

**Electric Potential Energy**

- Change in \_\_\_\_\_ due to \_\_\_\_\_
  - $F_G = G \frac{m_1 m_2}{r^2}$
  - $W = mgh_0 - mgh_f = PE_0 - PE_f$
- PE can only be differences because there is no absolute \_\_\_\_\_ position
- For point charges:  $PE = \frac{kq_1 q_2}{r}$
- Change in \_\_\_\_\_ due to \_\_\_\_\_
  - $F_E = k \frac{q_1 q_2}{r^2}$
  - $W = PE_0 - PE_f$

**Electric Potential (or Potential)**

$$V = \frac{\Delta PE}{q_0}$$

- For point charges:  $V = \frac{kq}{r}$

Potential Energy	Electrical Potential
Symbol: _____ $PE = q_0 V$	Symbol: _____ $V = \frac{\Delta PE}{q_0}$
Unit: _____	Unit: _____

- To add potentials from several point charges, \_\_\_\_\_ the potentials at that point

Two point-charges lie on the x-axis with  $q_1 = -2 \mu\text{C}$  at 1 cm and  $q_2 = 3 \mu\text{C}$  at 9 cm. Where is the electric potential zero between them?

**Practice Work**

12. Voltage is the common word for potential difference. Which term is more descriptive, voltage or potential difference?
13. What is the relationship between voltage and energy? More precisely, what is the relationship between potential difference and electric potential energy?
14. Voltages are always measured between two points. Why?

15. The drawing shows three possibilities for the potentials at two points, A and B. In each case, the same positive charge is moved from A to B. In which case, if any, is the most work done on the positive charge by the electric force? Account for your answer.

A • 150 V	B • 100 V	A • 25 V	B • -25 V	A • -10 V	B • -60 V
Case 1		Case 2		Case 3	

16. The potential at a point in space has a certain value, which is not zero. Is the electric potential energy the same for every charge that is placed at that point? Explain.
17. What is the potential  $0.530 \times 10^{-10}$  m from a proton (the average distance between the proton and electron in a hydrogen atom)? (OpenStax 19.25) **27.2 V**
18. How far from a  $1.00 \mu\text{C}$  point charge will the potential be 100 V? At what distance will it be  $2.00 \times 10^2$  V? (OpenStax 19.27) **89.9 m, 45.0 m**
19. What are the sign and magnitude of a point charge that produces a potential of  $-2.00$  V at a distance of 1.00 mm? (OpenStax 19.28)  **$-2.22 \times 10^{-13}$  C**
20. In nuclear fission, a nucleus splits roughly in half. (a) What is the potential  $2.00 \times 10^{-14}$  m from a fragment that has 46 protons in it? (b) What is the potential energy in MeV of a similarly charged fragment at this distance? (OpenStax 19.30)  **$3.31 \times 10^6$  V, 152 MeV**

21. Find the ratio of speeds of an electron and a negative hydrogen ion (one having an extra electron) accelerated through the same voltage, assuming non-relativistic final speeds. Take the mass of the hydrogen ion to be  $1.67 \times 10^{-27}$  kg. (OpenStax 19.1) **42.8**

22. An evacuated tube uses an accelerating voltage of 40 kV to accelerate electrons to hit a copper plate and produce x-rays. Non-relativistically, what would be the maximum speed of these electrons? (OpenStax 19.2)  **$1.17 \times 10^8$  m/s**

23. When lightning strikes, the potential difference can be ten million volts between the cloud and ground. If an electron is at rest and then is accelerated from the ground to the cloud, how fast will it be moving when it hits the cloud 0.5 km away

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