Day 7: Text Dependent Analysis and Theme

English Language Arts

- Now that you've read three primary sources, we are going to add in one more, President Reagan's national address following the explosion of the Space Shuttle Challenger. Using this new speech, you will write a text-dependent analysis that demonstrates your ability to link common themes together in a cohesive writing piece.
- Note: You do not have to complete the full TDA. However, you should use the planning area to describe how you might complete it to identify a common theme in all documents.
- Sketch out a possible response to the prompt. Note: you do not have to write the essay unless directed by your teacher(s).
    - TDA Prompt: Identify a common theme
    - Selection 1 (Kennedy)
    - Selection 2 (Jefferson)
    - Selection 3 (Reagan)

Day 7: Text Dependent Analysis and Theme English Language Arts

Name: _____ Period: _____ Score: _____/40

TEXT-DEPENDENT ANALYSIS QUESTION

E08.E.1.1
Within the selected sources, the authors each develop a theme to convey a central idea. Write an essay in which you identify a common theme set forth across each of the works. Within your response, use evidence from the multiple texts to support what you have identified as the common theme.

Writer's Checklist

PLAN before you write.
- Make sure you read the question carefully.
- Make sure you have read the entire passage carefully.
- Think about how the question relates to the passage.
- Organize your ideas on scratch paper. Use a thought map, outline, or other graphic organizer to plan your essay.

FOCUS while you write.
- Analyze the information from the passage as you write your essay.
- Make sure you use evidence from the passage to support your response.
- Use precise language, a variety of sentence types, and transitions in your essay.
- Organize your paper with an introduction, body, and conclusion.

PROOFREAD after you write.
- I wrote my final essay on the provided pages.
- I stayed focused on answering the question.
- I used evidence from the passage to support my response.
- I corrected errors in capitalization, spelling, sentence formation, punctuation, and word choice.

PLANNING AREA

Within the selected sources, the authors each develop a theme to convey a central idea. Write an essay in which you identify a common theme set forth across each of the works. Within your response, use evidence from the multiple texts to support what you have identified as the common theme.

Text Source 1: *John F. Kennedy Moonshot Speech*

TEXT OF PRESIDENT JOHN KENNEDY'S RICE STADIUM MOON SPEECH

President Pitzer, Mr. Vice President, Governor, Congressman Thomas, Senator Wiley, and Congressman Miller, Mr. Webb, Mr. Bell, scientists, distinguished guests, and ladies and gentlemen:

I appreciate your president having made me an honorary visiting professor, and I will assure you that my first lecture will be very brief.

I am delighted to be here, and I'm particularly delighted to be here on this occasion.

We meet at a college noted for knowledge, in a city noted for progress, in a State noted for strength, and we stand in need of all three, for we meet in an hour of change and challenge, in a decade of hope and fear, in an age of both knowledge and ignorance. The greater our knowledge increases, the greater our ignorance unfolds.

Despite the striking fact that most of the scientists that the world has ever known are alive and working today, despite the fact that this Nation[1]s own scientific manpower is doubling every 12 years in a rate of growth more than three times that of our population as a whole, despite that, the vast stretches of the unknown and the unanswered and the unfinished still far outstrip our collective comprehension.

No man can fully grasp how far and how fast we have come, but condense, if you will, the 50,000 years of man[1]s recorded history in a time span of but a half-century. Stated in these terms, we know very little about the first 40 years, except at the end of them advanced man had learned to use the skins of animals to cover them. Then about 10 years ago, under this standard, man emerged from his caves to construct other kinds of shelter. Only five years ago man learned to write and use a cart with wheels. Christianity began less than two years ago. The printing press came this year, and then less than two months ago, during this whole 50-year span of human history, the steam engine provided a new source of power.

Newton explored the meaning of gravity. Last month electric lights and telephones and automobiles and airplanes became available. Only last week did we develop penicillin and television and nuclear power, and now if America's new spacecraft succeeds in reaching Venus, we will have literally reached the stars before midnight tonight.

This is a breathtaking pace, and such a pace cannot help but create new ills as it dispels old, new ignorance, new problems, new dangers. Surely the opening vistas of space promise high costs and hardships, as well as high reward.

So it is not surprising that some would have us stay where we are a little longer to rest, to wait. But this city of Houston, this State of Texas, this country of the United States was not built by those who waited and rested and wished to look behind them. This country was conquered by those who moved forward--and so will space.

William Bradford, speaking in 1630 of the founding of the Plymouth Bay Colony, said that all great and honorable actions are accompanied with great difficulties, and both must be enterprised and overcome with answerable courage.

If this capsule history of our progress teaches us anything, it is that man, in his quest for knowledge and progress, is determined and cannot be deterred. The exploration of space will go ahead, whether we join in it or not, and it is one of the great adventures of all time, and no nation which expects to be the leader of other nations can expect to stay behind in the race for space.

