What is Mechanics?

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1. What is force and what does it do?

2. A ball is thrown vertically upwards. What forces act on the ball?

3. What is the direction of the resultant force acting on the thrown ball when the ball is

a) going up,

b) at the top of its motion and

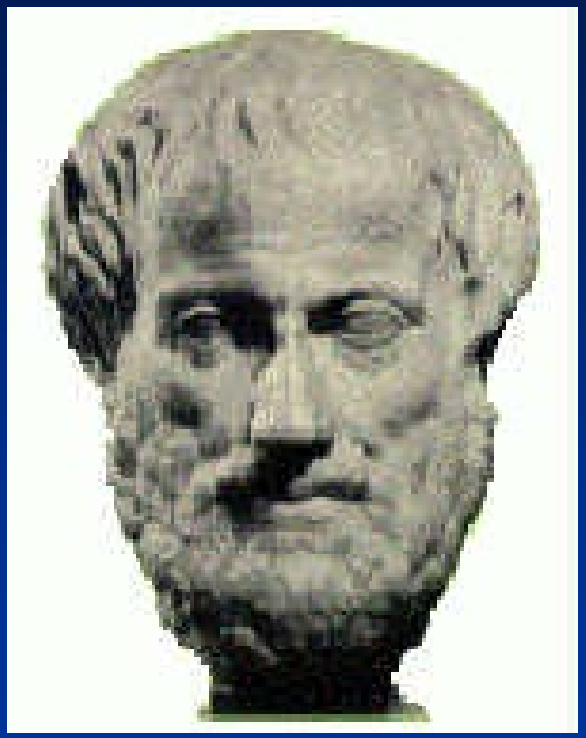
c) going down?

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c) going down?





ARISTOTLE 384-322 BC

Aristotle's Mechanics:

- Rest is the natural state for objects
- There are two types of motion: natural and forced
- In natural motion the object is seeking a state of rest
- In forced motion the object is moved by a mover



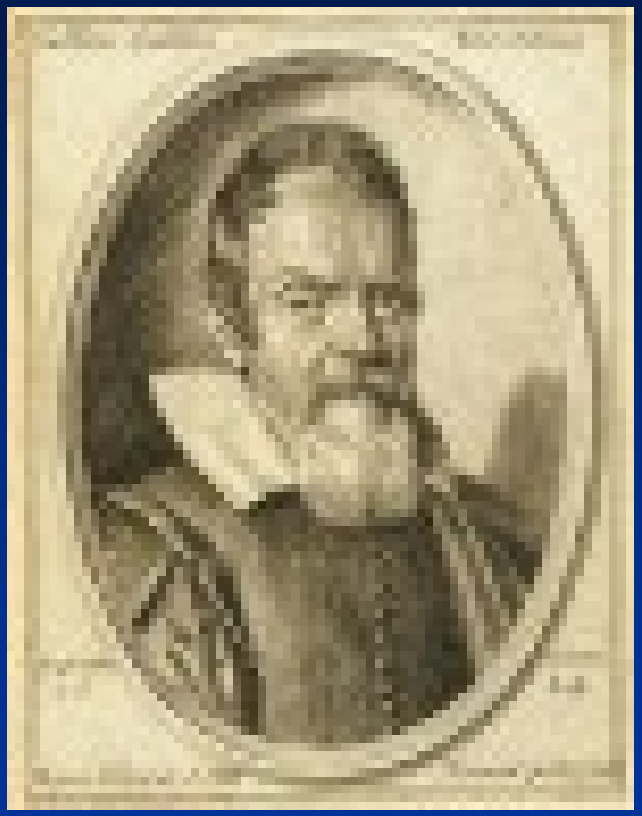
Projectile motion is a big problem for Aristotle's mechanics

Clearly it is forced motion, but what is this force that moves the projectile?

Aristotle: Displacement of air plus air turbulence

Buridan and the Medieval Impetus School (14th Century): The force of the thrower becomes the property of the projectile





Galileo Galilei (1564-1642)

