Problem B: Movement Of An Object In Microgravity Environments

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Although we were unable to come up with a concrete equation for solving this issue, we did have some ideas about how to solve it. The methods used for solving Mechanical and Electrical Vibrations[1] first came to mind after reading the given problem. In this method, the variables are mass[2], a friction factor, a spring constant, and an external force.

Our thoughts were since the probe is on the surface of an asteroid, the asteroid would have some sort of gravity, as all space objects do. However, in the problem, it specifies the asteroid has "a low gravity environment." We were unsure if this meant low as in a similar pull of Earth's moon or low as in zero or negligible. If the gravitational pull was zero it would make the problem more difficult to solve because many other variables also depend on gravity (mass and the spring constant).

As for the spring constant variable, there would need to be one, even if it is small because the probe will need to bounce on the asteroid to help prevent damage to the mechanisms. This concept is similar to shocks used in a vehicle to absorb any interference from rough terrain and prevent damage to the machinery. We would want to also include a friction factor into our solution because if there was not one the probe has the possibility to move without ever coming to a stop. This stopping is important because we want to be able to move the probe to a new "predetermined position." We agreed that the amount of friction needed would be indirectly proportional to the amount of gravity. For example, if there was almost no gravity then we would want an increase in friction to make sure the probe comes to a stop instead of it potentially hopping past the predetermined position.

Ultimately, the movement of this probe is dependent on an external force. In our case, we are looking at a "spring that will allow the probe to hop in a given direction without using a device that generates thrust." This external force will vary on the distance the new position is in relation to the current. The force will also need to depend on gravity and friction factors. The reasoning is similar to the need for friction. For the safety of researching with this probe, we would try to limit the movement of the probe to one-foot jumps possibly even six-inch jumps. These values would probably be given. This not only will protect the probe as it moves along a rugged terrain but also to potentially decrease the amount of external force needed.

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[1] $mu'' + \gamma u' + ku = F(t)$

[2] $m = w / g$

Possible limits to what can be explored are dependent on how far away the asteroid is, the material of the asteroid, and the speed of the asteroid. The farther away the asteroid is the more the probe will cost and if the asteroid gets farther away, the probe has an increased chance that we will never get information back as it will be outside our satellites' radius of service. Cost is, of course, a big issue as we would have to work in the parameters of the budget of the probe, which includes the cost of it being built and it is sent with enough materials to get it on the asteroid, therefore going too far would put an unnecessary risk on the project so we would need to choose an asteroid closer to Earth. The material of the asteroid also poses some issues, as we need a material that is solid enough to support the probe but soft enough that we can stick the probe in a rocket ship with little damage to the probe and its computerized systems. The material should allow for no more than the bounces, stated previously, and still be sturdy enough to hold the probe still for the duration of the probe's lifespan; while the asteroid loses chunks of itself in space, due to the gravity of other planets and the speed of the asteroid itself. Speed is also a limiting factor in what areas can be explored. If the asteroid is moving too fast, this would make things too difficult to try and land a probe on the asteroid without the possibility of damaging the probe. Constant recalculations may need to be performed due to the speed and position of the asteroid. To combat these limiters, we need find an asteroid relatively close to Earth and within a cost range, have a material that is strong and dense with enough give to land and stick a probe into it, and have a stable speed or velocity that is not too fast so it is easy to calculate the landing position of the probe on the asteroid.