bowl!)?

Part 6 – "640 kilobytes ought to be enough for anyone!"



There is a rumor that in 1981, Bill gates said "640 kilobytes ought to be enough for anyone!" when referring to the newly released IBM personal computer that had 640 kilobytes of RAM (random access memory). Nobody can confirm that Bill Gates said this and he denied ever saying it. In fact, some say that he actually said that "640 kilobytes should keep people happy for 10 years." After 6 years, we surpassed the 640 kilobyte limit.

1. Suppose that there was a way to connect these 1981 computers so that together they would have enough RAM to store one 4 megabyte photo. How many of these 640 kilobyte computers would it take to provide storage for one photo?

2. Suppose that 640 kilobytes of storage space is represented by a 1 foot by 1 foot square tiles. Now suppose that we created a number of these tiles to represent 1 gigabyte of storage space. If these tiles (1 gigabyte worth) were lined up side by side, how far would they stretch? Express this distance in the most appropriate unit (feet? yards? miles?).

Part 7 – Googol the Number not the Web Site

One googol is the number 1 with one hundred zeros after it:

10,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000.

Let's assume that the standard memory needs for a personal laptop computer today is 8 gigabytes and that the amount of standard memory is doubling every 3 years. How long will it be in years before a personal laptop will need 1 googol bytes of memory?