

The Race to Save *Apollo 13*

Nonfiction by Michael Useem

 Video link at thinkcentral.com

How can we achieve the **IMPOSSIBLE?**

COMMON CORE

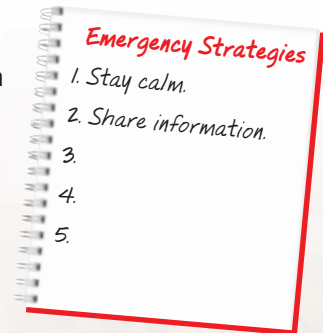
RI 1 Cite evidence to support analysis of what the text says explicitly. **RI 4** Determine the meaning of words and phrases as they are used in a text.

RI 5 Analyze how an author's ideas are developed and refined.

RI 6 Determine an author's purpose in a text.

Some situations may seem hopeless at first. But when lives are at stake, people often find a way to achieve the impossible. In "The Race to Save *Apollo 13*," Michael Useem describes the extraordinary efforts of NASA employees to rescue astronauts aboard a damaged spacecraft.

DISCUSS With a small group, discuss strategies that can help people deal with an emergency. Share your list of strategies with the class.



● TEXT ANALYSIS: SUSPENSE IN NONFICTION

To draw the reader into a story, writers often create **suspense**—a feeling of excitement or tension about what will happen next. In nonfiction, a writer may create suspense by raising questions about the outcome of a situation or by emphasizing the risks involved. For example, in “The Race to Save *Apollo 13*,” Michael Useem lets the reader know how much is at stake in the situation faced by the flight director.

He understood as well that his actions in the hours ahead might determine whether the U.S. space program experienced or avoided its biggest disaster.

As you read, notice the details that Useem included to increase the suspense of the narrative.

● READING STRATEGY: TAKE NOTES

“The Race to Save *Apollo 13*” contains many details about equipment and procedures used in the space mission. When you read this type of information-rich text, take notes to help you understand and remember important information. Your notes may include

- key words and phrases from the text
- summaries (essential ideas rephrased in your own words)
- diagrams, charts, and other graphic organizers

As you read “The Race to Save *Apollo 13*,” take notes about the problems people face and the solutions they find. Use a chart like the one shown.

Problem	Solution
The fuel cells that provided electricity to <i>Odyssey</i> were losing pressure.	The astronauts shut down all power in <i>Odyssey</i> and moved into the LEM.

▲ VOCABULARY IN CONTEXT

Michael Useem used the following boldfaced words to describe NASA procedures. To see how many you know, substitute a different word or phrase for each boldfaced term.

1. **replenish** our supplies
2. the ball’s **trajectory** in the air
3. a **mandate** from my boss
4. her **innovative** approach
5. a **respite** from our labor
6. **collaborative** employees

Michael Useem

born 1942

Deciding Moments

Michael Useem (yōō-sēm’) is a University of Pennsylvania professor who specializes in issues of leadership. “The Race to Save *Apollo 13*” is taken from his book *The Leadership Moment: Nine True Stories of Triumph and Disaster and Their Lessons for Us All*, which relates how leaders from various walks of life have made extremely difficult decisions during emergencies. Useem believes that their experiences illustrate what to do—and what not to do—in times of crisis.

BACKGROUND TO THE SELECTION

Space Race

In May 1961, President John F. Kennedy issued a challenge in a speech to Congress, stating that the United States should become the first nation to land astronauts on the moon and return them home safely. Kennedy believed this goal was necessary because the Soviet Union had recently sent a human into space.

The Apollo Program

Although Kennedy did not live to see it, NASA achieved his goal. In July 1969, the Apollo program successfully landed astronauts on the moon, and about 700 million television viewers around the world watched the historic moment. But after the mission ended, it was difficult to keep up this level of excitement. The launch of *Apollo 13* in April 1970 stirred little public interest. That changed when an oxygen tank exploded aboard the *Apollo 13* spacecraft *Odyssey*. In just moments, a seemingly routine mission became a full-blown crisis.



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Complete the activities in your **Reader/Writer Notebook**.

The Race to Save APOLLO 13

Michael Useem

“What do you think we’ve got in the spacecraft that’s good?”

“Hey, we’ve got a problem here.”

The day was April 13, 1970. The voice was that of astronaut Jack Swigert, speaking from aboard the spacecraft Odyssey.

Almost immediately, NASA’s Mission Control queried back: “This is Houston. Say again, please.”

Astronaut and mission commander James Lovell responded this time: “Houston, we’ve had a problem.”

