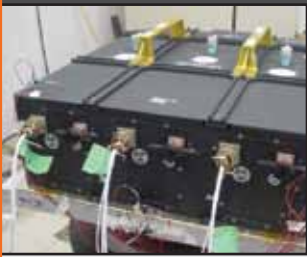


### On-board Battery



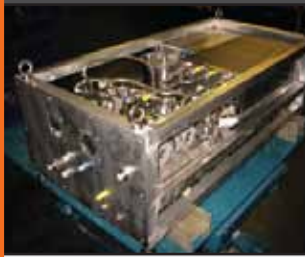
\$ 5  
 5  
 5

**A battery is required for all solar-powered missions.**

- ✓ **PROS:**
- Stores power collected by solar panels so your mission can survive when the sun is not visible.
- ✗ **CONS:**
- Increases the cost, mass and power points for your mission.

10

### Fuel Cell



\$ 40  
 25  
 50  
 POWER LIMIT

**Gives your mission electricity.**

- ✓ **PROS:**
- Does not need the sun or a battery.
  - Provides more power than solar panels.
  - Works everywhere.
- ✗ **CONS:**
- Lasts a few months.
  - Costs more than solar panels.

11

### Radioisotope Power System



\$ 75  
 30  
 75  
 POWER LIMIT

**Gives your mission electricity.**

- ✓ **PROS:**
- Does not need the sun or a battery.
  - Provides the most power of all.
  - Works everywhere.
  - Lasts over a decade.
- ✗ **CONS:**
- Costs the most.
  - Has the most mass.

12

### Low-Resolution Camera



\$ 10  
 1  
 1  
 1

**Makes discoveries about the environment on Mars.**

- ✓ **PROS:**
- Sees a very wide area of Mars.
  - Low cost, low mass.
  - Does not use much power.
- ✗ **CONS:**
- Can't see small details on Mars.

13

### Medium-Resolution Camera



\$ 25  
 2  
 2  
 1

**Makes discoveries about the environment on Mars.**

- ✓ **PROS:**
- Sees twice as much detail as the Low-Resolution Camera.
  - Low mass and low power usage.
- ✗ **CONS:**
- Medium cost.
  - Sees a smaller area on Mars than the Low-Resolution Camera.

14

### High-Resolution Camera



\$ 40  
 3  
 4  
 1

**Makes discoveries about the environment on Mars.**

- ✓ **PROS:**
- Sees the most detail of all.
- ✗ **CONS:**
- See only a tiny area of Mars.
  - Costs the most.
  - Has more mass and uses more power than other cameras.

15

### Infrared Camera



\$ 25  
 2  
 2  
 1

**Makes discoveries about the environment on Mars.**

- ✓ **PROS:**
- Gives basic information about minerals and grain size of the soil on Mars.
  - Low mass and low power usage.
- ✗ **CONS:**
- Medium cost.

16

### Infrared Spectrometer



\$ 30  
 3  
 2  
 1

**Helps discover if Mars was ever a habitat for microbial life.**

- ✓ **PROS:**
- Detects minerals in detail, including those that formed in water, which is essential to life.
  - Low mass and low power usage.
- ✗ **CONS:**
- High cost.

17

### High-Energy Spectrometer



\$ 30  
 4  
 5  
 1

**Helps discover if Mars was ever a habitat for microbial life.**

- ✓ **PROS:**
- Helps show where on Mars has water, which is essential to life.
  - Low mass and low power usage.
- ✗ **CONS:**
- High cost.

18

### Radiation Sensor



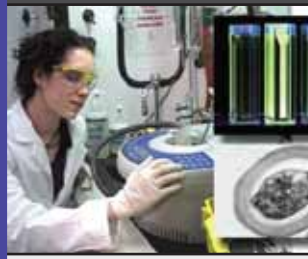
\$ 15  
 1  
 3  
 1

Helps discover if Mars could be a habitat for humans someday.

- ✓ **PROS:**
- Shows healthier places for people where radiation is lower.
  - Low cost, mass and power usage.
- ✗ **CONS:**
- Data may not be used for a long time to support human missions.

19

### Life Sciences Laboratory



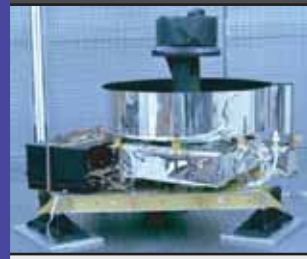
\$ 60  
 8  
 25  
 2

Helps discover signs of past or present microbial life on Mars.

- ✓ **PROS:**
- Helps find out if Earth is the only place that supports life.
- ✗ **CONS:**
- Highest cost, most mass and uses the most power.
  - Requires sample collection device (card #25).

20

### Laser Topography Mapper



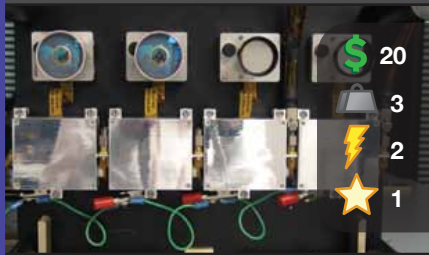
\$ 30  
 3  
 2  
 1

Makes discoveries about the environment on Mars.

