Tues: Warm Up 5 (D2L)

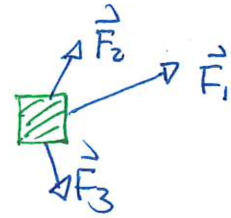
Thurs: Review

Fri: Exam I Covers Lectures 1→11
HW 1→4.

Newton's First Law

When multiple forces act on an object then

> The net force on a object is
> $\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \dots$



Then Newton's First Law states:

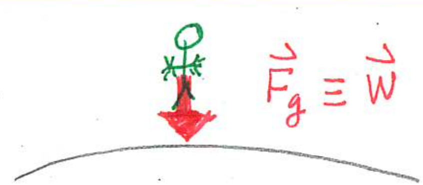
> The net force on an object is zero ⟺ acceleration is zero

Examples of forces

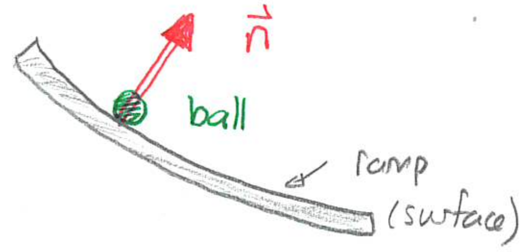
For objects in the vicinity of Earth's surface, the following are common forces:

1) gravity (weight) ~ force exerted by (the bulk) of Earth on an object

~ directed toward center of Earth



2) normal force - exerted by the surface of one object on another
- perpendicular to surface



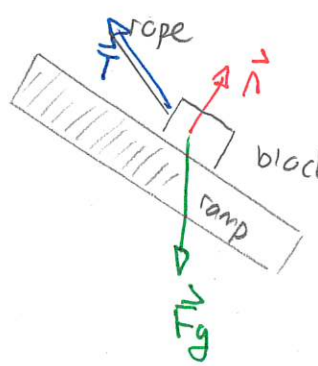
3) tension - force exerted by a rope, cable, wire
- along direction of rope pull

Free body diagrams

In any situation we need to account for all the forces acting on an object of interest. The strategy for managing this is to represent the forces on a free body diagram (FBD):

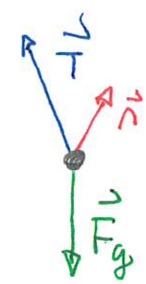
* a dot represents the object
* one vector for each force - tail of vector on dot.

For example consider a block lowered down a frictionless ramp



Actual

⇝

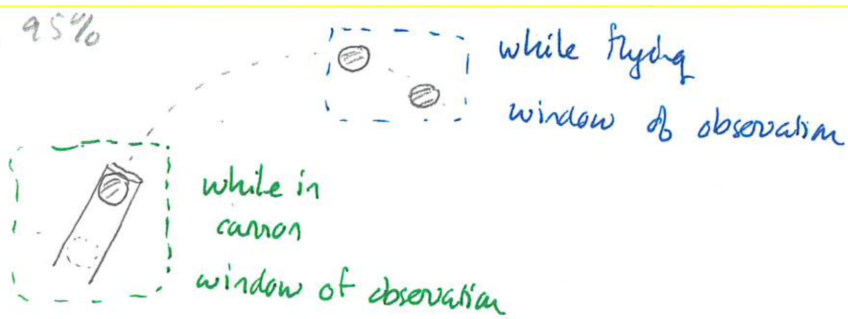


FBD

} Lists all forces under consideration (crucial)

Quiz1 80% – 95% } 95%

Quiz2 100% } 95%



Quiz 3 90% – 95%
90% –

Quiz 4 30% – 80%
30% – 60%

Dynamical effects of forces

When the net force on an object is non-zero then Newton's First Law implies that its acceleration is non-zero. Can we predict the acceleration? This requires:

1) a method for quantifying forces and describing magnitudes of forces
2) a method for relating non-zero net force and acceleration.

The scheme is:

> Select a special object that produces standard forces and can be duplicated.