THE THOUGHT EXPERIMENT

Imagine a world of no gravity

Imagine a frictionless surface

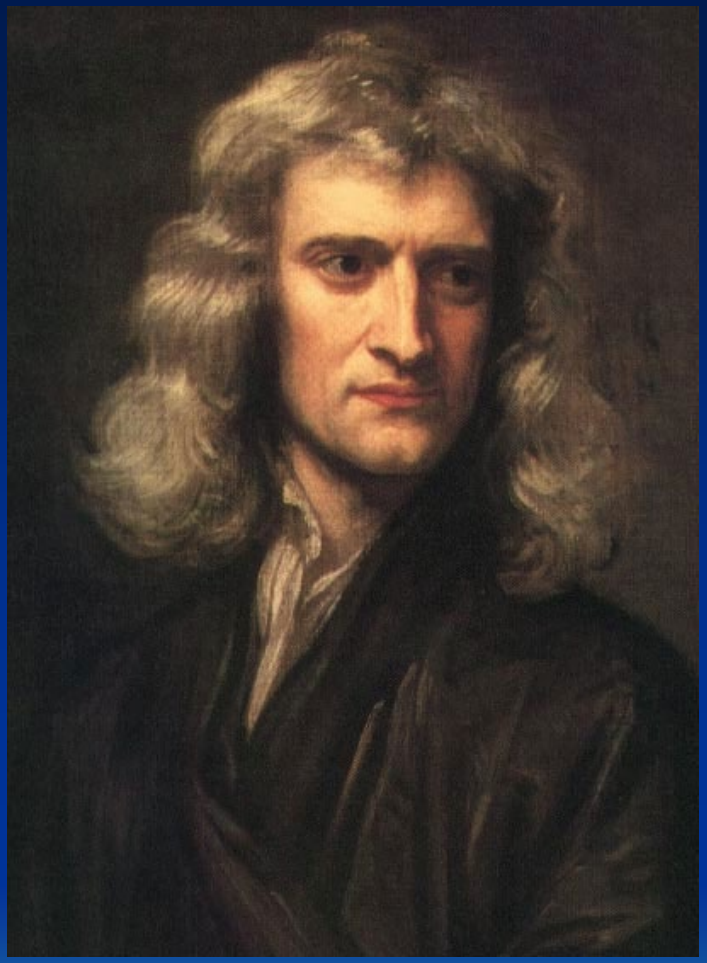
A sailor at the top of a mast drops a ball. Where does the ball land?

A Definition of a Force

A force will cause the motion of an object to change in some way.

No force ⇔ No change in motion







SIR ISAAC NEWTON (1642–1727)

Newton's First Law of Motion

A body will remain at rest or move with a constant speed in a straight line if no force acts on it

A body *perseveres* in a state of rest or in uniform motion in a straight line but is *compelled* otherwise due to the action of an impressed force



Newton's Second Law of Motion

When a force acts on a body
it will cause a change in motion:
The body will accelerate such that
force = mass x acceleration



Newton's Third Law of Motion

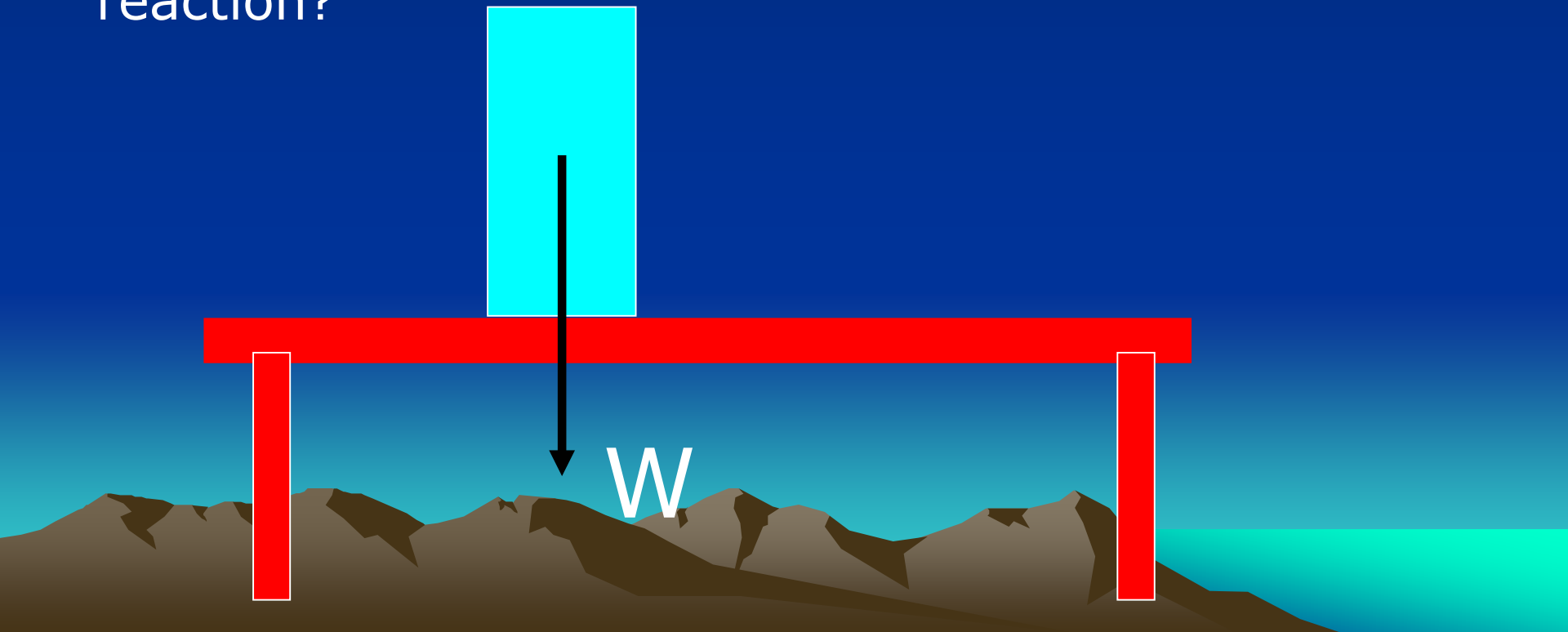
For *every* action there is an equal but opposite reaction



