US Metric Association (USMA) Science Fair Award Program

Welcome to the US Metric Association (USMA) Science Fair Award Program! Your dedication to judging and administering the **Metric Science Fair Award** is greatly appreciated. Program resources are available online (https://usma.org/science-fair-award program).

The International System of Units (SI), commonly known as the Metric System, is the language of science, technology, engineering, and mathematics (STEM) communication. It is essential to encourage students to use SI units to report science fair research results. USMA has developed several resources to help evaluate measurement writing style for this award.

USMA Science Fair Program Instructions and Resources

1) **Judging Guide**. Provide students with the judging criteria during the science fair planning phase. A research project that expresses measurements in the SI is an ideal candidate for this award. All reported measurements, including calculations, data, graphs, and conclusions should be expressed exclusively and accurately using the SI. Supplemental writing style tips are available online to help students become familiar with common mistakes (https://usma.org/correct-usage-of-the-si). Judges review the criteria before evaluating science fair projects.
2) **Breaking Science Fair Ties Guide**. When several students demonstrate extensive and correct use of SI units, judges need a process to unanimously determine which student should receive the award. This guidance uses a set of simple questions to quickly appraise student SI understanding.
3) **Award Certificate Template**. Recognize awardee using the certificate template (PDF), which is not posted online to prevent unauthorized use. Download the Award Certificate Template and Gift Code in the RAO section of the SFS Fair Dashboard.
4) **In-kind Award**. USMA Science Fair awardees are eligible for a free 1-year Individual Membership which may be redeemed between **1 January and 31 May** each year. The **Gift Code** is printed on page two of the *Award Certificate Template*. Awardees must visit the membership website to redeem the gift code during check-out (https://usma.org/shop/category/memberships). Contact the **USMA Website Manager** (webmaster@usma.org) with problems redeeming the Gift Code.
5) **Reporting**. Science Fair officials please use the online science fair *Reporting Form* within 30 days after the fair or as soon as is convenient (https://tinyurl.com/cytby62y). Many fairs and schools promote recipient achievements using social media, local newspapers, and school publications. To help recognize award accomplishments, please notify USMA (media@usma.org) about published student science fair award media highlights and tag @USMA_Metric (Twitter and Instagram) and U.S. Metric Association (LinkedIn and Facebook).
6) **Related Award Opportunities.** All US high school seniors are eligible to apply for the annual USMA Metric Scholarship Award. United States K-12 and academia educators are eligible to apply for the annual USMA Metric Award (non-student). Online applications accepted between **1 January and 31 March** (https://usma.org/metric-awards).

The US Metric Association appreciates your efforts to encourage students to prepare for and pursue STEM careers. Do not hesitate to contact USMA with any questions. Science Fair Committee: **Mark Henschel,** Chair mark.henschel@usma.org and **Elizabeth Benham**, Education Working Group elizabeth.benham@nist.gov.

US Metric Association (USMA) Science Fair Award Program

Breaking Science Fair Ties Guide

It is common for science fair officials to have multiple students demonstrate extensive and correct use of the International System of Units (SI), commonly known as the Metric System, in their research projects. When this situation occurs, judges need a process to unanimously determine which student should receive the award. This guide provides several tips to quickly appraise student SI understanding.

Conducting Research. Reward researchers must conduct measurements exclusively using SI units and use metric equipment. Interviews may reveal that students conducted research in non-SI units and then undertook risky unit conversions to report SI quantities.

Reporting the Results. Exclusive use of SI units is preferred. If dual units are used SI units must be reported first [e.g., SI (non-SI)].

Evaluate Proficiency. Student responses should demonstrate that they **APPLY** SI measurement techniques and **INTERPRET** metric system data during their project. For example:

- **DESCRIBE** the process used to collect your measurement data.
- **DEMONSTRATE** how to use the measurement equipment used in your research project.
- **EXPLAIN** how a common metric instrument used during your research, such as a ruler, caliper, graduated cylinder, thermometer, balance or scale.
- **DISCUSS** the significance of quantity or scale on your measurement results.
- **IDENTIFY** instances where measurement technique errors may have impacted the results.

