

## SCIENCE PROCESSES

### (Science & Technology, Scientific Inquiry, and Scientific Ways of Knowing)

All questions appeared on previous OGT Science exams or the public “practice test”.

1. A scientist’s paper is rejected by a journal because the paper did not reveal key details about the experiment she performed to get her results. What ethical argument could the editor give for this rejection? (Practice Test #1 / SWOK C)
  - A. Sample collection had been done by a graduate student.
  - B. The scientist’s findings were similar to results reported for other species.
  - C. The scientist had repeated her experiment several times with identical results.
  - D. Other scientists would not be able to verify her findings without more information.
  
2. Architects are working with engineers to build a lecture hall. How can they design it so that echoes are reduced and speech is not heard as garbled sounds? (Practice Test #2 / ST A)
  - A. build smooth marble walls, ceilings and polished floors
  - B. construct many flat walls, angled ceilings and smooth floors
  - C. use an ultramodern design of metal walls, pillars and seats
  - D. build walls out of porous materials, upholster the seats and add carpets

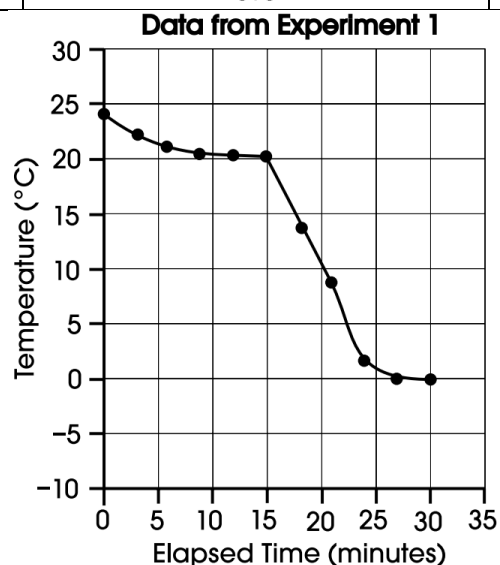
Use the following information to answer question 3.

### Temperature Experiment

Students pour 250.0 g of water into an open insulated container. The initial temperature of the water inside the container is recorded. The temperature of the contents of the container is recorded every 3.0 minutes. When 73.0 g of ice (at melting point) is added to the container, the students continue to collect temperature data and the mixture is gently stirred. The data from Experiment 1 are listed in the chart below. The data are also plotted on the following graph.

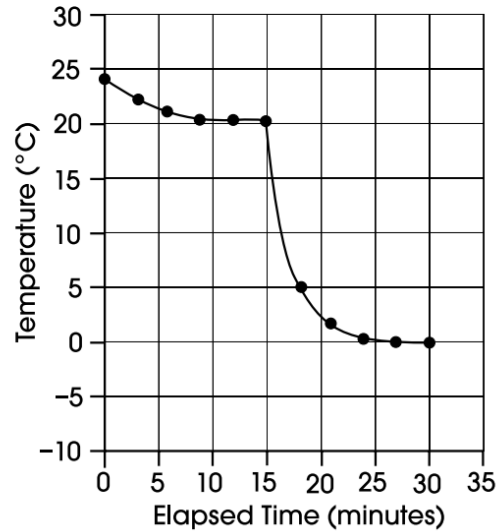
Chart for Experiment 1

Elapsed Time (minutes)	Temperature of System (°C)	Observations
0	24.3	water added
3	22.1	
6	21.0	
9	20.5	
12	20.3	
15	20.2	ice added
18	13.7	
21	8.2	
24	2.2	
27	0.0	
30	0.0	ice still present



3. In a proposed experiment using twice as much ice and half as much water as in Experiment 1, a student predicts the values shown in the graph below.

Predicted Values for Proposed Experiment



Compare the shapes of the graphed lines from Experiment 1 and the proposed experiment and explain why the predicted values are probable. Respond in the space provided **below**. (2 points) (Practice Test #6 / SI A)

