Lecture 14

Weds: Exam Review

Fri: Exam I Covers Ch 1→4

Lectures 1→11

HW 1→4

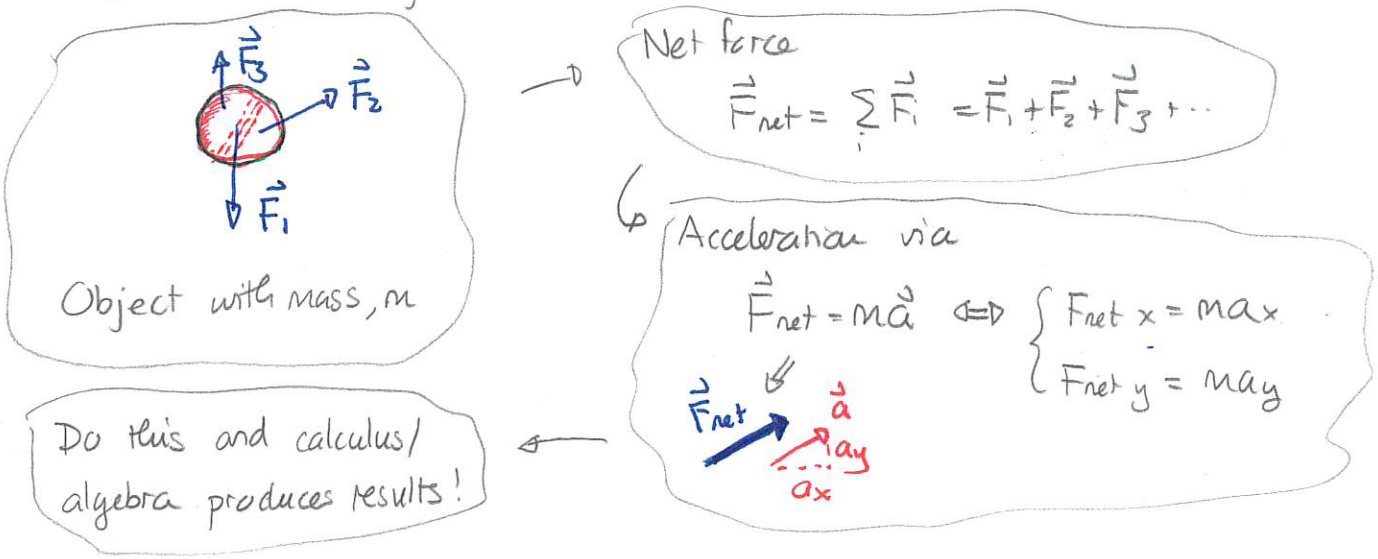
Discussion 1→4

Review 2022 Ex 1 all Q

2023 Ex 1 all Q

Newton's Second Law

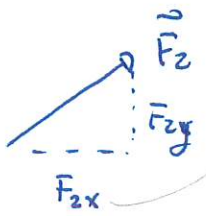
Newton's second law is the cornerstone of classical physics. It describes how interactions affect an object's motion.



Note:

1) the direction of the acceleration is the same as the direction of net force

2) In terms of components



$$F_{1x} + F_{2x} + \cdots = ma_x \qquad \Rightarrow \qquad \sum F_{ix} = ma_x$$

$$F_{1y} + F_{2y} + \cdots = ma_y \qquad \sum F_{iy} = ma_y$$

These act as a set of mathematical instructions:

* list all forces
* get values/expressions for x, y components of each force
* insert into $\Sigma F_{ix} = ma_x$

  $\Sigma F_{iy} = ma_y$
* insert any available information about acceleration.
* do remaining mathematics.

