Last time

- Non-steady state cases (time dependent processes)
- Charging a capacitor
- Time constant of a capacitor
- Discharging a capacitor

This time

- Electric current (time dependent processes)
- Activity #8

Current

A time dependent phenomenon

Loosely speaking, moving charges

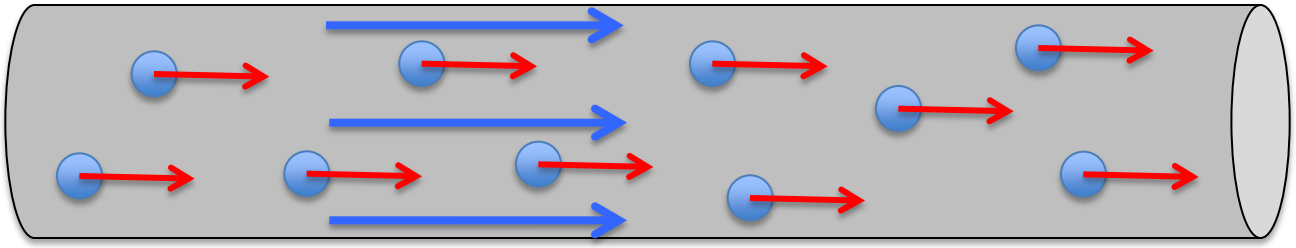
More precisely, the ordered flow of charges is called the electric current.

Currents carry energy and much of energy we consume is delivered by electricity, toaster, computer, refrigerator, TV, and many more electrical devices.

This is done using conducting wires.

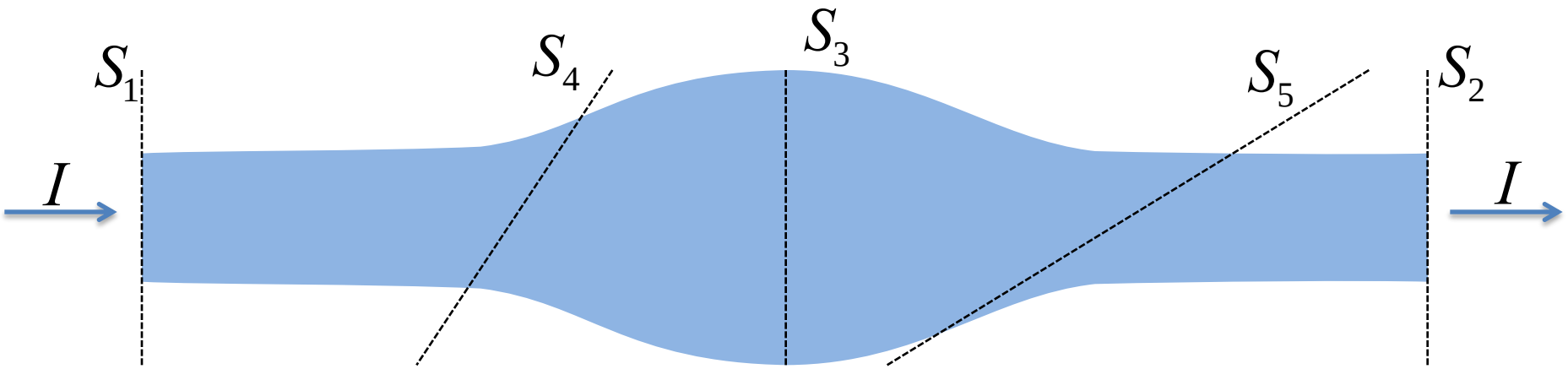
Current

Conductors are allowed to have non-zero electric field inside for non-steady state situations (this is what causes the charges to move).



The ordered flow of charges is called the electric current. What is the ordered flow of charges?