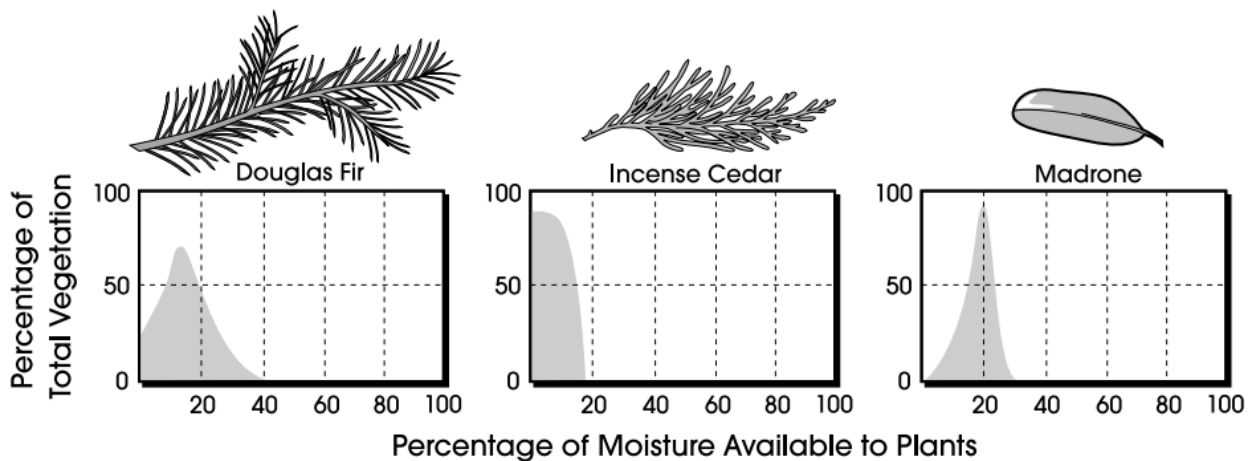
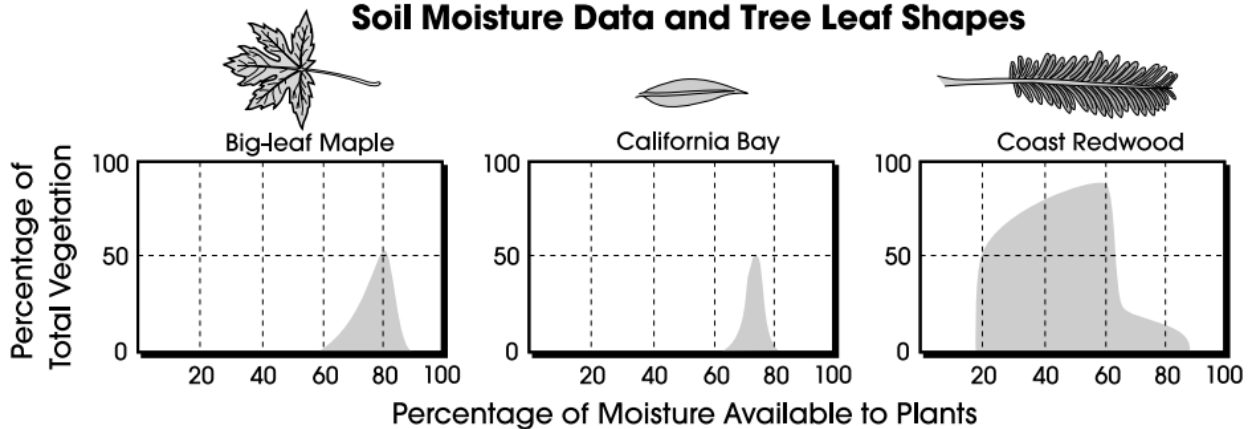
4. When a medical technician analyzes human body fluids such as blood, which safety precaution would not be necessary? (2005 #10 / SWOK D)
- A. protective gloves
  - B. safety goggles/face shield
  - C. closed-toed shoes
  - D. lead-lined apron

Use the information to answer questions 5 – 6.

### Plant Distribution

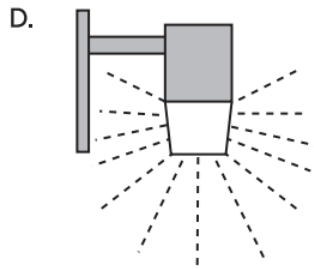
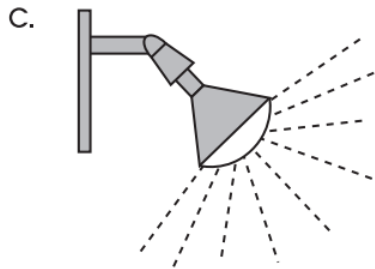
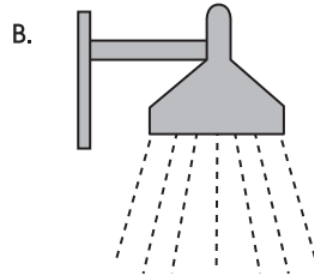
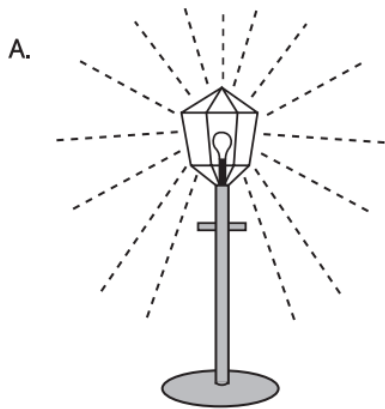
The distribution of plant species depends on many factors, including climate, topography, soil conditions and biological interactions. Data on moisture availability were collected along the coast of Northern California. In this area, each plant community has a dominant tree. The graphs below illustrate a dominant tree's percentage of the total vegetation compared to the percentage of soil moisture available. Each tree species studied has a distinct preference for a certain kind of habitat.

#### Soil Moisture Data and Tree Leaf Shapes



5. An ecologist observes that an area in California has experienced an increase in average soil moisture content. The area was once dominated by incense cedar but is now home to a greater variety of trees. Which types of trees would the ecologist most likely observe in this area if the soil moisture content has risen to 30%? (Practice Test #8 / SI A)
- A. madrone and California bay
  - B. Douglas fir and madrone
  - C. incense cedar and big-leaf maple
  - D. coast redwood and big-leaf maple
6. A survey of a small coastal valley in California finds only Douglas fir, madrone, and coast redwood. The soil moisture availability in this valley is most likely to be (Practice Test #11 / SI A)
- A. 0 – 20%.
  - B. 20 – 40%.
  - C. 40 – 80%.
  - D. 60 – 80%.
- 
7. Our country depends on energy use. Choose one alternative energy source from among wind power, nuclear power, geothermal power and biomass. Identify your choice and describe one potential benefit and one potential disadvantage if its use is significantly increased. Respond in the space provided **below**. (2 points) (Practice Test #36 / SWOK A)

8. Artificial light at night can negatively impact wildlife. Which outdoor light design minimizes the effect of the light on wildlife? (2005 #41 / ST A)



