Advanced Engineering Systems and Design

Name: ______________________

Activity 5.1.4 The Apollo Moon Challenge

Period: ____________________

Part I – The Moon Problem

1. President Kennedy’s 1961 mandate required solving multiple physics problems. List at least four distinct mission challenges described in the slides.

a) ____________________________
b) ____________________________
c) ____________________________
d) ____________________________

2. Why was landing on the Moon and returning safely considered a “battle against physics”?

Part II – Direct Ascent

3. Describe the Direct Ascent plan in your own words.

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4. According to the slides, what was the fatal flaw of Direct Ascent?

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5. Why would the required launch vehicle mass be 10–20 times larger than Saturn V?

Use physics reasoning in your explanation.

Part III – The Mass Problem

6. Using Newton’s Second Law ($a = F/m$), explain why increasing spacecraft mass creates a compounding problem.

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7. Why does adding more fuel actually worsen the mass problem?

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8. The slides describe an “exponential trap.”
Explain what that means in the context of rocketry.

Part IV – Earth Orbit Rendezvous (EOR)

9. What problem did Earth Orbit Rendezvous solve?

10. What major problem did it NOT solve?

Part V – Lunar Orbit Rendezvous (LOR)

11. What was the key breakthrough idea behind LOR?

12. List the three major components of the Apollo spacecraft and their roles.

Command Module:

Service Module:

Lunar Module:

13. Why was splitting the Lunar Module into descent and ascent stages so important?

Part VI – Mission Phases (Outbound & Return)

Using the mission profile slides:

14. Why does the Command Module remain in lunar orbit while the Lunar Module descends?

15. Why is rendezvous in lunar orbit a critical part of the mission?

16. During return to Earth, which parts of the spacecraft are discarded?

Part VII – Physics Connections

17. Why is maintaining lunar orbit essential for the LOR architecture?

18. The Lunar Module ascent engine produced about 15,000 N of thrust.
    Why was a relatively small engine sufficient?

Use Newton's 2nd Law in your explanation.

19. Why does staging improve thrust-to-mass ratio?

20. The rocket equation emphasizes mass ratio (m_0/m_f).
    Conceptually, why does reducing mass at each stage improve Δv capability?

Part VIII – Engineering Tradeoffs

21. Compare Direct Ascent and LOR in terms of:

Launch mass required:

Landing mass on Moon:

Operational complexity:

22. Why was LOR controversial despite being physically feasible?

Part IX – Final Synthesis

23. Using the concepts of force, acceleration, fuel mass, and velocity, explain why mass is the central challenge in space travel.

Write 5–7 complete sentences.