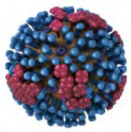
High School Science Enrichment

3 of 3

Wayne-Westland
COMMUNITY SCHOOLS

Name:_____ Class: _____ Date: _____

Tracing an Influenza Infected Passenger on an International Flight



adapted by Bethany Lau from

Shankar AG, Janmohamed K, Olowokure B, Smith GE, Hogan AH, De Souza V, et al. Contact trac
influenza A(H1N1)pdm09 virus–infected passenger on international flight. Emerg Infect Dis [Internet]. 2014 Jan [*May 2014*]. http://dx.doi.org/10.3201/eid2001.120101

Background

On April 27, 2009, influenza A(H1N1)pdm09 virus infection was confirmed in a passenger who had traveled on a commercial flight from Mexico to the United Kingdom. This was the first identified imported case of A(H1N1)pdm09 infection in the UK. The person departed Mexico on April 20, 2009, and arrived in Birmingham, UK, 9.5 hours later on April 21, 2009. In our study, we describe how we investigated the contacts the initial patient had on the flight. We tracked how many other passengers on the flight became ill. Using our data, we estimate the risk for transmission of A(H1N1)pdm09 virus to other passengers on this flight and other flights.

Method

During the flight aboard a Boeing 767-300 airplane from Mexico to the UK, the case-patient 1 was seated in the rear cabin. Bulkheads and toilets divided the airplane into 3 sections (front, middle, and rear). On the flight, 282 passenger seats were available. Case-patient 1 reports that he started to feel ill on April 18, 2009, 2 days before departing Mexico. The patient continued to be symptomatic during the flight. Reported symptoms were fever, cough, headache, muscle pain, and chills. A nasopharyngeal swab sample obtained on April 24 tested positive for the A(H1N1)pdm09 virus.

By using information from the airline's passenger manifest, we identified close contacts of case-patient 1. Close contacts were defined as passengers seated in the same row as or in the 2 rows in front of or behind the row in which case-patient 1 sat. This definition is consistent with World Health Organization guidance for post-flight influenza contact tracing. Beginning April 29, 2009, close contacts of case-patient 1 were interviewed by telephone. To identify case-patients who did not sit within 2 rows of case-patient 1, we reviewed a national database of confirmed cases of A(H1N1)pdm09 infection.

Passengers on the flight were considered to be post-flight case-patients, if they had influenza-like illness less than 7 days after arrival in the UK and had positive test results for the A(H1N1)pdm09 virus. Influenza-like illness was defined as fever, measured or subjective, plus more than 2 of the following signs or symptoms: cough, sore throat, runny nose, muscle pain, headache, vomiting, and diarrhea.

We defined the case-patient 1 as the initiator of the chain of transmission. We defined people who were on the flight and became ill after the flight as first-generation case-patients. Ill persons suspected to have caught the illness from other people from the flight were defined as second-generation case-patients.

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Results

Thirty-nine passengers on the flight (all of whom lived in the UK) were identified as close contacts of case-patient 1. Thirty-seven of the thirty-nine of the passengers were asymptomatic during the flight. The two passengers report that they were symptomatic with a cough and subjective fever. During the flight these two passengers sat within 1 row of case-patient 1. However, when both were tested for infection, both had negative test results. All close contacts were interviewed within 3 weeks after the flight.

Two of the 37 case-patients who were asymptomatic during the flight later tested positive for A(H1N1)pdm09 infection. One of these persons (case-patient 2, the traveling companion of case-patient 1) was seated next to case-patient 1. The other person (case-patient 3) was seated 2 rows behind case-patient 1. In our attack rate calculations, we exclude case-patient 2, because case-patient 2 is the travelling companion of case-patient 1. Therefore, after excluding case-patient 2, the attack rate for persons identified as first-generation cases and close contacts of case-patient 1 was 1/38 or 2.6%.

Details of 6 additional confirmed cases are shown in the Table below (cases 4–9). Case-patients 4 and 5 had been seated next to each other in the middle section of the cabin, 4 rows in front of case-patient 1. They were situated directly in front of the bulkhead separating the middle and rear sections of the cabin. Case-patients 6 and 7 were seated within 3 rows of each other and 5 and 8 rows, respectively, behind case-patient 1 in the rear section of the cabin. The attack rate for passengers sitting elsewhere in the plane and not regarded as close contacts of case-patient 1 was 4/238 or 1.7%. The attack rate for all passengers on the plane was 5/276 or 1.8%. Altogether, 4 of the confirmed cases were identified among the 96 passengers seated in the rear section of the cabin, where the attack rate was 4.2%.

Table. Selected characteristics of persons with confirmed cases of influenza A(H1N1)pdm09 virus infection, United Kingdom, April 2009*

Case-patient no.	Symptomatic during flight	No. rows from index case-patient	Day of symptom onset, April 2009, no. days before/after flight
1†	Yes		18th, 3 before
2‡	No	Same	23rd, 2 after
3	No	2 behind	24th, 3 after
4	No	4 in front	26th, 5 after
5	No	4 in front	24th, 3 after
6	No	5 behind	22nd, 1 after
7	No	8 behind	24th, 3 after
8§	NA	NA	25th, 4 after
9¶	NA	NA	26th, 5 after

*Characteristics were determined during flight-related contact tracing. NA, not applicable.
†Case-patient 1, the index patient, had the first laboratory-confirmed case of A(H1N1)pdm09 infection in the United Kingdom.
‡Case-patient 2 was the traveling companion of case-patient 1.
§Case-patient 8 was not on the flight and is a secondary case-patient who is believed to have been exposed to the virus by case-patient 2.
¶Case-patient 9 was not on the flight and is believed to have been exposed to the virus by a passenger who was on the flight but who had test results negative for A(H1N1)pdm09 virus.

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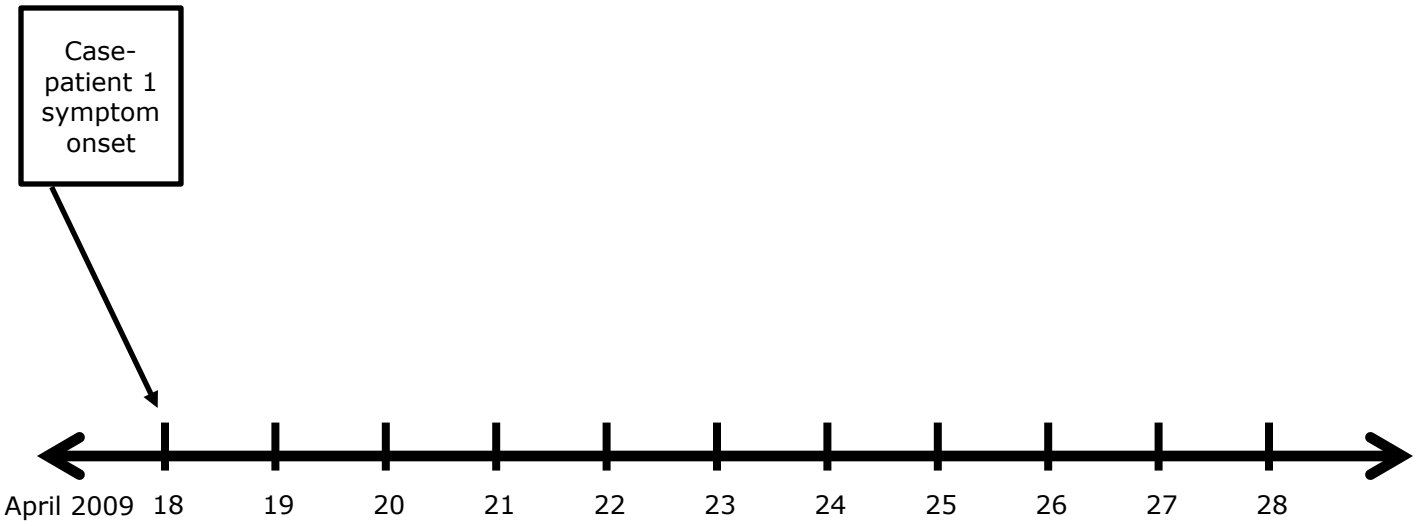
Conclusions

The investigation of passengers on this flight and their contacts identified 9 cases of confirmed A(H1N1)pdm09 infection: the index case-patient, 6 other passengers on the same flight, and 2 members of the public who had exposure to persons from the flight. Of the 6 confirmed case-patients on the flight, only two (including case-patient 2, the traveling companion of case-patient 1) had been seated within 2 rows of case-patient 1.

It cannot be stated that the virus was definitely transmitted from case-patient 1 to other passengers during this flight. However, several reasons support our assumption that these passengers did not receive the virus elsewhere. At the time of the flight arrival, there were no known cases of A(H1N1)pdm09 virus infection in the UK. No other plausible sources of infection were identified. These facts increase the likelihood that the two second-generation cases (8 and 9) received the virus from passengers on the flight who were identified as first-generation case-patients. It is possible that the first-generation cases caught the infection while they were in Mexico, but not likely. The first generation patients' symptoms began between 1 and 5 days after flight arrival. This incubation period for the virus is consistent with what we already know about the known epidemiology of the virus.

The results of this study suggest that contacting just the passengers within a 2-row zone of a virus case patient may not be enough to identify all cases. More studies are needed to learn more about global disease transmission.

Close Reading Question 1: As you re-read the passage, fill in the timeline below to show the time of each case-patient's symptoms onset, the time of the flight departure, and the time of flight landing. Case-patient 1 is done for you.



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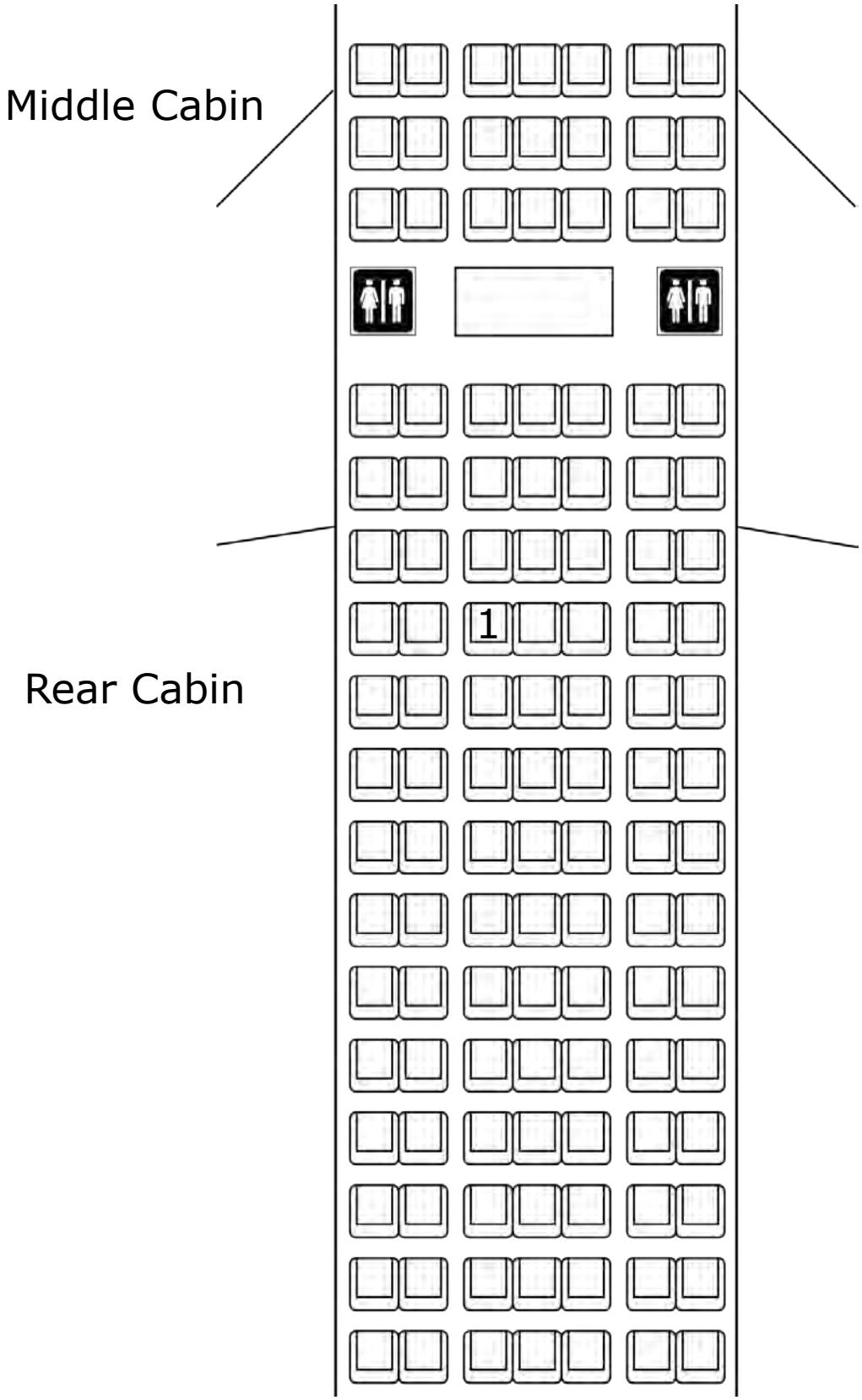
Close Reading Question 2: Using the information from the reading passage and the data table, fill in this airplane seat schematic with the case-patient numbers, placing them in the correct row (any seat in the correct row, because no exact seat location information is given.)



Name:_____ Class: _____ Date: _____

Close Reading Questions: Answer all questions in your own words and in complete sentences. Make sure to include details from the reading passage, table, airplane diagram, or timeline to support your answer.

3. Which virus's transmission rate is calculated in this study?

_____

4. Where did case-patient 1 likely contract the virus?

_____

5. How was the virus's transmission rate calculated?

_____

_____

6. Case-patient 2 is the traveling companion of case-patient 1. Why was case-patient 2 removed from the airplane attack rate calculations?

_____

_____

_____

7. Why is the seat placement of the first generation passengers important?

_____

_____

_____

8. Using your airplane seat diagram, suggest two possible ways that the A(H1N1)pdm09 virus spreads from person to person.

_____

_____

_____

_____

Name:_____ Class: _____ Date: _____

9. Would it be useful for the scientists to specify which seat in each row the case-patients sat in? Why or why not?

_____

_____

_____

_____

_____

10. Comment on the methods used in this study. Would you recommend that scientists in future studies use the same method of studying virus transmission? Why or why not?

_____

_____

_____

_____

_____

11. Is it possible that the first-generation case-patients caught the virus from someone else other from case-patient 1? Explain your answer.

_____

_____

_____

12. Suggest one way that airline companies could help reduce global transmission rate of infectious diseases.

_____

_____

_____

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Name: _____ Date: _____

The "MOO"-ving History of Vaccines

In order to effectively understand the history of vaccines, we must first familiarize ourselves with smallpox. You may just shrug it off, because smallpox has been completely eradicated (ahem, thanks to vaccines), and smallpox has in no way affected your life or your loved ones. However, smallpox was at one point a very devastating, and potentially fatal disease.

A virus known as *Variola* causes smallpox, which is a Latin term for "spotted" or "pimple." *Variola* is the same family as chickenpox or cowpox.

Symptoms of smallpox include fever, muscle aches, headaches, nausea, vomiting and backache. However, the most telltale signs of smallpox were the rashes it produced on the skin. The rash would first start off as small red spots on the mouth and tongue, which would eventually break open, depositing the virus into the mouth and throat. It was at that point in the virus life cycle that it's infected host was most contagious. As the mouth sores would start to break down, other rashes would appear on the face, then quickly spreading to the arms, legs and then hands and feet. With the appearance of this rash, an infected person would usually begin to feel better, but the rash would then turn into raised bumps. Within 24 hours, the bumps filled with a thick, opaque fluid and often had a depression in the center that looks like a bellybutton. Fever often will rise again at this time and remain high until scabs form over the bumps. The scabs would become pustules- meaning bumps that were filled with pus. It is important to note that pus is a dead type of white blood cell known as neutrophils. The pustules would scab over once again, and the person remained contagious until the scabs fell off.

Figures showing inoculation pustules
From a Chinese work on Vaccination

Smallpox is believed to have appeared around 10,000BC, at the time of the first agricultural settlements in northeastern Africa. From there, it may have spread from to India by ancient Egyptian merchants. The earliest evidence of skin lesions resembling those of smallpox is found on faces of mummies from the 18th and 20th Egyptian Dynasties (1570–1085 BC). At the same time, smallpox has been reported in ancient Asian cultures: smallpox was described as early as 1122 BC in China and is mentioned in ancient Sanskrit texts of India.

It was common knowledge that survivors of smallpox became immune to the disease; meaning, they could not contract the disease again. As early as 430 BC, survivors of smallpox were called upon to nurse the afflicted. Man had long been trying to find a cure for the smallpox disease.

However, the most successful way of combating smallpox before the discovery of vaccination was inoculation. The word is derived from the Latin *inoculare*, meaning, "to graft." Inoculation

referred to the subcutaneous (meaning under the skin) introduction of the smallpox virus into individuals who have not yet had the virus. The inoculator usually used a sharp lancet dipped in pus taken from a ripe pustule of some person who suffered from smallpox. The person was then pricked with the lancet on arms or legs.

1. What causes smallpox? _____
2. When is smallpox believed to have appeared? When is the earliest known recording of smallpox? _____
   _____
   _____.
3. During which symptom is the virus the most contagious? _____
   _____
   _____.
4. What is a pustule? _____
5. What is inoculation? What is its purpose? _____
   _____
   _____
   _____
   _____.

Inoculation was likely practiced in Africa, India, and China long before the 18th century, which was when it was introduced to Europe. In 1670, Circassian traders introduced inoculation “Ottoman” Empire in Turkey. Circassian women, who were in great demand in the Turkish sultan's harem in Istanbul because of their legendary beauty, were inoculated as children in parts of their bodies where scars would not be seen. These women must also have brought the practice of inoculation to the government of the Sublime Porte in Instanbul.

A Tribute to the Lady Mary Montague

Inoculation came to Europe at the beginning of the 18th century with the arrival of travelers from Istanbul; however, they did not change the ways of the conservative English physicians, who believed that Eastern medicine was inferior and thought inoculation would go the way of bloodletting.

It was the continued advocacy of the English aristocrat Lady Mary Wortley Montague that was responsible for the introduction of inoculation in England. In 1715, Lady Montague suffered from an episode of smallpox, which severely disfigured her beautiful face. Her 20-year-old brother died of the illness 18 months later. In 1717, Lady Montague's husband, Edward Wortley Montague, was appointed ambassador to the Sublime Porte. A few weeks after their arrival in Istanbul, Lady Montague wrote to her friend about the method of inoculation. Lady Montague was so determined to prevent smallpox that she ordered the embassy surgeon to inoculate her 5-year-old son.

Upon their return to London in April 1721, Lady Montague had the family physician, Charles Maitland, inoculate her 4-year-old daughter in the presence of physicians of the royal court.

Given the success of Lady Montague's children, Charles Maitland was granted a royal license to perform a trial of inoculation on six prisoners in 1721. Several court physicians, members of the Royal Society, and members of the College of Physicians observed the trial. All prisoners survived the experiment, and those exposed to smallpox later proved to be immune. In the months following this very first trial, Maitland repeated the experiment on orphaned children, again with success. Finally, on April 17, 1722, Maitland successfully treated the two daughters of the Princess of Wales.

Not long after Lady Montague presented inoculation, physicians performed inoculation on a massive scale. Although 2% to 3% of inoculated persons died from disease, inoculation rapidly gained popularity among both aristocratic and common people in Europe. The case-fatality rate associated with inoculation was 10 times lower than that associated with naturally occurring smallpox. In the 1750s more European princes died of smallpox, giving further motivation for inoculation. Many well-known royal families were inoculated. In fact, inoculation was becoming widespread throughout the world. That is, until a discovery made by a man named Edward Jenner.

6. During the 18th century, what was England's view on inoculations?

_____
_____.

7. Who is Lady Montague and why is she is a historic figure in inoculations?

_____
_____
_____
_____
_____.

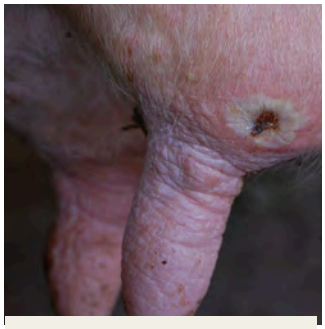
8. When and how did inoculation finally become acceptable in England?

_____
_____
_____
_____
_____.

9. The fatality risk of inoculation was _____ times lower than the fatality risk of naturally occurring smallpox.

Edward Jenner was born on May 17, 1749, in Berkeley, Gloucestershire. During his early school years, Edward developed a strong interest in science and nature that continued throughout his life. At age 13 he was apprenticed to a country surgeon named George Harwicke, where Jenner heard a dairymaid say, "I shall never have smallpox for I have had cowpox. I shall never have an ugly pockmarked face." In fact, it was a

common belief that dairymaids were in some way protected from smallpox.



Cowpox visible on udder of a sow

While Jenner's interest in the protective effects of cowpox began during his apprenticeship with George Harwicke, it was not until 1796 before he made the first step in eradicating smallpox. For many years, Jenner had heard the tales that dairymaids were protected from smallpox naturally after having suffered from cowpox.

Cowpox is similar to smallpox, but it is a much more mild disease. Pondering this, Jenner concluded that cowpox not only protected against smallpox but also could be transmitted from one person to another as a deliberate mechanism of protection. In May 1796, Edward Jenner found a young dairymaid, Sarah Nelms, who had fresh cowpox lesions on her hands and arms. On May 14, 1796, using fluid from Nelms' lesions, he inoculated an 8-year-old boy, James Phipps. Subsequently, the boy developed mild fever and discomfort. Nine days after the procedure he felt cold and had lost his appetite, but the next day he was much better. In July 1796, Jenner inoculated the boy again, this time with fluid from a fresh smallpox lesion. No disease developed, and Jenner concluded that protection was complete.

Medical drawing of Sarah Nelms' hand

In 1797, Jenner sent a short communication to the Royal Society describing his experiment and observations. However, the paper was rejected. Then in 1798, having added a few more cases to his initial experiment, Jenner privately published a small booklet entitled *An Inquiry into the Causes and Effects of the Variolae Vaccinae, a disease discovered in some of the western counties of England, particularly Gloucestershire and Known by the Name of Cow Pox.* The Latin word for cow is *vacca*, and cowpox is *vaccinia*; Jenner decided to call this new procedure ***vaccination.***

Eventually, vaccination became popular through the activities of others, particularly the surgeon Henry Cline, to whom Jenner had given some of the inoculant. Later in 1799, other respectable doctors began to support vaccination among their patients. Jenner conducted a nationwide survey in search of proof of resistance to smallpox or to inoculation among persons who had cowpox. The results of this survey confirmed his theory. Despite errors, many controversies, and chicanery, the use of vaccination spread rapidly in England, and by the year 1800, it had also reached most European countries.

In 1800, a professor by the name of Benjamin Waterhouse, a professor of physics at Harvard University, was given some of Jenner's smallpox "vaccine". Waterhouse introduced vaccination in New England, and then persuaded Thomas Jefferson to try it in Virginia. Waterhouse received great support from Jefferson, who appointed him to the National Vaccine Institute, an organization set up to implement a national vaccination program in the United States.

Although he received worldwide recognition and many honors, Jenner made no attempt to enrich himself through his discovery. However, he not only received honors but also found himself subjected to attacks and ridicule. Despite all this, he continued his activities on behalf of the vaccination program. Gradually, vaccination replaced inoculation, which became prohibited in England in 1840.

10. How did vaccinations get their name? _____
_____
_____.

11. What was the procedure during the first successful vaccination? _____
_____
_____
_____
_____.

12. Why was Jenner's vaccination a more ideal way to prevent smallpox than traditional inoculation? _____
_____.

13. Hypothesize a reason as to why vaccinations were successful in immunizing an individual for the smallpox virus. _____
_____
_____
_____
_____.

14. Name two interesting facts that you learned during this article:
_____
_____
_____
_____
_____

15. How has the term "vaccination" changed over time? Thanks to Edward Jenner, what other diseases can be prevented with vaccines? _____
_____
_____
_____.

HYPONATREMIA: DEATH BY WATER INTOXICATION

(1) When we think about death by water, we usually think of drowning. This is when water floods our lungs, preventing us from breathing air. However, there is another type of death by water that might be surprising to you; it's through drinking too much water. A poison is any substance that can cause a dysfunction in the body once it is consumed in large enough quantities. You might think that water is a harmless substance, but it can be a poison when too much of it is consumed. This condition is called hyponatremia, also commonly known as water intoxication.

(2) The symptoms of hyponatremia include nausea, vomiting, headache, confusion, lethargy, cramps, seizures, decreased consciousness and eventually coma and death if the case is severe enough. Many of these are neurological symptoms, meaning that it affects the nervous system, which includes the brain.

(3) How does drinking too much water cause these symptoms? The key isn't actually the water, it is the salt, or electrolytes, in your body. A healthy body has a balanced concentration of electrolytes, but when excess water is added, these electrolytes become diluted in the large amount of water. Hyponatremia literally means lack of salt. Water itself likes to move from an area of low electrolyte concentration to an area of higher electrolyte concentration within the body. As more water is consumed, it first gets dumped into the blood and dilutes the electrolytes in the blood. When these electrolytes become very diluted, then the place that has a higher concentration of electrolytes becomes the tissues surrounding the blood vessels. Since water prefers to move towards places with a higher concentration of electrolytes, the water will migrate, through a process called osmosis, from the blood into the tissues. The tissues will swell and expand to accommodate the extra water. So far, none of this seems life threatening, however, neuronal (brain) tissue is a different matter. The brain is the only organ encased within bone, so if brain tissue swells, it has nowhere to go and begins to become squeezed within its casing. This swelling is called cerebral edema and can result in the neurological symptoms previously listed.