9. Biotechnology is the science of manipulating biological components to develop products that may be beneficial to humans. Identify two different industries in which biotechnology has made major contributions. Describe one contribution for each industry. Respond in the space provided **below**. (4 points) (Practice Test #24 / ST B)

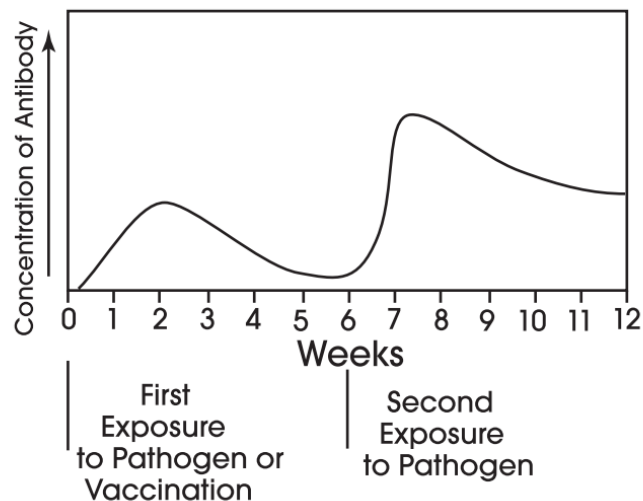
10. In 1960, physicist Theodore Maiman constructed the first working laser. This design was improved upon by Bell Telephone Laboratories in 1961. Since then, lasers have been found to have a wide variety of applications. Identify one application of laser technology and explain how this application has impacted society. Respond in the space provided **below**. (2 points) (2005 #24 / ST B)
11. Hydroelectric power is considered a clean energy source because it (2005 #40 / ST B)
- A. is available in most areas.
  - B. increases the amount of power available.
  - C. does not produce the pollutants that burning fossil fuels do.
  - D. requires minimal investment in equipment.
12. An agricultural scientist wants to determine the effect of fertilizers on corn plant growth. She selects a fertilizer to treat a soil plot where corn seeds have just sprouted. Describe an appropriate control she could use to determine whether the fertilizer affects growth of the corn plants. Explain why it is important to include this control. Respond in the space provided **below**. (2 points) (2005 #42 / SI A)

Use the following information and graph to answer question 13.

A medical researcher is investigating immune response in patients exposed to a specific pathogen. The graph below shows the concentration of a particular antibody in the bloodstream produced during the process of acquired immunity. One curve shows the primary immune response (after the first exposure to the pathogen), and the other curve shows the secondary immune response (after the second exposure to the pathogen).

A vaccination serves as the first exposure to a pathogen and triggers the body's primary immune response. Some vaccines contain weakened or inactive pathogens. Other vaccines contain highly similar but nonpathogenic forms.

Concentration of Antibody in Primary and Secondary Acquired Immune Response



13. Describe two benefits of receiving a vaccine, such as the polio vaccine, in protecting the body against disease, and include data from the graph to support each benefit. Respond in the space provided **below**. (4 points) (2005 #36 / SWOK D)

Use the information to answer questions 14 – 15.

### Cataracts

In 2004, wildlife rescuers found a great horned owl nearly dead from starvation. The owl's eyes had formed cataracts, which cloud the natural lens and inhibit the eye's ability to focus and form clear images. Cataracts can be inherited or acquired as a result of aging, disease and/or use of certain medications. Without clear vision, the owl, named Minerva, had been unable to hunt.

Minerva was taken to the Veterinary School at the University of Wisconsin, Madison, after a local veterinarian confirmed the presence of cataracts. A pair of lenses specifically made for owls was implanted in Minerva's eyes. After the surgery and a recovery period, Minerva was moved to a large, enclosed area where small rodents were released and her ability to hunt was to be evaluated. Scientists confirmed that, if she showed a clear ability to hunt, she would be released back into her natural habitat.

14. Provide two reasons why the researchers' actions in rescuing and operating on Minerva either were or were not ethical. Respond in the space provided **below**. (2 points) (2006 #7 / SWOK C)

15. All cataracts were originally thought to be acquired; however, recent research indicates that some cataracts are genetic in nature.

What type of study would be most likely to lend support to the claim that cataracts can be inherited? (2006 #10 / SWOK A)

- A. analysis of cataract thickness in several species
- B. studying age-related onset of cataracts within a species
- C. linkage studies on DNA from families with a history of cataracts
- D. comparing characteristics of cataracts caused by specific diseases

Use the following information to answer questions 16 – 18.

