Phys 100 2023

Lecture 12

Mon: Read 4.2-4.4 **Weds: Group Exercise**

Today: * Free fall motion
* Forces.

Free fall motion

When an object moves in one direction, the acceleration is defined via

$$\text{acceleration} = \frac{\text{change in speed}}{\text{time elapsed}}$$

We can now look at situations where an object accelerates. One situation is free fall.

> Free fall ~ motion where the only external influence is Earth's gravity.

For such motion we might want to know:

1) how long it takes for the object to drop
2) speed just before reaching Earth, ...

These questions can be answered if we know how the object accelerates as it falls. We ask:

1) does acceleration depend on the object's mass?
2) does acceleration depend on the distance dropped?
3) does acceleration depend on the object's speed?

⋮

We have to answer these questions using experiments.

DEMO: Guinea / feather

DEMO: Teralab guinea feather.

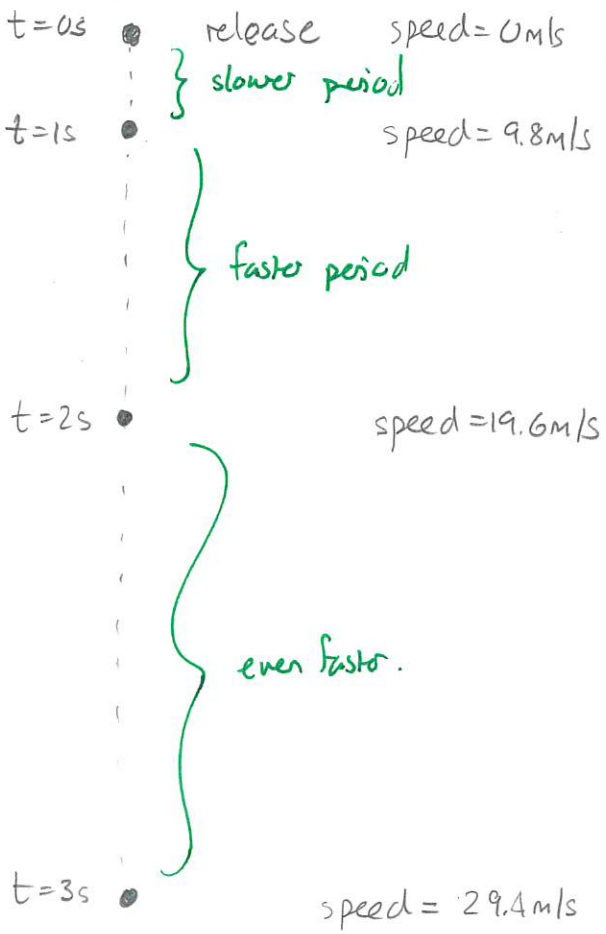
Experiments show that for free fall

1) acceleration does not depend on mass
2) acceleration does not depend on speed, height, time of fall
3) acceleration is constant with value

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

Quiz) 40%

The actual distance is complicated since the falling object is constantly speeding up. A detailed analysis gives:



> Consider an object released from rest. Suppose that the object travels with constant acceleration. Then
>
> Distance traveled since release
> $= \frac{1}{2} \times (\text{acceleration}) \times (\text{time})^2$

Demo: Dropped washers.

The situation is different when air resistance is present

Quiz 2 (not done)

Newtonian mechanics

The Law of Inertia refers to situations where the velocity of an object is constant. In these cases no outside influence or interaction is required to sustain the motion. We describe outside influences or interactions in terms of forces

> Force ~ describes interactions between objects
> ~ can be regarded as push/pull

Then the Law of Inertia states that no force is required to keep an object moving at constant velocity.

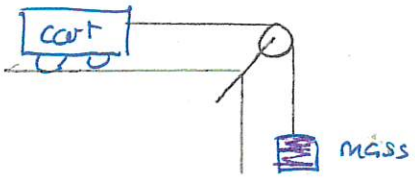
This contradicts Aristotelean physics which does require such a force in many cases. We therefore need a new system of physics. The system currently in use was originally developed by Isaac Newton (1642-1726) and is called Newtonian mechanics or classic mechanics. The system ultimately explains a large range of phenomena such as:

1) projectiles
2) orbiting planets
3) tumbling boxes.
4) terminal velocity
5) gravity
6) aircraft flight.
7) cheerios in water.

Forces:

Consider a cart that is pulled by a string attached to a suspended mass. If the cart is released from rest then we observe that it accelerates.

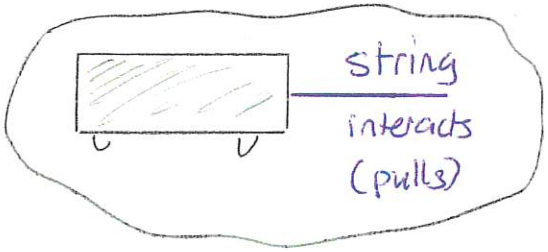
Demo →



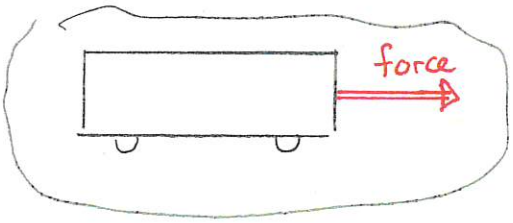
It appears that we have

String interacts with (pulls on) cart → Causes → Cart accelerates $a \neq 0$

We describe the interaction between the string and the cart as a force



same as



It then follows that

The string exerts a (non-zero) force ⇒ Causes ⇒ acceleration of the cart is non-zero

This is an example of a key idea in Newtonian physics

> Forces on an object tend to produce acceleration of that object.
>
> An object can only have non-zero acceleration if one or more forces act on the object.

Thus

> If no forces act on an object then the object's acceleration is zero. So its velocity remains constant

Quiz 3

Quiz 4