**EART160: Equations You Should Know (in addition to high school physics)**

## Gravity and impacts

| | | | |
|---|---|---|---|
| Newton's law | $F=GMm/r^2$ | Surface gravity | $g=GM/R^2$ |
| Escape velocity | $v=(2gR)^{1/2}$ | Gravitational potential | $U=-GM/r$ |
| Orbital period | $GM=a^3\omega^2$ | | |

## Flexure and Stresses

| | | | |
|---|---|---|---|
| Hooke's law | $\sigma=E\varepsilon$ | Thermal expansion | $\varepsilon=\alpha\Delta T$ |
| Flexural parameter | $\alpha = \left[\frac{ET_e^3}{3g\Delta\rho(1-\nu^2)}\right]^{1/4}$ | | |

## Interiors

| | | | |
|---|---|---|---|
| Hydrostatic assumption | $dP=(-)\rho g dz$ | Heat flow | $F=k\,dT/dz$ |
| Specific heat capacity | $E=mC_p\Delta T$ | Rayleigh number | $Ra = \frac{\rho g\alpha\Delta T d^3}{\kappa\eta}$ |
| Thermal diffusivity | $\kappa=k/\rho C_p$ | Diffusion timescale | $t=d^2/\kappa$ |

## Atmospheres

| | | | |
|---|---|---|---|
| Black-body radiation | $F=\varepsilon\sigma T^4$ | Gas law | $PV=P\mu/\rho=RT$ |
| Scale height | $H=RT/g\mu$ | Coriolis acceleration | $a=2v\omega\sin\theta$ |

## Gravity and Tides

| | | | |
|---|---|---|---|
| Angular momentum | $L=I\omega$ | Moment of inertia | $I = \int r^2 dm = \sum mr^2$<br>$= mr^2$ (point mass)<br>$= 0.4\,MR^2$ (uniform sphere) |
| Kinetic energy of rotation | $E=I\omega^2/2$ | | |
| Orbital period | $GM=a^3\omega^2$ | Orbital energy | $E=-GMm/2a$ |

Equilibrium tide (fluid body) $H = \frac{5}{2} R \frac{M}{m}\left(\frac{R}{a}\right)^3$ ($M$ is the mass of the tide-raising body)