Artemis (Weir)

Artemis

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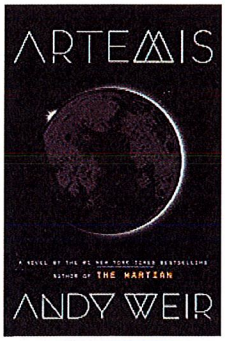

Summary

The bestselling author of The Martian returns with an irresistible new near-future thriller—a heist story set on the moon.

Jazz Bashara is a criminal.

Well, sort of. Life on Artemis, the first and only city on the moon, is tough if you're not a rich tourist or an eccentric billionaire.

So smuggling in the occasional harmless bit of contraband barely counts, right? Not when you've got debts to pay and your job as a porter barely covers the rent.

Everything changes when Jazz sees the chance to commit the perfect crime, with a reward too lucrative to turn down. But pulling off the impossible is just the start of her problems, as she learns that she's stepped square into a conspiracy for control of Artemis itself—and that now, her only chance at survival lies in a gambit even riskier than the first. (*From the publisher*.)

Author Bio

- Birth—June 16, 1972
- Where—Davis, California, USAb
- Education—University of California, San Diego (no degree)
- Currently—lives in Mountain View, California

Andy Weir is an American novelist and software engineer known internationally for his debut novel *The Martian*, which was later adapted into a film of the same name directed by Ridley Scott in 2015. *Artemis*, his second novel, was released in 2017.

Early life

Weir was born and raised in California, the only child of an accelerator physicist father and an electrical-engineer mother who divorced when he was eight. Weir grew

up reading classic science fiction such as the works of Arthur C. Clarke and Isaac Asimov At the age of 15, he began working as a computer programmer for Sandia National Laboratories. He studied computer science at UC San Diego, although he did not graduate. He worked as a programmer for several software companies, including AOL, Palm, MobileIron and Blizzard, where he worked on Warcraft 2.

Writing

Weir began writing science fiction in his 20s and published work on his website for years. His first work to gain significant attention was "The Egg", a short story that has been adapted into a number of YouTube videos and a one-act play.

Weir is best known for his first published novel, *The Martian*. He wrote the book to be as scientifically accurate as possible and his writing included extensive research into orbital mechanics, conditions on Mars, the history of manned spaceflight, and botany. Originally published as a free serial on his website, some readers requested he make it available on Kindle.

First sold for 99 cents, the novel made it to the Kindle bestsellers list. Weir was then approached by a literary agent and sold the rights of the book to an imprint of Penguin Random House. The print version (slightly edited from the original) of the novel debuted at #12 on the *New York Times* bestseller list. A *Wall Street Journal* review called the novel "the best pure sci-fi novel in years." In 2015 it was adapted to film, starring Matt Damon and Jessica Chastain.

Weir is working on his second novel, initially titled *Zhek*. He describes it as "a more traditional sci-fi novel, with has aliens, telepathy, faster-than-light travel, etc."

Personal

He currently lives in Mountain View, California, in a rented two-bedroom maisonette. Since he has a deep fear of flying, he never visited the set of the filming of *The Martian* in Budapest, which is where most of the Mars scenes were shot. With some therapy and medication, however, he was able to fly to Houston to visit Johnson Space Center and to San Diego to attend Comic-Con.

Weir refers to himself as an agnostic. As a fiscally-conservative social liberal, he tries to keep his political views out of his writing. (*Adapted from Wikipedia. Retrieved 12/22/2015.*)

Book Reviews

This is a heist narratie at heart — but it lacks the core elements of modern heist narratives: no team of charming specialists, no surprise plot twists. That may be fine for "hard" science fiction fans who prioritize idea over execution, or who simply crave well-researched technical speculation presented as fiction. Otherwise, this is a 300-page film pitch that, like its predicessor, will probably be more appealing after it goes to Hollywood.

