What is Physics?

What is physics about?

What is chemistry about? atoms and molecules

What is biology about? living things

What is geology about? Earth and its processes

So what is physics about?

the laws of nature, expressed in mathematical equations

We live in a scientific age.

Technology	Physics
Electric power	Faraday's law of induction
Car	Mechanics
Airplane	Aerodynamics
Radio	Maxwell's theory
Cable television	Transmission lines
Computer	Transistor electronics
Cell phone	Radio waves
Laser	Einstein's theory of S.E.
Microwave oven	Electromagnetic oscillations

Science creates technology.

The Laws of Nature

A remarkable fact about the physical world…

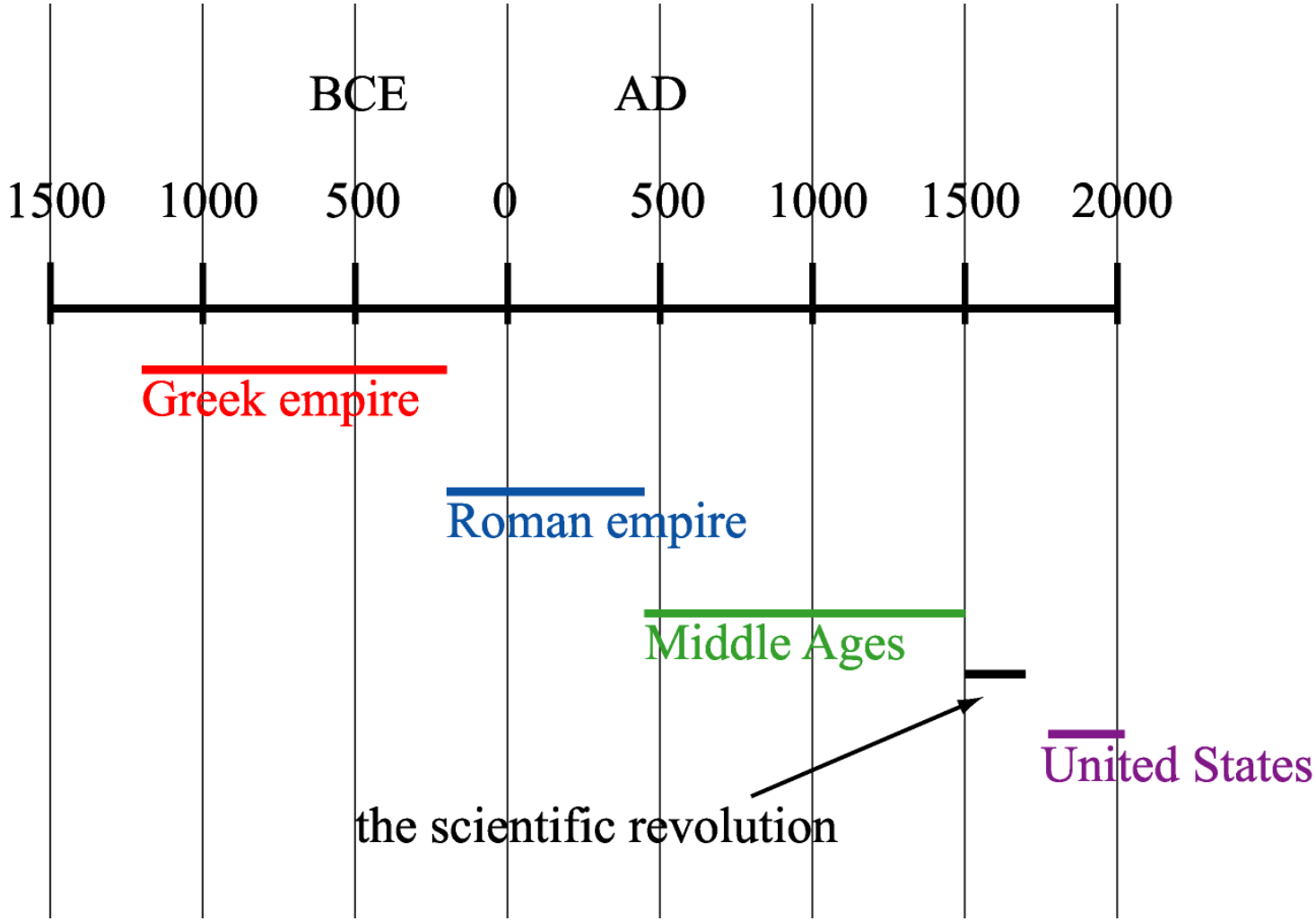
…the world looks complicated on the surface, but beneath the surface it is simple.

