MATH AND SCIENCE @ WORK

AP* PHYSICS Student Edition

LUNAR SURFACE INSTRUMENTATION

Background

Exploration provides the foundation of our knowledge, technology, resources, and inspiration. It seeks answers to fundamental questions about our existence, responds to recent discoveries and puts in place revolutionary techniques and capabilities to inspire our nation, the world, and the next generation. Through NASA, we touch the unknown, we learn and we understand. As we take our first steps toward sustaining a human presence in the solar system, we can look forward to far-off visions of the past becoming realities of the future.

Outpost concepts are now being designed and studied by engineers, scientists, and sociologists to facilitate long-duration human missions to the surface of the Moon or other planetary bodies (Figure 1). Such outposts will include habitat modules, laboratory modules, power systems, transportation, life support systems, protection from the environment, communications for planetary surface operations, and communications back to Earth.

During past and current space missions, astronaut activity outside of the vehicle (e.g. space shuttle) is referred to as an extravehicular activity, or EVA. In a similar way, extrahabitat activities, or EHA, will be performed during a mission to accomplish exploration work. One EHA may be to place environmental sensors and instruments within the proximity of an outpost (Figure 2).

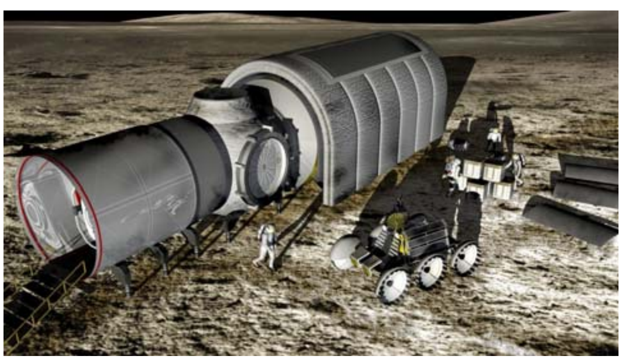

Figure 1: Habitat, airlock, and vehicles (NASA concept)

Figure 2: Astronaut services a surface instrument (NASA concept)

Such instruments may measure the radiation received from solar flares or characterize micrometeorites impacting the surface. Telescopes may also be set up for observations of Earth, other planets, and stars.

Problem

An astronaut services three instruments on the relatively flat lunar surface around an equatorial lunar outpost. She starts at the lunar habitat airlock and walks 180 meters southwest to replace the sample cell in the first instrument. She then walks 140 meters due north to add a lens to a second instrument. She then finishes the task by walking 100 meters 30 degrees north of east where she resets the pointing of a third instrument. The astronaut walks directly back to the same habitat airlock and reenters the habitat module. Using a Cartesian coordinate system with the *x*-axis pointed east and *y*-axis pointed north, determine the following information for her activities outside the airlock.

Round all answers to one decimal place.

A. Determine the astronaut's displacement vector (distance and direction) from the airlock when she is standing at each instrument. Include a sketch of the path taken by the astronaut.

B. Determine her displacement (using unit-vector notation) from the airlock when she is standing at each instrument.

C. Determine the astronaut's displacement from the first instrument and the third instrument.

D. Determine the distance she walked from the third instrument to the habitat airlock.

E. Determine the total distance she traveled on her EHA.

F. Why is it important to use vector analysis for this solution?