

# Walking Down a Mountain



Consider the topo. map at left.

Starting at the center of the dot, which direction starts you downhill the fastest?

- |      |       |
|------|-------|
| 1. N | 2. NE |
| 3. E | 4. SE |
| 5. S | 6. SW |
| 7. W | 8. NW |

# Walking Down a Mountain

(1) Start off going North



The fastest way downhill (or uphill) is always to walk perpendicular to contours of constant height. From the peak the fastest way down is NW, but from here it is N.

## Changing C Dimensions

A parallel-plate capacitor has plates with equal and opposite charges  $\pm Q$ , separated by a distance  $d$ , and **is not** connected to a battery. The plates are pulled apart to a distance  $D > d$ .

What happens to the potential difference  $V$  and the charge  $Q$ ?

1.  $V$  increases,  $Q$  increases
2.  $V$  decreases,  $Q$  increases
3.  $V$  is the same,  $Q$  increases
4.  $V$  increases,  $Q$  is the same
5.  $V$  decreases,  $Q$  is the same
6.  $V$  is the same,  $Q$  is the same
7.  $V$  increases,  $Q$  decreases
8.  $V$  decreases,  $Q$  decreases
9.  $V$  is the same,  $Q$  decreases

## Changing C Dimensions

(4)  $V$  Increases,  $Q$  remains the same

With no battery connected to the plates the charge on them has no possibility of changing.

In this situation, the electric field doesn't change when you change the distance between the plates, so:

$$V = E d$$

As  $d$  increases,  $V$  increases.

## Changing C Dimensions

A parallel-plate capacitor has plates with equal and opposite charges  $\pm Q$ , separated by a distance  $d$ , and is connected to a battery. The plates are pulled apart to a distance  $D > d$ .

What happens to the potential difference  $V$  and the charge  $Q$ ?

1.  $V$  increases,  $Q$  increases
2.  $V$  decreases,  $Q$  increases
3.  $V$  is the same,  $Q$  increases
4.  $V$  increases,  $Q$  is the same
5.  $V$  decreases,  $Q$  is the same
6.  $V$  is the same,  $Q$  is the same
7.  $V$  increases,  $Q$  decreases
8.  $V$  decreases,  $Q$  decreases
9.  $V$  is the same,  $Q$  decreases

## Changing C Dimensions

(9)  $V$  is the same,  $Q$  decreases

With no battery connected to the plates the potential  $V$  between them is held constant

In this situation, since

$$V = E d$$

As  $d$  increases,  $E$  must decrease.

Since the electric field is proportional to the charge on the plates,  $Q$  must decrease as well.

## Changing C Dimensions

A parallel-plate capacitor, disconnected from a battery, has plates with equal and opposite charges, separated by a distance  $d$ . Suppose the plates are pulled apart until separated by a distance  $D > d$ . How does the final electrostatic energy stored in the capacitor compare to the initial energy?

1. The final stored energy is smaller
2. The final stored energy is larger
3. Stored energy does not change.

## Changing C Dimensions

(2) The stored energy increases

As you pull apart the capacitor plates you are increasing the amount of space in which the E field is non-zero and hence increase the stored energy. Where does the extra energy come from? From the work you do pulling the plates apart.