(4) You might think it would be difficult to become hyponatremic. All you have to do is avoid drinking too much water to prevent this, however, every year hundreds of people accidently die of hyponatremia. The most common cases involve exercise-associated hyponatremia. When exercising, athletes lose a lot of water through sweat, and try to replace this with water or sports drinks during and after exercise. It's estimated that up to one sixth of marathon runners can become hyponatremic. Infants under 9 months old are also at risk of being hyponatremic because of their low body mass. It's easy for them to over consume liquids and if they are in distress, it's difficult for them to communicate this. People who use MDMA, a party drug commonly known as Ecstasy, can become hyponatremic. MDMA is often used during events with prolonged periods of energetic dancing, sweating and over-hydration. Also, people with certain psychiatric conditions, like psychogenic polydipsia, will feel a compulsion to drink large quantities of water, putting them at risk of hyponatremia. People who are unconscious in a hospital need to be cared for intravenously, meaning that they are delivered liquids and electrolytes right into their blood. If not monitored properly, they run the risk of developing hyponatremia. It is suspected that Andy Warhol, a famous artist, died due to hyponatremia after being admitted into hospital after routine gallbladder surgery.

HYPONATREMIA: DEATH BY WATER INTOXICATION

When admitted, he weighed 128lb and was given intravenous fluids during and after surgery. When he died shortly after, his body was 150lb which indicates that his body might have taken on a large volume of water. Sadly, there are also cases of death due to a form of child abuse that involves forcing children to drink excessive amounts of water and other liquids as a form of discipline and punishment.

(5) How much water is too much? Here are some examples. In 2002, 3 year old Rosita Gonzalez died when her babysitter forced her to drink 3 liters of water in a 4 hour period as a form of punishment. In 2007, 28 year old Jennifer Strange died after drinking 7.5 liters of water in a 3 hour period during a water drinking contest. In 2014, 17 year old Zyrees Oliver died after drinking 15 liters of water and Gatorade during and after a football practice.

(6) Treatment for mild hyponatremia involves restricting fluid intake until the body is able to remove most of the excess water in the urine naturally. It may also involve administering saline solution into the blood. Saline contains electrolytes to help restore the proper amount of salts in the body. Drugs like diuretics and vasopressin receptor antagonists can also be administered. Both of these drugs cause the kidneys to produce urine more rapidly and in greater volumes than it normally would. Healthy adult kidneys can produce 800mL to 1000mL of urine an hour, but these drugs will cause them to produce even more.

Article Questions

1) What do neurological symptoms mean and what are some neurological symptoms of hyponatremia?

2) How is brain tissue different from other tissues during hyponatremia?

3) The process of water migrating from areas of low electrolyte concentration to areas of high electrolyte concentration is called _____. _____ is the medical term for the swelling of the brain.

4) Why are athletes at risk of exercised-associated hyponatremia?

5) Why are infants under 9 months old at risk of hyponatremia?

6) How do diuretics and vasopressin receptor antagonists help counteract the effects of hyponatremia?

LOVE AND CUPID'S CHEMICALS

and is released by mothers after giving birth. This causes them to strongly bond with their baby. Oxytocin is also released by both men and women after orgasm (sexual release) during sex. It causes them to feel closer to one another and more connected. Vasopressin is another hormone that began to draw attention as an attachment hormone due to the research conducted on prairie voles (which are rodents that look a lot like mice). Like us, prairie voles have sex beyond what is needed for reproduction and they form strong monogamous (having only a single sexual partner) bonds with their partners. Many will not seek out new mates once their mate dies. When researchers took a group of male voles and injected them with a drug that inhibited their vasopressin production, the strong bonds they had developed with their partners were erased and they were no longer devoted to their partners.

(6) Some evolutionary biologists say that attachment hormones have been vital for causing couples to stay with one another (even through difficult times) so that they can successfully raise children. Another theory says that attachment decreases promiscuity (having multiple sexual partners) and this is important to prevent the spread of sexually transmitted diseases that could harm reproductive ability and cause illness or death.

Article Questions

1) List the three components of love.

2) How does testosterone affect sex drive?

3) In the experiment with the 400 men and testosterone and estrogen, why were half of the men given a drug to inhibit their estrogen production and half of the men not given this drug?

4) Why do some people say that love is like a drug?

5) In the chart below, describe the effect of each chemical during attraction.

Adrenalin	Dopamine	Serotonin

6) If a person cannot make oxytocin, what problems might they experience?

7) Describe two reasons why it might have been useful for humans to develop strong bonds of attachment.

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7) Describe two reasons why it might have been useful for humans to develop strong bonds of attachment.

LOVE AND CUPID'S CHEMICALS

(1) What is love? Why do humans feel love and is there a purpose for it? Let's explore some of these questions. Scientists who study love usually break it down into three main components. The first is the *sex drive* which compels people to seek out romantic and sexual partners. The second is *attraction* which causes people to narrow down their search to only a few individuals. This helps conserve time and energy during the search. The third is *attachment* which causes a committed bond to form, making it possible to support and help one another in life and in child rearing.

(2) The first component, *sex drive* (also known as libido), is affected by psychological and biochemical components. Illness, stress, depression, anxiety, distraction, body image issues and a history of abuse or trauma can be psychological components that decrease sex drive. Biochemically, testosterone has a huge effect on the sex drives of all humans. Men make testosterone in their testes and women make it mostly from their ovaries and adrenal glands. One symptom of low testosterone levels is lowered sex drive. For those for whom a lack of libido is distressing, they can be prescribed medication to help increase their sex drive and often testosterone is one of the primary medications recommended. Not surprisingly, for most males, their libido is the highest in their teens and twenties when their testosterone levels are also at their highest.

(3) Endocrinologists (doctors who specialize in the hormonal systems of the body) are also beginning to realize that estrogen plays an important role in both male and female sex drives. Without adequate levels of estrogen, both men and women experience a decrease in libido. A recent study, published in the *New England Journal of Medicine*, took 400 healthy men between the ages of 20-50 and wiped out their sex hormones. The men were then given treatments with testosterone gel but half also received a drug to prevent them from making estrogen. After several weeks on the drugs, their levels of libido were examined. Those without the ability to make estrogen were not able to regain their sex drive as well as those who were still able to make estrogen. Further studies need to be done to understand the full effects of estrogen on libido.

(4) When it comes to the second component of love, *attraction*, the chemicals and feelings created by them are very similar to the chemicals and feelings created by using cocaine. This might be why love is sometimes called a "drug". It creates a sense of euphoria (an intense feeling of excitement and happiness). Brain scans of both people in love and people who are cocaine addicts show a similar pattern of activation in the areas that control reward, pleasure and motivation. During attraction, adrenaline is released by the body. This causes your heart to beat faster, it dilates your pupils, it makes your palms sweaty, mouth dry and makes you feel giddy and nervous around the person to whom you are attracted. Dopamine, a neurotransmitter (brain chemical), is released in your brain when something pleasurable happens like when you consume sugar, when you're taking some types of drugs and when you're attracted to someone. Dopamine tells you that you're being rewarded by pleasurable feelings when you're around someone and this causes you to want to be around them more. Finally, serotonin, another neurotransmitter, causes you to have an obsessive focus on your love interest. You think about them all the time even when you should be focusing on other things.

(5) For a relationship to move beyond attraction and towards lasting attachment, the levels of adrenaline, dopamine and serotonin have to lower to make way for two other hormones: oxytocin and vasopressin. These hormones are important in helping people to feel bonded and devoted to one another. Oxytocin is often called the "cuddle hormone"

Name: _____ Date: _____

THE WORLD'S DEADLIEST ANIMAL

For this article, a "deadly animal" refers to an animal that causes human deaths. Below is a list of six animals that can be considered deadly. As a warm up, try to put them in order from most deadly to least deadly:
Elephant, dog, mosquito, crocodile, snake, tapeworm.

MY GUESS: MOST DEADLY ANIMALS					
Most deadly:	2nd most deadly:	3rd most deadly:	4th most deadly:	5th most deadly:	Least deadly:

The second most deadly animal in the world is not on the list above. The second most deadly animals in the world are humans, causing an estimated 475,000 of their own deaths through accidents, violence, and war. But the *most* deadly animal in the world nearly doubles the deaths caused by humans. An estimated average of 725,000 deaths per year is caused by this most deadly animal, an insect capable of carrying a series of deadly diseases. The most deadly animals in the world are mosquitoes.

How can they kill so many? Maybe you think it's allergic reactions? Or perhaps it's giant vampire mosquitoes that can drain the blood with one bite that are causing all these deaths? No, there are rarely any deadly allergic reactions, and there are certainly no such things as giant vampire mosquitoes. There is, however, such a thing as vector-borne diseases.

Mosquitoes carry viruses and bacteria with them, such as malaria, the West Nile virus, yellow fever, Rift Valley fever virus, and they are even responsible for heartworm in dogs. The mosquitoes are unaffected by these pathogens, and the pathogens thrive inside the mosquitoes using them as a host. In vector-borne diseases, the host can spread the virus or bacteria from one animal to another. Other animals that carry vector-borne diseases are ticks and fleas. A vector-borne disease is any disease involving a pathogen that is carried from one animal to another through means of a traveling host.

Mosquitoes are not hatched from the egg with these diseases. They actually receive the diseases from infected animals when they feed upon them. Then, as they feed on more animals, they can transmit the disease into the blood of their next meal.

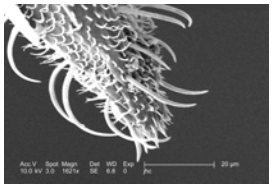
Only female mosquitoes bite; most male mosquitoes only live about one week. Females need a blood meal in order to lay eggs. There are a few species of mosquitoes that do not require blood to lay eggs; they instead use the nectar and juices of plants. Most mosquitoes attack birds and mammals though some feed on the blood of reptiles and amphibians.

Various clues enable mosquitoes to zero in on people and other animals they seek to bite. They can detect carbon dioxide exhaled by their hosts many feet away. Mosquitoes also sense body

chemicals, such as the lactic acid in perspiration and body odor, as well as heat. Some people are more attractive to mosquitoes than others. A person sleeping in a mosquito-infested room may wake up with dozens of mosquito bites while the person sleeping next to them has none. Similarly, people react differently to mosquito bites, some showing very little sign of being bitten, while others exhibit substantial redness, swelling and itching. This is an allergic reaction to the mosquito's saliva, the severity of which varies among individuals.

Mosquito eggs are laid in the water; they need water to reproduce for this reason. The eggs hatch into larvae, which grow into pupae and finally into adults. The entire process depends on the temperature and conditions but takes an average of two weeks. The Mosquitoes can fly long distances; some more than 20 miles from the water source that produced them. But they don't fly fast, only about 4 miles an hour. And because they typically fly into the wind to help detect host odors, fewer mosquitoes are around on windy days.

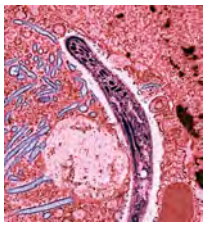
As a mosquito flies closer to its target, it looks for the movement of dark objects. Once it finds you, it lands, inserts its proboscis and probes for blood vessels beneath the skin. When it finds one, it injects saliva into the wound. The saliva contains an anticoagulant that ensures a steady, smooth flow of blood.



This is a close up of a mosquito's proboscis, which is a highly serrated end point of the mosquito's labrum. Basically, the labrum is the tube that connects the proboscis to the body, and the proboscis is the mouth of the mosquito. Surprisingly, the serrated proboscis is not smooth but has tiny sharp hair-like protrusions that pierce the skin. Believe it or not, this design is what makes it virtually impossible to feel. In fact, some Japanese scientists are working to design a virtually painless hypodermic needle based on the design of a mosquito's proboscis.

When a mosquito bites, it leaves some of its saliva behind. This is what causes the classic mosquito bite: itching, swelling, reddening of the skin. The red bump left behind is actually from increased blood flow, and not because the mosquito was sucking blood from that spot, rather from an immune response in your body. The mosquito saliva leftover in your blood is labeled as "foreign" by your immune system, which triggers a response, increasing blood flow (swelling), and releasing histamines (itching). Eventually, as the immune system breaks down the saliva, the bump disappears.

Unfortunately, the mosquito's saliva also may contain pathogens such as malaria parasites or the encephalitis virus. This is how mosquitoes transmit disease. The pathogens are released straight into your bloodstream and can wreak havoc on your body, and may lead to death.



The most common pathogen transmitted by mosquitoes is malaria, which is caused by parasitic Protozoans in the Plasmodium family (four species total). There are some terms that are used to describe the relationship between mosquitoes, humans, and malaria-causing protozoans (Plasmodium) in this vector disease. In the life cycle of Plasmodium, a female mosquito is known as the "definitive host." She transmits the Plasmodium during a specific stage of its lifecycle to a vertebrate host such as a human, known as the "secondary host", thus acting as a transmission vector.

The name “malaria” came far before we knew what caused it. Malaria translates to mean “bad air”, because it was originally thought that this disease was caused by vapors, particularly from the foul air of swamps (and is also known as “swamp fever”). Malaria is one of the oldest known infections of man though it was not quite understood until recently.

Once the Plasmodium protozoans enter the bloodstream from the mosquito’s saliva, they then settle within the liver, where they grow and reproduce. Once the protozoans are fully-grown, the liver cells burst open, releasing thousands of new protozoan parasites into the bloodstream, where they attack the red blood cells, killing red blood cells in the process.

Mosquito net

Malaria is a huge problem, mostly in sub-Saharan Africa where the conditions favor the breeding of mosquitoes. *Though, scientists seem to think that with the onset of global warming, Malaria will become another widespread problem.* Sadly, in 2013 alone there were an estimated 584,000 deaths, most of which were among children.

Malaria is preventable and curable. A huge awareness has been raised in places most affected by Malaria (such as Africa, India, Thailand and parts of South America). Now many mosquito nets (sometimes called “malaria nets”) are available to prevent mosquito bites while sleeping. Repellents are also useful, but not widely available in third-world countries. The same applies to medication used to treat malaria by killing the protozoans; though it exists, it is not readily available in poor communities.

The answer to the order of the most deadly animal that was listed at the beginning of this reading exercise. Now we know that mosquitoes are the most deadly, followed by snakes, dogs, tapeworms, crocodiles, and lastly elephants.

ANALYSIS QUESTIONS

1. What is a vector-borne disease and what are four diseases that mosquitoes can carry and transmit? _____

_____

_____.

2. How do mosquitoes transmit diseases? _____

_____

_____.

3. Why do mosquitoes need a blood meal? _____.

4. How do mosquitoes detect their prey? _____

_____

_____.

5. Why do you generally not feel pain (or anything at all) when a mosquito bites you?

_____

_____.

6. Why does our skin form raised, red, itchy bumps after a mosquito bites?

_____

_____

_____.

7. The most common disease transmitted by mosquitoes is _____, and it is caused by

_____.

8. If malaria is contracted, where within the body does it reproduce before attacking red blood cells? _____

9. Which countries/continents is malaria mostly found within the world? _____

_____.

10. How are people trying to help others avoid contracting malaria in less privileged countries?

_____

_____.

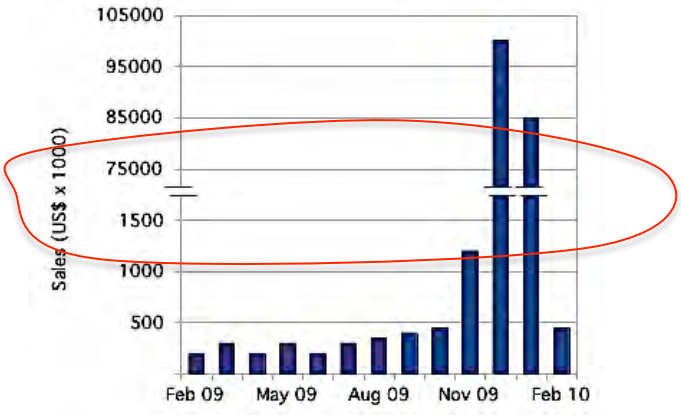
THE MOST DEADLY ANIMAL ON THE PLANET

Disease Transmitted by Mosquitoes	Estimated number of Cases in the Year 2013	Estimated number of Deaths in the Year 2013
Yellow Fever	200,000	30,000
Dengue	54,000	22,000
Malaria	300,000,000	584,000

The above chart only lists 3 of the diseases that are transmitted by mosquitoes. Create a bar graph that depicts both the reported cases and the reported deaths of each type of disease. Use one color for reported cases and another color (or pattern) for number of deaths. Be sure to label your graph appropriately so that the data can be easily read.

Tips on how to set up your graph (you should probably read this):
Since there is such a wide range of data when graphing these particular numbers (22,000 to 300,000,000), it is a good idea to insert a bar break. A bar break is depicted as two slashes, and is used to drastically jump from one value to another (that way your bar graph isn't 4 feet tall! It is contained within a reasonable amount of space).

Here is an example of a bar break jumping from 1,500 to 75,000:
Notice this particular example at first has increments of 500, and then after the bar, the increments jump to 10,000 increases per point. The bar graph you will be creating has a similar setup, with two breaks to account for the large range of numbers.



Remember to label! Remember to insert breaks into your bar when necessary (aligned with breaks on y-axis; see example above.

Cases and deaths/ 50,00,000

300,000,000

200,000,000

100,000,000

50,000,0000

Cases and deaths / 100,000

500,000

400,000

300,000

200,000

150,000

Cases and deaths/ 10,000

50,000

20,000

10,000

SHOW ME THE NUMBERS!

11. Why are using breaks within graphs useful for wide ranges of data?

_____

_____

12. Quick Glance

At a quick glance, if you had to pick one disease that is "more deadly" or "less curable" (in other words, a higher percentage of deaths given the number of cases), which one would you pick? _____

13. **Percentage of Deaths**

In order to find the percentage of cases that result in death, you must plug the numbers into this formula (malaria has been done for you):

$$\frac{\text{Number of deaths}}{\text{Number of cases}} \times 100$$

Percentage of cases that result in death		
Yellow fever	Dengue	Malaria
		19%

14. Which disease has the highest death rate?

_____

15. Which disease has the most successful rate (lowest death rate)?

_____

16. Notice that the first break indicates an increment of 100,000 per line. That's *half* of the Yellow Fever cases per line. The next break FIFTY times that at 50,000,000 (FIFTY MILLION).

Looking at your answers to 12 and 13, do you think the breaks might take away from the visual aspect of graphs? How so?

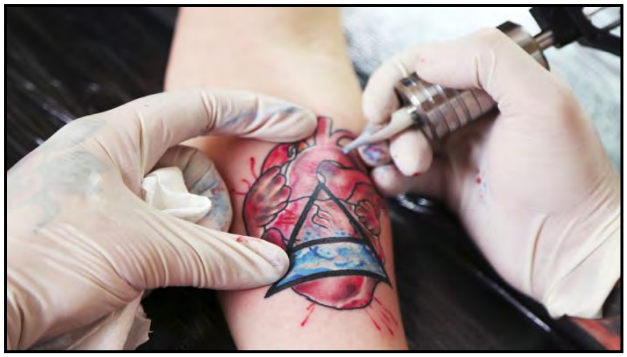
_____

_____

_____.

THE SCIENCE OF TATTOOS

(1) Though tattoos seem to have become recently popular, they have actually been around for thousands of years. Some of the oldest tattoos date back to over 3200 BC and were found on mummies that were preserved in the glacial ice of the Alps. Tattoos have been used by many cultures to mark rites of passage from childhood to adulthood, to signify status, to symbolize fertility and to identify someone as a part of a group or tribe. These days many people also get tattoos as a form of self-expression and body adornment.



(2) The process of tattooing involves using a tattoo machine which is fitted with a single use, multi-pointed disposable needle. The needle is dipped into a small pot of ink (similar to the way a paint brush is used) and when the machine is turned on, the needle extends and retracts (like a sewing machine) at a rate of up to 50 times/second. The sharp tips of the needle puncture the epidermis (the outermost layer of the skin) and carry the ink further down into the dermis (the layer just below the epidermis). Despite what most people think, the ink is not "injected" into the skin. Unlike medical needles, which are hollow, tattoo needle tips are solid and are merely used to create small punctures. The ink coating the outside of the tips is pushed into the wounds by the tips and the tissues of the dermis will "suck up" the ink using capillary action.

(3) Reaching the dermal layer is critical for creating a permanent tattoo. If the ink only reaches the epidermis, the tattoo will fade quickly as cells of the epidermis are easily shed. Epidermal cells shed at a rate of 30 000 to 40 000 an hour, so you lose about 1 million epidermal cells a day. In a months time, your entire epidermis will have replaced itself. The dermal layer is permanent and is the perfect area to place the ink. If the needle goes too deep, then the ink is put in the sub-cutaneous fat, under the dermal layer, which can cause the ink to migrate and make the tattoo blurry.

(4) Tattooing causes an inflammation reaction for two reasons: first, because tissue has been physically damaged by the puncture wounds and second, because the tattoo ink is treated like an invading pathogen (much like a bacteria or virus) by your immune system. The macrophages (a type of white blood cell) of your immune system flood into the inked area and try to engulf the ink particles and carry them away through the blood stream toward the liver for disposal. However, the macrophages can only engulf the smaller ink particles. The majority of the ink particles are much bigger than any one macrophage. It would be like a rabbit trying to engulf a 3 foot carrot in one bite.

(5) Ink particles that aren't disposed of by macrophages stay in the dermis causing the tattoo to become permanent. They can be suspended in the gel-like matrix of the dermal layer and they can also be permanently taken inside of dermal cells called fibroblasts. Ironically, they are also found inside of any macrophages that end up trapped in the dermal layer. However, macrophages are persistent and will try to break apart, engulf and carry away the ink as long as the ink is there. As this happens, the crispness of any new tattoo begins to get fuzzy over time and look increasingly faded as the macrophages nibble away at the ink.

(6) Tattoo laser removal technology depends on the action of the macrophages. This technique uses a laser that produces short bursts of intense light that fractures the large ink particles into smaller fragments that are easily engulfed by macrophages. Different lasers must be used for different ink colors because different colors respond to different wavelengths of light. Since black absorbs all wavelengths of light, it is the easiest ink color to remove, while other colors, like green, are

THE SCIENCE OF TATTOOS

difficult to break apart as they absorb only specific and limited frequencies of light.

(7) The removal process is expensive, takes a long time, and comes with its own side effects. Laser removal can take more than 12 laser sessions depending on the tattoo and how a person's body responds to the treatments. Each session requires a recovery phase of 4-6 weeks, for the skin to respond and heal, before the next session can begin. Thus, the total time required to remove some tattoos can take over a year. Even then there still might be a ghost image left. For people with darker skin, they also risk hypopigmentation (loss of natural skin pigment) in the area that's treated with lasers. This is because the lasers can accidentally target some of the dark natural pigments in the skin (e.g. melanin) and destroy them. Tattoos further away from the heart are also harder to remove because circulation is poorer.

(8) There is some controversy over the tattoo inks used as their safety is not tightly regulated. Many of the colored inks use toxic heavy metals to increase their stability. For example, mercury is found in red inks and lead is found in yellow, green and white inks. These heavy metals can cause issues if a person needs an MRI (magnetic resonance imaging) to locate tumors or other diseases in the body. Since MRIs use very strong magnets, sometimes heavy metals in tattoos can respond by heating up and causing burns in the tattooed area.

Article Questions

1) Why is the epidermis a bad location to place the tattoo ink?

2) Why don't macrophages get rid of all of the tattoo ink?

3) Why does a tattoo begin to lose its sharp lines as time goes by?

4) How do lasers help remove tattoos?

5) In paragraph 7, the last sentence states, "Tattoos further away from the heart are also harder to remove because circulation is poorer." Why do you think this makes tattoos harder to remove using laser removal techniques?

6) How might the heavy metals used in inks become a health concern when trying to remove tattoos using laser?

THE ZIKA VIRUS EMERGES

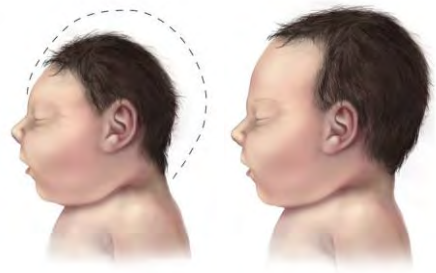
(1) What is the Zika virus (ZIKV), what does it do and how fearful should we be of it? Though you might only have heard of the Zika virus recently, it has been known by scientists for almost 70 years. It was first discovered and isolated in Uganda in a forest called the Zika Forest. This virus comes from the genus of viruses called flaviviruses which includes related viruses like the West Nile virus, yellow fever virus and dengue (fever) virus. All of these viruses are *arboviruses* which means that they are transmitted from person to person by *arthropod vectors*. In terms of disease, a vector is anything that can carry and transmit an infectious agent from one host to the next. An arthropod is any invertebrate which has an exoskeleton and a segmented body. In the case of the Zika virus, its preferred arthropod vector is the *Aedes aegypti* mosquito. Since the Zika virus can be found in the blood of infected humans, mosquitos can pick up this virus and spread it to uninfected humans.

