Phys 100 2024

Lecture 11

Fri: HW by 5pm

Notes:

Q5 - estimation problem

- look up speed of aircraft → convert to m/s
- estimate time to take off
- how does it compare to $9.8 m/s^2$

Q11 - Moving Man activity

- Can run on CMU Networked computers

Returned HW

* Grade annotations $3/3$ ← actual correctness
  $+2$ ← completeness
* Provide explanations + show work

Fri: * Read 4.3 → 4.4

* Group Exercise

Free fall motion

Consider an object near Earth's surface. It can be released, falling toward Earth. If the air resistance can be ignored, then the object is in free fall. Observations suggest that the object accelerates. We want to know

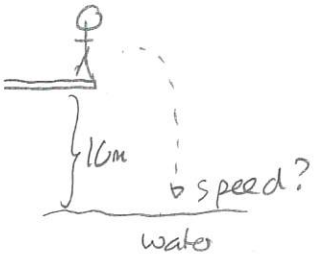
1) does the acceleration depend on mass?

2) does the acceleration depend on the state of motion?

3) is the acceleration constant as the object falls.

This will be useful because it can help answer questions such as:

1) how long will it take for an object to fall?
2) how fast will the object move just before hitting the ground?



Experiments show:

For free fall acceleration

1) is independent of the object or its state of motion.
2) is constant (near Earth's surface) with value

$$g = 9.80 m/s^2$$

Demo: Teralab video ~~Demo: Dropped washers.~~

Quiz 1

The acceleration due to gravity is what you feel when
* falling off a diving board
* in vertical amusement park rides.

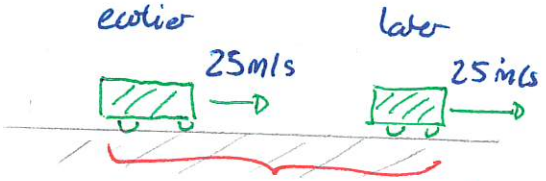
Newtonian Mechanics

The law of Inertia can be rephrased in terms of acceleration

> If there is no overall external influence on an object then its acceleration is zero.

In physics we describe external influences via forces:

> Force → describes interactions between objects
>
> → can be thought of as a push or pull



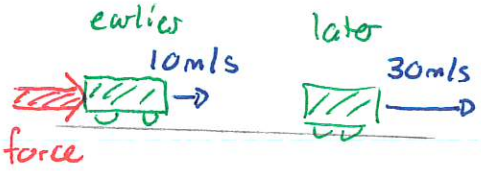
No ~~NET~~ external influence needed.

⇓

NO FORCE NEEDED

The law of Inertia shows that one does not need a force to sustain motion. This contradicts Aristotelian physics.

So we will consider situations where there are forces and there is acceleration



DEMO: PhET Forces and Motion → Force Graphs Tab

→ Ice

→ File Cabinet ~~100kg 25N~~ 50kg F=25N

→ Show velocity

We aim to answer

> Given particular forces acting on an object what will its acceleration (and maybe velocity?) be?

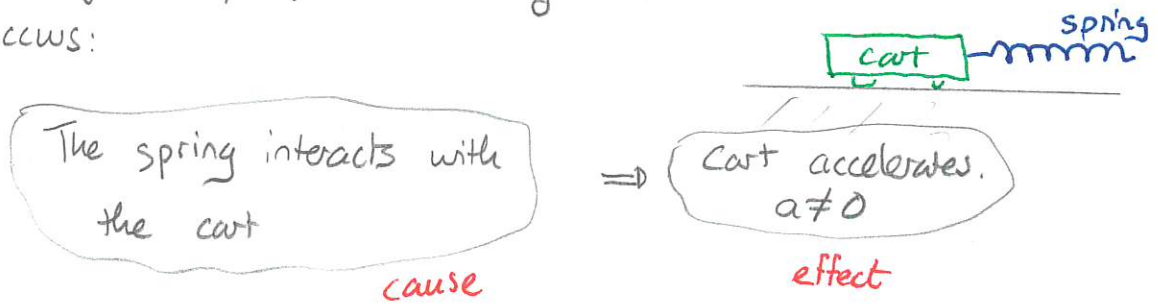
Why is this important? It covers all sorts of moving objects

* projectiles
* gravity → amusement park rides
* aircraft / flight
* gyroscopes — DEMO Bicycle wheel
* terminal velocity
* chaotic motion
* spinning balls - Veritasium Magnus force Video

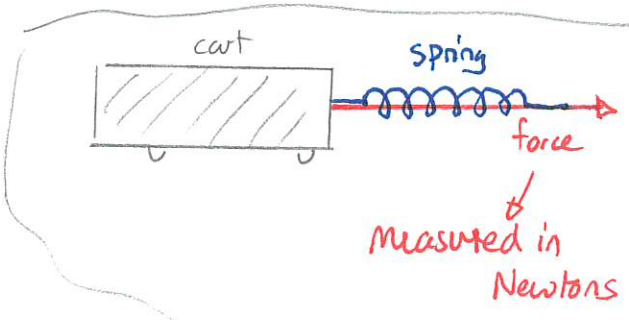
The system that we now use to understand this was developed by Isaac Newton (1642-1726) and is called Newtonian mechanics or classical mechanics

Forces

As a simple example, consider a cart that can slide horizontally and is pull by a spring. The following occurs:



We say that the spring exerts a force on the cart.



The force has
* a size measured in Newtons (N)
* a direction corresponding to the pull.

The example shows that:

> Forces acting on an object tend to produce acceleration of the object

We can rephrase the Law of Inertia: (in a special case)

> If no forces act on an object then the object's acceleration is zero

⇒ Velocity of object is constant (may be non-zero)

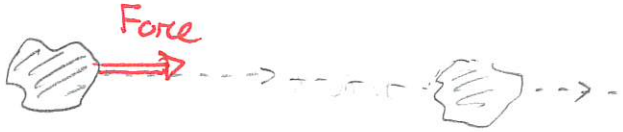
Quiz 2 80%

Quiz 3

Forces and acceleration

We can ask what the effects of force on motion are. Consider a simple case:

* object moves right
* force points right



By observing the velocities we would eventually learn that:

$$\text{acceleration} = \frac{\text{Force}}{\text{mass of object}}$$

Force → in Newtons (N)

acceleration → in m/s^2

mass of object → in kg

This is an example of Newton's Second Law. To consider this completely we need to consider situations where → acceleration can be negative
→ multiple forces act on object