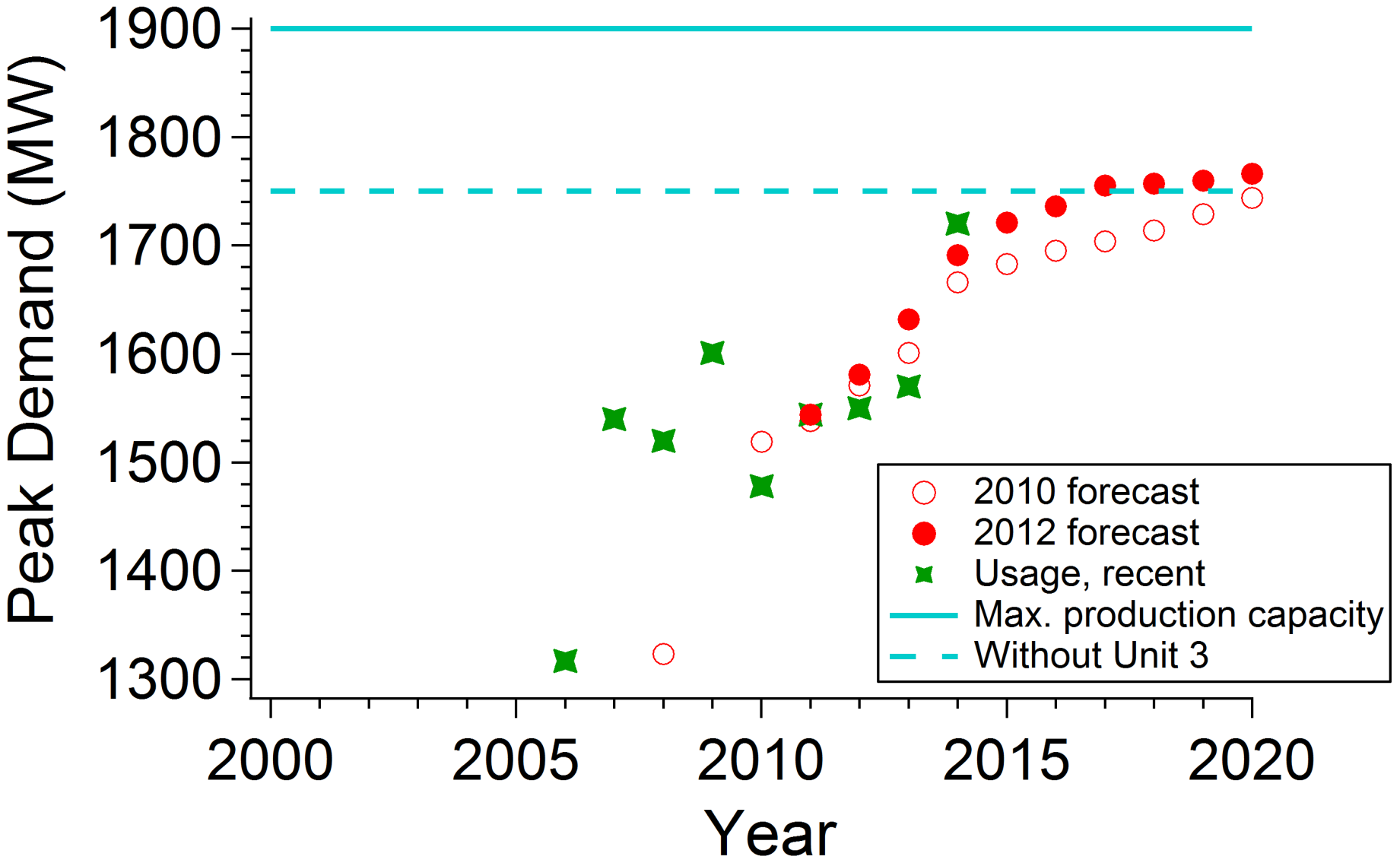