Quiz 1 70% – 95% & 80% – 95%

Quiz 2 20% – 90% & 70% – 90%

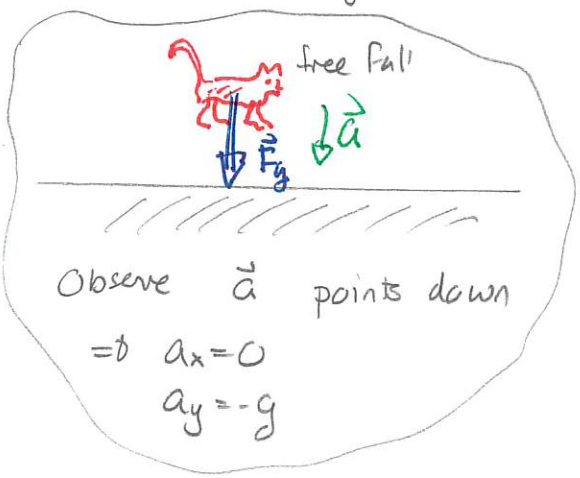
Quiz 3 90% & 90%

DEMO:  scale + suspended ...

We now consider rules for determining individual forces

Gravitational force

Earth exerts a gravitational force on any object. Near Earth's surface



Newton's Second Law

$\Sigma F_x = ma_x \Rightarrow F_{gx} = 0$

$\Sigma F_y = ma_y \Rightarrow F_{gy} = ma_y = -mg$

Thus

Earth always exerts a gravitational force on any object with mass. For an object with mass m:

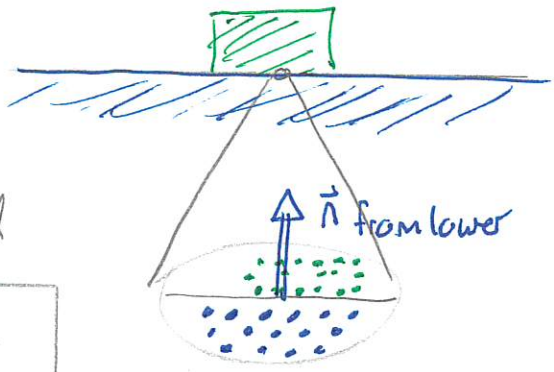
1) $\vec{F}_g$ is vertically down
2) $\vec{F}_g$ has magnitude $F_g = mg$

Note:

1) "F_g" is not "g"
2) the gravitational force is always active and cannot be turned off
3) the gravitational force only depends on the object's mass and not its state of motion.
4) sometimes the gravitational force is called weight $\vec{W}$.

Normal force

Normal forces result from interactions between microscope constituents in surfaces of objects. They depend on the situation. In general



> When two objects are in contact each exerts a normal force on the other. The normal force exerted by an object is:
> 1) perpendicular to the object's surface
> 2) has a magnitude that adjusts according to the circumstances

Quiz 4 40%-50% & 60%-90%

Quiz 5 80%-80% & 75%-90%

143 Lowering a bunch of bananas

A bunch of bananas has mass 40 kg. Starting from rest, they are lowered from a ship by a rope through a distance of 12.0 m. The rope pulls vertically upward with tension 305 N and there is an upward air resistance force of 60 N. Determine the time taken to lower the bananas. *(131F2024)*

Answer: The strategy is:

Use forces to get acceleration → Use kinematics to find time

Forces:

$\sum F_{ix} = ma_x \Rightarrow 0 = ma_x \Rightarrow a_x = 0$

$\sum F_{iy} = ma_y \Rightarrow T + F_{air} - F_g = ma_y$

$\Rightarrow T + F_{air} - mg = ma_y$

$\Rightarrow 305N + 60N - 40kg \times 9.8m/s^2 = 40kg\, a_y$

$\Rightarrow -27\,N = 40kg\, a_y$

$\Rightarrow a_y = \frac{-27N}{40kg} \Rightarrow a = -0.675\,m/s^2$

Kinematics

	$t_f = ?$	
initial ②	$y_i = 12.0N$	$y_f = 0.0M$
	$V_{iy} = 0M/s$	$V_{yf} = ?$
final	$a_y = -0.675m/s^2$	

$y_f = y_i + v_{iy}\Delta t + \frac{1}{2}a_y \Delta t^2$

$\Rightarrow 0.0m = 12.0m + 0m/s\,\Delta t + \frac{1}{2}(-0.675m/s^2)\Delta t^2$

$\Rightarrow -12.0m = -0.3375m/s^2\,\Delta t^2$

$\Rightarrow \Delta t^2 = \frac{12.0m}{0.3375m/s^2} = 36s^2$

$\Rightarrow \Delta t = 6.0s$