The viscosity of blood is to be determined from measurements of shear stress and shear rate obtained from a small blood sample tested in a suitable viscometer. Based on the data given in the table below, determine if the blood is a Newtonian or a non-Newtonian fluid. Explain how you arrived at your answer.

data set	1	2	3	4	5	6	7	8
shear rate [s^{-1}]	2.25	4.50	11.25	22.5	45.0	90.0	225	450
shear stress [N/m^2]	0.04	0.06	0.12	0.18	0.30	0.52	1.12	2.10

SOLUTION:

Plot the ratio of the shear stress to the shear rate to give the apparent dynamic viscosity:

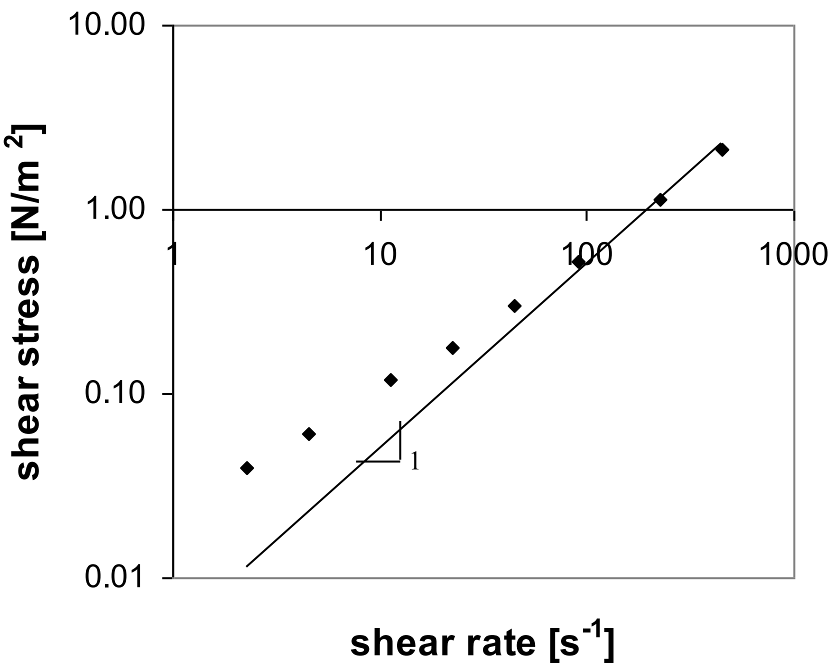
$$\mu_{\text{app}} = \frac{\tau}{\left(du/dy\right)}$$

data set	1	2	3	4	5	6	7	8
apparent viscosity, μ_{app} [kg/(m·s)]	0.0178	0.0133	0.0107	0.0080	0.0067	0.0058	0.0050	0.0047

Since the apparent viscosity is decreasing with increasing shear rate (increasing data set number), blood is not Newtonian, but is instead shear thinning.

Another way to look at the problem:

Plot the data on a log-log scale as shown below. Note that if $y = x^n$ (*i.e.* a power law function), then $\ln(y) = n\ln(x)$ (*i.e.* the function is a straight line with slope n on a log-log scale). Hence, if blood is Newtonian, then the shear rate-shear stress data plotted on a log-log scale will have a slope of one since $\tau \propto du/dy$ for a Newtonian fluid.



The slope of the blood data is not equal to one indicating that blood is non-Newtonian. In fact, since the slope is less than one over most of the range of shear rate, blood is shear thinning.