History

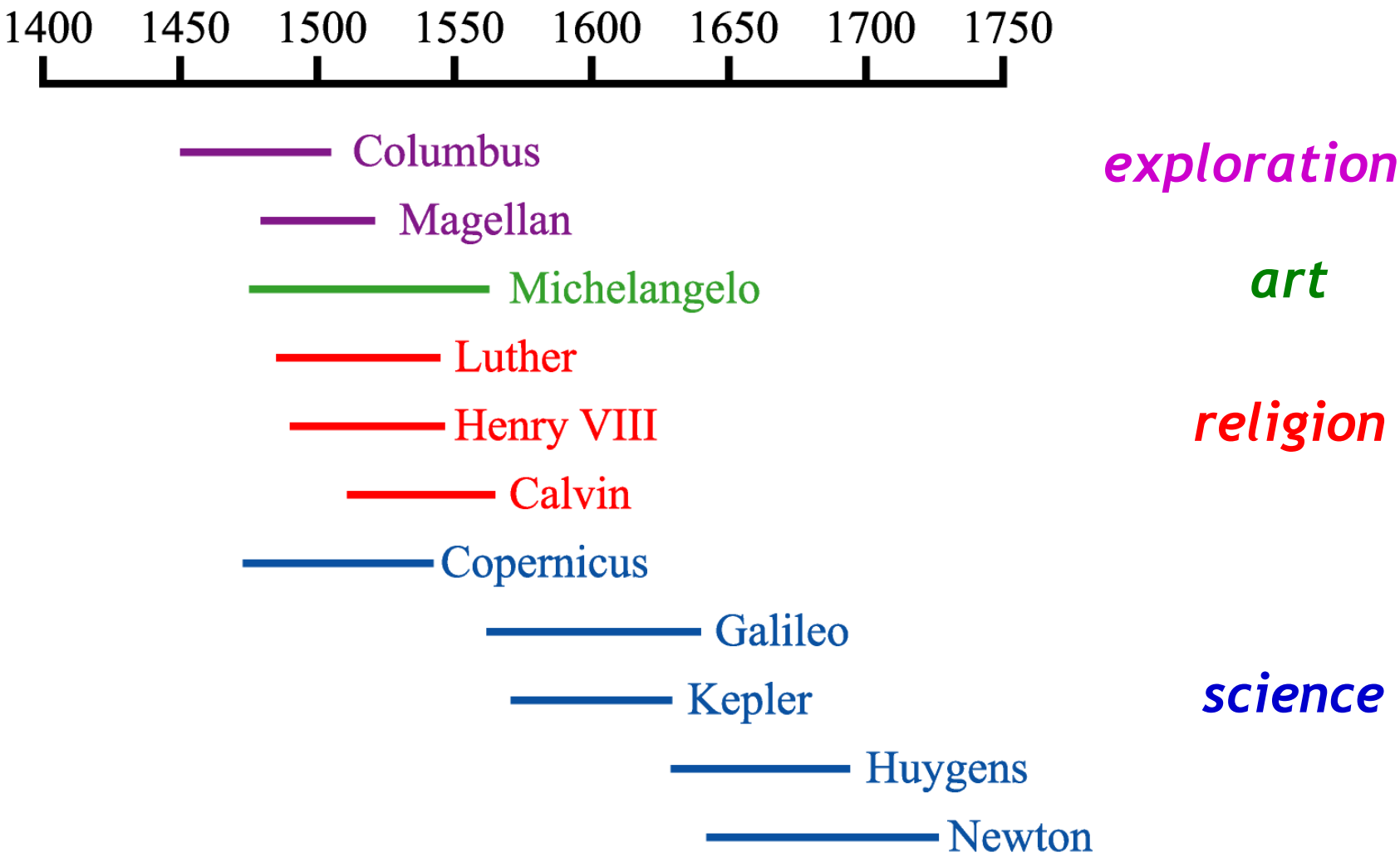
The *Scientific Revolution* had its beginnings in the 16th century, approximately 500 years ago.