- ✓ **PROS:**
- Measures the high and low points of the Martian terrain, including mountains and craters.
  - Low mass and low power usage.
- ✗ **CONS:**
- High cost.

21

### Color Stereo Camera



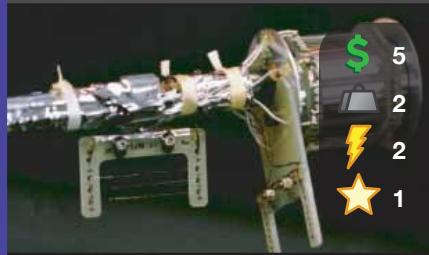
\$ 20  
 3  
 2  
 1

Makes discoveries about the environment on Mars.

- ✓ **PROS:**
- Provides a 3D experience of Mars by combining images taken by a set of cameras.
  - Low mass and low power usage.
- ✗ **CONS:**
- Medium cost.

22

### Atmosphere/Wind Sensors



\$ 5  
 2  
 2  
 1

Makes discoveries about the environment on Mars.

- ✓ **PROS:**
- Collects detailed data about wind speeds and chemicals in the atmosphere.
  - Very low cost, low mass and low power usage.

23

### Magnetometer



\$ 5  
 2  
 2  
 1

Helps discover areas that might protect microbial or human life.

- ✓ **PROS:**
- Measures where Mars has a magnetic field, which can protect life from radiation.
  - Very low cost, low mass and low power usage.

24

### Sample Collection Device



\$ 5  
 3  
 1  
 1

Required for Life Sciences Laboratory.

- ✓ **PROS:**
- Collects air, rocks or soil samples for study by the Life Sciences Laboratory.
- ✗ **CONS:**
- Adds minor costs, mass and power usage to your mission.

25

### Wheels



\$ 15  
 10  
 12

Either wheels or tracks are required for rover missions.

- ✓ **PROS:**
- Wheels carry rovers to discoveries beyond their landing sites.
  - Medium speed and work on rocky terrain.
- ✗ **CONS:**
- Have a little more mass, and use a little more power than tracks.

26

### Tracks



\$ 15  
 8  
 10

Either wheels or tracks are required for rover missions.

- ✓ **PROS:**
- Have less mass and use less power than wheels.
- ✗ **CONS:**
- Can make it harder to climb over some obstacles.
  - Less precise steering.

27

### Robotic Arm



\$ 5  
 8  
 1  
 1

**Collects samples and carries a number of science instruments.**

✓ **PROS:**

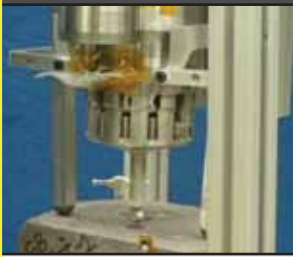
- Doesn't use much power.
- Low cost.
- Provides an added science point.

✗ **CONS:**

- Medium mass.

28

### Rock Drill



\$ 5  
 3  
 5  
 1

**Collects samples by drilling into rocks.**

✓ **PROS:**

- Low cost, low mass.
- Provides an added science point.

✗ **CONS:**

- Medium power.

29

### Rotating Instrument Mount



\$ 5  
 3  
 1  
 1

**Provides flexible structure for multiple science instruments.**

✓ **PROS:**

- Holds science instruments so they can collect data in a circle without moving the spacecraft.

✗ **CONS:**

- Adds minor costs, mass and power usage to your mission.

30

### Heat Shield



\$ 5  
 10  
 0

**Required to protect all landers and rovers traveling through the atmosphere to the surface.**

✓ **PROS:**

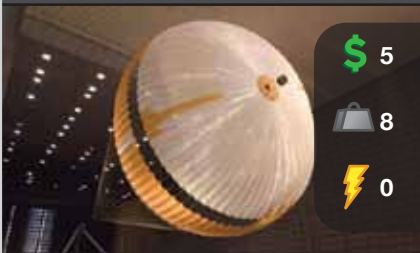
- Very low cost.
- Does not use power.

✗ **CONS:**

- Medium mass.

31

### Hypersonic Parachute



\$ 5  
 8  
 0

**Required for all Mars landers and rovers.**

✓ **PROS:**

- Slows the spacecraft down prior to using airbags or retro rockets.
- Low cost.
- Does not use power.

✗ **CONS:**

- Medium mass.

32

### Retro Rockets



\$ 10  
 8  
 0

**Either airbags or retro rockets are required for Mars landers and rovers.**

✓ **PROS:**

- Slows the spacecraft down for a controlled landing.
- Lower cost and mass than airbags.

✗ **CONS:**

- Spacecraft can be damaged by landing in rocky terrain.

33

### Airbags



\$ 40  
 15  
 0

**Either airbags or retro rockets are required for Mars landers and rovers.**

✓ **PROS:**

- Protects spacecraft from impacts on rocks and slopes.

✗ **CONS:**

- Higher cost and mass than rockets.
- Precise landings are difficult because the airbags bounce.

