# Topic 01. Introduction to Physics

## HOMEWORK

By solving these problems you can check your understanding of the concept of significant figures, conversion of units, making estimations, and coordinate systems.

1. How many seconds are there in a year?
   (Note: Assume a 365-day year)

2. How many years older will you be 1.00 gigasecond from now?
   (Note: Assume a 365-day year)

3. The speed of light is about $3.00 \times 10^8$ m/s. Convert this figure to miles per hour.
   (Note: 1 mi = 1609 m = 1.609 km)

4. In the ancient Roman Empire, large distances were measured in miliarum. A miliarum was subdivided into 8 stadia, 1 stadium into 125 passus, 1 passus into 5 pes, 1 pes into 4 palmus, 1 palmus into 4 digitus. Knowing that 1 pes = 0.296 m, find the number of (a) meters in 1.00 miliarum, and (b) centimiters in 1.00 digitus.

5. Fuel consumption of a car is the amount of fuel used per unit distance. It is customary to give fuel consumption in liters per 100 km (L/100 km). For example, a fuel consumption of 5.5 L/100 km means that a car uses 5.5 liters of petrol for every 100 km driven. If this car's petrol tank holds 40 L, how many tanks of petrol will you use to drive 1200 km?

6. Suppose your hair grows at the rate of 1/32 inch per day. Find the rate at which it grows in nanometers per second. Since the distance between atoms in a molecule is on the order of 0.1 nm, your answer suggests how rapidly atoms are assembled in this protein synthesis.

7. An automobile tire is rated to last for 50 000 km. Estimate the number of revolutions the tire will make in its lifetime.

8. A useful way and easy-to-remember value for the number of seconds in a year is $\pi \times 10^7$. Determine the percent error in this approximate value.
   (Note: in this problem use the value of 365.24 days in one year)

9. A certain corner of a room is selected as the origin of a rectangular coordinate system. If a fly is crawling on an adjacent wall at a point having coordinates $(2.0, 1.0)$, where the units are meters, (a) what is the distance of the fly from the corner of the room? (b) Express the location of the fly in polar coordinates.

10. The radius of the planet Saturn is $5.85 \times 10^7$ m, and its mass is $5.68 \times 10^{26}$ kg. (a) Find the density of Saturn (its mass divided by its volume) in grams per cubic centimeter. (The volume of a sphere is given by $\frac{4}{3}\pi r^3$.) (b) Find the area of Saturn in square feet. (The surface area of a sphere is given by $4\pi r^2$.)
    (Note: 1 ft = 30.48 cm)

11. (ADVANCED) If one micrometeorite (a sphere with a diameter on the order of $10^{-6}$ m) struck each square meter of the Moon each second, estimate the number of years it would take to cover the Moon with micrometeorites to a depth of one meter.
    (Hint: Consider a cubic box, 1 m on a side, on the Moon, and find how long it would take to fill the box.)

12. (ADVANCED) You are testing parcel delivery by drone for a project. Your team uses vector displacements to record the route of the drone, with the origin taken to be the position of the control centre. During one test, the drone starts its flight at $+10\hat{i} - 50\hat{j}$, where the units are meters, $\hat{i}$ is to the east, and $\hat{j}$ is to the north. Subsequent displacements of the drone are $+90\hat{i}$, $+110\hat{j}$, $-60\hat{i} + 40\hat{j}$, and $+120\hat{i} + 180\hat{j}$. If the final destination of the drone is $-70\hat{j}$, how far and in which direction must the drone fly?
    (Note: it is recommended to make a sketch of the situation before solving this numerically)