













Appendix A.—Rubrics

A.1 Engineering Design Process (EDP)

EDP Step	Novice (0)	Apprentice (1)	Journeyperson (2)	Expert (3)	Level of student knowledge (Score)
 Identify the problem (Ask)	Student does not identify the problem	Student incorrectly identifies the problem	Student identifies part of the problem	Student fully and correctly identifies the problem	
 Brainstorm a solution (Imagine)	Student does not brainstorm	Student generates one possible solution	Student provides two solutions	Student provides three or more possible solutions	
 Develop a solution (Plan)	Student does not select or present a solution or the solution is off task	Student presents a solution that is incomplete or lacking details	Student selects a solution but does not consider all criteria and constraints	Student selects a solution that considers all criteria and constraints	
 Create a prototype (Create)	Student does not directly contribute to the creation of a prototype	Student creates a prototype that does not meet problem criteria and constraints	Student's prototype meets most problem criteria and constraints	Student creates a prototype that meets all problem criteria and constraints	
 Test a prototype (Test)	Student does not contribute to the testing of the prototype	Student conducts tests that are irrelevant to the problem or do not accurately assess strengths and weaknesses of the prototype	Student conducts carefully performed tests that consider one to two strengths and weaknesses of the prototype	Student conducts relevant and carefully performed tests that consider three or more strengths and weaknesses of the prototype	
 Redesign based on data and testing (Improve)	Student does not contribute to the redesign	Student does not improve the design or address concerns	Student addresses one concern to improve the design	Student addresses two or more test-based concerns to improve the design	
 Communicate results from testing (Share)	Student does not communicate results	Student shares random results	Student shares organized results, but results are incomplete	Student shares detailed, organized results with group	
Total					

A.2 Problem-Based Learning Process

PBL Step	Novice (0)	Apprentice (1)	Journey person (2)	Expert (3)	Level of student knowledge (Score)
 Meet the problem	Student does not identify the problem	Student incorrectly identifies the problem	Student identifies part of the problem	Student fully and correctly identifies the problem	
 Explore knowns and unknowns	Student does not identify knowns and unknowns	Student incompletely identifies knowns and unknowns	Student identifies knowns and unknowns using experience but uses no resources	Student completely identifies knowns and unknowns using experience and resources	
 Generate possible solutions	Student does not brainstorm	Student generates one possible solution	Student provides two solutions	Student provides three or more possible solutions	
 Consider consequences	Student does not identify any consequences	Student determines inaccurate or irrelevant consequences	Student identifies consequences accurately	Student identifies consequences accurately and provides a rationale	
 Present findings	Student does not communicate results	Student shares random results	Student shares organized results, but results are incomplete	Student shares detailed, organized results with the larger group	
Total					

Appendix B.—Glossary of Key Terms

Abiotic factors. The nonliving components that influence an ecosystem

Analog. Situation on Earth that produces physical, mental, and/or emotional effects on the body similar to those experienced in space; analog studies help prepare for long-duration missions

Atrophy. Thinning or loss of muscle tissue

Biotic factors. The living components that influence an ecosystem

Cartilage. Strong tissue that cushions between bones

Celestial body. A natural object outside the Earth's atmosphere, such as the Moon, Sun, planet, or star

Confinement. The state of being enclosed (such as being confined within borders or walls)

CONNECT. The acronym NASA uses for the mitigation focus points for preventing side effects from isolation and confinement—community, openness, networking, needs, expeditionary mindset, countermeasures, and training and preparation

Coronal mass ejection (CME). A violent release of gas and magnetic fields from the solar corona

Countermeasure. An action or device designed to prevent a danger

Femur. Longest bone in the human body, extending from the hip to the knee

Galactic cosmic radiation (GCR). A dominant source of radiation that must be dealt with aboard current spacecraft and future space missions within our solar system; galactic cosmic rays originate outside the solar system and are likely formed by explosive events such as supernova

Human Research Program (HRP). A NASA program in which HRP scientists and engineers work together to discover the best methods and technologies to support safe, productive human space travel

Humerus. Long bone in the upper arm that runs from the shoulder to the elbow

Isolation. The state of being set apart from others

Joint. The location where two bones meet

Ligament. Strong tissue that connects bone to bone

Magnetosphere. Area of space around a planet that is controlled by the planet's magnetic field; provides safety from most forms of radiation coming from space

Mitigation. The process or result of making something less severe, dangerous, painful, harsh, or damaging

Osteoporosis. Bone disease that occurs when the body loses too much bone, makes too little bone, or both

Pandemic. Disease outbreak occurring over a wide geographic area (such as multiple countries or continents) and typically affecting a significant proportion of the population

Pelvis. Basin-shaped body structure that connects the trunk and the legs

Side effects. A secondary and usually adverse effect (as of a drug)

Sievert. The standard unit for radiation in the International System of Units (SI)

Solar energetic particles (SEPs). Energetically charged particles (such as electrons and protons) traveling much faster than ambient particles in the space plasma, at a fraction of the speed of light

Vertebrae. Small bones that form the backbone and protect the spinal cord