(2) Until recently, Zika has been isolated to the equatorial regions of Africa and Asia where it causes symptoms that are referred to as Zika fever, which resemble a very mild case of dengue fever. These symptoms include a fever, rash, joint pain, and conjunctivitis (red eyes). Sometimes headaches and muscle pain are also present. The symptoms begin 2 to 7 days after being bitten by an infected mosquito but the symptoms are not severe and last only a few days to a week. Rest and fluids usually help a person recover fully. Acetaminophen (e.g. Tylenol) can be used for the pain. However, since only 1 in 5 infected people ever develop symptoms, most people don't know they've been infected and Zika hasn't been widely reported in the media until recently.

(3) In 2014, Zika began spreading eastward across the Pacific Ocean where it reached French Polynesia and then jumped over to Easter Island. Zika then spread to Central and South America and the Caribbean in 2015. Zika infected mosquitos did not make it across the ocean, but people infected with Zika did. Local mosquitoes in Zika free zones who bit infected humans would pick up the virus and begin to spread it among the previously uninfected human population, thus beginning a new chain of disease transmission. With ever increasing international travel, the threat of a Zika pandemic (an infection that becomes widespread over large regions and even multiple continents) is of great concern.

Aedes aegypti mosquito with its characteristic white banded legs.

(4) The current alarm that has arisen over Zika is not due to the Zika fever symptoms, it is due to the increasing evidence that pregnant women infected with Zika may give birth to children with microcephaly. Microcephaly is a neurodevelopmental birth defect. This means that it involves a disorder that affects the development of the brain. "Micro" is the Latin prefix that means small and "cephaly" comes from the Greek word for head or brain. Most babies born with microcephaly are either born with a noticeably small head or a normal one. However, for those born with normal heads, they soon show outward signs of microcephaly when their faces and body grow larger but their skulls do not. This causes the characteristic shrunken head appearance of people with microcephaly. Not only are the heads smaller, the brains within them are also smaller which results in severe intellectual and motor impairment. Some children might also have seizures and life expectancy is reduced.



A baby with microcephaly (left), compared to a baby with a normal head size (right).

(5) Microcephaly can be caused by many factors, but an alarming number of cases of microcephaly have shown up in places like

THE ZIKA VIRUS EMERGES

Brazil where there were 2782 cases of microcephaly reported in 2015 while there were less than two hundred reported cases in each of the two previous years. The rise in microcephaly seems to follow the 2015 outbreak of Zika in Brazil that led to increasing numbers of pregnant women being infected. It will remain to be seen how the 2016 Summer Olympic Games in Brazil affects the international spread of Zika.

(6) Many countries infected with Zika have warned women to postpone getting pregnant until the outbreak of the virus can be contained. The CDC (Centers for Disease Control and Prevention) in the United States along with many other countries have issued travel warnings advising pregnant women against traveling to Brazil and other infected areas. Effective vaccines currently exist for some flaviviruses, like the yellow fever virus, and now scientists are intensely focusing on developing a vaccine for Zika as well.

(7) Currently, few Europeans and North Americans report Zika infections because the type of mosquitoes that carry Zika are not found where they live. However, there might be evidence that once a person is infected, they may be able to transmit the virus through sexual intercourse. The evidence for this is currently supported by only a few cases, but as more research is done, sexually transmitted Zika may become confirmed.

Article Questions

1) Zika is a type of arbovirus. What is an arbovirus?

2) List some of the symptoms of Zika fever.

3) What is the treatment for Zika fever?

4) What is microcephaly and what are some of the symptoms of microcephaly?

5) Why should health officials around the world be worried about the 2016 Summer Olympic Games in Brazil?

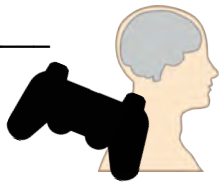
6) Why has the Zika virus not made much of an impact in Europe and North America thus far?

7) Why have pregnant women specifically been warned to stay way from countries currently experiencing a Zika outbreak?

8) What are two potential ways that a human can contract the Zika virus?

Name: _____ Date: _____ D

The Effects of Video Games on Your Brain



The fact is, 90% of school aged children play video games, but did you know that the age of the average gamer today is 33 years old? Video games are found in nearly all households; in fact after the one-month release of popular video games, there is an average of 68,000 years worth of game time played within homes across the U.S. It looks like they are here to stay.

First and foremost, video games are not good for your health. But, they are not necessarily bad for your health in *reasonable doses.* A reasonable dose is game time played anywhere from 5-15 hours a week.

1. What is the average age of a gamer these days? _____
2. What is considered a "reasonable dose" of video games? _____

If you play action games within the 5-15 hours weekly range, the effect of video games on your brain can actually be positive. First of all, it can help to improve your vision in a number of ways. It has been proven in a laboratory setting that action gamers are better able to resolve small detail in the context of clutter. In addition, action gamers can differentiate between different levels of gray. The eyes working to coordinate with the brain lead to overall better vision. Video games that contain high levels of action, such as Unreal Tournament, can actually improve your vision.

Researchers at the University of Rochester have shown that people who played action video games for a couple hours a day over the course of a month improved by about 20 percent in their ability to identify letters presented in clutter—a visual test similar to ones used in eye clinics. In essence, playing video game improves your bottom line on a standard eye chart.

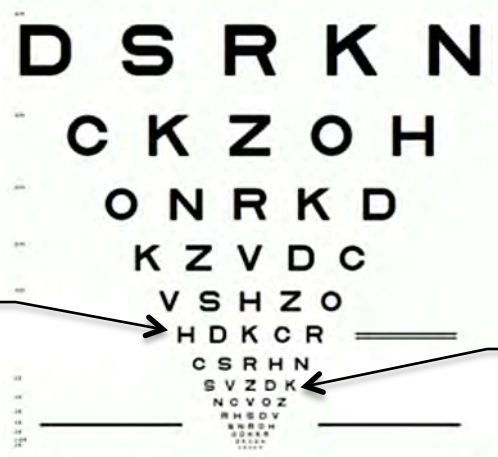
3. Describe ways in which your vision can improve from playing action video games: _____

_____

_____

_____

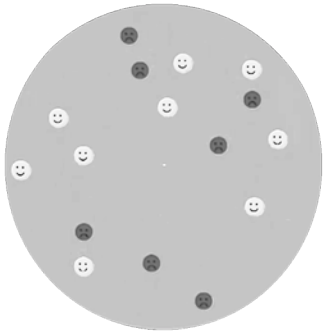
_____.



Average non-action gamer vision

Average action gamer vision

Testing Attention: Do Video Games Increase Attention Span?



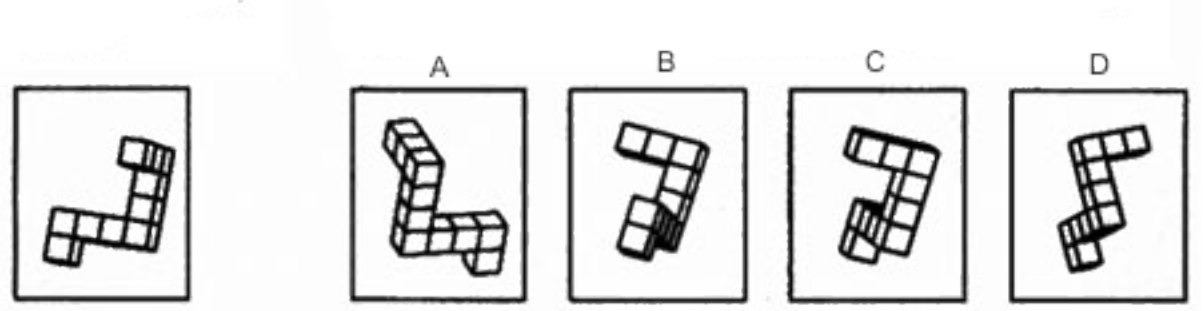
In another experiment, subjects were asked to track the colors of the "sad faces" (the happy faces remained yellow). The faces were constantly moving around on the screen.

Experimental Results	
Number of hours played per week	**Number of moving objects tracked**
0-2	3
3-5	5
6-8	6
9-11	7
12-14	7
15-17	7

4. Review the information and chart above. Given this information, what were the results of the experiment? Does this support the idea that video games may lead to a better attention span?

   _____
   _____
   _____
   _____
   _____.

   The results encouraged scientists to test if the brain can actually improve, or learn, from using video games. This is called "brain plasticity". To do this, scientists decided to use something called mental rotation.



   Look at the very first image on the far left. Can you tell which of the following images (A, B, C or D) is the rotated version of the first image? After a while does your brain start to cringe a little bit? That's because it's doing work! This was also tested in a laboratory. Scientists wanted to test if the results of video games could be long lasting, if the brain could actually learn from them.

   Test subjects came into the lab and were tested with their mental rotation skills (similar to the one above). Then, they played action video games for one hour a day for two weeks. After the two weeks their mental rotation skills were retested. This went on for 4 months. The results are found in the chart below:

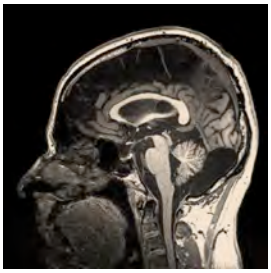
Week	Number of Correct Tries (Mental Rotation)
0	1
2	2
4	4
6	7
8	11
10	16

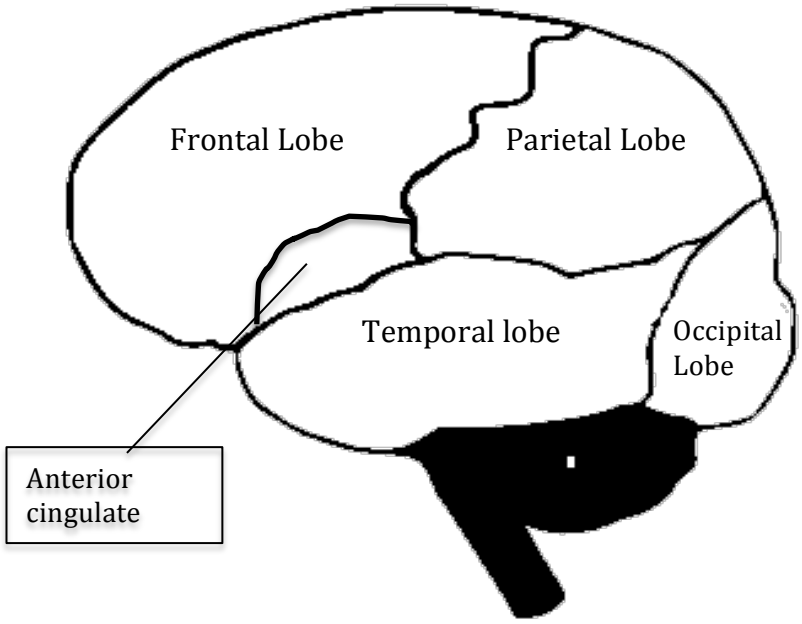
DIRECTIONS: Review the information in the chart. Using the template below, create a line graph (time as the x-axis; number of correct tries as the y-axis) to depict the results. Remember to title your graph appropriately!

Graph title: _____

Let's look at how the brain works while playing video games, using brain imagery. First, review what the colors mean (refer to these as necessary):

Color	Indication
Red	The most active area(s) of the brain
Orange	Active
Yellow	Somewhat active
Green	Mostly inactive
Blue	Inactive





General Brain Image During Tetris

- Color the frontal lobe red
- Color the parietal lobe orange
- Color the occipital lobe green
- Color the temporal lobe blue
- Color the anterior cingulated red

Brain Part	Function
Frontal lobe	Associated with reasoning, planning, maintaining attention, and problem solving
Parietal lobe	Associated with movement, orientation, recognition, perception of stimuli, and orienting attention
Occipital lobe	Associated with visual processing
Temporal lobe	Associated with perception and recognition of auditory stimuli, memory, and speech
Anterior cingulate	Associated with award-anticipation, decision-making, and controlling/regulating attention.

5. What are the most active parts of the brain during gaming?
   _____

6. What are the least active parts of the brain during gaming?
   _____

7. Using the table above, explain how brain imagery achieved in the lab (similar to the one you have just created) suggests that gaming can improve attention:
   _____
   _____
   _____
   _____

The Negative Effects of Video Games

The studies above were all tested with subjects who played 5-15 hours a week, the "reasonable dose" of video games. However, devoting time to more than 15-20 hours a week of video games, puts health at risk. Here's how:

1. **Weight gain**- not being active enough.
2. **Poor circulation**- sitting too much without stretching or moving can lead to poor circulation (oh yeah, and weight gain).
3. **Sleep depravation**- not having enough energy throughout the day (also, did you know too little sleep can lead to weight gain?)
4. **Spine and neck problems**- sitting for long periods of time can lead to poor posture. You may not be worried about it now, but poor posture can have severe and permanent affects on your neck and spine. It can also lead to kyphosis (hunchback).
5. **Isolation**- in severe cases, gamers do not get enough "face time" or social interaction with friends. This can lead to depression if for any reason they had to part with their video games and gaming network. This may lead to obsession.

There is much debate as to whether or not video games should be banned from young people, because of many reasons including childhood obesity, and that violent video games could cause violence in real life. Then, there are others, including many scientists that think video games can be good for learning, but in moderation and without extreme violence. No person claims that **lots** of game time is good for you. Nor do people claim that violent video games are optimal.

What is your stance? Do you think that video games should be banned? Yes or no? Suggest reasons for your decision. Also, provide a compromise, or a solution, that would make both sides of the debate satisfied.

How do I feel about video games? What is one solution I can offer?

WHY WE LOVE AND HATE SPICY FOODS

(1) Imagine eating something that makes your eyes water, your skin sweat and causes you burning sensations of pain? Would you willingly eat this? Every day hundreds of millions of people around the world volunteer to eat spicy foods that produce these results. Some not only volunteer, some demand that their food be even spicier. What exactly is "spiciness" and why do some people like it?

(2) The sensation of spiciness comes from a substance called capsaicin found in spicy foods like chili peppers. When capsaicin comes into contact with your tongue, it triggers receptors in the tongue called VR1 receptors which, strangely enough, are not actually made to detect a taste. VR1 receptors are thermoreceptors intended to detect temperature and when they are accidently triggered by capsaicin, the VR1 receptors send a signal to your brain telling it that heat has been detected. This is why eating spicy food makes your tongue feel like it's on fire; your brain is tricked into thinking that it is! This can also make the body feel hot which causes it to sweat. The sweat produced by spicy foods is called gustatory perspiration.

(3) Why does our tongue have VR1 receptors? VR1 receptors may have evolved to enable us to sense the temperature of foods to avoid eating foods that could burn our tongue and mouth when food is too hot. This may have come in handy as humans evolved from eating raw foods to cooked foods.

(4) Besides the capsaicin compound found in chili peppers, the piperine found in black peppers and the allyl isothiocyanate found in mustard and radishes also accidentally trigger the VR1 receptors in the same way that capsaicin does, therefore they all produce a similar burning sensation we call spiciness or heat.

(5) Chili peppers produce the most heat but there are different types of chili peppers. In 1912 Wilbur Scoville, an American pharmacist, developed a method of measuring the amount of spiciness in various foods. He called his measurement system the Scoville Scale and the units used to measure the amount of spiciness

in foods are called Scoville Heat Units (SHU). The higher the SHU measurement of a food, the more capsaicin it has and the spicier it is.

(6) The spiciest food in the world is currently a pepper called the Carolina Reaper which measures over 2 200 000 SHU of spicy pain. It is so spicy that the oil from this pepper can cause burning sensations if it comes into contact with skin. Your skin also has temperature receptors that can be fooled by capsaicin. Through selective breeding the Carolina Reaper was developed by Ed Currie, owner of PuckerButt Pepper Company in the United States. It has held the Guinness World Record as the world's hottest chili pepper since August 7th 2013.

Carolina Reaper, photo by Dale Thurber

(7) If chilies can produce so much discomfort and feelings of pain, how did some humans grow to use and enjoy chilies in their food? Cultures that have a tradition of eating spicy foods are usually located in warmer climates. This may be related to where chilies can grow best, as well as to the antibacterial action of chilies. In warmer climates, food spoils faster. Our ancestors did not have refrigeration

WHY WE LOVE AND HATE SPICY FOODS

technology and so had to find different ways of preserving foods in hot climates. One way is to add spicy ingredients because the spice has an antibacterial property that helps preserve the food.

(8) However, even people without a tradition of eating spicy foods can grow to love it. When eating spicy foods, the pain centers of the brain are triggered but so are the pleasure centers. In response to feelings of pain, your brain produces chemical painkillers called endorphins which relieve pain and cause a sensation of pleasure. People who love spicy foods are called pyro-gourmaniacs: *pyro* means fire and *gour* from the word *gourmand* which is a person who loves eating.

(9) If you are not a pyro-gourmaniac and you accidentally eat food that is too spicy, then the cure for that is milk, yogurt or ice cream, and the colder the better. The reason why dairy products take the fire away is because they contain a substance called casein which can dissolve capsaicin. When you drink milk, the capsaicin on your tongue is picked up by the casein and washed down and away from your tongue when you swallow. No more fire.

Article Questions

1) _____ is the chemical responsible for the sensation of spiciness in hot food. The level of spiciness in food is measured using the _____.

2) Why does spicy food feel "hot"?

3) The world record holder for the spiciest pepper is the _____.

4) Why would adding chilies to foods in hot climates be useful?

5) Define the term pyro-gourmaniac.

6) Why do people like spicy food?

7) If you ate food that was too spicy, what could you do to calm down the spice? Why does this method work?

THE SCIENCE BEHIND THE FLU SHOT

(1) Every year the medical community urges the public to get the flu shot to prevent people from getting sick with the flu during the flu season. In North America, the flu season typically goes from October to May and peaks in February. Many people choose to get the flu shot but have no idea what it is, how it was created or what it actually does.

(2) The flu is a disease caused by the influenza virus or flu virus for short. A virus is a small but non-living infectious particle. There are many strains of the flu virus. A strain is a variation of the flu virus. These strains all tend to do similar things like give you a runny or stuffed up nose, sore throat, fever, body aches, chills and fatigue.

(3) Some influenza strains are more virulent than others. Virulence determines the ability of the virus to cause disease. A virus with greater virulence is more dangerous. You may catch two different strains of flu virus, but one may be able to make you sicker than the other. The Spanish Flu of 1918 was caused by an extremely virulent strain of the H1N1 influenza virus. Unlike most flu strains that target young, old and sick individuals, the 1918 strain targeted healthy individuals and killed them instead of just giving them the typical flu symptoms. The Spanish flu virus killed 3-5% percent of the world's population (50 million – 100 million people), making it one of the largest infectious disease disasters to date.

(4) Some strains of the flu virus prefer certain hosts over others. A host is the organism that the influenza virus infects. For example, there are different strains of swine flu virus. Most of these strains prefer pigs as hosts. If a cat gets infected by the swine flu virus, it most likely won't get sick because it is not the preferred host. In some cases, the influenza virus can change by mutating and this makes it capable of infecting more than its typical host species. In 2009, there was an outbreak of the swine flu within human populations. When it mutated, swine flu H1N1 developed the ability to jump from its usual pig hosts to human hosts.

(5) Since the influenza virus can mutate, this also allows it to confuse and trick the immune system. Normally, when your body is exposed

to new viruses or bacteria, your immune system will memorize the outside coatings of these microorganisms. Each coating contains a very unique set of proteins called antigens that allow the immune system to recognize the same virus in the future. For example, when children get the chicken pox for the first time, they usually never get it again because their immune systems will be able to memorize the chicken pox virus antigens. If exposed to this virus again in the future, the immune system recognizes the virus immediately and can destroy it before it has a chance to multiply. However, when a virus is capable of mutating, it can change its antigens making it hard for the immune system to recognise it. The chicken pox virus mutates very slowly so the immune system can recognize this virus year after year. The influenza virus, however, mutates quickly and this causes frequent antigens changes, making it difficult for the immune system to detect the virus. This is why a new flu shot needs to be made yearly to deal with the new antigens.

(6) A flu shot is a vaccine that contains antigens from flu virus strains. A vaccine works by "introducing" the immune system to the possible antigens that belong to viruses it has not encountered yet, but may encounter in the future. When the antigens in the vaccine are detected, the immune system will create memory cells which will be able to detect these antigens on real viruses in the future.

(7) The typical flu shot contains vaccines for three strains of influenza virus. Every February, the World Health Organization (WHO) announces the three most likely strains of influenza virus that will hit the public in the upcoming flu season. This will give flu vaccine

THE SCIENCE BEHIND THE FLU SHOT

manufacturers several months to create a vaccine with the proper antigens for these three strains. The strains are typically Type A H1N1, Type A H3N2 and a Type B strain. Since there are three strains, this flu shot is called the trivalent vaccine. There is also a quadrivalent vaccine that covers an additional Type B strain. If the WHO correctly predicts which strains will hit the public, the flu shot will be more effective. If they don't predict correctly, then the flu shot is less effective.

(8) The flu vaccine is made by injecting the flu virus into fertilized chicken eggs. Eggs that are 11 to 12 days old are chosen and disinfected. A small hole is poked into the egg shell and the flu virus strains are injected inside. The hole is then sealed with wax. The virus incubates within the egg at 37°C/99°F for 48 hours during which time the virus will multiply. After 48 hours, the egg is cracked open and the flu virus is obtained in the fluid. The flu virus is then deactivated and the antigens in the viral coating are isolated and purified. The antigens are then used to make the vaccine which is put into an injectable needle or nasal spray. There are also methods to grow viruses in cell cultures that don't involve chicken eggs. This is to prevent some allergic reactions that can occur in people who may be allergic to eggs.

Article Questions

1) A _____ is a non-living infectious particle. The different varieties of flu viruses are called _____. The Spanish flu outbreak occurred in _____. The _____ determines which strains of influenza virus will most likely be those that are the most active during the flu season. An _____ is a part of the viral coating that the immune system recognizes. _____ flu shots contain antigens from three strains of flu virus.

2) When are you the most likely to get the flu if you live in North America?

3) If a certain strain of bacteria was called "highly virulent", what does this mean?

4) How was the Spanish flu different from the regular flu?

5) What is a host?

6) How does your immune system remember a virus that you've been exposed to?

7) Why does a new flu shot need to be made each year?

8) What host is used to make the flu vaccine and why can this be a problem for some people?

STEM CELL SCIENCE

reprogrammed, "induced", to act and behave like pluripotent embryonic stem cells. When stem cells begin to specialize, certain genes turn off so that only the genes needed for a specific cell type stay active. The IPSCs are reprogrammed by reactivating the genes that have been switched off.

(7) In addition to skipping over the moral dilemma of using embryos, IPSCs also allow for the custom tailoring of stem cell therapies to individual patients. This removes the risk of immune system rejection. For example, if your liver is damaged and you need a new liver, you would have to get a liver transplant. This means you will have to wait for a liver donor whose cells are a match for yours so that your immune system doesn't reject the transplanted organ. However, if healthy cells of your own body are harvested and turned into IPSCs, these IPSCs in turn can be made into liver cells that form liver tissue that can be transplanted back into you. You will not need to wait for a compatible donor and you will not reject transplanted tissue from our own cells. Though using IPSCs for tissue regeneration is just beginning, there is hope that this type of treatment will become a common reality in the near future.

(8) Another benefit is for drug testing. Many drugs tested on non-human animals harm and kill them. This is often considered a cruel but necessary step in early drug testing, however, testing on human tissues made from IPSCs is a very good alternative. The response of human cells provides more accurate results than using non-human animals and no one is harmed.

Article Questions

1) What are three characteristics of a stem cell?

2) What is the ethical controversy over using human embryonic stem cells for research?

3) How are most embryos obtained?

4) What is the difference between a totipotent stem cell and a pluripotent stem cell?

5) What is the difference between a pluripotent stem cell and a multipotent stem cell?

6) What does IPSCs stand for and what are they?

7) Name two potential uses of using IPSCs?

Science Enrichment

Section 4

General Science

Which type of Alternative Energy is "the best?"
Project on the types of alternative energy

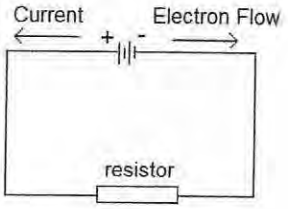
- Conduct research to locate information related to **alternative energy sources (solar, hydroelectric, wind, biomass, biofuel, tidal energy, and geothermal energy or other alternative form of energy).**
- **Choose one alternate energy form based on your research to present as the best form of alternative energy.**
- **Locate at least three quality sources related to your chosen energy type**. Note these sources in a bibliography.
- Now that you have gathered evidence for your alternative energy source, answer the question: **Do the benefits of using this alternative energy outweigh the environmental impact of this technology?**
- In this project, you will make a claim about relationship between the benefits of using this type of energy and its impact on the environment.
- Your claim should directly relate to the evidence you found for and against using this type of alternative energy. You must decide if it is more beneficial than harmful to use this type of energy.
- You will provide evidence to support your claim in your project. You need 2-3 pieces of evidence to present in your project.
- You will provide sound reasoning for how your evidence supports and relates to your claim about the benefits of using this type of energy and its impact on the environment.
- Choose a format for your project. You may choose from the following formats: Power point, Prezi, poster, video, brochure, News report, or story.
- Add a section to your project for resources (Bibliography) which details the location (or source) of your articles and websites. Include the website name and URL for each website you used. If you used journal articles, include the journal name, publication data, volume, and page numbers.
- Once you have completed your project, share your project with classmates and your science teacher.

