Team 524

Problem A: Space Diving

Abstract:

The scenario of launching a skydiver into space via rocket, exiting at a high altitude, and safely returning to Earth's surface with a total mass of 190 kg involves a complicated combination of problems and hazards. The first obstacle is the launch of the rocket, as reaching altitudes above the Earth's atmosphere necessitates powerful propulsion systems and precision navigation. The skydiver and their equipment must sustain severe acceleration pressures during this ascent, which may cause physiological stress and safety problems. When the skydiver has reached the required height, he or she must depart the rocket wearing a space suit intended to survive the severe conditions of deep space, such as vacuum, radiation, and high temperatures. The design and integrity of the space suit are critical for the survival of the skydiver. The transfer from space to Earth's atmosphere is fraught with danger. Because there is no air in space, standard parachute deployment is impractical, necessitating the development of new parachute systems that can work in the vacuum of space. To avoid overheating and severe G-forces, the transition from space to Earth's atmosphere must be carefully regulated. The greatest height for a successful fall would be determined by a variety of factors, including technology, equipment, and the skydiver's physical condition. To accomplish such a feat, cutting-edge engineering, rigorous testing, and a thorough grasp of the obstacles involved in this amazing expedition would be required. So, In this paper, we will discuss the challenges and dangers in such a descent and the maximum altitude from which a person could successfully descend to the surface in detail.

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1 NOMENCLATURE / NOTATIONS USED

Serial No.	Notation	Meaning
1	F (N)	Lift-Force
2	F_D (N)	Drag Force
3	C_D	Drag Co-efficient
4	A (m^2)	Cross Sectional Area
5	ρ (kgm^{-3})	Atmospheric Density
6	v (ms^{-1})	Velocity
7	BC (kgm^{-2})	Ballistic Co-efficient
8	m (kg)	Mass
9	g (ms^{-2})	Gravity
10	k	Karman Parameter
11	a_{max} (ms^{-2})	Maximum Deacceleration
12	$V_{re\text{-}entry}$ (ms^{-1})	Re-Entry Velocity
13	β (m^{-1})	Atmospheric scale height
14	γ (deg/rad)	Angle
15	ρ_0 (kgm^{-3})	Atmospheric Density at Sea Level
16	E (V)	Emitted Energy
17	ε	Emissivity
18	σ ($Wm^{-2}k^4$)	Stefan-Boltzmann Constant
19	T (K)	Temperature
20	Q	Heating Rate

2 ASSUMPTIONS

There are some assumptions to consider for a safe landing for a skydiver. Those are listed below-

1. The average weight of a human is 60 kg (130 lb.) in Asia and Africa [1]
2. The weight of parachute and spacesuit is 130 kg [2]
3. There will be no Rotation of the human while jumping from high altitude because rotation can cause unsuccessful jumps and failure of the projects
4. Here β= 0.000139 m^{-1}
5. BC=19.9 kgm^{-2}
6. γ= 45 Degree
7. ρ_0=1.225 kgm^{-3}
8. E = 45360 V
9. ε=0.8

3 INTRODUCTION

3.1 SKYDIVING THEORY

In the recreational and sporting activity known as skydiving, participants leap from an airplane, travel through the air, and then use a parachute to slow their descent and make a safe landing on the ground. It's commonly called "parachuting" or "parachute jump."

Here's how skydiving typically works:

Aircraft Ascent: Skydivers get on a plane or chopper and take off towards a predetermined altitude.

Exit: The skydivers leap from the plane at a prearranged height. This is frequently a thrilling freefall.

Freefall: Skydivers encounter an exciting moment of swift drop during the freefall phase, frequently reaching speeds of up to 120 miles per hour (193 kilometers per hour) or more. Depending on the jump's altitude, the freefall's duration can change, although it normally lasts between thirty and sixty seconds.

Parachute Deployment: At a certain altitude, skydivers deploy their main parachutes, which drastically slows their descent. This makes it possible for a safe drop to the earth.

