UNIT FOUR

GENERAL SCIENCE SKILLS

SKILL AREA 1
SAFETY IN THE SCIENCE CLASSROOM

Working in a science classroom can be great fun, but there are many safety rules (procedures) you must follow.

FOLLOWING DIRECTIONS
Make sure you read all rules for laboratories before beginning any science investigation.

CHEMICAL SAFETY
- Treat all chemicals as harmful.
- Avoid direct contact with your hands.
- Wear safety glasses at all times.
- Dispose of chemicals as outlined by the teacher.
- If a chemical needs to be smelled, use your hand in a wafting motion toward your nose. Do not inhale the fumes of the chemical all at once. This could irritate your lungs.
- Ask the teacher what to do if there is a chemical spill.
- You should not eat any food (gum included) in a lab.
- Do not mix chemicals together unless specified by the teacher. When mixed together, certain chemicals can release toxic fumes. Some chemicals might be so reactive that they can explode, causing harm to you and others.

GLASS SAFETY
- Do not place heated glass on a cold surface. The sudden change in temperature may cause the glass to crack.
- Lubricate glass rods before placing through a rubber cork. Use a gentle twisting motion to move the tube through the cork.
- Heat test tubes so that the open end faces away from you and others.
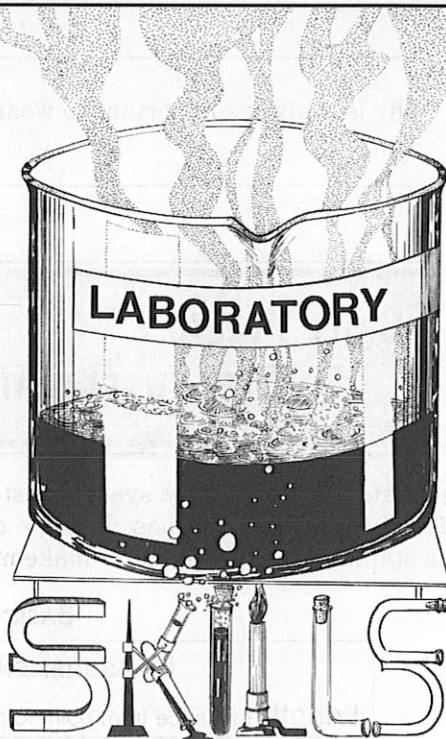
OPEN FLAMES SAFETY
- Never reach over an open flame. If not using the open flame, turn it off and relight it only when needed.

EYE SAFETY
- Always wear safety glasses when required.

CLOTHING SAFETY
- Avoid loose clothing.
- Pull long hair back in order to avoid contact with chemicals or an open flame.
- Wear aprons if provided by your school.

ELECTRICAL SAFETY
- Use dry hands when plugging wires into sockets.

WORK AREA SAFETY
- Keep your work area uncluttered, clean, neat, and organized.
- Have only the equipment you need for the investigation in your work area.

1   Why is it important to follow all directions when working in a laboratory? _____

_____

_____

2   Describe two safety procedures to follow when handling chemicals. _____

_____

_____

3   Why is it always important to wear safety glasses in a laboratory when it is required? _____

_____

SKILL AREA 2
MEASUREMENT IN THE SCIENCE CLASSROOM

Scientists use the **metric system** instead of the English system. In fact, the metric system is used by most countries of the world. It is based on the **decimal system**. Prefixes (see table at bottom of the page) are used with the standard measurement to make measures.

BASIC UNITS OF METRIC MEASUREMENT

MEASUREMENT	BASIC UNIT
Length (distance from point to point)	meter (m)
Mass (amount of matter)	kilogram (kg)
Volume (space matter occupies)	liter (L)
Temperature (average kinetic energy in matter)	Celsius or Kelvin(C or K)
Weight/Force (push or pull)	Newton (N)
Work (force applied through a distance)	Joule (j) or Newton-meter (N-m)
Power (work per unit of time)	watt (W)
Speed (distance per unit of time)	meter per second (m/s)
Acceleration (speed per unit of time)	meter per second squared (m/s^2)

BASIC UNITS OF METRIC MEASUREMENT

Some basic units and what they measure are summarized in the table above and some common prefixes are given at the right.

COMMON PREFIXES

PREFIX	VALUE OF BASIC UNIT
nano-	0.000 000 001
milli-	0.001
centi-	0.01
giga-	1 000 000 000
mega-	1 000 000
kilo-	1 000

4   What is the basic unit for: *a* mass? _____

    b distance? _____   *c* volume? _____

5   One gram is equal to _____ kg

EQUATING METRIC & ENGLISH UNITS

METER

- A **meter** (m) is a little longer than a yard. It is equal to 39.37 inches.
- One inch is is equal in length to 2.54 **centimeters** (cm) .
- A **kilometer** (km) is about 0.6 miles or think a little longer than half a mile.

LITER

- 1 **liter** (1,000 milliliters, mL) is equal to 1.1 quarts – a little more than a quart.
- 1 ml = 1 cm³ This means that a cube with a 1 cm side can hold exactly 1 mL of volume.
- 250 ml is equal to about 1 cup.

CELSIUS

The best way to remember the **Celsius** temperature scale (metric) is to use reference points to **Fahrenheit** (English). Water boils at 100°C (212°F) and freezes at 0°C (32°F). Body temperature is 37°C (98.6°F). A comfortable room temperature is about 22°C (72°F).

You can convert Celsius to Fahrenheit with the following formula:

$$°C = \frac{5}{9} \times (°F - 32)$$

SAMPLE PROBLEM

If the temperature is 212°F, what is the Celsius temperature?

$$°C = \frac{5}{9} \times (212°F - 32) = \frac{5}{9} \times (180°F) = 100°C$$

The **Kelvin** temperature scale is also a metric scale. It begins at **absolute zero** (the temperature at which no heat can be transferred out of matter). Water freezes at 273°K and boils at 373°K.

GRAM

- A **gram** (g) has a mass of about one small aluminum paper clip or one M&M candy. It is about 0.04 ounces.
- A **kilogram** (kg) is equal to 2.2 pounds. Think of your weight in terms of a little more than one-half your weight in pounds and you have your mass in kilograms.

NEWTON

The **newton** (N) is used to measure force. It is the amount of force required to accelerate a mass of one kilogram one meter per second per second.

- 9.8 Newtons = 1000 grams of force
- 4.5 Newtons = 1 pound of force

6   What would happen to the size of a football field, if it measured 100 meters instead of 100 yards? _____

_____

7   a   Would you be running a fever if your temperature was 38°C? _____   b   Explain. _____

_____

8   a   Will a liter of milk fit nicely into a cup? _____   b   Explain. _____

_____

_____

9   Mass (weight) is measured in _____ (metric).
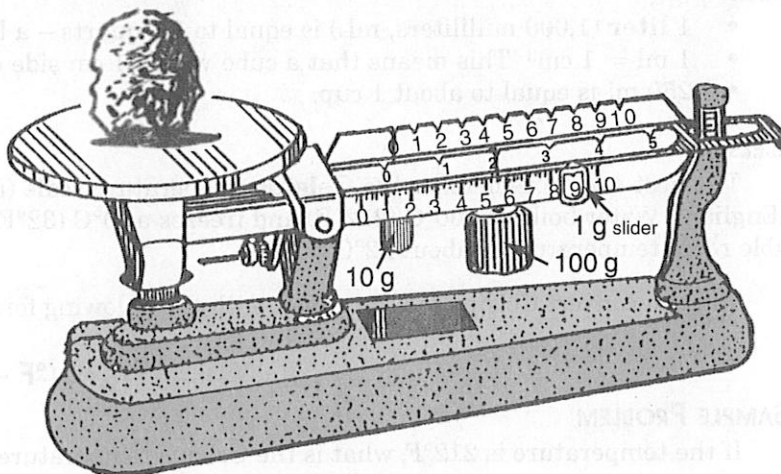
TRIPLE BEAM BALANCE

A beam balance is used to measure mass.

For example, the mass of the item in the diagram is determined by adding together the mass of each slider scale.