PHYSICS

Mrs. Mrock, WMHS

ELECT

Electric Charge and Electricity Learning Activities



Complete 3 tasks by _____

Create	Write	Display
Create a concept map illustrating the relationship between our lifestyle and the uses of electricity or electrical devices.	Write a story or comic strip from the point-of-view of an electron on a piece of clothing as the piece of clothing becomes charged during the drying cycle and produces static electricity when removed from the clothes dryer.	Develop and design a schematic diagramming the electric wiring arrangement in your home as determined from your research of circuit breakers and the individual electric circuits found in your home using circuit symbols.
Create a log book detailing your personal use of electricity by activity, and length of use, calculate the usage by kilowatt hours (using the equation E = Pt), and calculate the cost of your electrical usage for a one week period or longer. Create a household plan for reducing your electrical consumption by 10%.	Write and perform a rap lyric that compares the characteristics, uses, and advantages/disadvantages of series and parallel circuits.	Research, design, and illustrate a poster comparing the parts of electric circuits to electric circuits found in your body (brain/nervous system or heart) or the body of electric fish such as electric eels or knife fish.
Create a graph using Microsoft Excel to compare electrical energy consumption by country. Include a minimum of 12 countries from around the globe with at least one country from each continent. Calculate the % of total world electrical energy consumed by the U.S. Reflect on and summarize the meaning of your data.	Write a pamphlet or create a brochure that illustrates and details how electric charges are at work in (vinyl window clings, cell phone screen protectors, or plastic food wrap).	Design a Power point presentation demonstrating electrical safety measures everyone should know and use around electrical devices, electrical outlets, electrical power lines, and lightning.
Student Choice #1	Student Choice #2	Student Choice #3

Choose 1 activity from each vertical column for a total of 3 learning activities.

Concept: Relationships; Conservation of energy/resources; Change/transformations. **Skills:** Problem solving; comparing and contrasting; interpreting/analyzing scientific data. **Student Interests:** MP3 players, cell phones, friends, singing and music, clothing, their bodies, drawing/art.

Your Energy Audit

You will conduct an energy audit of your household and compute how many kilograms of CO_2 you are responsible for releasing into the atmosphere—your carbon footprint. Your investigation will focus on the three major areas:

- transportation
- electricity
- space and water heating

Transportation

1. Keep track of how many gallons of gas your family buys in the course of a week, or ask family members for their best estimate. Estimate the number of gallons used for one month, then multiply by 12 to get the total fuel per year.
2. Enter your family's yearly fuel use in the table. Since the burning of one gallon of gasoline emits 8.2 kilograms of CO_2, multiply your answer by 8.2 and enter the new value under "CO_2 Emission" in the table.
3. Divide the CO_2 emission by the number of family members in your household to get a general idea of how much each person uses.

Electricity

1. Ask to see your electric bills over the course of a year. If you cannot obtain all 12, try to average your family's monthly use and multiply by 12 to obtain the kilowatt-hours used per year. Keep in mind that your electric bill may fluctuate quite a bit over the 12 months.
2. Enter your family's electricity use in the table. Since each kilowatt-hour of electricity results in the emission of 1 kilogram of CO_2, multiply your answer by 1 and enter the new value under "CO_2 Emission" in the table.
3. Divide the CO_2 emission by the number of family members in your household to get a general idea of how much each person uses.

Space and Water Heating

1. Find your natural gas or fuel oil bills. You will need to find the number of cubic feet of natural gas or oil equivalent used. If you have a gas bill, multiply the number of therms by 100 to find the number of cubic feet of gas used that month. Average all 12 months if possible. If you use fuel oil, one barrel of oil (42 gallons) is equivalent to 7700 cubic feet of natural gas.
2. Enter your family's yearly natural gas usage in the table. Since the burning of one cubic foot of natural gas emits 0.062 kilogram of CO_2, multiply by 0.062, and enter the new value under "CO_2 Emission" in the table.
3. Divide the CO_2 emission by the number of family members in your household to get a general idea of how much each person uses.

Calculate Totals

Find your totals in the last row of your table.

Mrs. Mrock

Graphing Unit

Anchor Activities

***Complete 3 tasks**

***Choose and complete one activity from each vertical column**

Create	Write	Display
Conduct an online survey (using survey monkey) and create a line graph to show the correlation between student age and the average hours of study outside of school hours. Write several statements that can be made after analysis of your data on the graph.	Write detailed instructions for making a line graph using the computer program Microsoft Excel (or other program) in your own words. Use an example of a graph you created in your explanation. Type your instructions using Google docs or other program.	Create a video presentation explaining in detail how to plot data on a line graph and how to read values from line graph.
Conduct an online survey of high school students and create a line graph illustrating the average number of text messages they send per month and the hour of the day they text message the most. Write several statements that can be made after analysis of your data on the graph.	Create a rap lyric detailing the difference between the dependent variable and the independent variable and their location on a line graph.	Create a poster detailing how to instructions for making an evenly spaced number scale to fit a range of data for use on a line graph.
Create a video presentation of yourself explaining the parts of a line graph and how to read a line graph.	Write a children's story about the relationship between X and Y that begins: Once upon a time there were two variables named X and Y or Independent and Dependent..... Include pictures or illustrations of a line graph in your story.	Create a poster of a line graph illustrating the relationship between two variables such as-food cost and relative calories (examples: pasta, lean meat, hotdogs, ground chuck, ground sirloin, etc.).
Student Choice #1	Student Choice #2	Student Choice #3

Concept: understanding and interpreting line graphs, understanding scientific information from multiple sources, making meaning from scientific information, analyzing and interpreting scientific data, critical thinking skills. **Student Interests:** cell phones, texting, videos of yourself, creating art or illustrations, acting, friends, singing, music, clothing.

Newton's Laws of Motion Project – choose one of the following four projects and complete the written portion. Share your final product with three other students online to receive their feedback. Email your final product to your science teacher.

Role	Audience	Format	Topic
1. Sir Isaac Newton England 1692	Fellow Scientists at a meeting	Prepare and present a scientific report of experimental data to support his theories. Conduct research and record observations using the scientific method. Write your report and share it online.	3 Laws of Motion They are not blasphemy!
2. Rap Star	Rap Radio listeners	Create and perform an original song lyric or rap lyric explaining and giving examples of Newton's 3 laws of motion in a video and share it.	Physics are so cool, let me tell you bout a dude (Newton)
3. News Paper Reporter in England 1692	Towns people/Newspaper readers	Prepare and perform a report on the events of Sir Isaac Newton's discoveries/laws in newspaper column format and share it online.	Read All About It! 3 New Laws (of Motion)
4. Actors	Performance for an online audience	Write and perform a skit /mini-play to show how Sir Isaac Newton arrived at his law of universal gravitation after observing an apple falling from a tree. Make a video to share online.	Eureka! By George, I think I've got it!

Note: if you choose project # 4, your project will focus on Newton's law of universal gravitation and not on his 3 laws of motion.

Each project must include the following:

Written portion of the is Project

This means you are turning in your rap, report, and written parts for actors in your skit to me via email

Title

Explanation & Illustration of Newton's 1st Law using an example

- Contains the law (textbook or other source)
- Contains an illustration or demonstration of the law
- Contains an explanation (in your own words) of the law and how your example shows the law

Explanation & Illustration of Newton's 2nd Law using an example

- Contains the law (textbook or other source)
- Contains an illustration or demonstration of the law
- Contains an explanation (in your own words) of the law and how your example shows the law

Explanation & Illustration of Newton's 3rd Law using an example

- Contains the law (textbook or other source)
- Contains an illustration or demonstration of the law
- Contains an explanation (in your own words) of the law and how your example shows the law

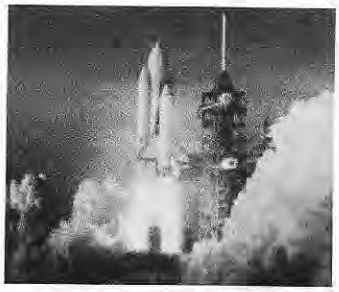
Panel 4: Newton's Laws Vocabulary

Contains definitions of the following words: inertia, mass, force, acceleration, friction, and motion

Project Information

Contains your first and last name, class period, date, ***bibliography (a list of your sources or websites at least 3)***

Physics – Newton's Laws Web Quest



Get an introduction to Newton's Laws with this Web quest!

Essential Question: ***How do certain universal laws govern all motion?***

Learning Target: ***I can summarize each of Newton's 3 Laws in my own words and give a real-world example of each***

Instructions:

- Come up with a working definition of each of Newton's 3 Laws (in your own words) and a real-world example for each that you can relate to

  Create a Microsoft word document that includes the following information: summarization of the 3 laws in your own words with a real world example and a picture for each

- Go to each of the following sites to find the information you need:

1. Newton's 1st Law Animation – check it out and read the info

   http://www.physicsclassroom.com/mmedia/newtlaws/cci.cfm

2. Newton's 1st Law Summary – now go read the summary

   http://www.physicsclassroom.com/Class/newtlaws/u2l1a.cfm#first

3. Newton's 2nd Law Animation - watch the animation

http://www.tutorvista.com/content/physics/physics-i/newtons-laws-motion/animation-newtons-second-law.php

4. Newton's 2nd Law *Summary* – summary of the 2nd law

   http://www.physicsclassroom.com/Class/newtlaws/u2l3a.cfm

5. Newton's 3rd Law Animation – another animation!

   http://www.tutorvista.com/content/physics/physics-i/newtons-laws-motion/animation-newtons-third-law.php

6. Newton's 3rd Law Summary - summary of the 3rd law

   http://www.physicsclassroom.com/Class/newtlaws/u2l4a.cfm

7. Hyperphysics - great concept webs and examples for all 3 laws

   http://hyperphysics.phy-astr.gsu.edu/hbase/Newt.html

Project: Create an online Game that relates to a class topic or unit of instruction for your current science class (preferably a unit that has not been taught yet this year).

Students will work with a partner (using phone or online resources to communicate and share the workload) to create a review game for one unit or topic from your current year science course using an online program such as Kahoot.

Once you have designed your game, you will invite two or more classmates to play your game and give you feedback about your game. Also, Share your game with your current science teacher.

Sources: websites, online tutorials, online textbooks, etc.

GAME MUST INCLUDE THE FOLLOWING:

- Questions must be original not copied directly or plagiarized from class resources or websites.
- Answers to questions must be correct or accurate.
- Questions must stay on topic and not stray from topic you chose.
- Game must show creativity and originality.
- Game must be school appropriate in terms of language and content.
- Include a list of sources with your game (resources used to create the questions or images used in the game).
- Games must exhibit the cooperative work of students involved in project. Group work means everyone contributes an equal share of quality work.

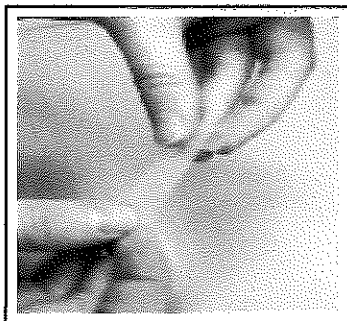
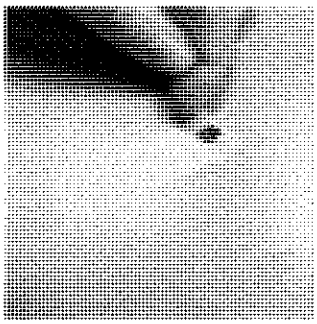
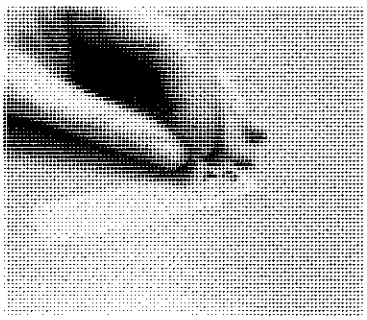
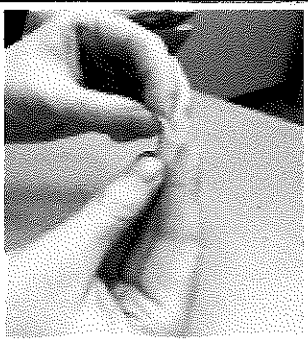
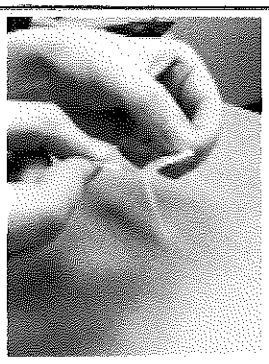
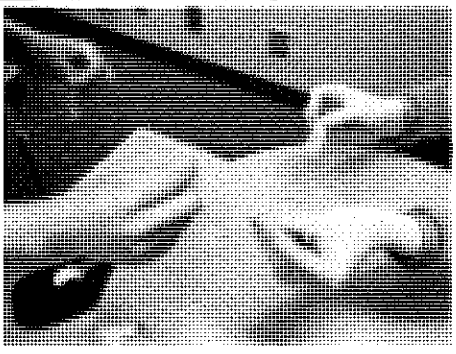
Page title:
Tape

Materials

- Scotch tape
- pen or pencil for labeling

Investigate

Each person in your group should follow the steps below.

		
1. Get a strip of tape that is 1.5 to 2 inches long. Fold over one end of the tape as shown in the figure above. This will give you a non-sticky handle to hold the tape with.	2. Stick this piece of tape to the desk, and label the handle "B," for *bottom*.	3. Get a second strip of tape that is 1.5 to 2 inches long, and fold it in the same way. Place it directly on top of the first piece of tape, and label the handle "T," for *top*.
		

4. Using the handles, lift both pieces of tape off the desk at the same time. Then touch the entire length of the strip on both sides with your fingers several times.	5. Pull the pieces of tape apart, making sure to not touch the tape anywhere except on the non-sticky handles you made.	6. Experiment with your partner to see how the pieces of tape interact with each other when you bring two of them close together in different combinations. **Tip:** *Try not to let the pieces of tape touch each other. If they do touch a little bit, it might be okay but it might change their behavior. Try to avoid having the pieces of tape touch if possible.*

This link is a video clip that illustrates the procedure: How to do the tape activity.

The activity questions are shown in bold and your answers are presented in order below.

What are some patterns in how things stick together or push apart?

in Unit 1 - Inv. 1: Why do some things stick together and other things don't? (Fall 2015)

1: Write your observations of what happens when you bring the pieces of tape close together in each combination (T-T, B-B, and B-T).

2: Based on your observations, what patterns can you identify when two pieces of tape interact?

3: Use the magnets to test your tape to see if the tape behaves like a magnet. Can you get the magnet and the tape to interact in all the same ways as the two pieces of tape? Describe any similarities or differences in behavior.

4: What patterns do you notice in the way the spheres interact with each other?

5: Use your observations from the tape activity, the magnet tests, and the patterns you identified from the simulation to explain what may have caused the pieces of tape to interact. Support your explanation using the results of the magnet test and your observations of the different conditions in the simulation.

6:

Adjust the charges on the spheres to make them behave like the two T strips of tape did when they were brought close together. Then take a snapshot of the simulation and indicate how the spheres interact.

7:

Now adjust the charges on the spheres to make them behave like the T and B tape strips did when they were brought close together. Then take a snapshot of the simulation and indicate how the spheres interact.

8:

Finally, adjust the charges on the spheres to make them behave like the two B tape strips did when they were brought close together, and take a snapshot. Don't forget to include the interaction between them.

9: A simulation is a type of model, and a model must connect to a phenomenon. How does this simulation relate to the phenomenon you observed with the T and B tape strips?

Science Enrichment

Section 5

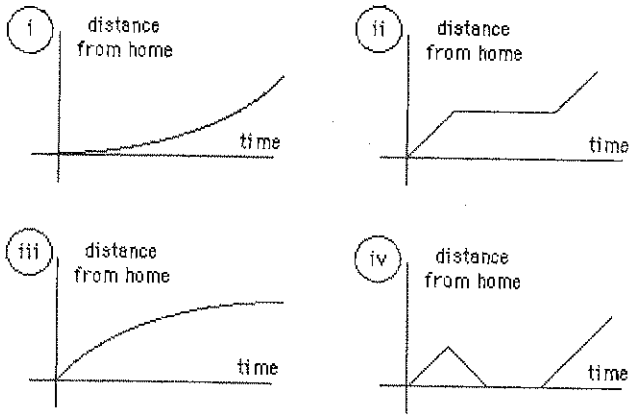
Graphing

Practice Interpreting Data:

In addition to drawing graphs, it is also important that you be able to intrepret data that is represented in graph form. The following examples are provided to help you develop the ability to read information shown on a graph.

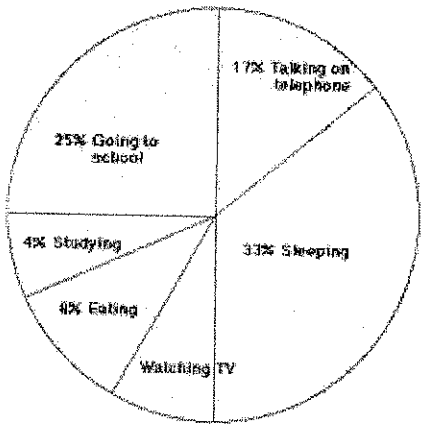
1. Identify the graph that matches each of the following stories:

   a. I had just left home when I realized I had forgotten my books so I went back to pick them up.
   b. Things went fine until I had a flat tire.
   c. I started out calmly, but sped up when I realized I was going to be late.



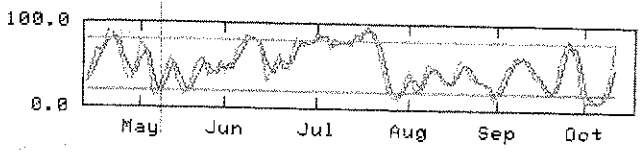
2. The graph at the right represents the typical day of a teenager. Answer these questions:

   a. What percent of the day is spent watching TV?
   b. How many hours are spent sleeping?
   c. What activity takes up the least amount of time?
   d. What activity takes up a quarter of the day?
   e. What two activities take up 50% of the day?
   f. What two activities take up 25% of the day?



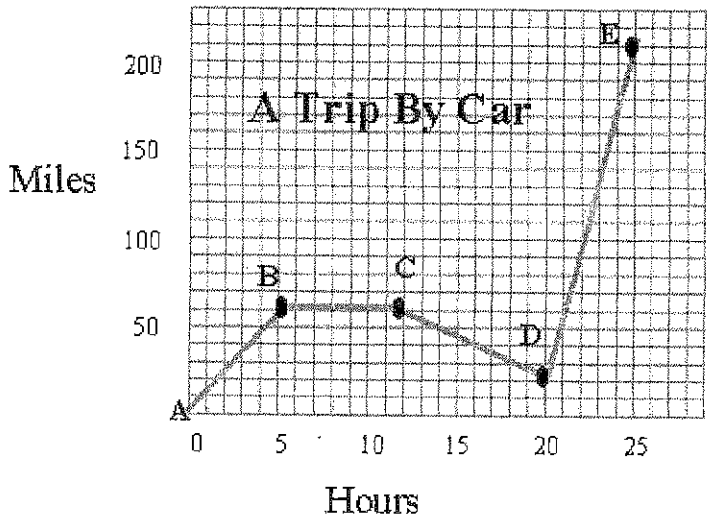
3. Answer these questions about the graph at the right:

   a. How many sets of data are represented?
   b. On approximately what calendar date does the graph begin?
   c. In what month does the graph reach its highest point?



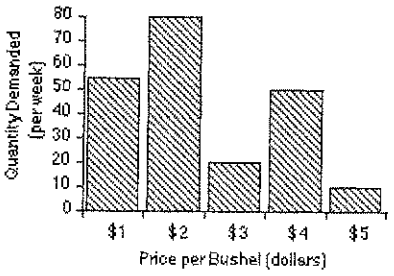
4. Answer these questions about the graph on the right:

   a. How many total miles did the car travel?
   b. What was the average speed of the car for the trip?
   c. Describe the motion of the car between hours 5 and 12?
   d. What direction is represented by line CD?
   e. How many miles were traveled in the first two hours of the trip?
   f. Which line represents the fastest speed?



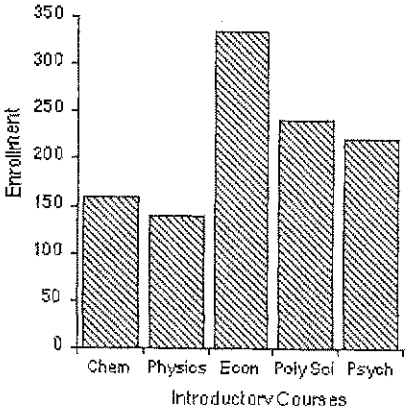
5. Answer these questions about the graph at the right:

   a. What is the dependent variable on this graph?
   b. Does the price per bushel always increase with demand?
   c. What is the demand when the price is 5$ per bushel?



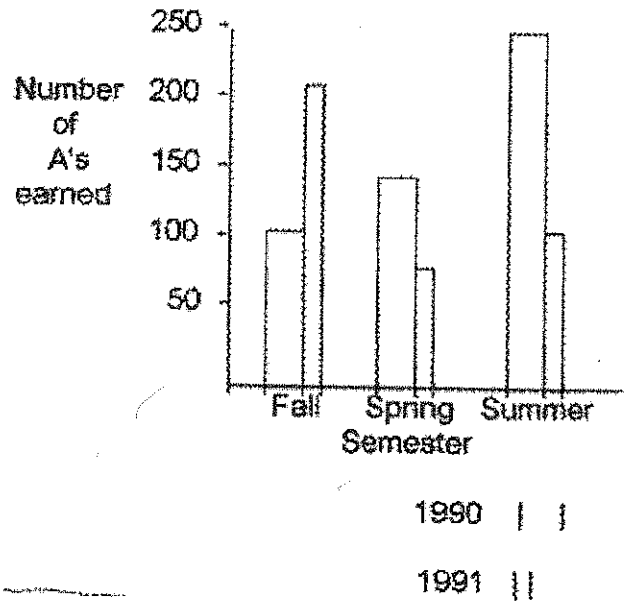
6. The bar graph at right represents the declared majors of freshman enrolling at a university. Answer the following questions:

   a. What is the total freshman enrollment of the college?
   b. What percent of the students are majoring in physics?
   c. How many students are majoring in economics?
   d. How many more students major in poly sci than in



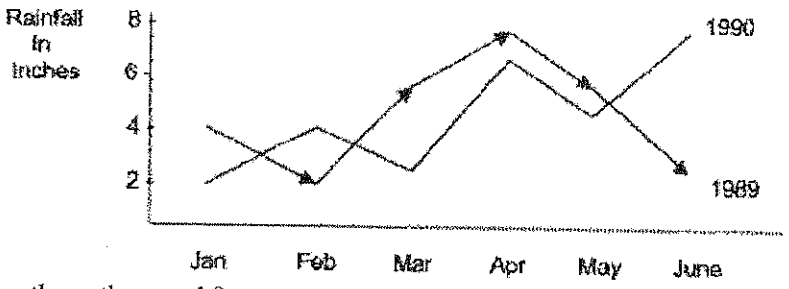
7. This graph represents the number of A's earned in a particular college algebra class. Answer the following questions:

   a. How many A's were earned during the fall and spring of 1990?
   b. How many more A's were earned in the fall of 1991 than in the spring of 1991?
   c. In which year were the most A's earned?
   d. In which semester were the most A's earned?
   e. In which semester and year were the fewest A's earned?



8. Answer these questions about the graph at the right:

   a. How much rain fell in Mar of 1989?
   b. How much more rain fell in Feb of 1990 than in Feb of 1989?
   c. Which year had the most rainfall?
   d. What is the wettest month on the graph?



9. Answer these questions about the data table:

   a. What is the independent variable on this table?
   b. What is the dependent variable on this table?
   c. How many elements are represented on the table?
   d. Which element has the highest ionization energy?
   e. Describe the shape of the line graph that this data would produce?

Atomic Number	Ionization Energy (volts)
2	24.46
4	9.28
6	11.22
8	13.55
10	21.47

10. Answer the following using the data table:

a. How many planets are represented?
b. How many moons are represented?
c. Which moon has the largest mass?
d. Which planet has a radius closest to that of Earth?
e. How many moons are larger than the planet Pluto?
f. Which of Jupiter's moons orbits closest to the planet?
g. Which planet is closest to Earth?

Solar System Data Table

Name	Orbits	Distance (000 km)	Radius (km)	Mass (kg)
Sun			697000	1.99×10^{30}
Jupiter	Sun	778000	71492	1.90×10^{27}
Saturn	Sun	1429000	60268	5.69×10^{26}
Uranus	Sun	2870990	25559	8.69×10^{25}
Neptune	Sun	4504300	24764	1.02×10^{26}
Earth	Sun	149600	6378	5.98×10^{24}
Venus	Sun	108200	6052	4.87×10^{24}
Mars	Sun	227940	3398	6.42×10^{23}
Ganymede	Jupiter	1070	2631	1.48×10^{23}
Titan	Saturn	1222	2575	1.35×10^{23}
Mercury	Sun	57910	2439	3.30×10^{23}
Callisto	Jupiter	1883	2400	1.08×10^{23}
Io	Jupiter	422	1815	8.93×10^{22}
Moon	Earth	384	1738	7.35×10^{22}
Europa	Jupiter	671	1569	4.80×10^{22}
Triton	Neptune	355	1353	2.14×10^{22}
Pluto	Sun	5913520	1160	1.32×10^{22}

AFTERSCHOOL TRAINING TOOLKIT

Tutoring to Enhance Science Skills

Tutoring Four: Learning to Make Line Graphs

Guidelines for Making a Line Graph

The effect on increasing coils on the number of paperclips an electromagnet picks up.

