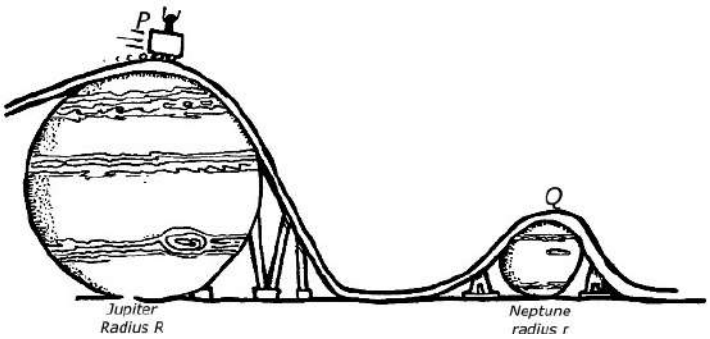
NAME _____ DATE _____

Scenario

Engineers A, B, and C are responsible for creating a new roller-coaster ride. Engineer A comes up with the idea sketched to the right, which is a solar-system themed coaster. The track starts at point P on top of a sphere (radius R) representing Jupiter, then goes down to ground level, then goes over a sphere (radius r) representing Neptune (the top of which is point Q), and then back to the ground again, etc. The spheres are intended to be built to the actual scale of the planets they represent. The coaster consists of a single cart of mass m that experiences no friction or other dissipative forces. The coaster starts from rest at point P.



The other two engineers are extremely concerned about the safety of this coaster. If the normal force becomes any number less than zero, the cart loses contact with the track and becomes a projectile, severely injuring the occupants. The engineers reason this way:

Engineer B: "If the height difference between the top of Jupiter and the top of Neptune is too much, the cart will go too fast at point *Q*, causing the cart to lose contact with the track."

Engineer C: "No, it's not the difference between heights that is the problem, but the small radius of curvature of the track as it goes over Neptune."

Quantitative Analysis

PART A: Write expressions for the following.

i. The speed of the cart when it is on the top of the Neptune sphere

ii. The normal force of the cart when it is on top of the Neptune sphere

Argumentation

PART B: Choose any step of work in Part A, except the final answer to Part A (ii) and explain how that step supports each engineer's reasoning.

i. Engineer B

ii. Engineer C

PART C: Is this ride safe? If Neptune is not safe, what combination of planets could be safe? Justify your answer.

Planet	Radius (In terms of the Radius of Jupiter)
Jupiter	1.00
Saturn	0.83
Neptune	0.35
Earth	0.09

Page 126 has been left intentionally blank