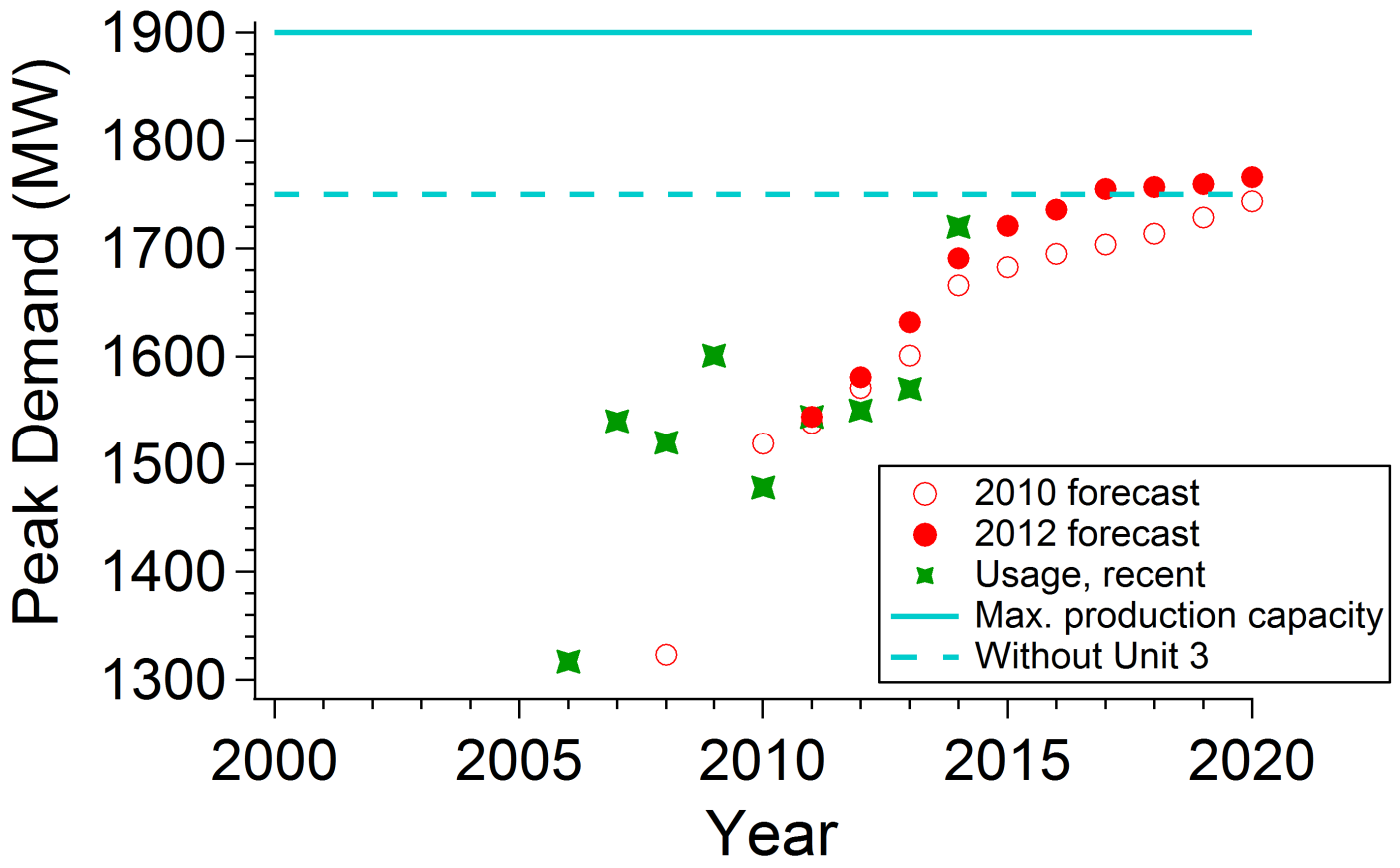
Identify this.

