The measurement of mass -

Mass, length (distance) & time form

Mass ~~is one of~~ the three fundamental

All other physical quantities may be expressed in

physical quantities. In contrast

terms of these three fundamentals -

to length, which may be measured by direct comparison to ~~a~~ some standard, mass must be ~~determined~~ derived by measurement of some other quantity usually relating to force. The most common example of this is weighing. Here the force produced by the unknown mass in the fixed gravitational field of earth is measured by means of comparison to a 2°, known mass through a balance or by means of deflection of a calibrated spring. The mass measurement is ~~in terms~~ derived from the acceleration produced by a gravitational field; $\frac{F}{A} = M$ where A ~~represents~~ is the gravitational attraction G given by $G = K\frac{m_1 m_2}{d^2}$.

In ~~an ordinary~~ a linear reference frame ~~the~~ force on a particle of mass M is

$$F = M\sqrt{A^2 + \frac{V^4}{r^2}}$$

where:

A = acceleration $\frac{d^2x}{dt^2}$

V = velocity of particle $\frac{dx}{dt}$.

r = radius of a circle –

If the particle is moved in a straight line only the radius r become infinite & the 2° term of the equation relating to ~~curving~~ motion of curvature becomes 0. yrs. ~~+~~ The familar $F = MA$ results, ~~from~~

If now the particle moves ~~or~~ at constant rate in a circle, Acceleration is zero and the ~~ff~~ expression for centrifugal force, results.

$$F = \frac{MV^2}{r}$$ ~~results~~

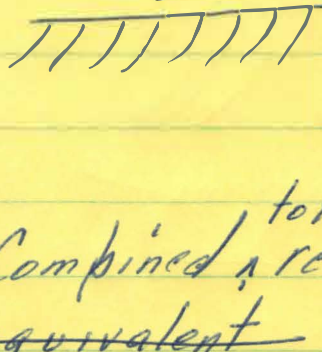
There are a number of other relationships of mass to other quantities which ~~mas~~ may allow the mass to be quantitated. ~~by mass application~~ ~~Some of these are the~~

Included are the equations for ~~period~~ frequency when ~~the mass is made part of~~ a restoring force (spring) ~~is added~~ is added

& the mass is displaced & the system allowed to oscillate. The variety of such oscillatory systems is almost infinite but three common types are shown here.

$$f = \frac{1}{2\pi}\sqrt{\frac{K}{m + \left(\frac{m_s}{3}\right)} - \frac{R^2}{4\left(M+\frac{m_s}{3}\right)^2}}$$

f = freq. cps.



K, m_s

K = spring const (Lb/in) (Lb/in)

M = Mass to be measured (lb. · sec²/in)

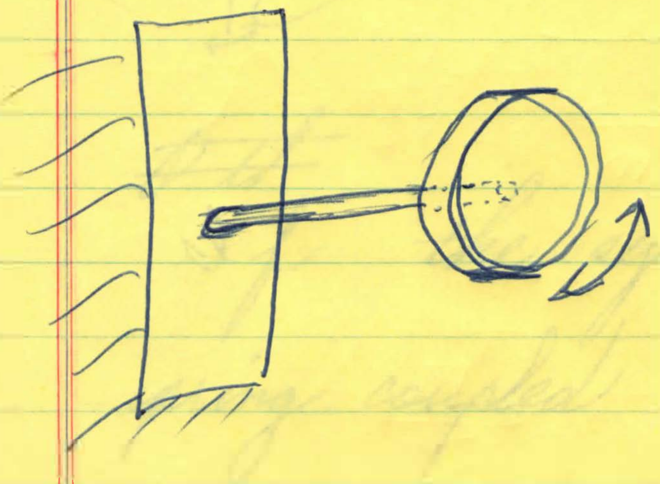
M_s = Mass of spring (lb. · sec.²/in.)

R = Combined total resistance ~~& equivalent~~ & ~~ie. on~~ equivalent resitive elements of system

$\left(\text{lb} / \frac{\text{in}}{\text{sec}} \right)$

The ~~equivalent~~ equation for the equivalent rotary ~~oscill~~ system is -

$$f = \frac{1}{2\pi}\sqrt{\frac{K_f}{I + \frac{I_s}{3}} - \frac{R^2}{2\left(I + \frac{I_s}{3}\right)^3}}$$



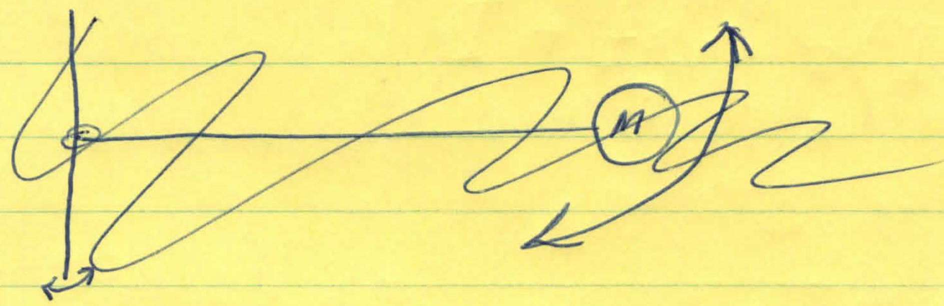
K_f = Torsional Stiffness of shaft Lb. in./rad.

I = Mass moment of inertia Lb·in·sec^2

R = Equiv. Res. #/in/sec

~~The equation using a shaft~~

~~The equation of a system oscillating in a plane~~



~~Oth~~

If the system were spring coupled to a 2° mass resulting in a 2 degree of freedom system, the equation is, Other possibly useful equations ~~involving~~ containing mass are:

$M_1 V_1 =$

Energy in a moving particle is given by -

$$E = \tfrac{1}{2} m V^2$$

~~If one lists the~~ The equations are listed in their various forms ~~it is simple to see the~~ in table 1.

Other Factor to be Known

~~Quanti~~ Effect Measured		Applied (Known)		~~Derived~~
F	÷	A	=	~~M~~
A	÷	F	=	~~M~~
$\frac{2F}{}$	÷	V^2	=	~~M~~

$F = MA$

$F = \frac{1}{2} M V^2$

$$f = \frac{1}{2\pi}\sqrt{\frac{K}{m + \frac{m_s}{3}} - \frac{R^2}{4\left(m + \frac{m}{3}\right)^2}}$$

Time

or freq

Displacement

$R - K + \frac{m_s}{3}$

$$f = \frac{1}{2\pi}\sqrt{\frac{K_f}{I + \frac{I_s}{3}} - \frac{R^2}{2\left(I + \frac{I_s}{3}\right)}}$$

$I = M \times L$

$E = \frac{1}{2} m V^2$

$\frac{I_s}{3}$ L, R

E

~~Time~~

V^2

As a ~~limit~~ primary limiting factor of the method, the ~~methods~~ accuracy of measurements and knowlege of applied and