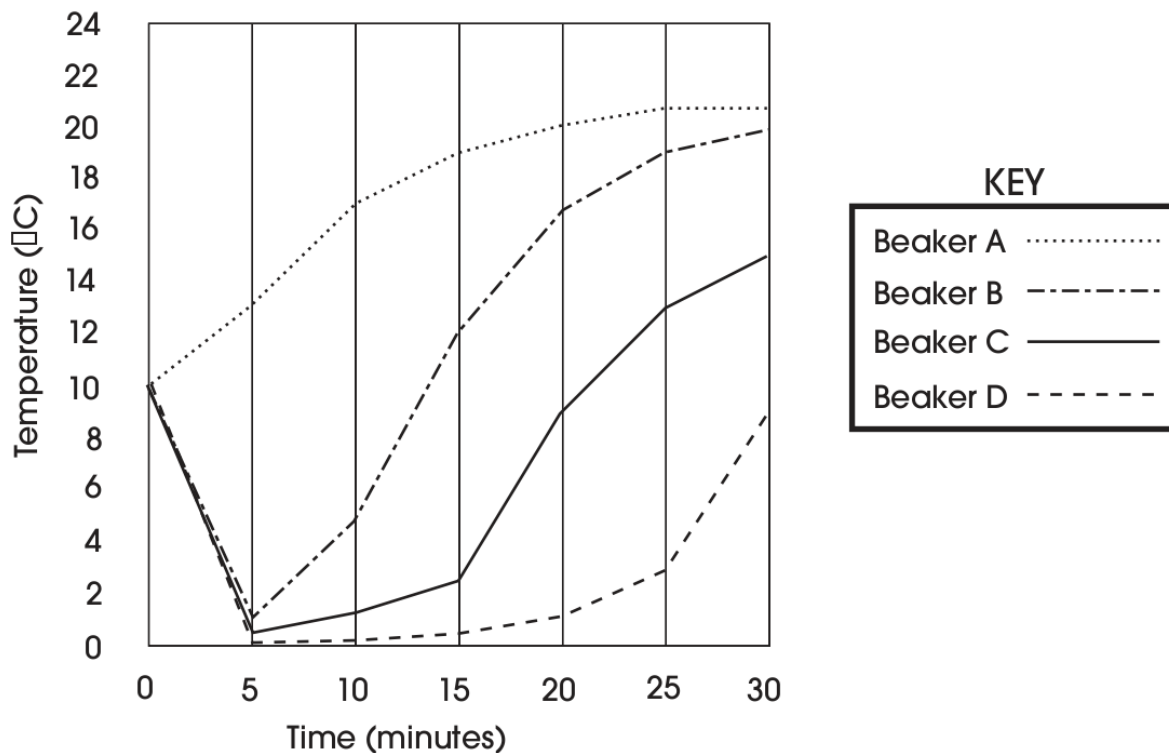
### Water Temperature Experiment

Students studied the effect of ice on the temperature of a sample of water. First, they put 500 mL of cold water (at 10°C) into each of four beakers. Next, they measured and recorded the initial temperature of the water in each beaker. Then, they added various amounts of ice as shown in the table below. They continued to measure the temperature over a period of 30 minutes. Their results are shown in the graph below. The temperature of the room during the experiment was 22°C.

Data Table

Beaker	Amount of Ice (in scoops)	Volume of Water (in milliliters)
A	0	500
B	1	500
C	2	500
D	3	500

Results of Experiment



16. Which was the dependent (responding) variable in this experiment? (2006 #11 / SI A)
- A. the temperature of the water
  - B. the amount of ice added to each beaker
  - C. the initial amount of water in each beaker
  - D. the amount of time during which observations took place
17. After reviewing these results, Archie suggested, The more ice you add to a drink, the colder the drink will become. Using data collected in the experiment, write an explanation to Archie for why his conclusion is incorrect and what effect additional ice will have on the temperature of his drink. Respond in the space provided **below**. (2 points) (2006 #13 / SI A)
18. Which was the independent (manipulated) variable in this experiment? (2006 #14 / SI A)
- A. the amount of water in each beaker
  - B. the amount of ice added to each beaker
  - C. the initial temperature of the water in each beaker
  - D. the amount of time during which observations took place
-

19. A medical research group placed the following advertisement in a newspaper:

**Seeking Volunteers for Medical Research Study**

Volunteers are needed to participate in a 12-week research study to test a new drug for type 2 diabetes. Participants must be between the ages of 18 and 80 and must not be taking more than one oral medication for diabetes. The following will be provided to participants at no cost:

- Medical evaluations (physical exam)
- Diagnostic testing (blood & urine tests)
- Experimental study medication
- Compensation for time and travel expenses

If you are interested in participating, please contact Rudy at 1-808-555-5000.

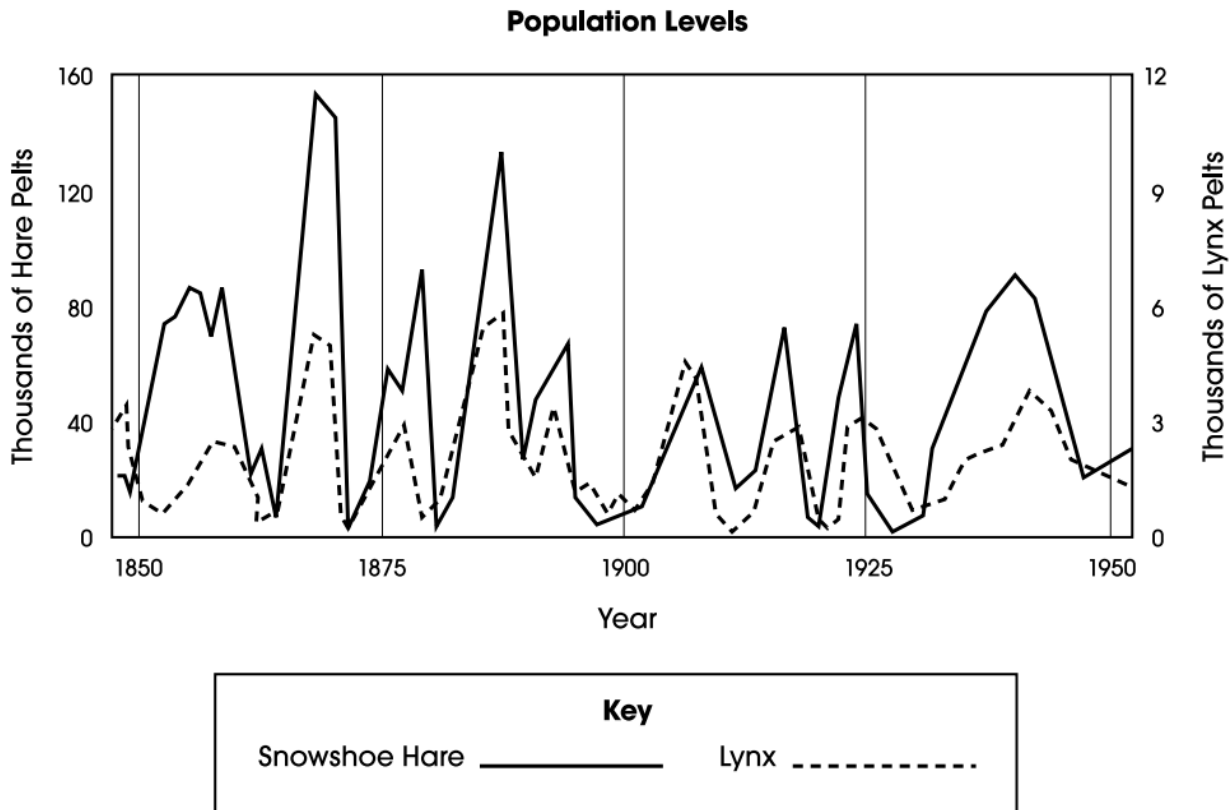
In order for potential participants to make a medically sound decision, what is the research group's ethical obligation? (2007 #17 / SWOK C)