For flight director Eugene Kranz, the message from *Apollo 13* presaged the test of a lifetime.

10 Only nine months earlier, on July 20, 1969, *Apollo 11* had landed Neil Armstrong and Buzz Aldrin in the Sea of Tranquillity,¹ fulfilling John F. Kennedy’s promise to place a man on the moon before the end of the decade. Five months earlier, *Apollo 12* had placed Pete Conrad and Alan Bean in the Ocean of Storms. Just fifty-five hours earlier, at 1:13 P.M. on Saturday, April 11, 1970, *Apollo 13* had lifted up from the Kennedy Space Center on what to this moment had seemed a flawless trip to the moon’s ridges of Fra Mauro.² Now, suddenly, the bottom was falling out.

1. **Sea of Tranquillity:** many areas of the moon are called seas or oceans, although the moon has no liquid water.

2. **Fra Mauro:** the area on the moon where *Apollo 13* was supposed to land.

COMMON CORE RI.4

Language Coach

Etymologies Reread line 2. The word *astronaut* comes from the Greek words *astron*, meaning “star” and *nautēs*, meaning “sailor.” Use a dictionary to find other words that use *astron* or *nautēs*.



NASA flight director Eugene Kranz at his console

NASA technician George Bliss was both transfixed and horrified by what he saw on his computer console³ in a Houston back room. “We got more
20 than a problem,” he warned colleague Sy Liebergot. The video screen told why: One of *Odyssey’s* two oxygen tanks had broken down. The pressure in two of its three fuel cells, devices that use oxygen to generate electricity, was plummeting.

As Gene Kranz sifted through damage reports, the picture was distressing. The astronauts and their protective shell were unscathed, but it was evident that some kind of explosion had ripped through vital equipment. Two days into the flight, three quarters of the way to the moon, the astronauts were hurtling away from Earth at 2,000 miles per hour. The only practical way they could return was to round the moon and depend on its gravity to fire
30 them back like a slingshot. But this would require more than three days and demand more oxygen and electricity than Lovell and his crew had left. **A**

As flight director for *Apollo 13*, Kranz was the responsible official, and he was watching his mission spin out of control: his crew would consume their oxygen and power long before they neared Earth. Even if they survived to reenter the Earth’s atmosphere, they would have no way to control their capsule’s fiery plunge. Kranz could neither retrieve the astronauts nor **replenish** their supplies. He knew what options were out, yet he also knew he must somehow engineer a safe return. He understood as well that his

3. **computer console:** a computer’s monitor and keyboard.

◀ Analyze Visuals

What can you **infer** from the expression on Eugene Kranz’s face in the photograph?

A SUSPENSE

What facts in lines 24–31 help generate suspense?

replenish (rĭ-plĕn’ĭsh)
v. to fill again

actions in the hours ahead might determine whether the U.S. space program
40 experienced or avoided its biggest disaster.

The Explosion's Wake

Hundreds of officials and engineers confronted the singular task of bringing the astronauts back alive. Four rotating flight teams—dubbed White, Black, Gold, and Maroon—were scheduled to spell one another during the mission's long days ahead. A backup crew for *Apollo 13* was on call to lend its expertise. Dozens of space program contractors were ready to assist.

Yet no one on the ground bore the burden that Eugene Kranz carried that evening and would continue to carry over the next four days. NASA's policy was unflinchingly clear: the flight director had the final call on all decisions. Moreover, "The flight director can do anything he feels is necessary for the
50 safety of the crew and the conduct of the flight regardless of the mission rules."

As Sy Liebergot, the frontline electrical official, gazed at his console in the minutes just after the explosion, he allowed himself to hope that the ominous screen displays might reflect sensor failure rather than a genuine problem. During NASA's countless simulations⁴ of the flight, he had often seen disastrous instrument readings that had later proved inaccurate. The astronauts themselves were reporting that their oxygen tanks seemed fine, lending momentary support to Liebergot's hopeful search for instrumental error.

But Kranz was already learning from other flight officials that the problems were indeed real. The guidance officer reported that an onboard
60 computer was signaling a major glitch. The communications officer reported that the craft had mysteriously switched antennas. (As would be learned later, one had been hit by the explosion's debris.) And the astronauts themselves soon reported that one oxygen tank had emptied, two of the three fuel cells were generating no electricity, and two panels supplying power to the entire spacecraft were losing voltage. Lovell added even more distressing news: "We are venting⁵ something into space." A glowing cloud was hovering outside *Odyssey*, suggesting rupture of its oxygen tanks.