10   What is the mass of the object pictured on the triple beam balance?

_____

11   What measurement is made with a

triple beam balance? _____

12   Explain how to use a triple beam balance. _____

_____

GRADUATED CYLINDER

A **graduated cylinder** is used to measure volume. Each calibration in the graduated cylinder shown in the diagram is equal to 1 mL. The value of the liquid is read at the **meniscus** (the lowest level of the liquid).
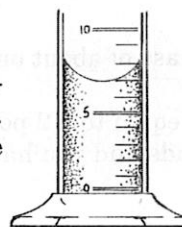
13   What is the volume of the liquid in this cylinder? _____

14   Explain how to read the measurement on a graduated cylinder. _____

_____

15   Explain how to determine the volume of an irregularly shaped object.

_____
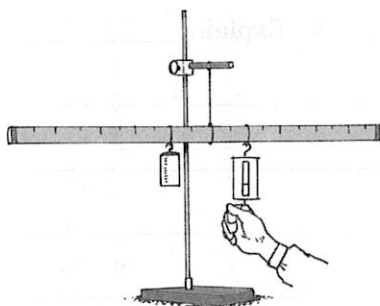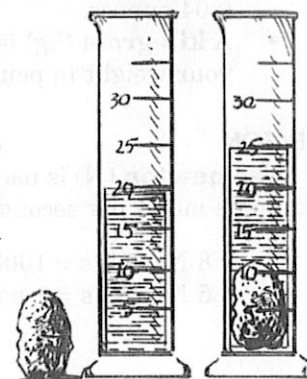
A graduated cylinder can be used to determine the volume of an irregularly shaped solid such as a rock. The volume of the object is equal to the amount of water it displaces. For example, if the starting volume of the water is 20 mL and the final volume is 25 mL, then the volume of the object is 5 mL.

SPRING SCALE

A **spring scale** measures force (at right) or weight (at left). A kilogram or 1000 g is equal to 9.8 Newtons or about 10 N.
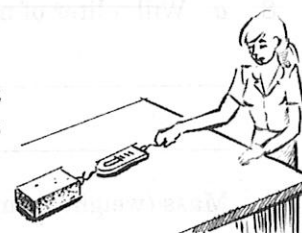
VOLTMETER

A **voltmeter** measures voltage or potential difference which is measuring the "push" from the flow of electricity. Voltmeters are adjusted for whether the voltage is direct current ("DC" – voltage from a a battery) or alternating current ("AC" – current from a generator). Your teacher should show you how to use a voltmeter.

METRIC RULER

A **metric ruler** measures length. Each small unit is equal to a millimeter. There are 10 mm in each segment shown.
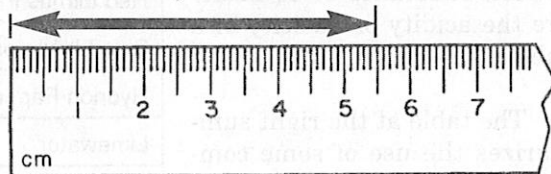
16 What is the distance shown on the metric ruler? _____

The volume of some regularly shaped objects can be determined by using a metric ruler. For example, the volume of all rectangular blocks is determined by the formula:

Volume = Length x Width x Height.   v = l x w x h

17 *a* What is the volume of the block shown below? _____
    b Show work in space provided below and be sure to show the measuring units as cm³.
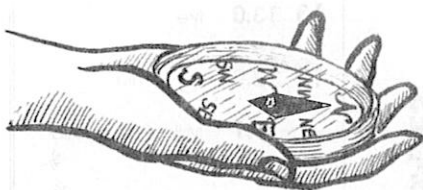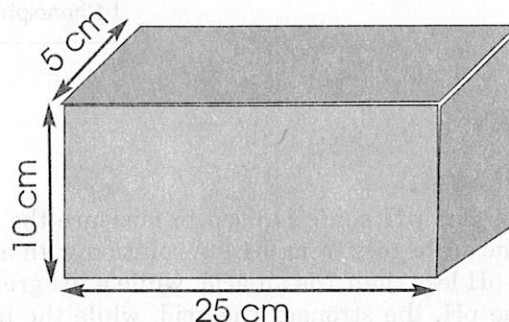
MAGNETIC COMPASS

A **magnetic compass** shows cardinal directions N, S, E, W. The magnetic needle points to the magnetic north pole of Earth. This compass is showing a north (N) orientation.

STOP WATCH

A **stop watch** can be used to make precise time observations and measurements.

THERMOMETER

Scientists use metric thermometers. Metric temperature can be measured in Celsius or Kelvin. The temperature chart at the right compares the three temperature scales: °Fahrenheit (English system) to °Celsius to Kelvin.

18 At what temperature does water freeze? _____°F _____°C _____K

19 At what temperature does water boil? _____°F _____°C _____K

20 What is the human body's normal temperature? _____°F _____°C

21 What is 140° F in Celsius degrees? _____°C Kelvin? _____K
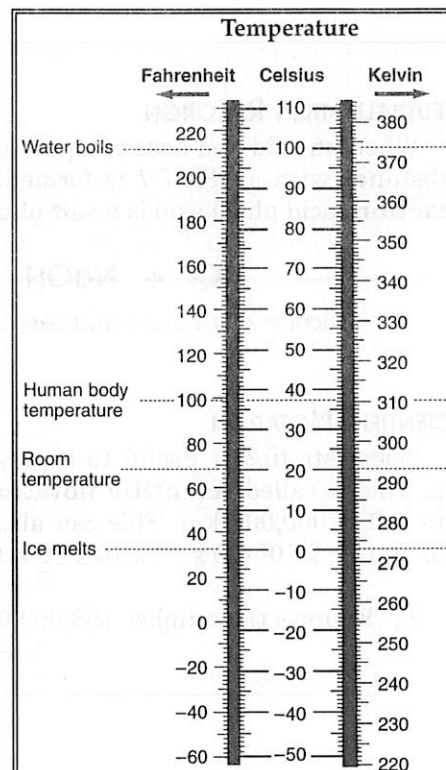
Scientists use **indicators** to determine the presence of a certain substance or to measure the acidity or basicity of a substance.

The table at the right summarizes the use of some common indicators.

TESTING INDICATORS

| INDICATOR	POSITIVE TEST
Red Litmus Paper	turns blue in presence of a base
Blue Litmus paper	turns red in presence of an acid
Hydrion Paper	pH* less than 7 indicates acid; pH greater than 7 indicates base
Limewater	turns cloudy in presence of carbon dioxide
Bromthymol Blue	turns yellow in presence of carbon dioxide
Iodine	turns blue black in presence of starch or cellulose
Universal Indicator	pH less than 7 indicates acid; pH greater than 7 indicates base
Benedict's Solution	turns light green to brick red in presence of sugar
Methylene Blue	stains DNA
Phenolphthalein	turns pink in presence of base

pH SCALE

The **pH scale** is used to measure the strength of an **acid** or a **base**. The scale goes from 0-14. A solution with a pH of 7 is considered **neutral**. A pH less than 7 is an acid, while a pH greater than 7 is a base. The lower the pH, the stronger the acid, while the higher the pH, the stronger the base.

22 Give an example of a solution with a high pH. _____

23 Give an example of a solution with a low pH. _____

pH SCALE
Acid & Base Identification

BASES	14	
	13 13.0	lye
	12.2	lime
	12 12.0	ammonia
	11 11.1	Milk of Magnesia
	10	
	9	
	8.5	sea water
	8 8.1	Baking Soda
	8.0	Lake Ontario water
NEUTRAL	7 7.0	distilled water
	6	
	5.6	unpolluted rain
	5 5.0	tomatoes
Acid Rain	4	
	3.5	orange juice
	3 3.0	carbonated drinks
	2.8	vinegar
	2 2.0	lemon juice
	1.2	sulfuric acid
	1 1.0	hydrochloric acid
	1.0	battery acid
	0	

NEUTRALIZATION REACTION

When an acid and base of equal concentration are combined, a neutral substance with a pH of 7 is formed. The product of a **neutralization reaction** (acid plus base) is a salt plus water. Example:

$$HCl + NaOH \rightarrow NaCl + H_2O$$
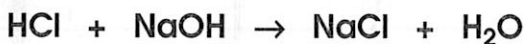
Hydrochloric Acid + Sodium Hydroxide (base) → Sodium Chloride (salt) + water

SCIENTIFIC NOTATION

Scientists find it useful to express very large numbers as powers of ten. This is called **scientific notation**. For example, the distance to the Sun is 148,000,000 km. This can also be expressed using scientific notation as 14.8×10^7 (10 x 10 x 10 x 10 x 10 x 10 x 10).

24 Express the number 158,000,000,000 in scientific notation.

_____

SOLVING LINEAR EQUATIONS

Scientists often use **mathematics** to describe order in the natural world. The following steps are useful when applying a mathematical equation.

1   Decide which equation is appropriate.
2   Solve for the **unknown** by plugging in the known values.
3   Use the correct units when expressing the answer.

SAMPLE PROBLEM

What is the density of a block of wood that has a mass of 50 g and a volume of 100 cm^3?

