# Safety Symbols

**These symbols warn of possible dangers in the laboratory and remind you to work carefully.**

**Safety Goggles** Wear safety goggles to protect your eyes in any activity involving chemicals, flames or heating, or glassware.

**Lab Apron** Wear a laboratory apron to protect your skin and clothing from damage.

**Breakage** Handle breakable materials, such as glassware, with care. Do not touch broken glassware.

**Heat-Resistant Gloves** Use an oven mitt or other hand protection when handling hot materials such as hot plates or hot glassware.

**Plastic Gloves** Wear disposable plastic gloves when working with harmful chemicals and organisms. Keep your hands away from your face, and dispose of the gloves according to your teacher's instructions.

**Heating** Use a clamp or tongs to pick up hot glassware. Do not touch hot objects with your bare hands.

**Flames** Before you work with flames, tie back loose hair and clothing. Follow instructions from your teacher about lighting and extinguishing flames.

**No Flames** When using flammable materials, make sure there are no flames, sparks, or other exposed heat sources present.

**Corrosive Chemical** Avoid getting acid or other corrosive chemicals on your skin or clothing or in your eyes. Do not inhale the vapors. Wash your hands after the activity.

**Poison** Do not let any poisonous chemical come into contact with your skin, and do not inhale its vapors. Wash your hands when you are finished with the activity.

**Fumes** Work in a ventilated area when harmful vapors may be involved. Avoid inhaling vapors directly. Only test an odor when directed to do so by your teacher, and use a wafting motion to direct the vapor toward your nose.

**Sharp Object** Scissors, scalpels, knives, needles, pins, and tacks can cut your skin. Always direct a sharp edge or point away from yourself and others.

**Animal Safety** Treat live or preserved animals or animal parts with care to avoid harming the animals or yourself. Wash your hands when you are finished with the activity.

**Plant Safety** Handle plants only as directed by your teacher. If you are allergic to certain plants, tell your teacher; do not do an activity involving those plants. Avoid touching harmful plants such as poison ivy. Wash your hands when you are finished with the activity.

**Electric Shock** To avoid electric shock, never use electrical equipment around water, or when the equipment is wet or your hands are wet. Be sure cords are untangled and cannot trip anyone. Unplug equipment not in use.

**Physical Safety** When an experiment involves physical activity, avoid injuring yourself or others. Alert your teacher if there is any reason you should not participate.

**Disposal** Dispose of chemicals and other laboratory materials safely. Follow the instructions from your teacher.

**Hand Washing** Wash your hands thoroughly when finished with the activity. Use antibacterial soap and warm water. Rinse well.

**General Safety Awareness** When this symbol appears, follow the instructions provided. When you are asked to develop your own procedure in a lab, have your teacher approve your plan before you go further.

# Science Safety Rules

## General Precautions

Follow all instructions. Never perform activities without the approval and supervision of your teacher. Do not engage in horseplay. Never eat or drink in the laboratory. Keep work areas clean and uncluttered.

## Dress Code

Wear safety goggles whenever you work with chemicals, glassware, heat sources such as burners, or any substance that might get into your eyes. If you wear contact lenses, notify your teacher.

Wear a lab apron or coat whenever you work with corrosive chemicals or substances that can stain. Wear disposable plastic gloves when working with organisms and harmful chemicals. Tie back long hair. Remove or tie back any article of clothing or jewelry that can hang down and touch chemicals, flames, or equipment. Roll up long sleeves. Never wear open shoes or sandals.

## First Aid

Report all accidents, injuries, or fires to your teacher, no matter how minor. Be aware of the location of the first-aid kit, emergency equipment such as the fire extinguisher and fire blanket, and the nearest telephone. Know whom to contact in an emergency.

## Heating and Fire Safety

Keep all combustible materials away from flames. When heating a substance in a test tube, make sure that the mouth of the tube is not pointed at you or anyone else. Never heat a liquid in a closed container. Use an oven mitt to pick up a container that has been heated.

## Using Chemicals Safely

Never put your face near the mouth of a container that holds chemicals. Never touch, taste, or smell a chemical unless your teacher tells you to.

Use only those chemicals needed in the activity. Keep all containers closed when chemicals are not being used. Pour all chemicals over the sink or a container, not over your work surface. Dispose of excess chemicals as instructed by your teacher.