Those who came before us made certain that this country rode the first waves of the industrial revolutions, the first waves of modern invention, and the first wave of nuclear power, and this generation does not intend to founder in the backwash of the coming age of space. We mean to be a part of it--we mean to lead it. For the eyes of the world now look into space, to the moon and to the planets beyond, and we have vowed that we shall not see it governed by a hostile flag of conquest, but by a banner of freedom and peace. We have vowed that we shall not see space filled with weapons of mass destruction, but with instruments of knowledge and understanding.

Yet the vows of this Nation can only be fulfilled if we in this Nation are first, and, therefore, we intend to be first. In short, our leadership in science and in industry, our hopes for peace and security, our obligations to ourselves as well as others, all require us to make this effort, to solve these mysteries, to solve them for the good of all men, and to become the world's leading space-faring nation.

We set sail on this new sea because there is new knowledge to be gained, and new rights to be won, and they must be won and used for the progress of all people. For space science, like nuclear science and all technology, has no conscience of its own. Whether it will become a force for good or ill depends on man, and only if the United States occupies a position of pre-eminence can we help decide whether this new ocean will be a sea of peace or a new terrifying theater of war. I do not say the we should or will go unprotected against the hostile misuse of space any more than we go unprotected against the hostile use of land or sea, but I do say that space can be explored and mastered without feeding the fires of war, without repeating the mistakes that man has made in extending his writ around this globe of ours.

There is no strife, no prejudice, no national conflict in outer space as yet. Its hazards are hostile to us all. Its conquest deserves the best of all mankind, and its opportunity for peaceful cooperation many never come again. But why, some say, the moon? Why choose this as our goal? And they may well ask why climb the highest mountain? Why, 35 years ago, fly the Atlantic? Why does Rice play Texas?

We choose to go to the moon. We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win, and the others, too.

It is for these reasons that I regard the decision last year to shift our efforts in space from low to high gear as among the most important decisions that will be made during my incumbency in the office of the Presidency.

In the last 24 hours we have seen facilities now being created for the greatest and most complex exploration in man's history. We have felt the ground shake and the air shattered by the testing of a Saturn C-1 booster rocket, many times as powerful as the Atlas which launched John Glenn, generating power equivalent to 10,000 automobiles with their accelerators on the floor. We have seen the site where the F-1 rocket engines, each one as powerful as all eight engines of the Saturn combined, will be clustered together to make the advanced Saturn missile, assembled in a new building to be built at Cape Canaveral as tall as a 48 story structure, as wide as a city block, and as long as two lengths of this field.

Within these last 19 months at least 45 satellites have circled the earth. Some 40 of them were "made in the United States of America" and they were far more sophisticated and supplied far more knowledge to the people of the world than those of the Soviet Union.

The Mariner spacecraft now on its way to Venus is the most intricate instrument in the history of space science. The accuracy of that shot is comparable to firing a missile from Cape Canaveral and dropping it in this stadium between the the 40-yard lines.

Transit satellites are helping our ships at sea to steer a safer course. Tiros satellites have given us unprecedented warnings of hurricanes and storms, and will do the same for forest fires and icebergs.

We have had our failures, but so have others, even if they do not admit them. And they may be less public.

To be sure, we are behind, and will be behind for some time in manned flight. But we do not intend to stay behind, and in this decade, we shall make up and move ahead.

The growth of our science and education will be enriched by new knowledge of our universe and environment, by new techniques of learning and mapping and observation, by new tools and computers for industry, medicine, the home as well as the school. Technical institutions, such as Rice, will reap the harvest of these gains.

And finally, the space effort itself, while still in its infancy, has already created a great number of new companies, and tens of thousands of new jobs. Space and related industries are generating new demands in investment and skilled personnel, and this city and this State, and this region, will share greatly in this growth. What was once the furthest outpost on the old frontier of the West will be the furthest outpost on the new frontier of science and space. Houston, your City of Houston, with its Manned Spacecraft Center, will become the heart of a large scientific and engineering community. During the next 5 years the National Aeronautics and Space Administration expects to double the number of scientists and engineers in this area, to increase its outlays for salaries and expenses to $60 million a year; to invest some $200 million in plant and laboratory facilities; and to direct or contract for new space efforts over $1 billion from this Center in this City.

To be sure, all this costs us all a good deal of money. This year[1]s space budget is three times what it was in January 1961, and it is greater than the space budget of the previous eight years combined. That budget now stands at $5,400 million a year--a staggering sum, though somewhat less than we pay for cigarettes and cigars every year. Space expenditures will soon rise some more, from 40 cents per person per week to more than 50 cents a week for every man, woman and child in the United Stated, for we have given this program a high national priority--even though I realize that this is in some measure an act of faith and vision, for we do not now know what benefits await us.