Evaluate and demonstrate basic SI knowledge and application skills. Align questions with the research project. For example:

- Describe how you selected the appropriate SI prefixes when reporting your research results.
- Describe how environmental factors during your research may have impacted the measurement results.
- Describe how you selected the measurement equipment used during this project.
- If you were to repeat this research, describe ideas on how to improve the measurement process.
- What is the temperature of this room in Celsius (e.g., ~ 20 °C)?
- What is the average human body temperature in degree Celsius (e.g., 37 °C)?
- Describe your height in centimeters or meters (e.g., ~ 155 cm to 180 cm or 1.5 m to 1.8 m).
- What is the approximate mass of 1 mL of water at 4 °C (e.g., ~ 1 g)?
- What is the mass of 1 m^3 of water at 4 °C (e.g., 1 metric ton or 1 tonne)?
- How many cubic centimeters (cm^3) are in 1 L (e.g., 1000 cm^3)?
- Describe how you would represent the concept of parts per million concentration to another researcher using liters (e.g., 1 mg/L or one milligram per liter)?
- Describe how to illustrate parts per billion using 1 m^3 (e.g., 1 mg/m^3 or one milligram per cubic meter).

US Metric Association (USMA) Science Fair Award Program

Science Fair Judging Guide

https://usma.org

ELIGIBILITY: All U.S. student science fair competitors are eligible.

PROJECT: Research should involve quantitative measurements and use the International System of Units (SI), commonly known as the metric system. The subject of the project should not be the SI system itself.

ABOUT US: The US Metric Association is a national non-profit organization that was founded in 1916 and advocates completing the US transition to the International System of Units (SI). Additional USMA Science Fair Program information is available online (https://usma.org/science-fair-award-program).

SI UNIT USE: All reported measurements, including calculations, data, graphs, and conclusions should be expressed exclusively and accurately using the SI. The exclusive use of metric units is preferred. When non-SI equivalents are presented, they shall be presented secondary to the SI expression. Original observations and data collection should be obtained using metric measurements. To mitigate risk, avoid non-SI measurements. Do not make observations using non-SI units or mathematically convert to SI. Supplemental writing style tips are available online to become familiar with common mistakes (https://usma.org/correct-usage-of-the-si).

CRITERIA: A research project that expresses measurements in SI is an ideal candidate for the USMA metric award. Use the **Common SI Units for Science Fairs Table** to evaluate each project. Research may use a variety of SI parameters, such as force (newtons), kilopascals (pressure), joules (energy), power in watts (power), millimeters (length), or liters (volume). Measurement should be integral to the research, rather than superficially used to describe supplies (e.g., container capacity, substances quantities, or display board dimensions).

COMMON ERRORS: Incorrect unit symbol use is frequently used in science fair projects. Inappropriate capitalization (e.g., uppercase/lowercase font) can change the meaning of a unit symbol. For example, kilowatts (kW) is correct while (Kw, kw and KW) are incorrect. Symbols are always singular and are never followed by an “s.” For example gram (g), not gs, grs, gms, etc. Avoid multiple slashes for division. For example, use m/s^2, not m/s/s. The product of units is formed by a raised dot or a space between the separate symbols. For example, the symbol for the newton–second is N·s or N s, but not Ns. Symbols should not be mixed with words. Write the symbol km/h or spell out kilometers per hour; do not use kilometers/hour. Use approved SI symbols, not abbreviations. For example, use s rather than sec. for second. Use cm^3, not cc or c.c. for cubic centimeter. Use h not hr or hr. for hour. Symbols are not abbreviations of words, therefore do not require punctuation (e.g., a period). Use of deprecated (non-SI) metric system units are *unacceptable*. For example: Pressure (mmHg, cmHg, or millibars); energy (calories, kilocalories, or ergs), heat (dynes), or force (gram and kilogram).

