CONSERVATION OF ANGULAR MOMENTUM

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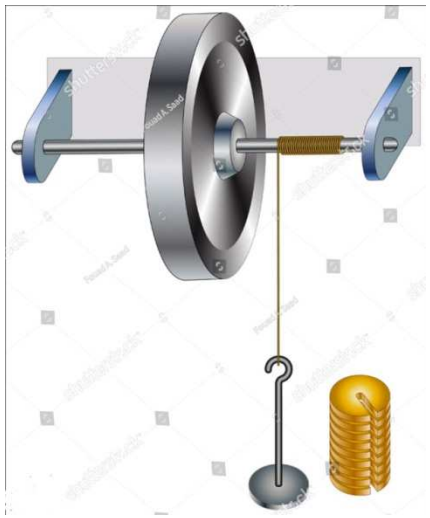
ANGULAR MOMENTUM

Rotational form of LINEAR MOMENTUM

Mass used to increase linear momentum

Mass used to apply torque and increase angular momentum



LINEAR MOMENTUM

LINEAR MOMENTUM
is the
Quantity of motion

Ability of the system to
Produce the change in the dynamic state of another system - acceleration

LINEAR MOMENTUM

Product of MASS and VELOCITY

$$p = m \times v$$

LINEAR MOMENTUM

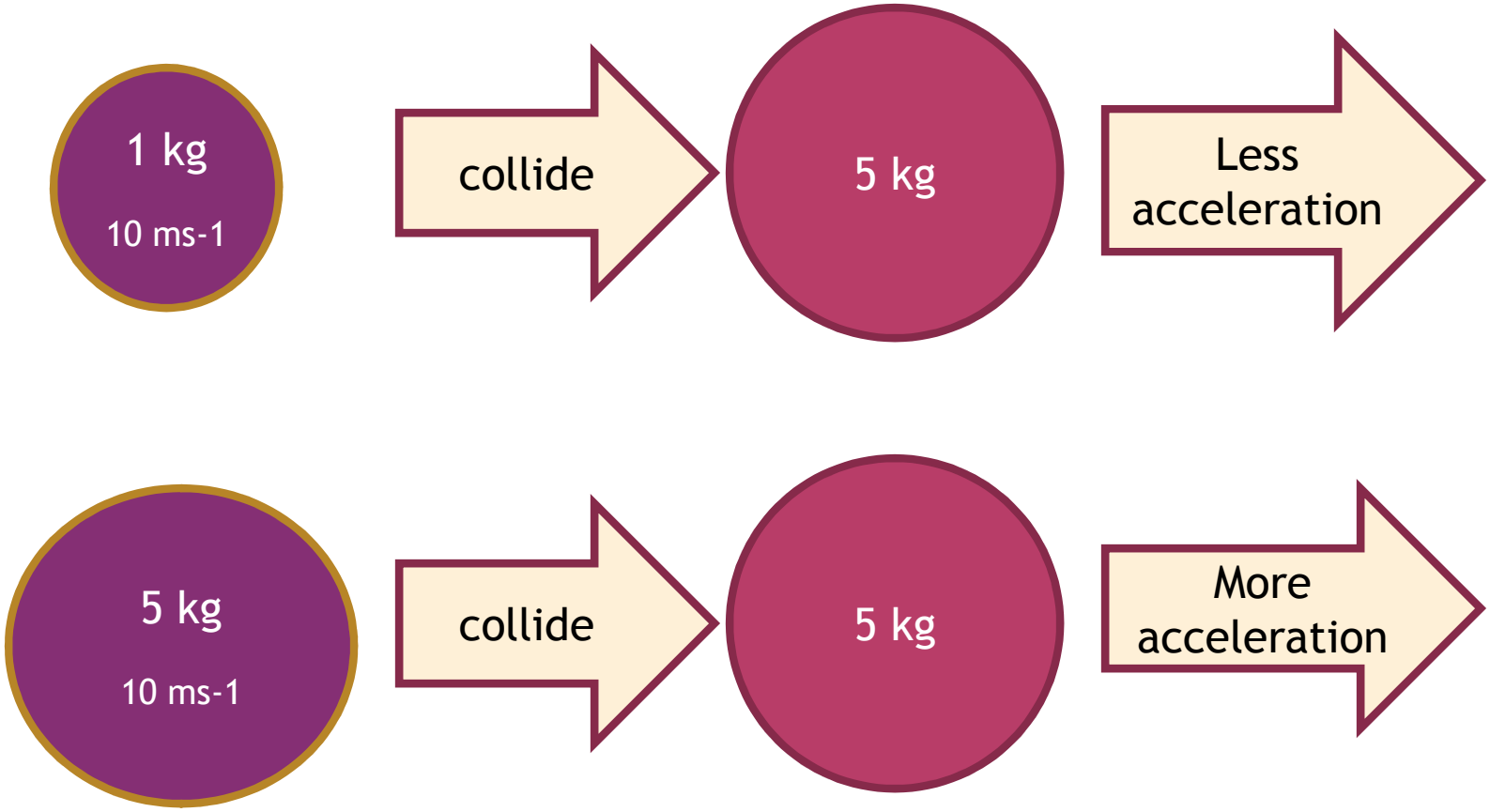
Velocity
100 ms-1

momentum
100 kgms-1

Velocity
5 ms-1

momentum
50 kgms-1

LINEAR MOMENTUM



ANGULAR MOMENTUM

Quantity of rotational motion

Ability of the system to

Produce the change in rotational motion – angular acceleration

ANGULAR MOMENTUM

Whenever a torque acts
There is a corresponding angular acceleration

There exists a change in
ANGULAR MOMENTUM

ANGULAR MOMENTUM

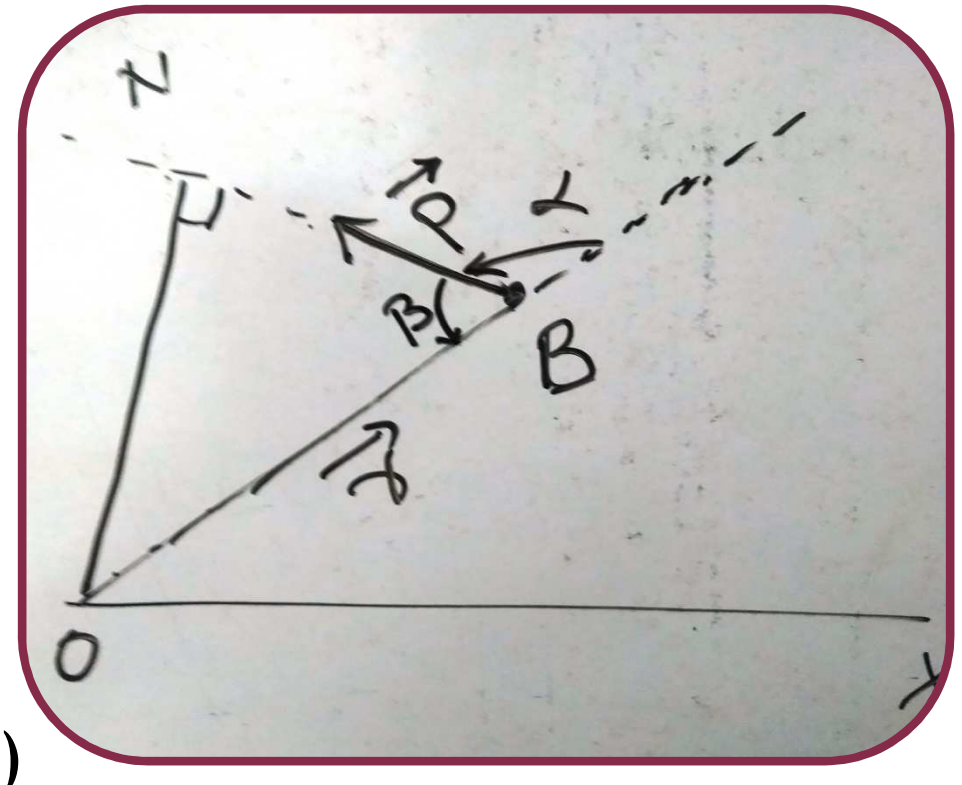
Definition

Vector product of position vector and momentum vector

$$\mathbf{J} = \mathbf{r} \times \mathbf{p}$$

Vector in a direction perpendicular to both position vector and momentum vector

$\vec{P}$



J = **r** x **p**

= r p sin(α)

= r p sin(180 – β)

= r p sinβ

= p x ON

= moment of P about O

Thus **J** is moment of momentum

$\vec{P}$

$J = r\ mv$

$= r\ mr\omega$ since $r\ mr = I$

$= I\ \omega$

Where ω is the angular velocity and

I is the moment of inertia

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Statement of the Law

In a system having no external torque the angular momentum of the system remains a constant

Torque is the one which changes the angular momentum.
Hence if torque is absent no change in J
J remains constant

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Illustrations 1

Since J remains constant

Any change in moment of inertia (I) produce a corresponding change in ω

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Illustrations 1

Consider a person holding a pair of dumbbells in his outstretched hands sitting on a turntable. Let the turntable rotate with a given angular speed. If the person pulls his hands inward the turntable begins to rotate with an increased speed. As his moment of inertia (I) decreases his angular speed increases due to **conservation of angular momentum**