Newton's Third Law of Motion

For *every* action there is an equal but opposite reaction

If the weight of the bottle is the action, then under the third law of motion what is the reaction?



Newton's Third Law of Motion

In any interaction between two bodies, the magnitude of the force is the same for both bodies but acts in opposite directions

Mechanics determines one form of description of the world by saying that all propositions used in the description of the world must be obtained in a given way from a given set of propositions – the axioms of mechanics. It thus supplies the bricks for building the edifice of science, and it says. ‘Any building that you want to erect, whatever it may be, must somehow be constructed with these bricks, and with these alone’. (Wittgenstein, 1974. proposition 6.341, p.68).

Mechanics is an attempt to construct to a single plan all the *true* propositions that we need for the description of the world. (Wittgenstein, 1974, proposition 6.343).

The laws of motion define force

Work is defined as the product of force and distance

Energy is defined in terms of work

Power is defined as the rate of doing work

The law of conservation of mechanical energy :

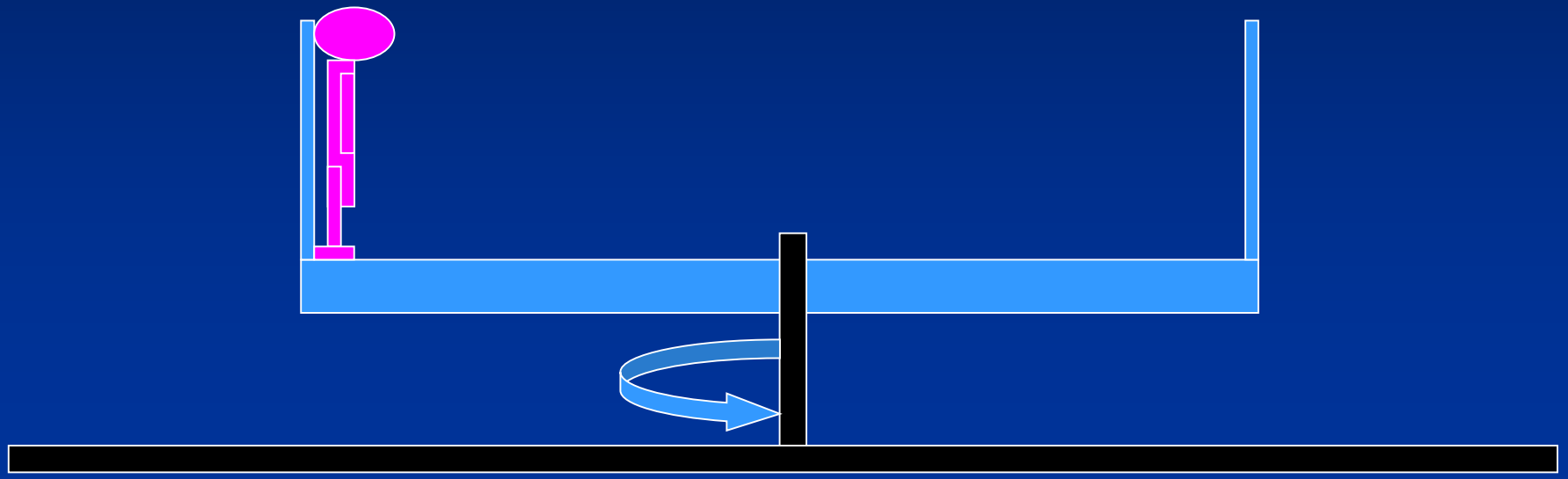
The work that a body can do is equal is the work done on the body.

