Skill 37: Electrical Work/Energy and Potential Difference

104. What is the work done moving 4C of charge through a potential difference of 6V?

$W = Vq$

$(6V)(4C) = 24J$

105. What is the work done in moving 3 electrons through a potential difference of 4 V? Find this energy in both joules and eV's.

$q = 3e = 4.8 \times 10^{-19} C$

$V = 4V$

$W = qV = (3e)(4V) = 12eV$

or $(4.8 \times 10^{-19} C)(4V) = 19.2 \times 10^{-19} J = 1.92 \times 10^{-18} J$

106. Convert 3.5×10^{-16} joules to electron-volts.

$$3.5 \times 10^{-16} J \times \frac{1eV}{1.6 \times 10^{-19} J} = 2.19 \times 10^{3} eV$$

107. 4×10^{-8} joules of work are done in moving a charge of 2×10^{-6} coulombs.

a. Since work had to be done to move the charge, what form of energy is increasing? electrical energy

b. How much electrical potential is generated during this process?

$V = W/q = \frac{4 \times 10^{-8} J}{2 \times 10^{-6} C} = 2 \times 10^{-2} J/C = 2 \times 10^{-2} V$

108. A 0.005 kilogram object with a charge of 2×10^{-5} coulombs is positioned in an electric field so that it has an electrical potential of 1.5 volts. The charged body is released so that it is free to move.

a. How much kinetic energy will the object gain after it is released?

$m = .005 kg$
$q = 2 \times 10^{-5} C$
$V = 1.5V$

$KE = W = Vq = (1.5V)(2 \times 10^{-5} C) = 3 \times 10^{-5} J$

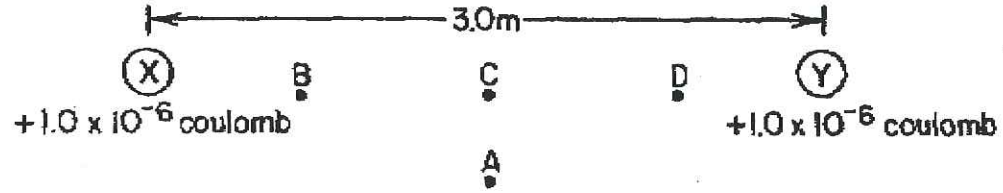
b. What maximum velocity will this object reach?

$KE = \frac{1}{2} m v^2$

$3 \times 10^{-5} J = \frac{1}{2}(.005 kg) v^2$

$v = .11 m/s$

Base your answers to questions **109** and **110** on the diagram below which represents two charged spheres, *X* and *Y*.



109. Moving the two spheres toward each other would cause their electrical potential energy to

A) decrease
B) increase
C) remain the same

It requires work to move 2 like charges toward one another. Work done on a charge is electrical potential energy

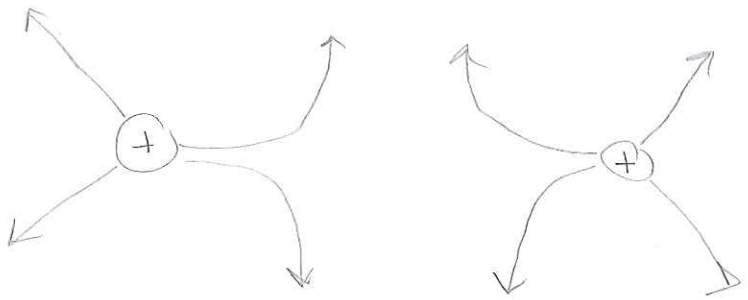
110. If a unit positive charge moves directly from point *B* to point *D*, the potential energy of the charge will

A) decrease, only
B) increase, only
C) decrease then increase
D) increase then decrease

a positive test charge would move from B to C due to the field
- kind of like falling — decrease in potential

But from C to D requires work "uphill"
- increase in potential

Electrical field is like a gravitational field

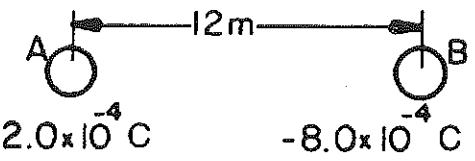


If a ⊕ charge follows the arrows it loses potential energy & gains kinetic

If a ⊕ charge goes against the arrows, work is required, so PE is increased

The lines arrows are drawn for ⊕ so the rules reverse for a negative charge

111. Base your answer to the following question on the diagram below which represents a system consisting of two charged metal spheres with equal radii.