N.K. Jemisin - New York Times Book Review

(*Starred review.*) Jazz Bashara, the heroine of this superior near-future thriller ... grew up in Artemis ... where she dreams of becoming rich.... The independent, wisecracking lead could easily sustain a series. Weir leavens the hard SF with a healthy dose of humor.
Publishers Weekly

(*Starred review.*) [Sci Fi] fans everywhere can once again rejoice because [Weir's] done it again.... Narrated by a kick-ass leading lady, this thriller has it all—a smart plot, laugh-out-loud funny moments, and really cool science. *—Jane Henriksen Baird, Anchorage P.L., AK*
Library Journal

(*Starred review.*) An exciting, whip-smart, funny thrill-ride ...one of the best science fiction novels of the year.
Booklist

Strip away the sci-fi trappings, though, and this is a by-the-numbers caper novel with predictable beats and little suspense. The worldbuilding is mostly bland and unimaginative.... One small step, no giant leaps.
Kirkus Reviews

Discussion Questions

We'll add publisher questions if and when they're available; in the meantime, use our LitLovers talking points to help start a discussion for Artemis *... then take off on your own*:

1. How would you describe Jazz Bashara? Did you enjoy her flippancy, finding it amusing? Or did you find it tiresome? How do you view Jazz's illegal activities: first her smuggling and then her involvement in the aluminum smelting scheme? Does she have a moral compass? Is she an easy or difficult character to root for?

2. *Follow-up to Question 1*: If Jazz is so intelligent, which both she and others make frequent mention of, why does she remain in her menial, low-paying job? What role has the rift with her father had on her life choices.

3. What is the moon city like? Consider aspects such as safety, living with 1/6 the gravity of earth, the monetary system, economic stratification ... even the seemingly insignificant details like watches or the taste of coffee. Is Artemis a place you would want to visit as a tourist?

4. *Follow-up to Question 3*: Andy Weir endows his stories with nerdy scientific detail.

Many find this minutia fascinating, others not so much. Which camp are you in?

5. Are you satisfied with the way the novel ended? Did the pacing of the last segment live up to the phrase "compulsive reading" or "a real page-turner" for you?

6. If you've read (and/or seen) *The Martian*, Weir's first work, how does this novel compare? Some (not all, by any means) believe it was written more as a future film than as a literary work.

(*Questions by LitLovers. Please feel free to use them, online or off, with attribution. Thanks.*)

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ARTEMIS

Reader's Group Guide

1. Would you leave Earth for Artemis if given the opportunity? If so, which bubble would you live in?

2. If you were in Jazz's position, would you agree to destroy the harvesters for Trond?

3. What is your opinion of Trond? Is he a trustworthy or dishonest person? Explain.

4. In which ways do you relate to the main character, Jazz Bashara, if at all?

5. Which character do you find to be the most relatable? Why?

6. Which character undergoes the most change throughout the book?

7. If you were Jazz, would you accept Dale's friendship? Why or why not?

8. Why does Rudy lose interest in arresting Jazz for smuggling?

9. Would you agree or disagree that, despite their strained relationship, Jazz's dad has been a major influence in her life?

10. What do you think about the methods used by Ngugi to first establish KSC and then keep Artemis's economy afloat? Would you do the same? What does this say about the world of politics and economics?

11. Who is responsible for the do-or-die state of Artemis? Why?

12. If you lived on Artemis, would you choose to join Jazz in her final mission? What does her companions' willingness to participate say about the significance of this situation for Artemis and its future?

13. What do you think of the punishment Jazz receives? Is it fair? If you were an Artemisian, would you forgive Jazz?

14. Do you think Ngugi owes Jazz a debt? Is she doing enough to repay Jazz for her actions?

15. Considering his explanation for Jazz's upbringing, do you have a better understanding of why Jazz's dad was so strict? Do you think he did a good job of raising her?

16. When we first meet Jazz, it is clear that she is very ambitious but seems to be struggling to get by. After learning more about her, do you think she is to blame for her quality of life, or lack thereof? Do you sympathize with her?

17. What does the final scene between Jazz and her dad say about his acceptance of Jazz and her life choices/lifestyle?

A Conversation with Andy Weir

Q) You've already taken us to Mars. In *Artemis,* you take readers to the moon. Why the change in location?

A) Because this story is about colonization, not exploration. And I think we will colonize the moon before we colonize Mars. While Mars has more raw materials, the moon is just so much closer it's considerably easier to colonize. Also, unlike Mars, the moon could be a tourist destination due to the comparatively short travel time to get there.