Canopy Flight: A more relaxed canopy flight is experienced by skydivers once the parachute is released. They are able to navigate to a predetermined landing spot by steering and controlling the parachute.

Landing: Skydivers use their parachute to slow and control their descent with the goal of landing safely on the ground or in a designated landing zone. To guarantee a comfortable and secure landing, landing methods are taught throughout training.

3.2 SKYDIVING IN SPACE

Similar to skydiving, space diving is the act of jumping from an aircraft or spacecraft in near space and falling towards Earth. Space skydiving is a theoretical notion as well as an extremely difficult and demanding undertaking. The concept of skydiving in space would entail jumping or descending from a spaceship or space station in the vacuum of space or at great altitudes above the Earth, as opposed to ordinary skydiving, which requires jumping from an airplane in Earth's atmosphere.

3.3 HISTORY OF SPACE DIVING

Colonel Joseph William Kittinger II, a retired colonel and former command pilot in the United States Air Force, was born in Tampa, Florida, on July 27, 1928, and passed away on December 9, 2022. In 1959, he made history by parachuting from a high-altitude balloon, being the first person to do so. He took part in Project Excelsior, which tested the effects of high-altitude ejection on pilots. In 1960, he broke the records for the longest skydive, longest distance, and longest duration, all from above 102,000 feet (31 km).

Yevgeni Andreyev and Pyotr Dolgov climbed out of Volsk, which is close to Saratov, on November 1, 1962.At 83,523 feet (25.458 km), Andreyev leaped from the capsule and descended freely for 80,380 feet (24.50 km) before effectively opening his parachute. Dolgov continued to soar to 93,970 feet (28.64 kilometers) while still inside the capsule. Like Kittinger's last leap, Dolgov would have used a drogue chute to release his experimental pressure suit. He hit his helmet and broke the visor as he got out of the gondola, which caused depressurization and ultimately resulted in his death.

Nick Piantanida made a series of vain efforts to leap from 123,500 feet (37.6 km) and 120,000 feet (37 km) in 1965 and 1966. Piantanida had depressurized her face mask during the last try. As soon as possible, his ground controllers jettisoned the balloon at over 56,000 feet (17,000 meters). Piantanida barely made it out of the fall, and the oxygen deprivation caused brain damage and a coma from which he never came out.

Kittinger took the lead in helping British SAS Soldier Charles "Nish" Bruce break his own record for the highest parachute jump in the early 1990s while working with NASA. In 1994, the project was put on hold due to Bruce's mental health collapse.

Cheryl Stearns, a pilot and parachutist, founded Stratoquest in 1997 with the goal of surpassing Kittinger's record as the first female space diver. This idea did not materialize because of a serious shoulder injury or project financial concerns. Felix Baumgartner had already finished his jump when Stearns got ready to try hers, so she postponed the event.

When Felix Baumgartner leaped from more than 128,000 feet (39 kilometers) on October 14, 2012, he beat both Andreyev's record for the greatest free fall distance and Kittinger's record for the highest altitude.

Alan Eustace jumped from 135,908 feet (41.425 km) in 2014, setting the record for both the highest and longest free fall jump in the world. He then stayed in free fall for 123,334 feet (37.592 km). Still, Joseph Kittinger's 1960 jump from 102,800 feet (31.3 km) still holds the record for the longest free fall, clocking in at 4 minutes and 36 seconds.

3.4 EARTH'S ATMOSPHERE

The layer that is closest to the Earth's surface is known as the troposphere, and it rises an average of 8 to 15 kilometers (5 to 9 miles) above the surface. It is the layer that holds the air we breathe and is where weather happens.

Stratosphere: The stratosphere is located above the troposphere and usually reaches a height of around 50 kilometers (31 miles) above the top of the troposphere. The ozone layer, which is found in the stratosphere, is essential for shielding the planet from damaging ultraviolet (UV) radiation.

Mesosphere: Rising to a height of roughly 85 kilometers (53 miles), the mesosphere is situated above the stratosphere. Increasing altitude causes the temperature of this layer to drop.

