Answer on Question#56031 - Physics - Classical Mechanics

Momentum is closely related to which of the following? and why?

(1) impulse

(2) kinetic energy

(3) angular momentum

(4) velocity

Solution:

The momentum $\boldsymbol{p}$ is related to all of these.

The impulse $\boldsymbol{J}$ is the integral of the resultant force with respect to time. From Newton's second law, the force $\boldsymbol{F}$ is related to momentum $\boldsymbol{p}$ by

$$\boldsymbol{F} = \frac{d\boldsymbol{p}}{dt}$$

Therefore

$$\boldsymbol{J} = \int_{t_1}^{t_2} \boldsymbol{F} dt = \int_{t_1}^{t_2} \frac{d\boldsymbol{p}}{dt} dt = \int_{\boldsymbol{p_1}}^{\boldsymbol{p_2}} d\boldsymbol{p} = \boldsymbol{p_2} - \boldsymbol{p_1}$$

Namely it is the change in momentum.

Kinetic energy E_k of the particle of mass m can be expressed through its momentum $\boldsymbol{p}$ as follows

$$E_k = \frac{\boldsymbol{p}^2}{2m}$$

Angular momentum $\boldsymbol{L}$ of the particle with respect to some point O (distance from O to the particle is $\boldsymbol{r}$) cam be expressed through its momentum $\boldsymbol{p}$ as follows

$$\boldsymbol{L} = \boldsymbol{r} \times \boldsymbol{p}$$

The velocity $\boldsymbol{v}$ of the particle of mass m is connected with its momentum $\boldsymbol{p}$ by the following relation

$$\boldsymbol{p} = m\boldsymbol{v}$$

Answer: (1), (2), (3), (4).