# Electrostatics & Field Modeling

## 1. Electric Charges and Fields

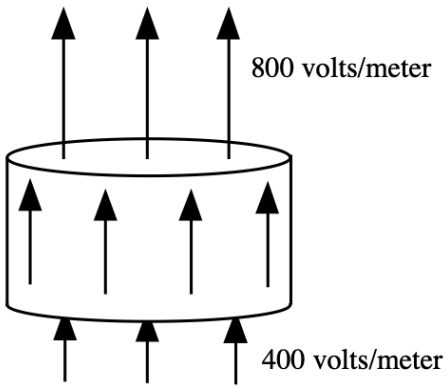
Two small objects each with a net charge of +Q exert a force of magnitude F on each other:


We replace one of the objects with another whose net charge is +4Q:


The original magnitude of the force on the +Q charge was F; what is the magnitude of the force on the +Q charge now?

(a) 4F
(b) 5F/2
(c) 3F
(d) 2F
(e) F
(f) F/4
(g) None of the above

## 2. Gauss's Law




Here is a cylinder on whose surfaces there is a vertical electric field of varying magnitude as shown. The electric field is uniform on the top face, and also uniform on the bottom face. This cylinder encloses

(a) no net charge.
(b) net positive charge.
(c) net negative charge.
(d) There is not enough information available to determine whether or not there is net charge inside the cylinder.

# Electric Potential & Circuits

## 3. Electric Potential

In static equilibrium, the potential difference between two points inside a solid piece of metal

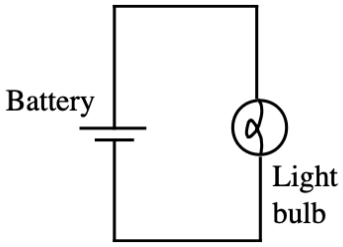
(a) is zero because metals block electric interactions.
(b) is zero because the electric field is zero inside the metal.

(c) is non-zero if the piece of metal is not spherical.
(d) is non-zero if there are charges on the surface of the metal.
(e) is non-zero for reasons not given above.
(f) is zero for reasons not given above.

### 4. Current and Resistance

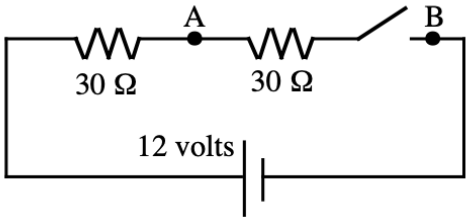
Which of the following statements is true about the electric field inside the bulb filament?

(a) The field must be zero because the filament is made of metal.
(b) The field must be zero because a current is flowing.
(c) The field must be zero because any excess charges are on the surface of the filament.
(d) The field must be non-zero because the flowing current produces an electric field.
(e) The field must be non-zero because no current will flow without an applied field.
(f) The field must be zero for reasons not given above.
(g) The field must be non-zero for reasons not given above.




### 5. Direct-Current Circuits

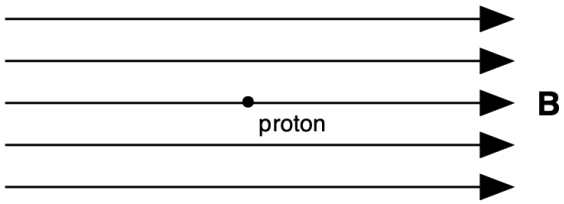
What is the magnitude of the potential difference between points A and B on the circuit, while the switch is open?
(a) 0 volts.
(b) 3 volts.
(c) 6 volts.
(d) 12 volts.
(e) None of the above.



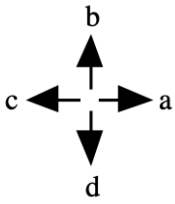

## Magnetism & Induction

### 6. Magnetic Forces and Fields

A proton is initially at rest in a region of constant magnetic field (shown below). There are no other charges present.



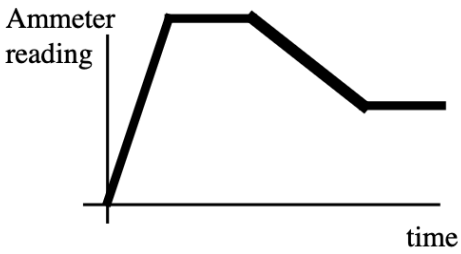

What is the direction (a-h) of the initial magnetic force on the proton? Choose from the following possible directions to answer the question below:

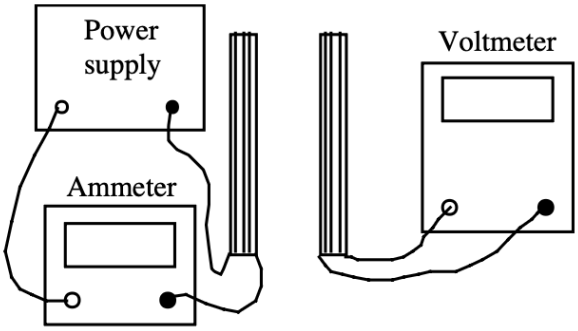



| | |
|---|---|
| ⊙ out of page | e |
| ⊗ into page | f |
| zero force | g |
| none of the above | h |

