**Bridging to Polymers: Thermoset Lab Activity –
Thermoset Lab Worksheet – Answers**

**Pre-Lab Questions**

1. Why is it possible to vary the mechanical properties of our material?

**The number of connections changes.**

1. Is the material that you are making a (thermoplastic or a **thermoset**)? *Circle the correct answer.*
2. In *your own words,* what is a thermoplastic?

**A thermoplastic is a collection of many linear polymers whose final shape can be changed through heating the material up and melting it.**

1. In *your own words,* what is a thermoset?

**A thermoset is a polymer system that has gone through a curing reaction and is “set” in its final shape. A thermoset cannot be reshaped by heating.**

1. In a laboratory, it is common to use a mass ratio instead of a volume ratio. If the density of epoxy and amine is 1.1 and 0.9 grams/mL, respectively, how much volume of each do you need to make a 10 gram sample with a 10:1 epoxy to amine mass ratio?

**10 g sample (10 g epoxy / 11 g sample ) ( 1 ml epoxy/ 1.1 g epoxy) = 8.26 ml epoxy**

**10 g sample (1 g amine / 11 g sample ) ( 1 ml amine/ 0.9 g amine) = 1.01 ml amine**

1. What ratios were assigned to your group?

**Varies by group.**

1. To get stiff materials, what type of ratio(s) do you need (large or small or **in between)**?
*Circle the answers(s) that apply.*
2. For flexible materials what type of ratio(s) do you need (**small or large** or in between)?
*Circle the answer(s) that apply.*

**Making Thermosets (sharing and interpreting data)**



**Post-Lab Questions**

1. Which ratio(s) of amine hardener is/are the stiffest? **10:1**
2. Which ratio(s) of amine hardener is/are the softest? **20:1**
3. What can you conclude about the amine hardener or what is the general trend between mL versus flexure weight (N)?

**The stiffest is when the amines are stoichiometrically in balance with the epoxy. Our data showed this to be a 10:1 ratio. (This may differ from theoretical value due to how accurate the students were)**

**The most flexible was the 20:1 before the stoichiometric ratio was reached and once past the stoichiometric ratio, the strength fell to approximately a third of what it was at its peak. Unreacted functional groups (amines) in this case caused loose ends which causes the material to become flexible again.**

1. Think back to the bridge analogy, why is there a difference in strength between ratios?

**When you have just the optimum number of beams for support on a bridge it is very strong.**

**When you have just the optimum number of bonds (stoichiometric ratios) you get a very strong thermoset.**

**Note: The analogy does break down when comparing the chemical to a bridge that has too many extra connections. The chemical bridge will get weaker, but the actual bridge does not necessarily get weaker; it just has wasted materials.**