Spring 2018 ASTR 1200-001 General Astronomy: Stars & Galaxies.
Temperature Worksheet.

1. What is temperature?

2. What does absolute zero mean?

3. What are the common units of absolute temperature?

4. Where on Earth has the coldest temperature been reached?

5. When can an object be described by a temperature?

6. What is the conversion factor between degrees and energy called?

7. What is the name of the characteristic spectrum of photons which is described by a temperature?

8. What is Wien's Law?

9. What is the Stefan-Boltzmann Law?

10. What happens when the temperature-energy exceeds the rest mass energy of particles?

Answers

1. Temperature is a measure of the mean energy per particle of random motions of particles. (More correctly, temperature is a measure of the mean energy per particle in excess of the zero-point quantum energy.)

2. Absolute zero is a condition where motions of particles are at a minimum. The motions are not quite zero because quantum mechanics gives particles a finite jitter even at absolute zero.

3. The common units of absolute temperature are degrees Kelvin, or simply Kelvin, denoted K. An interval of 1 K is the same as an interval of 1°C (1 degree centigrade), or an interval of 1.8°F (1.8 degrees Farhenheit). Absolute zero is $0\,\mathrm{K} = -273.15°\mathrm{C}$.

4. On Earth, the coldest temperature reached has been in cold-atom labs, such as those at JILA and MIT.

5. An object can be described by a temperature when it is in "thermodynamic equilibrium," a condition in which particle motions are as random as possible.

6. The conversion factor between degrees and energy is called Boltzmann's constant k. The mean energy per particle is proportional to kT.

7. The name of the characteristic spectrum of photons described by a temperature is a thermal (or blackbody, or Planck) spectrum.

8. Wien's Law is that the frequency f_{peak} of the peak of the blackbody spectrum is proportional to temperature, $f_{\mathrm{peak}} \propto T$. Alternatively, the wavelength λ_{peak} of the peak is inversely proportional to temperature, $\lambda_{\mathrm{peak}} \propto 1/T$.

9. The Stefan-Boltzmann Law is:

Luminosity	=	Area	×	Stefan-Boltzmann constant	×	Temperature^4
L	=	A		σ		T^4 .

10. When the temperature-energy exceeds the rest mass energy of particles, particle-antiparticle pairs are created.