Q) What are some of the similarities between *The Martian* and *Artemis*? And the differences?

A) They're similar in that they both involve scientific solutions to complicated scientific problems, but *The Martian* was a straight-up human-versus-nature story, where the goal was simple survival. *Artemis* is a crime story with mysteries involved—a plot that was harder to write but also more interesting, I think.

Q) How did you go about creating this fictional world on the moon? Walk us through your process: What kind of research was involved, do you have a map of Artemis, did you create a character storyboard?

A) Creating Artemis was actually a lot of fun. It's one of those things where I spent weeks and weeks carefully crafting all the details of the city, of which the reader will see about 1 percent in the story. I worked out the foundations of the economics and why it works, why the city actually exists there, why everything is. And yes, absolutely, I have a pretty detailed map of Artemis.

Q) What was the hardest part about writing a follow-up to *The Martian,* a book that made a crater on pop culture?

A) It's pretty scary. It's going to be a hard act to follow. I think I've done a good job, but in the end all I can do is my best and hope people like it.

Q) When beginning a new project, do you start with a story idea and then research the science behind it, or do you come across an intriguing scientific concept and then see if there's a story there? Something in between?

A) I usually start with the setting. In the case of *The Martian,* I started by imagining how a manned mission to Mars would work. In the case of *Artemis,* I designed a functional city on the moon. From there, the plot tends to develop and present itself.

Q) In Artemis, the population lives in various bubbles named after famous astronauts—Aldrin, Conrad, etc. What kind of research did you do when thinking about the kinds of habitats/architecture we would need to construct for people to actually colonize the moon?

A) I wanted to make sure the structures could be made from locally available materials. That means aluminum, pretty much—it's incredibly plentiful on the moon. And also, I wanted to ensure that a breach was incredibly unlikely. After all, an entire city's population will die if there's a leak. Because of this, Artemis has a double-hull system with a meter of crushed lunar rock between the hulls. Also, I did extensive research on the processes needed to smelt anorthite (a mineral found all over the place on the lunar surface) into aluminum and oxygen.

Q) For those on Earth lucky enough to be able to afford a trip to the moon, how long would it take them to get there? Did you calculate the actual science and logistics of moon tourism when writing the novel?

A) Travel to the moon is done with lunar cyclers. Those are space stations in an orbit that takes them periodically close to the moon and to the Earth. It takes seven days for the cycler to reach the moon from Earth, and seven days to get back to Earth from the moon. There is a catch, though. The path the cycler takes requires it to spend quite a lot of time in other, less useful locations between those efficient-path portions of its cycle. So there are many cyclers in operation at the same time, in different phases; there's always one coming or going every few days.

Q) *Artemis* is set sometime in the late twenty-first century. Is lunar colonization something we could see within the next fifty or a hundred years?

A) I think so, yes. Artemis is based on the presumption that commercial space travel, and competition within that industry, will drive the cost of putting mass into low Earth orbit down low enough that middle-class people can afford a trip to space. Once that becomes a reality, lunar tourism becomes a viable business model. And that's the economic foundation of Artemis.

Q) Interplanetary travel and survival are core parts of both of your novels. Do you think humanity will become a multiplanet species? What's the next step?

A) I think it's inevitable. At some point in the distant past, humanity was a "one-continent" species. But our ancestors spread out from Africa to become a multicontinental species. Humans tend to go wherever we possibly can. Once we have the ability to form colonies off-Earth, we will certainly do so.

Q) If you could live on the moon in a city like Artemis, would you? What do you think would be your favorite thing about it? What would you find most difficult?

A) I don't think I'd actually like to live in Artemis. It's a frontier town dealing with frontier problems, and it's a little bit rough and tumble for me. I'm kinda spoiled; I like having a nice, cushy, easy life. So, no, I don't think I'd live there. If I did live there, I think the coolest part about it would *be* that it's a frontier town, that you kind of get to make your own rules. There's not too many people looking over your shoulder telling you what to do. The downside would be, of course, the constant risk of death! They've never had any sort of hull breach or anything like that, but it's still dangerous and you're far away from anything other than basic medical care.