1   **Write the formula**:   Density = Mass/Volume
2   **Plug in the values**:   Density = 50 g/100 cm^3
3   **Solve**:   Density = 0.5 g/cm^3

The formula for speed is $$\text{Speed (s)} = \frac{\text{distance (d)}}{\text{time (t)}}$$

25   a   What is the speed of a car that travels 400 km in 3 hours? _____
     b   Show all work in the space provided below.

STATISTICS

Scientists use statistics to help determine the validity of data.

PERCENTAGE OF ERROR

The **percentage of error** compares data (observed value) to a standard value. For example, you took an exam and received a grade of 90%. All scientists are interested in the size of their error. If you received a grade of 90% on the exam, it means you had a 10% error. Mathematically, percent of error can be expressed as

$$\text{Percentage Error} = \frac{\text{difference between your value and a standard value}}{\text{standard value}} \times 100$$

SAMPLE PROBLEM

What is the percentage of error, if you measure the density of aluminum and find it to be 2.9g/cm^3 while the standard value is 2.7g/cm^3? Plug in the given information and solve. Remember, always subtract the lower value from the higher value. You cannot have a negative value for percent of error.

$$\text{Percentage Error} = \frac{0.2 \text{ g/cm}^3 \text{ or } (2.9\text{g/cm}^3 - 2.7\text{g/cm}^3)}{2.7\text{g/cm}^3} \times 100 = 7.4\%$$

26   What is the percentage of error if the length of a room was estimated to be 15.5 m and when measured,

the length turned out to be 14 m? _____ %

MEAN

The **mean** is the value obtained by dividing the sum of a set of quantities by the number of quantities in the set, or in other words, the average. Mathematically, the mean is expressed with the following formula:

$$\text{Mean (Average)} = \frac{\text{Sum of the Trials (samples)}}{\text{Total Number of Trials}}$$

Suppose a student was studying the effects of fertilizers on the growth of bean plants. The length of the primary stalks was measured and recorded in the data table at the right for both groups of bean plants (with and without fertilizer).

EFFECTS OF FERTILIZER ON BEAN PLANT GROWTH

PLANT WITH FERTILIZER	HEIGHT (CM)	PLANT WITHOUT FERTILIZER	HEIGHT (CM)
A	9	A	6
B	7	B	5
C	8	C	7
D	7	D	8
E	7	E	6
F	9	F	6
G	10	G	7

What is the mean growth of each group of bean plants?

$$\text{Mean (Average) Plants with Fertilizer} = \frac{9 + 7 + 8 + 7 + 7 + 9 + 10}{7} = \frac{57}{7} = 8.14 \text{ cm}$$

$$\text{Mean (Average) Plants No Fertilizer} = \frac{6 + 5 + 7 + 8 + 6 + 6 + 7}{7} = \frac{45}{7} = 6.43 \text{ cm}$$

MODE:

The mode is the sample size that occurs most frequently. In the case of the plants that received fertilizer, the mode was 7, while the mode for the group that did not receive fertilizer was 6.

MEDIAN:

This is the score that occurs in the middle of a sample of data that is ranked from lowest to highest.

After ranking the fertilizer group:
7 7 7 8 9 9 10, it can be seen that 8 is the median.

After ranking the non-fertilizer group:
5 6 6 6 7 7 8, it can be seen that 6 is the median.

SPEEDS OF TOY CAR

TRIAL	SPEED (CM/S)
1	10
2	12
3	12
4	11
5	9
6	12
7	8

27 What are the mean, mode, and median of the speeds of a toy car recorded in the data table at the right?

a mean _____

b mode _____

c median _____

SKILL AREA 5
SKILLS FOR THE LIVING ENVIRONMENT

DEVELOP & USE A DICHOTOMOUS KEY

CLASSIFY THINGS ACCORDING TO A STUDENT GENERATED SCHEME AND AN ESTABLISHED SCHEME

Scientists often organize the natural world by **classifying** or grouping living and nonliving thing. Classifying looks more closely at how things are similar (placed in the same group) or different (placed into separate groups).

One way to organize things is through the use of a **dichotomous key**. In a dichotomous key, things are organized by arranging them based on their traits or characteristics. A dichotomous key is a series of couplets that describe two different sets of characteristics. Choosing the set of characteristics that fits the object you are examining leads you to further couplets and further choices. This continues until the object you are examining is identified. Each couplet has two choices, that is why it is called a dichotomous key (di, meaning two).

For example, you are trying to organize all the vertebrates (animals with back supporting structures) into groups. How would you classify humans? Use the following dichotomous key to determine the answer.

Directions: Read couplet 1 and choose A or B. Follow the directions until you find how humans are classified.

A KEY TO THE CLASSES OF VERTEBRATES

	Couplet	Description	
1	A	Legs and arms as fins; one or more pairs of gill slits	go to 2
	B	Legs and arms not as fins; legs usually present	go to 4
2	A	Fins not in pairs; no scales; round mouth	Class Agnatha
	B	Some paired fins; scales; mouth with jaw	go to 3
3	A	Skeleton of cartilage	Class Chondrichthyes
	B	Skeleton of bone	Class Osteichthyes
4	A	Body smooth; no scales; no claws	Class Amphibia
	B	Body covered with scales, feathers, hair or fur	go to 5
5	A	Body covered with scales or in shell; no feathers, hair or fur	Class Reptilia
	B	Feathers, hair or fur present	go to 6
6	A	Body covered with feathers	Class Aves
	B	Hair or fur present on body	Class Mammalia

CLASSIFY HUMANS

Read the first couplet. Which of the descriptions, A or B, fits humans? . . . _____
   Since humans have legs and arms you should have chosen 1B.
1B sends you to couplet 4.

Read couplet 4. Which of the descriptions, A or B, fits humans? . . . . _____
   Since humans have hair you should have chosen 4B.
4B sends you to couplet 5.

Read couplet 5. Which of the descriptions, A or B, fits humans? . . . . _____
   Since humans have hair you should have chosen 5B.
5B sends you to couplet 6.

Read couplet 6. Which of the descriptions, A or B, fits humans? . . . . ._____

Since humans have hair you should have chosen 6B.

6B leads you to our answer. Humans are in the Class Mammalia, mammals.

****

28 The diagram on the opposite page represents ten types of fish that are found in the northeastern United States. Create a dichotomous key so that each type of fish can be distinguished. To start, determine which traits you will use to distinguish the different fish. Look at the labeled diagram of a fish for some hints.

Here is the beginning of a key to help you get started.

- **1A** _____

   B _____

- **2A** _____

   B _____

- **3A** _____

   B _____

- **4A** _____

   B _____

- **5A** _____

   B _____

- **6A** _____

   B _____

- **7A** _____

   B _____

- **8A** _____

   B _____

- **9A** _____

   B _____

- **10A** _____

   B _____

Fish Key: General Characteristics
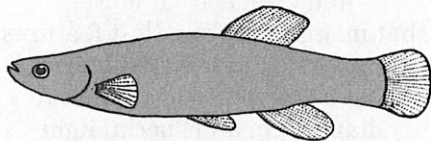
(1) Pectoral fin
(2) Pelvic (ventral) fin
(3) Anal fin
(4) Lateral Line
(5) Caudal fin
(6) Adipose fin
(7) Dorsal fin
(8) Barbel
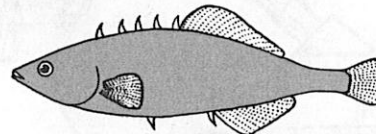(9) Operculum
(10) Maxillary
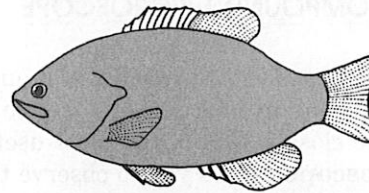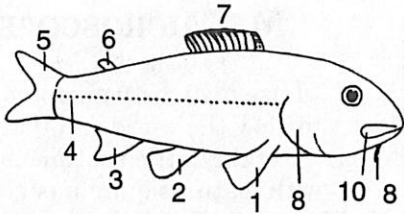
Family Centrarchidae
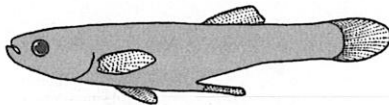*Micropterus salmoides*
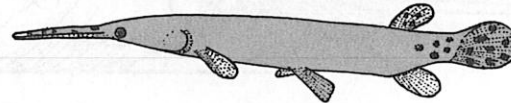- Largemouth Bass
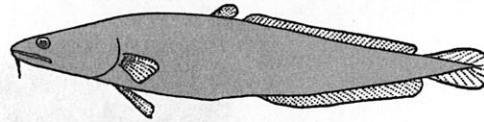
Family Gadidae
Lota lota - The Burbot