It has made dramatic changes in the way people live, and the changes are continuing today.

Timeline of Western Civilization



The Renaissance, the Protestant Reformation and the Scientific Revolution



The Science of Motion

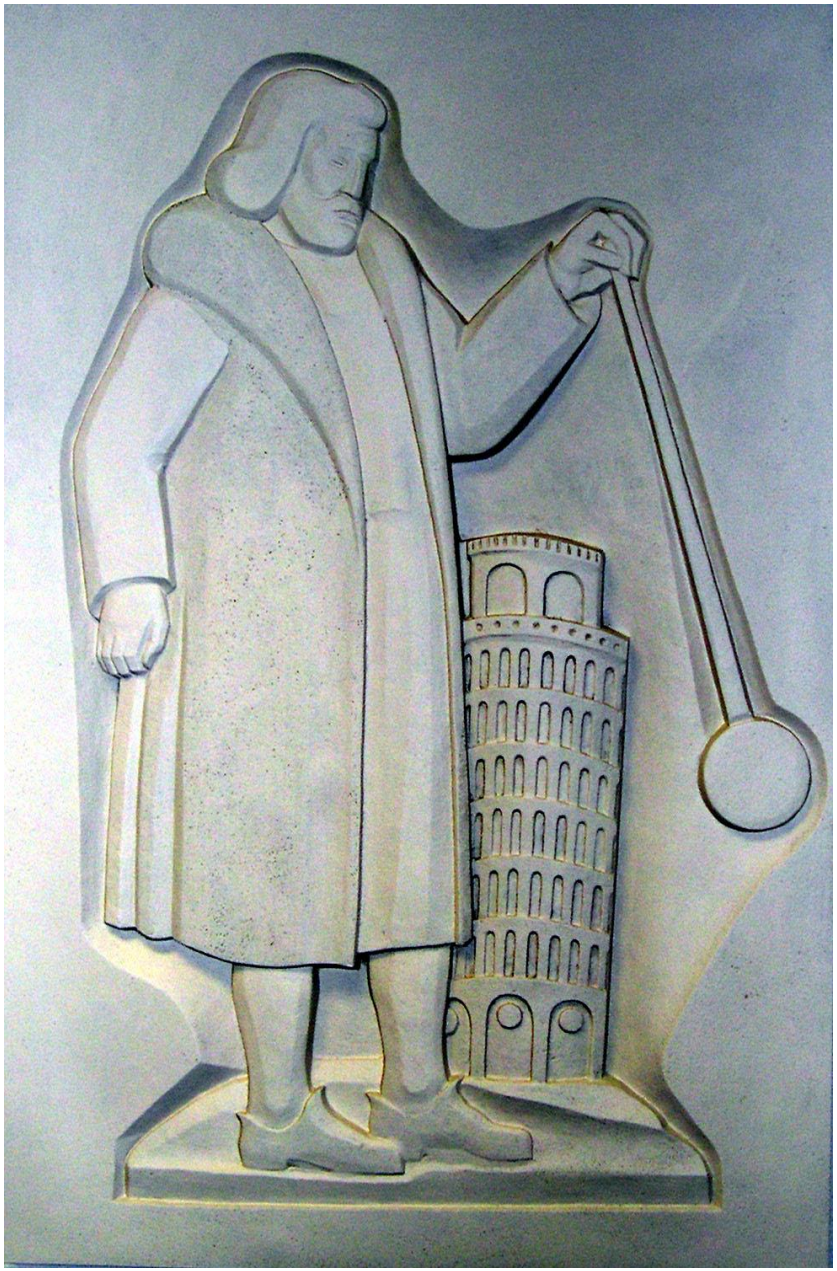
Aristotle – philosopher of ancient Greece (384 - 322 BC) He developed laws of motion based on philosophical assumptions and common sense. His theories were wrong, but they lasted for 1,900 years.

Galileo Galilei – professor of mathematics (1564-1642) He revolutionized both physics and astronomy, by theories based on observation and experimentation.

