

Light-Lift Rocket I



\$ 50

45
MASS LIMIT

This rocket can lift a mission that has up to 45 mass units.

- ✓ **PROS:**
- Low cost.
 - Low risk: works 5 times out of 6.
- ✗ **CONS:**
- Lifts small, lightweight missions with few science tools.

1

Light-Lift Rocket II



\$ 75

90
MASS LIMIT

This rocket can lift a mission that has up to 90 mass units.

- ✓ **PROS:**
- Lifts medium-size missions due to add-on thrusters.
- ✗ **CONS:**
- Costs more than Light-Lift Rocket I due to additional thrusters.
 - Medium risk: works 4 times out of 6.

2

Medium-Lift Rocket A



\$ 100

125
MASS LIMIT

This rocket can lift a mission that has up to 125 mass units.

- ✓ **PROS:**
- Lifts large missions with more science tools.
- ✗ **CONS:**
- Costs more than Light-Lift Rockets.
 - Medium risk: works 4 times out of 6

3

Medium-Lift Rocket B



\$ 120

125
MASS LIMIT

This rocket can lift a mission that has up to 125 mass units.

- ✓ **PROS:**
- Able to lift large missions with more science tools.
 - Low risk: works 5 times out of 6.
- ✗ **CONS:**
- Costs more than Light-Lift I & II and Medium-Lift Rocket A

4

Heavy-Lift Rocket



\$ 100

200
MASS LIMIT

This rocket can lift a mission that has up to 200 mass units.

- ✓ **PROS:**
- The most powerful on Earth! Able to lift very large missions with the most science tools.
- ✗ **CONS:**
- High risk: works 3 times out of 6.

5

Rocket Nose Cone



\$ 10

7

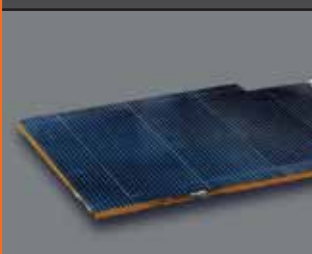
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Protects your spacecraft during launch. **Required for all missions!**

- ✓ **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

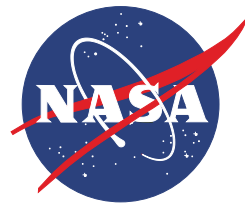
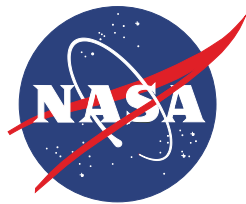
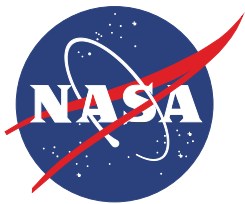
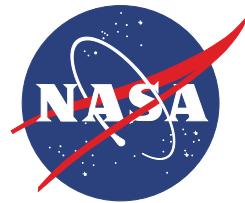
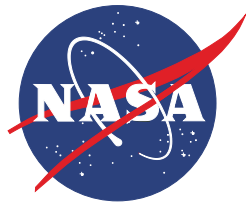
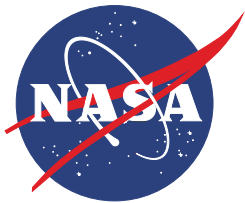
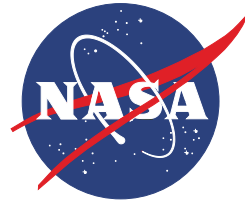
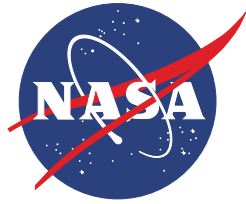
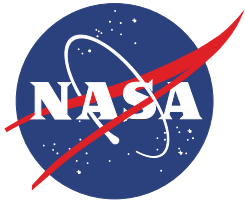
20