But if I were to say, my fellow citizens, that we shall send to the moon, 240,000 miles away from the control station in Houston, a giant rocket more than 300 feet tall, the length of this football field, made of new metal alloys, some of which have not yet been invented, capable of standing heat and stresses several times more than have ever been experienced, fitted together with a precision better than the finest watch, carrying all the equipment needed for propulsion, guidance, control, communications, food and survival, on an untried mission, to an unknown celestial body, and then return it safely to earth, re-entering the atmosphere at speeds of over 25,000 miles per hour, causing heat about half that of the temperature of the sun--almost as hot as it is here today--and do all this, and do it right, and do it first before this decade is out--then we must be bold.

I'm the one who is doing all the work, so we just want you to stay cool for a minute. [laughter]

However, I think we're going to do it, and I think that we must pay what needs to be paid. I don't think we ought to waste any money, but I think we ought to do the job. And this will be done in the decade of the sixties. It may be done while some of you are still here at school at this college and university. It will be done during the term of office of some of the people who sit here on this platform. But it will be done. And it will be done before the end of this decade.

I am delighted that this university is playing a part in putting a man on the moon as part of a great national effort of the United States of America.

Many years ago the great British explorer George Mallory, who was to die on Mount Everest, was asked why did he want to climb it. He said, "Because it is there."

Well, space is there, and we're going to climb it, and the moon and the planets are there, and new hopes for knowledge and peace are there. And, therefore, as we set sail we ask God's blessing on the most hazardous and dangerous and greatest adventure on which man has ever embarked.

Text Source 2: *Jefferson's Letter to Lewis (1803)*

Transcript: Jefferson's Instructions for Meriwether Lewis

Thomas Jefferson and Early Western Explorers

Transcribed and Edited by Gerard W. Gawalt, Manuscript Division, Library of Congress. June 20 1803

To: Captain Meriwether Lewis esq. Capt. of the 1st. regimt, of Infantry of the United States

Full Transcript Available at https://www.loc.gov/exhibits/lewisandclark/transcript57.html

[ante June 20 1803]
To <Captain> Meriwether Lewis esq. Capt. of the 1st. regimt, of Infantry of the US. of A.

Your situation as Secretary of the President of the US has made you acquainted with the objects of my confidential message of Jan. 18. 1803 to the legislature; you have seen the act they passed, which they expressed in general terms, was meant to sanction these objects, and you are appointed to carry them into execution.

(5) Instruments for ascertaining by ***celestial*** observations, the geography of the country through which you will pass, have been already provided. Light articles for barter and presents among the Indians, arms for your attendants, say from 10. to 12. men, boats, tents, & other travelling apparatus with ammunition, medicine, surgical instruments and provisions you will have prepared with such aids as the Secretary at War can yield in his department; & from him also you will receive authority to (10) engage among our troops, by voluntary agreement, the number of attendants above mentioned, over whom you, as their commanding officer, are invested with all the powers the laws give in such a case.

The object of your mission is to explore the Missouri river, & such principal stream of it as by it's course and communication with the waters of the Pacific ocean whether the Columbia, Oregon, Colorado or any other river may offer the most direct & practicable water communication across this (15) continent for the purposes of commerce.

Beginning at the mouth of the Missouri, you will take careful observations of latitude & longitude at all remarkable points on the river, & especially at the mouth of rivers, at rapids, at islands, & other places & objects distinguished by such durable natural marks & characters of a durable nature kind as that they may with certainty be recognized hereafter.

(20) The course of the river between these points of observation may be supplied by the compass, the log-line & by time, corrected by the observations themselves. The variations of the compass too, in different places should be noticed.

The interesting points of the portage between the heads of the Missouri, & of the water offering the best communication with the Pacific ocean, should also be fixed by observation, & the course of that (25) water to the ocean, in the same manner as that of the Missouri.

Your observations are to be taken with great pains & accuracy, to be entered distinctly & **intelligibly** for others…fix the latitude and longitude of the places at which they were taken, and are to be rendered to the war office for the purpose of having the calculations made concurrently by proper persons within the US. several copies of these as well as of your other notes should be made at
(30) leisure times, & put into the care of the most trust-worthy of your attendants, to guard by multiplying them against the accidental losses to which they will be exposed. A further guard would be that one these copies be on the paper of the birch, as less liable to injury from damp than

common paper.

The commerce which may be carried on with the people inhabiting the line your will pursue, renders a (35) knowledge of those people important. You will therefore **endeavor** to make yourself acquainted with as far as a **diligent** pursuit of your journey shall admit, with the names of the nations & their numbers; the extent & limits of their possessions; their relations with other tribes of nations; their language, traditions, monuments; their ordinary occupations in agriculture, fishing, hunting, war, arts & the implements for these; their food, clothing, & domestic accommodations; the diseases prevalent (40) among them, & the remedies they use; moral & physical circumstances which distinguish them from the tribes we know; peculiarities in their laws, customs & dispositions; and articles of commerce they may need or furnish & to what extent.