- A. Pay all participants' health insurance costs during the entire course of the study.
- B. Inform participants of the exact amount of compensation they will be receiving.
- C. Provide participants with a list of additional studies that may be relevant to their condition.
- D. Disclose all medical procedures and provide information on risks and potential side effects.

Use the information to answer question 20.

### Hare and Lynx Populations

In a classic study of predator-prey interactions, the numbers of snowshoe hare pelts and lynx pelts sold to a trading company by trappers were recorded over a period of 100 years. Both lynx and hare populations appear to oscillate in a regular pattern over a period of about ten years. One explanation for this pattern is that heavy predation reduces the snowshoe hare population, which in turn reduces the lynx population. More recently, scientists have proposed that the hare population oscillates due to diseases caused by overcrowding or by the effects of its own feeding activities on vegetation.



20. One assumption about the data used in this study is that (2007 #43 / SI A)

- A. oscillations in population size occur every ten years.
- B. the number of pelts reflects the size of the populations .
- C. snowshoe hares have an impact on their food supply.
- D. hares and lynx were trapped over a period of 100 years.

21. Telemedicine is defined as the practice of medicine from a distance. It allows doctors to communicate with patients and other health care workers from a remote area. Early ways of transmitting medical information included the postal service and telegraph. Identify two advances in technology that have improved the speed and accuracy of modern telemedicine. Explain how each improves the ability of doctors to treat or diagnose patients.

Respond in the space provided **below**. (4 points) (2006 #25 / ST B)

22. Engineers are designing an auditorium that will be used for performances by orchestras.

What must they do to maximize the loudness of the sound heard by the audience?  
(2006 #40 / ST A)

- A. hang curtains behind the orchestra
- B. put carpet all around the walls of the auditorium
- C. hang reflecting panels from the ceiling behind the orchestra
- D. install narrow glass windows and skylights around the top of the walls

23. *Bacillus thuringiensis* (Bt) is a bacterium that contains a gene that results in the production of a natural pesticide that kills insects. Genetic engineers have successfully inserted this Bt gene into the DNA of some corn varieties, allowing the corn to produce its own pesticide.

What negative consequence could result from this technology? (2007 #34 / ST B)

- A. Only corn that is resistant to the Bt gene will survive.
- B. Individual insects that eat the genetically modified corn will develop resistance to Bt.
- C. The genetically modified crops will insert this Bt gene into the DNA of humans that eat the corn.
- D. Only Bt resistant insects will survive to reproduce, eventually producing a population of entirely resistant individuals.

24. Scientists have written computer programs to model populations of organisms within ecosystems. By changing initial numbers of individuals and survival rates, these programs can simulate what will happen to members of the ecosystem over time.

Explain how computer modeling could be valuable to an ecologist studying a forest ecosystem. Speculate on why this type of data can only be gained by using a computer program. Respond in the space provided **below**. (2 points) (2007 #28 / ST B)

25. A university student wants to perform an experiment using mice as test subjects. The procedure would require the mice to be injected with a specific bacterial infection and then treated with an antibiotic. Their response to the treatment would be observed and recorded . Provide two questions that an ethics review board would raise regarding the proposed work. For each question, explain why it is important that the question be answered prior to granting permission for the experiment. Respond in the space provided **below**. (4 points) (2007 #33 / SWOK C)

26. The water level in a graduated cylinder rises from 10 cm<sup>3</sup> to 35 cm<sup>3</sup> when a solid lead ball is added. What is the approximate volume of the lead ball? (2005 #44 / SI A)

A. 3.5 cm<sup>3</sup>

B. 25 cm<sup>3</sup>

C. 35 cm<sup>3</sup>

D. 45 cm<sup>3</sup>

27. Some strains of laboratory mice have been inbred for many generations, resulting in large numbers of mice with nearly identical genetic makeup. Explain an advantage of using these mice in designing an experiment to test the effects of a new drug. Compare this to a test using mice with varied genetic makeup. Respond in the space provided **below**. (2 points) (2007 #37 / SI A)

Use the information to answer question 28.