"OK," called Kranz, sensing signs of panic in Mission Control. "Let's everybody keep cool. Let's make sure we don't do anything that's going to
70 blow our electrical power or cause us to lose fuel cell number two." Then he addressed what would have to be done. "Let's solve the problem." And finally he moved on to self-discipline: "Let's not make it any worse by guessing." **B**

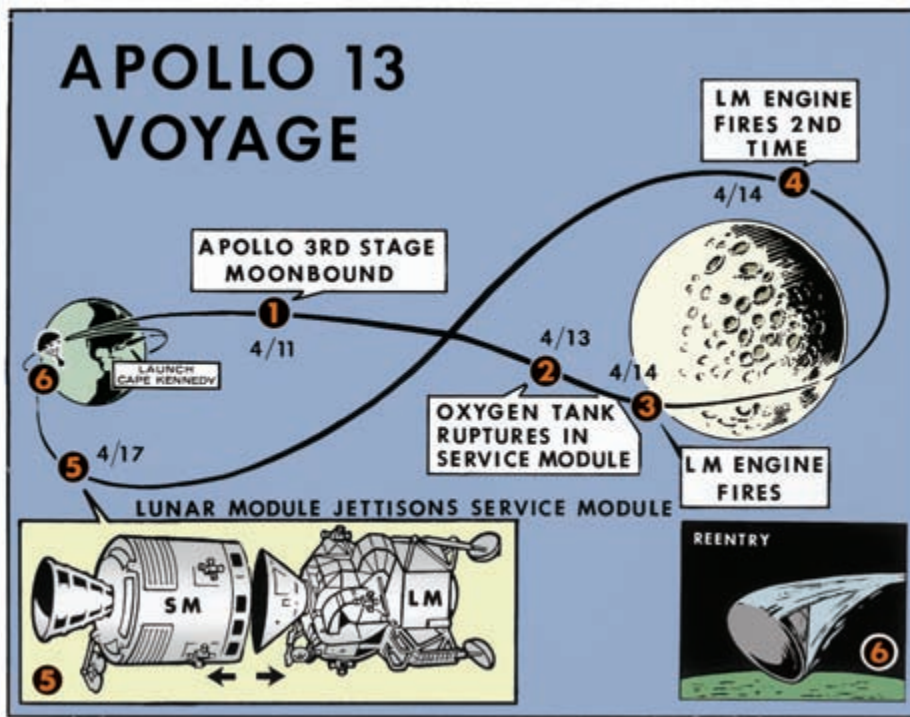
By now, more bad news from *Odyssey*. Though a moon landing had been eliminated by the loss of the first oxygen tank and fuel cell, the

B TAKE NOTES

What problems did Kranz want to prevent at Mission Control?

4. **simulations:** here, mock space flights used to test procedures and train astronauts.

5. **venting:** discharging.



◀ Analyze Visuals

This diagram was created on April 15, 1970, to illustrate the plan for saving the *Apollo 13* voyage. What information does a graphic aid of this sort help clarify?

second system should still carry the astronauts safely home. Lovell noticed, however, that the pressure needle for the second tank was falling as well, and Liebergot was discovering the same thing. Normally the tank should register 860 pounds per square inch (psi); now it was approaching 300. The explosion had come at 9:07 P.M., and the clock was now just past 10 P.M. At that rate of loss, the spaceship would exhaust all of its electricity and air sometime between midnight and 3 A.M.

Kranz telephoned the home of Chris Kraft—the former flight director and his onetime mentor, and now deputy director of the Manned Spacecraft Center. Kraft’s wife pulled him out of the shower, and he heard Kranz urging, “Chris, you’d better get over here now. We’ve got a hell of a problem. We’ve lost oxygen pressure, we’ve lost a bus [an electrical power distribution system], we’re losing fuel cells. It seems there’s been an explosion.” Kranz, age thirty-six, had worked with NASA for a decade, overseeing all Apollo missions since taking over from Kraft when the prior Gemini series had come to an end. He was an experienced hand who sounded no undue alarm, solicited no unneeded counsel. Kraft raced to the space center, just ten miles away. When he arrived, Kranz brought his former mentor up to speed. . . .

With the oxygen for *Odyssey’s* life support systems in rapid decline, Kranz barked rapid-fire demands for information and support to attack the problems.

To the telemetry and electrical officer: “Will you take a look at the prelaunch data⁶ and see if there’s anything that may have started the venting?”

To the technicians running NASA’s fast, on-site computers: “Bring up another computer . . . will you?”

100 *To the guidance and navigation officer:* “Give me a gross amount of the thruster propellants⁷ consumed so far.”