Other objects worthy of notice will be the soil & face of the country, it's growth & vegetable productions, especially those not of the US. the animals of the country generally, & especially those (45) not known in the US. the remains & accounts of any which may be deemed rare or extinct; the mineral productions of every kind; but more particularly metals; limestone, pit-coal, & salt-petre; salines & mineral waters, noting the temperature of the last & such circumstances as may indicate their character; volcanic appearances; climate, as characterized by the thermometer, by the proportion of rainy, cloudy, & clear days, by lightening, hail, snow, ice, by the access & recess of (50) frost, by the winds prevailing at different seasons, the dates at which particular plants put forth or lose their flower, or leaf, times of appearance of particular birds, reptiles or insects.

Although' your route will be along the channel of the Missouri, yet you will endeavor to inform yourself, by enquiry, of the character & extent of the country watered by it's branches & especially on it's Southern side, the North river or Rio Bravo which runs into the gulph of Mexico, and the North (55) river, or Rio Colorado which runs into the gulph of California, are understood to be the principal streams heading opposite to the waters of the Missouri, and running Southwardly. Whether the dividing grounds between the Missouri & them are mountains or flat lands, what are their distance from the Missouri, the character of the intermediate country, & the people inhabiting it, are worthy of particular enquiry.

(60) The Northern waters of the Missouri are less to be enquired after, because they have been ascertained to a considerable degree, & are still in a course of ascertainment by English traders, and travellers. But if you can learn anything certain of the most Northern source of the Mississippi, & of it's position relatively to the lake of the woods, it will be interesting to us.
Two copies of your notes at least & as many more as leisure will admit, should be made & confided to (65) the care of the most trusty individuals of your attendants.

In all your intercourse with the natives, treat them in the most friendly & **conciliatory** manner which their own conduct will admit; allay all jealousies as to the object of your journey, satisfy them of it's innocence, make them acquainted with the position, extent character, peaceable & commercial dispositions of the US. of our wish to be neighborly, friendly, & useful to them.

(70) If a few of their influential chiefs within practicable distance, wish to visit us, arrange such a visit with them, and furnish them with authority to call on our officers, on their entering the US. to have them conveyed to this place at the public expense.

If any of them should wish to have some of their young people brought up with us, & taught such arts as may be useful to them, we will receive, instruct & take care of them. Such a mission whether of (75) influential chiefs or of young people would give some security to your own party.

Carry with you some matter of the kinepox; inform those of them with whom you may be, of it's efficacy as a preservative from the smallpox; & instruct & encourage them in the use of it. This may be especially done wherever you winter.

As it is impossible for us to foresee in what manner you will be received by those people, whether (80) with hospitality or hostility, so is it impossible to prescribe the exact degree of perseverance with which you are to pursue your journey. We value too much the lives of citizens to offer them to probable destruction. Your numbers will be sufficient to secure you against the unauthorized opposition of individuals or of small parties: but if a superior force authorized, or not authorized by a nation, should be arrayed against your further passage, and inflexibly determined to arrest it, you (85) must decline it's farther pursuit, and return.

In the loss of yourselves, we should lose also the information you will have acquired. By returning safely with that, you may enable us to renew the essay with better calculated means. To your own discretion therefore must be left the degree of danger you risk, and the point at which you should decline, only saying we wish you to err on the side of your safety, and to bring back your party safe (90) even if it be with less information.

Should you reach the Pacific Ocean inform yourself of the circumstances which may decide whether the furs of those parts may not be collected as advantageously at the head of the Missouri …
On your arrival on that coast endeavor to learn if there by any port within your reach frequented by the sea-vessels of any nation, & to send two of your trusty people back by sea, in such way as they (95) shall judge shall appear practicable, with a copy of your notes: and should you be of opinion that the return of your party by the way they went will be eminently dangerous, then ship the whole, & return by sea, by the way either of cape Horn, or the cape of good Hope, as you shall be able. As you will be without money, clothes or provisions, you must endeavor to use the credit of the U.S. to obtain them, for which purpose open letters of credit shall be furnished you, authorizing you to draw upon (100) the Executive of the U.S. or any of it's officers…

Should you find it safe to return by the way you go, after sending two of your party round by sea, or with your whole party, if no conveyance by sea can be found, do so; making such observations on your return, as may serve to supply, correct or confirm those made on your outward journey.

On re-entering the U.S. and reaching a place of safety, discharge any of your attendants who may (105) desire & deserve it, procuring for them immediate payment of all arrears of pay & clothing which may have incurred since their departure, and assure them that they shall be recommended to the liberality of the legislature for the grant of a soldier's portion of land each, as proposed in my message to Congress; & repair yourself with your papers to the seat of government ….

To provide, on the accident of your death, against **anarchy**, **dispersion**, & the consequent danger to (110) your party, and total failure of the enterprise, you are hereby authorized, by any instrument signed & written in your own hand, to name the person among them who shall succeed to the command on your decease, and by like instruments to change the nomination from time to time as further experience of the characters accompanying you shall point out superior fitness…

Given under my hand at the city of Washington this 20th day of June 1803.
Th. J. Pr. U.S. of A.

