

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.



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?

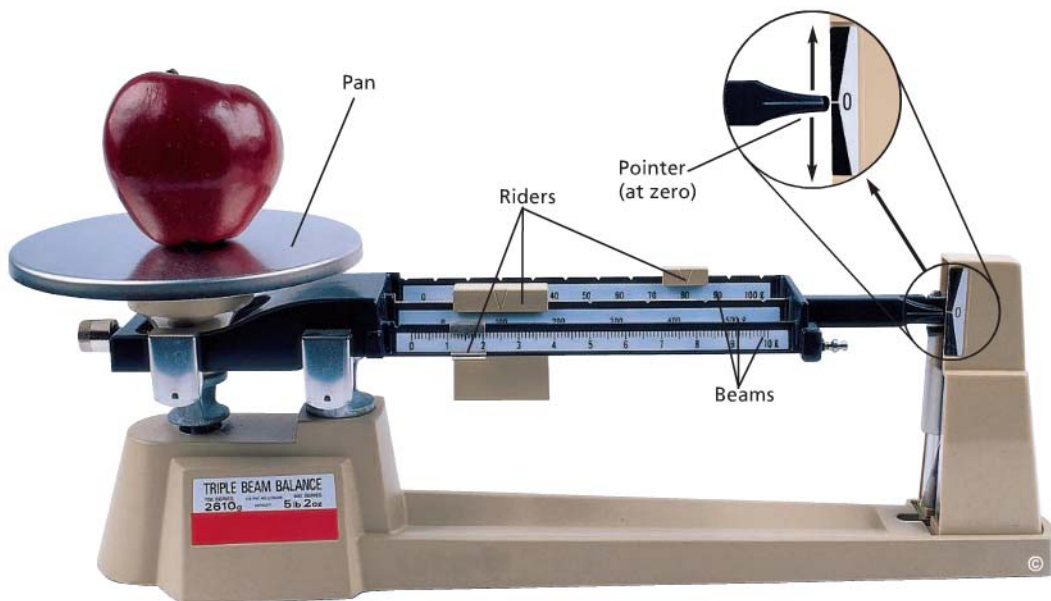
The Triple-Beam Balance

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 6.0×10^{24} kg. To find Jupiter's actual mass, multiply its relative mass by Earth's mass: $317.8 \times (6.0 \times 10^{24} \text{ kg}) = 1.9 \times 10^{27}$ 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 = 2.0×10^{30} kg	Radius = 7×10^6 km
Average Surface Temperature = $5,500^\circ\text{C}$	Absolute Brightness (Luminosity) = 3.86×10^{26} J/s
Average Core Temperature = 1.6×10^7 °C	Average Density = $1,410$ kg/m ³

Table 6: Data for Some Well-Known Stars

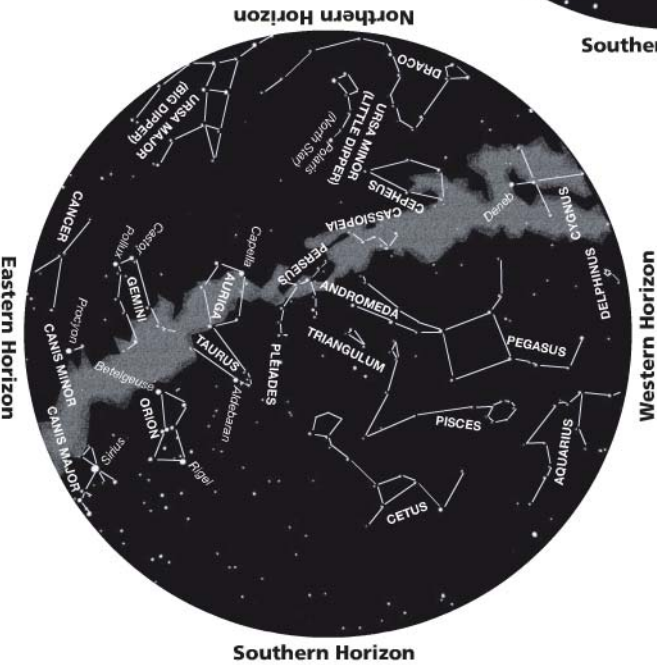
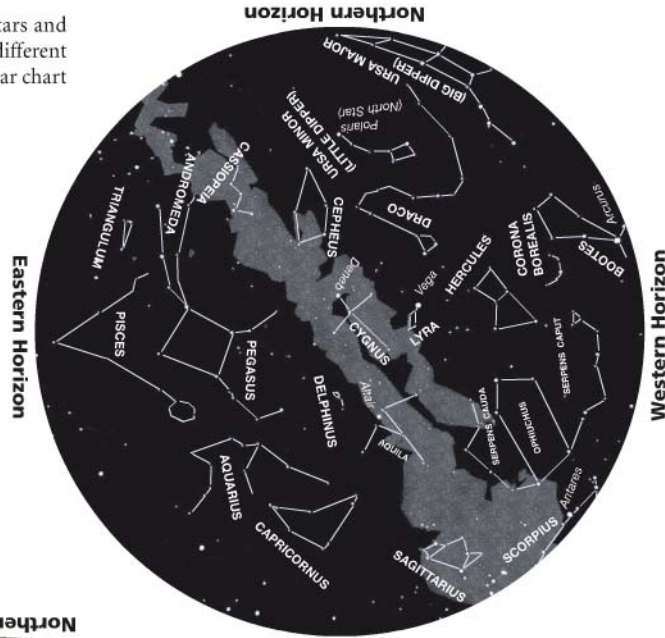
Name	Constellation	Type	Distance From Sun (light-years)	Apparent Brightness (Sirius = 1)*
Sirius A	Canis Major	White main sequence	8.6	1.00
Canopus	Carina	Yellow giant	313	0.47
Arcturus	Bootes	Orange giant	37	0.278
Alpha Centauri A	Centaurus	Yellow main sequence	4.4	0.268
Vega	Lyra	White main sequence	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.