To Sy Liebergot: “What does the status of your buses tell you now?”

Off line, Liebergot and his backup engineer, George Bliss, were reaching even more forlorn conclusions: The single remaining oxygen tank was below 300 psi of pressure and losing another 1.7 psi each minute. If tank pressure fell below 100 psi, it would have insufficient force to move its precious contents into the fuel cells for power generation, and that point was just 116 minutes away. They made several attempts to stem the flow, but none succeeded.

110 *Liebergot:* “George, it looks grim.”

Bliss: “Yes, it does.”

Liebergot: “We’re going down. We’re losing it.”

Bliss: “Yes, we are.”

6. **prelaunch data:** information collected before launch of a spacecraft.

7. **thruster propellants:** fuel for rockets used to maneuver spacecraft.

Apollo 13 control room



Now Liebergot was back on line with Kranz, arguing that the astronauts must move immediately into the attached lunar excursion module (LEM). Dubbed *Aquarius* on this mission, the LEM had been designed to set two astronauts on the moon and sustain life for several days. For three astronauts, *Aquarius* would be overcrowded, the power system would not work for long, and it would vaporize on reentry. But for the moment
120 it would have to do. The dying command module would support the astronauts for a matter of minutes; the LEM at least offered hours. Kranz again sought instant analysis. “I want you guys figuring our minimum power needed in the LEM to sustain life,” he instructed a LEM technical group, which had anticipated no real action until the planned moon landing two days later. “And I want LEM manning around the clock.”

The oxygen loss from *Odyssey* was accelerating to 3 psi per minute, and Bliss now estimated that they had eighteen minutes left before total power shutdown. A few moments later, he revised that down to seven minutes. And then, a moment later, to four. **C**

130 The Black Team had just taken over from White, and Glynn Lunney, who would spell Kranz at the director’s console while the White Team stood down, sent up an urgent command: “Get ‘em going in the LEM!” Lovell and Haise moved through the connecting hatch, and while Swigert stayed behind to wind down *Odyssey*, they powered up *Aquarius*. They worked frantically to transfer irreplaceable guidance data from the command module into the LEM computer in the seconds before everything was lost. Finally, Lovell radioed Houston, “*Aquarius* is up, and *Odyssey* is completely powered down.”

140 There was a momentary relief, but with days to go, they had bought only a little time. “OK, everybody,” counseled Lunney, “we’ve got a lot of long-range problems to deal with.”

Oxygen and Power

Among the mission’s first long-range problems was that the return **trajectory** would miss the Earth by some forty thousand miles. The astronauts would need to fire the LEM’s rocket in just five hours to close the gap. Producing the precision adjustment, however, would require immediate, massive recalibrations of instruments. By now the teams in Houston were humming, and they delivered the requisite data to Jim Lovell and his crew with an hour to spare.

150 While Glynn Lunney staffed the director’s console, Kranz remained only feet away, his mind turning over what to do next. He had already passed word that as soon as Houston had the fuel burn plan set, he would meet

C SUSPENSE

How do the references to time in lines 126–129 increase suspense?

trajectory

(trə-jĕk'tə-rē) *n.* the path of a moving body through space

mandate
(măn'dāt') *n.*
a command or
instruction

D TAKE NOTES

Summarize the reasons Kranz created a new team that would work in a separate room.

with his entire White Team in a nearby room. As it gathered, Kranz laid down his new **mandate**: “For the rest of this mission, I am pulling you men off console. The people out in that room will be running the flight from moment to moment, but it’s the people in this room who will be coming up with the protocols they’re going to be executing. From now on, what I want from every one of you is simple: options, and plenty of them.” Their new name would be the Tiger Team, and for the remainder of the flight they would work and live in Room 210.

160 A mere twenty feet by twenty feet and windowless, Room 210 was bare except for several overhead TVs and tables along the walls, but its location was good: adjacent to the operations room and just a floor below the control room. Above all, it permitted the team to assemble all past and current data in one place. Now, Kranz believed, they could determine what had happened and was happening, essential for deciding what should happen next. **D**

Kranz pressed them to focus on solutions. He sought to build, he later reported, “a positive frame of mind that is necessary to work problems in a time-critical and true emergency environment.” And he wanted quick answers to specific questions:

170 “How long can you keep the systems in the LEM running at full power?”
“Where do we stand on water? What about battery power? What about oxygen?”

“In three or four days we’re going to have to use the command module again. I want to know how we can get that bird powered up and running from a cold stop . . . and do it all on just the power we’ve got left in the reentry batteries.”