Thermosphere: Rising to a height of approximately 600 kilometers (373 miles) or higher, the thermosphere is the layer that sits above the mesosphere. Both the auroras and the International Space Station (ISS) circle around it. The thermosphere can experience exceptionally high temperatures because of exposure to solar radiation, even if it is located at a high altitude.

Exosphere: The outermost layer of Earth's atmosphere, with no upper bound clearly defined. It fades away till it's completely in space. This region, which is regarded as a portion of space, is where molecules and atoms grow progressively scarcer.

3.5 PROBLEM RESTATEMENT

Here we will consider a skydiver, carried by a rocket vertically up to an altitude, perhaps above the Earth's atmosphere, who then exits the rocket in a space suit with a parachute, to descend back down to the Earth's surface. Then we will analyze the challenges and dangers in such a descent, assuming that the total mass of the skydiver, space suit, and parachute is 190 kg. Also, what the maximum altitude from which a person could successfully descend to the surface would be also calculated.

4 THEORETICAL ANALYSIS

Descending from a high altitude in a scenario like the one you described presents several challenges and dangers for a skydiver. Let's analyze some of the key factors involved and make some theoretical considerations

4.1 CHALLENGES AND DANGERS IN SUCH A DESCENT

There are many challenges and dangers for a skydiver to descend back down to the Earth's Surface. Some of them are listed below:

1) Equipment failure: Equipment failure is one of the most common causes of skydiving accidents. Malfunctioning parachutes, harnesses, and other equipment can lead to serious injuries or fatalities
2) Weather conditions: Unfavorable weather conditions, such as strong winds, turbulence, or variable winds, can cause the canopy to collapse, leading to potentially fatal consequences
3) Human error: Many skydiving accidents occur due to simple human error, such as misjudging the landing or making an error in judgment while performing a maneuver.
4) Health risks: Skydiving can pose health risks, such as middle ear squeeze and sinus squeeze, due to the fast changes in altitude that occur during the jump
5) Fear and anxiety: Skydiving can be a stressful and anxiety-inducing experience, which can lead to panic and poor decision-making
6) Lack of Atmospheric Pressure: At high altitudes, there is a lack of atmospheric pressure, which can lead to a lack of oxygen. To counter this, astronauts and space travelers typically wear pressurized space suits to maintain a stable environment for breathing and body functions.
7) Extreme Temperatures: Space can be extremely cold, and without proper insulation, a space suit may not provide sufficient protection against the cold temperatures. Conversely, re-entry into Earth's atmosphere generates intense heat due to friction, which could be a danger if not properly managed.
8) Lack of Gravity: In space, there is microgravity or weightlessness. While this can be a unique experience, it can make controlling the descent and parachute deployment more challenging.
9) Re-Entry and Atmospheric Heating: When the skydiver re-enters Earth's atmosphere from space, there is a risk of extreme heating due to air friction. This could damage the space suit and affect the stability of the descent.
10) Parachute Deployment: Deploying a parachute in a space environment can be challenging due to the lack of air resistance needed to open the parachute properly. It would require specialized systems and techniques.
11) G-Forces: During the descent, the skydiver will experience G-forces, especially during the opening of the parachute and landing. High G-forces can be dangerous, leading to injuries if not managed properly.
12) High speed and air friction: The skydiver would be traveling at very high speeds during their descent, reaching up to Mach 1 (the speed of sound). This would create a lot of air friction, which could heat up the spacesuit and parachute to dangerous levels.
13) Unstable air currents: The upper atmosphere is very dynamic, with strong and unpredictable air currents. This could make it difficult for the skydiver to control their descent and could also cause them to be blown off course.