Definition of current



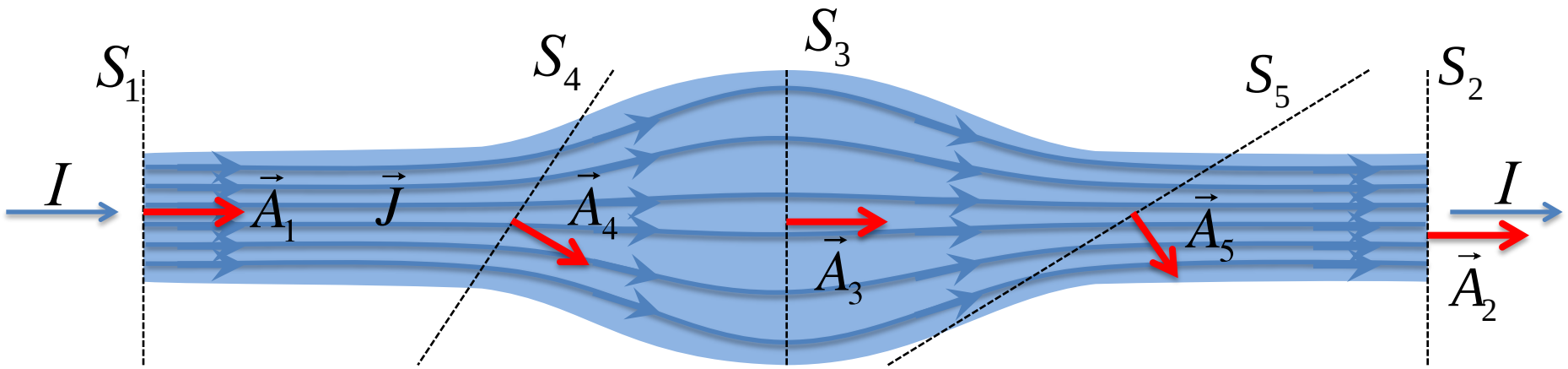
Total amount of charge flowing past this surface in a time Δt

$$I = \frac{dq}{dt}$$

Total amount of charge flowing past this surface in the same time Δt

Total amount of charge flowing through **ANY** surface in a time Δt must be constant, otherwise charges would begin to accumulate. **Current in a wire is constant**.

Current and Current Density



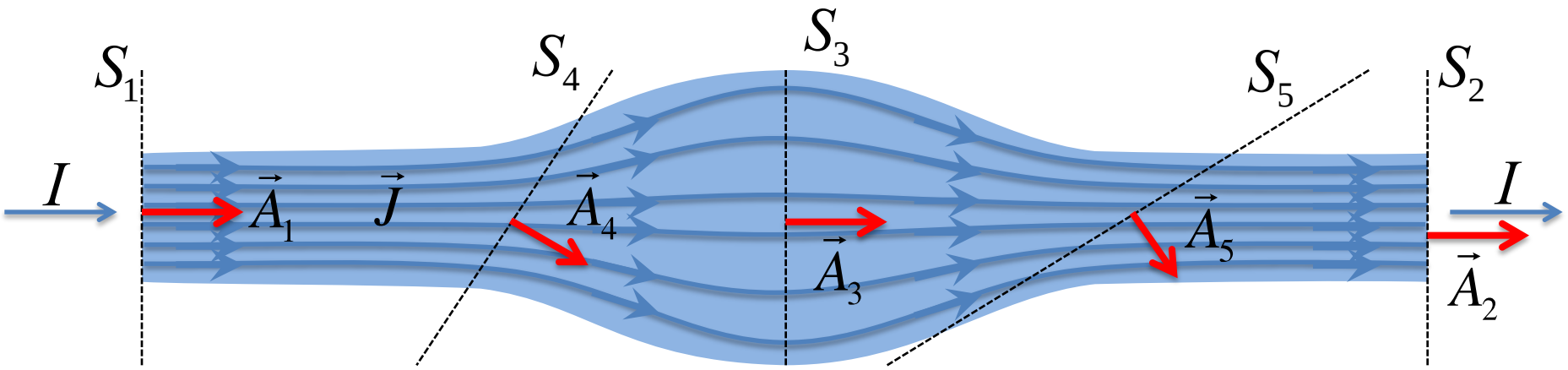
Current is the total amount of charge flowing through **ANY** surface in a time Δt. This should be reminiscent of **FLUX**.

$$I = \int \vec{J} \cdot d\vec{A}$$

The current in a wire is the flux of charge carriers (i.e. electrons) through a surface.

Since the current is constant in this case, the flux through any cross-sectional surface must be the same.

Current and Current Density



We call $\vec{J}$ the **current density**. It encodes information about:

- The density of conduction electrons in the conductor
- The net velocity of these conduction electrons

The current I is then interpreted as the number of charges passing through a surface in a specified direction. Note: current density is a vector, current is a scalar.