“I also want to know how we plan to align this ship if we can’t use a star alignment. Can we use sun checks? Can we use moon checks? What about Earth checks?”

180 “I want options on . . . burns and midcourse corrections from now to entry.”

“What ocean does it put us in?”

Once again, Kranz insisted on strategies and solutions without guesswork: “For the next few days we’re going to be coming up with techniques and maneuvers we’ve never tried before,” he concluded. “And I want to make sure we know what we’re doing.”

Kranz left his men to do their work and returned to the control room. Glynn Lunney of the Black Team had focused everybody on the forthcoming course correction, and minutes later Lovell and his colleagues

190 executed a flawless blast of the LEM's engines. In one of the first bits of good news since disaster struck, they had corrected their path perfectly.

Good news, though, was still in terribly short supply. The new course required nearly four days for return, and *Aquarius* was provisioned for less than two. The LEM's oxygen supply was not a problem since enough had been placed on board for several moon walks, yet its supply of lithium hydroxide was another story. This chemical was carried to remove carbon dioxide accumulating in the cabin, but its LEM capacity was for two men for two days, not for three men for twice that long. The available electricity would last for even less time if *Aquarius* remained fully powered. Water, too, 200 was in desperately short supply. **E**

Kranz decided he wanted more seasoned talent crunching the numbers. He sent the Tiger Team's electrical specialist back to the consoles on Tuesday morning and in his place recruited Bill Peters from the Gold Team. Other flight directors had sometimes found Peters slow to react and explain. But Kranz had constructed a relationship with him, and he knew that he brought exceptional experience: Peters had worked every space mission since *Gemini 3* in 1965. "Peters was utterly brilliant," Kranz recalled, but he could not explain himself well and one had to work with him to "bring out the pieces."

210 After consulting with Kranz and the lead engineer for Grumman Aerospace, the LEM maker, Peters was heartened by his preliminary calculations: He could find ways to cut *Aquarius*'s electrical flow from 55 amperes to 12, though this would require draconian⁸ measures on board: no computer, no guidance system, no heater, no panel display. Communications would stay up, a fan would stir the air, and a little coolant would circulate. Otherwise, all systems would be off.

Kranz also recruited another outsider, John Aaron, the Maroon Team's twenty-seven-year-old electrical specialist. He understood power better than anyone else, he was **innovative**, and he was unflappable—"Mr. Cool under 220 pressure" in Kranz's phrase. Kranz charged Aaron with a similar task for conserving *Odyssey*'s power, and together they took a first cut at the figures. Their numbers were encouraging, and Aaron designed the plan. He believed he could find the power to rev up the command module for reentry—but only if almost all engineering corners were cut.

Aaron patiently presented his plan to a skeptical Tiger Team, reporting that the powering up, normally a full day's affair, could take no more than two hours. Bill Strahle, a guidance and navigation officer, interjected, "John, you can't do it in that time." Aaron responded, "Well, now, that's what I

8. **draconian**: extremely harsh.

E SUSPENSE

What details in lines 192–200 raise questions about the outcome of the mission?

innovative

(ɪn'ə-vā'tīv)

adj. able to create new, original ideas

Language Coach

Multiple-Meaning

Words The word *fire* has more than one meaning. In line 232 it means “to ignite.” What does it mean in the following sentences?

The fire burned many acres of forest.

The manager had to fire the lazy employee.

thought, Bill. But I think if we’re willing to take a few shortcuts, we just
230 might be able to pull it off.”

Late on the evening of Tuesday, April 14, nearly twenty-four hours after the accident, Lovell and crew rounded the moon and were scheduled to fire the LEM’s rocket to accelerate their return to Earth. The engine burn, like virtually all other maneuvers of the past day, would be crucial, but this one would be especially so. The smallest error of alignment or duration would send the ship in a wrong direction with virtually no fuel remaining for any correction. Though the Gold Team was still on duty as the time of the scheduled firing approached, Kranz decided to install his own Tiger Team at the controls. His men quietly walked into Mission Control, muttered
240 apologies to their sitting counterparts, and took over the consoles. Under Kranz’s direction, the “big burn” worked. Another essential milestone for the journey home had been reached, and the room erupted with cheers.

The moment’s glow had barely passed when three men made their way from different directions to Kranz’s workstation. Chris Kraft was one; Deke Slayton, astronaut and director of flight crew operations, the second. Max Faget, engineering director for the entire Manned Spacecraft Center, trailed slightly behind. “So what’s our next step here, Gene?” opened Slayton, one of the original seven Mercury astronauts.