The law of conservation of momentum:

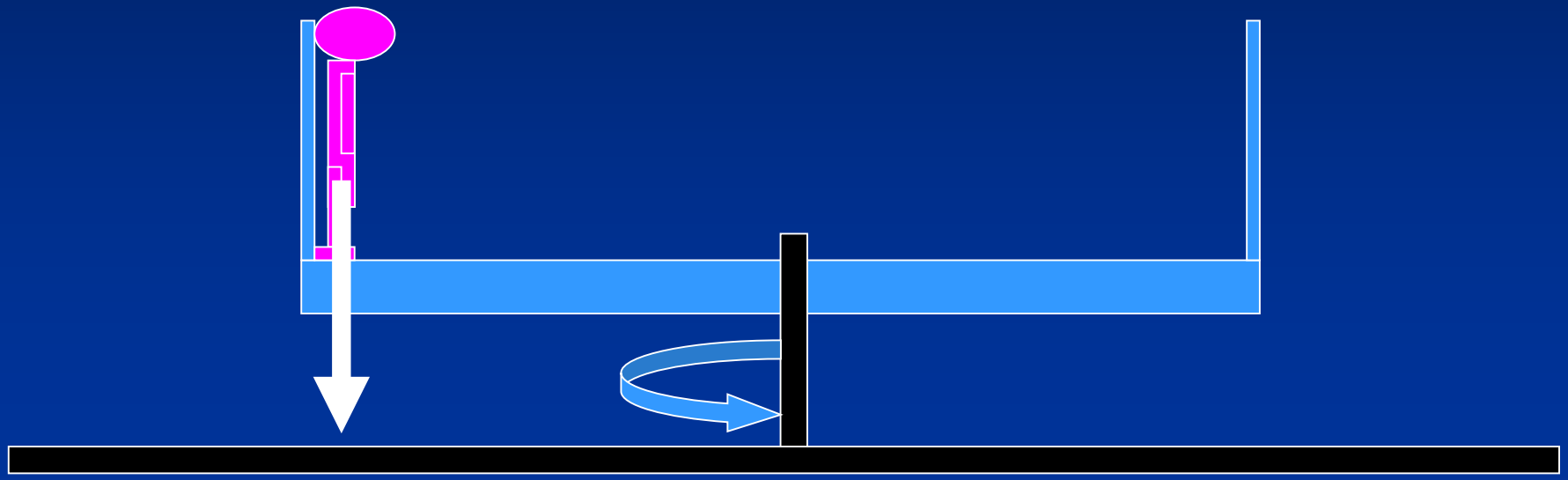
In any interaction, the total momentum before and after remains the same.

Derived by the laws of motion

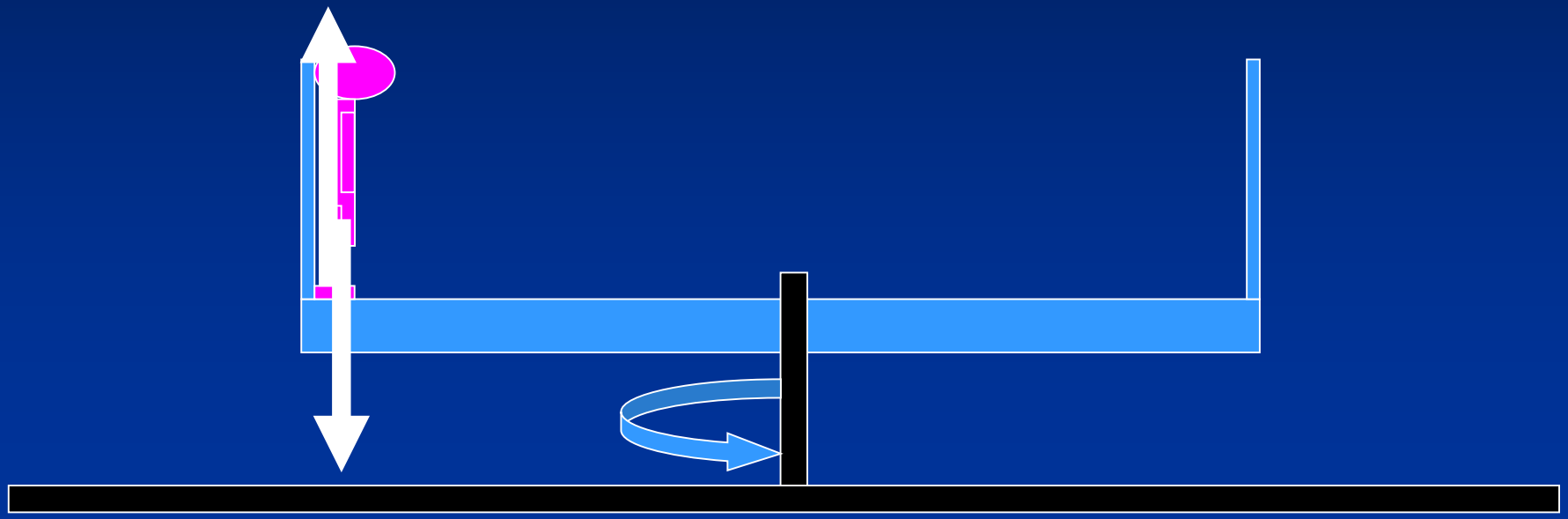
You are on a circular fairground ride, what forces are acting on you?