Compared to the electrical potential energy of the system at a separation of 12 meters, the electrical potential energy of the system at a separation of 6 meters is

(A) less B) greater
C) the same

opposites attract so the field does the work - like falling. So the potential is less

112. What is the total amount of work required to move a proton through a potential difference of 100. volts?

A) 1.60×10^{-21} J (B) 1.60×10^{-17} J
C) 1.00×10^{2} J D) 6.25×10^{20} J

W = ? all answers J
q = proton = 1.6×10^{-19} C
V = 100 V

$W = Vq$
$= (100\text{V})(1.6 \times 10^{-19}\text{C})$
$= 1.6 \times 10^{-17}$ J

113. Which electrical unit is equivalent to one joule?

A) volt per meter B) ampere•volt
C) volt per coulomb (D) coulomb•volt

Work

$W = qV$
units: J = CV

114. A potential difference of 10.0 volts exists between two points, A and B, within an electric field. What is the magnitude of charge that requires 2.0×10^{-2} joule of work to move it from A to B?

A) 5.0×10^{2} C B) 2.0×10^{-1} C
C) 5.0×10^{-2} C (D) 2.0×10^{-3} C

V = 10V
q = ?
W = 2×10^{-2} J

$q = \frac{W}{V} = \frac{2 \times 10^{-2}\text{J}}{10\text{V}} = .2 \times 10^{-2}\text{C}$
2×10^{-3} C

115. If 1.0 joule of work is required to move 1.0 coulomb of charge between two points in an electric field, the potential difference between the two points is

(A) 1.0×10^{0} V B) 9.0×10^{9} V
C) 6.3×10^{18} V D) 1.6×10^{-19} V

$V = W/q = \frac{1\text{J}}{1\text{C}} = 1\text{V}$

~~116.~~ If 1.0 joule of work is required to move a charge of 1.0 coulomb between two points in an electric field, the potential difference between these two points is

(repeat)

(A) 1.0 V B) 1.6×10^{-19} V
C) 9.0×10^{9} V D) 6.3×10^{18} V

W

117. A 12-volt automobile battery has 8.4×10^{3} coulombs of electric charge. The amount of electrical energy stored in the battery is approximately

(A) 1.0×10^{5} J B) 8.4×10^{3} J
C) 7.0×10^{2} J D) 1.4×10^{-3} J

V = 12V
q = 8.4×10^{3} C
W = ?

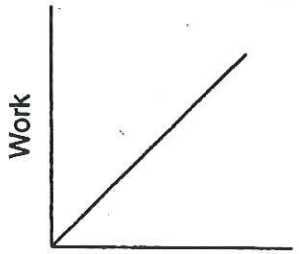
$W = Vq$
$= (12\text{V})(8.4 \times 10^{3}\text{C})$
$= 100.8 \times 10^{3}$ J
$= 1 \times 10^{5}$ J

118. How much work is done in moving 5.0 coulombs of charge against a potential difference of 12 volts?

A) 2.4 J B) 12 J C) 30. J D) 60. J

$W = ?$
$q = 5C$
$V = 12V$
$W = qV = (5C)(12V) = 60J$

119. The graph below shows the relationship between the work done on a charged body in an electric field and the net charge on the body.



$\text{Slope} = \frac{y}{x} = \frac{W}{q} = V$

What does the slope of this graph represent?

A) power
B) potential difference
C) force
D) electric field intensity

120. If 15 joules of work is required to move 3.0 coulombs of charge between two points, the potential difference between these two points is

A) 45 V B) 15 V
C) 3.0 V D) 5.0 V

$W = 5J$
$q = 3C$
$V = ?$
$V = W/q = 15J/3C = 5V$

121. The work needed to move a 10-coulomb charge between two charged plates is 500 joules. The voltage between the plates is