Kranz: “Well, Deke, we’re gonna work on that.”

250 *Slayton:* “I’m not sure how much there is to work on. We’re going to put the crew to bed, right?”

Kranz: “Eventually, sure.”

Slayton: “Eventually may not do it, Gene. Their last scheduled sleep period was twenty-four hours ago. They’re going to need some rest.”

Now Kraft jumped in.

Kraft: “How do we stand with that power-down problem, Gene?”

Kranz: “It’s coming along, Chris.”

Kraft: “We ready to execute it?”

260 *Kranz:* “We’re ready, but it’s a long procedure and Deke thinks we ought to get the crew ready to sleep first.”

Kraft: “Sleep? A sleep period’s six hours! Take the crew off stream that long before powering down, and you’re wasting six hours of juice you don’t need to waste.”

Slayton: “But if you keep them up and have them execute a complicated power-down when they’re barely awake, someone’s bound to screw something up. I’d rather spend a little extra power now than risk another disaster later.”

Max Faget appeared, and Kranz drew him into the discussion.

270 *Kranz:* “Max, Deke and Chris were just telling me what they think our next step ought to be.”

Faget: “Passive thermal control,⁹ right?”

Slayton, alarmed: “PTC?”

Faget: “Sure. That ship’s had one side pointing to the sun and one pointing out to space for hours. If we don’t get some kind of barbeque roll going on soon, we’re going to freeze half our systems and cook the other half.”

Slayton: “Do you have any idea what kind of pressure it’s going to put on the crew to ask them to execute a PTC roll now?”

Kraft: “Or what kind of pressure it’s going to put on the available power? I’m not sure we can afford to try something like that at the moment.”

280 *Faget:* “I’m not sure we can afford not to.”

The three-way argument escalated for several minutes, with each point and counterpoint more fiercely asserted than the last. Kranz said little throughout, mainly listening to what his three superiors had to say. Finally, he held up his hand, and they stopped speaking.

290 “Gentlemen,” Kranz said, “I thank you for your input.” The discussion was over, his decision made: “The next job for this crew will be to execute a thermal roll. After that, they will power down their spacecraft. And finally, they will get some sleep. A tired crew can get over their fatigue, but if we damage this ship any further, we’re not going to get over that.” **F**

With the decision made, Kranz turned to his console, and Slayton and Faget turned to leave. Kraft lingered, considered objecting, but then quietly moved off as well. His protégé was in control, and he had ruled firmly. The



The Latin phrase on this insignia means “From the Moon, Knowledge.”

9. **passive thermal control:** any method of controlling temperature on a spacecraft without using electricity.

COMMON CORE RI 6

F AUTHOR’S PURPOSE

An **author’s purpose** is what the writer hopes to achieve in a particular work. The main purpose of this narrative is to show readers an example of leadership in a crisis. To achieve this purpose, Useem shares both important details and less important details with his readers. Reread lines 281–295, in which Useem shows how Kranz makes and expresses an important decision. If you were to summarize this passage for a friend, you would share only the most important details. Which details are most important to showing Kranz’s leadership skills? The *less-important* details are not *unimportant* details, however. These details provide background and elaborate on the important details, help create suspense, and create a more complete picture of the event. What are some of the less important details in this passage?

astronauts spent the next two hours performing their assigned tasks and
300 finally began a long-overdue slumber.

The Return

With the trajectory successfully fixed for the return to Earth, Kranz and his Tiger Team resumed their calculations and planning in Room 210. The biggest challenge: restarting the moribund command module. *Aquarius* had been life-sustaining, but the LEM would disintegrate on reentry. *Odyssey* would be life-returning: the command module came with a heat shield to endure reentry's 5,000 degrees Fahrenheit. For that, though, *Odyssey* would have to be coaxed back from dormancy—with a defunct regular electric supply and a mere two hours of power remaining in its auxiliary batteries.

It was now late Wednesday evening, and the Tiger Team had been
310 working relentlessly since Monday evening, struggling to surmount problem after problem if reentry were to succeed. Most of the team members had worked nonstop for more than forty-eight hours, and Kranz finally ordered a six-hour **respite**. Yes, they needed their sleep, but even more compelling was the fact that the most critical troubleshooting might finally be behind them. John Aaron, the electrical officer borrowed from the Maroon Team, had evidently found a way around *Odyssey*'s repowering problem. **G**