Number of Coils	Number of Paperclips			Average Number of Paperclips
	Trial 1	Trial 2	Trial 3	
5	3	5	4	4
10	7	8	6	7
15	11	10	12	11
20	15	13	14	14

Step 1: Identify the variables

Independent Variable (purposefully changed by the experimenter): *Number of coils*
Dependent Variable (changes with the independent variable and is measured): *Number of paperclips*

Step 2: Determine the variable range

Subtract the lowest data value from the highest data value for each variable.
Range of paperclips: *14-4 = 10*
Range of coils: *20-5 = 15*

Step 3: Determine the scale of the graph

Determine the numerical value for each grid unit that best fits the range of each variable.

Number of lines on graph: 36 (*y* axis)

$$\frac{\text{Range}}{\text{\# of lines}} \quad \frac{\text{10 paperclips}}{\text{36 lines}} = .28 \text{ paperclips/line} — \textit{round to .5 paperclips/line}$$

Number of lines on graph: 25 (*x* axis)

$$\frac{\text{Range}}{\text{\# of lines}} \quad \frac{\text{15 coils}}{\text{25 lines}} = .6 \text{ coils/line} — \textit{round to 1 coil/line}$$

Step 4: Number and label each axis and title the graph

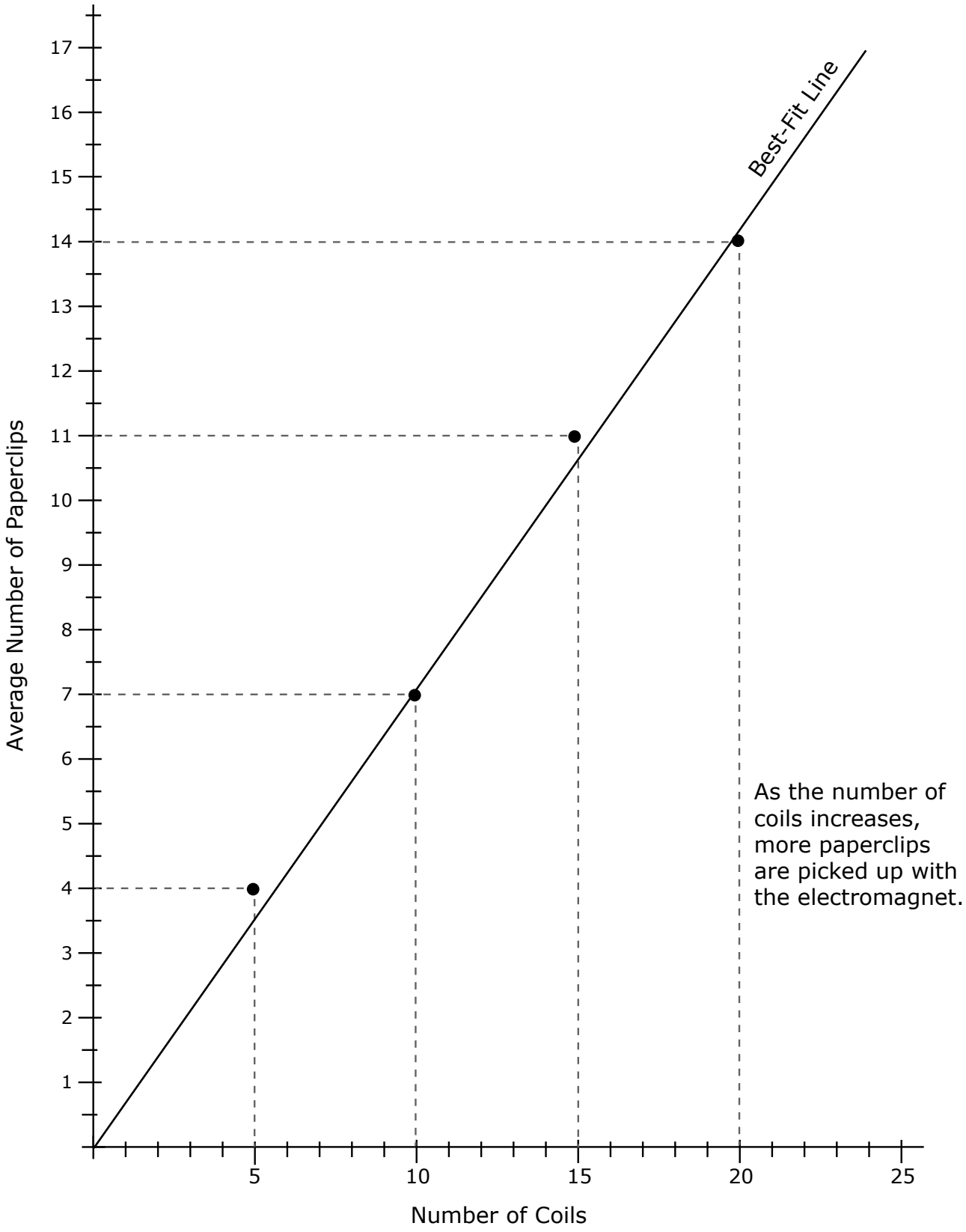
Step 5: Determine the data points and plot on the graph

(5, 4) (10, 7) (15, 11) (20, 14)

Step 6: Draw the graph

Draw a curve or a line that best fits the data points. Do not connect the dots.

Average Number of Paperclips vs. Number of Coils



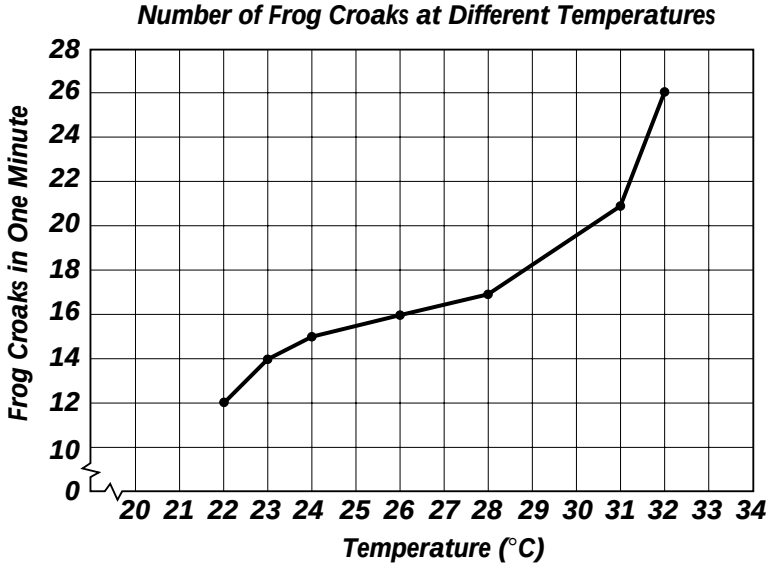
Name _____ Date _____ Class _____

SKILLS INTRODUCTION

Creating Line Graphs

A science class studying frogs counted the number of times the frogs croaked at different temperatures. The results are shown in the data table on the right. To help interpret that data, the class then created a line graph. A **line graph** is used to display data that show how one variable (the responding variable) changes in response to another variable (the manipulated variable). You should use a line graph when your manipulated variable is continuous, that is, when there are other measurements possible between the ones you tested. For example, in this experiment, temperature is a continuous variable since 27°C is between 26° and 28°, and 22.5°C is between 22° and 23°. Temperature, time, mass, and velocity are just a few examples of continuous variables.

Number of Croaks vs. Temperature	
Air Temperature in °C	Frog Croaks per Minute
22	12
23	14
24	15
26	16
28	17
31	21
32	26



A line graph is a powerful tool because it shows a relationship between two variables. Here, the line graph shows how the number of frog croaks per minute changes as temperature changes. Line graphs also allow you to identify trends and relationships in the data, and thus infer values you did not actually measure. For example, you can infer that at 30°C, the frogs might make 20 croaks per minute. At 20°C, they might make about 10 croaks per minute. (To find out whether these inferences were true, you would have to do additional research.)

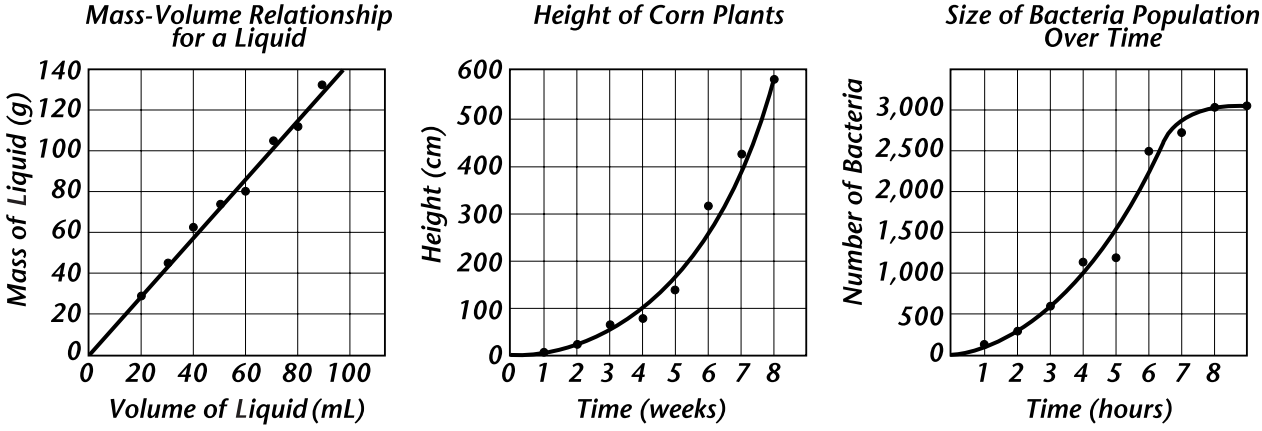
Name _____ Date _____ Class _____

Creating Line Graphs *(continued)*

What Is a Best Fit Line Graph? Notice that unlike the graph on page 64, the lines on the graphs below were not drawn from point to point. Instead, the graphs are smooth and continuous. They flow through as many of the data points as possible but do not necessarily touch all the points. This kind of graph is called a "best fit graph." A best fit graph shows an average, a trend, or a pattern in the data.

You may wonder how scientists know when to use a best fit graph. As you continue to study science, you will see that certain kinds of graphs commonly result from scientific experiments. The graphs shown below are three examples.

The first graph shows a straight line. You can read that graph to see that as the volume of a liquid (the manipulated variable) increases, the mass of that liquid (the responding variable) also increases.



The center graph shows a curve that continues to rise. You can read that graph to see that over time (the manipulated variable), a corn plant's height (the responding variable) continues to increase.

The graph on the right shows a curve that rises and then flattens out. Here, as time (the manipulated variable) passes, the size of the bacteria population (the responding variable) increases steadily until it reaches a certain size. Then, the size of the population becomes constant.

Look for these and other patterns as you examine additional graphs. Recognizing the pattern of a graph will help you to understand the actual events it represents.

Name _____ Date _____ Class _____

Creating Line Graphs *(continued)*

Tips for Creating Line Graphs

1. On graph paper, draw a horizontal, or *x*-, axis and a vertical, or *y*-, axis.
2. Label the horizontal axis with the name of the manipulated variable. Label the vertical axis with the name of the responding variable. Include the units of measure.
3. Create a scale on each axis by marking off equally-spaced numbers along the axis. Begin with zero or a number slightly less than the smallest number to be graphed. Be sure that each scale covers the entire range of data collected for that variable. Label the units on each scale.
4. Plot each point where the variables intersect. You can do this by following an imaginary line up from the measurement on the *x*-axis. Then follow a second imaginary line across from the corresponding measurement on the *y*-axis. Place a dot where the two lines intersect.
5 Consider whether you will plot from point to point or make a best fit graph. If you plot from point to point, each segment connecting two adjacent points should be straight. If you make a best fit graph, the connecting line should be smooth.
6. Give your graph a title that identifies the variables or the relationship between the variables in the graph. On page 64, "Number of Frog Croaks at Different Temperatures" is a complete title that clearly describes this graph.

Checkpoint How could you use a line graph to help you make predictions about data that were not actually measured? Use one of the graphs on page 64 or 65 to help you answer this question.

Name _____ Date _____ Class _____

SKILLS PRACTICE

Creating Line Graphs

Use a sheet of graph paper to make a graph of the data given below. Then answer the questions that follow on the back of this page or on a separate sheet of paper.

Time vs. Temperature for Unknown Substance		
Time (min)	Temperature (°C)	Solid, Liquid or Gas
0	–20	Solid
5	0	Solid (melting)
10	0	Solid (melting)
15	52	Liquid
20	100	Liquid (boiling)
25	100	Liquid (boiling)
30	100	Liquid (boiling)
35	100	Liquid (boiling)
40	100	Liquid (boiling)
45	100	Liquid (boiling)
50	100	Liquid (boiling)
55	100	Liquid (boiling)
60	100	Liquid (boiling)
65	100	Liquid (boiling)
70	100	Liquid (boiling)
75	110	Gas
80	120	Gas

A group of researchers were investigating the properties of an unknown substance. They decided to heat the material to study its melting and boiling behavior. They heated a 1-kg sample of the solid material at a steady rate. They measured and recorded the temperature of the sample every 5 minutes.

1. On a sheet of graph paper, make a line graph of the data the group collected.

2. What does the graph tell you about the temperature of the substance at different times during the investigation?

3. Think About It Use the information from the third column of the data table to explain what is happening during the various sections of your graph.

Graph of the Week

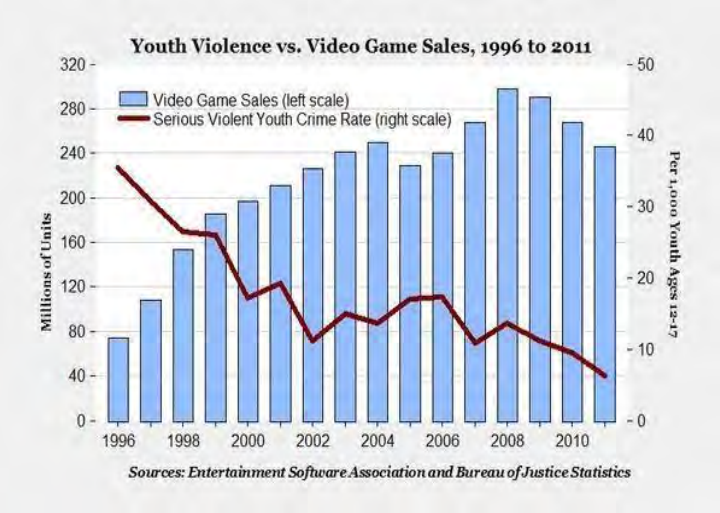
September_____, 2018

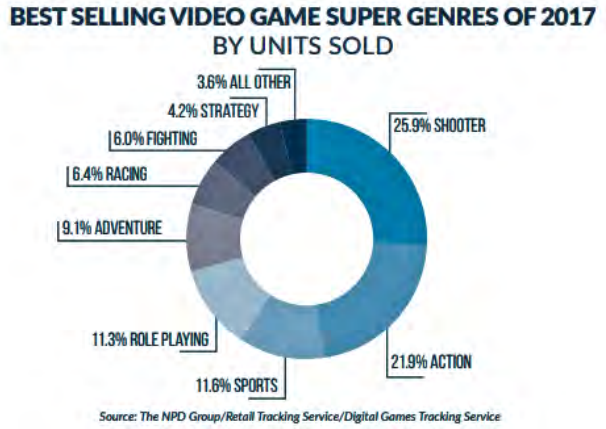
Analyze the graphs below and write a reflection on what you think the graphs are communicating to you. To guide you with your response, start with some observations.

- What is the topic of each graph?
- What does the x-axis represent? What does the y-axis represent?
- What are some observations that you can make based on the graph?
- What do you foresee happening in the next 10 years?

Questions to ask when reading graphs:

- Is there an upward or downward trend?
- Are there any sudden spikes in the graph?
- What is being compared in the graph?
- What prediction can I make for the future?
- What inferences can I make about the graph?





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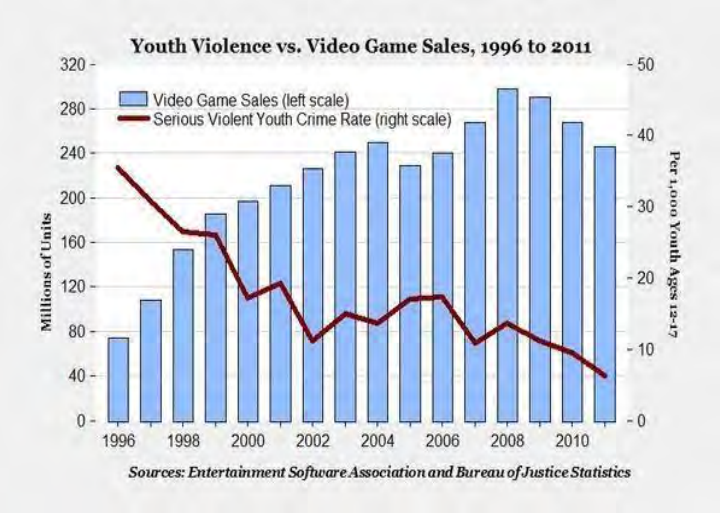

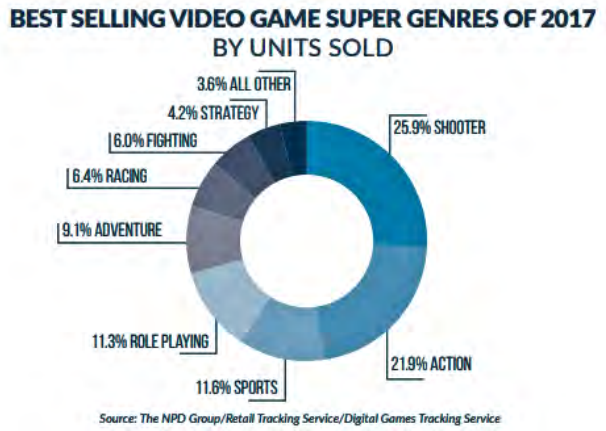

Graph of the Week

August_____, 2018

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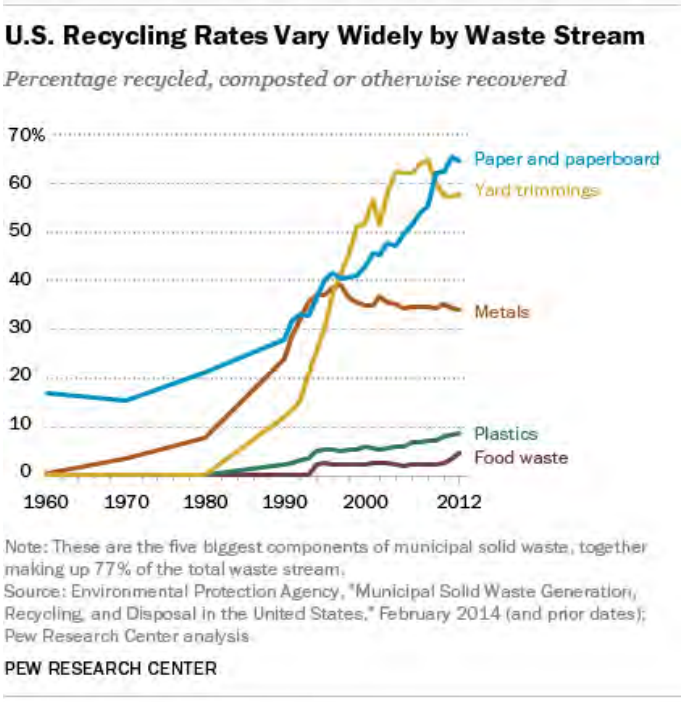

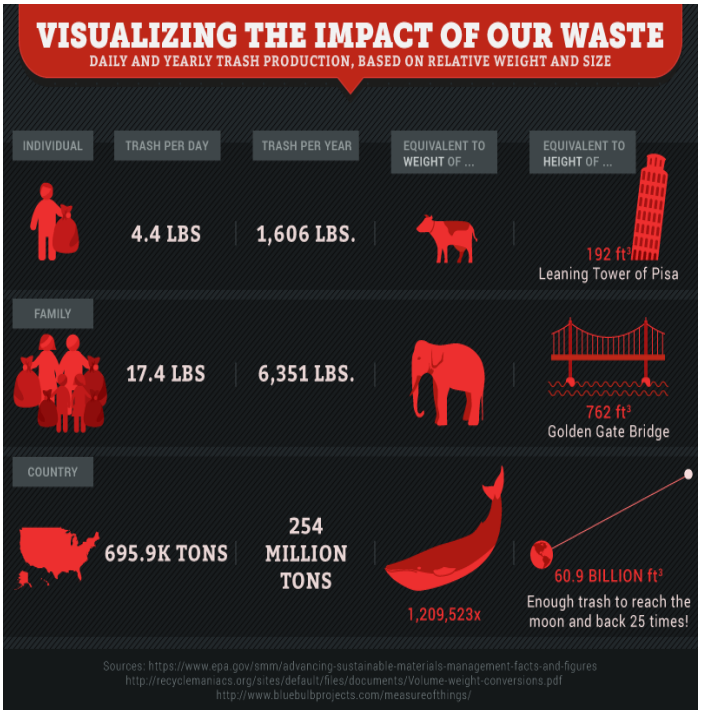

Graph of the Week

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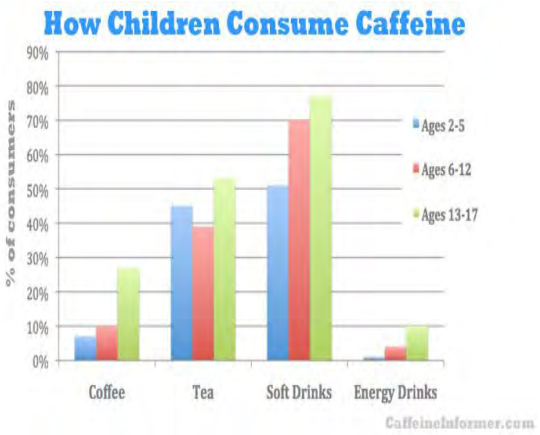
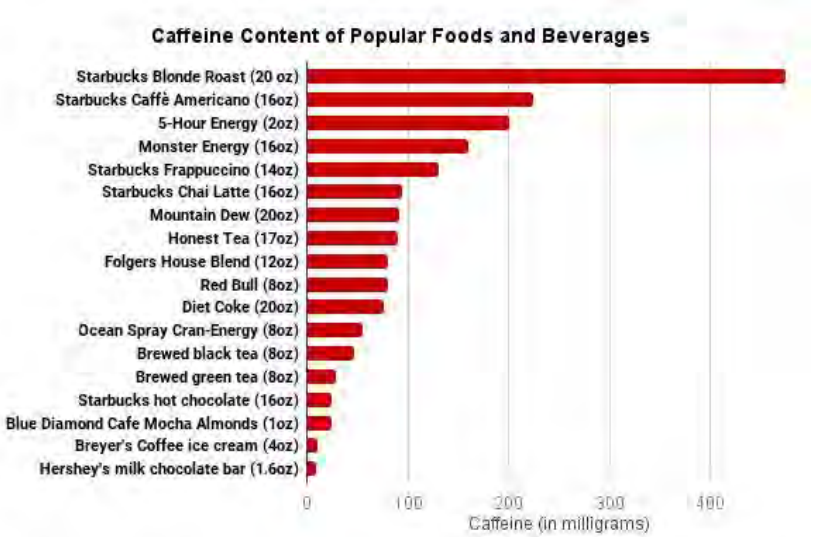




Graph of the Week

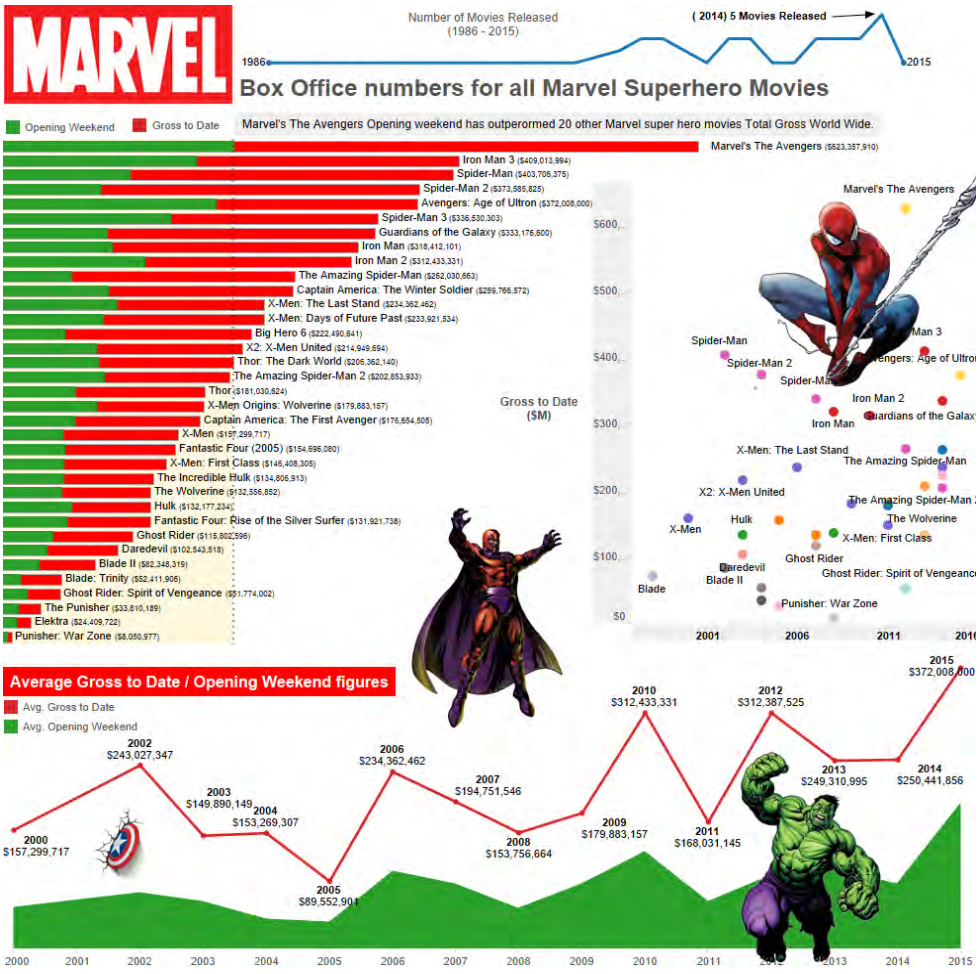
April _____, 2017

Analyze the graphs below and write a reflection on what you think the graphs are communicating to you. To guide you with your response, start with some observations.