Q) Tourism is a big driver of Artemis's economy. In Artemis, visitors can go onto the moon's surface in the wonderfully named "hamster balls": This feels a lot like lunar zorbing. Have you ever zorbed?

A) I've never zorbed, but I've seen people doing it; that looks like it would be really fun. It's just what I thought would be the most convenient and easy way to get unskilled people out directly on the surface of the moon. Just a big, clear, plastic balloon that you run around in and just make sure that it's thick enough that it won't pop.

Q) When you first self-published *The Martian*, could you have imagined that it would become not only a bestselling novel but a hugely popular movie as well, starring Matt Damon, Jessica Chastain, and more? What have been the best things about the level of success you have achieved with your first book? Has there been any downside?

A) Well, the best part about *The Martian*'s success is that I get to be a writer now, which is what I've always dreamed of doing for a living. The worst part is that I used to be a computer programmer and I really enjoyed going into work in the morning and saying "hi" to my co-workers. I'm a pretty social guy, I like working on a team, and now I don't get to do that anymore, and I miss that.

Q) Your writing has been interpreted into film, television, theater, and even a rap album. What about these stories do you think makes them so ripe for adaptation? Are there any other mediums in which you think *Artemis* or another story would work well?

A) I've always been surprised at the popularity of my stories. I guess people just like imagining themselves in those situations. I think *Artemis* would make a good film. But then again, most writers like the idea of their books becoming films, so I'm hardly unique there.

Q) You've been a vocal fan of *The Martian* movie; what would you be most excited to see from a film version of *Artemis*?

A) I'd love to see the visual representation of the city itself. It would be a fantastic visual.

Q) Were there any books or movies that particularly influenced you in writing *Artemis*?

A) I think my biggest inspiration for the story was *Chinatown*. It shows the ugly underbelly of how cities grow and flourish, and that's a core element of Artemis.

Q) What do you hope readers will take away from *Artemis*?

A) I hope they have a fun time reading it. That's all I ever want when I write a story. None of my stories have a moral or a point to be made. I just want the reader to think "well, that was cool" when they're done.

Q) And finally: What if Jazz Bashara meets Mark Watney in Hartnell's Pub in Artemis. Would they get along?

A) If Jazz met Mark, I imagine they'd be really, really smart-ass toward each other.

"The Economics of Artemis"

Introduction

Are you a pedantic little shit? Do you ask questions like "Why does the Federation have starships if they can beam people hundreds of light-years?" or "Why don't the Galactic Empire and Rebel Alliance just mass-produce droids with piloting skills instead of risking their own lives?"

Well, good. So am I.

Artemis takes place in a city on the moon. Lunar colonies in sci-fi usually have medium-to-high levels of bullshit in their economics. Yeah, I know, nobody reads sci-fi for an economics lesson. But I want it to at least make sense.

So this paper is all about Artemis's economy and how it works. There are no spoilers for the story, so you can freely read it beforehand if you're the sort of person who likes bonus material so much you'll read it before you read the actual story.

Why isn't this in the book?

Because it's boring. Hell, if we learned anything from "The Phantom Menace" it's this: Never start a sci-fi story with a description of complex macroeconomics.

You might not even make it through this paper. That's okay; it's not supposed to be entertaining. If you get bored, stop reading. This paper is for the one percenters—the folks who have nagging doubts in their suspension of belief because something sticks in their craw. I'm one of those people, and for me the economics has to make sense for a setting to work.

Price point

If you could have a lunar vacation for $70,000, would you do it? Many people would jump at the chance. They'd get a second mortgage just to pay for it. This, in a nutshell, is the economic foundation of Artemis. It's all about tourism, and it's based on the presumption that the price for that tourism can be driven down to the point that ordinary people can afford it.

The pricey part of anything space-related is getting it to space in the first place. It's incredibly expensive to put mass into LEO (Low Earth Orbit). And if you want to put something on the moon, you have to get a whole ship into LEO that can then travel to the moon. If that impediment were removed, or greatly reduced, we'd have a thriving space tourism industry.

My belief is that we are already on track to a commercial space industry that will do just that.

Money? What money?

I did the research for this in 2015, so all the monetary references in this paper refer to prices and values in 2015 US dollars.

Current cost to LEO

Before I talk about predictions, let's talk about reality. How much does it cost to put mass into LEO right now?

