A

Level 3 Certificate/Extended Certificate

APPLIED SCIENCE

Unit 3 Science in the Modern World

June 2022

ASC3/PM

Pre-release Material

- **This pre-release material should be opened and issued to learners on or after 31 March 2022.**

- **A clean copy of the pre-release material will be provided at the start of the examination.**

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INFORMATION

This pre-release material is to be issued to learners for use during preparation for this examination. The pre-release material consists of four sources (A–D) on the subject of SPACE EXPLORATION.

This material is being given to you in advance of this examination to enable you to study each source in preparation for questions based on the material in SECTION A of the examination.

A wider understanding of the topics and issues raised in the sources would be beneficial for the assessment. You are not required to understand any detailed scientific explanations beyond that outlined in SOURCES A–D and that in the Applied Science specification.

You may write notes on this copy of the pre-release material, but you will not be allowed to bring this copy, or any other notes you may have made, into the examination room. You will be provided with a clean copy of this pre-release material at the start of the examination.

It is suggested that a minimum of three hours detailed study is spent on this pre-release material.

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SOURCE A: adapted article from 'NASA', July 2019

World Joins NASA in Celebrating Apollo as the Agency Looks to the Future

Last Updated: July 23, 2019
Editor: Brian Dunbar, NASA

When Apollo 11 landed on the Moon, more than 600 million people – approximately one-sixth of the world's population – reportedly saw the television footage of Neil Armstrong and Buzz Aldrin taking humanity's first steps on another world.

Fifty years later, the world came together again around Apollo 11, but the advent of social media fundamentally changed how people did so, allowing them to interact much more directly by sharing imagery, memories and thoughts with their own global audience.

NASA led the celebrations with a commemorative program, "Giant Leaps: Past and Future", featuring Apollo 11 Command Module Pilot Michael Collins and Flight Director Gene Kranz, among many others. On the National Mall in Washington, the National Air & Space Museum's multimedia program "Apollo 50: Go for the Moon" projected a 363-foot image (life size!) of the Saturn V onto the Washington Monument, followed by a multi-screen film on the mission.

For NASA's digital properties, the anniversary will be a highlight of the year. The celebration brought about the highest engagement of any 2019 story across the agency's YouTube, Twitter, Facebook and Tumblr channels, and the third-highest engagement of the year across Instagram.

On NASA TV, approximately 25 000 people watched the "live" rebroadcast of the Apollo 11 moonwalk. So far, 1.5 million people have watched the video on YouTube. The anniversary may well prove to be the biggest online event in the agency's history other than the 2017 solar eclipse.

Even as NASA is remembering the past, it is looking forward to its next giant leap. As part of the celebration, on Friday NASA Administrator Jim Bridenstine unveiled the logo for Artemis, the program that by 2024 will send the first woman and next man to the Moon. At the Kennedy Space Centre on Saturday, Vice President Mike Pence showed off the Orion capsule that will make the first Artemis test flight beyond the Moon.

"Our goal 50 years ago was to prove we could land humans on the Moon and return them safely to Earth," Bridenstine said on the anniversary of Apollo 11's launch. "Our goal now is to return to the Moon in a sustainable way, under the Artemis program, to prepare for the next giant leap – sending humans to Mars."

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SOURCE B: adapted article from 'LiveScience', September 2019

Why Is It So Hard to Land on the Moon?

By Adam Mann
Live Science Contributor
Updated on Monday 16th September 2019

More than one-third of attempts to land there have ended in failure.

Space is hard. That was the takeaway on September 7, when the Indian Space Research Organisation (ISRO) lost contact with its Vikram lunar lander during an attempt to touch down at the moon's south-pole.

India was poised to become the fourth nation to ever successfully touch down softly on the lunar regolith, doing so in a place that no other country has previously reached. Though the space agency is still scrambling to revive communication with Vikram — which has been spotted from lunar orbit — the unhappy landing sequence seemed like a painful echo of the situation earlier this year, when a private robotic Israeli lander, Beresheet, crashed into our natural satellite.

It's all a reminder that, despite the fact that humans landed on the moon many times during the Apollo missions half a century ago, doing so remains a tough

business. Of the 30 soft-landing attempts made by space agencies and companies around the world, more than one-third have ended in failure, space journalist Lisa Grossman tweeted.

But why exactly is it so hard to land on the moon?

No one particular event is responsible for the many failed attempts, aerospace engineer Alicia Dwyer Cianciolo of NASA's Langley Research Centre in Hampton, Virginia, told 'Live Science'. To land on the moon, "so many things have to happen in exactly the right order," she said. "If any one of them doesn't, that's when trouble starts."

First, there's the matter of getting to lunar orbit, which is no small feat. The Apollo program's Saturn V vehicle packed in enough propellant to rocket astronauts to the moon in a mere three days. But in order to save on fuel costs, ISRO's recent Chandrayaan-2 mission, which carried Vikram, used a much more circuitous pathway and took more than a month to reach the moon.