- What is the topic of the graph?
- What does the x-axis represent? What does the y-axis represent?

Questions to ask when reading graphs:

- Is there an upward or downward trend?
- Are there any sudden spikes in the graph?
- What is being compared in the graph?
- What prediction can I make for the future?
- What inferences can I make about the graph?



- What are some observations that you can make based on the graph?
- What do you foresee happening about 5 years from now?

AFTERSCHOOL TRAINING TOOLKIT

Tutoring to Enhance Science Skills

Tutoring Three: Learning to Make Bar Graphs

Guidelines for Making a Bar Graph

Bar graphs are ideal for showing information that reflect quantities or the frequency of things, such as kinds of pets, number of children, or people's favorite brands. Bar graphs are frequently used to display data in science and are the first graphs that students learn to create. Follow the steps below to create bar graphs based on data in a data table.

Which detergent makes the best bubbles?

Detergent Brand	Size of Bubbles (cm)				Average Size of Bubbles (cm)
	Trial 1	Trial 2	Trial 3	Trial 4	
A	44.0	38.9	30.8	29.4	35.8
B	25.6	30.2	23.3	20.1	24.8
C	10.0	15.4	21.6	12.9	15.0

Step 1: Identify the variables

Independent variable (purposefully changed by the experimenter): *Detergent brand*
Dependent variable (changes with the independent variable and is measured):
Size of bubbles

Step 2: Determine the variable range

Subtract the lowest data value from the highest data value for the dependant variable.
Range of average bubbles: *35.8 cm - 15.0 cm = 25.8 cm*

Step 3: Determine the scale of the graph

Determine the numerical value for each grid unit that best fits the range of each variable.

Number of lines on graph: 36 (y axis)

$$\frac{\text{Range}}{\text{\# of lines}} \qquad \frac{25.8 \text{ cm}}{36 \text{ lines}} = .72 \text{ cm/line} — \textit{round to 1 cm/line}$$

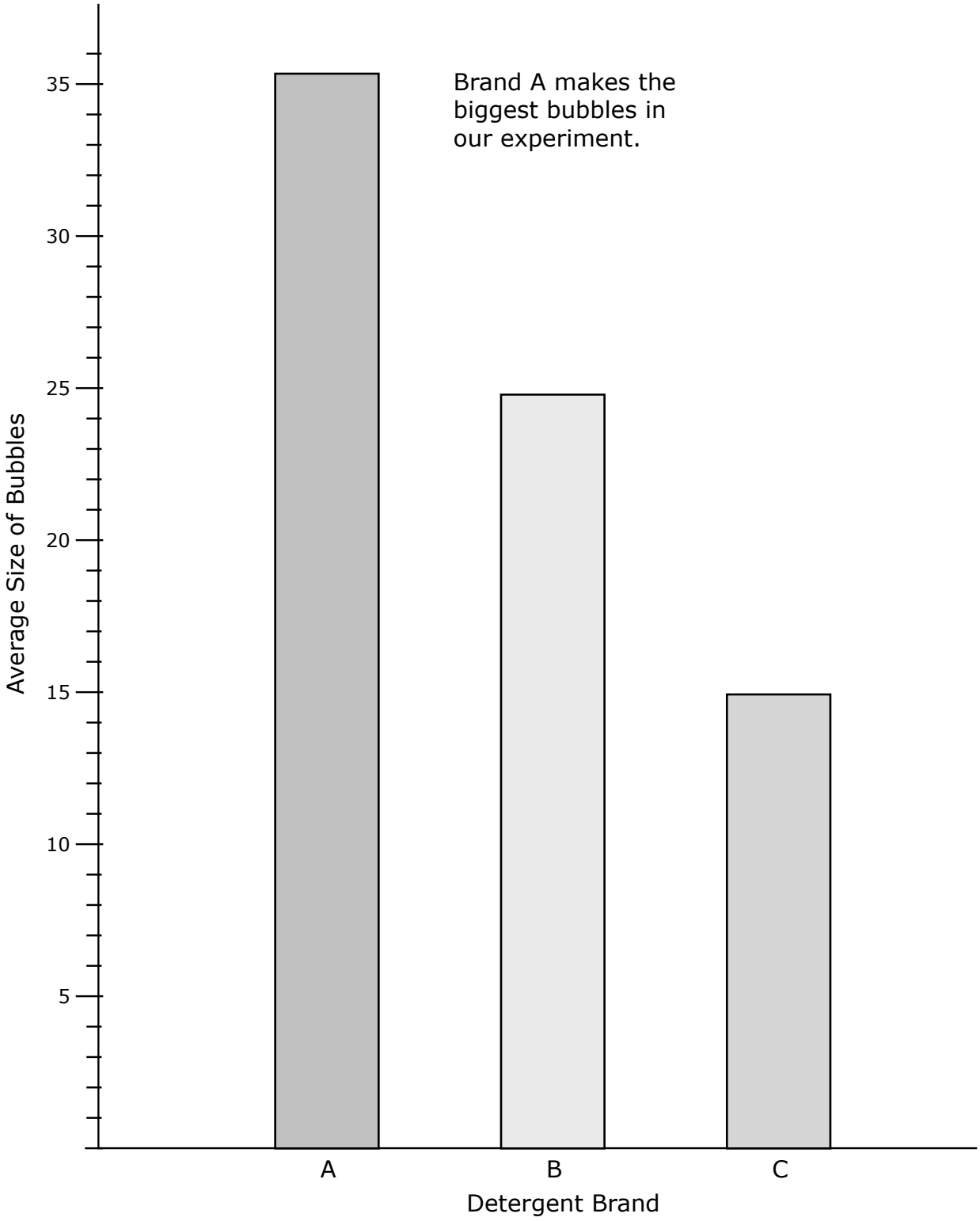
Number of bars on graph: (x axis)
3 brands: evenly spaced

Step 5: Number and label the y axis, label the x axis, and title the graph

Step 4: Determine the data points and create the bar graph

(A, 35.8 cm) (B, 24.8 cm) (C, 15.0 cm)

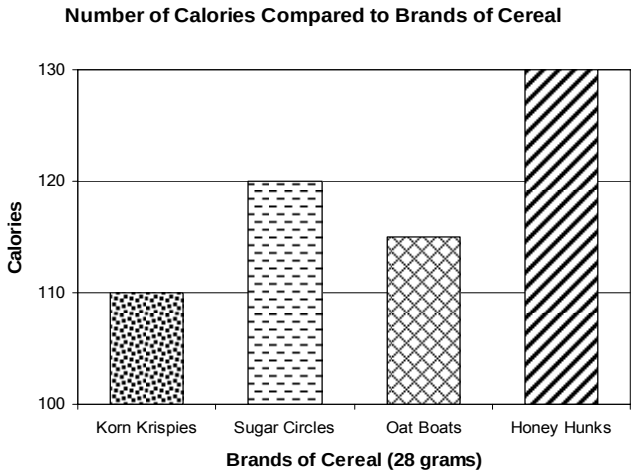
Which Detergent Makes the Biggest Bubbles?



Understanding Graphing Worksheet

Graphs appear not only in textbooks and scientific journals, but also in newspapers and popular magazines. They are useful because they clearly show relationships between two or more variables. Two of the most common graphs are bar and line graphs.

Bar graphs compare several variables according to one characteristic. For example, the bar graph below compares four kinds of cereal according to the number of calories each contains in 28 grams.



1. Look at the numbers used on the vertical axis. What would happen to the bars on the graph if these numbers were changed to 100, 150, 200, and 300?

_____

_____

_____

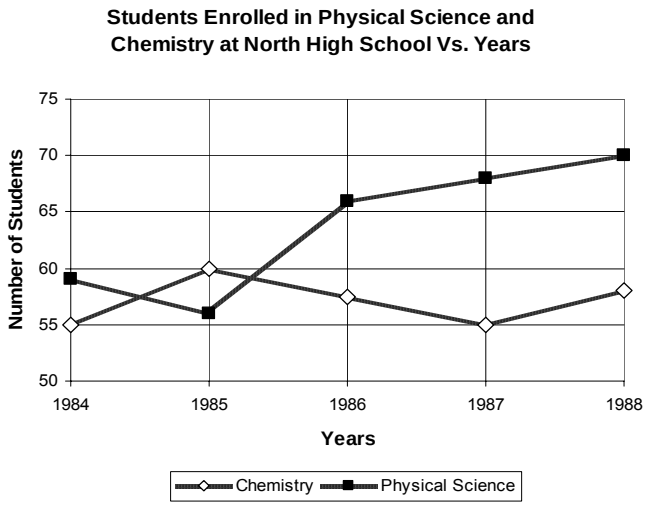
2. How would the graph change if the numbers on the vertical axis started with 0 and increased in increments of 10?

_____

_____

_____

Line graphs, such as the one below, show a change in one or more variables over time. They can also illustrate a trend.



3. How does the enrollment in physical science compare with that in chemistry over the years? Do you see any trends?

_____

_____

_____

_____

_____

_____

4. Why does this graph include a legend?

_____

_____

_____

_____

Notice that the independent variables in both graphs (the kind of Brands of Cereal and the Years) are plotted along the horizontal axis. Independent variables are chosen or changed by the experimenter. The dependent variables (the Number of Calories and the Number of Students) are plotted along the vertical axis. Dependent variables change when the independent variable changes. Notice, too, that both graphs include titles and labels for the variables.

To practice making a bar graph, let's compare the number of students in several high schools. **School A has 850, school B has 600, school C has 1200, school D has 900, and school E has 350**.

5. In a bar graph of these data, what would be the independent variable and on which axis would it be plotted?

_____

_____

_____

_____

6. What would be the dependent variable and on which axis would it be plotted?

_____

_____

_____

_____

We will have a fixed number of variables on the horizontal axis. However, we must establish an appropriate range of numbers for the vertical axis.

7. What is the highest and lowest number of students?

8. Considering the range of numbers, what would be appropriate numbers to use on the vertical axis?

Now, on a piece of the graph paper, draw this bar graph. Be sure to label the variables and give the graph a title. Draw in the bars and set them at the levels listed above.

9. How is comparing school enrollment in a graph better than just listing the numbers in a sentence?

To practice making a line graph, let's say an optometrist has noticed an increase in the number of her patients requesting contact lenses. She wonders how this number compares with the number of people asking for glasses during the past five years. The chart below lists her raw data.

Year	Patients Wanting Glasses	Patients Wanting Contact Lenses
1984	37	42
1985	29	61
1986	32	74
1987	25	74
1988	17	86

10. In a line graph for these data, what would be the independent variable and on which axis would it be plotted?

11. In a line graph for these data, what would be the dependent variable and on which axis would it be plotted?

12. Considering the highest and lowest number of patients for each year, what numbers would be the most appropriate to list on the vertical axis?

On the back side of the graph paper, draw the line graph. Be sure to label the variables and include a title. Use a legend to indicate each category of patient. Mark the points on the graph that show the number of patients who asked for glasses and number who requested contact lenses for each year.

Now connect the points that you have plotted in each category.

13. What trends does the graph indicate?

You have just constructed two graphs. Being familiar with the construction of graphs will not only help you when making your own, it will help you understand those you encounter in everyday life.

The Basics of Graphs and Charts

Polly Dornette
Updated August 2016

Graphs and charts communicate information visually. They can show patterns, help scientists identify correlations, and get the point of the experiment across quickly.

- Typically, the **independent variable** is plotted on the **x-axis**
- The **dependent variable** is plotted on the **y-axis**.

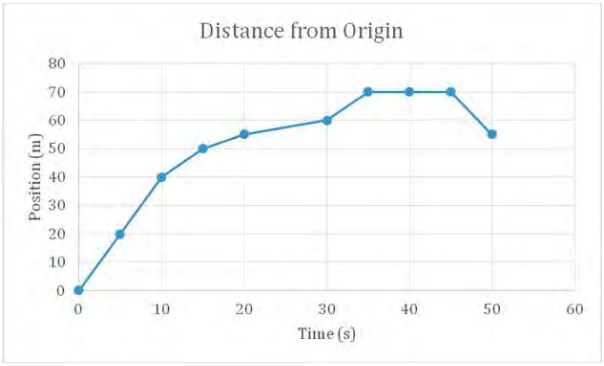
The mnemonic DRY MIX, for "dependent, responding, y-axis" and "manipulated, independent, x-axis," can help us remember this point. Or simply remember the variable "I" control is the "Independent" variable.

Let's look at the different types of graphs and which types of data are best represented by each.

Line graph

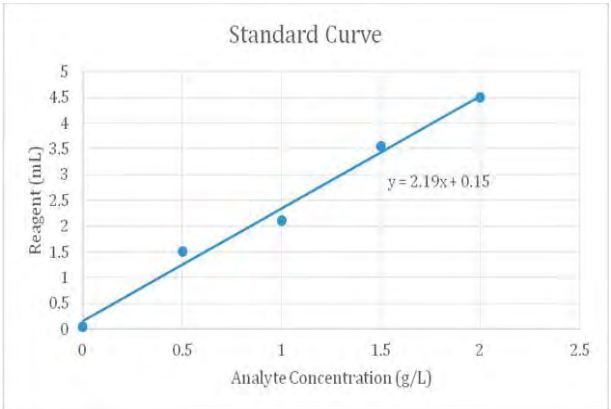
Line graphs show continuous data over periods of time. Before setting up a line graph, determine the dependent and independent variables. The independent variable may be a scalar (numeric) or ordinal (order) quantity. The independent variable always goes on the x-axis. If an experiment requires taking data points every 5 seconds for a minute, or every day for a month, it is appropriate to use a line graph.

Line graphs are similar to x-y scatter plots, except that the individual data points are connected. These graphs may be useful in circumstances when the change from point to point is of interest (as in a titration curve or absorbance spectrum). See the example below of a line graph showing the distance an object traveled from its starting point over time.



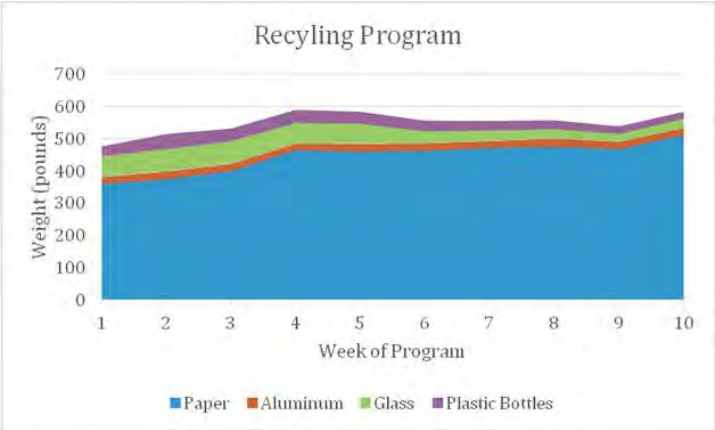
X-Y (scatter) plot

A scatter plot is often used to show relationships between independent and dependent variables. Instead of connected data points with a line, a best-fit line can be used to find a trend in data. Scatter plots are frequently used for creating a standard curve in chemistry, as is shown in the graph below. An equation for the trend line can be determined.



Area graph

Similar to a line graph, an area graph is used to track changes over time for one or more groups. An area chart works well for data that both changes over time and indicates where the sum and the parts are important.

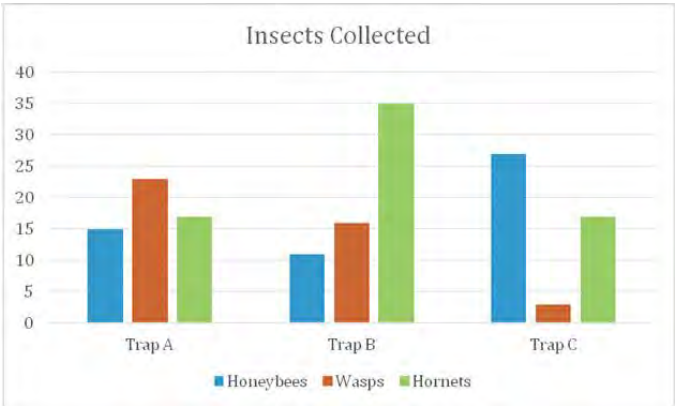


Pie chart

Use pie charts to compare parts of a whole. They depict a single point in time rather than changes over time. A pie chart can display percent composition, such as the composition of air. The area of each sector is proportional to a percentage.

Bar graph

Bar graphs are used to compare different groups or to track a change over a period of time. Bar graphs compare data that do not continuously change over time, and they are helpful when you need to compare information collected by counting. A bar graph should be used if you are not looking for trends over time and when the items are not part of a whole. Bar graphs can also be used to compare values from different trials or different experimental groups, and they are ideal when the independent variable is not numerical.



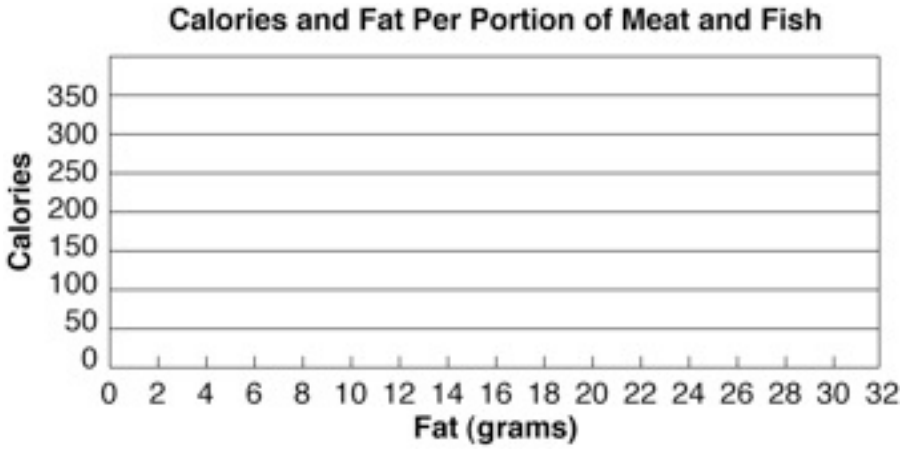
Name _____ Date _____ Class _____

9.9 Scatter Plots Worksheet

1. Use the given data to make a scatter plot.

Calories and Fat Per Portion of Meat & Fish

	Fat (grams)	Calories
Fish sticks (breaded)	3	50
Shrimp (fried)	9	190
Tuna (canned in oil)	7	170
Ground beef (broiled)	10	185
Roast beef (relatively lean)	7	165
Ham (light cure, lean and fat)	19	245



Do the following data sets have a positive, a negative, or no correlation?

2. The size of the bag of popcorn and the price of the popcorn: _____

3. The increase in temperature and number of snowboards sold: _____

4. Use the data to predict how much money Tyler would be paid for babysitting $7\frac{1}{2}$ hrs.

Amount Tyler Earns Babysitting

Hours	1	2	3	4	5	6	7	8
Amount	$4	$8	$12	$16	$20	$24	$28	$32

According to the data, Tyler would get paid $ _____ for babysitting $7\frac{1}{2}$ hours.

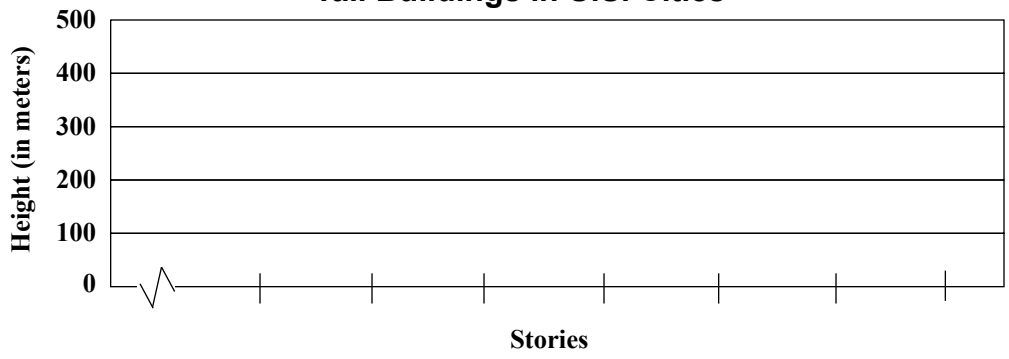
Name _____ Date _____ Class _____

5. Use the given data to make a scatter plot, and describe the correlation.

Tall Buildings in U.S. Cities

Building	City	Stories	Height (meters)
Sears Tower	Chicago	110	442
Empire State Building	New York	102	381
Bank of America Plaza	Atlanta	55	312
Library Tower	Los Angeles	75	310
Key Tower	Cleveland	57	290
Columbia Seafirst Center	Seattle	76	287
NationsBank Plaza	Dallas	72	281
NationsBank Corporate Center	Charlotte	60	265

Tall Buildings in U.S. Cities



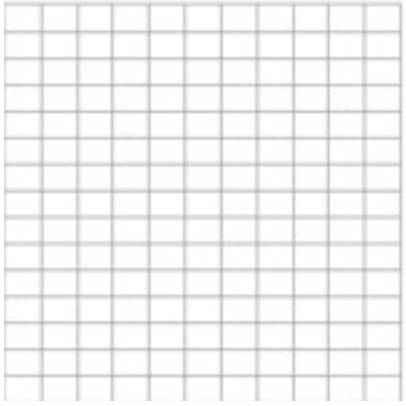
Describe the correlation:_____

6. **Make a scatter plot of the data, and draw a line of best fit. Then use the data to predict the percentage of American homeowners in 1955.**

Percent of Americans Owning Homes

Year	1950	1960	1970	1980	1990
Percent	55.0%	61.9%	62.9%	64.4%	64.2%

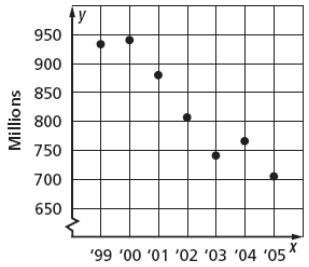
Prediction: _____



Name _____Hour_____ Date_____

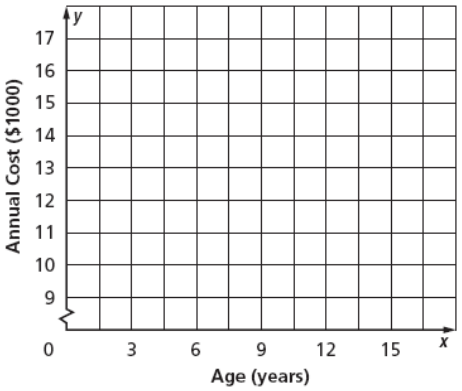
Scatter Plots and Lines of Best Fit Worksheet

1. **MUSIC** The scatter plot shows the number of CDs (in millions) that were sold from 1999 to 2005. If the trend continued, about how many CDs were sold in 2006?



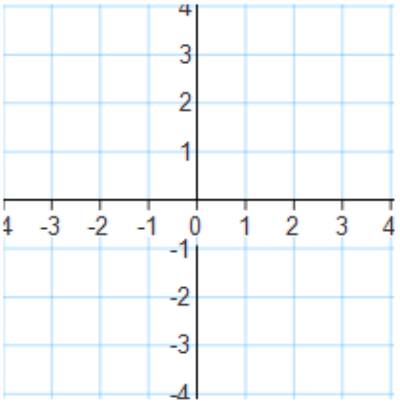
2. **FAMILY** The table below shows the predicted annual cost for a middle income family to raise a child from birth until adulthood. Draw a scatter plot and describe what relationship exists within the data.

Cost of Raising a Child Born in 2003					
Child's Age	3	6	9	12	15
Annual Cost ($)	10,700	11,700	12,600	15,000	16,700



3. Make a scatter plot of the data in the table. Draw a line of best fit. What is the equation of the line of best fit?

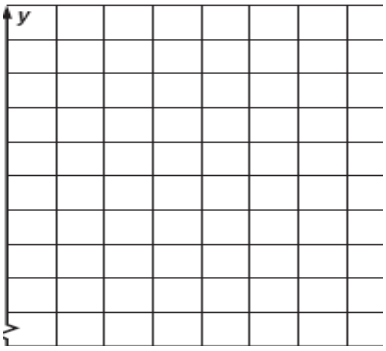
X	-2	-2	-1	0	1	1	1	2	2	3
Y	2	3	2	1	0	1	-1	-1	-2	-2



4. **EDUCATION** The table at the right gives the number of hours spent studying for a science exam and the final exam grade.

Study Hours	3	2	5	1	0	4	3
Grade	84	77	92	70	60	90	75

   a. Draw a scatter plot of the data and draw in the line of best fit.