34

### Impact Probe



\$ 10  
 5  
 0  
 1

**Probes can be added to enhance discoveries.**

✓ **PROS:**

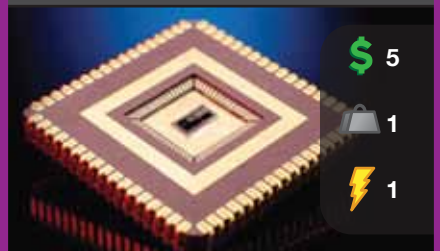
- Penetrates the Martian surface at high speeds to collect data from below the surface.
- Does not use power.

✗ **CONS:**

- Adds cost and mass to your mission.

35

### Standard Microprocessor



\$ 5  
 1  
 1

**At least one microprocessor is required for all Mars missions.**

✓ **PROS:**

- Provides mission "brainpower."
- Low cost, mass and power usage.

✗ **CONS:**

- Provides only basic functions needed to receive commands and send data.

36



### Advanced Microprocessor



\$ 10  
 1  
 2  
 1

**At least one microprocessor is required for all Mars missions.**

- ✓ **PROS:**
- More "brainpower" lets the spacecraft make simple choices without commands from Earth.
- ✗ **CONS:**
- Costs more and uses more power than the standard microprocessor.

37

### Main Bus



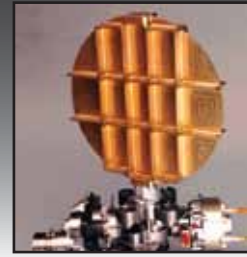
\$ 20  
 5  
 1

**Connects science tools with the onboard computer so they work. Required for all missions!**

- ✓ **PROS:**
- Low power usage.
  - Allows you to make discoveries with your science tools.
- ✗ **CONS:**
- Medium cost and mass.

38

### High-Gain Antenna



\$ 10  
 1  
 5  
 1

**At least one antenna is required to communicate with Earth.**

- ✓ **PROS:**
- Sends large amounts of data at one time.
- ✗ **CONS:**
- Costs more and uses more power than the Low-Gain Antenna.

39

### Low-Gain Antenna



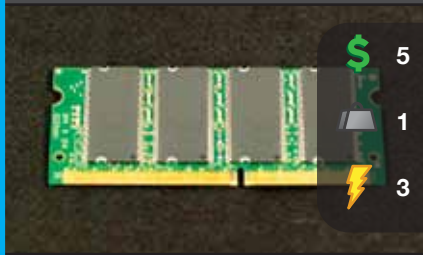
\$ 5  
 1  
 3

**At least one antenna is required to communicate with Earth.**

- ✓ **PROS:**
- Low cost and power.
  - Can be used as a backup for the High-Gain Antenna.
- ✗ **CONS:**
- Cannot send much information at one time.

40

### Main Memory Card



\$ 5  
 1  
 3

**Stores all Mars data until it can be sent back to Earth. Required for all missions!**

- ✓ **PROS:**
- Low cost, mass and power usage.
- ✗ **CONS:**
- None! Your mission does not have a continuous link with Earth, so you need a way to store your data.

41

### Rocket Nose Cone



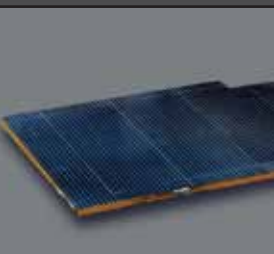
\$ 10  
 7  
 0

**Protects your spacecraft during launch. Required for all missions!**

- ✓ **PROS:**
- Low cost.
  - No power needed.
- ✗ **CONS:**
- Medium mass.

6

### Low-Power Solar Panel



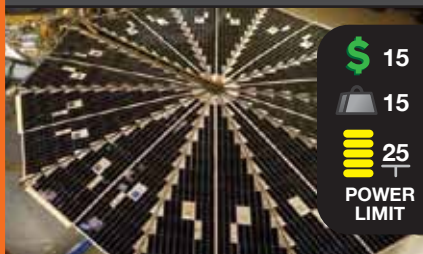
\$ 10  
 7  
 10  
 POWER LIMIT

**Gives your mission electricity.**

- ✓ **PROS:**
- Low cost, low mass.
  - Lasts a few years.
- ✗ **CONS:**
- Must have sunlight. Only works during daylight.
  - Only works near the equator.
  - **Requires on-board battery (card #10)**

7

### Medium-Power Solar Panel



\$ 15  
 15  
 25  
 POWER LIMIT

**Gives your mission electricity.**

- ✓ **PROS:**
- Low cost, medium mass.
  - Lasts a few years.
- ✗ **CONS:**
- Must have sunlight. Only works during daylight.
  - Only works near the equator.
  - **Requires on-board battery (card #10)**

8

### High-Power Solar Panel



\$ 25  
 20  
 40  
 POWER LIMIT

**Gives your mission electricity.**

- ✓ **PROS:**
- Medium cost, medium mass.
  - Lasts a few years.
- ✗ **CONS:**
- Must have sunlight. Only works during daylight.
  - Only works near the equator.
  - **Requires on-board battery (card #10)**

9