A) 5 volts B) 0.02 volt.
C) 50 volts D) 5,000 volts

$q = 10C$
$W = 500J$
$V = ?$
$V = \frac{W}{q} = \frac{500J}{10C} = 50V$

122. An electrical potential of one joule per coulomb is equal to

A) one coulomb B) one ampere
C) one ohm D) one volt

$V = 1J/C = W/q = V$

123. The work required to move a charge of 3.0 coulombs through a potential difference of equal to 12 volts is

A) 0.25 joule B) 9 joules
C) 36 joules D) 4.0 joules

$q = 3C$
$V = 12V$
$W = ?$
$W = Vq$
$= (12V)(3C)$
$= 36J$

124. If 20.0 joules of work is needed to move 5.0 coulombs of electrical charge through a circuit, the voltage is

A) 100 volts B) 25 volts
C) 0.25 volt D) 4.0 volts

$W = 20J$
$q = 5C$
$V = ?$
$V = W/q = \frac{20J}{5C} = 4V$

125. It takes 15 joules of work to bring 3.0 coulombs of positive charge from infinity to a point. What is the electric potential at this point in an electric field?

A) 45 V B) 5.0 V
C) 0.20 V D) 0 V

126. The work required to move 2 coulombs of charge through a potential difference of 5 volts is

A) 10 J B) 2 J C) 25 J D) 50 J

$q = 2C$
$V = 5V$
$W = Vq$
$= (5V)(2C)$
$= 10J$

127. The electronvolt is a unit of

A) energy
B) charge
C) electric field strength
D) electric potential difference

$qV = W$
$eV = W$

128. Which object will have the greatest change in electrical energy?

A) an electron moved through a potential difference of 2.0 V
B) a metal sphere with a charge of 1.0×10^{-9} C moved through a potential difference of 2.0 V
C) an electron moved through a potential difference of 4.0 V
D) a metal sphere with a charge of 1.0×10^{-9} C moved through a potential difference of 4.0 V

$W = qV$

129. If a 1.5-volt cell is to be completely recharged, each electron must be supplied with a minimum energy of

A) 1.5 eV
B) 1.5 J
C) 9.5×10^{18} eV
D) 9.5×10^{18} J

$V = 1.5$ V
$q = 1e$ or 1.6×10^{-19} C
$W = qV = 1.5$ eV

130. An electron is accelerated from rest through a potential difference of 200. volts. The work done on the electron is

A) 8.00×10^{-3} eV
B) 3.20×10^{-17} eV
C) 320. eV
D) 200. eV

$W = qV$
$= (1e)(200\text{V})$
$= 200$ eV

131. How much energy is required to move 3.2×10^{-19} coulomb of charge through a potential difference of 5 volts?

A) 5 eV
B) 2 eV
C) 10 eV
D) 20 eV

all answers are in eV so q must be in elementary charge
$q = 3.2 \times 10^{-19}\text{C} = 2e$
$W = (2e)(5\text{V}) = 10\text{eV}$

132. An alpha particle with a charge of +2 elementary charges is accelerated by a potential difference of 1.0×10^6 volts. The energy acquired by the particle is

A) 0.50×10^6 eV
B) 1.6×10^{-19} eV
C) 2.0×10^6 eV
D) 3.2×10^{-13} is eV

$W = (2e)(1 \times 10^6\text{V}) = 2 \times 10^6\text{eV}$

133. An alpha particle with a charge of +2 elementary charges is accelerated in a vacuum through a potential difference of 10,000. volts. what is the energy acquired by the particle?

A) 3.2×10^{-15} eV
B) 2.0 eV
C) 20,000. eV
D) 40,000. eV

$W = (2\text{eV})(10{,}000\text{V}) = 20{,}000$ eV

134. What is the maximum amount of kinetic energy that may be gained by a proton accelerated through a potential difference of 50 volts?

A) 1 eV
B) 10 eV
C) 50 eV
D) 100 eV

eV!

$KE = W$
$q = \text{proton} = 1.6 \times 10^{-19}\text{C} = 1e$
$V = 50\text{V}$
$W = qV$
$= (1e)(50\text{V})$
$= 50$ eV

135. An energy of 13.6 electron-volts is equivalent to

A) 1.60×10^{-19} J
B) 2.18×10^{-18} J
C) 6.25×10^{-19} J
D) 6.63×10^{-18} J

$13.6\text{eV} \times \frac{1.6 \times 10^{-19}\text{J}}{1\text{eV}} = 21.8 \times 10^{-19}\text{J}$
$= 2.18 \times 10^{-18}\text{J}$