Isaac Newton – another mathematician (1643-1727) Developed mathematical equations to describe nature—the three laws of motion.

Have you seen this sculpture?

Relief sculpture at the front door of the old Physics-Astronomy Building , MSU



What keeps the Earth rotating at a constant rate?

There is no force, or torque, that acts on the Earth to maintain its rotation. It continues to rotate because of inertia. Inertia is not a force, but a property of matter in motion. Inertia is the resistance to a change in motion.

The Law of Inertia

A body at rest remains at rest if there is no net force acting on it. (seems obvious!)

A body in motion remains in motion, with constant velocity, if there is no net force acting on it. (not so obvious!)

The law of inertia was first stated by Galileo.

The law of inertia is Newton's first law of motion.

Aristotle's Physics

"The natural state of motion of a mass is to be at rest."

Aristotle taught that any object in motion will come to rest *because* the natural state of a mass is to be at rest (like the Earth). In other words, to keep an object moving you must exert a force on it.

Wrong!

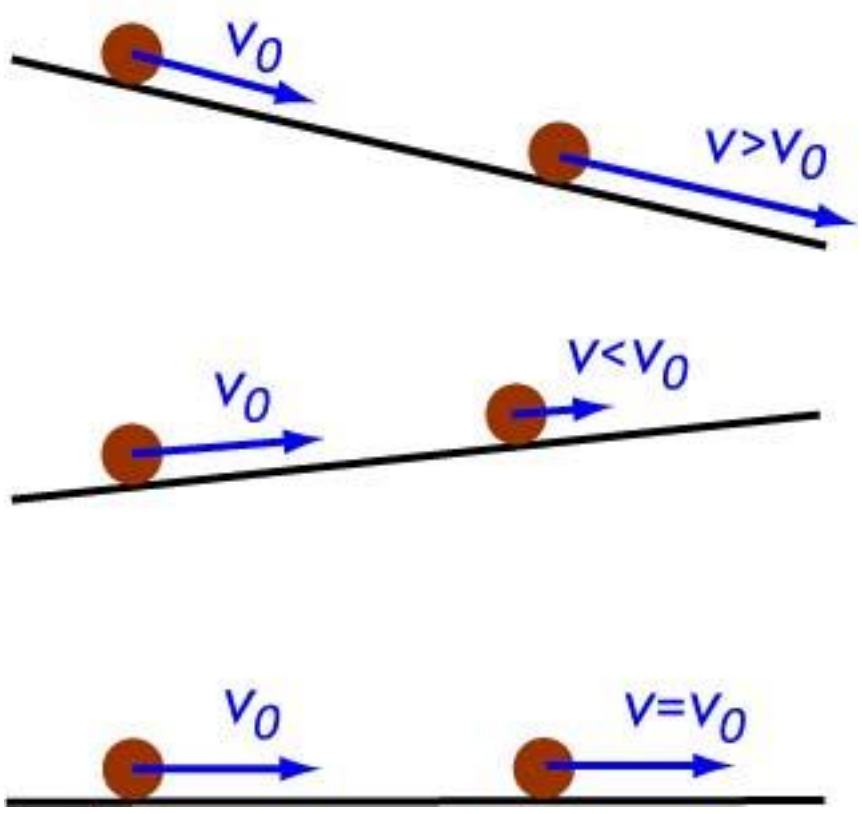
Aristotle's errors ---

- He held the *false premise* that the Earth is at rest.
- He overlooked the force of *friction*.
- He did not understand the concept of *inertia*.

How did Galileo demonstrate the law of inertia?

Science requires proof – i.e., experimental observations and accurate measurements.