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



On-board Battery



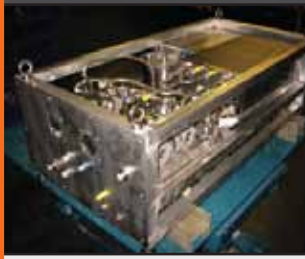
\$ 5
 5
 5

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

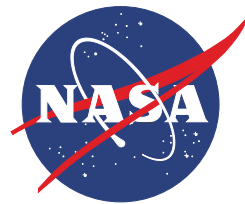
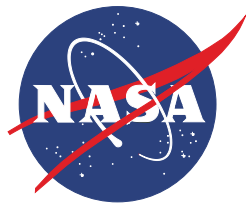
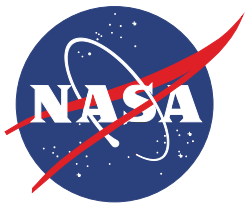
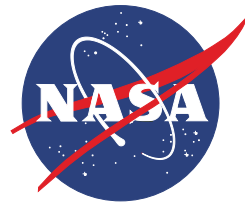
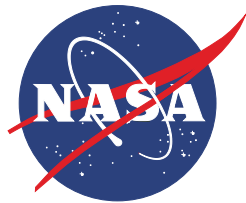
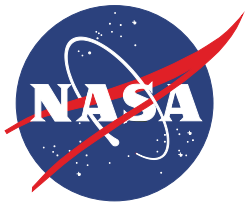
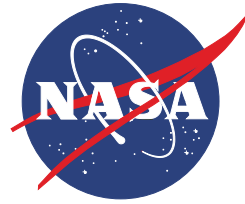
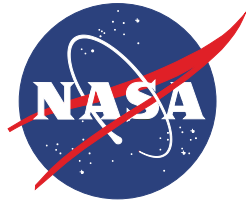
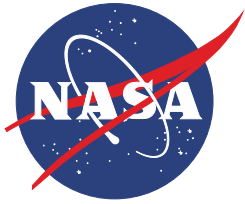


\$ 30
 4
 5
 1

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



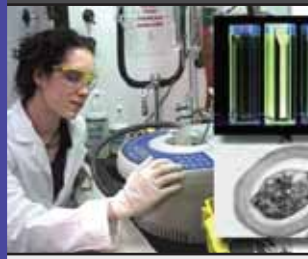
\$ 15
 1
 3
 1

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



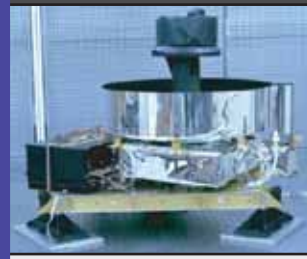
\$ 60
 8
 25
 2

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



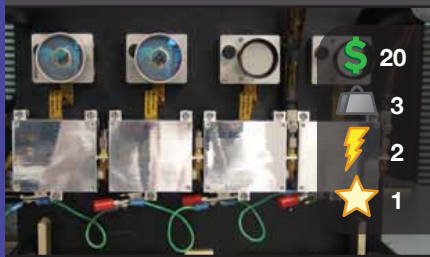
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 3
 2
 1

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



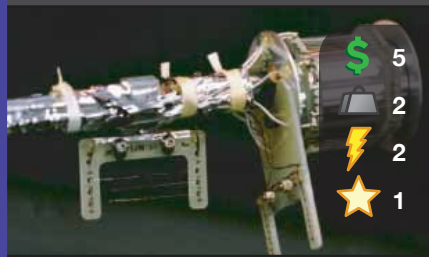
\$ 20
 3
 2
 1

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

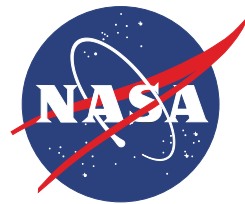
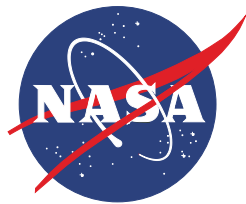
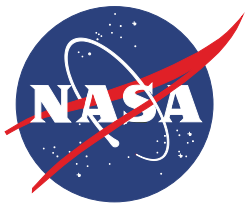
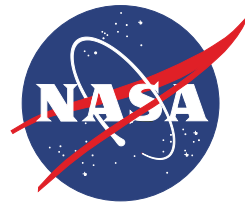
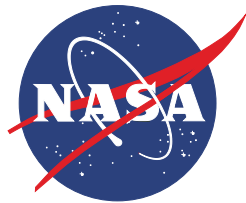
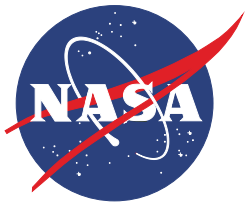
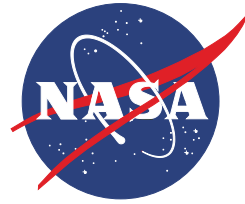
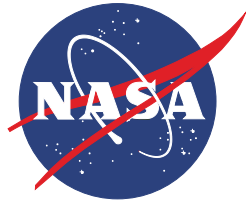
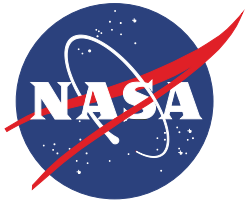