14) Exposure to radiation: The upper atmosphere is exposed to high levels of radiation from the sun and cosmic rays. This could pose a serious health risk to the skydiver, even with a spacesuit on Maximum Altitude for Successful Descent.
15) Extreme Thinness of the Atmosphere: At altitudes above 80 kilometers (50 miles), the atmosphere becomes extremely thin, with a pressure less than 1% of that at sea level. This means that the parachute would have very little air to resist against, making it difficult to slow down the skydiver's descent.
16) High Speeds: The skydiver would reach extremely high speeds during freefall, potentially exceeding the speed of sound. This could cause severe aerodynamic forces that could damage the parachute or even tear the skydiver apart.

Besides those major concern there are many other factors like (In a summary),

Atmospheric Factors

1. Temperature extremes
2. Lack of oxygen
3. Cosmic radiation exposure
4. Micrometeoroid risk
5. Ultraviolet radiation exposure
6. Vacuum of space
7. High-speed wind conditions
8. Solar flares and space weather
9. Electrical disturbances in space
10. Space debris hazards
11. Extreme low-pressure conditions
12. Hypoxia risk
13. Space suit integrity in vacuum

Technological Factors:

1. Space suit design and construction
2. Space suit life support systems
3. Parachute design and materials
4. Spacecraft design and reliability
5. Rocket propulsion systems
6. Redundancy in life-critical systems
7. Communication equipment
8. Navigation and guidance systems
9. Monitoring equipment
10. Heat shields for reentry
11. Thrusters for orientation control
12. Escape mechanisms
13. Power sources
14. Material compatibility with extreme conditions
15. Thermal protection systems
16. Structural integrity
17. Emergency abort systems

Biological and Physiological Factors:

1. Effects of extreme acceleration
2. Vestibular system adaptation
3. Decompression sickness risk
4. Physiological adaptation to microgravity
5. Space sickness
6. Cardiovascular health in space
7. Bone and muscle atrophy
8. Immune system effects
9. Psychological stress
10. Risk of decompression sickness during ascent
11. Radiation exposure to the human body
12. Dehydration in a space suit
13. Nutritional requirements
14. Musculoskeletal health
15. Vision changes in space

Safety Measures:

1. Pre-flight training and simulation
2. Medical evaluation of the skydiver
3. Communication protocols
4. Emergency response plans
5. Contingency procedures
6. Search and rescue teams
7. Tracking and telemetry systems
8. Emergency oxygen supply
9. Fire suppression systems
10. Evacuation procedures
11. Safety margins for equipment
12. Redundant life support systems
13. Environmental control systems
14. Backup navigation systems
15. Legal and Regulatory Considerations:

Compliance with space treaties and laws

1. Licensing and permits for the mission
2. Liability insurance
3. International coordination for reentry
4. Intellectual property rights
5. Liability waivers for the skydiver

Logistical and Operations Factors:

1. Launch window considerations
2. Fuel and propellant management
3. Ground support teams and equipment
4. Range safety
5. Coordination with air traffic control
6. Recovery and retrieval operations
7. Refueling and maintenance
8. Launch site selection
9. Contingency landing sites
10. Weather conditions
11. Launch and landing zones
12. Weather forecasting for descent
13. Coordination with aviation authorities
14. Risk assessment and mitigation
15. Crew training
16. Ground support personnel
17. Transportation of equipment
18. Mission control operations

Budget planning and management

1. Funding and sponsorship
2. Cost of equipment and technology
3. Insurance premiums
4. Legal and licensing fees

Public Relations and Marketing:

1. Outreach to the public
2. Sponsorship agreements
3. Social media engagement
4. Public safety and perception
5. Documentary and film production & Media coverage and promotion

Ethical and Moral Considerations:

1. Ethical use of space technology
2. Risk to the skydiver
3. Public perception of space exploration
4. Impact on the environment
5. Scientific Objectives:

Data collection and analysis during descent

1. Scientific instruments and payloads
2. Research objectives
3. Data transmission and storage

Global Cooperation:

1. International collaboration and diplomacy
2. Sharing of scientific findings
3. Data sharing with other space agencies

Educational and Outreach Activities:

1. Educational programs for schools
2. STEM initiatives
3. Outreach to young people
4. Space-related exhibitions

Sustainability and Environmental Impact:

1. Minimizing space debris
2. Environmental impact assessments
3. Sustainable technology and practices

Artistic and Creative Elements:

1. Artistic collaboration
2. Creative expression through the mission
3. Artifacts left in space

Crisis Management and Risk Mitigation:

1. Crisis communication strategies
2. Contingency plans for emergencies

Post-Mission Activities:

1. Debriefing and evaluation
2. Mission reports and documentation
3. Preservation of mission records

5 The Maximum Altitude From Which A Person Could Successfully Descend To The Surface

A number of variables, like the person's gear, training, and the particulars of the fall, affect the highest altitude from which a human could safely descend to Earth's surface. Nonetheless, there are a few general things to remember:

5.1 Atmospheric Reentry:

The journey of an object from outer space into and through the gasses of an atmosphere of a planet, dwarf planet, or natural satellite is known as atmospheric entry (also written as Vimpact or Ventry). The two primary forms of atmospheric entry are controlled entry (or reentry) of a spacecraft that can be guided or that is reentering the atmosphere on a predefined route, and uncontrolled entry, which includes the entry of bolides, space debris, and astronomical objects. EDL refers to the methods and technologies that enable spacecraft to enter, descend, and land in the atmosphere under controlled conditions.

An animated depiction shows the various stages that a meteoroid goes through when it reaches the Earth's atmosphere, turning into a meteor and landing as a meteorite.

When an item enters an atmosphere, it experiences two things: aerodynamic heating, which is largely brought on by the air in front of the object compressing, as well as atmospheric drag, which causes mechanical stress on the object. Smaller things may experience ablation, or total disintegration, due to these forces, while items with lower compressive strengths may burst.

From 7.8 km/s for low Earth orbit to about 12.5 km/s for the Stardust spacecraft, reentry has been accomplished. Air brakes and parachute deployment are not possible until crewed spacecraft have decelerated to subsonic speeds.

The density of the Earth's atmosphere decreases with altitude, and there is a specific threshold known as the Kármán line, which is often considered the boundary of space. This line is approximately 100 kilometers (62 miles) above sea level. Below this altitude, there is enough atmosphere to provide aerodynamic lift and control for a descending object.

5.1.1 Karman Line

The widely recognized Kármán line, commonly referred to as the "von Kármán line," delineates the boundary between Earth's atmosphere and outer space. It bears the name Theodore von Kármán in honor of the Hungarian-American physicist and aeronautical engineer who made significant contributions to the fields of rocketry and aerodynamics.

It is common knowledge that the Kármán line is situated at a height of roughly 100 kilometers (62 miles) above sea level. This boundary is important because it marks a transition from extremely low Earth's atmosphere density to circumstances that are closer to those of space.

Let us imagine a spacecraft with mass M_E, cross sectional area A, and lift and drag coefficients C_L and C_D. It is assumed that the velocity v is the orbital Keplerian circular velocity v_c. The spaceship is moving through the density-heavy atmosphere of ρ at a geocentric radius of r within the Earth's mass-matter gravity field.

Then the lift force is

$$F=\frac{1}{2}AC_L\rho v^2$$

and in case of the drag force, it will be the same equation with a different coefficient C_D.

The drag force on an object depends on

- Its size (cross-sectional area exposed to the wind)
- Its drag coefficient (how streamlined it is)
- Its velocity (how fast it's going)
- The density of the air

The ratio of gravitational force (weight W) to aerodynamic force (F) is

$$R=\frac{W}{F}=mg/\frac{1}{2}AC_D\rho v^2$$

Where $g = GM_E/r^2$ & circular orbital velocity, $v = \sqrt{GM_E/r}$

Considering the ballistic co-efficient $B = C_D A/\text{m}$

Then it can be written as $R = \frac{2}{Br\rho}$

According to the original von Karman argument, orbital dynamics dominates aerodynamics when R is significantly bigger than unity, making lifting flight impossible.

R varies by because of the quick change in density with height orders of magnitude within the relevant field.

$$k(B,r,\rho) = log_{10}R = log_{10}(\frac{2}{Br\rho})$$

This logarithmic measure is called Karman parameter.