### Himalayan Rabbits

Himalayan rabbits are native to the Himalayan Mountains, where a great deal of snow falls annually. These rabbits have white fur over most of their bodies, with black fur on the ears, noses, feet and tails. This color pattern results from temperature differences in different parts of the rabbits' bodies. Areas where the body temperature is below  $33^{\circ}\text{C}$  the fur grows in black.

To demonstrate this color change, a scientist shaved a small area of fur on the backs of adult Himalayan rabbits. Ice packs were kept on the shaved areas long enough for the rabbits' fur to begin growing back. When the ice packs were removed, the fur growing beneath them was black.

Before Experiment



After Experiment



28. Suppose the same scientist wanted a Himalayan rabbit with white feet. Which procedure would most likely generate these results? (2007 #39 / SI A)

- A. place ice packs on the rabbit's feet
- B. place the rabbit outside on a sunny day
- C. place the rabbit outside when it is snowing
- D. place the rabbit in a cage with a heated floor

29. The pesticide DDT was at one time referred to as a miracle pesticide. Its widespread use in the United States peaked in 1959, but then usage steadily declined until its ban in late 1972. Reasons for declining usage included increased insect resistance and public concern over potentially harmful environmental effects.

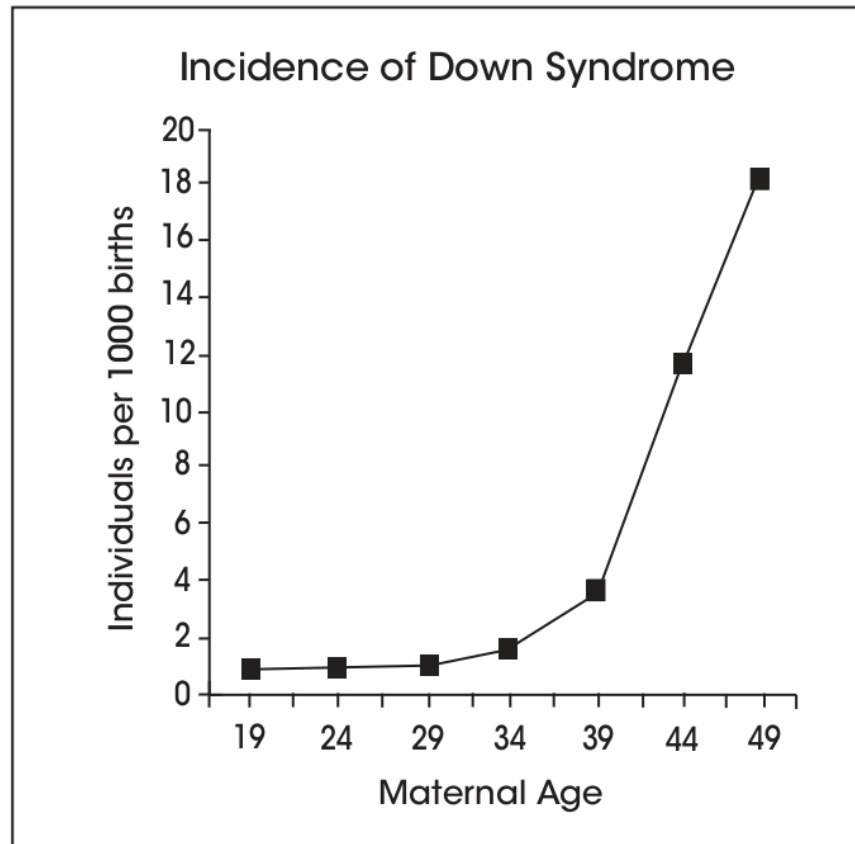
How did this concern affect the field of agricultural science? (2008 #8 / ST B)

- A. It led to the development of equally harmful herbicides.
- B. It encouraged farmers to violate the ban and increase the use of DDT.
- C. It led to the development of more effective, alternative pesticides.
- D. It encouraged farmers to reduce the number of crops grown in their fields.

30. Individuals suffering from debilitating and sometimes terminal diseases often advocate a more rapid development cycle for approving new drug treatments. If the development cycle is accelerated, describe one potential benefit and one potential hazard of treating a disease.

Respond in the space provided **below**. (2 points) (2008 #18 / SWOK C)

31. The graph below shows the relationship between maternal age and the incidence of children born with Down syndrome (a condition that results in an individual having an extra chromosome 21).

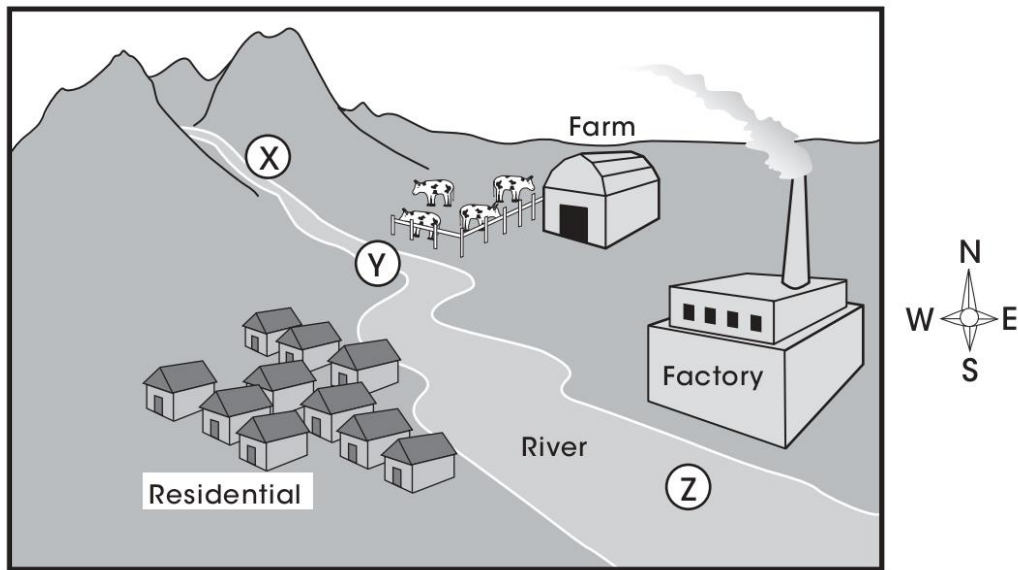


What conclusion is best supported by the data? (2008 #19 / SI A)

