Lecture (1)

https://youtu.be/rcDXQ-5H8mk?t=634

https://youtu.be/KBSCMTYaH1s?t=5

Classical Mechanics Lectures

References

1. Physics Principles and Problems, Contributing Writers. Physicspp.com
2. Fundamentals of college Physics, Peter J. Nolan
3. University Physics with Modern Physics Hugh D. Young & Roger A, Freedman

What is physics: physics is a science of Measurement, in order to study the entire physical world, we must first observe it. To be precise in the observation of nature, all the physical quantities that are observed should be measured and described by numbers.

SI Units: The system international, SI, uses seven base quantities, which are shown in table (1), in terms of direct measurements, other units, called derived unites, are created by combining the base units in various ways. For example energy is measured in joules where 1 joule equals one kilogram-meter squared per second squared or 1 J= $1 Kg.m^2/s^2$ Electric charge is measured in coulombs where 1C = 1 A.s

Table 1-1		
SI Base Units		
Base Quantity	**Base Unit**	**Symbol**
Length	meter	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Amount of a substance	mole	mol
Electric current	ampere	A
Luminous intensity	candela	cd

You probably learned in math class that is much easier to convert meters to kilometers than feet to miles. The ease of switching between units is another feature of the metric system. To convert between Si units, multiply or divide by the appropriate power of (10). Prefixes are used to change Si units by powers of (10) as shown in table (2), you often will encounter these prefixes in daily life, as in for example, milligrams, nano seconds and gigabytes

Table 1-2

Prefixes Used with SI Units

Prefix	Symbol	Multiplier	Scientific Notation	Example
femto-	f	0.000000000000001	10^{-15}	femtosecond (fs)
pico-	p	0.000000000001	10^{-12}	picometer (pm)
nano-	n	0.000000001	10^{-9}	nanometer (nm)
micro-	μ	0.000001	10^{-6}	microgram (μg)
milli-	m	0.001	10^{-3}	milliamps (mA)
centi-	c	0.01	10^{-2}	centimeter (cm)
deci-	d	0.1	10^{-1}	deciliter (dL)
kilo-	k	1000	10^{3}	kilometer (km)
mega-	M	1,000,000	10^{6}	megagram (Mg)
giga-	G	1,000,000,000	10^{9}	gigameter (Gm)
tera-	T	1,000,000,000,000	10^{12}	terahertz (THz)

1. **Scalar Quantity**: is a quantity that can be described by a magnitude that is, by a number and a unit. Some examples of scalar quantities are mass, charge, length, time, density, distance and temperature. $m1=3kg$, $m2=4kg$ then $m_{total} = m1+m2= 3+4=7kg$

2. **Vector Quantity**: is a quantity that needs both a magnitude and direction to completely describe it. Some examples of vector quantity are force, displacement, velocity and acceleration.

$$\vec{A} = \hat{U}\,A, \quad \vec{B} = \hat{U}\,B \quad \text{OR} \quad \vec{A} = \hat{U}\,|A|, \quad \vec{B} = \hat{U}\,|B|$$

3. **Displacement:** can be represented as a vector that described how far and in what direction the body has been displaced from its original position. When everybody moves from one position to another it undergoes a displacement

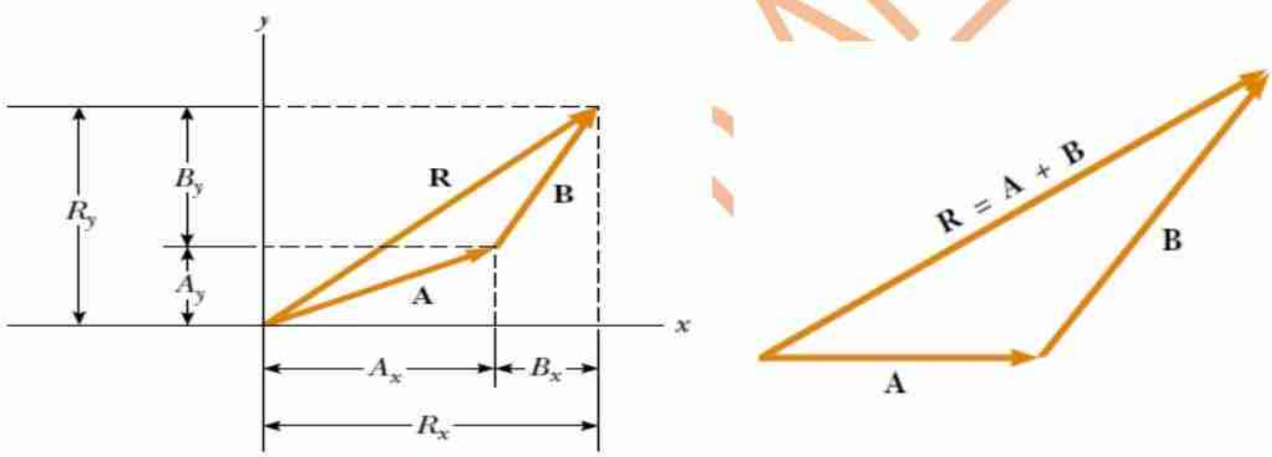
Displacement is the change in position of an object:

$\Delta X = Xf - X0$

Where ΔX is displacement, Xf is the final position and X0 is the initial position

4. Distance: is the total length of the path traveled between two positions. The path between two points can be represented by a straight line or curve. The direction of an object moving between two points does not affect the distance the object travels. Distance has magnitude but no direction so it is a scalar quantity.