First off, I start with the assumption that this has to be an actual profitable system. Not something that only exists on government support or subsidy. So I'm disregarding launch systems that are government-run. They have no profit motive, so even if they charge for freight to LEO and even if that charge is low, those are not real economic values. The system would not scale or sustain itself.

The cheapest way to get mass to LEO (at the time of this writing) is with a SpaceX Falcon 9 booster. They charge $61.2 million for the launch, and it can put 13,150kg of mass into LEO. So right now, that means it costs $4,653 per kilogram.

Now you have some context for comparing the real world to the imagined one I'm about to show you.

My bullshit assumption

I have absolutely nothing to back this up but instinct. But here it is, the core assumption I have made that enables the world of Artemis:

Assumption: The commercial space industry, through competition and engineering advances, will settle down to the same fuel-to-overhead ratio as the modern airline industry.

Okay, so what do I mean by that? How did airlines get into this?

The airline industry is a good parallel for the space industry. Both involve transporting people and freight. Both require extremely expensive, complex vehicles with maintenance overhead. Both consume fuel.

So I have assumed, right or wrong, that a fully profitable commercial space industry would eventually become very much like the commercial airline industry. So let's look at the airline industry for some clues as to what things cost.

Fuel overhead ratio

Airlines need staff to fly and maintain their aircraft. They need to pay applicable taxes and gate fees. The need to buy new planes, repair worn-out parts, manage their company pension plan, and everything else a service industry has to do. But, by far, the largest chunk of their non-payroll operating budget goes to fuel. That's what costs the most for any given flight.

So the question is this: What percentage of an airline's total revenues ultimately goes toward buying fuel? That's what we're going to work out first.

I have no special understanding of the airline industry. I just went online and did my own research. I looked at ticket prices, noted the price of jet fuel, etc. This could be wildly flawed, but it's a good place to start.

First off, I had to choose an aircraft to work with. I selected the Boeing 777-300ER. It's one of the most popular aircraft in the world, servicing long-haul flights by all the major airlines. It's fuel efficient, effective, and has a stellar safety record.

Here are some stats for the 777-300ER:

- Dry mass: 160,500kg
- Fuel burn rate: 8,100kg per hour
- Normal configuration:
  - 4 First Class seats
  - 56 Business Class seats
  - 292 Economy Class seats
- High-density configuration
  - 550 Economy Class seats

The next thing I did was look at some long-haul flights around the world. I wanted to get an even spread of information, so I looked at three different routes, of differing lengths, flown by three different airlines. A more comprehensive study would have to include dozens or maybe hundreds, but I just did three—I'm just trying to make a foundation for a story, not get investor money.

So, to that end, I looked at a United Airlines flight from New York to London, an Air France flight from Paris to Tokyo, and a Qantas flight from Los Angeles to Sydney. Each of these flights are on 777-300ER aircraft, and their ticket prices are all for the same day in late 2015. Note: the United flight prices are rough averages based on samples of different rates—

their Web page at the time was cagey on actual ticket prices.

Here's what I learned:

Flight	NY to London (United)	Paris to Tokyo (Air France)	LAX to Sydney (Qantas)
Duration (h)	8	11.58333	15.333
First Class ticket price	$4,000	$3,326	$10,240
Business Class ticket price	$1,200	$1,835	$3,140
Economy ticket price	$350	$462	$547
Total take per flight	$185,400	$250,968	$376,524
Fuel consumed (kg)	64800	93824.973	124197.3
Fuel cost	$30,780	$44,567	$58,994
Fuel overhead	16.60%	17.76%	15.67%

For each flight, I noted the price of each class of ticket, then worked out the take—the total amount of money the airline gets if every seat on the plane is sold at its listed cost. The fuel consumed is based on the flight duration and the fuel consumption rate of the aircraft. The cost of that fuel is based on the market price of jet fuel on the day I looked up those tickets, which was $0.475/kg. (Actually the price was 38 cents per liter but I wanted price per kg and jet fuel has a density of 0.8kg/L.)

I was surprised to see that they all had such similar fuel overhead ratios. It makes me feel like my crackpot theory might actually work out.