Ball rolling on an incline



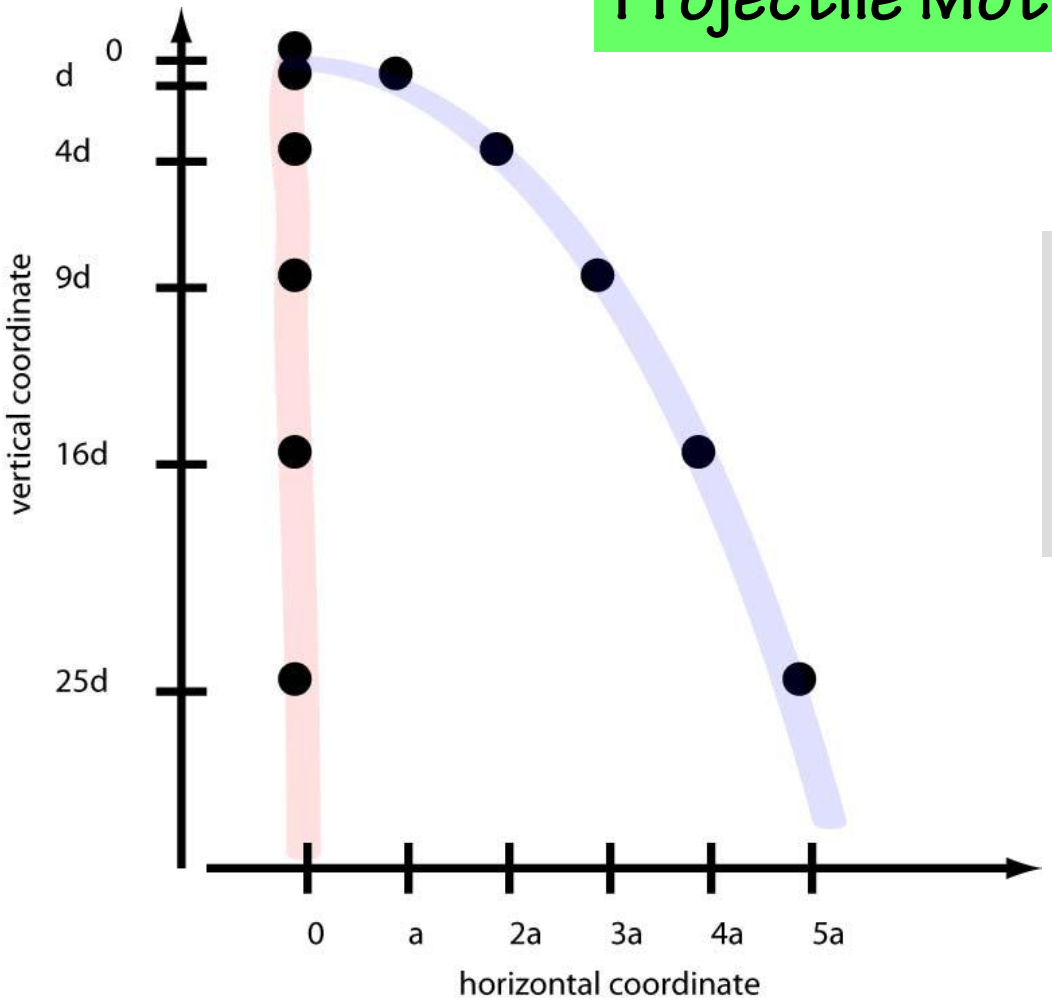
downward incline – ball speeds up

upward incline – ball slows down

zero incline – the speed is constant …

… law of inertia

Projectile Motion (Prof. Galilei)



- Equal time intervals
- Horizontal dist $\propto$ t
- Vertical dist $\propto t^2$
- The curve is a parabola.

The horizontal component of velocity is constant – *law of inertia*!!

Why does the Earth continue to rotate?

If the force on an object is zero, then the velocity of the object is constant.

What if the force is not zero?

Acceleration

If the velocity changes in time, then v(t) is a continuous function of time, going through all intermediate values between the initial and final velocities.

