Stellar Astronomer:

As a stellar astronomer you are an expert in the stellar classification system OBAFGKM, and know that this system goes from high mass and hot to low mass and cool stars. While you know our sun is a G type star (T = 5800 K), you understand the merits of looking for planets around even lower mass stars, like K and M types. You understand that for lower mass stars the habitable zone will move closer in because the star is dimmer, meaning planets are more likely to become tidally locked, but also that the star will live for a *very* long time, much longer even than the 10 Byr lifetime of our own sun. You are able to calculate the limits of the habitable zone for each stellar type. Your habitable zone limit and stellar age measurements will be useful to the orbital dynamicist.

From your sensor readings you can tell that there are planetary systems around two nearby stars. You record the following characteristics of each star and relay the information to your crewmembers so you can decide as a team which star to head towards.

M type star

- HZ limits: 0.25-0.4 AU
- Radius: 0.6 R_{sun}
- Mass: 0.6 M_{sun}
- T = 3800 K
- Lifetime: trillions of years
- Stellar age and activity level: 5 Byr old, no active flaring

K type star

- HZ limits: 0.4-0.7 AU
- Radius: 0.7 R_{sun}
- Mass: 0.8 M_{sun}
- T = 5000 K
- Lifetime: 15 Byr
- Stellar age and activity level: 150 Myr old, active flaring

Atmospheric Scientist:

As an atmospheric scientist you are an expert in all things atmospheric. You know that Earth's atmosphere is well-suited for life not only because of its oxygen and nitrogen content, but also because it has just the right amount of greenhouse gases like CO_2 to warm the planet, but not so many greenhouses gases that it is overheated. You also understand that an atmosphere is important for protecting a planet's surface from becoming heavily cratered due to meteorite impacts. You are aware that for liquid water to exist on the surface of a planet, there must be a certain amount of atmospheric pressure. You remind your crewmembers that too little atmosphere and the planet is Mars-like, but too much atmosphere and the planet is like Venus.

Molecular Signatures From Atmosphere:

- Planet A: strong CO_2
- Planet B: CO_2, N_2, H_2O
- Planet C : CO_2, N_2, H_2O
- Planet D: trace CO_2
- Planet E: water vapor detected

Atmospheric Pressure:

- Planet A: surface obscured under thick atmosphere
- Planet B: some cloud cover visible
- Planet C: some cloud cover visible
- Planet D: cratered surface visible
- Planet E: clouds detected

Orbital Dynamicist:
As an orbital dynamicist you are an expert in all things relating to the orbital properties of a planet. You are able to detect how eccentric an orbit is (i.e. how elongated), and know that eccentricities closer to zero mean more circular orbits, while higher eccentricities mean orbits are more elongated, or elliptical. You know that Pluto has a fairly elliptical orbit with an eccentricity of 0.25. You are aware that highly elliptical orbits can mean a planet spends more time outside the habitable zone, but that these types of orbits can also lead to tidal heating, creating a heat source other than the star for the planet. You can calculate the orbital distance from the planet to its host star, and this in turn tells you the tidal locking timescale for the planet, or how long it takes tidal forces to make the planet's rotation period equal to its orbital period (same side of the planet always faces the star). You can also get a reading on the axial tilt of the planet, and you know that Earth's axial tilt of 23.5 degrees gives us our stable seasons.

If your crew chose to pursue the planets around the K star, only choose from the K star parameters below, or vice-versa if your crew chose the M star.

Eccentricity of Orbit:

- Planet A: approximately zero
- Planet B: 0.2
- Planet C: 0.05
- Planet D: 0.1
- Planet E: 0.3

Orbital Distance:

M star:

- Planet A: 0.1 AU
- Planet B: 0.3 AU
- Planet C: 0.4 AU
- Planet D: 0.7 AU
- Planet E: 1.5 AU

K star:

- Planet A: 0.1 AU
- Planet B: 0.45 AU
- Planet C: 0.6 AU
- Planet D: 0.7 AU
- Planet E: 1.5 AU

Axial Tilt:

M star:

- Planet A: zero
- Planet B: zero
- Planet C: zero
- Planet D: zero
- Planet E: 23

K star:

- Planet A: zero
- Planet B: zero
- Planet C: 20
- Planet D: 25
- Planet E: 23

Tidal Locking Timescale:

M star:

- Planet A: 30,000 yrs
- Planet B: 8 Myr
- Planet C: 25 Myr
- Planet D: 1.4 Byr
- Planet E: 72 Byr

K star:

- Planet A: 17,000 yrs
- Planet B: 52 Myrs
- Planet C: 400 Myr
- Planet D: 1 Byr
- Planet E: 40 Byr

Planetary Geologist:

As a planetary geologist you are an expert in determining the mass, size and amount of geological activity present on a planet. You know that both Earth and super-Earth (planets larger than Earth but smaller than Neptune) sized planets are good choices for habitable planets because they are likely to have solid surfaces, potential for plate tectonics, and should be able to retain atmospheres. You know that planets any larger than this are likely to either be water worlds (no solid surface) or gas giants. You are also an expert in determining how geologically active a planet is. You understand that volcanic outgassing can be important for creating an atmosphere, and that geological activity and plate tectonics in particular can help regulate the greenhouse gases in an atmosphere. You remind your crewmembers that the density of water is 1 g/cm^3, the density of rock is 5 g/cm^3 and the density of iron is 8 gm/cm^3. Earth's density is 5.5 gm/cm^3.

Planet Mass:

- Planet A: 0.4 M_{earth}
- Planet B: 1.5 M_{earth}
- Planet C: 4 M_{earth}
- Planet D: 1.7 M_{earth}
- Planet E: 6.5 M_{earth}

Planet Size:

- Planet A: 0.8 R_{earth}
- Planet B: 1.1 R_{earth}
- Planet C: 1.6 R_{earth}
- Planet D: 1.3 R_{earth}
- Planet E: 2.7 R_{earth}

Signatures of Tectonic Activity:

- Planet A: undetermined due to thick atmosphere
- Planet B: continents visible, few craters
- Planet C: continents visible, few craters
- Planet D: cratered surface visible
- Planet E: undetermined due to cloud cover