Yeah, I don't have enough data, but screw it. I'm going to use the value 16.5 percent, which is roughly the average of those three. So for the rest of this paper, I'll assume a commercial airline spends 16.5 percent of its take on fuel.

A commercial spacecraft

Okay, great. I have a rough idea of fuel overhead. So what? What the hell would an efficient commercial spacecraft be like? What would it weigh? How many people could it carry? What would it use for fuel and how much would that fuel cost?

I don't have answers to any of that, of course. So I'll just pull a couple more assumptions right out of my ass:

Assumption: A passenger spacecraft would weigh the same as a passenger aircraft capable of carrying the same number of people.

Okay, yeah. That's a big assumption. But, to be clear, I'm talking about dry weight (not including fuel). And aircraft are pretty similar to spacecraft in a lot of ways. They're pressure vessels, they have

life support systems to keep everyone on board alive, they have big heavy engines, pilots, etc. So that's what I'm going with.

And for my comparison I'll use, of course, the Boeing 777-300ER. Same as before. I'm also assuming this is a trip to a transfer ship or space station. So the spacecraft itself doesn't have to serve as home to the passengers. All it does is get them to orbit. This means there's really no need for first class at all. The twelve-minute trip to orbit does not require high-end seating for anyone. So instead of its normal configuration, I'm going with the high-density version that can seat 550 people.

And now on to the final bit of guesswork:

Assumption: The commercial space industry will use hydrogen-oxygen fuel.

The thing that matters most about rocket fuel is a property called "specific impulse." I don't want to bore you with physics (I'm here to bore you with economics) so I'll just say this: Specific impulse is a measure of how efficient a rocket fuel is. The higher a fuel's specific impulse, the less of it you need to get a ship moving a given velocity. And hydrogen-oxygen fuel has the best specific impulse known. Also, it creates water as its exhaust, so there are no pollutants. And finally, it's cheap to produce.

Right now, there are engineering limitations to using hydrogen-oxygen fuel. The main one being that it burns very hot—hotter than any engine can handle. But again, I'm assuming all these challenges get researched and solved by a profit-hungry industry.

The final piece of the puzzle is the cost of hydrogen and oxygen. This was a little harder to find. I was able to find reliable data on the 2002 price of bulk hydrogen, so I adjusted the 2002 dollars into 2015 dollars and got $0.93/kg. As for oxygen, I used the publically available data on what NASA pays for it—$0.16/kg in 2015 dollars. The reaction requires one part hydrogen and eight parts oxygen (by mass), so the total fuel cost is $0.245/kg.

That's the last bit of information we needed to calculate the . . .

Price of getting a person into space

Okay, we have a ship that weighs 165,500kg and we're going to put 550 passengers on it. We'll give them 100kg each for their bodies and luggage. That's a total mass of 215,500kg.

The specific impulse of hydrogen-oxygen fuel is 389s (yes, the unit for measuring specific impulse is "seconds." It makes no intuitive sense, just roll with it). To get to LEO, you need to accelerate by 9,800m/s. LEO actually only requires 7,800m/s, but you lose around 2,000m/s during the ascent to air resistance and other inefficiencies.

Again, I'm skipping over the physics (Tsiolkovsky's Rocket Equation if you're curious), but those numbers mean we'll need 12.04kg of fuel for every 1kg we want to put into LEO. We want to put 215,000kg into LEO, so we need 2,594,620kg of fuel.

At our calculated fuel cost ($0.245/kg), that means the total fuel cost for the launch is $637,200.

Now I get to use my airline fuel overhead figure. Airlines have 16.5 percent fuel overhead ratio and we're going to assume the space industry will as well. So $637,109 is 16.5 percent of our total ticket take. And that means our total take is $3,861,266.

Our ship carries 550 passengers, meaning each passenger will have to pay:

$7,020.48

Sorry to put that in dramatic bold print with a box around it, but I thought it was exciting. Would you pay seven thousand bucks to go to low Earth orbit? Millions of people would say "yes."

What about freight?

I looked around at the prices for air freight and found that, on average, you can air mail 200kg of cargo for about the price it would take to send a person. This means people cost twice as much to ship as cargo. That makes sense—cargo doesn't need seats, air pressure, bathrooms, or complimentary peanuts. For space travel, the cargo ships also wouldn't need anywhere near as much safety. If a shipment of frozen food blows up on launch, replacing the cargo is trivial.