Text Source 3: Address to the Nation on the Challenger Accident
President Reagan

January 28, 1986

"Ladies and Gentlemen, I'd planned to speak to you tonight to report on the state of the Union, but the events of earlier today have led me to change those plans. Today is a day for mourning and remembering. Nancy and I are pained to the core by the tragedy of the shuttle Challenger. We know we share this pain with all of the people of our country. This is truly a national loss.

Nineteen years ago, almost to the day, we lost three astronauts in a terrible accident on the ground. But we've never lost an astronaut in flight; we've never had a tragedy like this. And perhaps we've forgotten the courage it took for the crew of the shuttle. But they, the Challenger Seven, were aware of the dangers, overcame them and did their jobs brilliantly. We mourn seven heroes: Michael Smith, Dick Scobee, Judith Resnik, Ronald McNair, Ellison Onizuka, Gregory Jarvis, and Christa McAuliffe. We mourn their loss as a nation together.

[To] the families of the seven: we cannot bear, as you do, the full impact of this tragedy. But we feel the loss, and we're thinking about you so very much. Your loved ones were daring and brave, and they had that special grace, that special spirit that says, "Give me a challenge, and I'll meet it with joy." They had a hunger to explore the universe and discover its truths. They wished to serve, and they did. They served all of us. We've grown used to wonders in this century. It's hard to dazzle us. But for 25 years the United States space program has been doing just that. We've grown used to the idea of space, and perhaps we forget that we've only just begun. We're still pioneers. They, the members of the Challenger crew, were pioneers.

And I want to say something to the schoolchildren of America who were watching the live coverage of the shuttle's takeoff. I know it is hard to understand, but sometimes painful things like this happen. It's all part of the process of exploration and discovery. It's all part of taking a chance and expanding man's horizons. The future doesn't belong to the fainthearted; it belongs to the brave. The Challenger crew was pulling us into the future, and we'll continue to follow them.

I've always had great faith in and respect for our space program, and what happened today does nothing to diminish it. We don't hide our space program. We don't keep secrets and cover things up. We do it all up front and in public. That's the way freedom is, and we wouldn't change it for a minute. We'll continue our quest in space. There will be more shuttle flights and more shuttle crews and, yes, more

volunteers, more civilians, more teachers in space. Nothing ends here; our hopes and our journeys continue. I want to add that I wish I could talk to every man and woman who works for NASA or who worked on this mission and tell them: ' Your dedication and professionalism have moved an impressed us for decades. And we know of your anguish. We share it.'

There' s a coincidence today. On this day 390 years ago, the great explorer Sir Francis Drake died aboard ship off the coast of Panama. In his lifetime the great frontiers were the oceans, and an historian later said, 'He lived by the sea, died on it, and was buried in it.' Well today we can say of the Challenger crew: Their dedication was, like Drake's, complete.

The crew of the space shuttle Challenger honored us by the manner in which they lived their lives. We will never forget them, nor the last time we saw them, this morning, as they prepared for their journey and waved goodbye and 'slipped the surly bonds of Earth' to 'touch the face of God. Thank you."

Day 7: Calculating Volume
Math

Using a calculator, Calculate the volume of each planet and fill out the chart

Planet	*Diameter (km)*	*Your Work*	*Volume*
Mercury	4879 km		
Venus	12,104 km		
The Moon	3475 km		
Jupiter	142,984 km		
Saturn	120,536 km		
Uranus	51,118 km		
Neptune	49,528 km		

Don't forget the first column is in diameter, not radius!!!!

Formula for Volume:

$V = 4/3*\pi r^3$

WQED education

Day 7: Characteristics of Mars Part 2

Science

Alien Project

Materials:

- Paper, colored pencils, markers, crayons, or any other materials to design an alien.
- Your Planet Chart from Day 4 and 5 Science

1. Finish and label your alien. Color it and give it a name (if you haven't already).

2. Be sure to label the parts of your alien to show why you made it the way you did. For example, if you gave it teeth, you should have an arrow pointing to the teeth saying "Teeth to chew the iron rocks on the surface for food".

