Kelvin Temperatures and Very Cold Things!

To keep track of some of the coldest things in the universe, scientists use the Kelvin temperature scale that begins at 0 Kelvin, which is also called Absolute Zero. Nothing can ever be colder than Absolute Zero because at this temperature, all motion stops. The table below shows some typical temperatures of different systems in the universe.

Table of Cold Places and Things

Temp. (K)	Object or Event
183	Vostok, Antarctica
160	Phobos- a moon of mars
134	Superconductors
128	Europa in the summer
120	Moon at night
95	Titan surface temp.
90	Liquid oxygen
88	Miranda surface temp.
81	Enceladus in the summer
77	Liquid nitrogen
70	Mercury at night
63	Solid nitrogen
55	Pluto in the summertime
54	Solid oxygen
50	Dwarf Planet Quaoar
45	Shadowed crater on moon
40	Star-forming nebula
33	Pluto in the wintertime
20	Liquid nitrogen
19	Bose-Einstein condensate
4	Liquid helium
3	Cosmic background light
2	Liquid helium
1	Boomerang Nebula
0	ABSOLUTE ZERO

You are probably already familiar with the Celsius (C) and Fahrenheit (F) temperature scales. The two formulas below show how to switch from degrees-C to degrees-F.

$$C = \frac{5}{9}(F - 32) \qquad F = \frac{9}{5}C + 32$$

Because the Kelvin scale is related to the Celsius scale, we can also convert from Celsius to Kelvin (K) using the equation:

$$K = 273 + C$$

Use these three equations to convert between the three temperature scales:

Problem 1: 212 F converted to K

Problem 2: 0 K converted to F

Problem 3: 100 C converted to K

Problem 4: -150 F converted to K

Problem 5: -150 C converted to K

Problem 6: Two scientists measure the daytime temperature of the moon using two different instruments. The first instrument gives a reading of +107 C while the second instrument gives +221 F.

A) What are the equivalent temperatures on the Kelvin scale;

B) What is the average daytime temperature on the Kelvin scale?

Answer Key

$$C = \frac{5}{9}(F - 32) \qquad F = \frac{9}{5}C + 32 \qquad K = 273 + C$$

Problem 1: 212 F converted to K :
First convert to C: C = 5/9 (212 - 32) = +100 C. Then convert from C to K:
K = 273 + 100 = **373 Kelvin**

Problem 2: 0 K converted to F: First convert to Celsius:
0 = 273 + C so C = -273 degrees. Then convert from C to F:
F = 9/5 (-273) + 32 = **-459 Fahrenheit**.

Problem 3: 100 C converted to K : K = 273 - 100 = **373 Kelvin**.

Problem 4: -150 F converted to K : Convert to Celsius
C = 5/9 (-150 - 32) = -101 C. Then convert from Celsius to Kelvin: K = 273 - 101 = **172 Kelvin**.

Problem 5: -150 C converted to K : K = 273 + (-150) = **123 Kelvin**

Problem 6: Two scientists measure the daytime temperature of the moon using two different instruments. The first instrument gives a reading of + 107 C while the second instrument gives + 221 F.

A) What are the equivalent temperatures on the Kelvin scale?;
107 C becomes K = 273 + 107 = **380 Kelvins.**
221 F becomes C = 5/9 (221 - 32) = 105 C, and so K = 273 + 105 = **378 Kelvins**.

B) What is the average daytime temperature on the Kelvin scale?
Answer: (380 + 378)/2 = **379 Kelvins**.

C) Explain why the Kelvin scale is useful for calculating averages of different temperatures. Answer: **Because the degrees are in the same units in the same measuring scale so that the numbers can be averaged.**

Note: Students may recognize that in order to average +107 C and +221 F they could just as easily have converted both temperatures to the Centigrade scale or the Fahrenheit scale and then averaged those temperatures. You may challenge them to do this, and then compare the averaged values in the Celsius, Fahrenheit and Kelvin scales. They should note that the final answer will be the same as 379 Kelvins converted to F and C scales using the above formulas.