The ***(Holyrood)*** plant was constructed in two stages. In 1969, Stage I, consisting of two generating units (Units 1 and 2) each capable of producing 150 MW, was started and placed in service in April 1971. In December 1979, Stage II, consisting of one generating unit (Unit 3) capable of producing 150 MW, was completed.

Peak Demand (Megawatts)

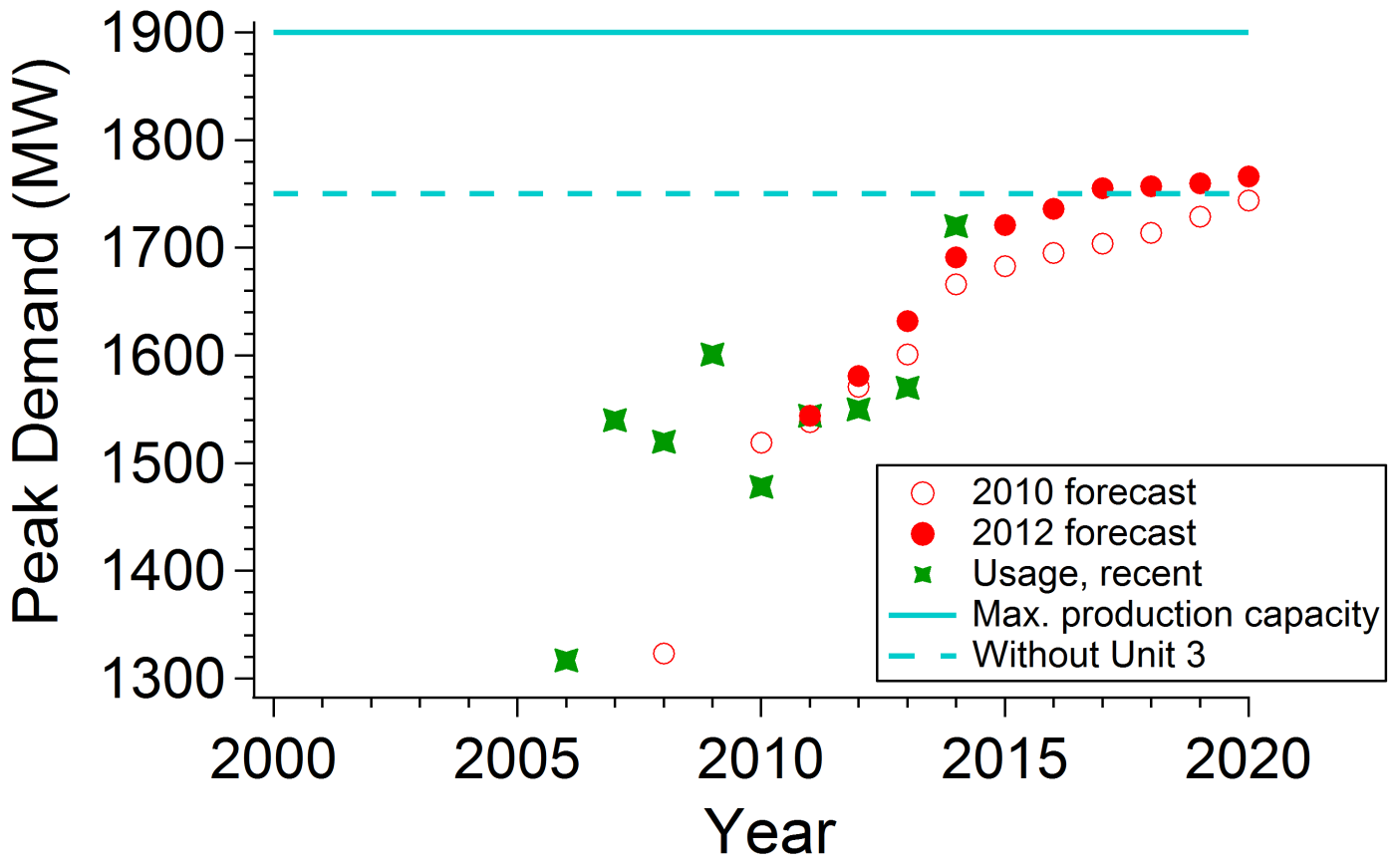


Peak Demand (Megawatts)



When demand reaches or exceeds maximum supply capacity, one expects what we experienced (and the power utility is likely not that surprised either).