\$ 15
 8
 10

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:**

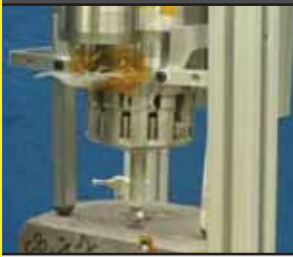
- Doesn't use much power.
- Low cost.
- Provides an added science point.

✗ **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:**

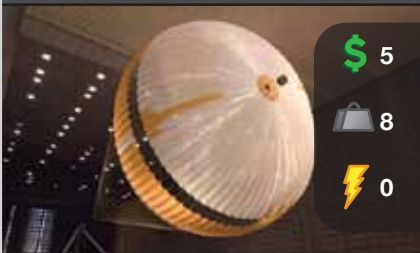
- Very low cost.
- Does not use power.

✗ **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:**

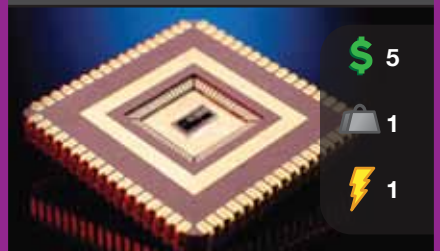
- Penetrates the Martian surface at high speeds to collect data from below the surface.
- Does not use power.

✗ **CONS:**

- Adds cost and mass to your mission.

35

Standard Microprocessor



\$ 5
 1
 1

At least one microprocessor is required for all Mars missions.

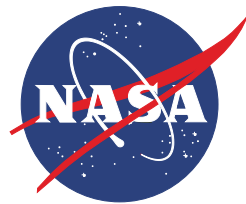
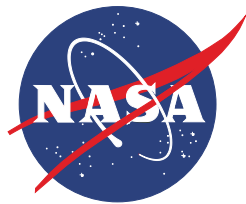
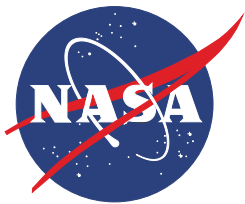
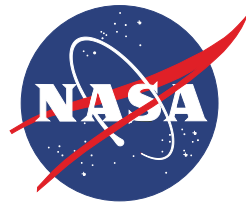
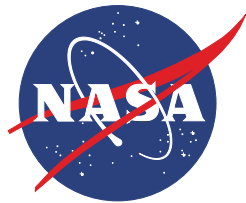
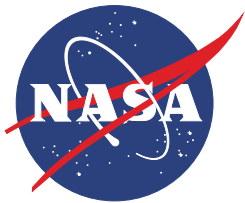
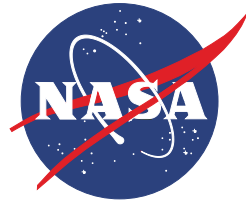
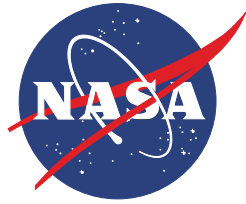
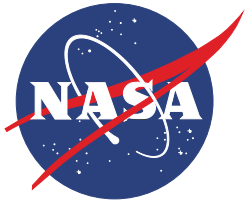
✓ **PROS:**

