Sample quiz questions. Preparation for the midterm exam in Planetary System Astrophysics ASTC25. Partly answered.

In the quiz, your work is that of a scientific editor of a text somebody has submitted for publication. Don't let any nonsense pass, but don't suppress the truth.

Please read the questions very carefully and answer *Y or N in front of the question.* You will submit the pages of the Quiz with your exam booklet.

Questions are sometimes tricky, for example only one word or value may be wrong. You will be asked to mark one or more wrong word or phrase by circling them. If you don't mark anything or mark a *correct word/phrase*, you get 0 points for that question, even if you correctly state "N" (meaning the sentence contains an error). Therefore be careful to mark the wrong part of the sentence, if any. It has happened more than once that students forgot about this requirement and only marked Y/N, losing lots of credit points. There will be up to about 35 questions in the midterm quiz.

Since it is difficult to write perfectly unambiguous questions, 2 points will be added for free to your score, to account for the possibility that one or two quiz questions can appear to be unclear.

Part II – TRUE-OR-FALSE quiz (please mark with Y or N for Yes or No, in a text file. Circle at least one wrong word of a sentence that you judge false. Disregard language errors and typos, errors are related to science. All questions are worth one point.

Some but not all questions are solved below.

[1] The most famous book about natural sciences was Isaac Newton's Principia Mathematica Philosophiae Naturalis, written in the 17th century and among others containing the principles of dynamics.

Y[1] Although Newton denied it later, exchange of ideas with Robert Hooke gave him a lot of motivation to perform the calculations of the shape of orbits.

[1] Angular momentum of Mars is a conserved quantity. Angular momentum of an interstellar comet 2I is not conserved.

Y[1] Specific angular momentum is equal $r^2 d\theta/dt$, where θ is true anomaly angle in a 2-body problem (or simply the azimuthal angle counted from the pericenter)

[1] Circular speed around the Earth, also called Keplerian speed or escape speed, equals about 11.2 km/s.

N[1] The Voyager space probes first photographed **active volcanos** on Mars.

Y[1] If the period of heliocentric orbit of a comet is 1000 years, then its semi-major axis is 100 AU.

[1] If a body reaches perihelion and aphelion at 1.1 and 1.9 AU, the semi major axis is equal 3.0 AU.

[1] Mars is approximately 1.52 AU from the sun. Neglecting eccentricities, the Earth would approach Mars to a minimum distance of 0.52 AU.

N[1] The Earth is **always** precisely 1 AU from the sun, by definition

N[1] Laplace (or Laplace-Runge-Lenz) vector can be computed from position and velocity of a body orbiting another body. The concept applies to 2-Body **and 3-body problem**, as long as two masssive bodies move on cirles.

[1] Energy of a binary system (e.g. sun-planet system) depends only on the semi-major axis, but not on the eccentricity of orbit.

N[1] Parabolic orbits in the 2-Body problem have zero **gravitational** energy E

[1] If a body exits solar system on a clearly hyperbolic orbit, it necessarily means that it also came in as an interstellar object

Y[1] Surprisingly, many cold icy satellites of Solar System planets show evidence of fluidized eruptions or cryovolcanism. This is possible by addition of tidal heating to the radiation from the sun.

N[1] Ancient theory of Democritus proposed that there is **only one** gravitational center of the universe, which rests insode the Earth.

[1] Roche lobe is the critical Roche surface, which narrows to a point at L1 Langrange quilibrium point.

N[1] French mathematician and astronomer **Pierre-Simon Laplace** proposed in 1787: "The worlds come into being as follows: many bodies of all sorts and shapes move from the infinite into a great void; they come together there and produce a single whirl, in which, colliding with one another and revolving in all manner of ways, they begin to separate like to like."

Y[1] The newly established coffee houses of London in mid-1600s played a role in development of physics of gravity and orbits

[1] Jacobi energy is being released as tidal heat Io and causing volcanism

[1] The triangular Lagrange points can be either stable or unstable equilibria, depending on the mass ratio. For mass ratio less than about 1:27, they are stable.