Be extra careful when working with acids or bases. When mixing an acid and water, always pour the water into the container first and then add the acid to the water. Never pour water into an acid. Wash chemical spills and splashes immediately with plenty of water.

## Using Glassware Safely

If glassware is broken or chipped, notify your teacher immediately. Never handle broken or chipped glass with your bare hands.

Never force glass tubing or thermometers into a rubber stopper or rubber tubing. Have your teacher insert the glass tubing or thermometer if required for an activity.

## Using Sharp Instruments

Handle sharp instruments with extreme care. Never cut material toward you; cut away from you.

## Animal and Plant Safety

Never perform experiments that cause pain, discomfort, or harm to animals. Only handle animals if absolutely necessary. If you know that you are allergic to certain plants, molds, or animals, tell your teacher before doing an activity in which these are used. Wash your hands thoroughly after any activity involving animals, animal parts, plants, plant parts, or soil.

During field work, wear long pants, long sleeves, socks, and closed shoes. Avoid poisonous plants and fungi as well as plants with thorns.

## End-of-Experiment Rules

Unplug all electrical equipment. Clean up your work area. Dispose of waste materials as instructed by your teacher. Wash your hands after every experiment.

# Appendix B Using a Laboratory Balance

The laboratory balance is an important tool in scientific investigations. You can use a balance to determine the masses of materials that you study or experiment with in the laboratory.

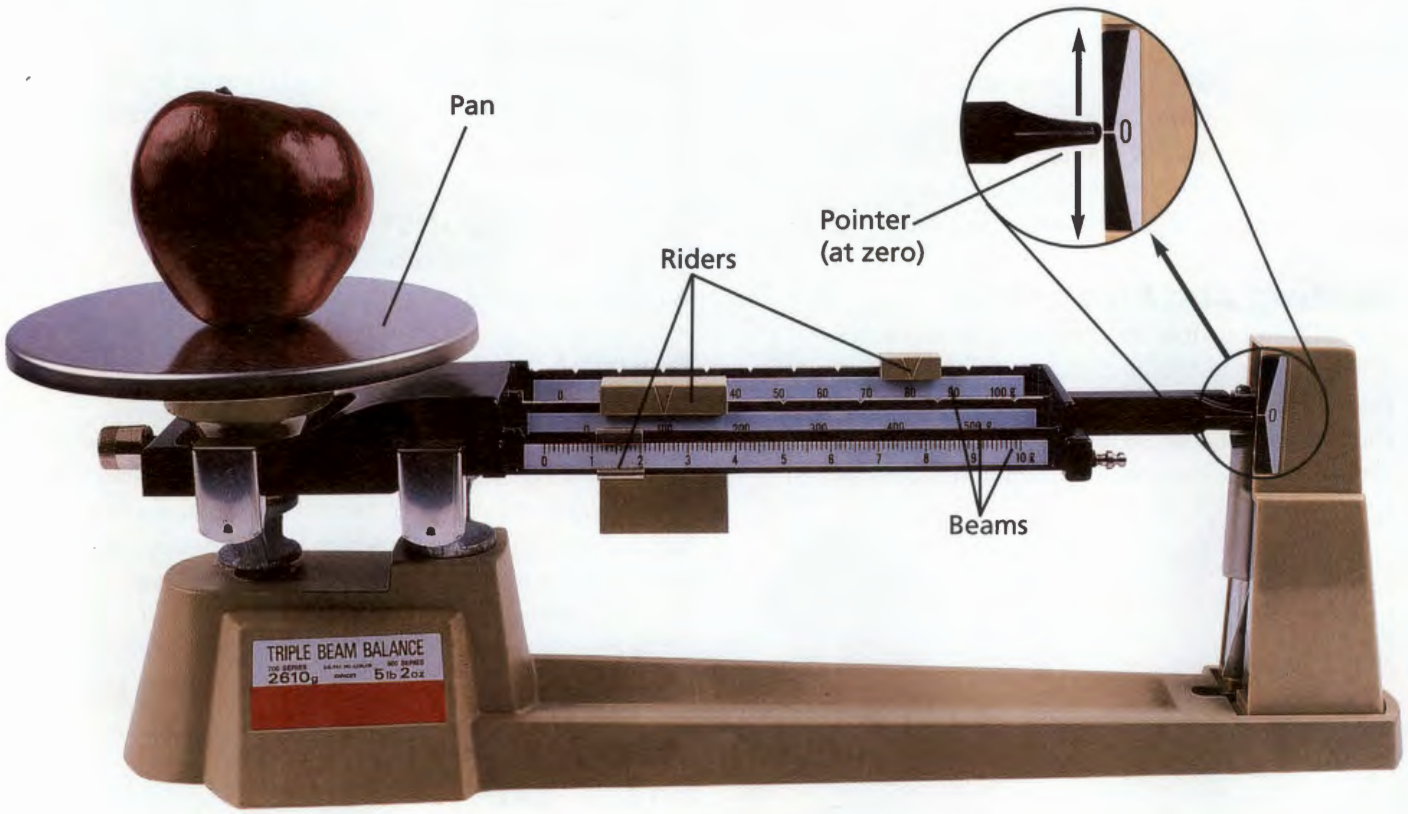
Different kinds of balances are used in the laboratory. One kind of balance is the triple-beam balance. The balance that you may use in your science class is probably similar to the balance illustrated in this Appendix. To use the balance properly, you should learn the name, location, and function of each part of the balance you are using. What kind of balance do you have in your science class?