- A. There is no risk of Down syndrome in children born to mothers under age 34.
- B. The risk of Down syndrome increases dramatically in children born to mothers after age 34.
- C. The risk of Down syndrome doubles in children born to mothers for each year over the age of 34.
- D. There is no correlation between the number of Down syndrome births and age.

32. Environmental monitoring of a lake located to the southeast of a factory has shown a consistent decrease in pH over the period of a year. A researcher investigating the pH change hypothesizes that either a factory or a farm along the river is responsible for the pH change. The river flows into the lake.

**pH Sampling**



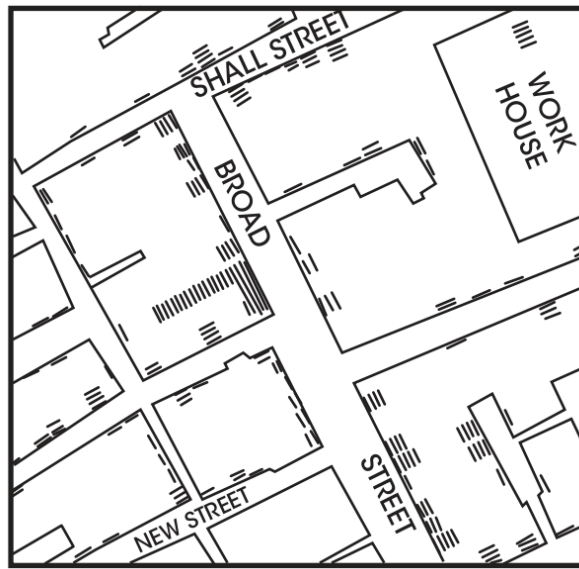
The researcher collects a water sample from locations Y and Z in the diagram and runs pH analyses on each sample. He finds that the pH in sample Z is lower than the pH in sample Y and concludes that the factory is responsible for the low pH values in the lake.

Based on the diagram and the researcher's investigation, provide two reasons why this may not be a valid conclusion. Describe how each reason could invalidate the conclusion.

Respond in the space provided **below**. (4 points) (2008 #35 / SI A)

33. In 1854, a cholera epidemic spread throughout parts of London causing hundreds of deaths. Physician John Snow, in investigating the epidemic, plotted the locations of cholera-related deaths on a map of the city. Numbers of deaths are indicated by parallel lines in front of buildings where deaths occurred.

### Locations of Cholera Deaths



How did the data obtained from Snow's map most likely assist city officials in stopping the cholera epidemic? (2008 #39 / SWOK B)

- A. It allowed them to verify the exact number of cholera-related deaths.
- B. It allowed them to determine the average age of the individuals infected.
- C. It allowed them to predict the rate at which the epidemic would continue to spread.
- D. It allowed them to pinpoint the area most affected and determine the source of infection.

34. When submitting research proposals to funding agencies, investigators must follow ethical guidelines.

What information in a research proposal would be considered bogus and lead to rejection of the proposal? (2008 #2 / SWOK C)

- A. plan for monitoring safety
- B. estimates of the number of participants required for the study
- C. data from experiments that have not been performed
- D. projected budget for equipment and laboratory personnel

35. Significant progress has been made in the development of oxygen-carrying solutions that may replace whole blood. Describe two reasons why researchers are so interested in developing artificial blood to replace the use of whole blood.

Respond in the space provided **below**. (2 points) (2008 #40 / ST B)

36. If you were working for the Center for Disease Control and discovered a new, highly dangerous pathogen, what information should be presented to the public that may prevent a widespread epidemic of the disease? (2009 #3 / SWOK D)

- A. the fatality rate caused by the pathogen
- B. a report on how the pathogen is transmitted from one organism to another
- C. pictures showing microscopic images of the pathogen so they will be familiar with it
- D. a description of the surface receptors found on the pathogen and the immune response

37. Companies seeking new drug approval are required to conduct clinical trials involving human volunteers. During these trials, people with the disease are separated into different groups. One group receives a placebo (an inert or harmless substance used in controlled experiments). Each of the remaining groups receives a different dose of the drug (i.e., Group A receives a 30 mg dose once a day, Group B receives a 50 mg dose once a day, etc.).

Describe two reasons for testing new drugs at varying doses.

Respond in the space provided **below**. (2 points) (2009 #18 / SWOK C)

38. Some coal-burning power plants install “chemical scrubbers”. These scrubbers reduce the amount of sulfur dioxide ( $\text{SO}_2$ ) that is released when coal is burned.