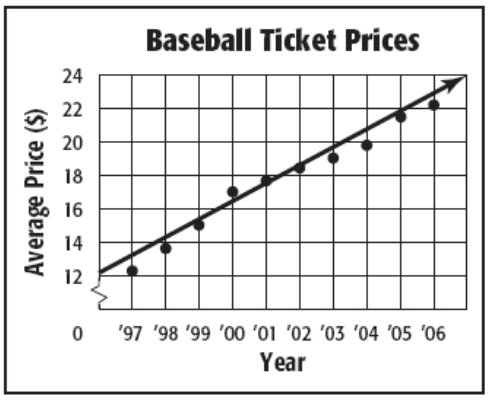


   b. What is the equation for the line of best fit?

   c. Predict the grade for a student who studied for 6 hours.

   d. Could this line go on forever? Why or why not?

5. **BASEBALL** The scatter plot shows the average price of a major-league baseball ticket from 1997 to 2006.
   a. Use the points (2001, 17.60) and (2002, 18.75) to write the slope-intercept form of equation for the line of fit shown in the scatter plot.

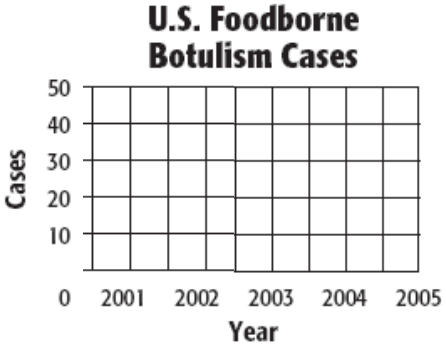


Source: Team Marketing Report, Chicago

   b. Use your equation to tell the price of a ticket in 2009. Is this extrapolation or interpolation?

6. **DISEASE** The table shows the number of cases of Foodborne Botulism in the United States for the years 2001 to 2005.
   a. Draw a scatter plot and determine, what relationship, if any, exists in the data.

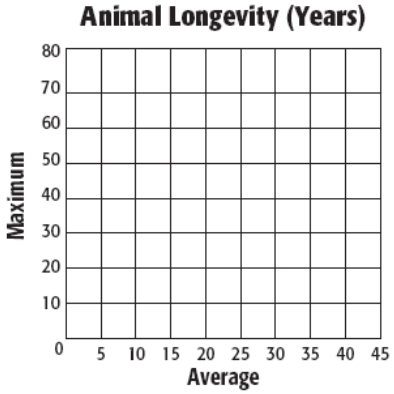
U.S. Foodborne Botulism Cases					
Year	2001	2002	2003	2004	2005
Cases	39	28	20	16	18



   b. Draw a line of fit for the scatter plot, and write the slope-intercept form of an equation for the line of fit.

7. **ZOOS** The table shows the average and maximum longevity of various animals in captivity.
   a. Draw a scatter plot and determine, what relationship, if any, exists in the data.

Longevity (years)								
Avg.	12	25	15	8	35	40	41	20
Max.	47	50	40	20	70	77	61	54



   b. Draw a line of fit for the scatter plot, and write the slope-intercept form of an equation for the line of fit.

   c. Predict the maximum longevity for an animal with an average longevity of 33 years. Is this an example of Extrapolation or Interpolation?

Name_____ Period _____

Scatter Plots

Algebra 10.S

Scatter Plots display data in two variables.
Data points are plotted on a graph to represent data and determine **correlation.**
Scatter Plots may show **positive, negative,** or **no correlation.**

Positive correlation means when one variable increases, so does the other.
Negative correlation means that when one variable increases, the other decreases.
No correlation means that the data appear unrelated.

Practice: Label the correlation that you suspect would be demonstrated by each: (pos., neg., or no)

1. Height versus weight of 100 male African elephants. _____

2. Distance driven versus gas used. _____

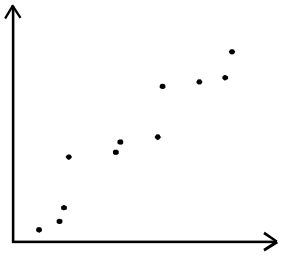
3. Amount of time spent studying versus G.P.A. _____

4. Hair length versus height of 150 adult women. _____

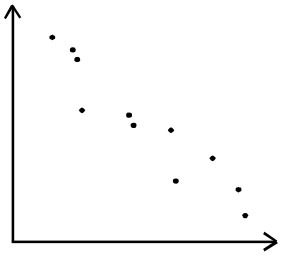
5. Distance walked in a pair of shoes versus the thickness of the sole. _____

On a graph, it is easy to recognize the correlation:

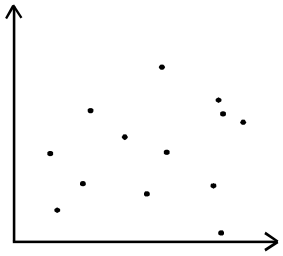
Positive



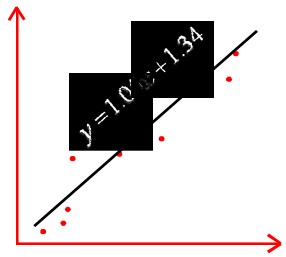
Negative

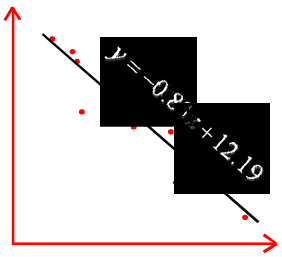


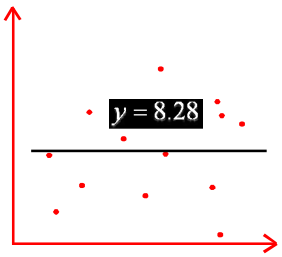
No Correlation



The trend line for a scatter plot is called the **Best Fit Line** or Line of Best Fit and can be described as a linear equation in slope-intercept form.







Name_____ Period _____

Scatter Plots

Algebra 10.S

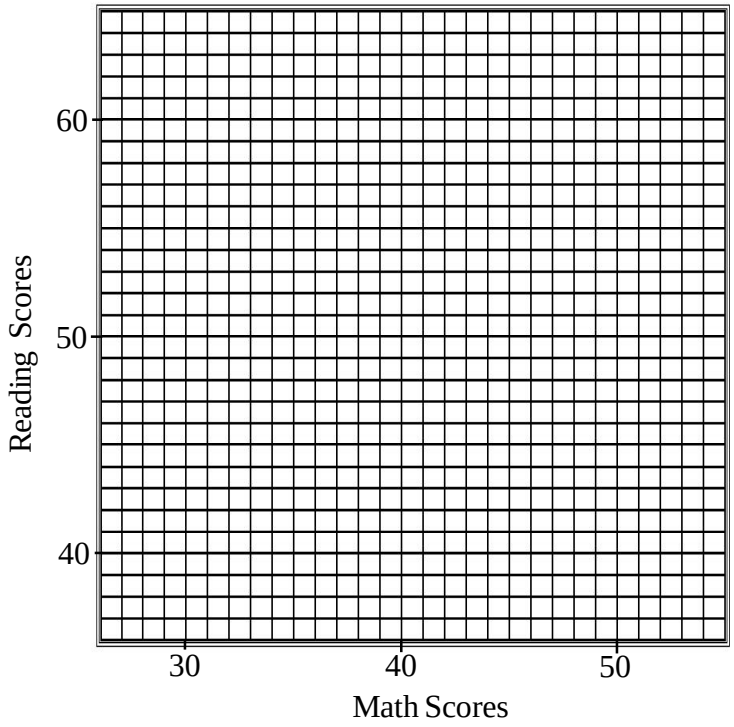
Creating a scatter plot is easy once the graph is drawn.

Practice: The Data Below shows the average test scores in California on the standardized Reading and Math tests for 8 years from 1992-1999. Create a Scatter Plot to display the data.

Math vs. Reading Scores

Year	Math Score	Reading Score
1992	32	38
1993	40	39
1994	50	55
1995	48	48
1996	39	46
1997	45	50
1998	42	45
1999	40	47

Relationship shown: _____



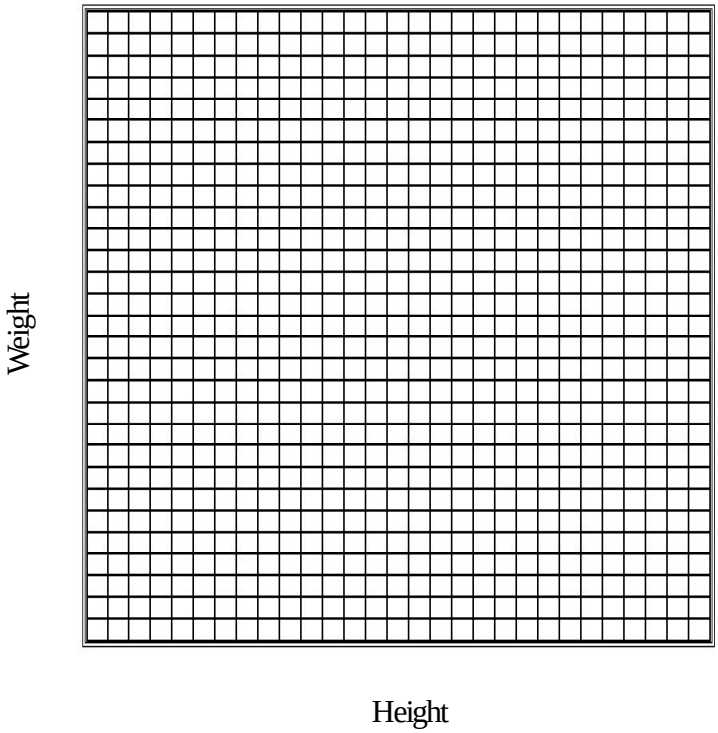
Creating a scatter plot is more difficult when you must create your own graph.

Practice: The Data Below shows the height and weight of 12 female students in Mrs. Phillips' first grade class. Label the graph so that the data fits and plot the points below.

Height versus Weight

Name	Height	Weight
Lisa	44	47
Simone	50	57
Meredith	38.5	32
Penny	39	42
Sheila	41	36
Tara	45.5	49
Meg	48	62
Mara	51	47
Steph	53	65
Callie	50.5	49
Cynthia	46.5	52
Joy	45	43

Relationship shown: _____



Name_____ Period _____

Scatter Plots on the TI-83 Calc.

Algebra 10.S

Using the data from Mrs. Phillips' first grade class, we will use the graphing calculator to display the data and determine the line of best fit.

Clear the memory of your calulator before starting.

1. Enter the data. Choose STAT and select 1: Edit...

Enter the height data under L1 and the weight data under L2.

Name	Height (L1)	Weight(L2)	Name	Height (L1)	Weight(L2)
Lisa	44	47	Meg	48	62
Simone	50	57	Mara	51	47
Meredith	38.5	32	Steph	53	65
Penny	39	42	Callie	50.5	49
Sheila	41	36	Cynthia	46.5	52
Tara	45.5	49	Joy	45	43

Tips:

Make sure all of the data lines up properly.

If you need to delete an entry use DEL. To insert a missing entry use INS (2nd DEL).

2. Plot the data.

Choose STAT PLOT (2nd Y=)
Select 1: Plot 1...
Turn the graph On. (highlight On and hit Enter)
Note the other settings, we will not change these.
ZOOM 9: ZoomStat

3. Calculate the Line of Best Fit

Push the STAT button. This time toggle right to CALC in the menu.
Select 4: LinReg (ax+b) This will calculate an equation in the form y=mx+b. Hit ENTER.
(If you did everything correctly so far, you should have gotten a=1.652 and b=-27.573).

4. Plot the Line of Best Fit

Go to Y_1= and then hit VARS.
Choose 5: Statistics...
Toggle right to EQ and select 1: RegEQ and GRAPH.
You may also enter the equation manually, but it will not be as accurate in most cases.

5. Trace the Line of Best Fit

Hit TRACE. Use the left and right arrows to bounce from point to point.
Use the down arrow to toggle onto the line (not the points).

Answer: Round to the tenth.

How much would you expect a first grade girl to weigh for each height given below?

40in _____lbs 42in _____lbs 45in _____lbs

48in _____lbs 50in _____lbs 53in _____lbs

hint: Discover the TABLE function on your own.

Name_____ Period _____

Scatter Plots on the TI-83 Calc.

Algebra 10.S

Use each table of data to create a graph and a line of best fit on your calculator to answer the questions that follow.

Latitude and Average Daily Temperature in July for 10 world cities

Name	Latitude (°N)	July Temp. (°C)
Oslo	59	7
Berlin	52	18.5
London	51	17
Vancouver	49	17
Tunis	37	26
Tomsk	56	18
Kiev	50	20
Coppermine	67	10
Rome	41	24
Salah	27	37

1. What is the linear equation that represents the July temperature of a city based on its north latitude? (Round decimals to the thousandth 0.001)

_____

2. What would be the expected July temperature at each of the given latitudes below?

25°N _____°C 54°N _____°C 70°N _____°C

Latitude and Average Daily Rainfall in July for 10 world cities

Name	Latitude (°N)	July Rainfall (mm)
Oslo	59	73.6
Berlin	52	57.4
London	51	59.5
Vancouver	49	31.3
Tunis	37	3.3
Tomsk	56	73.6
Kiev	50	77.1
Coppermine	67	31.9
Rome	41	16.3
Salah	27	0.1

1. Write the equation (to the thous.): _____

2. What would be the expected July rainfall at each of the given latitudes below?

35°N _____mm 45°N _____mm 60°N _____mm

3. Does this graph appear to show more or less correlation than the one above? _____

Name_____ Period _____

Scatter Plots on the TI-83 Calc.

Algebra 10.S

Use each table of data to create a graph and a line of best fit on your calculator to answer the questions that follow.

Global Temperature by Year 1900-2000

Year	Temp. (°F)
1900	57.20
1910	56.82
1920	56.97
1930	57.13
1940	57.47
1950	56.93
1960	57.16
1970	57.27
1980	57.67
1990	58.08
2000	57.92

1. Write the Linear equation (to the thous.): _____

2. According to this (very limited) data, predict the mean global temperature for the following years.
(Use TBLSET and TABLE, or change your WINDOW values and use TRACE)

2010 _____ 2025 _____ 2050 _____ 2100 _____

North American Population 1986-1995

Year	Population (millions)
1986	346
1987	350
1988	354
1989	358
1990	363
1991	369
1992	374
1993	379
1994	383
1995	388

3. Write the Linear equation (to the thous.): _____

4. Calculate and graph the **Exponential** Equation (Stat - Calc - ExpReg) AND the Linear Equation. What does each predict for the North American population for the year 1900?

Exponential _____million **Linear** _____million

5. What is wrong with the linear prediction? _____

Name_____ Period _____

Scatter Plots on the TI-83 Calc.

Algebra 10.S

Use each table of data to create a graph and a line of best fit on your calculator to answer the questions that follow.

Made-Up Meaningless Statistical Data Table 1

Age (years)	Length (cm)
15	143.6
20	140.7
25	132.9
30	133.7
35	129.1
40	108.9
45	109.1

6. What is the slope of the line of best fit to the hundredth? _____

7. What is the length at age 0 according to this equation? _____cm

8. Predict the length at age 100: _____cm

Made-Up Meaningless Statistical Data Table 2

X:	10	11	16	7	4	-5	1	-3
Y:	-2	-1.5	1	-3.5	-5	-9.5	-6.5	-8.5

9. What equation does this table represent (in slope-intercept form)? _____

10. What is the value of y when x=100? _____

Made-Up Meaningless Statistical Data Table 3

X:	6.1	8.7	9.9	10.1	11.0	12.9	15.1	17.3
Y:	19.3	6.1	3.2	3.5	2.8	1.5	0.3	0.1

11. Write the **linear** equation for the line of best fit (to the hundredth). _____

12. Write the **exponential** equation for the line of best fit (to the hundredth). _____

13. Which of the two equations above better fits the data given? _____

Made-Up Meaningless Statistical Data Table 4

14. Fill-in the missing data point in the table below.

X:	7.2	8.9	9.1	18.7	21.9	32.2	35.8	41.1
Y:	23.1	29.1	29.9	63.1	74.5	_____	123.2	142.1

Name_____ Period _____

Types of Data

Algebra 10.S

We have generally dealt with three types of data:
Linear data points form a straight line with a slope and intercepts.
Quadratic data forms a parabola with a vertex and (sometimes) root(s).
Exponential data forms a 'ramp' with increasing slope.

You should be able to identify data types without a calculator in many cases.

Identify each table of data as linear, quadratic, or exponential:

1. _____

X:	-2	4	10	16	22	28	34	40
Y:	-9	-10	-11	-12	-13	-14	-15	-16

2. _____

X:	0	1	2	3	4	5	6	7
Y:	1	2	4	8	16	32	64	128

3. _____

X:	-4	-3	-2	-1	0	1	2	3
Y:	6	1	-2	-3	-2	1	6	13

4. _____

X:	5	7	9	11	13	15	17	19
Y:	1.64	1.05	.67	.43	.27	.18	.11	.07

Coefficient of Correlation
The **coefficient of correlation** is a number between -1 and 1 which describes how well the equation 'fits' the data. It only works for linear and exponential data and can be found using the VARS - Statistics - EQ - r menu.
A value close to 1 or -1 means there is a strong correlation.
A value close to 0 means very weak correlation.

5. Calculate the linear equation for #4 (to the thousandth): _____

6. Calculate the coefficient of correlation (to the thousandth): _____

7. Calculate the exponential equation for #4 (to the thousandth): _____

8. Calculate the coefficient of correlation (to the thousandth): _____

Practice:

X:	-5	-2	6	9	-8	11	7	4
Y:	1.9	2.5	5.3	7.2	1.2	8.1	6.0	4.4

5. Calculate the linear equation (to the hundredth): _____

6. Calculate the coefficient of correlation (to the hundredth): _____

7. Calculate the exponential equation (to the hundredth): _____

8. Calculate the coefficient of correlation (to the hundredth): _____

Name_____ Period _____

Types of Data

Algebra 10.S

Practice:

X:	0	1	2	3	4	5	6	7
Y:	29	22	13	8	5	4	5	8

9. Calculate the linear equation (to the hundredth): _____

10. Calculate the coefficient of correlation (to the hundredth): _____

11. Calculate the exponential equation (to the hundredth): _____

12. Calculate the coefficient of correlation (to the hundredth): _____

13. Calculate the coefficient of correlation (to the hundredth): _____

13. Calculate the quadratic equation (to the hundredth): _____

14. Which of the three equations (Linear, Exponential, or Quadratic) fits the data? _____

15. If x=10, what will y=? _____

Practice:

X:	-3	-8	19	4	-1	30	14	9
Y:	7	23	102	21	12	145	54	32

16. Calculate the linear equation (to the hundredth): _____

16b. Graph the linear equation for Y_1

17. Calculate the coefficient of correlation (to the hundredth): _____

18. If the data is linear and x=10, y= (to the hundredth): _____

19. Calculate the exponential equation (to the hundredth): _____

19b. Graph the exponential equation for Y_2

20. Calculate the coefficient of correlation (to the hundredth): _____

21. If the data is exponential and x=10, y= (to the hundredth): _____

22. Calculate the quadratic equation (to the hundredth): _____

22b. Graph the quadratic equation for Y_3

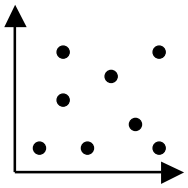
23. If the data is quadratic and x=10, y= (to the hundredth): _____

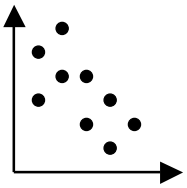
24. Based on the graphs, which data point makes the data appear quadratic? (_____ , _____)

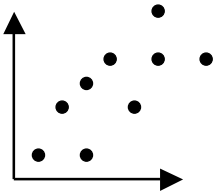
Name _____
Date _____ Class____

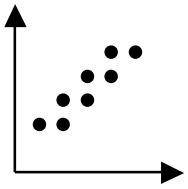
Practice with Scatter Plots

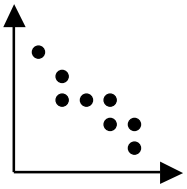
Classify the scatter plots as having a positive, negative, or no correlation.

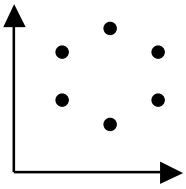
1. 

2. 

3. 

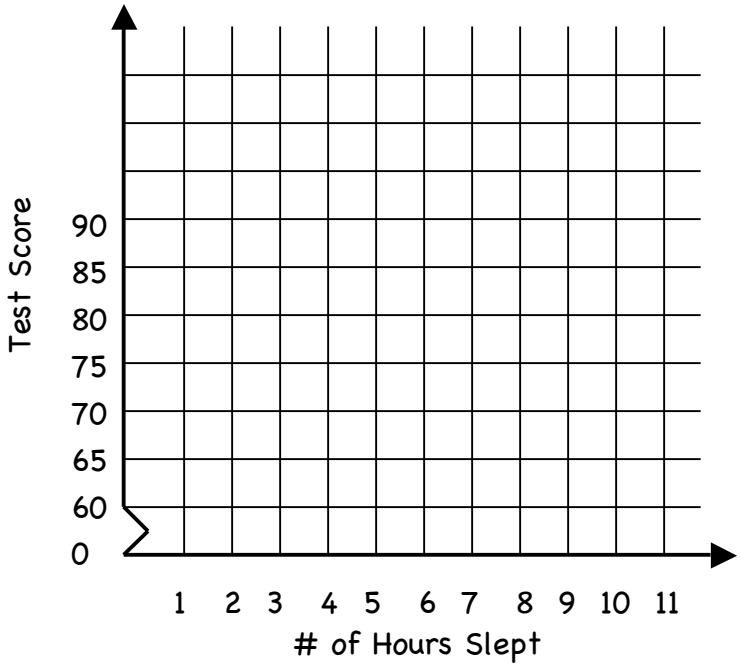
4. 

5. 

6. 

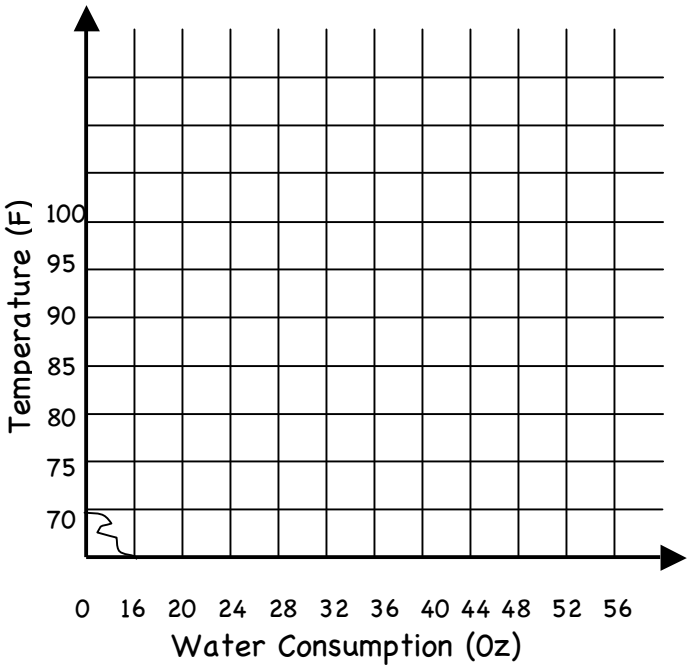
7. A history teacher asked her students how many hours of sleep they had the night before a test. The data below shows the number of hours the student slept and their score on the exam. Plot the data on a scatter plot.

Hours Slept	8	7	7	8	6	5	7	4	9	7
Test Score	83	86	74	88	76	63	90	60	89	81



8. Assume that during a three-hour period spent outside, a person recorded the temperature and their water consumption. The experiment was conducted on 7 randomly selected days during the summer. The data is shown in the table below.

Day	Temp-erature (F)	Water Consumption (oz)
1	99	48
2	85	27
3	97	48
4	75	16
5	92	32
6	85	25
7	83	20



Create a scatter plot with the data. What is the correlation of this scatter plot? (Hint: Do not use the day on the scatter plot.)

Identify the data sets as having a positive, a negative, or no correlation.

8. The number of hours a person has driven and the number of miles driven

9. The number of siblings a student has and the grade they have in math class

10. The age of a car and the value of the car

11. The number of weeks a CD has been out and the total sales

12. The number of years a person went to school and their income

13. The number of songs downloaded on your i-pod and the amount of memory available

14. The amount of time spent on the computer instant messaging your friends and the number of computers in your house

15. The age of a house and the number of people living in the house

.