## The Triple-Beam Balance

The triple-beam balance is a single-pan balance with three beams calibrated in grams. The back, or 100-gram, beam is divided into ten units of 10 grams each. The middle, or 500-gram, beam is divided into five units of 100 grams each. The front, or 10-gram, beam is divided into ten major units of 1 gram each. Each of these units is further divided into units of 0.1 gram. What is the largest mass you could find with a triple-beam balance?

The following procedure can be used to find the mass of an object with a triple-beam balance:

1. Place the object on the pan.
2. Move the rider on the middle beam notch by notch until the horizontal pointer drops below zero. Move the rider back one notch.
3. Move the rider on the back beam notch by notch until the pointer again drops below zero. Move the rider back one notch.
4. Slowly slide the rider along the front beam until the pointer stops at the zero point.
5. The mass of the object is equal to the sum of the readings on the three beams.




**Triple-Beam Balance**

| Name | Symbol | Atomic Number | Atomic Mass† |
|---|---|---|---|
| Actinium | Ac | 89 | (227) |
| Aluminum | Al | 13 | 26.982 |
| Americium | Am | 95 | (243) |
| Antimony | Sb | 51 | 121.75 |
| Argon | Ar | 18 | 39.948 |
| Arsenic | As | 33 | 74.922 |
| Astatine | At | 85 | (210) |
| Barium | Ba | 56 | 137.327 |
| Berkelium | Bk | 97 | (247) |
| Beryllium | Be | 4 | 9.012 |
| Bismuth | Bi | 83 | 208.980 |
| Bohrium | Bh | 107 | (264) |
| Boron | B | 5 | 10.811 |
| Bromine | Br | 35 | 79.904 |
| Cadmium | Cd | 48 | 112.411 |
| Calcium | Ca | 20 | 40.078 |
| Californium | Cf | 98 | (251) |
| Carbon | C | 6 | 12.011 |
| Cerium | Ce | 58 | 140.115 |
| Cesium | Cs | 55 | 132.905 |
| Chlorine | Cl | 17 | 35.453 |
| Chromium | Cr | 24 | 51.996 |
| Cobalt | Co | 27 | 58.933 |
| Copper | Cu | 29 | 63.546 |
| Curium | Cm | 96 | (247) |
| Darmstadtium | Ds | 110 | (269) |
| Dubnium | Db | 105 | (262) |
| Dysprosium | Dy | 66 | 162.50 |
| Einsteinium | Es | 99 | (252) |
| Erbium | Er | 68 | 167.26 |
| Europium | Eu | 63 | 151.965 |
| Fermium | Fm | 100 | (257) |
| Fluorine | F | 9 | 18.998 |
| Francium | Fr | 87 | (223) |
| Gadolinium | Gd | 64 | 157.25 |
| Gallium | Ga | 31 | 69.723 |
| Germanium | Ge | 32 | 72.61 |
| Gold | Au | 79 | 196.967 |
| Hafnium | Hf | 72 | 178.49 |
| Hassium | Hs | 108 | (265) |
| Helium | He | 2 | 4.003 |
| Holmium | Ho | 67 | 164.930 |
| Hydrogen | H | 1 | 1.008 |
| Indium | In | 49 | 114.818 |
| Iodine | I | 53 | 126.904 |
| Iridium | Ir | 77 | 192.22 |
| Iron | Fe | 26 | 55.847 |
| Krypton | Kr | 36 | 83.80 |
| Lanthanum | La | 57 | 138.906 |
| Lawrencium | Lr | 103 | (262) |
| Lead | Pb | 82 | 207.2 |
| Lithium | Li | 3 | 6.941 |
| Lutetium | Lu | 71 | 174.967 |
| Magnesium | Mg | 12 | 24.305 |
| Manganese | Mn | 25 | 54.938 |
| Meitnerium | Mt | 109 | (268) |
| Mendelevium | Md | 101 | (258) |