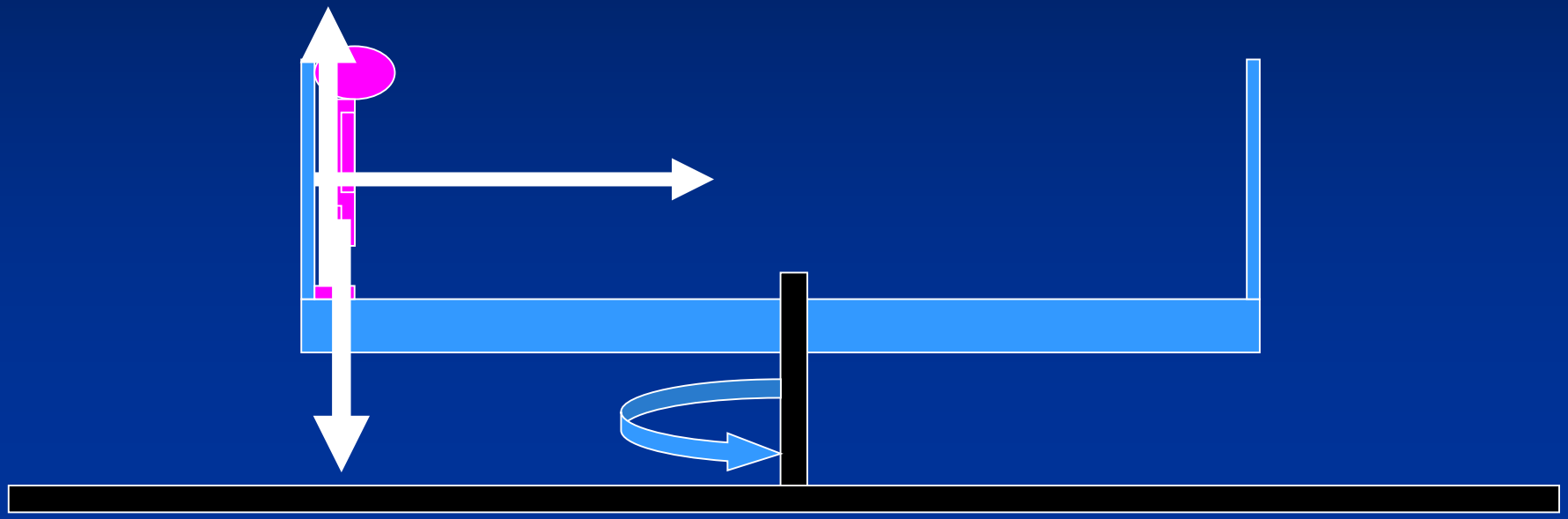
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You are on a circular fairground ride, what forces are acting on you?



You are on a circular fairground ride, what forces are acting on you?



1. Representation of a physical object or person (real or imagined) as a *particle* or *extended body*.
2. Identifying the interactions with other bodies, and representing the interactions as *interaction variables*. The basic interaction variable in mechanics is *force* (Hestenes, 1987).
3. Making assumptions so that the model can be simplified.
4. Applying the laws or principles of mechanics to the model.
5. Utilising the principles of pure mathematics to arrive at a result.
6. Comparing the result with reality.
7. Refining the model, if necessary, by including a previously omitted variable, and repeating the steps 4 to 7.