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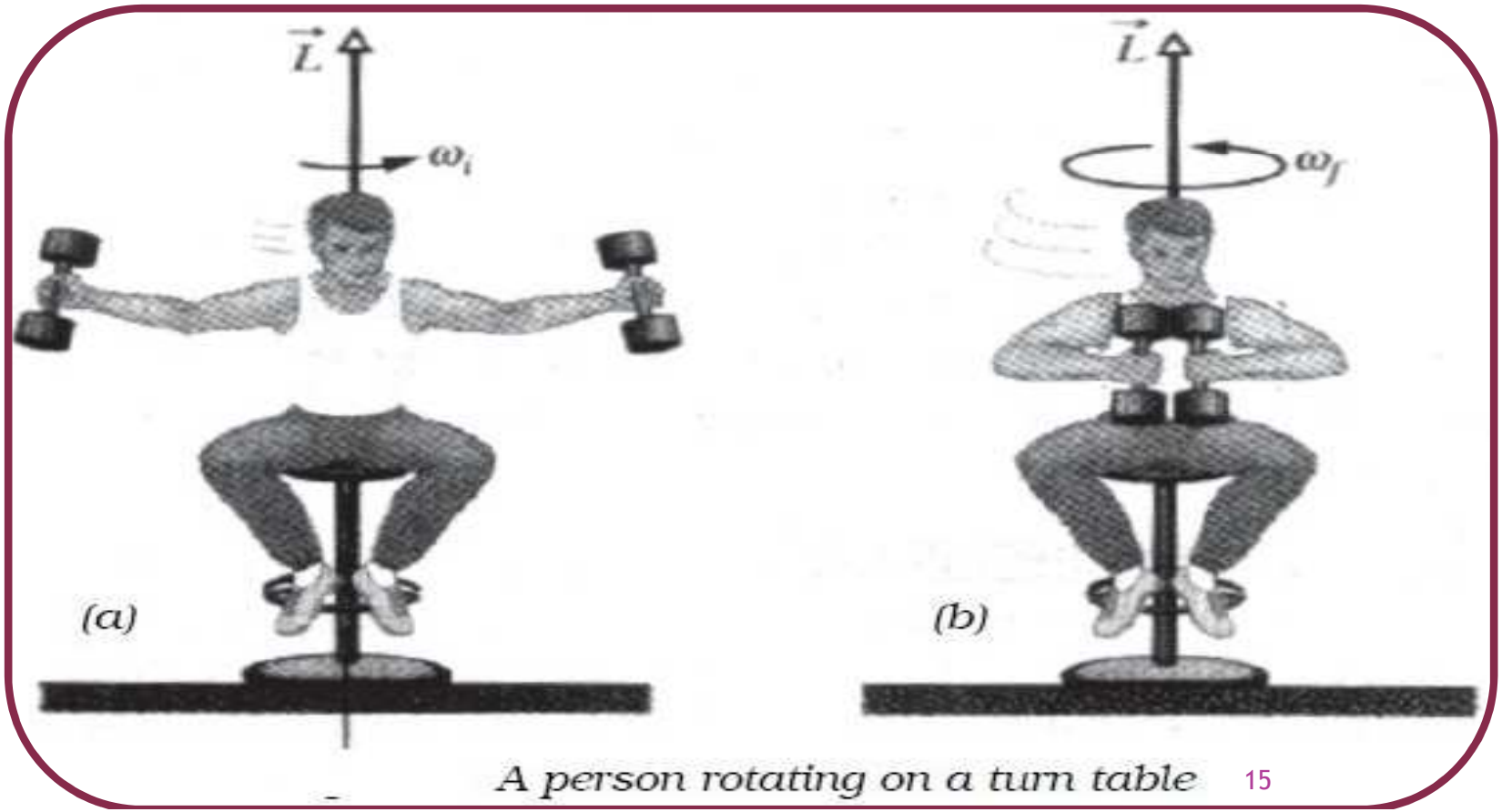
Illustrations 1

Decrease in moment of inertia (I) increase in ω



A person rotating on a turn table

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Illustrations 2

Consider a ballet dancer performing spins on her toes with arms out stretched. When she pulls her arms inward she spins fast giving an amazing sight. Again this is due to conservation of angular momentum.

