Reference Material – Unit 3

Note: *You may* not *bring this reference to the exam on Tuesday. This is only for your practice exam, in case you've not made your own yet. However, I will give you the moments-of-inertia information here on Tuesday whenever you need it.*

Hooke's law for elasticity: $F_{\text{elastic}} = -k\Delta x$

The work-energy theorem:

$$\frac{1}{2}mv_i^2 + W_{\text{all}} = \frac{1}{2}mv_f^2$$

The work-energy theorem, using potential energy:

$$\frac{1}{2}mv_i^2 + \text{PE}_{\text{i}} + W_{\text{other}} = \frac{1}{2}mv_f^2 + \text{PE}_{\text{f}}$$

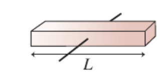
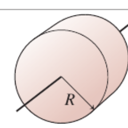
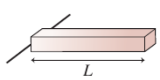
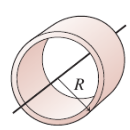
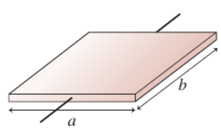
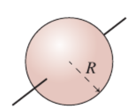
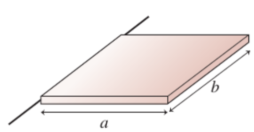
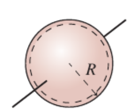
Kinetic energy of translation: $\frac{1}{2}mv^2$ Kinetic energy of rotation: $\frac{1}{2}I\omega^2$

Gravitational potential energy: mgy
Elastic potential energy: $\frac{1}{2}k(\Delta x)^2$, where Δx is the amount by which the spring is stretched or compressed

If an object rotates at angular velocity ω, a point at radius r moves at a speed $v_T = \omega r$.

Translation	Rotation
Position $\vec{s}$ Velocity $\vec{v}$ Acceleration $\vec{a}$	Angle θ Angular velocity ω Angular acceleration α
Kinematics: $\vec{s}(t)\frac{1}{2}\vec{a}t^2 + \vec{v}_0 t + \vec{s}_0$	$\theta(t) = \frac{1}{2}\alpha t^2 + \omega_0 t + \theta_0$
Force $\vec{F}$ Mass m Newton's second law $\vec{F} = m\vec{a}$	Torque τ Rotational inertia I Newton's second law for rotation $\tau = I\alpha$
Kinetic energy $KE = \frac{1}{2}mv^2$ Work $W = \vec{F} \cdot \Delta\vec{s}$ Power $P = \vec{F} \cdot \vec{v}$	Kinetic energy $KE = \frac{1}{2}I\omega^2$ Work $W = \tau\Delta\theta$ Power $P = \tau\omega$
Momentum $\vec{p} = m\vec{v}$	Angular momentum $L = I\omega$ (extended object) $L = mvr_\perp$ (point-like object)

TABLE 12.2 Moments of inertia of objects with uniform density

Object and axis	Picture	I	Object and axis	Picture	I
Thin rod, about center		$\frac{1}{12}ML^2$	Cylinder or disk, about center		$\frac{1}{2}MR^2$
Thin rod, about end		$\frac{1}{3}ML^2$	Cylindrical hoop, about center		MR^2
Plane or slab, about center		$\frac{1}{12}Ma^2$	Solid sphere, about diameter		$\frac{2}{5}MR^2$
Plane or slab, about edge		$\frac{1}{3}Ma^2$	Spherical shell, about diameter		$\frac{2}{3}MR^2$