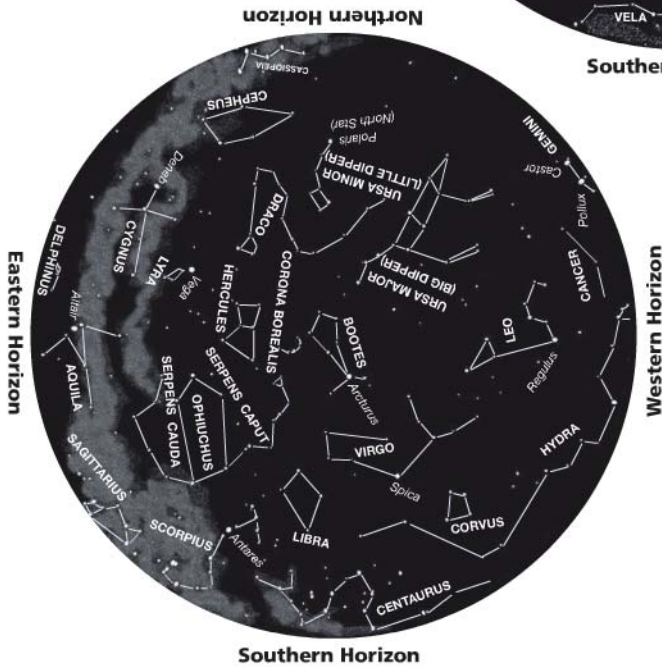
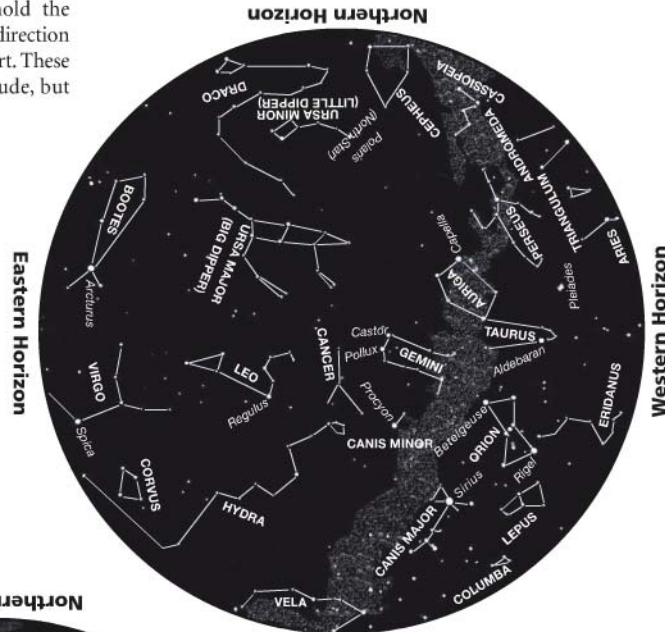
Winter Sky

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.