Day 7: Space Race, Cold War, and the Moon

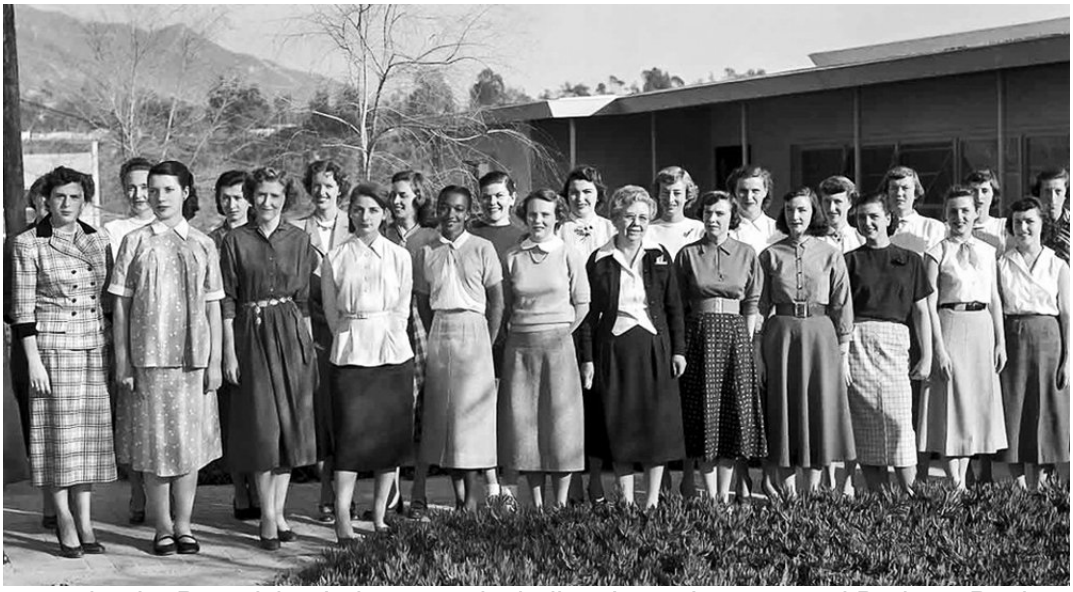
Social Studies

- Analyze the contributions of those who brought us to the Moon.
- Read the article about the Women Who Brought us the Moon.
- Complete a journal entry highlighting the contributions of one of the women to detail her contributions the nation's space program.
- Additional Interactive Online Resource: Chasing the Moon: https://ctm.americanexperience.org

The Women Who Brought Us the Moon

https://www.pbs.org/wgbh/americanexperience/features/chasing-moon-women-who-brought-us-moon/
By Nathalia Holt

A diverse and potent force in space exploration, women at NASA who served as human computers were ultimately responsible for sending astronauts to the moon.



Computers at the Jet Propulsion Laboratory, including Janez Lawson and Barbara Paulson. Credit: NASA/JPL

In 1965, Poppy Northcutt was the only female engineer at NASA's Houston Mission Control. As she gazed at the men around her she thought to herself, ***I'm as smart as they are***. Although she belonged among them, it was undeniably difficult to be the only woman in what sometimes felt like the domain of men.

As isolated as Northcutt felt in the historic control center, she was one of thousands of women who began their careers at NASA as computers. It was a job created before the advent of electronic machines, when human aptitude was required to perform all the mathematical calculations needed for experiments. Women have historically filled these positions, as exemplified by the groups of female computers who worked at the **Harvard Observatory** and the **Royal Observatory Greenwich** in the late 1800s. At NASA, these women came from all over the world, working at centers across the United States, and comprising a diverse and potent force in space exploration. Their calculations would ultimately be responsible for sending astronauts to the moon.

Unlike Northcutt, **Sue Finley** noticed the ubiquitous presence of female employees when she started work at the Jet Propulsion Laboratory in Pasadena, CA. Not only was her supervisor a woman, but all of her coworkers in the computing section were as well. It was January 31, 1958, and the country was on the precipice of historic achievement. That evening the laboratory would finally catch up with Sputnik 1 and 2, the world's first satellites, launched by the Soviet Union in October and November of 1957. In mission control that night, it was one woman, **Barbara Paulson**, who tracked Explorer 1, America's first satellite, as it left Earth's atmosphere and entered space. When Paulson declared that the satellite had made it into Earth's orbit, the room erupted in celebration. Although it would be another six months before NASA was officially formed, for those at the Jet Propulsion Laboratory the moon was already in their sights.

Helen Ling at the Jet Propulsion Laboratory in Pasadena, CA. Credit: NASA/JPL

Finley began adapting their designs and trajectories in order to launch robotic lunar missions. Her team was focused on sending the first camera to the moon as part of the **Ranger** series of missions, from 1961-1965, whose goal was to obtain close up images of the lunar surface and select a landing site for Apollo. Next, they would send uncrewed spacecraft as part of the **Surveyor**, from 1966-1968, which gathered further data on temperature and surface substrate to aid in Apollo planning. In addition, Finley was part of the team designing an array of large radio antennas that they called the **Deep Space Network**, which would form a massive tracking and communications system.

The women working at the Jet Propulsion Laboratory in the 1960s were all highly trained mathematicians, and many possessed advanced degrees. **Helen Ling** was born in China and experienced a tumultuous childhood formed under the pressures of WWII. Coming to the United States for college, she earned her master's degree in mathematics before leading the computing section in a managerial role for over three decades. There was also **Janez Lawson**, the first African American hired in a technical position at the laboratory. She held a bachelor's degree in chemical engineering from UCLA and by modern qualifications would be hired today as an engineer. However, in the 1950s, her gender and race impeded her employment and she was brought in as a computer.