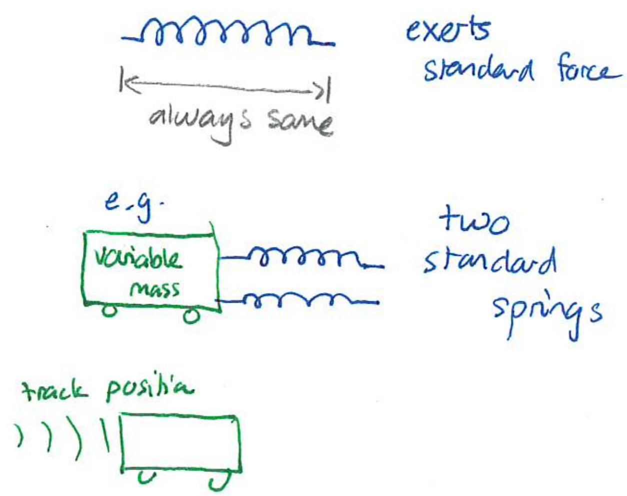
↓

> Apply various numbers of these to objects with variable masses

↓

> Observe motion of objects.

standard spring stretched to standard length

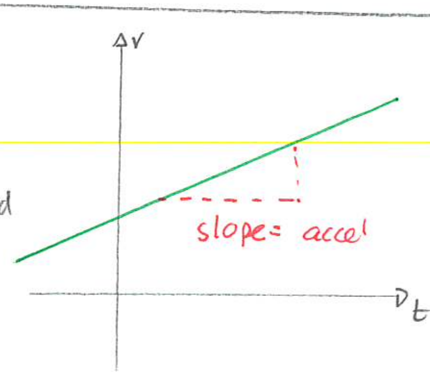


Demo: Cart /springs

Observations indicate

In the absence of all other interactions
1) graph of v vs t ≡ straight line.
2) the acceleration in any single situation is constant and
   a) is inversely proportional to mass of object
   b) directly proportional to force on object

$$\Rightarrow \quad a = \text{const} \times F/m$$



Quiz 5 70% - 90% ≷ 80% - 95%

The proportionality constant is fixed by setting the force units.

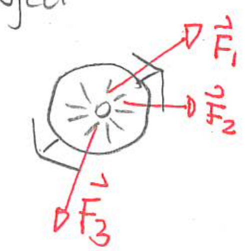
> A force of one Newton (N) in the absence of any other forces causes an object with mass 1.0kg to accelerate with acceleration $1.0 m/s^2$

It then becomes exactly true that $F = ma$.

Newton's Second Law.

When multiple forces act on an object the acceleration is predicted via Newton's Second Law:

1) Consider an object of interest. Let m be the mass of the object



2) List (FBD) all forces acting on the object of interest. Then the net force is

$$\vec{F}_{net} = \sum \vec{F}_1 + \vec{F}_2 + \dots = \sum \vec{F}_i$$

ADD VECTORS

3) the acceleration of the object is given by

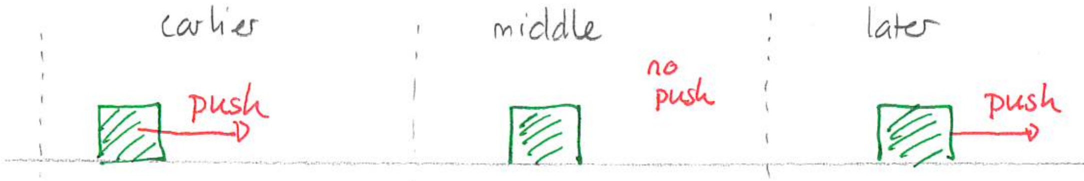
$$\vec{F}_{net} = m\vec{a}$$

Note:

Forces are related to changes in velocity (acceleration)

Forces are not immediately connected to velocity.

Note that a force is not needed to sustain motion.

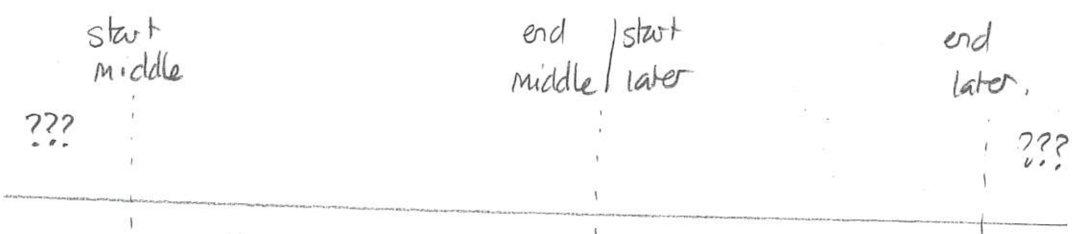


	earlier	middle	later
Velocity	increases	constant $\neq 0$	Increases
force	not zero	zero	not zero

Demo: PhET Forces and Motion (Original)

- Force Graphs TAB
- Settings: – No friction
  – ~~Sleeping dog~~ File cabinet
- Display – Force, Velocity

We might only view the middle and later segments. We would see.



UNKNOWN

$F = 0$

$v =$

Why this value of v?

– cannot say

$F \neq 0$

v increases

Can say how much

v increases

UNKNOWN.

Again there is no direct correlation between velocity and force.