Once in orbit, the spacecraft keep in contact with Earth using NASA's Deep Space Network, which consists of three facilities in different parts of the globe filled with ever-listening parabolic dishes that stay in touch with distant robotic probes in space.

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A communications failure might have been part of the reason behind Vikram's troubles, as the agency lost contact with the lander when it was just 1.2 miles (2 kilometres) above the lunar surface.

There's little room for error when a probe is screaming toward its landing spot at missile-like speeds. A faulty data transmission instrument that led to a total engine shutdown seems to be what did in the Israeli Beresheet lander on April 11, according to 'The Times of Israel'.

On Earth, engineers can rely on GPS to help guide autonomous vehicles, but no corresponding systems exist on other celestial bodies, Dwyer Cianciolo said. "When you're traveling fast and have to slow down in a vacuum where you have very little information, it's hard no matter who you are and what you're trying to do," she added.

NASA is currently working with commercial companies that plan to deliver robots to the moon in the coming years. These future lunar navigators will need to be able to trust their sensors, Dwyer Cianciolo said.

That's why the agency is designing instruments that can sit on a vehicle's undercarriage to scan otherworldly terrain for rocks, craters and other hazards and make course corrections, which could be used on private spacecraft as well as on future NASA missions, she added. Such technology will be tested during the descent sequence of NASA's upcoming Mars 2020

rover, which will launch next year and is scheduled to land on the Red Planet in February 2021.

Nearly all failed moon missions have been uncrewed, perhaps suggesting that it's useful to have a person at the helm when problems arise. Back during the Apollo days, human eyes and reflexes helped make for successful landings. After spotting rocky terrain at his intended landing spot, Neil Armstrong famously took control of the Apollo 11 descent vehicle and flew in search of a safer touchdown point.

But with their backgrounds as experimental test pilots, astronauts in those days expected to have some degree of control, Dwyer Cianciolo said. "We accept autonomy a little more nowadays," she added, saying engineers would like to get to the point where future human explorers can rely on such systems to help them travel safely to and from the moon's surface.

China's Chang'e-4 probe, which landed on the lunar far-side and deployed the Yutu-2 rover over the summer, provides some comfort to those worried about the difficulty of getting to the moon. Indian engineers can take solace in the fact that their Chandrayaan-2 orbiter is still functioning and doing science, and that perhaps their next attempt will be more successful.

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“My heart went out to them, because you know how much work and time has gone into it,” said Dwyer Cianciolo. “But we’re in a business where persistence pays off, so I’m hopeful.”

‘Editor’s Note: This story was updated to correct the location of NASA’s Langley Research Center. It is located in Hampton, Virginia, not Cosby, Missouri.’

END OF SOURCE B

SOURCE C: adapted article from 'Guardian online', August 2019

NASA mission to Jupiter moon Europa moves step closer to launch

Mission that could shed light on possibility of life on icy rock is expected to lift off in 2025

Nicola Davis
Tue 20 Aug 2019

A NASA mission to explore the most tantalising of Jupiter's 79 moons has been given the green light to proceed to the final stages of development.

Europa – which is slightly smaller than our own moon – has long been considered a possible candidate in the hunt for alien life. Evidence suggests there is an ocean below the moon's thick, icy crust that might be tens of miles deep. Scientists believe this body of water could contain the right chemical cocktail for life and could even be home to some form of living organisms.

Europa appears to have the hat-trick of conditions needed to kick off life: water, possibly chemistry, and energy in the form of tidal heating, a phenomenon arising from gravitational tugs acting on the moon.

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This could not only drive chemical reactions but also aid movement of chemical substances between rock, surface and ocean, possibly through hydrothermal vents.

It is proposed that the NASA mission, named Europa Clipper, will make a number of close flybys – it cannot orbit the moon as Jupiter's radiation belt would fry its electronics – carrying cameras and instruments to measure the moon's magnetic field.

The mission will look for subsurface lakes and provide data on the thickness of the moon's icy crust. The team also hope to confirm the presence of plumes of water, previously detected by NASA's Galileo spacecraft and the Hubble space telescope. If confirmed, it would mean scientists would not need to find a way of hacking through the moon's icy crust to explore the makeup of the ocean.

The new announcement means the mission has now been given the go-ahead for the final design to be made, the spacecraft to be built and the instruments to be developed and tested.

"We are all excited about the decision that moves the Europa Clipper mission one key step closer to unlocking the mysteries of this ocean world," said Thomas Zurbuchen, an associate administrator for the Science Mission Directorate at NASA's headquarters in Washington.

Clipper is expected to launch in 2025, although it could be ready a couple of years sooner. It is not the only mission heading for Europa: the European Space Agency's Jupiter Icy Moons Explorer, or Juice, is expected to launch in 2022 and will undertake flybys of three of Jupiter's moons, including Europa.