Peak Demand (Megawatts)



Electricity production has a very important practical impact on our lives.

Electricity and magnetism in natural phenomena

Lightning is electricity, the northern lights are caused by charged particles and the earth's magnetic field.

Photos courtesy of nasa.gov

Electricity and Magnetism

In this course we will delve deeper into the practical manifestations of electricity and magnetism, which have a huge impact on our lives.

Electricity

Module 01

- Overview: Electric flux and Gauss' law
- Electric potential energy and electric potential
- Conductors and capacitance
- Electric current
- Direct current circuits
- Kirchhoff's rules
- RC circuits

Electromagnetism

Module 02

- Overview: Ampere's law, Biot-Savart law, Faraday's law
- Inductors and RL circuits
- LC and RLC circuits
- Alternating current circuits
- Resonance and Q factor
- Electromagnetic waves

Electricity and Magnetism

Evaluation

- Assignments (around 5): 15%
- Quizzes (around 5): 10%
- Term test: 20%
- Lab: 20%
- Final exam: 35%

Evaluation Philosophy

- Assignments will test problem-solving ability.
- Quizzes (1 or 2 questions, 10-15 minutes in length) will test conceptual grasp.
- Term test & final exams test both of the above.
- Laboratory should relate concepts to reality.

We have made an attempt to make the lab a bit more in sync. with the in-class material: suggestions welcome.

Course Philosophy

The hope is that this course will bridge the gap between physics fundamentals (the “laws” of electromagnetism) and the practical aspects of electricity and magnetism.

Coulomb's law

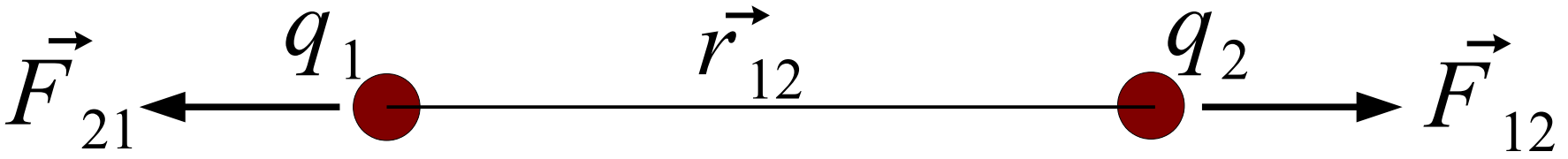
Force between two point charges:

$$\vec{F}_{12} = k \frac{q_1 q_2}{r_{12}^2}$$

r_{12} : distance between the two charges.

