Stars are spread out through space at many different distances from our own Sun and from each other. In this problem, you will calculate the distances between some familiar stars using the 3-dimensional distance formula in Cartesian coordinates. Our own Sun is at the origin of this coordinate system, and all distances are given in light-years. The distance formula is given by:

$$d = \sqrt{(X_2 - X_1)^2 + (Y_2 - Y_1)^2 + (Z_2 - Z_1)^2}$$

Star	Distance from Sun	Constellation	X	Y	Z	Distance from Polaris
Sun			0.0	0.0	0.0	
Sirius			-3.4	-3.1	7.3	
Alpha Centauri			-1.8	0.0	3.9	
Wolf 359			4.0	4.3	5.1	
Procyon			-0.9	5.6	-9.9	
Polaris			99.6	28.2	376.0	0.0
Arcturus			32.8	9.1	11.8	
Tau Ceti			-6.9	-8.6	2.5	
HD 209458			-94.1	-120.5	5.2	
Zubenelgenubi			64.6	-22.0	23.0	

Question 1: Within which constellations are these stars located?

Question 2: What are the distances of these stars from the Sun in light-years?

Question 3: If you moved to the North Star, Polaris, how far would the Sun and other stars be from you? Enter the answer in the table above.

Question 4: Which of these stars is the closest to Polaris?

Question 5: What does your answer to Question 4 tell you about the stars you see in the sky from Earth?

Star	Distance from Sun	Constellation	X	Y	Z	Distance from Polaris
Sun	**0.0**	**None**	0.0	0.0	0.0	**390**
Sirius	**8.68**	**Canis Major**	-3.4	-3.1	7.3	**384**
Alpha Centauri	**4.34**	**Cantaurus**	-1.8	0.0	3.9	**387**
Wolf 359	**7.8**	**Leo**	4.0	4.3	5.1	**384**
Procyon	**11.45**	**Canis Minor**	-0.9	5.6	-9.9	**399**
Polaris	**390**	**Ursa Minor**	99.6	28.2	376.0	**0**
Arcturus	**36**	**Bootes**	32.8	9.1	11.8	**371**
Tau Ceti	**11.35**	**Cetus**	-6.9	-8.6	2.5	**390**
HD 209458	**153**	**Pegasus**	-94.1	-120.5	5.2	**444**
Zubenelgenubi	**72**	**Libra**	64.6	-22.0	23.0	**358**

Question 1: Within which constellations are these stars located? **Answer:** Students may use books or GOOGLE to enter the answers in the table.

Question 2: What are the distances of these stars from the Sun in light-years? **Answer:** Use the formula provided with X1=0, y1=0 and z1 = 0. Example for Sirius where x2 = -3.4, y2 = -3.1 and z2=7.3 yields, D = ((-3.4)^2 + (-3.1)^2 + (7.3)^2)^0.5 = 8.7 light-years.

Question 3: If you moved to the North Star, Polaris, how far would the Sun and other stars be from you? Enter the answer in the table. **Answer:** To do this, students select the new origin at Polaris and fix x1 = **99.6**, y1=**28.2** and z1 = **376.0** in the distance formula. They then insert the X, Y and Z coordinates for the other stars and compute the distance. Example, for the Sun, the distance will be 390 light years, because that is how far Polaris is from the Sun. For HD 209458, the distance formula gives D = ((-94.1 – **99.6**)^2 + (-120.5 – **28.2**)^2 + (5.2 – 376)^2)^0.5 = (37519 + 22111 + 137492)^0.5 = 444 light years.

Question 4: Which of these stars is the closest to Polaris? **Answer:** Zubenelgenubi!

Question 5: What does your answer to Question 4 tell you about the stars you see in the sky from Earth? **Answer:** This is a great lesson in 3-d space visualization. Even though Polaris and HD 209458 are close in the sky as viewed from Earth (they are in Ursa Minor and Pegasus respectively as a star chart will show) they are actually the farthest apart of any two stars in this list.