The most extensive group of **African American computers** in the United States was based at the Langley Memorial Aeronautic laboratory in Hampton, Virginia. While employees of different racial backgrounds worked beside one another at many NASA centers, for those employees working in the Jim Crow South, segregation remained in effect. African American women were initially grouped in a section labeled the "**West Area Computers**." This separation meant that not only would they be paid far less than their white counterparts, but also that all working quarters, lunch areas and bathrooms were segregated by race.

Katherine Johnson at the Langley Memorial Aeronautical Laboratory in Hampton, VA. Credit: NASA

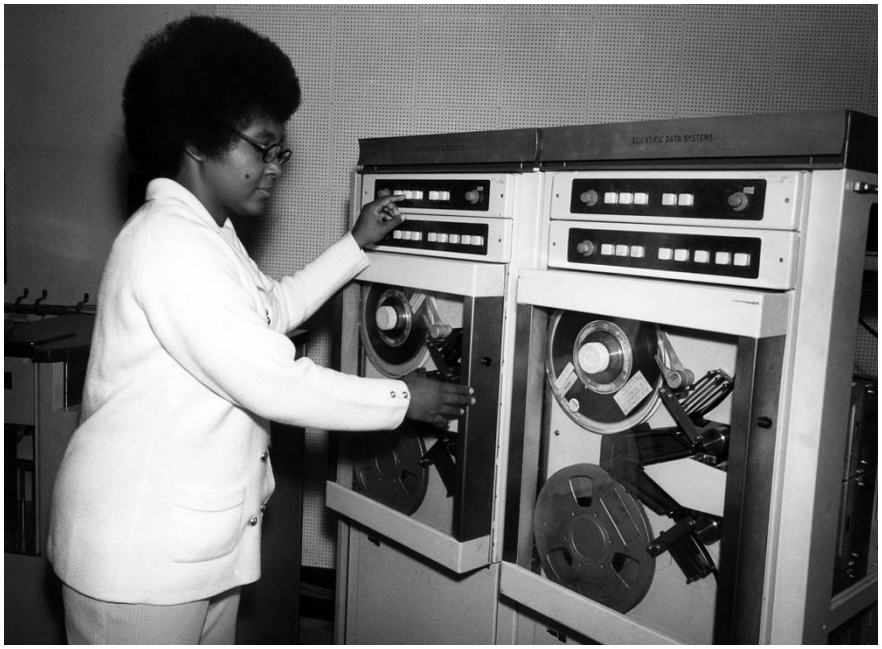
In a system designed to repress their advancement, the African American women became indispensable. "A Trojan horse of segregation opening the door to integration," Margot Lee Shetterly wrote in **Hidden Figures**, her 2016 nonfiction book documenting the groundbreaking female African American computers at Langley and adapted into a feature film of the same name. In the book, Shetterly focuses her narrative on three human computers turned engineers: **Katherine Johnson**, who was awarded the Presidential Medal of Freedom in 2015, **Dorothy Vaughan** and **Mary Jackson**. While their careers spanned decades, their contributions to early human spaceflight are most frequently lauded.

It was John Glenn himself, one of the original astronauts known as the Mercury Seven, who asked for Katherine Johnson. "**Have the girl check the numbers**," he said prior to his Friendship 7 launch. "If she says the numbers are good…I'm ready to go." Johnson not only checked the numbers, she also designed the trajectory for his record breaking 1962 orbit around the Earth. Next, her mathematics would take on new importance as she bent her trajectories beyond the Earth's gravitational pull, all the way out to the moon.

In 1962, when President John F. Kennedy said, "**We choose to go the moon in this decade, and do other things, not because they are easy, but because they are hard**," he was speaking to the heart of NASA operations across the country. At the Cleveland Flight Propulsion Laboratory in Ohio, the group of female computers was focused on developing rockets powerful enough to break the chains of gravity and function in the vacuum of space. To accomplish this, NASA needed **multistage**, or stacked, rockets, with the lower part of the rocket providing plenty of thrust, before falling off, back towards Earth, and the upper part of the rocket designed to give the final boost necessary to send astronauts to the moon. Chief among the female programmers at the laboratory in Ohio was **Annie Easley**, an African American woman with her bachelor's degree in mathematics from Cleveland State University.

Annie Easley at the Lewis Research Center in Cleveland, OH. Credit: NASA

Like Northcutt in Houston, Finley in California, and Johnson in Virginia, Easley started as a computer. By the mid-1960s, however, the world of human computers was in a vast state of upheaval, both in the development of electronic computers at IBM, now more powerful and flexible in their programming, and in the shifting perceptions instigated by the women's movement in the United States. As part of this social and technological revolution, female computers such as Easley were no longer calculating by hand, but were now responsible for writing the space agency's earliest computer programs. Easley was programming the Centaur rocket engines, whose technology would be incorporated into the upper stage rocketry that would form a critical component for Apollo.



