Name: _____ **Date:** _____

Viscosity Activity Worksheet Answers

1. **Describe the fluid you are working with using every day descriptive vocabulary.** (For example: "I am looking at honey. It is yellow(ish) and clear(ish). It is pretty thick and moves slowly. It feels sticky.")

   Answers to questions 1-6 will vary, depending on the fluids and equipment used.

2. **Calculate the <u>density</u> of the fluid using these steps:**
   - Weigh the empty graduated cylinder. Record its mass in grams.

     $M_{cylinder}$=_____ [g]
   - Fill the cylinder with fluid, and record the volume in cm^3. Note: 1 cm^3=1 ml.

     Vol_{fluid}=_____ [cm^3]
   - Weigh the full graduated cylinder. Subtract the mass of the empty graduated cylinder and record the mass of the fluid.

     M_{fluid}=_____ [g]
   - The density of the fluid is the mass over the volume. Calculate the density of the fluid.

$$\rho_f = \frac{Mass\,of\,Fluid\,[g]}{Volume\,of\,Fluid\,[cm^3]}$$

ρ_f = _____ [g/cm^3]

Name: _____ Date: _____

3. **Measure the <u>density</u> of the sphere using these steps:**

- Measure the radius of the sphere. Record as r [cm].

r_s = _____ [cm]

- Calculate the volume of the sphere. Either use the equation: $Vol_s = \frac{4}{3}\pi r^3$ or place the sphere in a graduated cylinder filled with water and record its displacement.

Vol_s = _____ [cm^3]

- Weigh the sphere. Record its mass.

M_s = _____ [g]

- Calculate the density of the sphere by dividing its mass by its volume.

$$\rho_s = \frac{Mass\,of\,Sphere\,[g]}{Volume\,of\,Sphere\,[cm^3]}$$

ρ_s = _____ [g/cm^3]

4. Measure the <u>terminal velocity</u> of the sphere falling through the fluid using these steps:

- With your stopwatch ready, drop the ball into the fluid.

  If the fluid is not very viscous, the ball will fall through it very fast, *so be ready!*

  If the fluid is thick enough, then the ball will reach a constant speed.
  This is the *terminal velocity*, the point at which the drag on the sphere by the fluid is equal to the force of gravity.

- Measure how fast the ball falls a distance. Record the distance, and the time.

distance = _____ [cm]

time = _____ [s]

- Calculate the velocity, which is the distance divided by the time.

V_s = _____ [cm/s]

Name: _____ Date: _____

5. **Using this equation, derived from Stokes' law, calculate the viscosity of your fluid.** Gravity is 981 cm/s^2. *Be very careful* to show your units and how they cancel out. Your final answer should be in units of [g/(cm s)].

$$\mu = \left(\frac{2}{9}\right) * \frac{r^2 * g(\rho_s - \rho_f)}{V_s}$$

μ= _____ [g/(cm s)]

6. **Viscosities are usually recorded in [Pa s]. To convert from [g/(cm s)] to [Pa s], simply divide by 10:**

$$1\,[Pa\,S] = 1\left[\frac{kg}{m\,s}\right] = 1\left[\frac{1000\,g}{100\,cm\,s}\right] = 10\left[\frac{g}{cm\,s}\right]$$

μ=_____ [Pa s]

7. **Using the internet, look up the viscosities of some common household fluids. Be sure to include units. Do any of the answers surprise you?**

Fluid	Viscosity
Example: **blood**	**3 x 10-3 to 4 x10-3 [Pa S]**
SAE 30 motor oil	**0.25 to 0.5 [Pa S]**
maple syrup	**0.15 to 0.2 [Pa S]**
milk	**2 x 10-3 to 5 x10-3 [Pa S]**

Fluid	Viscosity
castor oil	**0.25 to 0.5**
ketchup	**50 to 70 [Pa S]**
shortening or lard	**1,000 to 2,000 [Pa S]**
honey	**2 to 3 [Pa S]**

Note: In searching the internet, you may find viscosities in a variety of units. Some may be in Poise [P] or Centipoise [cP]. 1 [cP]=.001 [Pa s]. The viscosity of water is 1 [cP]. Other fluids may have viscosity in Stokes [St], which is the ratio of the viscosity to the density of the fluid. To convert from Stokes, multiply it by the fluid's density, or find another source! *Hint:* Search for "dynamic viscosity."