$k = \dfrac{1}{4\pi\epsilon_0}$: electrostatic constant

Coulomb's law

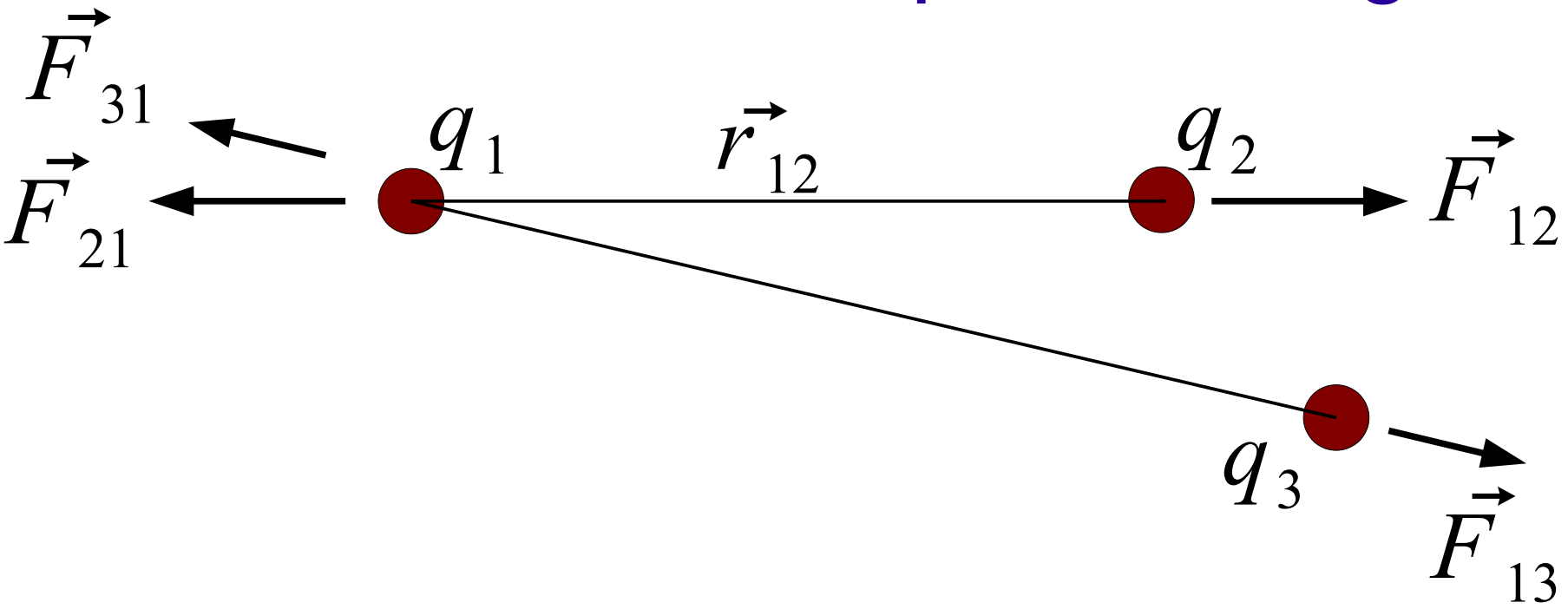


Force between two point charges:

$$\vec{F}_{12} = k\frac{q_1 q_2}{r_{12}^2} = k\frac{q_1 q_2}{r_{21}^2} = \vec{F}_{21}$$

- The magnitude of the force on charge 1 and charge 2 are the same.
- The direction of these forces oppose each other.