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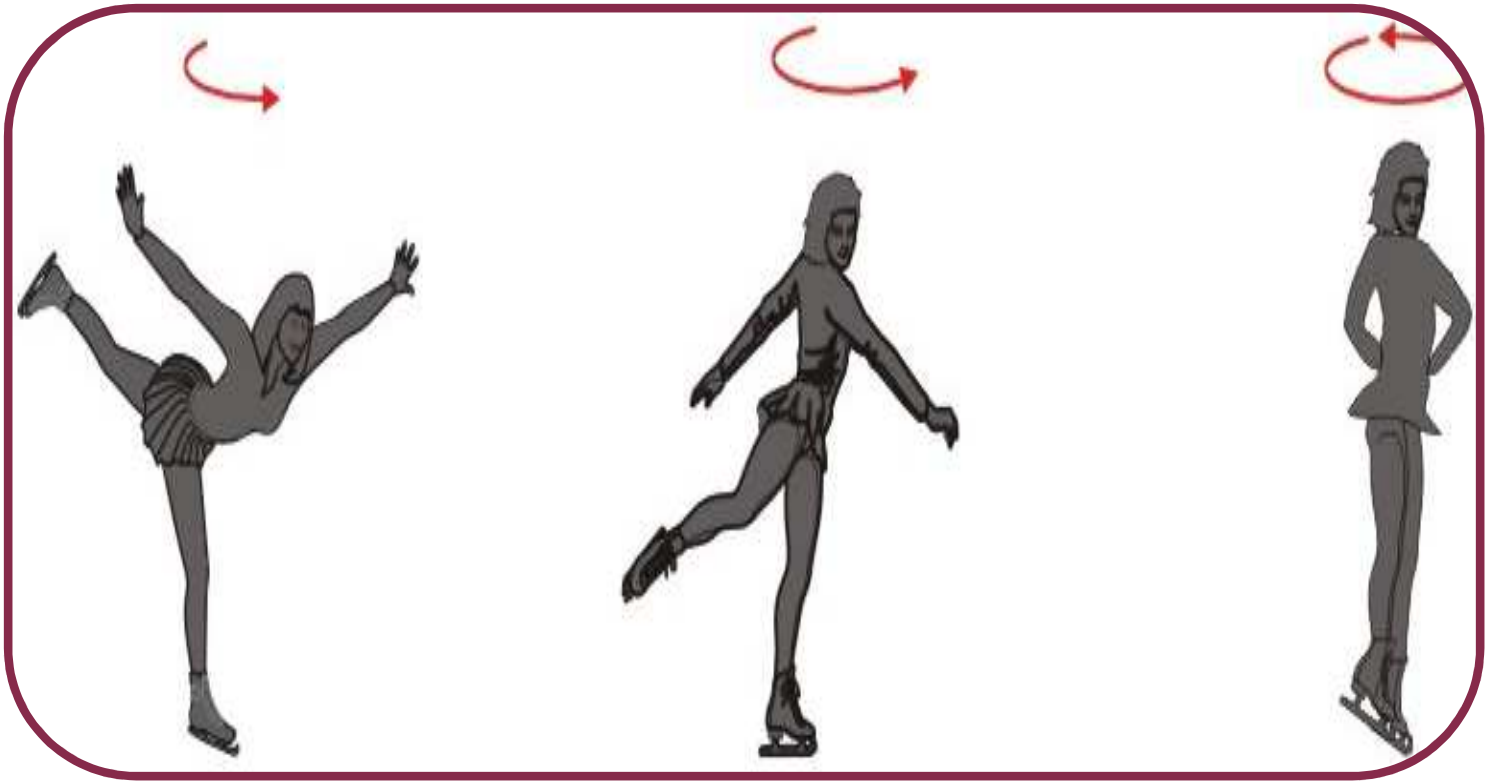
Illustrations 2

Decrease in moment of inertia (I) increase in ω



Assignment questions

1.Angular momentum is a _____quantity

a. Scalar
b. Vector
c. Tensor

Assignment questions

2.Angular momentum is defined by the equation

a. m X v
b. r X p
c. p X r

Assignment questions

3.Angular momentum is the quantity of

a. Linear Motion
b. Rotational Motion
c. Both

Assignment questions

4.Choose the correct statement

a. Angular momentum is in the direction of velocity

b. Linear momentum is in the direction of velocity

c. Both are not in the direction of velocity

Assignment questions

5.Choose the correct statement with respect to linear momentum and angular momentum

a. Both are vectors
b. Both are scalars
c. Linear momentum is vector and Angular momentum is scalar

Assignment questions

6.According to Law of conservation of angular momentum, the angular momentum of the system remain conserved if

a. Internal torque is zero
b. External torque is zero
c. Both internal and external torques is zero

Assignment questions

7.Which mathematical statement describe the law of conservation of angular momentum

a. dP/dt=0
b. dJ/dt=0
c. None of the above

Assignment questions

8.According to Law of conservation of angular momentum

a. Iw=constant
b. Iw=0
c. None of the above

Assignment questions

9.When a person withdraws his hands inwards, his

a. Moment of inertia increases
b. Moment of inertia decreases
c. Moment of inertia remains same

Assignment questions

10.When a ballet dancer stretches her hands, her

a. Moment of inertia increases
b. Moment of inertia decreases
c. Moment of inertia remains same