Jeanette Scissum at the Marshall Space Flight Center in Hunstville, AL. Credit: NASA

Rockets might be able to get astronauts to the moon, but they still needed to find a place to land. At the Marshall Space Flight Center in Huntsville, Alabama, a laboratory under the direction of the controversial Nazi turned American rocket scientist **Wernher von Braun**, the team was tackling this challenge. Like at other NASA centers across the country, the flight center team was comprised of a talented group of female mathematicians, including **Jeanette Scissum**, an African American scientist who joined the center as an entry-level mathematician in 1964. Scissum was developing a computer program capable of selecting landing locations for the Apollo lunar module. It was her work, and that of her team, that ultimately selected a flat region at the Sea of Tranquility for Apollo 11.

JoAnn Morgan at the Kennedy Space Center in Merritt Island, FL. Credit: NASA

At Cape Kennedy in Florida, the pieces of Apollo 11 were being assembled. Born from the calculations of female hands across the country, the multiple staged rockets were hoisted by cranes in the final assembly area before the payload, containing the lunar, service and command modules, was fitted on top. Waiting in anticipation was **JoAnn Morgan**, a twenty-eight year old instrumentation controller who had worked at Cape Kennedy since NASA's inception in 1958.

Like Poppy Northcutt in Houston, Morgan was accustomed to being the only woman in the control room in Cape Kennedy. While she had worked on all the previous Apollo launches, Apollo 11 would mark the first time she was allowed to sit at the console. The opportunity to be in command of the guidance computers for Apollo 11 was undeniably exciting. Yet she worried about the attention she would receive. She knew media photographers would be documenting their progress and she didn't want to stick out in the crowd of men. A previous Apollo mission had taught her how inappropriate journalists could be, when a cameraman making his way down her row had said to one of her colleagues, "**I wish you could let her go out and put on some lipstick**."

Morgan was not thinking of lipstick on the morning of July 16, 1969, when Apollo 11 launched from Cape Kennedy. Thirty minutes prior to blastoff, she and her colleagues were locked into the firing room, a standard precaution during an Apollo launch. The Florida sky was a flawless blue as the rocket bolted out of sight, entering Earth's orbit twelve minutes later, as expected. What happened next, however, was not planned.

Margaret Hamilton at the Draper Laboratory in Cambridge, MA. Credit: Courtesy of MIT Museum

Four days later, on July 20, the Eagle, the Apollo lunar module, began its descent towards the lunar surface. Just minutes from landing, the computers onboard overloaded. "**Give us a readout on that 1202 program alarm**," said Neil Armstrong, sitting next to Buzz Aldrin in the small cabin. The astronauts had no inkling what action had tripped their alarm. The flight controllers at Houston Mission Control were racing to understand the problem. They determined that the computers were burdened from trying to complete too many functions at once. In Houston they made a critical decision: instead of aborting the mission, they placed their trust in the Apollo onboard software written by **Margaret Hamilton**, director of Apollo flight computer programming, and her team at the Draper laboratory at MIT. Ultimately, MIT's code saved the day, overriding all other functions in order to make landing the priority. "**If the computer hadn't recognized this problem and taken recovery action, I doubt if Apollo 11 would have been the successful Moon landing it was**," Hamilton would later write.

Six and a half hours after the Eagle made its fraught landing, Neil Armstrong, with the eyes of the world watching, made his historic first step on the lunar surface. "That's one small step for man, one giant leap for mankind," Armstrong would famously say as he descended from the Eagle's ladder. Yet the moment was not made by men alone. Instead, it was the work of thousands of men and women, of all different races, nationalities and backgrounds, who were working together to bring about one of humanity's greatest achievements.

For the women of NASA, their work was in many ways just beginning. The decades that followed would be filled with new explorations as they returned spacecraft not only to the moon, but also to the edges of our solar system. For some pioneering female engineers, new missions still lie ahead.

Sue Finley, who started in 1958, before NASA's formation, is still working for the space agency today. At age 83 and with a career spanning six decades, she is **NASA's longest serving female employee**. She has witnessed a dizzying array of changes, both technologically and socially. Her work has sent rovers to Mars; sent ships to every planet of our solar system; yielded new data and

stunning images of Jupiter, Saturn, and Pluto; and even launched spacecraft all the way into interstellar space. Yet few outside her laboratory are aware of the pivotal role Finley has played in space exploration. It is only in the past few years that her contributions, and those of her fellow female colleagues at NASA, have begun to receive the acknowledgement they deserve. On the anniversary of Apollo 11, as we recognize the men whose accomplishments have long been lauded, it's worth remembering the many women who brought us the moon.

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