- 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



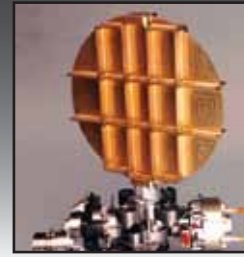
\$ 20
 5
 1

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



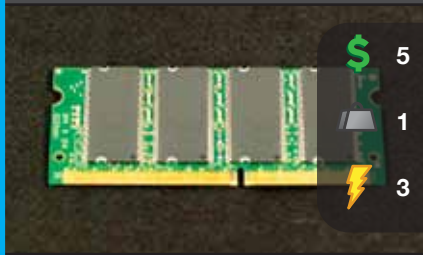
\$ 5
 1
 3

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

Spin-Off: Automobile Sensors



Hooray! Sensors created for your Mars mission help cars become more energy-efficient and easier to maintain!

- ✓ **EFFECT:**
- \$25 million for your future research.

42

Spin-Off: Communications

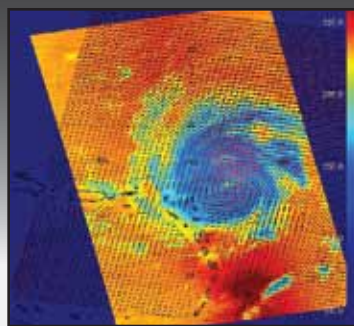


Hooray! People around the world can stay in touch more easily by using new communications technologies created for your Mars mission.

- ✓ **EFFECT:**
- \$35 million for your future research.

43

Spin-Off: Weather Prediction



Hooray! Your Mars mission discoveries gave new clues about Earth's atmosphere. Scientists can now predict weather better!

- ✓ **EFFECT:**
- \$15 million for your future research.

44

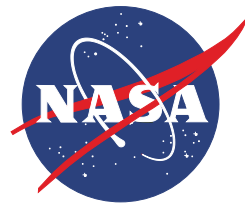
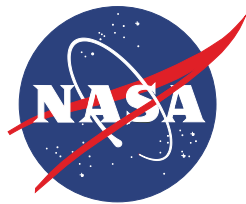
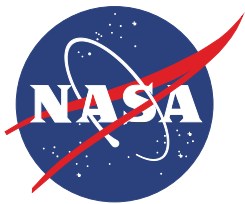
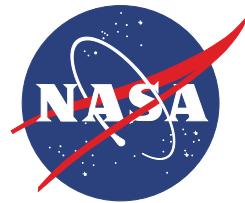
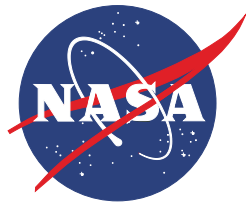
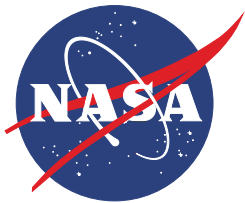
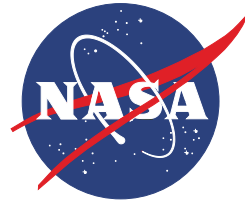
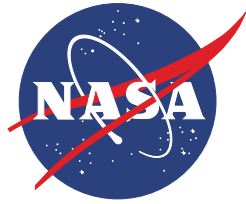
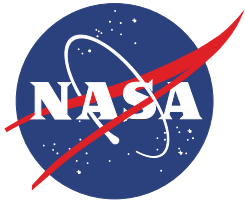
Budget Cut!



Sorry! Congress reduced NASA's budget.

- ✗ **EFFECT:**
- Your mission loses one science tool.

45



Rocket Failure!

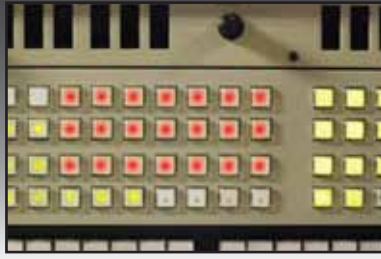


Sorry! Your rocket failed during testing. You had to buy another one.

X EFFECT:
You cut out two science tools to help pay for the new rocket.

46

System Failure!



Sorry! During system testing, one science tool failed to work.

X EFFECT:
Your mission loses one science tool.

47