5.2 Re-entry Speed

As an object reenters the Earth's atmosphere from space, it does so at high speeds. The maximum reentry speed that can be safely managed depends on the design of the reentry vehicle and the heat shield. It's typically around 25,000 to 30,000 kilometers per hour (15,500 to 18,600 miles per hour) for human spaceflight.

Re-entry Motion Analysis

We must comprehend how acceleration impacts a vehicle's velocity and, consequently, its position during reentry in order to comprehend re-entry motion more fully.

An object's constant acceleration allows us to calculate its velocity following a delay of t, from

$V = V_o + at$ where, V = Final velocity (m/s)

V_o = Initial velocity (m/s)

a = acceleration (m/s^2)

t = time (s)

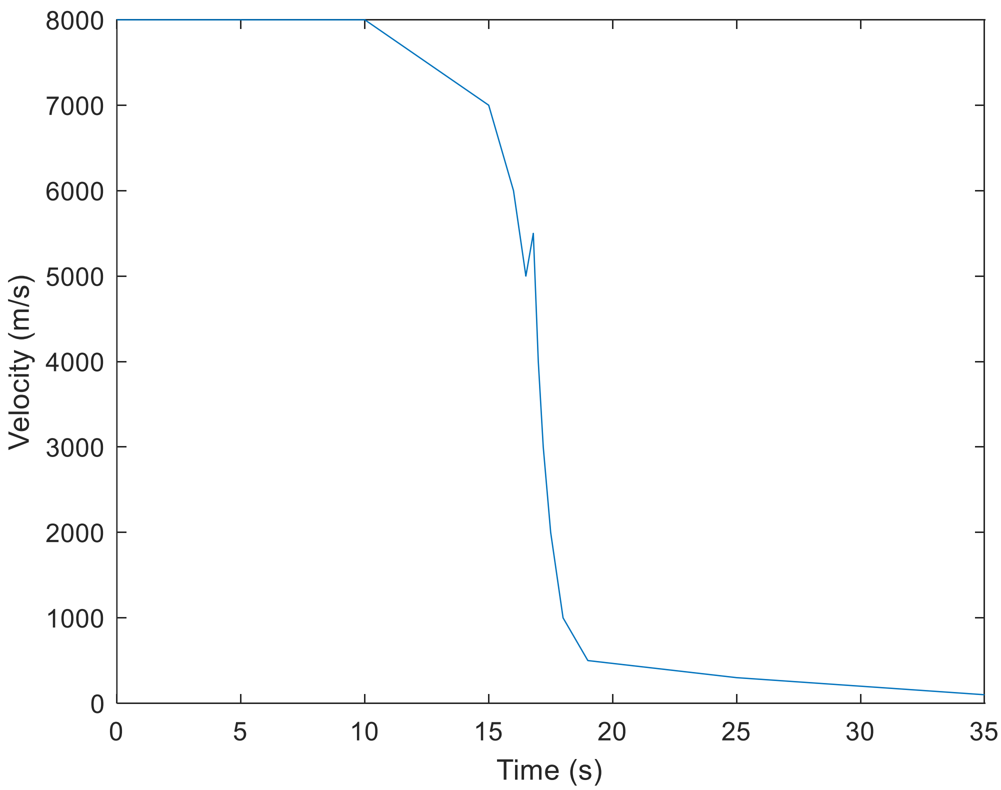
Then the final position of object is

$R = R_o + V_ot + ½ at^2$

Unfortunately, the acceleration of a re-entry vehicle varies. Drag causes a change in velocity, which in turn causes the drag deceleration! What should we do about this issue of tail-chasing? We employ mathematical integration, a technique first created by Isaac Newton. Sounds difficult? It's not that horrible, really.

