Chapters 4 and 5

Terms

Be able to define or discuss the following terms and ideas, with their SI units if appropriate.

1. contact force
2. parallel component of a contact force
3. perpendicular (i.e. normal) component of a contact force
4. sliding friction (i.e. kinetic friction)
5. coefficient of sliding friction, μ_k
6. static friction
7. coefficient of static friction, μ_s
8. derivative form of the momentum principle
9. static equilibrium (i.e. equilibrium)
10. parallel (i.e. tangential) component of $\frac{d\vec{p}}{dt}$
11. perpendicular component of $\frac{d\vec{p}}{dt}$
12. rate of change of magnitude of momentum
13. rate of change of direction of momentum
14. "kissing" circle
15. Newton's second law for the parallel (i.e. tangential) component of net force
16. Newton's second law for the perpendicular componet of net force
17. uniform circular motion
18. direction of net force for uniform circular motion
19. magnitude of net force for uniform circular motion
20. "weightlessness"
21. buoyancy
22. buoyant force
23. Archimedes' Principle
24. density
25. pressure
26. atmospheric pressure at sea level

Equations

Understand the meaning and know the SI units of all symbols in these equations; know how to perform each mathematical operation, such as trig functions; know how to solve for any unknown quantity; understand how changing one quantity affects another quantity (if all other quantities remain constant); be able to apply one or more equations to solve a problem.

- $$f_k = \mu_k F_N \tag{1}$$
- $$f_s \leq \mu_s F_N \tag{2}$$
- $$\vec{F}_{net} = \frac{d\vec{p}}{dt} \tag{3}$$
- $$\vec{F}_{net,tan} = \frac{d|\vec{p}|}{dt}\hat{p} \tag{4}$$
- $$\vec{F}_{net,tan} \approx m\frac{d|\vec{v}|}{dt}\hat{v} \qquad \text{for } v << c \tag{5}$$
- $$\vec{F}_{net,\perp} = |\vec{p}|\frac{d\hat{p}}{dt} \tag{6}$$
- $$|\vec{F}_{net,\perp}| \approx \frac{m|\vec{v}|^2}{R} \qquad \text{for } v << c \tag{7}$$
- for uniform circular motion:

$$\omega = \frac{\Delta\theta}{\Delta t} \tag{8}$$
$$\omega = \frac{2\pi}{T} \tag{9}$$
$$v = R\omega \tag{10}$$
$$v = \frac{2\pi R}{T} \tag{11}$$
$$\theta = \omega t + \theta_0 \tag{12}$$

- for a circular orbit:

$$v = \sqrt{\frac{GM}{R}} \tag{13}$$
$$T^2 = \frac{4\pi^2}{GM}R^3 \tag{14}$$

- $$|\vec{F}_{buoyant}| = m_{fluid\ displaced}g = \rho_{fluid}gV_{fluid\ displaced} \tag{15}$$
- $$P = \frac{F}{A} \tag{16}$$
- pressure as a function of depth in a fluid (h is the depth between the top point and the bottom point where pressures are being measured):

$$P_{bottom} = P_{top} + \rho_{fluid}gh \tag{17}$$
$$\tag{18}$$

Skills

1. Draw a force vector for the normal force on a particle in any given situation.
2. Identify and sketch all forces acting on a particle in any given situation.
3. Solve for an unknown force on a particle in static equilibrium.
4. Sketch the parallel and perpendicular components of the net force on a particle if given the path of the particle and whether the particle is speeding up or slowing down
5. Predict the path and whether the particle will speed up or slow down if given the momentum and net force vectors on the particle.
6. Apply the momentum principle and solve for an unknown force for a particle moving along a curved path if given all other known quantities.
7. Apply the momentum principle and solve for the speed of a particle moving along a curved path if given all other known quantities.
8. Describe what is meant by a person feeling "weightless".
9. Use the momentum principle to derive an expression for pressure as a function of depth in a static, incompressible fluid.
10. Use the momentum principle to derive an expression for the buoyant force of a fluid on an object floating or submerged in the fluid.
11. Apply the momentum principle to calculate unknown forces (or other unknown quantities) on an object floating or submerged in a fluid, if it is in static or dynamic equilibrium or if it is accelerating.

Lab Skills

1. Use video analysis to measure x(t) and y(t) for an object in uniform circular motion; from a graph of x(t), determine the radius, angular velocity, period, and speed of an object in uniform circular motion; from a graph of $\theta(t)$, determine the angular velocity.