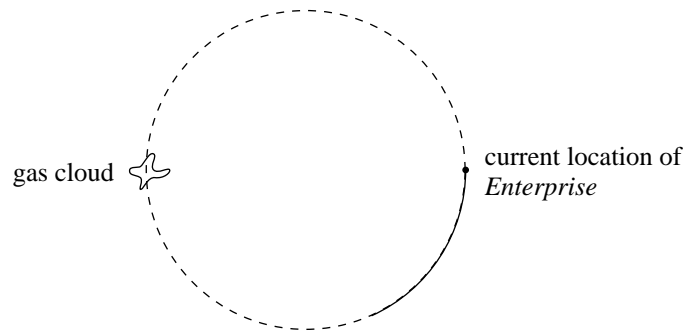


## Space: The Final Frontier

The USS *Enterprise* has been hit by a surprise attack from a Klingon fleet. Three warships attacked from all directions, knocking out the *Enterprise's* engines and causing heavy damage to the crew. Science officer Spock remains unconscious suffering from a concussion. Then the attacking ships vanished as quickly as they appeared, leaving behind only a mysterious orange gas cloud. Helmsman Sulu has been monitoring the crippled *Enterprise's* motion carefully as it drifts through space while Scotty's crew struggles desperately to repair the engines. Suddenly he realizes that the ship has been following a circular orbit which leads directly into the gas cloud! In the absence of Mr. Spock, Captain Kirk turns to you for advice.



[[From the diagram it's clear that Sulu happens to make this realization just as the *Enterprise* is at the greatest distance from the gas cloud. Call that distance  $R_0$ , the *Enterprise's* speed  $v_0$ , and the mass of the *Enterprise*  $m_E$ . Make the reasonable assumptions that the gas cloud exerts a spherically symmetric central force and that its mass is much greater than that of the *Enterprise*.]]

- (a.) How long will it be before the *Enterprise* runs into the gas cloud?
- (b.) Find the potential energy function  $U(r)$  for the cloud's force.
- (c.) Once the engines are repaired, Kirk decides to fire them directly away from the gas cloud. But before issuing the order, he asks you "How much kinetic energy will the engines have to generate to free us from the grip of the cloud?"