Family Cyprinodontidae
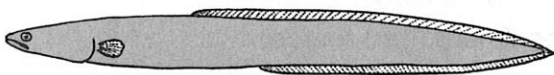*Fundulus diaphanus* - Barred killfish

Family Gasterosteidae
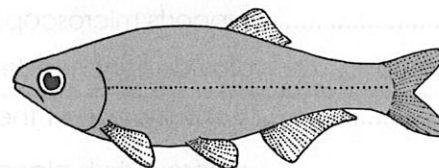*Eucalia inconstans* - Brook Stickleback

Family Poeciliidae
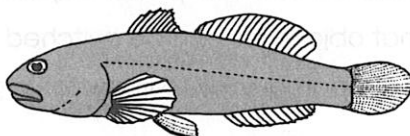*Gambusia affinis* - Mosquitofish
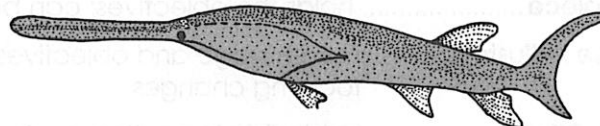
Family Lepisosteidae
Lepisosteus osseus - Longnose gar

Family Anguillidae
Anguilla rostrata - American eel

Family Hiodontidae
Hiodon tergisus - Mooneye

Family Cottidae
Cottus bairdi - Mottled sculpin

Family Polyodontidae
Polyodon spathula - Paddlefish

THE USE OF THE COMPOUND MICROSCOPE

Observing is the first step in learning about your world. Scientists have invented many instruments as tools to help you observe the world more closely. One of the most useful tools is the microscope. The **microscope** allows you to observe things that are too small for you to see. Microscopes open up the microscopic world to observation and study. Steps for study:

1 Examine the diagram of the compound microscope. Refer back to it as you review the use of the microscope.
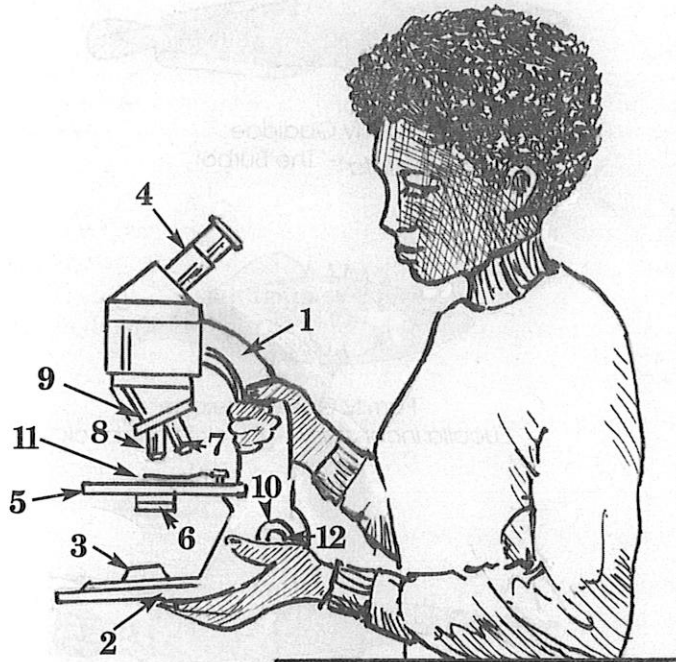
THE MICROSCOPE

> ## MY MICROSCOPE
> *by Joan Wagner*
> I use my trusty microscope
> to view the worlds around me
> of tiny little specimens
> with features quite unsightly!
> They dash about my viewing field
> swimming freely to and fro;
> and even though they are so small
> they reproduce and grow.
> My microscope has many parts
> to help me study these creatures
> and even special lenses
> that magnify the smallest features:
> The coarse and fine adjustments,
> and numerous objectives; the
> diaphragm and special light
> that focus these tiny "subjectives."
> And so I highly recommend
> this scientific tool
> to better understand the world
> and pass science in my school.

	PART	FUNCTION
1	**Arm**	connects body tube and base; supports stage; used to carry microscope
2	**Base**	supports microscope; may hold lamp or mirror
3	**Mirror** or **Lamp**	provide light needed to view specimens (light source)
4	**Eyepiece**	contains one of the lenses
5	**Stage**	where slide is placed
6	**Diaphragm**	regulates the amount of light reaching the specimen
7	**Low Power Objective**	contains one of the lenses; less magnification than high power objective
8	**High Power Objective**	contains one of the lenses; greater magnification than low power objective
9	**Nosepiece**	holds the objectives; can be rotated so that objectives can be switched
10	**Course Adjustment**	moves stage and objectives closer or farther apart quickly to allow for large focusing changes
11	**Stage Clip**	holds slide in position on stage
12	**Fine Adjustment**	moves stage and objectives closer or farther apart slowly to allow for fine focusing

2   Notice how the student is holding the microscope. Always carry the microscope with two hands, one holding the arm and one under the base. It is safest to carry the microscope in an upright position.

3   In order for a compound microscope to work, light must travel up through the specimen to your eye. Directly above the base of the microscope will be the mirror or lamp.

   If you have a mirror, while looking through the eyepiece, move the mirror until it reflects light from a source in the room. You should see a bright circle of light. NEVER use direct sunlight as a light source. Direct sunlight can seriously damage your eye.

   If you have a lamp, turn on the lamp and look through the eyepiece. You should see a bright circle of light.

   Whenever looking through the eyepiece keep both eyes open. This will reduce eye strain. If you have trouble focusing with the one eye, keep your other eye open but cover it with your hand.

4   Attached to the stage of the microscope is the diaphragm. The diaphragm is used to regulate the amount of light. Turn the diaphragm while looking through the eyepiece. You should be able to make your field brighter and darker. It is usually best to start with a brightly lit field.

5   The reason that your microscope is called a 'compound' microscope is that it has two lenses. One is in the eyepiece and one is in the objective. Each lens focuses the light so that the object being viewed is magnified. Using two lenses compounds this effect. In other words, if an eyepiece magnifies 10 times (10x) and the objective magnifies 10 times (10x) together in a compound microscope they magnify the object 100 times (100x).

   Your microscope may have more than one objective. Each one is labeled according to its magnification power. The low power objective is usually 10x. The high power objective is usually around 40x.

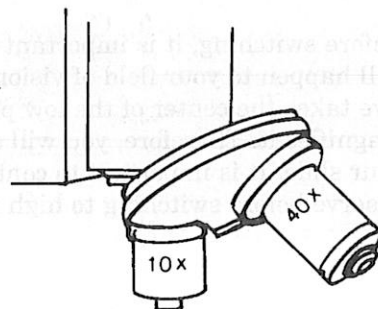   29 What is the magnification of your low power objective?_____

   30 What is the magnification of your high power objective?_____

   Turning the nosepiece allows you to switch objectives.

   Switch from the low power to the high power objective.

   You should hear a click when the objective is in place

   Switch back to low power.

   It is always best to start your observations with the low power objective. It is easier to find the object because your field of vision is bigger. (You see more of the surface of the slide.)

   Before using your microscope, it is always best to clean the lenses using lens paper.

6   Look for the large knob on the side of the microscope. This is the coarse adjustment wheel. This wheel is used to adjust the focus of the lenses. While looking from the side, turn the coarse adjustment wheel. Notice that it changes the distance between the stage and the objective.

   31 As you move the coarse adjustment clockwise, the objective and stage move _____.

   32 As you move the coarse adjustment counter-clockwise, the objective and stage move _____.

   NEVER move the coarse adjustment clockwise while looking through the eyepiece. When looking at slides, this may cause the objective to hit the slide and damage the slide and the microscope.

7   Place the slide you are going to use on the stage of the microscope. Place the slide so that the object you wish to view is directly over the opening in the stage. Use the clips to secure the slide.

8   Looking from the side, turn the coarse adjustment clockwise until the low power objective is as close to the slide as you can get it without touching.

9   While looking through the eyepiece, turn the coarse adjustment wheel in a counter-clockwise direction slowly until the object comes into focus. If you turn the wheel too quickly and pass the object, look from the side again and bring the objective and slide closer together. Repeat this step until you have the object in focus.

10 Use the fine adjustment wheel to bring your object (specimen) into a finer (more clear) focus. Fine means slight or small. Make a detailed, labeled diagram of what you observe. Label the diagram low power and include the magnification you are using.

It is important to note how things are positioned under a compound microscope. While looking through the eyepiece, move the slide to the right.

33 Which direction does the object appear to move? _____

Move the slide in a downward direction.

34 Which direction does the object appear to move?_____

Objects under a compound microscope appear upside down and backwards. Remember this when moving the slide around to find objects.

