# ECE 105 Quiz 1

## Thursday Tutorial

**Individual (10 marks):** You are in a balloon that is accelerating up with constant acceleration g/2. You throw a stone straight up in the air with speed of 5 m/s relative to you. At the instant you throw the stone, the balloon is falling at 5 m/s relative to the ground. What is the speed of the stone, relative to the ground, when it falls back into your hand again? Assume the mass of the stone is negligible, so there is no effect on the balloon’s motion.

**Thursday Group work:**

1. An object moves to the right, with an acceleration vector that points to the right and is decreasing in magnitude. Which of the following is true?
   1. Its speed decreases with time
   2. Is speed remains constant
   3. Its speed increases with time
   4. Its direction changes, so it begins to move to the left
2. In the quiz problem, how can the balloon be falling if it is accelerating upward?
   1. The direction of motion does not have to be the same as the direction of the acceleration
   2. The question neglects gravity. Since the gravitational acceleration g > g/2, the balloon is actually accelerating downward with magnitude g/2.
   3. It is not correct to say the balloon is falling. At one instant its velocity is 5 m/s downward, but because of the acceleration it immediately begins to move up.
   4. Since the balloon is in free fall, it is accelerating down with magnitude g
3. Which of the following are true?
   1. At the instant it leaves your hand, the acceleration of the stone is exactly the same as that of the balloon.
   2. The acceleration of the stone and balloon are both directed downward, but the magnitude of the stone’s acceleration is twice that of the balloon’s.
   3. The balloon is an inertial reference frame
   4. The acceleration of the stone and balloon are in opposite directions
4. Which of the following are true:
   1. The velocity of the stone relative to you is zero at the instant it falls into your hand.
   2. Between the time the stone leaves your hand, and the time you catch it again, the displacement of the stone and balloon are the same
   3. At the instant the stone falls into your hand, the balloon and the stone have the same velocity.
   4. All of the above
5. The initial velocity of the stone, relative to the ground, is
   1. 5 m/s upward
   2. 0 m/s
   3. 5 m/s downward
   4. 9.8 m/s downward

## Friday Tutorial

**Individual (10 marks):** A mouse is walking down a plane, inclined at 20 degrees, with initial speed vm=0.5 m/s. A cat at the bottom, initially at rest, spots the mouse when it is 10m up the ramp. The cat runs up the ramp with constant speed vc=6 m/s. What should be the mouse’s acceleration to ensure the cat does not catch it?

**Friday Group work:**

For all these questions, consider the quiz question and a coordinate system where the x-axis is parallel to the ramp, with the positive direction pointed up the ramp.

1. The mouse’s acceleration *a* and initial velocity *vm,i*, relative to the Earth are:
   1. *a* > 0, *vm,i*> 0
   2. *a* > 0, *vm,i*< 0
   3. *a* < 0, *vm,i*< 0
   4. *a* < 0, *vm,i*> 0
2. In order to ensure the cat does not catch the mouse, which of the following has to be true?
   1. vm > 0 when the distance between the cat and mouse is zero
   2. Only that vm > vc at some point
   3. vm > vc when the distance between the cat and mouse is zero
   4. Only that the mouse’s displacement s > -10m
3. In a reference frame where vc=0, which of the following statements is true about the instant when the cat is just barely able to catch the mouse?
   1. *vm* = 0 and *s* = -10
   2. *vm* < 0 and *s* = -10
   3. *vm* = 0 and *s* > -10
   4. *vm* > 0 and *s* < -10
4. In a reference frame where vc=0, what is the initial velocity of the mouse?
   1. -0.5 m/s
   2. 0.5 m/s
   3. 6.5 m/s
   4. -6.5 m/s
5. If we repeated the problem on flat ground, rather than on the inclined plane, what would change?
   1. The acceleration would be greater by a factor cosθ
   2. The acceleration would be smaller by a factor cosθ
   3. Nothing
   4. The acceleration would be zero

# Solutions to individual parts

## Thursday Quiz 1

Both the stone and the balloon are undergoing constant acceleration, but the accelerations are not the same. So we have two sets of kinematic equations. Take the initial time to be the instant the stone is thrown, and the final time the instant it is caught again. Both the displacement, *s*, and the total time, *t*, for the stone and the balloon will be the same between these instances.

For the stone, we have , defining up to be positive, since acceleration is due only to gravity. The initial velocity, *relative to the ground*, is m/s. Thus we can write

For the balloon, we have , so

Since *s* is the same for the balloon and the stone we can combine the last two equations to give

or , so . Using that value of t in the first equation, , we get

**m/s, down**.

## Friday Quiz 1

The incline is irrelevant. The easiest way to solve the problem is to choose a reference system where the cat is at rest. Choose the x-direction to be parallel to the ramp; up is positive. In that case, the initial velocity of the mouse is v=-0.5-6=-6.5m/s. To ensure the cat does not catch the mouse means the mouse’s velocity must reach zero, and then become positive, before it has moved a distance s=-10m. Use

so with v2=0 we have m/s2.