Graph of the Week

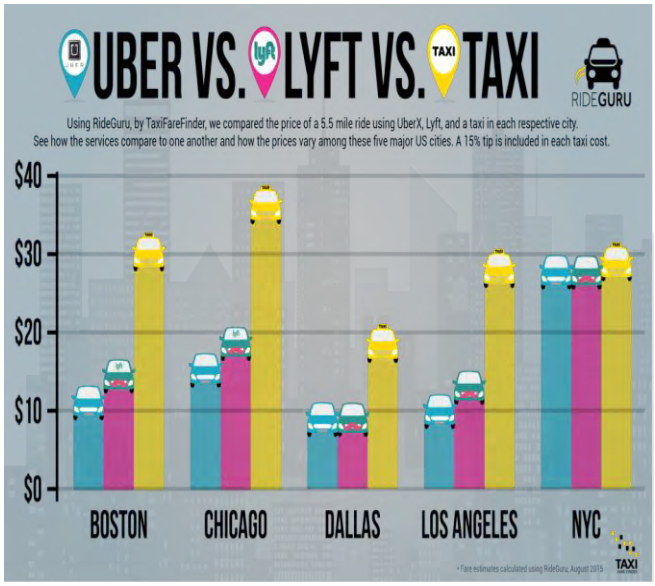
April 30-May 4, 2018

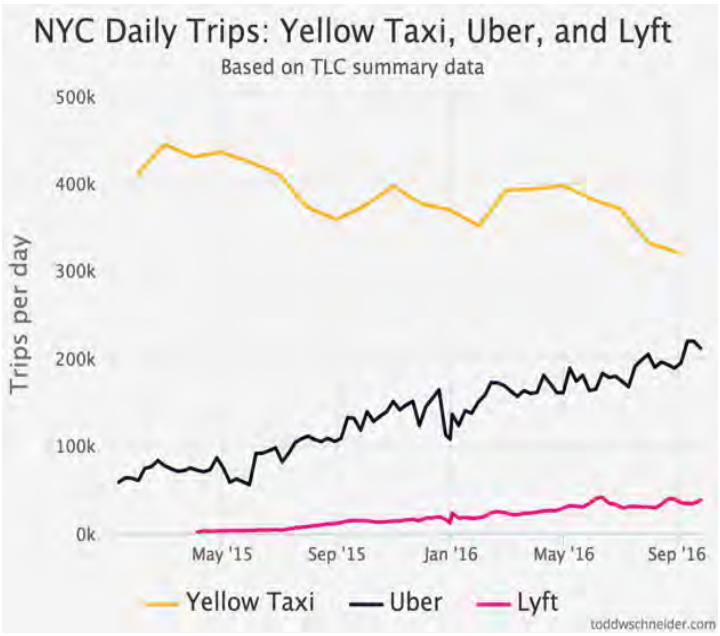
Analyze the graphs below and write a reflection on what you think the graphs are communicating to you. To guide you with your response, start with some observations.

- What is the topic of each graph?
- What does the x-axis represent? What does the y-axis represent?
- What are some observations that you can make based on the graph?
- What do you foresee happening in the next 5 years?

Questions to ask when reading graphs:

- Is there an upward or downward trend?
- Are there any sudden spikes in the graph?
- What is being compared in the graph?
- What prediction can I make for the future?
- What inferences can I make about the graph?





CLASS SIZE ESTIMATES

= **10 STUDENTS** = **5 STUDENTS**

TEACHER	
Mr. Smith	
Ms. Jones	
Ms. Willis	
Mr. James	

The picture above estimates the number of students in four different classes at Central High School. Use the picture/graph to answer the following questions.

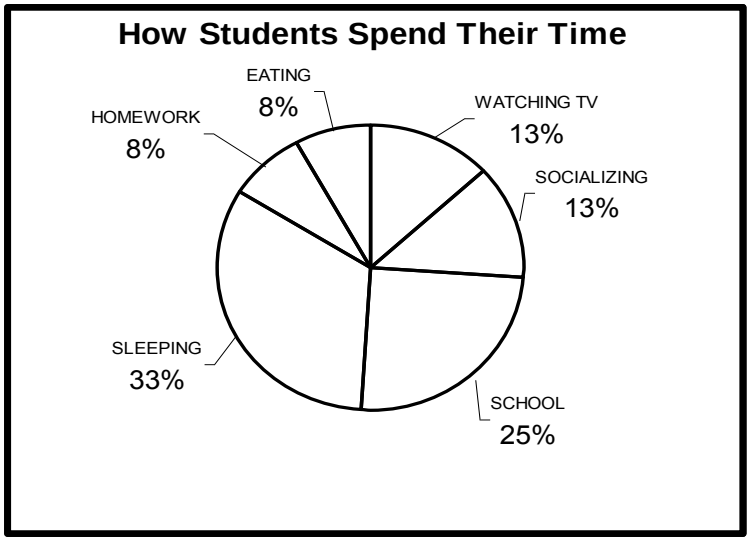
1. What is the approximate size of Mr. Smith's class?
   A. 40 Students
   B. 20 Students
   C. 45 Students
   D. 4 Students

2. How many more students are in Mr. Smith's class than in Mrs. Jones's class?
   A. 25
   B. 5
   C. 10
   D. 15

3. What is the total number of students in Ms. Jones's and Ms. Willis's classes?
   A. 55
   B. 45
   C. 65
   D. 60

4. What is the total of all students in all four classes at Central High School?
   A. 120 Students
   B. 14 Students
   C. 130 Students
   D. 140 Students

Use the pie chart/circle graph to find the best answer to each question.



5. Approximately how many hours a day are spent sleeping?
   A. 6 hours
   B. 9 hours
   C. 8 hours
   D. 10 hours

6. According to this graph, for every 24 hours, about how many hours are spent socializing and watching TV?
   A. 4 hours
   B. 2 hours
   C. 5 hours
   D. 6 hours

7. If a student ate ¾ (three-fourths) of their meals away from home, what % of the total day is spent eating other than at home?
   A. 6%
   B. 4%
   C. 7%
   D. 12%

8. Approximately how many hours a day are spent in school and doing homework?
   A. 7 hours
   B. 8.5 hours
   C. 9 hours
   D. 8 hours

9. Which equation shows how to figure the amount of time a student spends watching TV during a week? A equals the total amount of time watching TV for a week.
   A. A = 13% X 24 X 7
   B. A = 24 X 13 X 7
   C. A = 1.3 X 7 X 24
   D. A = 24 DIVIDED BY 13% X 7

10. Approximately how much time is spent in a week on socializing?
    A. 20 hours
    B. 21 hours
    C. 22 hours
    D. 23 hours

Study the table below and answer the following questions in reference to it.

DIAL DIRECT	WEEKDAY FULL RATE		EVENING 40% DISCOUNT		WEEKEND 60% DISCOUNT	
SAMPLE RATES FROM ORLANDO TO	FIRST MINUTE	EACH ADDITIONAL MINUTE	FIRST MINUTE	EACH ADDITIONAL MINUTE	FIRST MINUTE	EACH ADDITIONAL MINUTE
Atlanta, GA	.62	.43	.38	.26	.25	.18
Boston, Mass	.62	.43	.38	.26	.25	.18
Denver, CO	.62	.43	.38	.26	.25	.18
Detroit, Michigan	.58	.39	.35	.24	.24	.16
Los Angeles, CA	.64	.44	.39	.27	.26	.18
Miami, FL	.64	.44	.39	.27	.26	.18
Milwaukee, WS	.57	.37	.35	.23	.23	.15
Minneapolis, Minnesota	.59	.42	.36	.26	.24	.17
New Orleans, LA	.62	.43	.38	.26	.25	.18
New York, NY	.62	.43	.38	.26	.25	.18
Seattle, Washington	.64	.44	.38	.27	.25	.18
Washington, DC	.62	.43	.38	.26	.25	.18
Effective rates – do not include tax charges.						

OPERATOR ASSISTED*		
STATION-TO-STATION		**PERSON-TO-PERSON**
1 – 10 MILES	$.75	$3.00 FEE FOR ALL MILEAGES
11-22 MILES	$1.10	
23-3000 MILES	$1.55	

***NOTE: Add to this base charge – the minute rates from the above chart**

11. What is the price of a 7-minute DIAL DIRECT call to New York, NY, when you call in the evening?
    A. $1.56
    B. $1.94
    C. $1.65
    D. $1.74

12. What is the difference in cost of a 7-minute DIAL DIRECT call to New York, NY, and a 7-minute PERSON-TO-PERSON call to New York, NY?
    A. $1.55
    B. $3.00
    C. $4.55
    D. $4.10

13. What is the price of a 12-minute OPERATOR ASSISTED Station-to-Station call to Miami, FL on a Tuesday at noon?
    A. $5.48
    B. $7.03
    C. $8.45
    D. $7.53

14. What is the difference in price for a 9 minute DIAL DIRECT call to Los Angeles, CA, at 10:00 a.m. on a weekday – AND – the same call made in the evening?
    A. $3.26
    B. $2.36
    C. $1.61
    D. $3.18

15. What is the cost of an 18 minute EVENING, OPERATOR ASSISTED – STATION-TO-STATION call to New Orleans, LA?

A. $6.35

B. $5.80

C. $4.86

D. $5.24

16. If a 3% tax applied to the total cost of any call – what would be the total cost of a 12 minute WEEKDAY, DIAL DIRECT call to Detroit, Michigan?

A. $6.96

B. $4.87

C. $4.29

D. $5.02

17. Which of the following is NOT a type of charge for a DIAL DIRECT call?

A. Holiday

B. Evening

C. Weekday

D. Weekend

18. What is the amount of discount from a DIAL DIRECT, WEEKDAY call to Miami cost – as compared to a DIAL DIRECT, WEEKEND call to Miami?

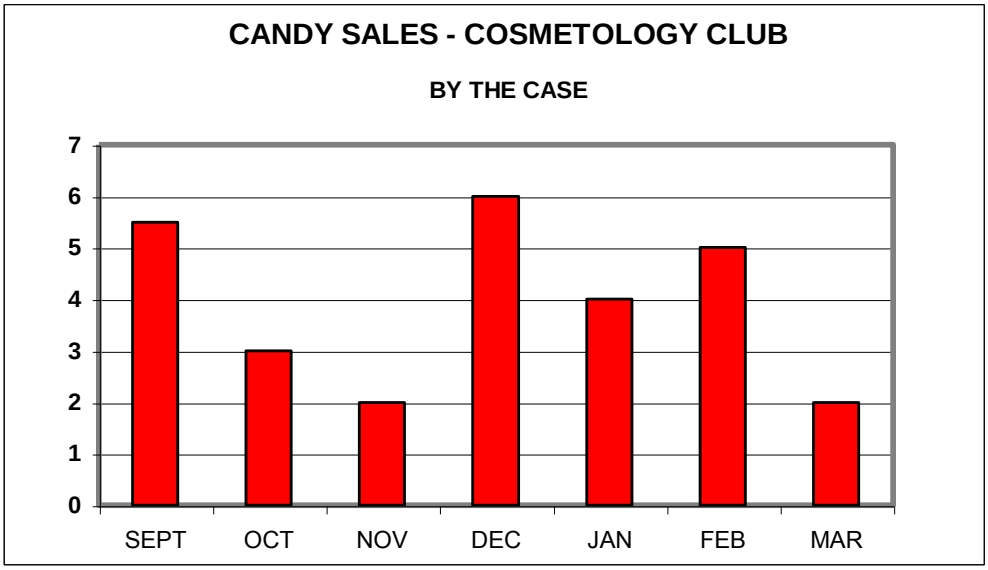
A. 60%

B. 40%

C. 20%

D. 80%

Study the bar graph below and answer the following questions.



19. What does the scale on the left beginning with 0 and ending with 7 represent?
    A. Number of students selling candy
    B. Number of cases of candy sold
    C. Number of candy in each case
    D. Number of days each month that candy was sold

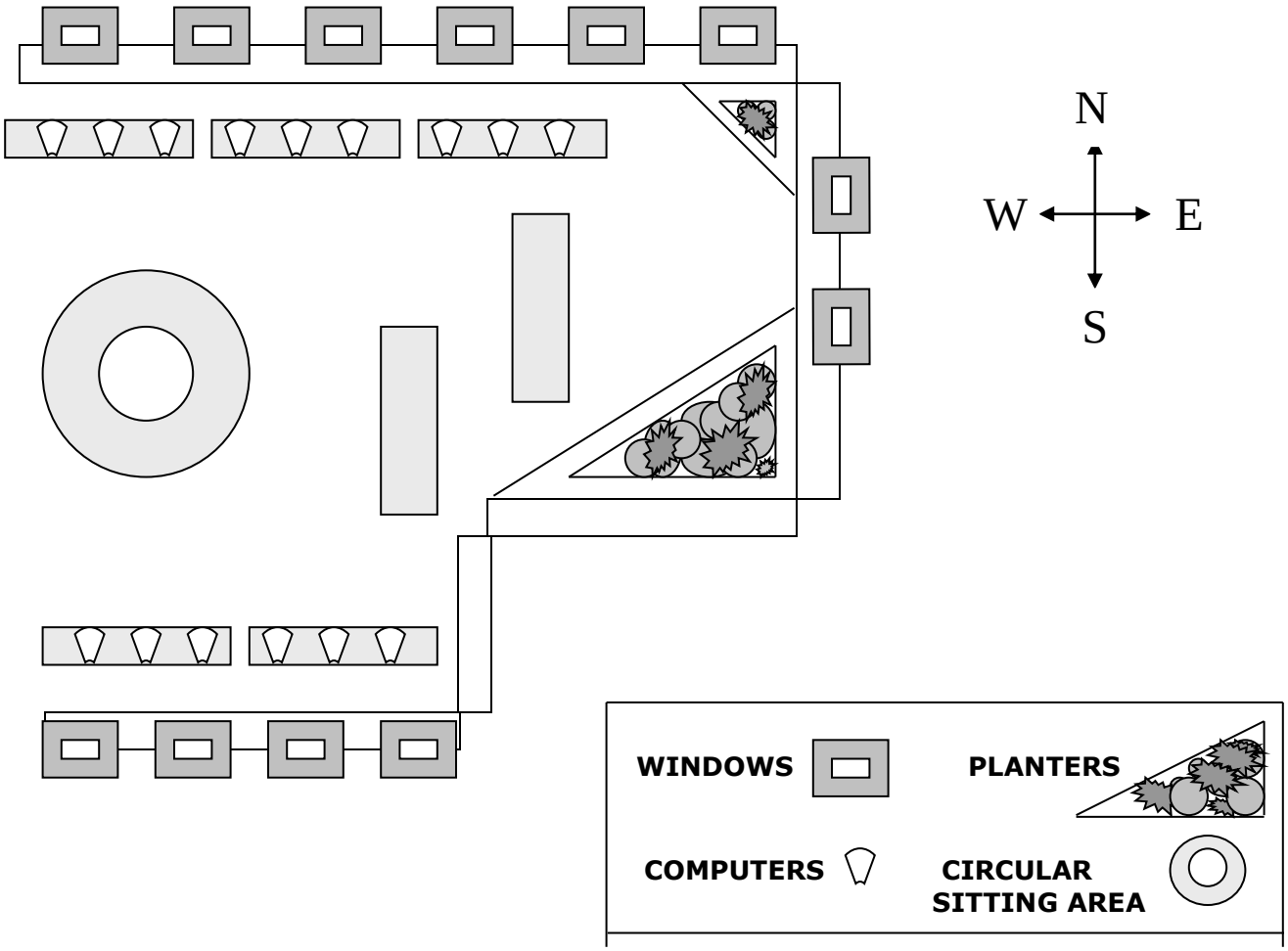
20. Which two MONTHS had approximately the same amount of candy sold?
    A. September & February
    B. October & March
    C. November & March
    D. September & December

21. The amount of candy sold in December is twice the amount of candy sold in which other month?
    A. October
    B. March
    C. January
    D. September

22. What was the total amount of candy sold during the school year shown in the graph?
    A. 27.5 Cases
    B. 43 Cases
    C. 35.5 Cases
    D. 23 Cases

23. Which month showed a 100% increase in sales over the month of November?
    A. March
    B. January
    C. December
    D. April

Study the diagram below then answer the following questions.



24. Each window for the new lab takes about 7 minutes to clean. About how long will it take to clean all the windows on the north and south walls of the building?

    A. 50 minutes
    B. 1 hour and 10 minutes
    C. 60 minutes
    D. 1 and ½ hours

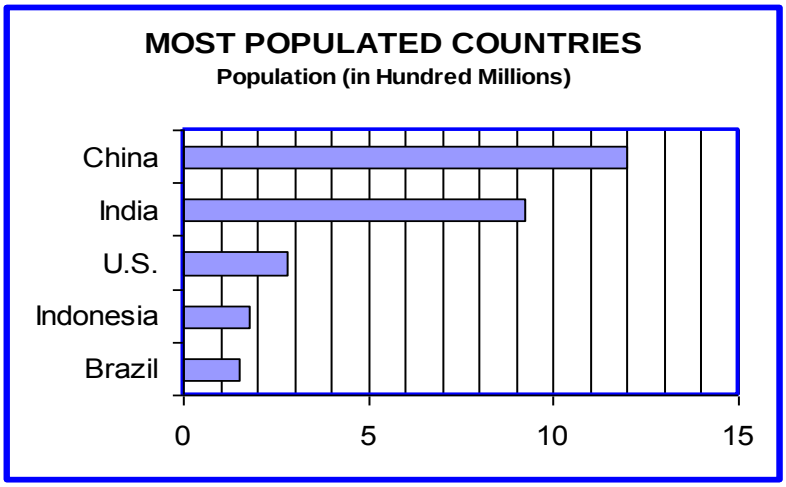
25. What fractional part of the windows is located on the south side of the building?
    A. 4/6
    B. 1/3
    C. 2/3
    D. 4/10

26. The largest planter is located on what wall of the room?
    A. North
    B. Northwest
    C. South
    D. Southeast

27. Most of the computers are located on which wall of the room?
    A. North
    B. South
    C. West
    D. East

28. What fractional part of the total number of computers is located on the south side of the building?
    A. 1/2
    B. 2/3
    C. 2/5
    D. 6/9

Study the graph below then answer the following questions.



Scott Foresman Addison Wesley

29. Which two countries have the closest population?
    A. China and Brazil
    B. U.S. and Indonesia
    C. Indonesia and Brazil
    D. India and China

30. About how many more people live in India than in the U.S.?
    A. 250,000,000
    B. 650,000,000
    C. 100,000,000
    D. 80,000,000

Answer Key

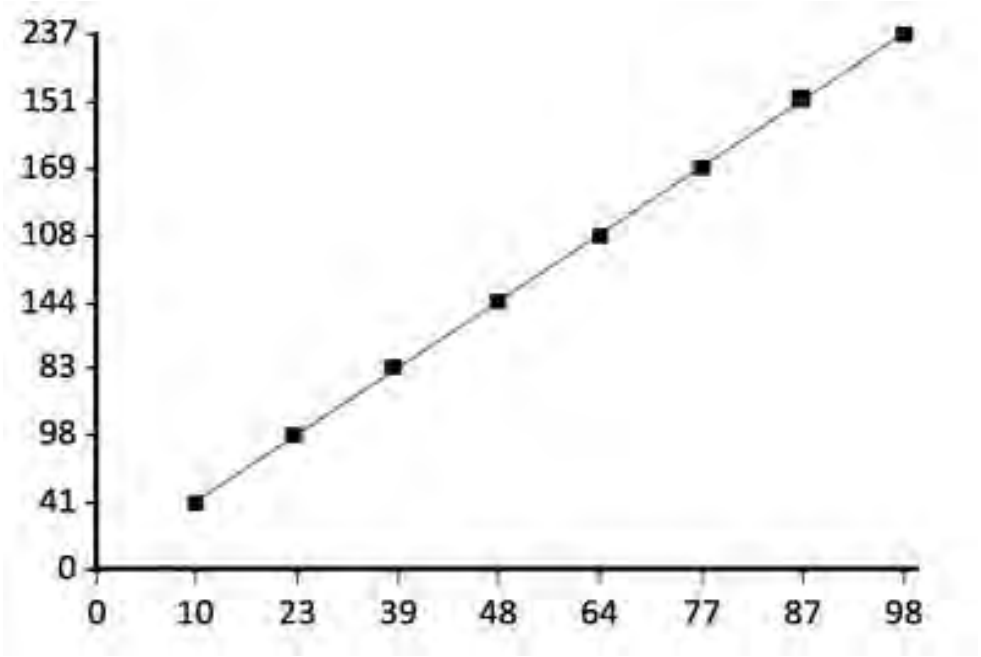
1. C
2. D
3. C
4. D
5. C
6. D
7. A
8. D
9. A
10. C
11. B
12. B
13. B
14. C
15. A
16. D
17. A
18. A
19. B
20. C
21. A
22. A
23. B
24. B
25. B
26. D
27. A
28. C
29. C
30. B

GRAPHS

Visualizing Data

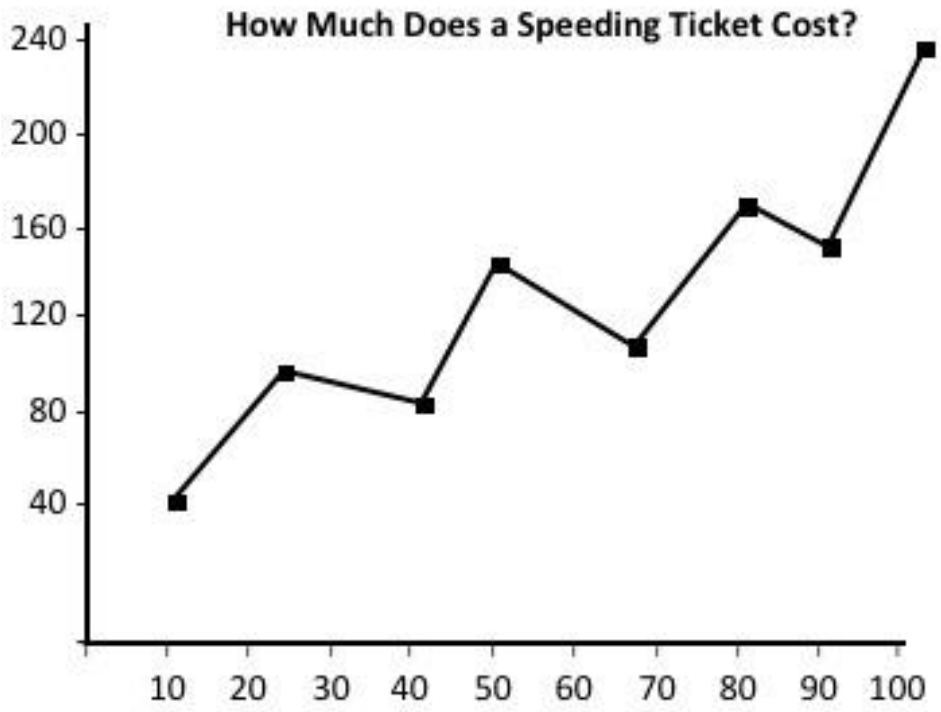
Science Section page297

This is a really bad graph



- Oh, boy, what ***isn't*** wrong with this graph? There is no title.
- There are no labels on the x- or y-axis. What are those numbers? Who knows?
- There are no units on the x- or y-axis. Is this a graph of speed in miles per hour or a graph of temperature in Kelvins? Who can tell?
- The data points are connected, but should they be?
- The line is completely straight. Science is all about the real world and the real world almost never gives us straight lines.

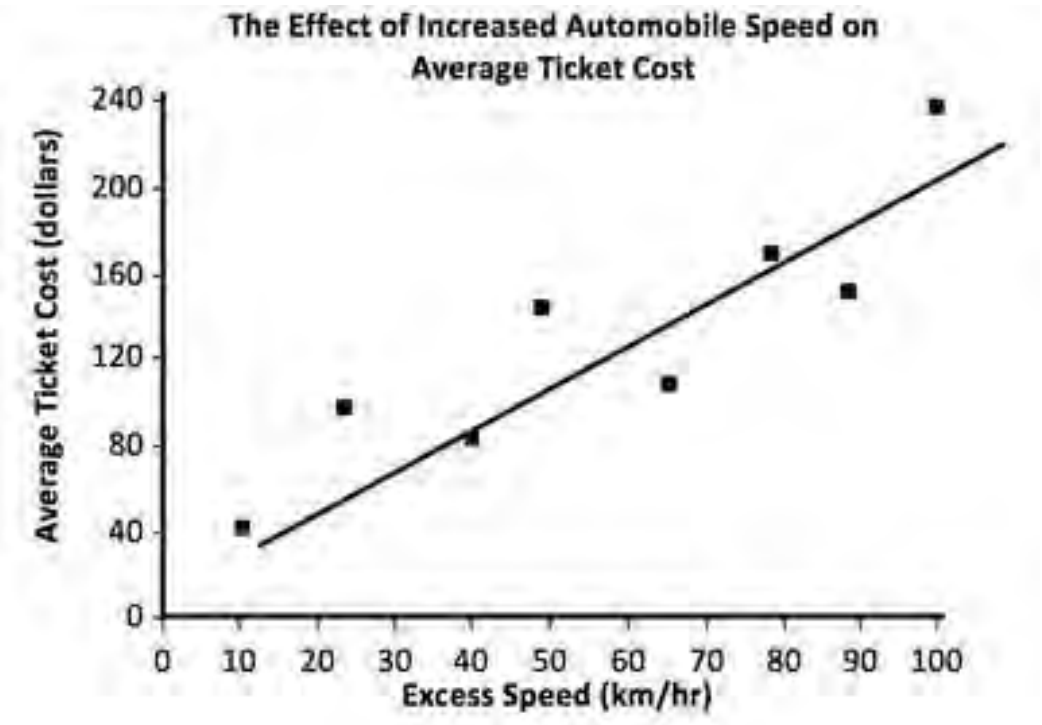
This is also a bad graph



•This one ***looks*** better, but it is still not a good graph. Let's see what's wrong with this graph:
There's a title, but it is not very informative. What's it a graph of? Who knows?
•There are still no labels on the x- or y-axis. What are those numbers? Who knows?
•Why does the y-axis apparently start below zero? And where is the zero on the x-axis?
•The data points are connect. Should they be?
•There are still no units on the x- or y-axis. Is this a graph of speed in miles per hour or a graph of temperature in Kelvins? Who can tell?

•Somebody played "connect the dots". This should be a nice straight line of best fit or a curve that tends to follow the points.

This is a good graph



- The title tells us both the independent variable and the dependent variable.
- We know what we are looking at.
- The axes are labeled correctly, including the units properly placed in the parentheses.
- The scales on both axes spread the graph out and are evenly spaced.
- Both axes start at zero.
- The data points are not connected. Instead, there is a line of best fit. This line shows that there is a possible correlation between the speed of an automobile and the cost of a ticket. *The faster you go, the more you owe!*