11 Now you will switch to the high power objective.

Before switching, it is important to understand what will happen to your field of vision. The high power objective takes the center of the low power objective field and magnifies it. Therefore, you will see less of what is on your slide. It is important to center what you want to observe before switching to high power.
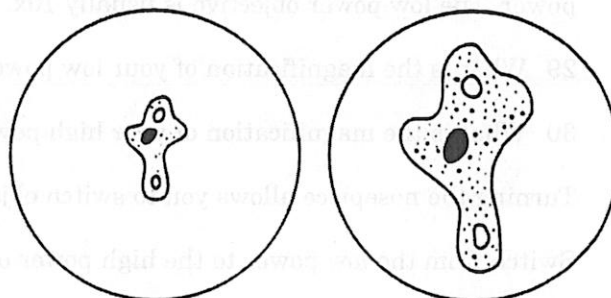
Low Power   **High Power**

35 Low power objective = more area and _____ magnification.

36 High power objective = _____ area and _____ magnification.

Turn the nosepiece until the high power objective clicks into place. If your object (specimen) is focused under low power, it will usually be focused when you switch to high power. Only use your fine adjustment wheel when observing under high power. If you use the coarse adjustment, you may drive the objective into the slide, damaging both. While using high power, you may need more light. Adjust the diaphragm if needed.

12 Focusing the microscope actually changes the depth or level of the specimen you are observing. You may be observing things from above the coverslip to down within the slide itself. Think of what you are observing as a ham and cheese sandwich. You can examine the upper slice of bread, the ham, the cheese, or the lower slice of bread depending on how you focus. This is especially evident when you are using high power objectives.

While looking at your specimen under high power, turn the fine adjustment wheel slowly back and forth. Observe the different layers of your specimen.

37 Make a detailed, labeled diagram of what you observe. Label the diagram high power and include the

magnification you are using. Magnification. _____

DETERMINING THE SIZE OF A MICROSCOPIC OBJECT USING A COMPOUND MICROSCOPE

How large are the objects (specimens) viewed under the microscope? An easy way to determine this is by using a transparent plastic ruler.

1 Place a transparent metric ruler on the stage of the microscope with its marked edge centered in the opening of the stage.

2 Using the low power objective, focus in on the marked edge. Measure the diameter of your field of vision (the white circle you see) in millimeters. Estimate to the nearest 0.001 of a millimeter (micron, μ or micrometer, mμ).

38 The diameter of my field under low power is _____mm.

Convert the diameter into microns. 1 mm = 1,000 μ

39 The diameter of my field under low power is _____ μ.

3 Switch to your high power objective. Measure the diameter of your field of vision. Estimate to the nearest tenth of a millimeter.

40 The diameter of my field under high power is _____mm.

41 The diameter of my field under high power is _____ μ.

4 Once you have estimated the diameter of your field of vision you can estimate the size of objects (specimens) in the field. For example, a microscopic organism is observed to be as long as one half of the low power field. The low power field is estimated to have a size of 1500 μ. The length of the microorganism would be estimated to be 750 μ.

42 Estimate the size of the following organisms. First, estimate what fraction of the field the specimen covers. If it covers 1/5 of the field, then: 1/5 x 1500 μ = 300 μ (size - low power). If this was done under high power, then the object takes up 4/5 of the field of vision. Its size is then 4/5 x 375 μ = 300 μ (same as low power)
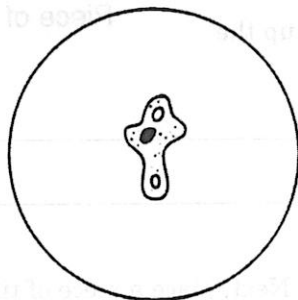

Low power

Field diameter 1500 μ
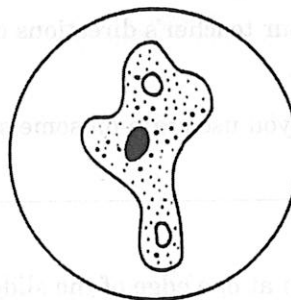
High Power

Field diameter 375 μ

43 Organism A is .2 under Low Power. _____   Organism A is .8 under High power. _____

PREPARING A WET MOUNT SLIDE

Objects are placed on a glass slide before being observed under a microscope. In order to make the object (specimen) easier to observe, it is placed in water between the slide and a coverslip. Make a wet mount in the follow way:

Forceps
Coverslip
Slide
Specimen in water
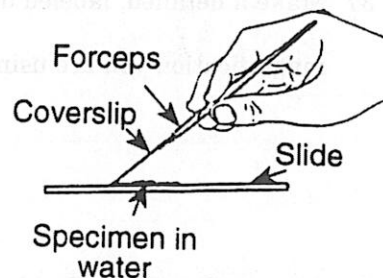
1   Place a drop of water on the center of the slide.

2   Place the object (specimen) to be viewed in the water. Add another drop of water onto the object.

3   Holding the edges of the coverslip, tilt the coverslip so that it touches the water on the slide only along its lower edge. Gently drop the coverslip onto the object. (This helps reduce the making of air bubbles which cause problems with observations.)

44 Why is it necessary to place a coverslip onto the object on the slide? _____

_____

STAINING TECHNIQUES

In order to make objects (specimens) easier to see when using a compound microscope, they may be stained. Staining makes an object (specimen) darker by adding a dark chemical to it.

Methylene blue
Slide
Coverslip
Specimen
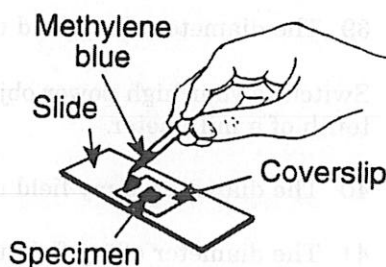
1   Prepare a wet mount of the object (specimen) to be observed.

2   Add a drop of stain along the side of the coverslip. Be careful using stains. Most will stain clothes.

3   Place a piece of tissue paper at the opposite end of the coverslip from where the stain was added. Be sure it touches the water of the wet mount. The stain will be drawn across the slide into the object.

Piece of toweling
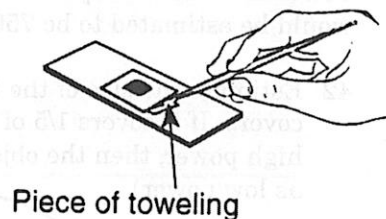
4   Be sure to follow your teacher's directions on how to clean up the extra stain.

45 What is the reason you use stain on some specimens? _____

_____

46 Place a drop of stain at one edge of the slide and coverslip. Next, place a piece of tissue paper at

the opposite side of the coverslip. Explain what happens with the stain and the specimen. _____

_____

_____

FIELD MAPS

Field maps describe the physical characteristics of a region by assigning values to all points in the region. When points of equal field value are connected, **isolines** are created. If the field value measures temperature, the lines are called **isotherms**. If the values connect points of equal atmospheric pressure, the lines are called **isobars**. **Topographic maps** are created by connecting points of equal elevation on a map. These lines are called **contour lines**.
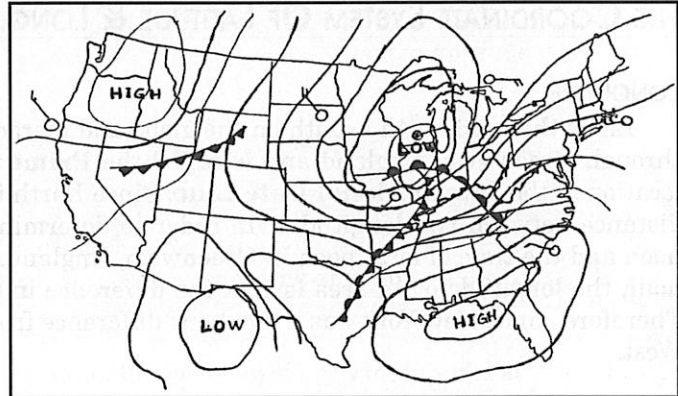
The rate of change between field values is called its gradient. The **gradient** on any field map can be determined with the following formula:

$$\text{gradient} = \frac{\text{Change in the Field Value}}{\text{Change in the Distance}}$$

In order to determine the gradient between point C and D, the distance between them must be determined. Using the scale, the distance is equal to 4 km.