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SOURCE D: adapted article from 'The Conversation', October 2019

Elon Musk's Starship may be more moral catastrophe than bold step in space exploration

Samantha Rolfe
Lecturer in Astrobiology, University of Hertfordshire
October 2, 2019 1.09pm BST

Elon Musk, founder of private space-faring company SpaceX, recently unveiled his new Starship craft. Amazingly, it is designed to carry up to 100 crew members on interplanetary journeys throughout the solar system, starting with Mars in 2024.

The announcement is exciting, invoking deep emotions of hope and adventure. But I can't help having a number of moral reservations about it.

Musk has declared a fascinatingly short timeline to achieve orbit with this rocket. He wants to build four or five versions of the vehicle by April 2020.

The first rocket will do a test launch to 20 km within a month, and the final version will orbit the Earth. Whether this is possible remains to be seen. Bear in mind that in the early 1960s when the then US president, John F Kennedy, announced the race to the

moon, it took nearly a decade to achieve and several crew members died during the testing phases.

Despite this, it has been an important goal since the beginning of the space age for people to travel between planets – helping us to explore, mine and colonise the solar system.

Planetary protection

There are many reasons to believe SpaceX will succeed. The company has been extremely impressive in its contribution to space, filling a gap when government agencies such as NASA could not justify the spending.

It's not the rocket technology that I doubt, my concern is mainly astrobiological. If life exists elsewhere in our universe, the solar system is a good place to start looking – enabling us to touch, collect and analyse samples in a reasonably short time.

Along with some of Jupiter's and Saturn's moons, Mars is one of the top contenders for hosting some sort of microbial life, or for having done so in the past.

However, there is a risk that microbe-ridden humans walking on the red planet could contaminate it with bugs from Earth. And contamination may threaten alien organisms, if they exist. It may also make it impossible to figure out whether any microbes found on Mars later on are Martian or terrestrial in origin.

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A mission to return samples from Mars to Earth is expected to be completed by the early 2030s, with all the collection work completed by sterilised robots. While such missions pose a certain risk of contamination too, there are rigorous protocols to help minimise the chance. These were initiated by the Outer Space Treaty in 1967 and must be followed by anyone in the space industry, governmental or non-governmental entities alike.

Can we be confident that, while pushing the boundaries of human exploration in such a short time frame, corners won't be cut, or standards won't be allowed to slip? It will be considerably harder to follow these protocols once humans are actually on the planet.

If SpaceX was serious about planetary protection, I would expect to see a policy on its website, or easily found by searching "SpaceX planetary protection". But that isn't the case. So, while it is possible that it has a rigorous planetary protection plan in place behind the scenes, its public-facing content seems to suggest that pushing the boundaries of human exploration is more important than the consequences of that exploration.

Musk doesn't seem too worried about contamination. He has eluded to the concept of panspermia, the idea that Mars and Earth have exchanged material or even life in the past due to asteroid impacts anyway. He also says: "I don't think some Earth-based bacterium is going to be able to migrate much through Mars" and "if there is any life, it will be very deep underground". But he simultaneously argues that we can excavate to make

room for humans underground on Mars, where they would be shielded from radiation.

Other moral issues

Another issue is the health of the humans who are being sent out to Mars. Deep space is not without its dangers, but at least working in low Earth orbit, on the moon and the International Space Station, the Earth's magnetic field offers some protection from harmful space radiation.

Mars doesn't have its own magnetic field and its atmosphere provides little shelter from cosmic radiation. Astronauts would also be exposed to deep space radiation for the minimum six-month journey between planets.

Though plenty of work is being conducted, radiation protection technology is a long way behind other aspects of rocketry. I'm not sure that it is fair or ethical to expect astronauts to be exposed to dangerous levels of radiation that could leave them with considerable health problems – or worse, imminent death.

Add to that the environmental impact of these missions, which release a lot of carbon dioxide, if they become frequent.

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So, while there is obviously a lot to gain from sending humans to Mars, the risks of contaminating Mars, injuring astronauts and damaging the environment are very real.

I would argue that it is our moral obligation to prevent such damage. I hope SpaceX is putting as much thought into this as it has into its launch vehicles, and I would like to see this become a priority for the company.

Once we have better radiation shielding and have proven that Mars is entirely uninhabited, albeit a very difficult thing to do, it will most likely be an adventure worth embarking on. But at the very least, the company should hold off sending people to Mars until we have the results of the upcoming life detection missions, such as the Mars Sample Return and ExoMars rover.

Until then the moon is a great target for human exploration, resource mining and colonisation. As it is nearby and we can be reasonably confident that it does not harbour life, why not start there?

Regardless of the thrill and feelings of hope this kind of adventure brings, just because we can do something, doesn't mean we necessarily should, now or in the future.

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