5. The Vector: The rules for adding vectors are conveniently described by geometric methods. To add vector **B** to vector **A**, first draw vector **A**, with its magnitude represented by a convenient scale, on graph paper and then draw vector **B** to the same scale with its tail starting from the tip of **A**, as shown in Figure 1. The **resultant vector R= A + B** is the vector drawn from the tail of **A** to the tip of **B**. This procedure is known as the triangle method of addition.



Consider a vector **A lying** the xy plane. The product of the component Ax and the unit vector **i** is the vector (A**xi**,)which lies on the x axis and has magnitude Ax . (The vector (Ax **i**)is an alternative representation of vector **A**x .) Likewise, Ay **j** is a vector of magnitude Ay lying on the y axis. (Again, vector (Ay **j**) is an alternative representation of vector **A**y .) Thus, the unit vector no tation for the vector **A** is

$$\mathbf{A} = \mathbf{A_x i} + \mathbf{A_y j}$$

Now let us see how to use components to add vectors when the geometric method is not sufficiently accurate. Suppose we wish to add vector **B** to vector **A**, where vector **B** has components Bx and By. All we do is add the x and y components separately. The resultant vector **R =A + B** is therefore for two-dimension

$$\mathbf{R} = (A_x\mathbf{i} + A_y\mathbf{j}) + (B_x\mathbf{i} + B_y\mathbf{j})$$

$$R_x = A_x + B_x$$

$$R_y = A_y + B_y$$

For th

$$\mathbf{R} = (A_x + B_x)\mathbf{i} + (A_y + B_y)\mathbf{j}$$

$$\vec{\mathbf{B}} = (\,B_x i + B_y j + B_z k)$$

$$\vec{\mathbf{C}} = (\,C_x i + C_y j + C_z k)$$

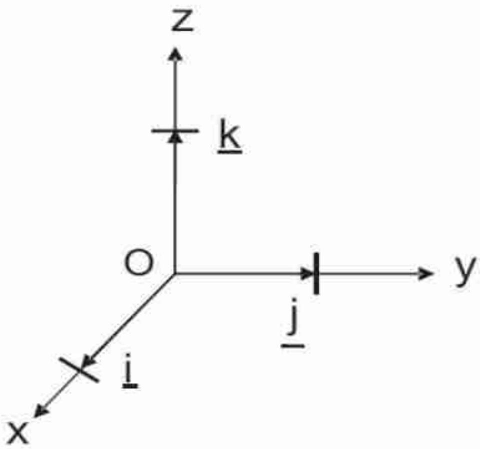
We obtain the magnitude of **R** and the angle it makes with the x-axis from its components, using the relationships

$$R = \sqrt{R_x^{\,2} + R_y^{\,2}} = \sqrt{(A_x + B_x)^2 + (A_y + B_y)^2}$$

$$\tan\theta = \frac{R_y}{R_x} = \frac{A_y + B_y}{A_x + B_x}$$

6. Unit Vector:

- A unit vector is a vector with magnitude equal to one.
- e.g. Three unit vectors defined by orthogonal components of the Cartesian coordinate system:
  - $\underline{\mathbf{i}} = (1,0,0)$, obviously $|\underline{\mathbf{i}}| = 1$
  - $\underline{\mathbf{j}} = (0,1,0)$, $|\underline{\mathbf{j}}| = 1$
  - $\underline{\mathbf{k}} = (0,0,1)$, $|\underline{\mathbf{k}}| = 1$
- A unit vector in the direction of general vector $\underline{\mathbf{a}}$ is written $\hat{\underline{\mathbf{a}}} = \underline{\mathbf{a}}/|\underline{\mathbf{a}}|$
- $\underline{\mathbf{a}}$ is written in terms of unit vectors $\underline{\mathbf{a}} = a_x\underline{\mathbf{i}} + a_y\underline{\mathbf{j}} + a_z\underline{\mathbf{k}}$



$U = \frac{\vec{A}}{|\vec{A}|}$, $\quad |\vec{U}| = 1$, also any unit vector is = 1

Example: Find the vector ($\overrightarrow{AB}$) from two point A(2,1), B(-1, 2), also find unit vector in direction of $\overrightarrow{AB}$

Solution: $\overrightarrow{AB} = (x2 - x1)i + (y2 - y1)j$

$$\overrightarrow{AB} = (-1 - 2)i + (2 - 1)j$$

$$\overrightarrow{AB} = -3i + j$$

Unit vector $\vec{U} = \frac{\overrightarrow{AB}}{|\overrightarrow{AB}|} = \frac{-3i+j}{\sqrt{(-3i)^2+(1)^2}} = \frac{-3i+j}{\sqrt{10}}$