[1] Trojan asteroids, in 1:1 mean motion resonance with Saturn, are in stable orbits under the assumptions of the restricted 3 body problem

Y[1] Escape velocity is defined by the condition $E = E_{kin} + E_{pot} = 0.$, where $E_{kin} = v^2/2$, if like in astrophycis we consider specific energies

[1] Specific kinetic energy and specific potential energy are kinetic and potential energies divided by the mass of a test particle.

Y[1] James Jeans derived the stability criterion of a spherical cloud of gas against the gravitational collapse. In essence, it reads: if the total gravitational energy is less negative than a certain value corresponding to the value of thermal energy of the cloud, then the cloud remains stable.

[1] A cloud with a given size and mass which is too **hot**, becomes gravitationally unstable.

Y[1] Hayashi tracks are almost vertical on the Herzsprung-Russell (luminosity-temperature) diagram.

[1] The mass of 13 Jupiter masses or 0.013 solar masses provides a useful but arbitrary watershed between the stars (brown dwarfs) and planets.

Y[1] Voyager 1 and 2 are the names of the space probes that were sent to the outer planets of the solar system at the end of 1970s. They are now far outside the region of planets.

N[1] **According to the 3rd law of Kepler**, Halley's comet returning every 76 years, reaches on its eccentric orbit the aphelion at about 1100 AU from the sun.

[1] A strange system was discovered in 2003. An Earth-mass object circles around a brown dwarf with mass equal to **0.14 solar masses**.

[1] All stars form within accretion disks, and gather their final mass through disk accretion, which is the gas flow along a tight spiral onto the central object.

[1] Escape speed from a spherical body is $\sqrt{2}$ times larger than the Keplerian (circular) speed near its surface.

N[1] In Orion nebula disks are seen against a bright background of gas cluds illuminated by **cosmic background radiation**

[1] Force of gravity and other conservative forces can be derived from potential in the following way: $F = -\nabla\Phi$.

Y[1] Drag forces on planetary bodies and asteroids from the solar wind and other interplanetary gas and dust, as well as radiation pressure, are negligible. Strongly affected particles are smaller than pebbles, for instance sand and dust.

N[1] **Angular momentum** is the sum of velocity vectors times masses of all the particles comprising a system.

[1] Angular momentum is a conserved quantity. In N-body system without friction, another conserved quantity is energy.

N[1] Eccentricity $e > 0$ means that the body is on an **elliptic** orbit, $e = 0$ means that it is unbound and can escape from the system.

Y[1] Kepler's 3rd law states that a planet with and orbit 4 times as large as a given orbit, has a period of motion eight times longer than the first planet.

[1] The Green Comet of 2023 came from **outside** the solar system.

Y[1] Democritus and Leukippus proposed that from the inifinite number of atoms, an infinite variety of planetary systems must follow, which was quite prescient.

[1] The tides on Phobos bring it closer to Mars. It will eventually fall onto Mars.

[] Only the Moon raises tides on Earth, the sun-induced tides are unmeasureably small.

Y[1] The tidal lag is due to viscosity of the substance of the planet. . Without it, the tidal bulge would lie in the direction between the planet's and the moon's centers.

N[1] Of all the orbits of constant energy, the circular orbits have the **minimum** angular momentum

[1] There are two tides per day, because tides are due to two bodies: Moon and Sun.

[1] The Roche lobe radius for small satellites with mass ratio μ w.r.t. the central body is approximately $\pm(\mu/3)^{1/3}a$, where a is the semi-major axis of the relative orbit.

N[1] In July 1994 a comet called Shoemaker-Levy 9 that had earlier split into many pieces while flying close to **Uranus**, have bombarded atmosphere.

Y[1] One of the methods of finding extrasolar planets is to detect (via Doppler effect) the back-and-forth wobble of the host star

[1] Every year the Moon is further from the Earth by almost 4 cm on average.