Our class in Physics classes on 22.9.2015 and 23.9.2015

**Introduction to physics**:

**Importance of physics**:

1. Physics is widely used in all aspects of human activity, especially in computers because physics is the scientific foundation of all computing processes.

**Theories of physics**:

2. We considered the Theory of Everything, String Theory, Standard Model of Physics, classical mechanics, kinematics, etc.

**Measures**:

**Significant figures**:

3. The standard form of a number has the correct number of significant figures.

The number 23000000 has 2 significant figures because 23000000 = 2.3 = 108.

**Error analysis**:

4. Assessing the result of multiplication 4.5×3.25 ≈ 15 because the smallest number of significant figures (two) of the two factors is in 4.5, that is why the answer must contain 2 significant figures.

**Mechanics**:

5. **The limits of classical mechanics**:

10-7 < D < 1025

v << c = speed of light

here D is the Distance and v is the velocity.

Many people miss that even in their PhD theses. Thus, you are better than many of those people who have PhD in physics.

**Kinematics**:

**6. Material point**:

We consider infinitely small material points with no sizes or dimensions. It is a physical and mathematical model because real objects are not infinitely small. This is a gross simplification which allows as solving many problems easily.

7. The main equations of kinematics are as follows:

V = V0 +at

D = D0 + V0t +0.5at2

V2 = (V0)2 + 2a(D – D0)

Va = 0.5(V + V0)

Here t is time, a is acceleration, V is the velocity, V0 is the initial velocity, Va is the average velocity, D is the distance, D0 is the initial distance.

8. I throw a ball vertically with initial velocity V0 = 15m/s. What is the return velocity (V)? What is the maximum height (H)? How much time does it take for the ball to return (Tc)? Neglect the air resistance.

**Solution**:

Due to the conservation of energy, the return velocity is V0.

Let us choose the reference frame pointing up with the point of the throw having zero coordinate in the one-dimensional motion up and down.

Kinematics gives us the equation of motion as D = D0 + tV0 + 0.5at2, V = V0 +at.

D0 = 0 due to the choice of the origin of the reference frame.

a = -g, here g is the gravity acceleration of the Earth.

At the top of the trajectory, when t = T, velocity V = 0, thus, 0 = V0 –gT, so T = V0/g.

Then H = TV0 - 0.5gT2 = (V0)2/g -0.5(V0)2/g = 0.5(V0)2/g.

Plugging V0 = 15m/c and taking g = 10m/s2, we get: V = V0 = 15m/c, T = 1.5s, Tc = 2T = 3s, H = 11.25m.

**Answer**: T = V0/g, Tc = 2T = 2V0/g, H = 0.5(V0)2/g, V = V0 = 15m/c, T = 1.5s, Tc = 2T = 3s, H = 11.25m.

**9. Vectors**:

Mathematically, vector is a directed segment of a line, the components of which change correspondingly with the change of the reference frame.

Physically, a vector is a physical quantity, which has direction, for example, force, moment, velocity, etc.

Not all sets of numbers are vectors, for example cars passing a building are not entering the building which would happen if we treat the number of cars passing the building in different directions as components of vectors. In this case, the components fit neither mathematical, nor physical definition of a vector.

10. Speedometer on a car measures speed, not velocity.

11. Projectile is launched with the initial velocity of V0 and with the angle of release A. Find the maximum height (H) and the maximum distance (L) of the projective. Neglect the air resistance.

**Solution**:

Vx = V0cosA

Vy = V0sinA – gt

x = tV0cosA

y = tV0sinA – 0.5gt2.

At the highest point (y = H) and t = T, Vy = 0, thus, 0 = Vy = V0sinA – gT, so T = V0sinA/g.

Plugging T into the expression of y gives us: H = TV0sinA – 0.5gT2

H = 0.5(V0sinA)2/g

The total time of the motion of the projectile Tc = 2T, putting it into the expression of x, we get:

L = TcV0cosA = 2sinAcosA(V0)2/g

Noting that 2sinAcoosA = sin2A, gives us L = sin2A (V0)2/g

**Answer**: H = 0.5(V0sinA)2/g, L = sin2A (V0)2/g.

12. Inertial vs. non-inertial reference frame:

The principle of Galileo says that is references frames rest or move with the constant velocity, then the equations of mechanical motion in all of these reference fames are the same. Indeed, the acceleration, which is the derivative of the velocity, adds zero contribution to the second order of differential equations of mechanical motion because the derivative of the constant relative velocity is zero.

This principle does not work in electrodynamics because of too large velocities there for the principles of the classical mechanics to stand, thus, instead of the Galileo transformation, Lorentz transformation, accounting for the effects of the Special Theory of relativity, is used in electrodynamics to achieve the invariance of the equations of electrodynamics for the transformations from one inertial reference frame to another.