47 Now use the formula for gradient to determine the gradient between those two points. Show your work in the space provided below. Gradient. _____
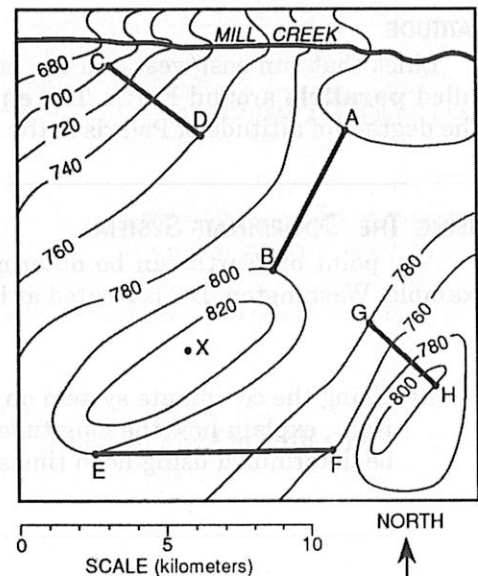
MEASURING ALTITUDE

The angular elevation of an object measured from Earth is called its **altitude**. It is equal to a celestial body's angular distance above the **horizon**. An object on the horizon has an altitude of 0°, while an object directly above an observer (at the zenith) has an altitude of 90°. Using instruments that measure angles, altitude can be measured such as the altitude of the airplane, a hot air balloon, or the Moon.

A type of protractor called an **astrolabe** can be used to measure the altitude of an object. A weight is suspended from the protractor. One edge of the protractor is aligned to the object. The angle through which the weight passes is equal to the altitude of the object.
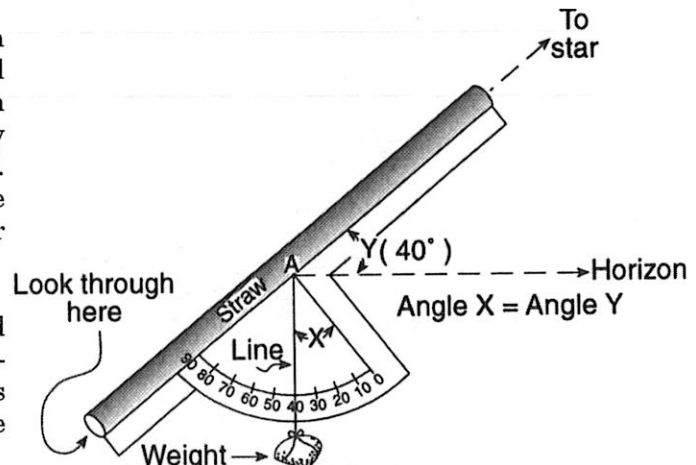
48 On a bright Moonlit night, you observe a Full Moon. It appears to be about halfway between the
horizon and directly over your head (**zenith**). What is the Moon's approximate altitude? _____

THE COORDINATE SYSTEM OF LATITUDE & LONGITUDE

LONGITUDE
Lines that run north / south on the globe and merge at the poles measure longitude. The 0° meridian passes through Greenwich, England and is called the **Prime Meridian**, while the 180° meridian is the approximate location of the **International Date Line**. Since Earth is basically round, the higher the latitude the shorter the distance between two longitudes. In order to determine your longitude, you must know two noon times, local noon and the time of local noon in Greenwich, England. Since Earth rotates west to east at the rate of 15° every hour, the longitude of an area is 15 x the difference in time between Greenwich noon time and local noon time. Therefore, since New York has a five hour difference from England, 5 x 15° places New York at the 75° longitude West.

LATITUDE
Lines that run east/west and are parallel to the equator are called lines of **latitude**. They form circles also called **parallels** around Earth. The **equator** has a latitude of 0° and forms the a **great circle** around Earth. The degrees of altitude of Polaris is the same as the latitude of the observer in the Northern Hemisphere.

USING THE COORDINATE SYSTEM
Any point on Earth can be determined by using the **coordinate system** of latitude and longitude. For example, Washington, DC is located at latitude 39° N and longitude 77°W.

49 Using the coordinate system on the globe at the
right, explain how the longitude of a place can
be determined using noon times.

_____

_____

_____

_____

_____

NORTH

Washington D.C.

Latitude
39° N

Longitude 77° W

EQUATOR

SOUTH
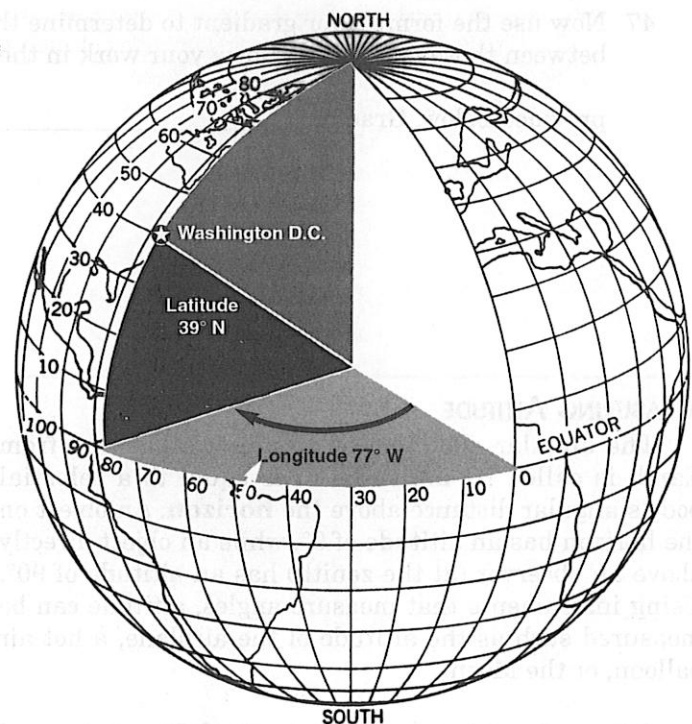
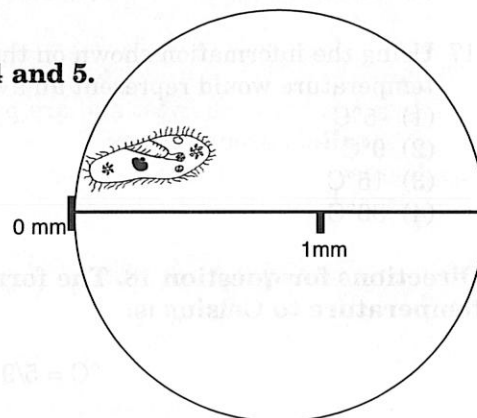**Directions: Circle the best answer in each of the following questions.**

1 From what direction does the light used to view a specimen with a compound microscope come?
  1 above the specimen
  2 below the specimen
  3 the side of the specimen
  4 the stage

2 What procedure should NOT be used while viewing a specimen with a compound microscope?
  1 raising the coarse adjustment
  2 lowering the coarse adjustment
  3 rasing the fine adjustment
  4 lowering the fine adjustment

3 What is the magnification if the eyepiece is 10x and the objective is 40x?
 (1) 10   (2) 40   (3) 50   (4) 400

Use the field of vision diagram at the right to answer questions 4 and 5.

4 What is the diameter of the field of vision?
  (1) 1.5 mm   (3) 1.5 cm
  (2) 150 mm   (4) 150 cm

5 What is the length of the organism in the diagram?
  (1) 0.5 mm
  (2) 0.5 cm
  (3) 5.0 mm
  (4) 5.0 cm

0 mm   1mm

6 When making a wet mount slide, why do you touch the coverslip to the water before dropping it?
  1 to trap the specimen
  2 so that it does not fall off
  3 to increase the air bubbles
  4 to reduce the air bubbles

7 When staining a specimen, why is a piece of paper towel placed at the edge of the coverslip?
  1 it draws the stain across
  2 it cleans up the slide
  3 it removes the extra stain
  4 to position the coverslip

Use the diagram and the key to answer questions 8 and 9.

