

# REFERENCE SHEET

Forces we have studied:

- Normal force: contact force between objects. Can only push, never pull.
- Gravity:  $mg$  downward on Earth,  $\frac{GMm}{r^2}$  in general, where  $r$  is the distance between the objects' centers
- Static friction: keeps objects which are in contact from sliding; maximum value  $F_{f,\max} = \mu_s F_N$ . Traction is a special case of static friction.
- Kinetic friction: opposes the relative motion of two surfaces in contact.  $F_f = \mu_k F_N$ .
- Tension: force that ropes exert on things. Can only pull, never push.

Centripetal acceleration of an object in uniform circular motion:

$$a_c = \frac{v_T^2}{r} \text{ or } \omega^2 r$$

Tangential velocity  $v_T = \omega r$

Newton's second law:  $\vec{F} = m\vec{a}$

Newton's third law:  $\vec{F}_{A \text{ on } B} = -\vec{F}_{B \text{ on } A}$

Kinematics of constant acceleration:

$$\begin{aligned}x(t) &= \frac{1}{2}at^2 + v_0t + x_0 \\v(t) &= at + v_0 \\v_f^2 - v_0^2 &= 2a\Delta x\end{aligned}$$

1 revolution = 360 degrees =  $2\pi$  radians

Momentum:  $\vec{p} = m\vec{v}$

Conservation of momentum:  $\sum \vec{p}_i = \sum \vec{p}_f$ , if there are no external forces