†Numbers in parentheses give the mass number of the most stable isotope.

| Name | Symbol | Atomic Number | Atomic Mass† |
|---|---|---|---|
| Mercury | Hg | 80 | 200.659 |
| Molybdenum | Mo | 42 | 95.94 |
| Neodymium | Nd | 60 | 144.2 |
| Neon | Ne | 10 | 20.180 |
| Neptunium | Np | 93 | (237) |
| Nickel | Ni | 28 | 58.69 |
| Niobium | Nb | 41 | 92.906 |
| Nitrogen | N | 7 | 14.007 |
| Nobelium | No | 102 | (259) |
| Osmium | Os | 76 | 190.23 |
| Oxygen | O | 8 | 15.999 |
| Palladium | Pd | 46 | 106.42 |
| Phosphorus | P | 15 | 30.974 |
| Platinum | Pt | 78 | 195.08 |
| Plutonium | Pu | 94 | (244) |
| Polonium | Po | 84 | (209) |
| Potassium | K | 19 | 39.098 |
| Praseodymium | Pr | 59 | 140.908 |
| Promethium | Pm | 61 | (145) |
| Protactinium | Pa | 91 | 231.036 |
| Radium | Ra | 88 | (226) |
| Radon | Rn | 86 | (222) |
| Rhenium | Re | 75 | 186.207 |
| Rhodium | Rh | 45 | 102.906 |
| Roentgenium | Rg | 111 | (280) |
| Rubidium | Rb | 37 | 85.468 |
| Ruthenium | Ru | 44 | 101.07 |
| Rutherfordium | Rf | 104 | (261) |
| Samarium | Sm | 62 | 150.36 |
| Scandium | Sc | 21 | 44.956 |
| Seaborgium | Sg | 106 | (263) |
| Selenium | Se | 34 | 78.96 |
| Silicon | Si | 14 | 28.086 |
| Silver | Ag | 47 | 107.868 |
| Sodium | Na | 11 | 22.990 |
| Strontium | Sr | 38 | 87.62 |
| Sulfur | S | 16 | 32.066 |
| Tantalum | Ta | 73 | 180.948 |
| Technetium | Tc | 43 | (98) |
| Tellurium | Te | 52 | 127.60 |
| Terbium | Tb | 65 | 158.925 |
| Thallium | Tl | 81 | 204.383 |
| Thorium | Th | 90 | 232.038 |
| Thulium | Tm | 69 | 168.934 |
| Tin | Sn | 50 | 118.710 |
| Titanium | Ti | 22 | 47.88 |
| Tungsten | W | 74 | 183.85 |
| Ununbium | Uub | 112 | (277) |
| Ununquadium | Uuq | 114 | * |
| Ununonium | Uuu | 111 | (272) |
| Uranium | U | 92 | 238.029 |
| Vanadium | V | 23 | 50.942 |
| Xenon | Xe | 54 | 131.29 |
| Ytterbium | Yb | 70 | 173.04 |
| Yttrium | Y | 39 | 88.906 |
| Zinc | Zn | 30 | 65.39 |
| Zirconium | Zr | 40 | 91.224 |