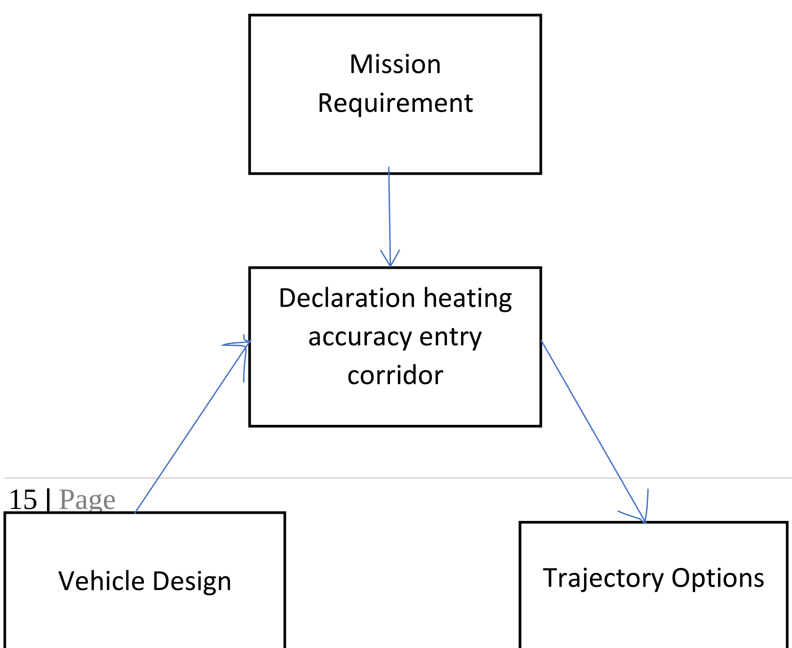
In order to use this strategy, we must assume that the acceleration is constant during a short time interval, t. This is a reasonable assumption if t is small enough.

This enables us to apply continuous acceleration for that duration of time using the velocity and position equations. We can calculate the cumulative effect on position and velocity by adding the acceleration effects over each time interval.



Notice in the figure that the velocity stays nearly constant through the first ten seconds.

5.2.1 Re-entry Design



5.2.2 Trajectory and Deceleration:

To see how varying the re-entry velocity and angle affects this maximum deceleration, let's apply

numerical tool to the re-entry equation of motion.We begin by keeping all other variables constant and change only

the initial re-entry velocity, $V_{re\text{-}entry}$, to see its effect on a_{max}. We can plot

the deceleration versus altitude for various re-entry velocities, if we following initial conditions

$$a_{max} = \frac{V_{re-entry}^2 \beta sin\gamma}{2e}$$

$$Altitude_{a_{max}} = \frac{1}{\beta} \ln \left(\frac{\rho_o}{BC\ \beta\ sin\gamma}\right)$$

By taking the value, we can find the value of altitude

$$Altitude = \frac{1}{0.000139} \ln \left(\frac{1.225}{19.9 \times 0.000139 \times \sin 45^0}\right)$$

= 46,329.72 m

=46.329 km

We may measure the heating rate, or "q dot," or rate of change of heat energy, a re-entry vehicle experiences without delving into the specifics of thermodynamics and aerodynamics. This amount, which is heat energy per unit area per unit time, is expressed in watts per square meter.

It depends on the atmosphere's density as well as the vehicle's velocity and nose radius. Empirically, this becomes about the case for Earth's atmosphere.

$$q = 1.83 \times 10^{-4}\ V^3 \sqrt{\frac{\rho}{r_n}}$$

Then Altitude,

$$Altitude_{q_{max}} = \frac{1}{\beta} \ln \left(\frac{\rho_o}{3BC\ \beta\ sin\gamma}\right)$$

5.2.3 Stefan-Boltzmann relationship

The energy emitted by an object depends on its temperature and its basic ability to store or give off heat (its emissivity).

$$E = \sigma\varepsilon T^4$$

It shows how the relationship to find an object’s temperature.

