



Universiti Teknologi MARA
Fakulti Sains Gunaan

Introduction to Electric Potential

PHY407: A Physical Science Activity

Name: _____ HP: _____ Lab # 3:

The goal of today's activity is for you to explore and describe the electric potential produced by and around point charges and a configuration of like and opposite charges.

At the end of the activity, students will be able to:

1. Produce a model for electrical potential produced by point charges and a charged plate.
2. Describe and obtain the relationship between electrical force, electrical field and electrical potential or voltage.

Background Information

Background: The activity before today investigated the electrical force acting on charges when those charges were placed in the electric field of other charges. We found that the electrical field point away from a positively charged particle (the field diverges) and points towards a negatively charged particle (the field converges). It was also found that the strength of the field produced by a point charge is inversely proportional to the square of the distance from the charge producing the field and directly proportional to the magnitude of the charge producing that field, $E \propto \frac{q}{r^2}$ and in equality form is written as, $E = k \frac{q}{r^2}$.

Experiments by physicists in the past found that the electric (coulomb) constant has a fixed value of $k = \frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \frac{N.m^2}{C^2}$. A charge placed in this field will experience a force.

How is the force related to the field? How much energy will be required to move a charge against the electric field? How much work is done in moving the charge?

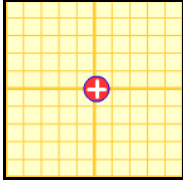
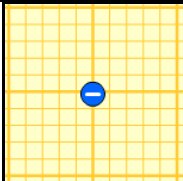
If a charge is moved along a path perpendicular to the field lines, there is no work done ($W = 0$) since there is no force component along the path. No work means no potential difference from point to point. Hence, the potential is constant along paths perpendicular to field lines. Such paths are called equipotentials. Potential difference is easily read by a voltmeter, whereas the measurement of forces would present numerous experimental problems.

Student Activity

Investigation 2-Electric Potential

Prediction 1

Predict how the strength of the electric potential changes at radius of 10 cm until 100 cm around (8 positions for each distance) the charged particle. Note that 1 small box represents 10 cm.

		Write down your predictions in the cell below
Case 1	 <p>Figure 1.1a</p>	
Case 2	 <p>Figure 1.1b</p>	

Activity 1:

Configure the charges in the PhET simulation (charges-and-field) as in Figure 1a and Figure 1b. Measure the electric field and the electric potential at the distances specified. Use the electric field and the electric potential sensors respectively to measure the electric field and the electric potential at each of the radii 10 cm until 100 cm in increments of 10 cm. Record the values (you will need to take the average readings) in Table 1.1. In addition, calculate the following quantity: $1/r$ and the ratios of V_{n+1}/V_n and r_n/r_{n+1} .

Table 1.1a: V and the ratios of V and r around a positively charged particle

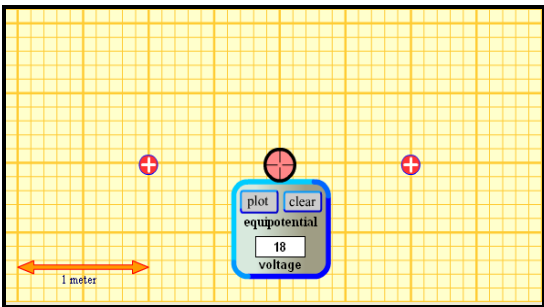
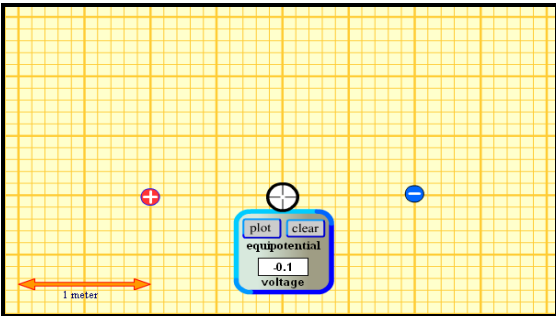
r cm	V Volts	V Volts	V Volts	V Volts	V Volts	V Volts	V Volts	V _{avg} Volts	1/r m ⁻¹	1/r ² m ⁻²	V _{n+1} /V _n	(r _n /r _{n+1})
10												
20												
30												
40												
50												
60												
70												
80												
90												
100												

Table 1.1b: V and the ratios of V and r around a negatively charged particle

r cm	V Volts	V Volts	V Volts	V Volts	V Volts	V Volts	V Volts	V _{avg} Volts	1/r m ⁻¹	1/r ² m ⁻²	V _{n+1} /V _n	(r _n /r _{n+1})
10												
20												
30												
40												
50												
60												
70												
80												
90												
100												

Prediction 2:

Predict how the strength of the electric field and the electric potential changes at radius of 10 cm until 190 cm between the charged particle in the Figures 2.2a and 2.2b . Note that 1 small box represents 10 cm.

		Write down your predictions in the cell below
Case 1	 <p>Figure 2.2a</p>	
Case 2	 <p>Figure 2.2b</p>	

Activity 2:

Configure the charges in the PhET simulation (charges-and-field) as in Figure 2.2a and Figure 2.2b. Measure the electric field and the electric potential at the distances specified.

Use the electric field and the electric potential sensors respectively to measure the electric field and the electric potential at each of the radii 10 cm until 190 cm in increments of 10 cm. Record the values (you will need to take the average readings) in Table 2.2.

Table 2.2a: V and E between 2 positively charged particles.

r, cm	r, m	V,volts	V, volts	E, V/m	E, V/m	V _{avg} , V/m	E _{avg} , V/m
10	0.1					0.00	0.00
20	0.2					0.00	0.00
30	0.3					0.00	0.00
40	0.4					0.00	0.00
50	0.5					0.00	0.00
60	0.6					0.00	0.00
70	0.7					0.00	0.00
80	0.8					0.00	0.00
90	0.9					0.00	0.00
100	1.0					0.00	0.00
110	1.1					0.00	0.00
120	1.2					0.00	0.00
130	1.3					0.00	0.00
140	1.4					0.00	0.00
150	1.5					0.00	0.00
160	1.6					0.00	0.00
170	1.7					0.00	0.00
180	1.8					0.00	0.00
190	1.9					0.00	0.00

Table 2.2b: V and E between a positively and negatively charged particles.

r, cm	r, m	V,volts	V, volts	E, V/m	E, V/m	V _{avg} , V/m	E _{avg} , V/m
10	0.1					0.00	0.00
20	0.2					0.00	0.00
30	0.3					0.00	0.00
40	0.4					0.00	0.00
50	0.5					0.00	0.00
60	0.6					0.00	0.00
70	0.7					0.00	0.00
80	0.8					0.00	0.00
90	0.9					0.00	0.00
100	1.0					0.00	0.00
110	1.1					0.00	0.00
120	1.2					0.00	0.00
130	1.3					0.00	0.00
140	1.4					0.00	0.00
150	1.5					0.00	0.00
160	1.6					0.00	0.00
170	1.7					0.00	0.00
180	1.8					0.00	0.00
190	1.9					0.00	0.00

Questions

1. How was your prediction compare to the data you collected?
2. Is there a relationship between the electric potential and the position from the charge producing it? Sketch a graph of potential V vs. r , V vs. $1/r$, for all the cases. Explain the relationship represented. Based on the results and the graphs, how would V be mathematically modeled as a function of distance measured from the charge?
3. How would the potential vary if the charge producing it is increased or decreased? What is the relationship between potential V and the amount of charge?
4. Is there anywhere along the line between the charges in case 1 and case 2 in activity 2 where the electric potential is zero? What would be the electric field at that point? What would happen to a charge placed at this point?