

## Quizzes (Fall 2024)

### PHYS 205A-002: UNIVERSITY PHYSICS

*School of Physics and Applied Physics, Southern Illinois University–Carbondale*

Due date: At 2:00 PM before each class, on D2L

## Instructions

- This document collects the quizzes for the complete semester. One question below is due on each day of lecture.
- Assessment of quizzes does not look for correctness. Instead, it expects you to be critical and creative.
- The questions are conceptual. They might be open ended, thus, it is not recommended to spend more than ten minutes on a question. You are encouraged to ponder about it though.
- After completion, scan the pages as a single PDF file, and submit the file on D2L (under Assessments → Assignments). The question number syntax Q-MMDD is derived from date of lectures.

## Questions

### Mathematical concepts

(Q-0819:) The following video,

<https://youtu.be/OfKBhvDjuy0>,

titled ‘Powers of Ten’ is a 1977 educational film describing the relative scale of the universe, by Charles and Ray Eames.

In the International System of Units (SI) the three fundamental units of measurement in mechanics are chosen to be time (second), length (meter), and mass (kilogram). If, instead, the three fundamental units of measurement in mechanics were chosen to be time (second), length (meter), and density ( $\rho$ ), then what would be the unit of measurement of mass in terms of second, meter, and  $\rho$ .

(Q-0821:) What is wrong with this road sign:

Carbondale 7 mi (11.263 km)?

## Motion along a straight line

(Q-0823:) Time always moves forward, that is, the time difference  $\Delta t > 0$ . In other words, time is monotonic. This is often referred to as the arrow of time. Change in position of an object, unlike time, could be positive, zero, or negative. Imagine and describe a universe where time is not monotonic.

(Q-0826:) When you throw a ball up in the air what is the velocity of the ball when it reaches the highest point? (Answer: Zero.) What is the instantaneous acceleration of the ball when the ball reaches the highest point? (Hint: The instantaneous acceleration of the ball at the highest point is not zero.) Is this consistent with the definition of the instantaneous acceleration as the derivative of velocity with respect to time,

$$\mathbf{a} = \frac{d\mathbf{v}}{dt}?$$
 (1)

(Q-0828:) The following BBC video captures the motion of a feather and a bowling ball when dropped together inside the world's biggest vacuum chamber.

<https://www.youtube.com/watch?v=E43-CfukEgs>

What would be the difference if you were to repeat this experiment on another hypothetical planet, say Mars.

## Vector algebra

(Q-0830:) The following TED-Ed YouTube video emphasizes on the dependence of the vector components on the choice of coordinate basis vectors.

<https://youtu.be/m14NSzCQobk>

Do the coordinate basis vectors, used to describe vectors, have to be orthogonal?

(Q-0804:) Is area a scalar or a vector? (Answer: Area is a vector.) Describe the direction associated with area.

## Projectile motion

(Q-0806:) Uniform velocity in both horizontal and vertical direction leads to a trajectory along a straight line path. Uniform velocity in the horizontal direction and uniform acceleration in the vertical direction leads to a trajectory along a parabolic path. What would be the trajectory for uniform acceleration in both horizontal and vertical direction?

(Q-0809:) The following video by National Science Foundation, USA,

<https://youtu.be/HB4ws7RoA3M>

clarifies how the vertical and horizontal components of velocity change on the trajectory of a projectile motion.

- (a) What is the vertical component of velocity at the highest point in projectile motion?
- (b) What is the horizontal component of velocity at the highest point in projectile motion?
- (c) What is the speed (magnitude of velocity) at the highest point in projectile motion?

**(Q-0811:)** The following video by National STEM Centre, United Kingdom,

[https://youtu.be/z8S0\\_SHqoeY](https://youtu.be/z8S0_SHqoeY)

demonstrates a counterintuitive feature in projectile motion. Next, ponder the following. In a room devoid of air a stuntman and a bullseye (target) are released from rest from the same height simultaneously. During the fall, the stuntman throws a ball horizontally towards the target. Is the ball expected to hit the target? If yes, explain. If not, why not?

## Galilean relativity

**(Q-0813:)** The richness and complexity of the seemingly simple idea of relativity is nicely captured in the following 26 minute educational film, titled ‘Frames of Reference’, released in 1960, starring Profs. Ivey and Hume, and produced by Richard Leacock:

[https://archive.org/details/frames\\_of\\_reference](https://archive.org/details/frames_of_reference).

Watch the first ten minutes of the video. Then, answer the following. In 1860’s Maxwell showed that speed of light in vacuum is a universal constant. How is this in direct conflict with the idea of (Galilean) relativity?