

Rate of Change and Electric Potential

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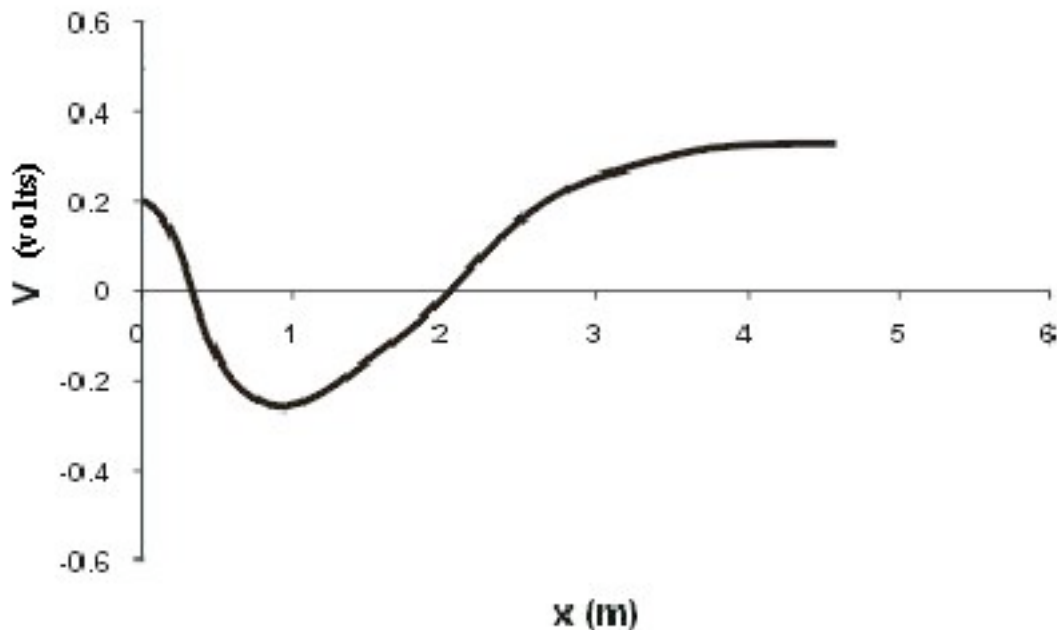
Question:

- What is the basis behind student difficulties relating change in electric potential to electric field?
- Do students have difficulty with electric potential because they have difficulty with the concept of rate of change?

How would a student answer the following?

- An electron is released from rest at $x = 2$ meters, what will be the motion of the electron?
- The electron is removed and a proton is placed at $x = 1$ meter. What will be the motion of the proton?

- A region in space, where the electric potential changes in the x direction as indicated by the following graph:



Student thinking of electric potential

- Primary difficulty is treating electric potential as though it was proportional to the electric field

“Rate of Change”

- We are really looking to see how students relate a quantity how that quantity changes
 - how does it change with time (rate of change)
 - how does it change with position (gradient)

Focus of potential questions

- Ignore effects of charge
- only looking at one-dimensional problems

Student mental models for rate of change

- A quantity and its rate of change look and behave the same:
 - If a quantity is zero, then its rate of change must be zero
 - If a quantity is not zero, then its rate of change cannot be zero
 - If a quantity is at its greatest value, the rate of change of that quantity must be at its greatest value

RAPT

- Rate and Potential Test
- KR-20 gives a reliability coefficient of 0.83
 - *“fairly high, possible for measurement of individuals”*
- Items further validated by examine student responses using think-aloud interviews (8 students)

Rate and Potential Scores

- Rate Score
 - This is the number of rate of change questions a student answered correctly
- Potential Score
 - The number of electric potential questions a student answered correctly

- Are students' incorrect answers consistent with the use of the same model?
- rate-quantity score
 - how many times did the student select the response for “rate of change proportional to its quantity”
- potential-field score
 - how many times did the student select the response for “electric field is proportional to electric potential”

Correlations between Rate and Potential Scores

	correlation	significant at 95% level?
rate-score and potential score	0.45	yes
rate-quantity and potential-field	0.38	yes

Conclusions

- Students make similar mistakes in rate of change questions as they do in electric potential questions
- Perhaps there is an underlying cause to both of these difficulties