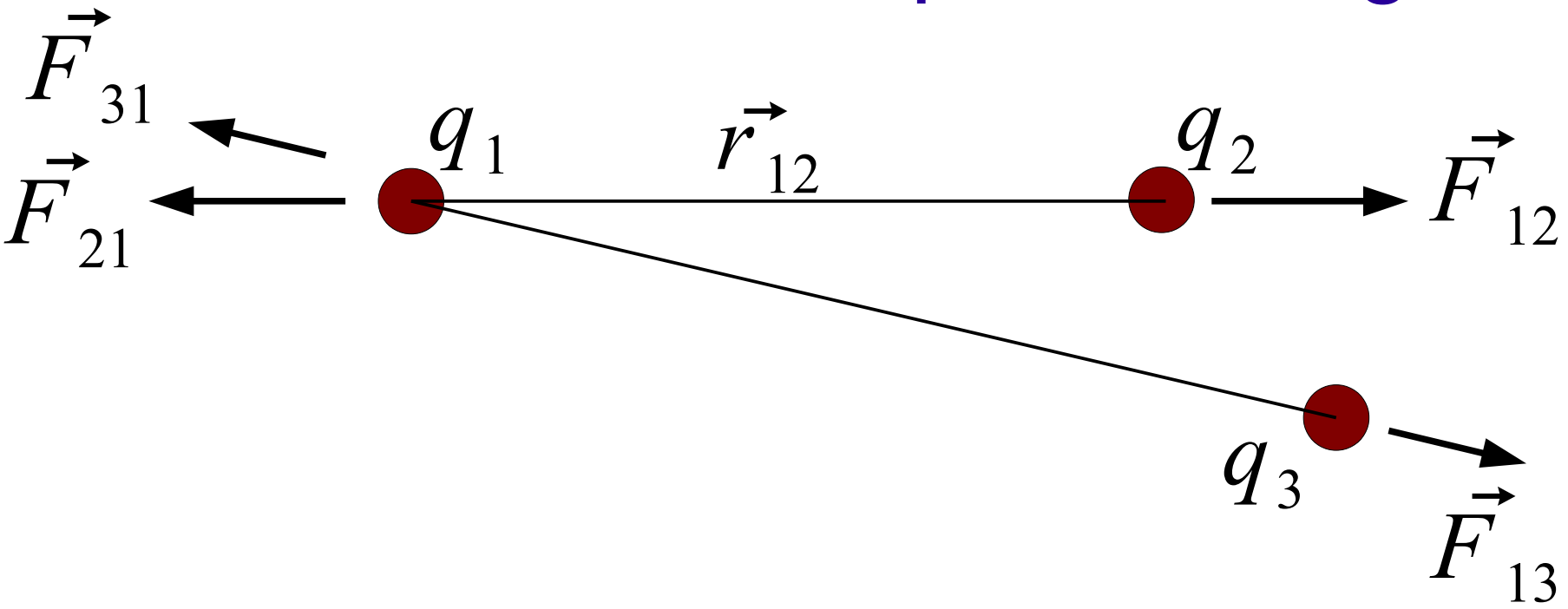
Coulomb's law example: 3 charges



The total force on charge 1 is simply the vector sum of the force due to ALL other charges:

$$\vec{F}_1 = \vec{F}_{21} + \vec{F}_{31}$$

Coulomb's law example: 3 charges



The total force on charge 1 is simply the vector sum of the force due to ALL other charges:

$$\vec{F}_1 = \vec{F}_{21} + \vec{F}_{31}$$

The superposition principle

This principle is crucially important in electrostatics. It says that all forces are a vector pairwise sum of “two-body” forces.

Coulomb's law

Force between two point charges:

$$\vec{F} = k\frac{Q\,q}{r^2}$$

: distance between the two charges.

: electrostatic constant

Electric Field

Doubling *q* doubles the force.

$$\vec{F} = k\frac{Q\,q}{r^2}$$

There is a quantity that stays constant:

$$\vec{E} = \frac{\vec{F}}{q} = k\frac{Q}{r^2}$$

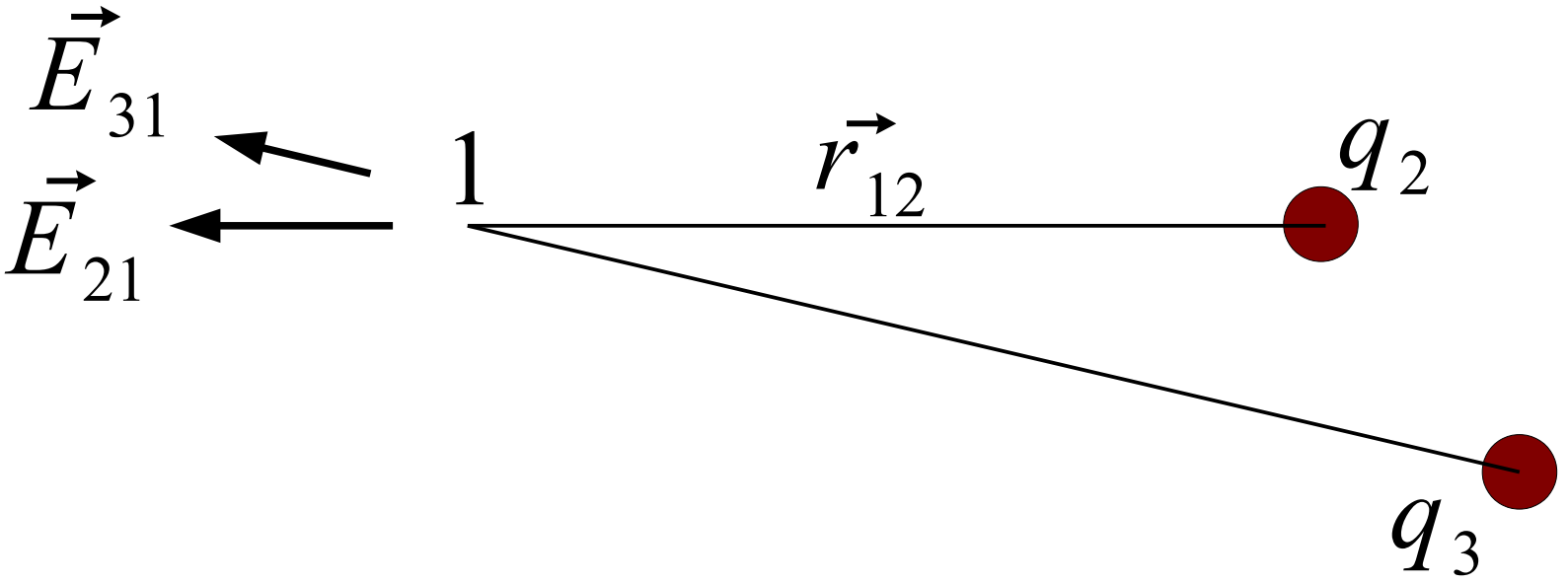
Electric Field

The electric “field” is a vector field. This field tells you the force experienced at any given point in space by a “unit” charge.

$$\vec{E} = \frac{\vec{F}}{q} = k\frac{Q}{r^2}$$

Then for a charge of magnitude q: $\vec{F} = q\,\vec{E}$

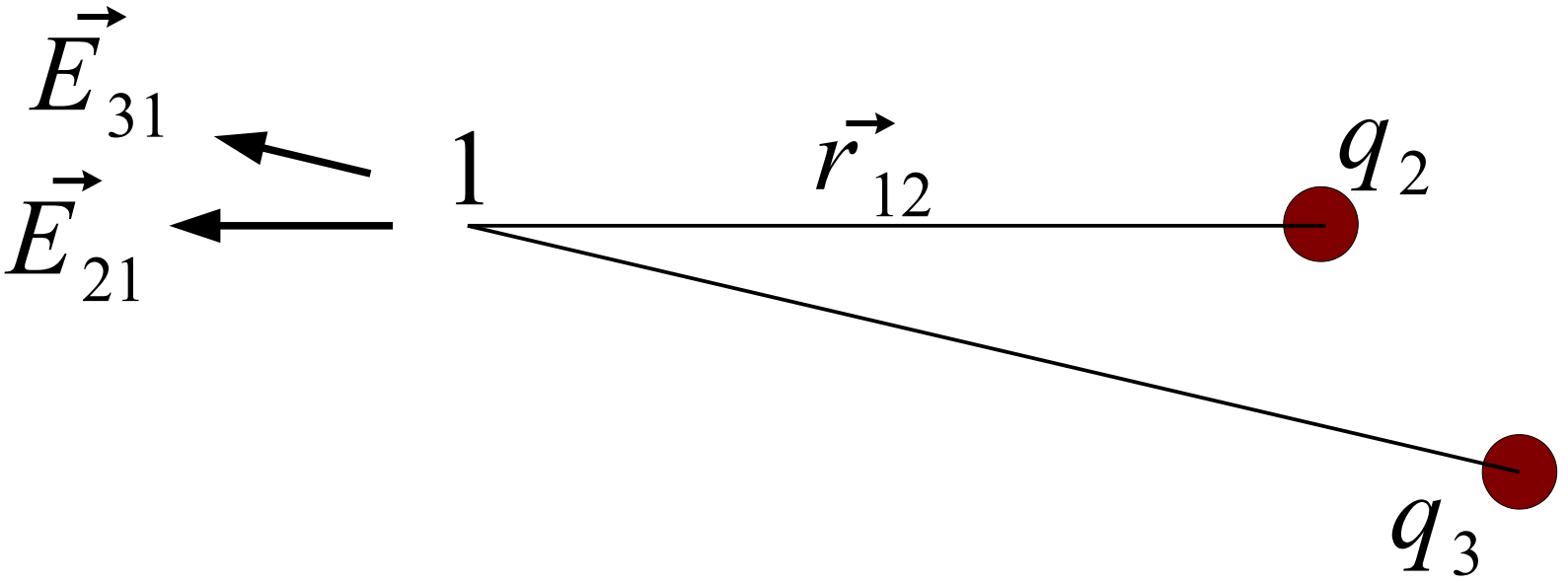
Electric field



Consider charge 1 as the test charge. The total *electric field at point* 1 is simply the vector sum of the *electric field* due to ALL other charges:

$$\vec{E}_1 = \vec{E}_{21} + \vec{E}_{31}$$

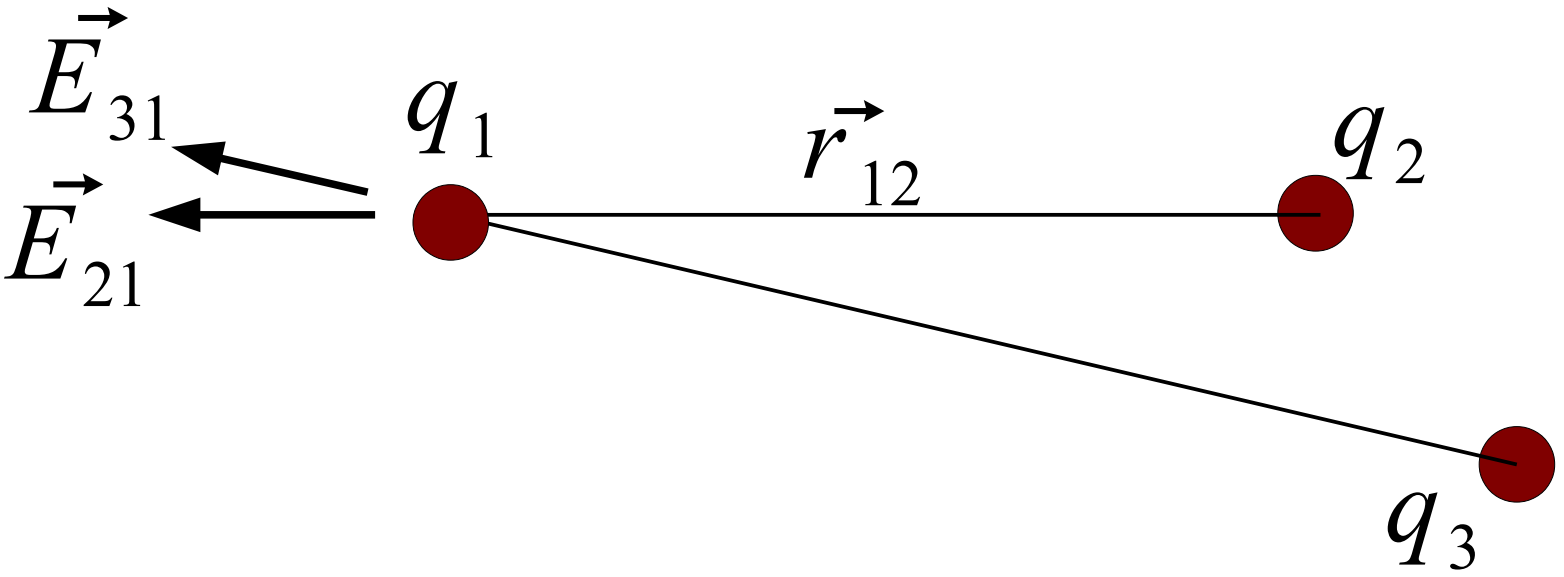
Electric field



Consider charge 1 as the test charge. The total *electric field at point* 1 is simply the vector sum of the *electric field* due to ALL other charges:

$$\vec{E}_1 = \vec{E}_{21} + \vec{E}_{31}$$

No self force!



The electric field caused by a charge cannot act on itself (if it did that force would be infinite).

Next class

- Lets stop here.
- Review *Electric Flux and Gauss' law* for the next class, and come prepared to answer conceptual questions from the back of the chapter.