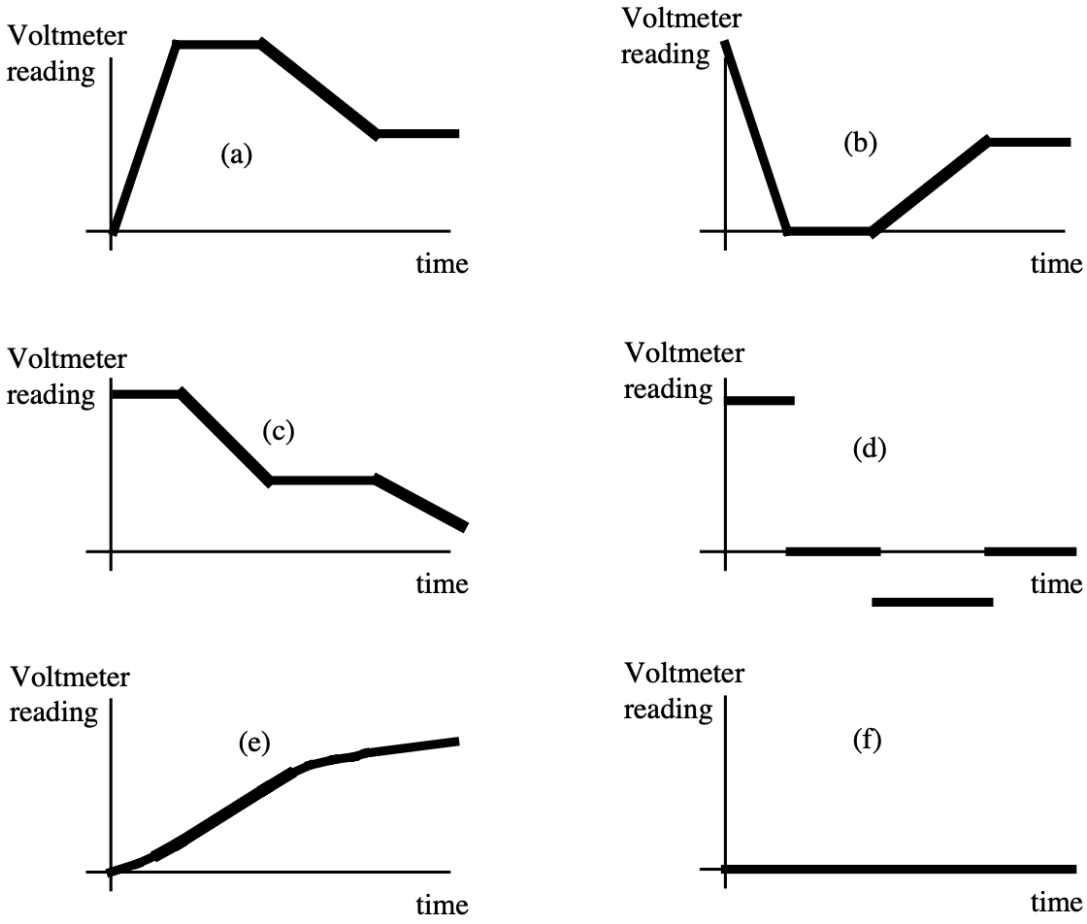
## 7. Sources of Magnetic Fields

A variable power supply is connected to a coil and an ammeter, and the time dependence of the ammeter reading is shown. A nearby coil is connected to a voltmeter.



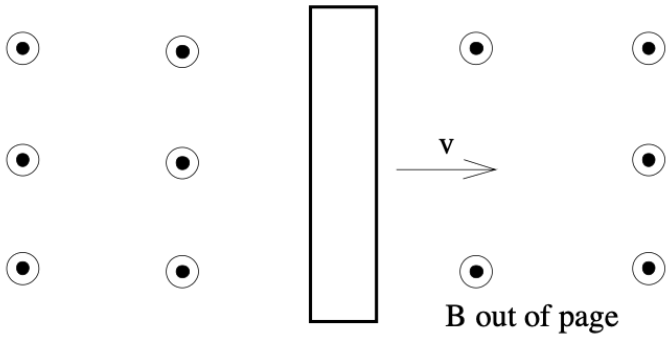




Which of the following graphs correctly shows the time dependence of the voltmeter reading?

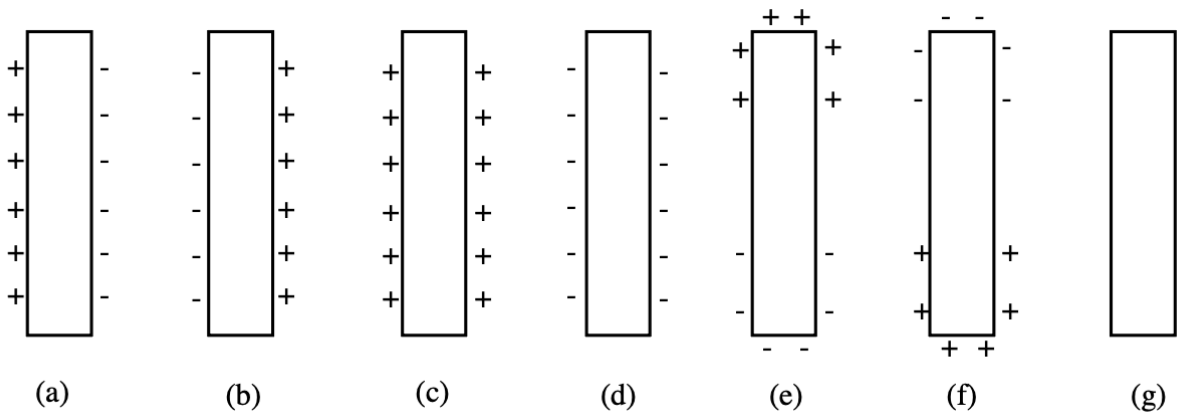



## 8. Electromagnetic Induction

A neutral metal bar is moving at constant velocity v to the right through a region where there is a uniform magnetic field pointing out of the page. The magnetic field is produced by some large coils, which are not shown on the diagram.




Which of the following diagrams best describes the state of the metal bar?


(a)
(b)
(c)
(d)
(e)
(f)
(g)