*Newly discovered

| Table 1: Physical Data for the Planets | | | | | | |
|---|---|---|---|---|---|---|
| Name | Equatorial Diameter (km) | Mass (Earth = 1)* | Surface Gravity (Earth = 1) | Average Density ($kg/m^3$) | Number of Moons | Axial Tilt (degrees)** |
| Mercury | 4,879 | 0.055 | 0.38 | 5,427 | 0 | 0.01 |
| Venus | 12,104 | 0.815 | 0.91 | 5,243 | 0 | 177.4 |
| Earth | 12,756 | 1.00 | 1.00 | 5,515 | 1 | 23.5 |
| Mars | 6,794 | 0.107 | 0.38 | 3,933 | 2 | 25.2 |
| Jupiter | 142,984 | 317.8 | 2.36 | 1,326 | 63+ | 3.1 |
| Saturn | 120,536 | 95.2 | 0.92 | 687 | 47+ | 26.7 |
| Uranus | 51,118 | 14.5 | 0.89 | 1,270 | 27+ | 97.8 |
| Neptune | 49,528 | 17.1 | 1.12 | 1,638 | 13+ | 28.3 |

*All masses are shown relative to Earth. Earth's mass is about $6.0 \times 10^{24}$ kg. To find Jupiter's actual mass, multiply its relative mass by Earth's mass: $317.8 \times (6.0 \times 10^{24}\ kg) \approx 1.9 \times 10^{27}$ kg. Surface gravity is also shown relative to Earth.
**Axial tilt is the angle that a planet's axis is tilted relative to a line perpendicular to the planet's orbit around the sun.

| Table 2: Data for Planetary Motions | | | | |
|---|---|---|---|---|
| Name | Distance From the Sun (AU) | Period of Revolution (Earth years) | Average Orbital Speed (km/s) | Period of Rotation (Earth days) |
| Mercury | 0.39 | 0.24 | 47.9 | 58.8 |
| Venus | 0.72 | 0.62 | 35.0 | 244* |
| Earth | 1.00 | 1.00 | 29.8 | 1.00 |
| Mars | 1.52 | 1.88 | 24.1 | 1.03 |
| Jupiter | 5.20 | 11.9 | 13.1 | 0.41 |
| Saturn | 9.58 | 29.4 | 9.7 | 0.45 |
| Uranus | 19.2 | 83.7 | 6.8 | 0.72* |
| Neptune | 30.05 | 163.7 | 5.4 | 0.67 |

*Direction of rotation for Venus, Uranus, and Pluto is opposite to planet's orbital motion.

| Table 3: Data for Selected Moons | | | | | |
|---|---|---|---|---|---|
| Name | Year Discovered | Parent Planet | Average Distance From Planet ($10^3$ km) | Diameter (km) | Period of Rotation (Earth days) |
| The Moon | – | Earth | 384.4 | 3,476 | 27.3 |
| Io | 1610 | Jupiter | 421.6 | 3,642 | 1.8 |
| Europa | 1610 | Jupiter | 670.9 | 3,120 | 3.6 |
| Ganymede | 1610 | Jupiter | 1,070.0 | 5,268 | 7.2 |
| Callisto | 1610 | Jupiter | 1,883.0 | 4,800 | 16.7 |
| Titan | 1655 | Saturn | 1,221.9 | 5,150 | 15.9 |
| Titania | 1787 | Uranus | 435.8 | 1,580 | 8.7 |
| Triton | 1846 | Neptune | 354.8 | 2,706 | 5.9 |

| Table 4: Data for Small Solar-System Bodies and Dwarf Planets | | | | | |
|---|---|---|---|---|---|
| **Name** | **Type** | **Year Discovered** | **Distance From the Sun (AU)** | **Diameter (km)** | **Period of Revolution (Earth years)** |
| Ceres | Dwarf planet / Asteroid | 1801 | 2.77 | 960 × 932 | 4.60 |
| Pallas | Asteroid | 1802 | 2.77 | 570 × 525 × 482 | 4.61 |
| Juno | Asteroid | 1804 | 2.67 | 240 | 4.36 |
| Vesta | Asteroid | 1807 | 2.36 | 530 | 3.63 |
| Pluto | Dwarf planet | 1930 | 39.24 | 2,390 | 248.0 |
| Quaoar | Kuiper Belt object | 2002 | 42 | ≈1300 | 285 |
| Sedna | Kuiper Belt object | 2003 | 76–1,000 | ≈1500? | 10,500 |
| 2005 FY9 | Kuiper Belt object | 2005 | 39–52 | ≈1500? | 307 |
| Eris | Dwarf planet | 2005 | 38–97 | ≈3000 | 560 |

| Table 5: Data for the Sun | |
|---|---|
| Mass = $2.0 \times 10^{30}$ kg | Radius = $7 \times 10^{6}$ km |
| Average Surface Temperature = 5,500°C | Absolute Brightness (Luminosity) = $3.86 \times 10^{26}$ J/s |
| Average Core Temperature = $1.6 \times 10^{7}$ °C | Average Density = 1,410 kg/m$^3$ |

