YouTube Physics

TAVURVUR ERUPTS! v=oMxIIXW56cQ

Watch "Mount Tavurvur Volcano Eruption Papua New Guinea 2014 (Extended Version)" on YouTube*.

Wikipedia: Tavurvur is an active stratovolcano that lies near Rabaul, on the island of New Britain, in Papua New Guinea. It is a sub-vent of the Rabaul caldera and lies on the eastern rim of the larger feature. An eruption of the volcano largely destroyed the nearby town of Rabaul in 1994.

1. a. What is the best way to estimate the distance from the volcano to the camera that recorded the video?

b. Record observed data and calculate the distance. Then convert the distance to miles using 1 mile = 1609 meters.

2. Make an observationally legitimate estimate of the launch speed of some of the boulders launched by the volcano. Neglect air resistance (for now).

a. Describe your strategy.

*If that **specific** video is no longer available, it's likely that some equally useful variation is available. You're looking for a video showing the Tavurvur eruption of 8/29/14 shot from the water. One variation includes the memorable exclamation, "Holy Smokin' Toledos".

b. Record data and calculate the launch speed. (Use the 9/4 ratio to see the m/s speed in mph.)

3. Make an observationally legitimate estimate of the maximum height (apex altitude) of some of the boulders launched by the volcano. Neglect air resistance. **Do not use kinematics.**

a. Describe your strategy.

b. Record observed data and calculate the maximum height. (Use 1 m = 3.3 ft to see the height in feet.)

4. **Speculations.** What if air resistance (drag) were taken into account? The time of flight for the boulders is fixed (unchanged).

a. With drag accounted for, the launch speed would have to be __greater __lesser __the same as the estimate made while neglecting drag.

b. With drag accounted for, the apex altitude would have to be __greater __lesser __the same as the estimate made while neglecting drag.

5. **Observations**.

a. Open the PhET sim, *Projectile Motion*.

b. Set the launch angle to 80˚ if it's not already there. Set the launch speed to the value calculated in part 2 above. Leave all other settings unchanged.

c. Fire the projectile to verify that the flight time matches what was expected. Adjust the launch speed if necessary.

d. Use the on-screen magnifiers to zoom out (–) until you can see the entire trajectory. Use the tape measure to see that the maximum height (apex altitude) compares reasonably to your estimate.

e. Activate Air Resistance. Select "Buick" from the projectile list, since the boulders are irregularly shaped and massive. Leave the altitude at 0, since the event occurred at sea level.

f. Launch the Buick.

g. Adjust the launch speed and re-launch until the flight time is correct.

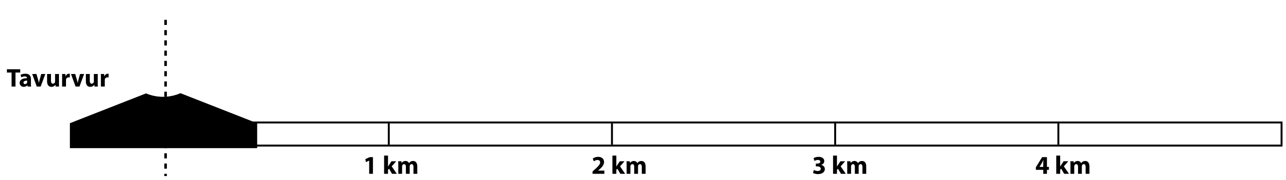
i. The launch speed, corrected with air resistance, is ____________________ m/s.

This is __more than double __more but not double __less but not half __less than half __actually, it's nearly the same as the uncorrected value.

ii. When does the Buick reach its apex?
__before the halfway point in the total flight time
__after the halfway point in the total flight time
__actually, it's right about at the halfway point in the total flight time

iii. How does the maximum height attained by the Buick with air resistance compare to the maximum height attained with no air resistance but flying for the same amount of time?
__significantly higher __significantly lower __actually, it's about the same

iv. Were the observers recording the eruption at a safe distance? What's the greatest distance a boulder could have traveled from the volcano? How did you determine this answer to this question? On the diagram below, show where the camera is and the trajectory of a boulder might could "land" (splash down) at the greatest distance from the volcano.



v. What about a rock that could best be modeled as a golfball. Tavurvur ejects felsic rocks, such as rhyolite.

• Why might a golfball-shaped projectile pose a greater danger to observers on the water?

• The PhET sim tells you the diameter of a golf ball, which is ____________________ m

• What is the density of rhyolite? Include units that we prefer in physics. ____________________

• What's the mass of a golfball-sized rock of rhyolite? Show work!

• What's the farthest such a rock could get from the volcano? Add the trajectory to the diagram on the previous page.

6. In addition to the darker plume of volcanic ash that bursts upward in the initial moments of the eruption, a white cloud rapidly forms and quickly disappears. Research "adiabatic expansion cloud" then describe what's going with that ephemeral cloud.