SOLAR SYSTEM B

1. **DESCRIPTION:** Participants will demonstrate their knowledge of **habitability within and beyond the Solar System**.

   A TEAM OF UP TO: 2 **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Each team may bring writing utensils.
   b. Each team may bring two 8.5" × 11" sheets of paper, which may be in a sheet protector sealed by tape or laminated, that may contain information on both sides in any form and from any source without any annotations or labels affixed.
   c. Calculators are not allowed.
3. **THE COMPETITION:** Participants will be tested on the content described below. Exams should emphasize mathematical reasoning, conceptual understanding, and interpretation of data presented in maps, graphs, images, photographs, charts, and/or tables (i.e., minimize trivia).
   a. Participants will be asked to identify and explain surface/atmospheric features, processes (e.g., cryovolcanism), and properties of the objects/systems listed below, as they relate to the content topics (3.b.). Questions should focus on Solar System objects (3.a.i) more than extrasolar systems (3.a.ii), and exams should not include detailed questions about objects/systems that are not listed.
      i. Objects in the Solar System: Venus, Mars, Ganymede, Europa, Enceladus, Titan, Makemake, 101955 Bennu, and 67P/Churyumov–Gerasimenko
      ii. Extrasolar Systems: TRAPPIST-1, Kepler-452, and LHS 1140
   b. Participants may also be tested on the following topics:
      i. Conditions relevant to habitability. Examples include: temperature, atmospheric composition and retention, presence of stable liquids (surface and subsurface), tidal heating, and chemical disequilibrium.
      ii. Geologic and chemical evidence relevant to habitability. Examples include: inferring historical evidence of liquid water from morphology, identifying surface/atmospheric composition from spectral features, and the delivery of water and organic material from small Solar System bodies.
      iii. Basic biology and chemistry relevant to habitability. Examples include: building blocks of life (e.g., proteins, nucleic acids, lipids, carbohydrates), phases/forms of water (e.g., liquid, amorphous and crystalline ice, brines, clathrates), and extremophiles (e.g., chemolithoautotrophs, tardigrades).
      iv. Exoplanet detection techniques, limited to transits, radial velocity, microlensing, and direct imaging.
      v. General engineering principles, science objectives, instrumentation, and tradeoffs underlying spacecraft and telescope design. Participants may be asked specific questions about only the following: Venus Express, DAVINCI, VERITAS, Perseverance, Mars Reconnaissance Orbiter, MAVEN, Galileo, Europa Clipper, JUICE, Cassini-Huygens, Dragonfly, OSIRIS-REx, Rosetta, Kepler, JWST, and Roman Space Telescope.
      vi. Mathematical concepts as they relate to habitability. Questions must not require a calculator and should emphasize algebraic manipulation (e.g., rearranging/deriving equations), order of magnitude estimation, dimensional analysis, sketching graphs, and proportions. Examples include:
         (1) Light, radiation, and temperature: Doppler shift, flux, inverse-square law, albedo, Stefan–Boltzmann law, Wien's displacement law, and equilibrium temperature.
         (2) Gravity, orbits, and tides: kinetic and potential energy, Newton's law of gravitation, Kepler's laws, escape velocity, and tidal forces.
         (3) Chemistry: ideal gas law, kinetics (e.g., Arrhenius equation), and chemical (dis)equilibrium.
4. **SCORING:**
   a. High Score wins.
   b. Points will be awarded for the quality and accuracy of responses.
   c. Preselected questions will be used as tiebreakers.