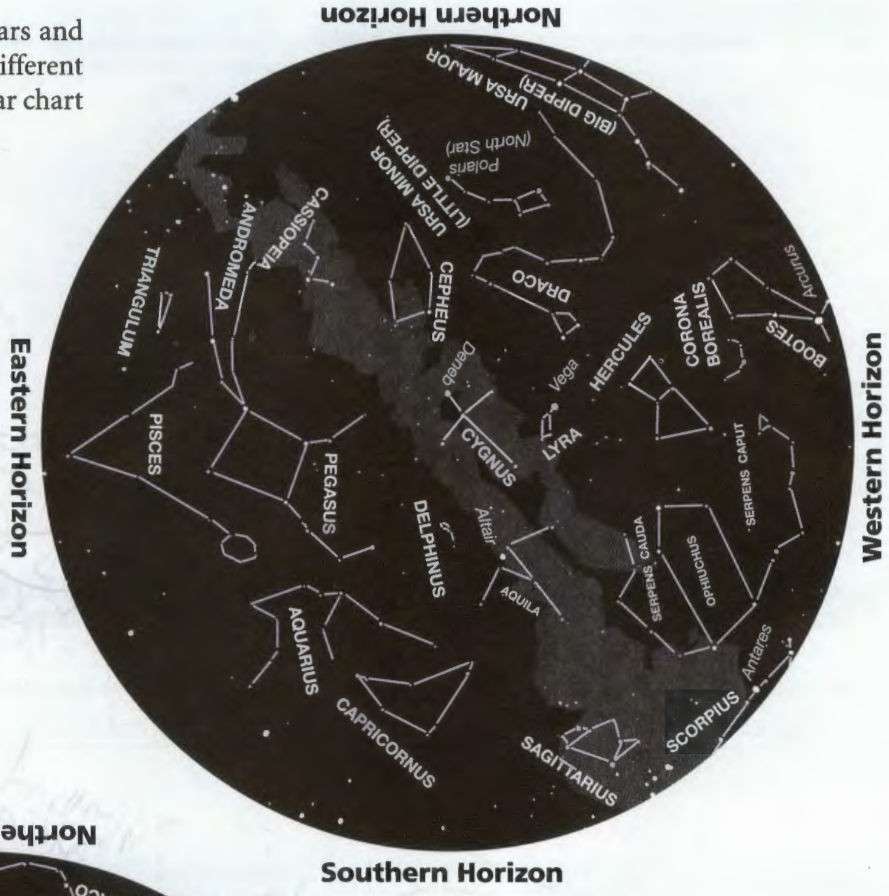
| Table 6: Data for Some Well-Known Stars | | | | |
|---|---|---|---|---|
| **Name** | **Constellation** | **Type** | **Distance From Sun (light-years)** | **Apparent Brightness (Sirius = 1)*** |
| Sirius A | Canis Major | White main sequence | 8.6 | 1.00 |
| Canopus | Carina | Yellow giant | 313 | 0.47 |
| Arcturus | Bootes | Orange giant | 37 | 0.278 |
| Alpha Centauri A | Centaurus | Yellow main sequence | 4.4 | 0.268 |
| Vega | Lyra | White main sequence | 25 | 0.258 |
| Capella | Auriga | Yellow giant (quadruple star system) | 42 | 0.247 |
| Rigel | Orion | Blue supergiant | 770 | 0.225 |
| Betelgeuse | Orion | Red supergiant | 430 | 0.175 |
| Altair | Aquila | White main sequence | 17 | 0.132 |
| Aldebaran | Taurus | Orange giant | 65 | 0.119 |
| Antares | Scorpio | Red supergiant | 600 | 0.100 |
| Pollux | Gemini | Orange giant | 34 | 0.091 |
| Fomalhaut | Pisces Austrinus | White main sequence | 25 | 0.090 |
| Deneb | Cygnus | White supergiant | 3200 | 0.084 |
| Regulus | Leo | Blue main sequence | 78 | 0.076 |