Bird A   Bird C

Bird B   Bird D
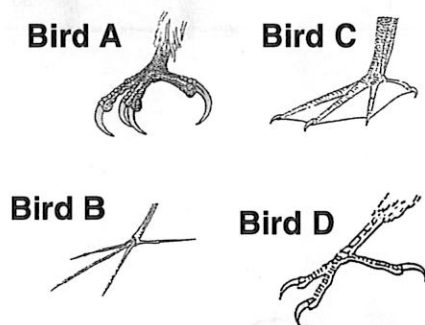
A KEY TO IDENTIFYING BIRDS

COUPLET		DESCRIPTION
1	A	TOES WEBBED 2
1	B	TOES NOT WEBBED 3
2	A	ALL 4 TOES WEBBED TOGETHER . . . . .CORMORANT
2	B	THREE TOES WEBBED TOGETHER .DUCK
3	A	CLAWS CURVED 4
3	B	CLAWS NOT CURVED . . . . .JACANA
4	A	CLAWS LARGE AND HEAVY . . . . .EAGLE
4	B	CLAWS SMALL . . . . .KINGFISHER

8 Bird A is a
  1 cormorant   2 duck   3 eagle   4 jacana

9 The characteristic used to tell eagles and jacanas apart is
  1 curve of the claw
  2 number of toes webbed
  3 size of the claw
  4 webbing

10 What type of blood vessel is used to count pulse rates?
  1   arteries   2   capillaries   3   ducts   4   veins

11 A student took her pulse for one minute four times and got the following results; first trial 80, second trial 80, third trial 79, and fourth trial 85. What is the student's average pulse rate per minute?
  (1) 80   (2) 324   (3) 81   (4) 20.25

12 How many grams make up a kilogram?
  (1) 10   (2) 100   (3) 1000   (4) 10,000

13 The temperature at which water freezes on the Celsius scale is
  (1) 0°C   (2) 32°C   (3) 100°C   (4) 212°C

14 A metric unit of volume is a
  1   gram   2   liter   3   meter   4   cubic foot

15 A millimeter is equal to
  (1) 0.1 m   (2) 0.01 m   (3) 0.001 m   (4) 0.0001 m

16 What is the average speed of a car that travels 1500 km in 12 hours. The formula for speed is: Speed = d/t.
  (1) 105 km/hr   (2) 110 km/hr   (3) 125 km/hr   (4) 130 km/hr
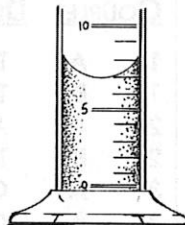
17 Using the information shown on the thermometers at the right, what temperature would represent an average fall day in New York State?
  (1) -5°C
  (2) 0°C
  (3) 15°C
  (4) 30°C

Directions for question 18. The formula for converting Fahrenheit temperature to Celsius is:
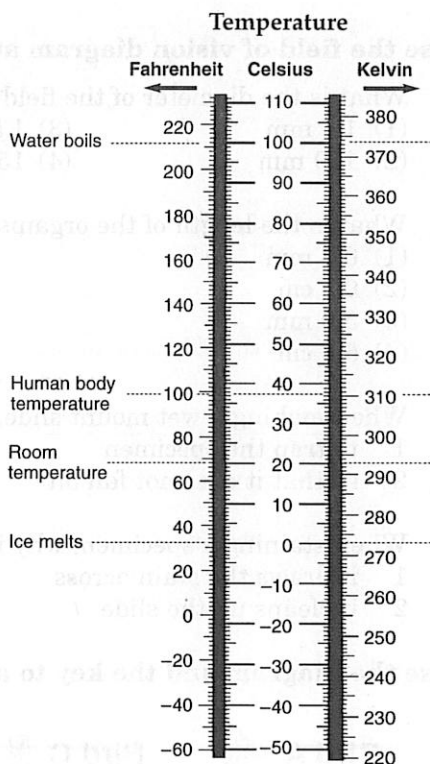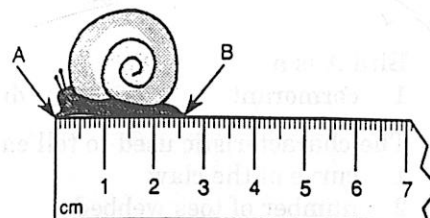
$$°C = 5/9 \ \text{x} \ (°F - 32)$$

18 If the temperature is 68°F, what would the temperature be in Celsius?
  (1) 5°C
  (2) 10°C
  (3) 15°C
  (4) 20°C

19 Water boils at 212° F. Using the conversion temperature scale at the right, what is the boiling point of water in degrees Celsius?
 (1) 32°C
  (2) 100°C
  (3) 212°C
  (4) 372°C

20 What is the volume of the water in the graduated cylinder at the right?
 (1) 5 mL
  (2) 7 mL
  (3) 8 mL
  (4) 10 mL

21 How many cm long is the snail in the diagram at the right?
 (1) 2.5 cm
  (2) 3.0 cm
  (3) 20 cm

Temperature

| | Fahrenheit | Celsius | Kelvin |

Water boils — 220, 200, 180, 160, 140, 120, 100, 80, 60, 40, 20, 0, -20, -40, -60 (Fahrenheit)
110, 100, 90, 80, 70, 60, 50, 40, 30, 20, 10, 0, -10, -20, -30, -40, -50 (Celsius)
380, 370, 360, 350, 340, 330, 320, 310, 300, 290, 280, 270, 260, 250, 240, 230, 220 (Kelvin)

Human body temperature
Room temperature
Ice melts

(4) 25 cm

22 What is the volume of the pebbles in the diagram at the right?
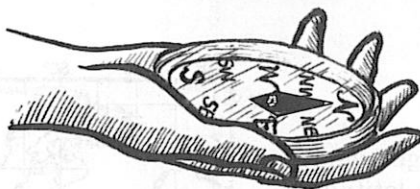(1) 15 cm³
(2) 14 cm³
(3) 5 cm³
(4) 4 cm³
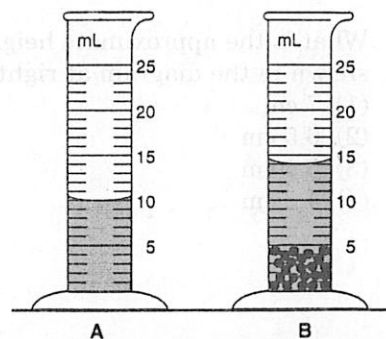
23 What is the volume of the wooden block shown below?
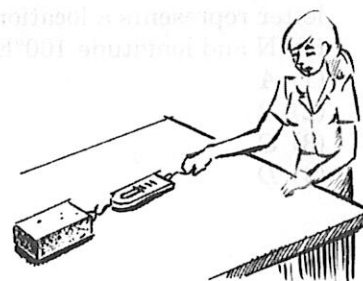(1) 35 cm³
(2) 205 cm³
(3) 1000 cm³
(4) 2050 cm³

5 cm

10 cm

20 cm
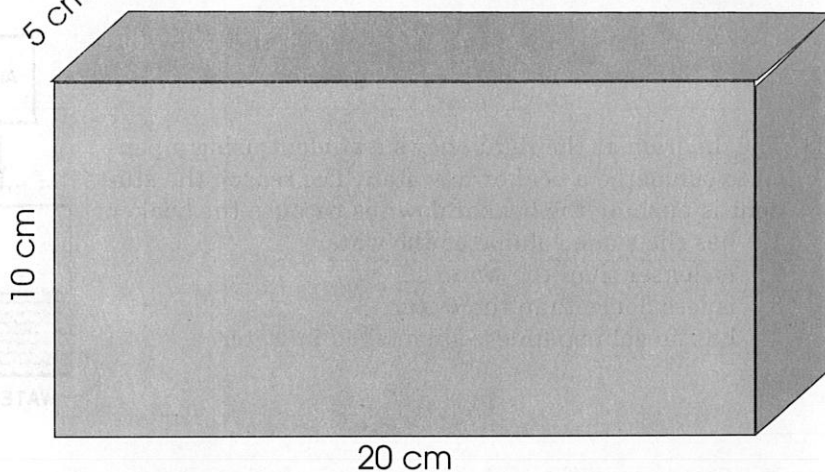
24 According to the triple beam balance at the right, what is the mass of the object?
(1) 209 g
(2) 219 g
(3) 409 g
(4) 419 g

1 g slider

10 g   200 g
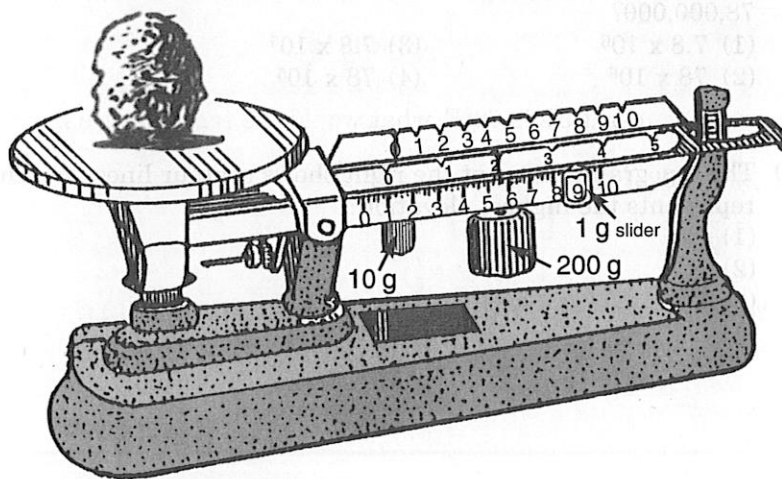
25 What direction is represented by the compass?
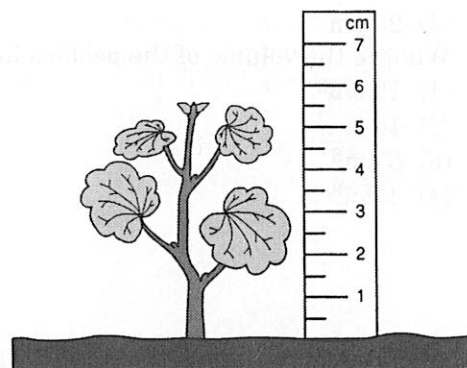1   NW
2   N
3   W
4   SE

