Transport Phenomena

Sheet No#2 Modeling

Q^1/ Develop an equation for the distance traveled by a freely falling body in time T assuming the distance depends upon the weight of the body, the acceleration of gravity, and the time.

Q^2/ The Reynolds number (Re) is a function of density, viscosity, and velocity of a fluid and a characteristic length. Establish the Reynolds number relation by dimensional analysis.

Q^3/ Determine the dynamic pressure exerted by a flowing incompressible fluid on an immersed object, assuming the pressure is a function of the density and the velocity.

Q^4/ For an ideal liquid, express the flow Q through an orifice in terms of the density of the liquid, the diameter of the orifice, and the pressure difference.

Q^5/ Assuming the drag force exerted by a flowing fluid on a body is a function of the density, viscosity, and velocity of the fluid and a characteristic length of the body, develop a general equation.

Table of dimension of several Quantities

	Quantity	Symbol	Solution: (a) *F-L-T*	(b) *M-L-T*
(*a*)	Area A in ft^2 or m^2	A	L^2	L^2
(*b*)	Volume v in ft^3 or m^3	v	L^3	L^3
(*c*)	Velocity V in ft/sec or m/s	V	$L\,T^{-1}$	$L\,T^{-1}$
(*d*)	Acceleration a or g in ft/sec^2 or m/s^2	a, g	$L\,T^{-2}$	$L\,T^{-2}$
(*e*)	Angular velocity ω in rad/sec	ω	T^{-1}	T^{-1}
(*f*)	Force F in lb or N	F	F	$M\,L\,T^{-2}$
(*g*)	Mass M in slugs or kg	M	$F\,T^2\,L^{-1}$	M
(*h*)	Specific weight γ in lb/ft^3 or N/m^3	γ	$F\,L^{-3}$	$M\,L^{-2}\,T^{-2}$
(*i*)	Density ρ in $slugs/ft^3$ or kg/m^3	ρ	$F\,T^2\,L^{-4}$	$M\,L^{-3}$
(*j*)	Pressure p in lb/ft^2 or Pa	p	$F\,L^{-2}$	$M\,L^{-1}T^{-2}$
(*k*)	Absolute viscosity μ in $lb\text{-}sec/ft^2$ or $N\cdot s/m^2$	μ	$F\,T\,L^{-2}$	$M\,L^{-1}T^{-1}$
(*l*)	Kinematic viscosity ν in ft^2/sec or m^2/s	ν	$L^2\,T^{-1}$	$L^2\,T^{-1}$
(*m*)	Modulus of elasticity E in lb/ft^2 or Pa	E	$F\,L^{-2}$	$M\,L^{-1}T^{-2}$
(*n*)	Power P in ft-lb/sec or $N\cdot m/s$	P	$F\,L\,T^{-1}$	$M\,L^2\,T^{-3}$
(*o*)	Torque T in ft-lb or $N\cdot m$	T	$F\,L$	$M\,L^2\,T^{-2}$
(*p*)	Rate of flow Q in ft^3/sec or m^3/s	Q	$L^3\,T^{-1}$	L^3T^{-1}
(*q*)	Shearing stress τ in lb/ft^2 or Pa	τ	$F\,L^{-2}$	$M\,L^{-1}\,T^{-2}$
(*r*)	Surface tension σ in lb/ft or N/m	σ	$F\,L^{-1}$	$M\,T^{-2}$
(*s*)	Weight W in lb or N	W	F	$M\,L\,T^{-2}$
(*t*)	Weight rate of flow W in lb/sec or N/s	W	$F\,T^{-1}$	$M\,L\,T^{-3}$