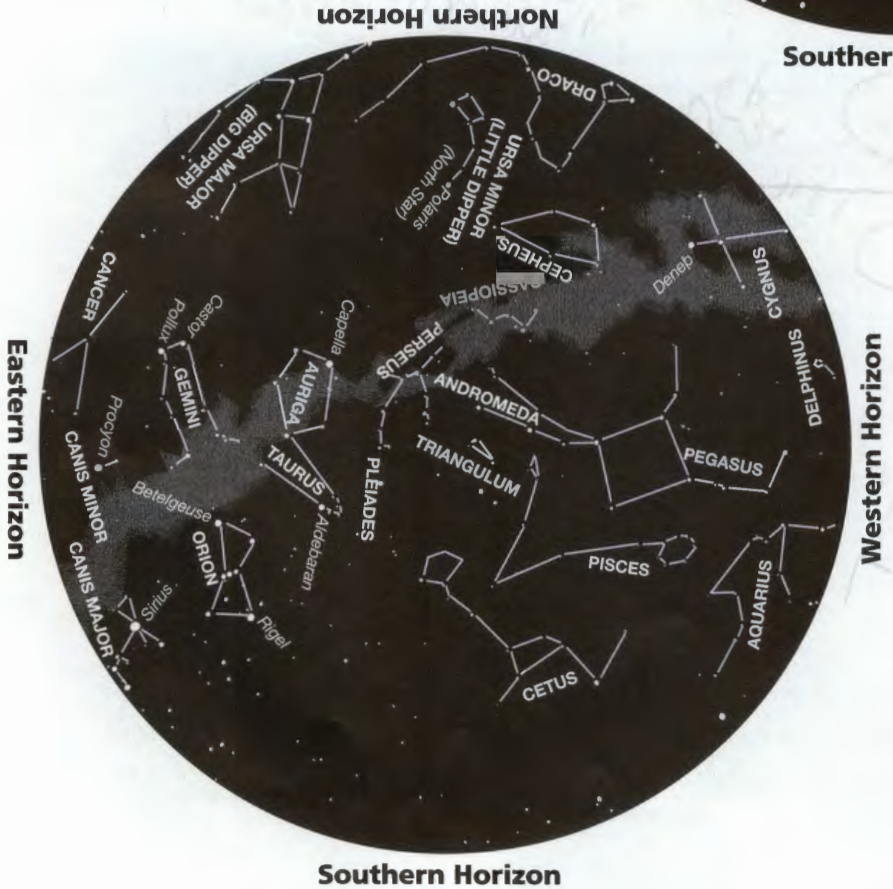
*The apparent brightness of some stars changes over time because of changes in their absolute brightness (luminosity).

Use these star charts to locate bright stars and major constellations in the night sky at different times of year. Choose the appropriate star chart for the current season.

## Autumn Sky

This chart works best at the following dates and times: September 1 at 10:00 P.M., October 1 at 8:00 P.M., or November 1 at 6:00 P.M. Look for the constellations Ursa Minor (the Little Dipper) and Cassiopeia in the northern sky, and for the star Deneb, which is nearly overhead in autumn.




## Winter Sky

This chart works best at the following dates and times: December 1 at 10:00 P.M., January 1 at 8:00 P.M., or February 1 at 6:00 P.M. Look for the constellations Orion and Gemini, the bright star Sirius, and the Pleiades, a star cluster, in the winter sky.

Using a flashlight and a compass, hold the appropriate chart and turn it so that the direction you are facing is at the bottom of the chart. These star charts work best at 34° north latitude, but can be used at other central latitudes.

## Spring Sky

This chart works best at the following dates and times: March 1 at 10:00 P.M., March 15 at 9:00 P.M., or April 1 at 8:00 P.M. Look for the constellations Ursa Major (which contains the Big Dipper), Bootes, and Leo in the spring sky. The bright stars Arcturus and Spica can be seen in the east.



## Summer Sky

This chart works best at the following dates and times: May 15 at 11:00 P.M., June 1 at 10:00 P.M., or June 15 at 9:00 P.M. Look for the bright star Arcturus in the constellations Bootes and Hercules overhead in early summer. Towards the east look for the bright stars Vega, Altair, and Deneb, which form a triangle.