The **Common SI Units for Science Fair** table provides the measurable quantity, unit name, and symbol for commonly encountered science fair units. Examples of acceptable multiples and submultiples and a selection of non-SI units that are officially considered acceptable for use with SI.

THANK YOU! The US Metric Association appreciates your service as a Science Fair Metric Award judge.

US Metric Association (USMA) Science Fair Award Program

Science Fair Judging Guide: Common SI Units for Science Fair Projects

Select Units of The International System of Units (SI). Columns 1 and 2 of the table are a subset of SI units and does not contain all SI base units or derived quantities but highlights base units and quantities frequently used in secondary school science fair projects. Column 3 is not all inclusive but contains examples of acceptable multiples and submultiples formed by using SI prefixes. Any of the 24 SI prefixes are acceptable for use. Each is shown followed by the power of 10 it represents and the symbol. For example, tera represents 10^{12} and its symbol is T, as in one terawatt (1 TW) equals one trillion watts (10^{12} W).

Measurable Quantity	Unit	Examples of Acceptable Multiples & Submultiples	Non-SI Units Accepted for Use with the SI
Length, Distance	meter (m)	millimeter (mm) kilometer (km)	Astronomical unit (au)
Mass (not weight)	kilogram (kg)	gram (g) milligram (mg) microgram (µg)	
Time	second (s)	millisecond (ms) microsecond (µs)	minute (min) hour (h) day (d)
Speed, Velocity	meter per second (m/s)	kilometer per second (km/s)	kilometer per hour (km/hr)
Acceleration	Meter per second squared (m/s^2)	centimeter per second squared (cm/s^2)	-----
Force (including weight)	newton (N)	kilonewton (kN)	-----
Energy (all forms, including Heat)	joule (J)	kilojoule (kJ) megajoule (MJ)	electron-volt (eV) kilowatt-hour (kW.h)
Power	watt (W)	kilowatt (kW) megawatt (MW)	-----
Pressure, also Stress	pascal (Pa) or newton per square meter (N/m^2)	megapascal (MPa) kilonewton per square meter (kN/m^2)	-----
Area	square meter (m^2)	square kilometer (km^2)	hectare (ha)
Volume or Capacity	cubic meter (m^3)	cubic centimeter (cm^3)	liter (L) milliliter (mL)
Angle	radian (rad)	milliradian (mrad)	degree (°), minute ('), second (")
Electromotive force (voltage)	volt (V)	millivolt (mV) kilovolt (kV)	-----
Current	ampere (A)	milliampere (mA)	-----
Resistance	ohm (W)	kilohm (kW) megohm (MW)	-----
Capacitance	farad (F)	microfarad (mF) picofarad (pF)	-----
Inductance	henry (H)	millihenry (mH)	-----
Temperature	kelvin (K), degree Celsius (°C)	millikelvin (mK) (prefixes are not used with °C)	-----

SI Prefixes

Multiples						Submultiples					
deka	(10^1)	da	peta	(10^{15})	P	deci	(10^{-1})	d	femto	(10^{-15})	f
hecto	(10^2)	h	exa	(10^{18})	E	centi	(10^{-2})	c	atto	(10^{-18})	a
kilo	(10^3)	k	zetta	(10^{21})	Z	milli	(10^{-3})	m	zepto	(10^{-21})	z
mega	(10^6)	M	yotta	(10^{24})	Y	micro	(10^{-6})	µ	yocto	(10^{-24})	y
giga	(10^9)	G	ronna	(10^{27})	R	nano	(10^{-9})	n	ronto	(10^{-27})	r
tera	(10^{12})	T	quetta	(10^{30})	Q	pico	(10^{-12})	p	quecto	(10^{-30})	q