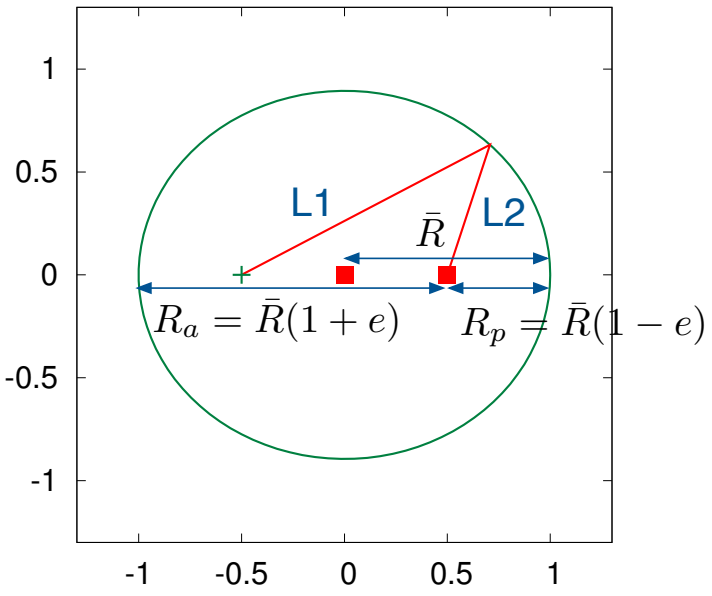

These are *only* the formulas needed for the homework. There were of course many concepts (gravitation lensing, falling, equivalence)

Kepler Laws

1. The average radius and the perihelion R_p and aphelion R_a are related to the eccentricity of the orbit
$$R_p = \bar{R}(1-e) \qquad R_a = \bar{R}(1+e) \tag{1}$$
2. For elliptic orbits the sum of the distances to the focii is constant
$$L_1 + L_2 = 2\bar{R} = \text{Constant} \tag{2}$$
3. The period T is related to the average radius $\bar{R}$
$$\frac{GM}{(2\pi)^2}T^2 = \bar{R}^3$$

Orbits and acceleration

1. When an object orbits in a circle its acceleration is
$$a = \frac{v^2}{R}$$
and is directed towards the center of the circle.

2. For constant acceleration in the (typically) vertical direction the distance covered is related to the acceleration and the time difference

$$\Delta x = \frac{1}{2} a \Delta t^2 \tag{3}$$

3. For constant velocity we have

$$\Delta x = v \Delta t \tag{4}$$

Special Relativity

1. For an observer sitting on a clock moving with speed v with respect to a fixed observer, the time between ticks as measured by the clock is $\Delta\tau$. This is a proper time. However the time between the ticks of the clock according to the stationary observer is Δt, and is longer than $\Delta\tau$:

$$\Delta t = \gamma \Delta\tau \qquad \gamma \equiv \frac{1}{\sqrt{1-(v/c)^2}}$$

The ticks according to the stationary observer do not happen at the same place in space and therefore is not proper time.

General-Relativity

1. The deflection of light by the sun. The angle of deflection

$$\theta = \frac{4GM}{Rc^2}$$

where R is the distance of closest approach

2. The Schwarzchild radius, is the radius from which no light can escape.

$$R_{sch} = \frac{2GM}{c^2}$$

Distances

You should have know alll these numbers It is not so important that you know all the numbers exactly. It is important that you know rougly the size. And can place it in context.

1. $R_E \sim 6000\,\mathrm{km}$
2. $R_{EM} \sim 400,000\,\mathrm{km}$
3. $R_\odot \sim 700,00\mathrm{km}$
4. $R_{ES} = 1\,\mathrm{AU}$,
5. Distance to α-centauri is $4.2\,\mathrm{ly}$,
6. The size of the galaxy $\sim 60\,000\mathrm{ly}$