PHYS121

Mechanics and Fluids

Dr. T. Greenshaw,
Room 332, Oliver Lodge Lab.
Tel 43383

First Semester 2000/2001

Lectures:

Mon	12:00	Chad M
Wed	10:00	Chad M

Problems Class:

Fri	12:00	Chad L

Contents

Contents cont.

Fluids

- Pascal’s principle
- Archimedes’ principle
- Bernoulli’s equation

Bibliography

- “Fundamentals of Physics”, extended sixth edition, by Halliday, Resnick and Walker.
- “University Physics”, Young and Freedman.
- “Physics for Scientists and Engineers”, Serway.
- “Physics”, Breithaupt.
- “Classical Mechanics”, H. Goldstein.

Lecture 1

- Introductory remarks
  - Units
  - SI prefixes
  - Force and Motion, suggested reading
  - Newton's Laws
  - Vectors

Introductory Remarks

Units

We use SI units, but you will encounter other systems, the fundamental quantities in some of these are:

	SI	cgs	fps
Length	metre (m)	centimetre (cm)	foot (ft)
Mass	kilogram (kg)	gram (g)	pound (lb)
Time	second (s)	second (s)	second (s)
Accel-eration	($m\ s^{-2}$)	($cm\ s^{-2}$)	($ft\ s^{-2}$)
Force	newton ($N = kg\ m\ s^{-2}$)	dyne ($g\ cm\ s^{-2}$)	pound-force (lbf)

Units cont.

Conversion factors:

1 inch =2.54 cm so 1 ft = 0.3048 m

1 lb = 0.4536 kg

SI Prefixes

Prefix	Symbol	Factor
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
hecto	h	10^{2}
deca	da	10^{1}
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}
atto	a	10^{-18}

Force and Motion

- Read H, R & W Chapt.s 1 – 5, in particular:
  - Straight line motion
  - Vectors
  - Relative motion
  - Newton’s Laws
- Have a go at the problems!

Newton's Laws

- First Law:
  - No net force acting on a body
    - » Body at rest remains at rest.
    - » Body in motion continues motion with constant velocity.
- Second Law
  - A net force acting on a body causes it to change it's momentum according to:

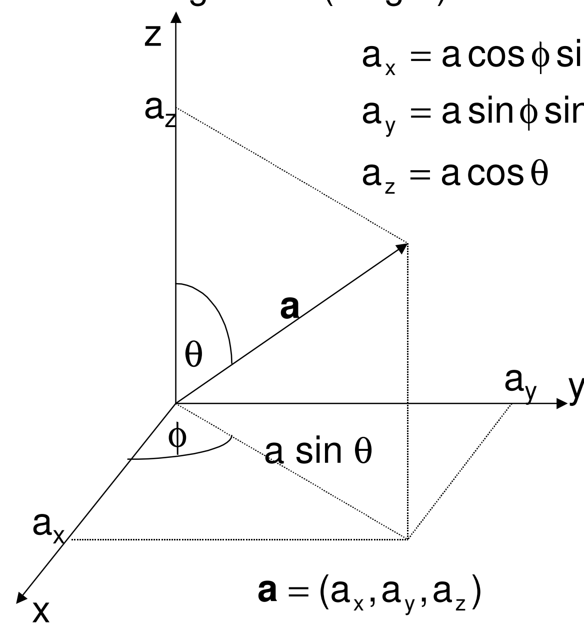
$$\sum \mathbf{F} = \frac{d}{dt}\mathbf{p}$$

- Third Law
  - If body A exerts a force $\mathbf{F}_{AB}$ on body B, then body B exerts a force $\mathbf{F}_{BA}$ on body A such that $\mathbf{F}_{AB} = -\mathbf{F}_{BA}$.

Vectors

- Vectors have direction (arrow) and magnitude (length).

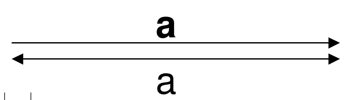
$$a_x = a\cos\phi\sin\theta$$
$$a_y = a\sin\phi\sin\theta$$
$$a_z = a\cos\theta$$



$$\mathbf{a} = (a_x, a_y, a_z)$$
$$= a_x\mathbf{i} + a_y\mathbf{j} + a_z\mathbf{k}$$

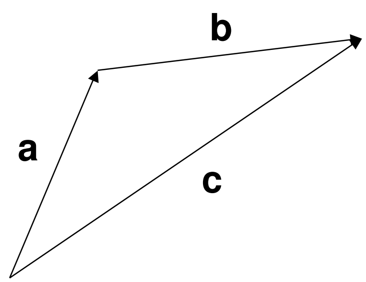
Vectors cont.

- Magnitude



$$a = |\mathbf{a}| = \sqrt{a_x^2 + a_y^2 + a_z^2}$$

- Vector addition

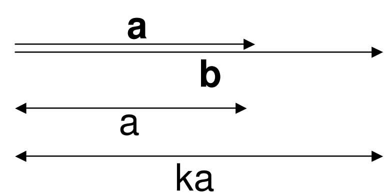


$$\mathbf{c} = \mathbf{a} + \mathbf{b}$$

$$(c_x, c_y, c_z) = (a_x + b_x, a_y + b_y, a_z + b_z)$$

Vectors cont.

- Multiplication by scalar

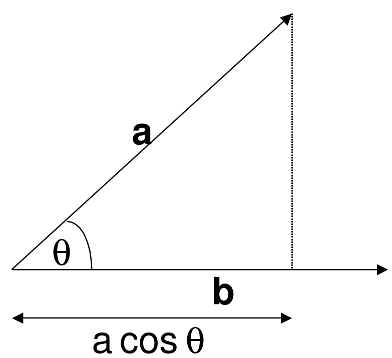


$$\mathbf{b} = k\mathbf{a}$$

$$(b_x, b_y, b_z) = (ka_x, ka_y, ka_z)$$

Vectors cont.

- Scalar or dot product



$$\mathbf{a}\cdot\mathbf{b} = ab\cos\theta$$
$$= (a_x b_x + a_y b_y + a_z b_z)$$

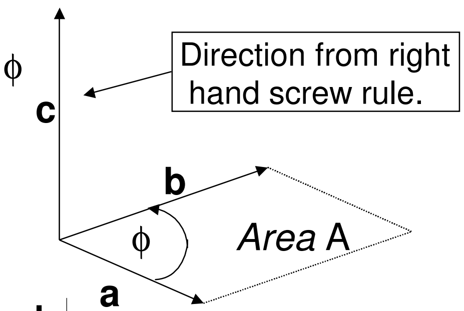
e.g. Work done by force **F** *moving displacement* **d***:*

$$W = \mathbf{F}\cdot\mathbf{d}$$

Vectors cont.

- Vector or cross product

$$c = ab\sin\phi$$
$$= A$$



$$\mathbf{c} = \mathbf{a}\times\mathbf{b}$$

$$\mathbf{c} = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ a_x & a_y & a_z \\ b_x & b_y & b_z \end{vmatrix}$$

$$= (a_y b_z - a_z b_y)\mathbf{i} - (a_x b_z - a_z b_x)\mathbf{j} + (a_x b_y - a_y b_x)\mathbf{k}$$

e.g. Torque of force **F** *at displacement* **r***:* $\tau = \mathbf{r}\times\mathbf{F}$