26 What is the spring balance shown at the right used to measure?
1   temperature   3   density
2   force   4   direction

27 What is the approximate height of the highest point of the plant shown in the diagram at right?
(1) 7 cm
(2) 6.5 cm
(3) 5.5 cm
(4) 4.5 cm

28 The diagram at the right shows a student using a pencil to submerge a beaker in water. The reason the student is pushing the beaker down is because the beaker
1   has the same volume as the water
2   is denser than the water
3   is less dense than the water
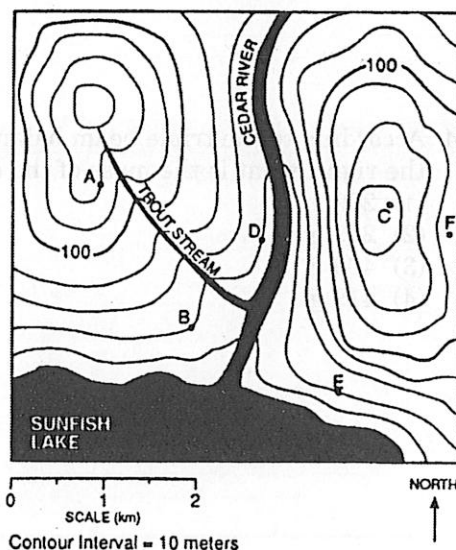4   has no volume unless submerged in water
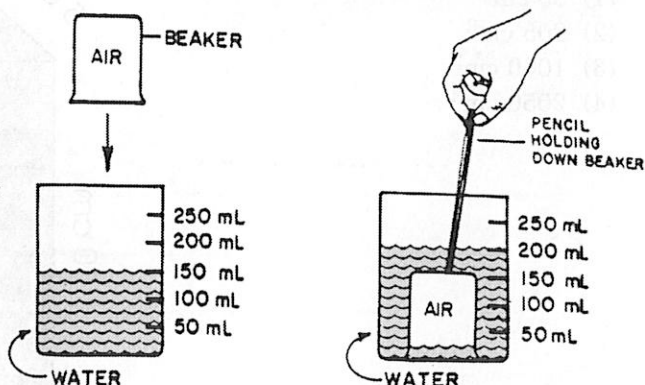
29 Which of the following would be the scientific notation for 78,000,000?
(1) 7.8×10^6 (3) 7.8×10^5
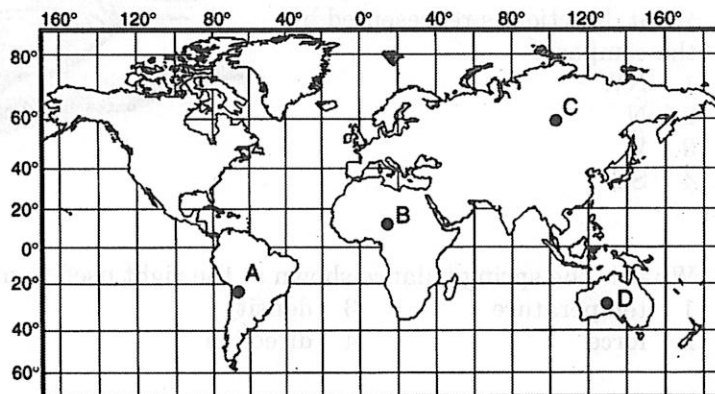(2) 78×10^6 (4) 78×10^5

30 The topographic map at the right shows contour lines. Which letter represents the highest elevation?
(1) F
(2) B
(3) C
(4) D

31 Using the map of the world at the right, what letter represents a location that is at latitude 60° N and longitude 100°E?
(1) A
(2) B
(3) C
(4) D

32 The illustration at the right is part of a procedure used with a micro-
scope and object study. The piece of toweling is being used to
1   support the cover slip
2   keep the cover slip away from the object
3   absorb extra fluids from the object
4   pull the stain across the object
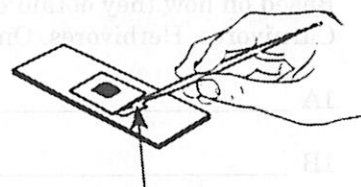
Piece of toweling

CONSTRUCTED RESPONSE

CHART OF THE PLANETS

	DISTANCE FROM SUN (MILLIONS OF KM)	PERIOD OF ROTATION	PERIOD OF REVOLUTION	NUMBER OF SATELLITES
Mercury	58	59 days	88 days	0
Venus	108	243 days	225 days	0
Earth	150	23 hours 56 minutes 4 seconds	365 1/4 days	1
Mars	228	24 hours 37 minutes 23 seconds	687 days	2
Jupiter	778	9 hours 50 minutes 30 seconds	11.9 years	11 (4 rings)
Saturn	1,427	10 hours 14 minutes	29 1/2 years	15 (1000 rings)
Uranus	2,869	10 hours 49 minutes	84 years	5
Neptune	4,496	16 hours	165 years	2
Pluto	5,900	6 days 9 hours	29 1/2 years	1?

1   Use the Chart of Planets above to answer the following questions.
    a   State a general relationship between a planet's period of revolution and distance from the Sun?

    (1 point)_____

    b   Which planet's revolution breaks this rule? _____ (2 points) Give a possible reason.

    _____

    _____

2 Based on how they obtain energy, develop a dichotomous key to distinguish the following groups. (2 points)
Carnivores, Herbivores, Omnivores, Producers (The first few couplets are provided. Use more if needed.)
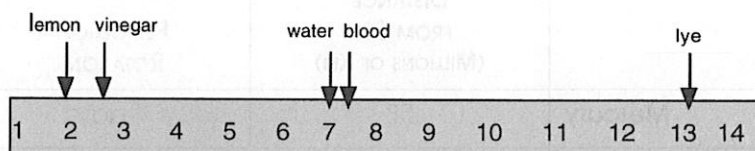
1A _____

1B _____

2A _____

2B _____

3A _____

3B _____

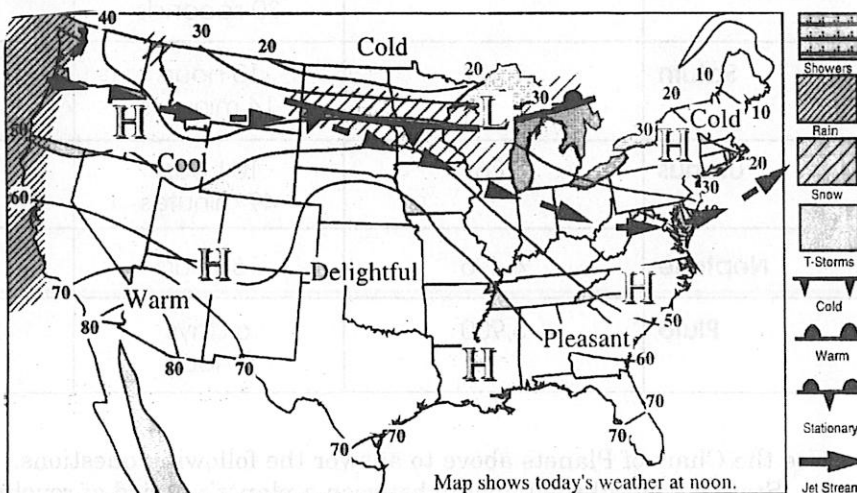3 Use the diagram of the pH scale at the right to answer the questions that follow.

lemon vinegar   water blood   lye

1 2 3 4 5 6 7 8 9 10 11 12 13 14

a Which substance(s) would be considered a strong base? Explain. (1 point) _____

_____

_____

b Phenolphthalein turns pink in the presence of a base. Which substance(s) will turn pink? Explain. (1)

_____

_____

4 Use the diagram of the weather map of the United States to answer the following questions.

Schenectady Gazette, January 15, 2000

a What type of front is moving out of Canada? (1)

_____

b In which direction is the jet stream moving? (1)

_____

Map shows today's weather at noon.

Showers / Rain / Snow / T-Storms / Cold / Warm / Stationary / Jet Stream

Cold / Cool / Delightful / Warm / Pleasant / H / L

c How would you characterize the temperature of air the jet stream is carrying and describe one factor that affects the temperature of the air carried by the jet stream? (2 points)

_____

_____

_____