It was a **collaborative** solution. One of the command module's chief engineers, Arnie Aldrich, had worked with Aaron to ensure that the switches for the various systems would be thrown in a workable sequence so that
320 early systems would be ready for later ones as needed. Kranz himself had examined each step, and astronaut Ken Mattingly had tested everything in a nearby command module simulator. Mattingly had been scheduled to serve as the command module pilot for *Apollo 13*, but after he had been exposed to German measles, NASA had replaced him with Swigert. Severely disappointed at first, Mattingly now applied his insider's knowledge to testing and refining Aaron's scheme. Ultimately, it worked—at least on the simulator. **H**

To add to the tension, the fate of *Apollo 13* had become a global drama. The Soviet Union volunteered rescue vessels. Religious groups across
330 America and around the world prayed for the astronauts' safe deliverance. The Chicago Board of Trade added its own supplication, briefly suspending trading at 11 a.m. on Thursday “for a moment of tribute to the courage and gallantry of America's astronauts and a prayer for their safe return to Earth.”

By Thursday evening, just eighteen hours before splashdown, the list of procedures to restart *Odyssey* was finalized and ready for transmission. Kranz, Aaron, and Aldrich pushed their way through the rows of consoles

respite (rēs'pīt) *n.* a period of rest or relief

collaborative (kə-lāb'ə-rə'tīv) *adj.* done in cooperation with others

GRAMMAR AND STYLE

Reread lines 311–315. Rather than writing a series of short sentences, Useem uses the **coordinating conjunctions** *and* and *but* to join two sets of independent clauses.

TAKE NOTES

How did Ken Mattingly help solve the problem of repowering the command module?



The command module is recovered from the Pacific Ocean after splashdown.

in Mission Control to deliver the list. Mission Control would require nearly two hours to radio the start-up sequence, line by line, to Jack Swigert, who would have to copy each of the hundreds of technical instructions by hand.

340 Swigert and crew successfully followed the start-up protocol, moved back into *Odyssey*, and jettisoned *Aquarius*. By mid-Friday, the command module was approaching Earth's outer atmosphere at 25,000 miles per hour, and Kranz took the director's console for the final time. With four minutes to go before *Odyssey* hit the atmosphere's upper layers, Kranz stood and asked each of the system officers if they were ready. "Let's go around the horn once more before entry," he said. Each officer declared his readiness. Kranz gave the mission communicator, astronaut Joe Kerwin, the green light: "You can tell the crew they're go for reentry."

350 Soon all radio contact with the crew was lost as intense heat enveloped the plunging craft. Four minutes of anxious silence passed on the ground until the fiery spray around the capsule subsided; then Kranz instructed Kerwin to resume contact. "*Odyssey*," Kerwin called. "Houston standing by,

1 SUSPENSE

How did the writer build suspense in lines 349–355?

over.” No response. Kranz: “Try again.” Kerwin did, again and again, to no avail, and another minute passed, more blackout time than experienced on any other mission. **1**

Then, faintly, came the scratchy but unmistakable voice of astronaut Jack Swigert: “OK, Joe.” Moments later Jim Lovell, Jack Swigert, and Fred Haise were floating down on three parachutes for a soft landing in the Pacific. Eugene Kranz punched the air.

360 Sy Liebergot faced weeks of recurrent nightmares about undervoltages. Jim Lovell declared the mission a failure, but, he added, “I like to think it was a successful failure.” And Grumman Aerospace, maker of the LEM, sent a mock bill for more than \$312,421 to North American Rockwell, producer of the command module, for a “battery charge, road call,” and “towing fee” for returning *Odyssey* home.

Eugene Kranz, James Lovell, and their crews matched wits with a technology failure, and they won. They orchestrated thousands of actions—many minute, some momentous—to fix what seemed unfixable. In the end, they triumphed over one of NASA’s worst nightmares.



Astronauts Fred Haise, James Lovell, and John Swigert after their return to Earth

Comprehension

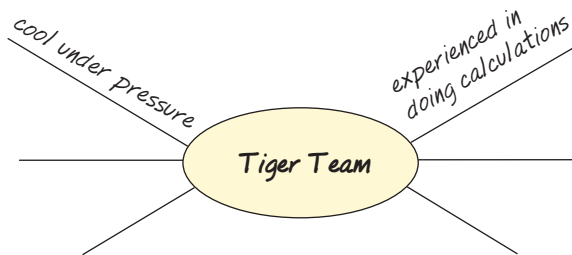
1. **Recall** What was the original goal of *Apollo 13*?
2. **Recall** Why did NASA have to cancel the mission?
3. **Summarize** What were the main steps taken to save the astronauts?



RI 1 Cite evidence to support analysis of what the text says explicitly. **RI 5** Analyze how an author's ideas are developed and refined.