So I followed the aviation industry's general pattern and decided that freight to LEO would end up costing about half as much as a human. Or, more important, would cost $7,020.48 per 200kg. So that means you can get mass to LEO for:

$35.10 per kg!

Again, I apologize for the drama, but holy shit! That's a hell of a lot less than the $4,653/kg it costs today.

Are such advances reasonable? Well, *Artemis* takes place in the 2080s, which is more than sixty years from the time of this writing. Consider the advancements in the aviation industry from its beginnings in the 1930s to the 1990s. Yes, it's possible. When enough money is up for grabs, *anything* is possible.

What about getting from LEO to the moon?

Okay, so we have people and cargo in LEO. So what? We want them on the moon. Well, here's where things bifurcate.

To get people to the moon, they would make lunar cyclers. These are space hotels in a ballistic orbit (meaning: it doesn't require fuel to maintain) that regularly visits Earth and the moon. It would take seven days to get to the moon with this system. You still have to accelerate the people to catch up with the space hotel, but at least you don't have to accelerate the hotel itself over and over. So the fuel cost is minimized.

It's hard to say how much that would cost. But with a $35.10/kg cost to LEO, the mass of the hotel wouldn't be too much of a financial burden for what-

ever company built it. I admit I didn't work out the economics of the space hotel or what it would cost for your stay. But considering how cheap the cost of freight to LEO is, I'm sure it would be small compared to the rest of the trip. On the order of an actual hotel stay (and a hell of a lot more awesome).

But you still have to accelerate people up to the cycler and then decelerate them to land on the moon.

According to my research, it takes a total of 5,930m/s of delta-v to get from LEO to the surface of the moon. More physics and math happens here, but it means that for every kilogram of cargo you want to put on the lunar surface, you have to put 4.73kg of mass into LEO, 1kg of actual cargo, and 3.73kg of fuel to get that cargo to the moon.

So what's it cost to put freight on the moon? Well, it would cost 4.73 times what it would cost to put the cargo in LEO. So, while it costs $35.10 to put a kilogram into LEO, it would cost $166.02 to put it on the surface of the moon.

So what's it cost to go to the moon!?

You have to get your body to LEO ($7020), and then soft-land on the moon. So you end up needing the same overhead—4.73 times the LEO cost.

$33,206.87

Yeah, I did the box/bold thing again. Call the cops, I don't care. People would be *very* willing to pay $33,000 for a trip to the moon.

What about the trip back? Well, it's much cheaper, because you're leaving the moon's gravity, not Earth's. Plus, you don't have to use rocket fuel to dump velocity at Earth—you can use the atmosphere to brake with. And you would probably also be using fuel generated on the moon (aluminum and oxygen, both in massive supply on the moon, make a good monopropellant), so it even wouldn't have to be imported.

I didn't do the math on the return trip, but let's approximate it to half the trip out. So the round trip is clocking in at about $45,000 (not including a total of fourteen days' stay in the space hotel).

What does it cost to stay on the moon?

You have to eat. You can eat Gunk if you want—that's a product created right in Artemis out of algae. It's nutritionally balanced and grown locally, so it's nice and cheap. But if you want real food, you'll have to eat imports. A typical person will eat 500 to 1,000 grams of food per day (not including the water weight). We've established that lunar freight costs about $166/kg. So you'll spend $80 to $160 every day just to eat. Not bad for an extravagant vacation.

Total cost

Accommodation and meal prices would be comparable to high-end hotels and restaurants on Earth. Say $160/day for food and $500/day for a hotel. Of course you'll want to do stuff while you're there, which will cost more money. So call it $800/day.

However long you want to stay on the moon, add fourteen days (for the space hotel that takes you

there and back) and multiply by $800. That's your expenses on the trip itself. So let's say you want a two-week stay. That's a total of twenty-eight days of expenses at $800, so $22,400. Round that up to $25,000 because vacations always cost more than you expect. That plus the $45,000 travel costs totals $70,000.

So I ask again: Would you pay $70,000 for a lunar vacation?