A heated object with a high emissivity will release nearly as much energy as it takes in. This implies that it attains thermal equilibrium at a comparatively lower temperature earlier. This method of lowering temperature equilibrium by releasing the majority of the heat energy prior to a

The process of radiative cooling allows the vehicle's structure to absorb it. But still,

The equilibrium temperature during re-entry can nevertheless be higher than the melting point of aluminum, even for materials with very high emissivities.

The elevated temperatures during re-entry present two challenges for us in determining

components for cooling by radiation. We have to choose a surface covering first.

substance with a high melting point and strong emissivity, such a porcelain.

Second, the aluminum would melt fast if we pressed this surface layer up against the car's aluminum skin. As a result, we need to use very effective methods to separate the heated surface from the vehicle's skin.

emissivity of the insulator is high.

By taking the value from **Stefan-Boltzmann relationship**

$$T = \sqrt[4]{\frac{E}{\sigma\varepsilon}}$$

$$= \sqrt[4]{\frac{45360}{5.67\times10^{-8}\times0.8}}$$

= 1000 K

5.3 Heat shield Technology:

Generally speaking, a "heat shield" is a specially designed structure meant to shield a re-entry vehicle from the extreme heat produced by friction with the planet's atmosphere. In less widespread usage, it can also refer to the insulating layer that encloses the spaceship as a whole, shielding the inside from temperature extremes experienced during the voyage. Every vehicle intended to safely return its crew and/or instruments to Earth must have heat shields since a spaceship without this kind of protection would quickly burn up due to the heat of re-entry. The heat shield dissipates the heat and prevents the object from burning up.

It includes:

Material Selection: Materials intended to endure the extreme heat and aerodynamic forces experienced during reentry are usually used to make heat shields. Absorbent heat shield materials, such as heat-resistant tiles, phenolic resin impregnated carbon ablator (PICA), or other ablative composites, are among the most often utilized materials. Relative materials dissipate heat and keep it from getting to the spaceship by slowly burning away or vaporizing.

Shape and Design: For a heat shield to be effective during reentry, its shape and design are essential. For the purpose of producing a shockwave in front of the spaceship, heat shields are frequently made with a blunt, rounded front surface. Through the formation of an ionized gas boundary barrier that shields the car from the intense heat, this shockwave aids in the dissipation of heat.

Angle of Reentry: This is another important factor to consider. While a shallower angle decreases temperature but lengthens the time and distance required for reentry, a steeper angle can produce higher temperatures while offering greater deceleration.

Heat Dissipation: The heat shield progressively vaporizes or chars the ablative material during reentry in order to dissipate heat. The thickness and makeup of the heat shield are intended to keep the spacecraft safe and cool throughout the fall.

TPS (Thermal Protection System): The heat shield and other frequently used insulating materials make up the thermal protection system, which shields the spacecraft's structure and occupants from extremely high temperatures. The heat shield could be a component of a bigger TPS that envelops the car.

Active Cooling: To better dissipate heat during reentry, spacecraft may occasionally use active cooling technologies like regenerative cooling.

5.4 Parachute Deployment:

Deploying a parachute in space is difficult since there isn't enough air to expand and stabilize the canopy, as was indicated in the preceding comment. To provide a controlled drop, specialized parachute systems are necessary.

6 Conclusion

Several important obstacles and risks must be considered in the hypothetical situation of a skydiver being propelled vertically into space and then falling down to Earth. The severe environment of deep space, including the vacuum, extreme cold, and radiation exposure, is the fundamental difficulty. To protect the skydiver throughout the climb and fall, a customized space suit would be required.

When the skydiver departs the rocket, they must safely re-enter the Earth's atmosphere. To avoid overheating and structural damage to the space suit and parachute, the speed and angle of re-entry must be carefully planned.

The greatest height for a successful drop would be determined by several elements, including the velocity of the skydiver, the aerodynamic design of the space suit, parachute deployment, and atmospheric conditions. The 190 kg weight of the skydiver and equipment would also have an effect on the pace and stability of the drop.

To conduct such a fall safely, rigorous preparation, advanced technology, and astronaut skill would be necessary, with the highest height feasible subject to these complicated circumstances.

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