How does installation of these scrubbers benefit the environment? (2009 #19 / ST B)

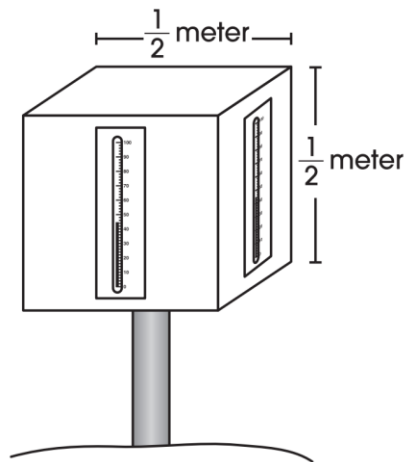
- A. reduce the amount of acid rain
- B. reduce the amount of coal mined
- C. increase the amount of atmospheric  $\text{CO}_2$
- D. increase the amount of ground level ozone

Use the information and illustration to answer question 39.

### Solar Warming

A group of students in Ohio conducted an investigation during the month of January to study the effects of solar warming. The students used a wooden box painted white. The box was mounted on a post in an open area and a thermometer was fastened on each of the four sides. The box was oriented so that each thermometer faced squarely in a different direction: north, south, east or west. The temperature on each thermometer was recorded in degrees Fahrenheit at 12:00 noon during five consecutive days of clear skies.

The picture shows the apparatus used by the students.



The table shows the data collected by the students.

**Effects of Solar Warming (Temperature in °F)**

	North	South	East	West
<b>Day 1</b>	29	36	32	32
<b>Day 2</b>	29	36	32	31
<b>Day 3</b>	30	37	34	33
<b>Day 4</b>	27	34	32	30
<b>Day 5</b>	30	37	35	33

39. Based on the data, which statement best summarizes the effects of solar warming in January? (2009 #23 / SI A)

- A. Solar warming at noon is greatest on south-facing surfaces.
- B. Solar warming is greatest in January when the weather is clear.
- C. Solar warming in Ohio is greatest in the northern part of the state.
- D. Solar warming increases from the west side of Ohio to the east side of Ohio.

40. A teacher gives a student a non-toxic, odorless, white powder to identify. Generate four questions, each regarding a different property of the unknown powder, that could be safely tested and answered in the laboratory.

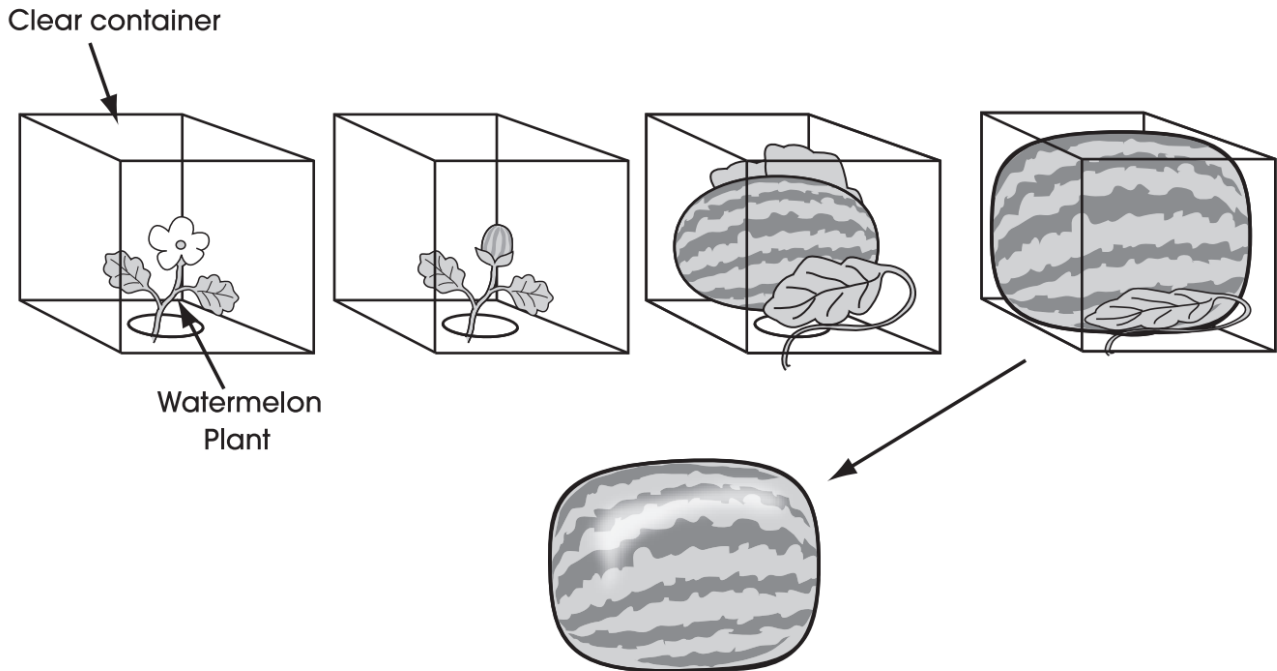
Respond in the space provided **below**. (4 points) (2009 #35 / SI A)

41. An aquatic ecologist collects data about the water quality of an Ohio lake throughout the year. In the summer, the ecologist shares data with a public health official from a nearby town.

Which data would a public health official use to determine whether the water was safe for swimming? (2009 #27 / SWOK A)

- A. the temperature of the surface water
- B. the amount of dissolved oxygen in the deep water
- C. the number of water lilies, *N. odorata*, growing in the lake
- D. the concentration of *E. coli* bacteria near the surface of the lake

42. In a recent agricultural experiment, farmers in Japan inserted fertilized watermelon blooms into square containers, which resulted in the fruit taking the shape of its container as it grew.



Describe two benefits of farming practices that produce square watermelons.

Respond in the space provided **below**. (2 points) (2009 #40 / ST B)