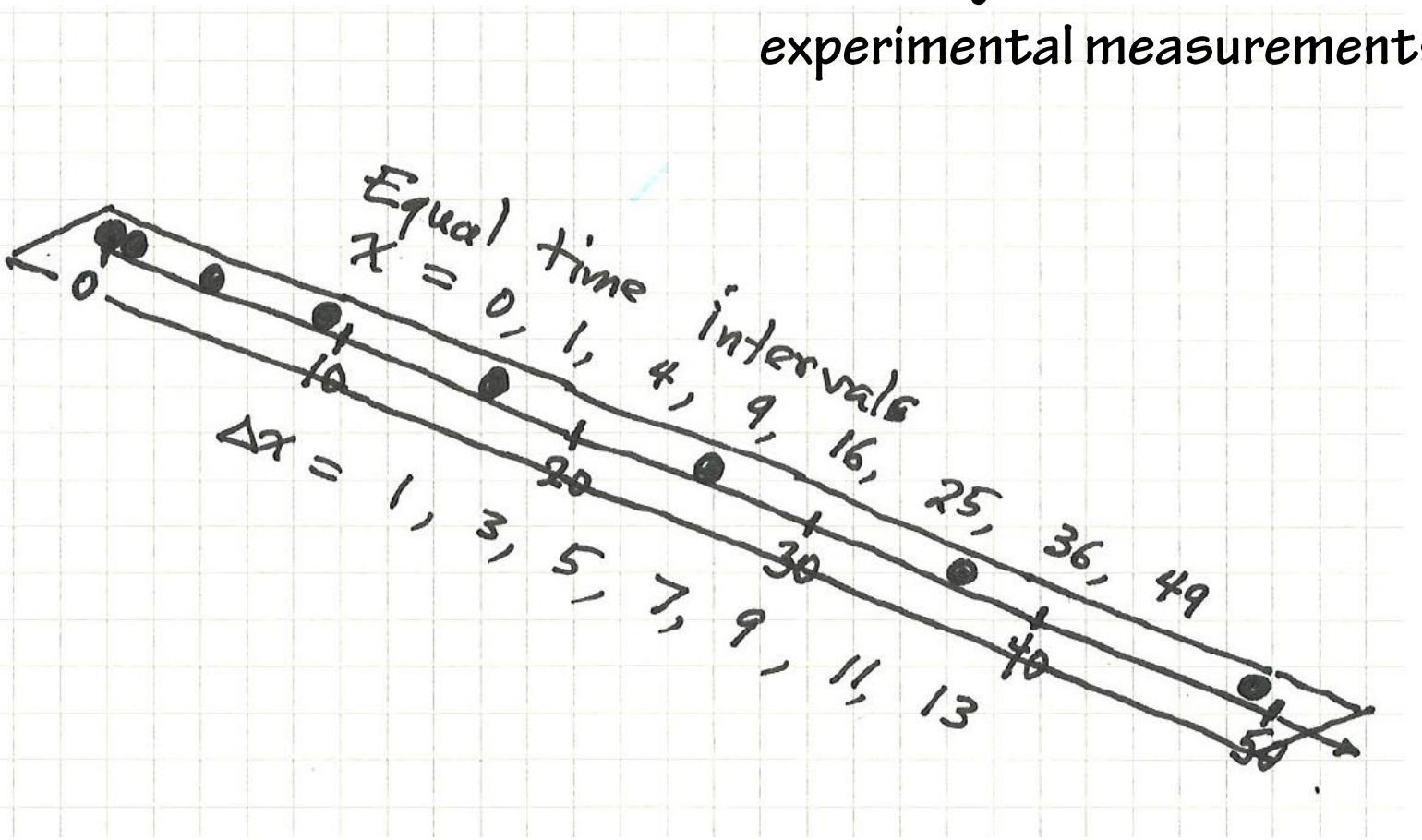
➔ Concept of instantaneous velocity, v(t).

In calculus, $$v(t) = \frac{dx}{dt} = \text{limit of } \frac{\Delta x}{\Delta t}$$

Then in calculus, $$a(t) = \frac{dv}{dt} = \text{limit of } \frac{\Delta v}{\Delta t}$$

Constant acceleration

The equations for constant acceleration were discovered by Galileo, by accurate experimental measurements.



Equations of constant acceleration

$$x(t) = x_0 + v_0 t + \tfrac{1}{2} a t^2$$

$$v(t) = v_0 + at$$

$$x - x_0 = (v^2 - v_0^2)/(2a)$$

} for constant a

An example is free fall in Earth's gravity,
neglecting air resistance

$a = g$ where $g = 9.81$ m/s^2 or 32 ft/s^2

Newton's second law

If a mass *m* moves under the action of a net force *F*, the acceleration is *a* = *F*/*m*.

Or,

$$F=ma$$

Homework Set A is due Sept. 5.

Go to msu.loncapa.org .
Log on with your MSU NetId.
Click on the PHY 101 connection.
If you have trouble…

Physics help room = Room 1248 BPS.