Text Analysis

4. **Make Inferences** Why did astronaut James Lovell declare the *Apollo 13* mission “a successful failure”?
5. **Analyze Decisions** What skills, knowledge, and traits did Eugene Kranz look for when choosing members of the Tiger Team? Use a graphic organizer like the one shown to record your answer.



6. **Analyze Notes** Review the chart you created as you read. Which of the problems provided the biggest test of Kranz's leadership? Cite specific evidence to support your conclusion.
7. **Draw Conclusions** Why might the author have chosen to focus on the employees at Mission Control rather than on the astronauts in space? Support your answer.
8. **Interpret Main Idea** Reread lines 366–369. What idea does the writer express about the ways in which Kranz and his colleagues achieved the impossible?
9. **Make Judgments** Do you agree with NASA's policy of giving the flight director final authority on all decisions during the mission? Cite evidence to support your opinion.
10. **Predict** How might the space program have been affected if NASA had failed to rescue the astronauts aboard *Apollo 13*?
11. **Evaluate Suspense** Michael Useem included extensive technical information in his account of *Apollo 13*. How well did he balance the need to explain with the need to tell a suspenseful story? Find examples to support your answer.

How can we achieve the IMPOSSIBLE?

What qualities do you have that would help you deal with an emergency?

Vocabulary in Context

▲ VOCABULARY PRACTICE

Identify the word that is most different in meaning from the others.

1. remove, empty, replenish, discard
2. path, course, trajectory, perimeter
3. command, question, decree, mandate
4. standard, innovative, boring, unoriginal
5. rest, stillness, action, respite
6. oppositional, collaborative, solitary, dividing

ACADEMIC VOCABULARY IN WRITING

- affect
- communicate
- definite
- establish
- identify

The problems that *Apollo 13* encountered lacked a *definite* solution, which forced both the crew aboard the ship and the crew in Houston to improvise. Write a paragraph about a time in your life when you were faced with a difficult problem and had to improvise to solve it. Use at least one Academic Vocabulary word in your response.

VOCABULARY STRATEGY: SPECIALIZED VOCABULARY

The astronauts, scientists, and engineers who work at NASA have their own specialized vocabulary. This vocabulary includes terms such as *return trajectory*, which is the path of a spacecraft on its return to Earth. It is often possible to figure out the special meanings of words from the context. Otherwise, check a dictionary and look for labels—such as *space flight* and *computer science*—that may precede definitions and indicate special uses of a word.

PRACTICE Write the space flight term that matches each definition. If you need to, check a dictionary or glossary.

- vent
- protocols
- bus
- satellite
- transponder

1. an electrical power distribution system
2. a small body that orbits a larger one
3. data transmissions between computers
4. an electronic device that combines a transmitter and a receiver
5. to release or discharge

WORD LIST

collaborative
innovative
mandate
replenish
respite
trajectory

COMMON CORE

L 6 Acquire and use accurately domain-specific words and phrases.

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Language

◆ GRAMMAR AND STYLE: Improve Sentence Flow

Review the **Grammar and Style** note on page 130. Writing flows more smoothly when it doesn't merely consist of short, choppy sentences. Follow Michael Useem's example by inserting a **coordinating conjunction** (such as *and*, *but*, *for*, *or*, *so*, or *yet*) between two independent clauses to form a longer, **compound sentence** and to clarify the relationship between ideas. Remember to use a comma before a coordinating conjunction that joins two independent clauses. Here are two examples from the selection.

The astronauts and their protective shell were unscathed, but it was evident that some kind of explosion had ripped through vital equipment.
(lines 25–26)

He knew what options were out, yet he also knew he must somehow engineer a safe return. (lines 37–38)

Notice how the revisions in blue use a coordinating conjunction to make smoother sentence structures. Revise your own writing by using similar techniques.

STUDENT MODEL

A small explosion has occurred aboard the Odyssey. Some vital equipment was damaged, ^{but} The astronauts were not harmed.

READING-WRITING CONNECTION



Increase your understanding of “The Race to Save *Apollo 13*” by responding to this prompt. Then use the **revising tip** to improve your writing.

WRITING PROMPT

Short Constructed Response: Press Release

Imagine that you are working for NASA at the time of the *Apollo 13* crisis. Using information from the selection, write a **one- or two-paragraph press release** in which you describe events in the first hour after the explosion.

REVISING TIP

Review your response. How have you used coordinating conjunctions to make your writing flow more smoothly?



L3 Apply knowledge of language to make effective choices for meaning or style.

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