

Ranking Tasks with the WebWork Quiz System

Michael R Gallis (mrg3@psu.edu)

Abstract

Ranking Tasks are a type of question which encourages a different mode of thinking than students employ for standard quiz problems. This presentation describes some preliminary work on implementing Ranking Tasks on WebWork, a web based quiz system. The questions are used in low stakes quizzes in which the students receive randomized data but identically formatted questions. The unique requirements of Ranking Tasks Web Questions with regards to the randomization of quiz data will be discussed. Example Ranking task questions will be shown, as well as anecdotal assessment of their impact. The computer algorithm for answer assessment will also be presented.

Background

Ranking Tasks (RT)

A **Ranking Task** is an exercise that presents students with a set of variations, sometimes three or four but usually six to eight, on a basic physical situation. The variations differ in the values (numeric or symbolic) for the variables involved but also frequently include variables that are not important to the task. The students' task is to rank the variations on the basis of a specified physical quantity. Student must also explain the reasoning for their ranking scheme and rate their confidence in their ranking. These tasks require students to engage in a comparison reasoning process that they seldom do.

<http://tycphysics.org/tipers.htm>

WeBWorK is a **free** Perl-based system for delivering individualized homework problems over the web. By providing students with immediate feedback as to the correctness of their answers, students are encouraged to make multiple attempts until they succeed. By individualizing problems, cheating is discouraged. By providing instructors with real-time statistics, lesson plans can be customized to better serve students.

http://webwork.maa.org/wiki/Main_Page

Randomized Ranking Task Problems

- Range of values for physical parameter(s)
 - Coarse Graining of values: potential ambiguity for equal vs. not equal
 - Students perceptions of a visual presentation of a problem
 - Select values from a discrete set
 - Computer roundoff
 - Values are equal if they are within a set difference
- Representations of physical system for student ranking
 - Numbers
 - Graphs
 - Simple drawings
 - Distracters
- Ranking answers: $D > E = A > C = B$

Some Nuts and Bolts

- **This new type of questions takes a significant amount of code (in the background) to**
 - Determine the numerical ranking of the physical parameters (1st, 2nd, tied for third etc)
 - Determine a numerical ranking from students (text) response
 - Evaluate student ranking for correctness
 - Numerical ranking from student response
 - Trap and give hints for common mistakes

Thanks to Davide Cervone (Dept. of Mathematics, Union College) for writing the Webwork code and putting it in the main distribution.
<http://webwork.maa.org/moodle/mod/forum/discuss.php?d=6129>

Examples

Numerical Literacy

Consider the following number assignments:

A = $-9.75E+08$
B = $-1.25E+00$
C = $-5.25E-02$
D = $3.50E+07$
E = $5.00E-03$
F = 50
G = $-1.50E-03$
H = -6.25

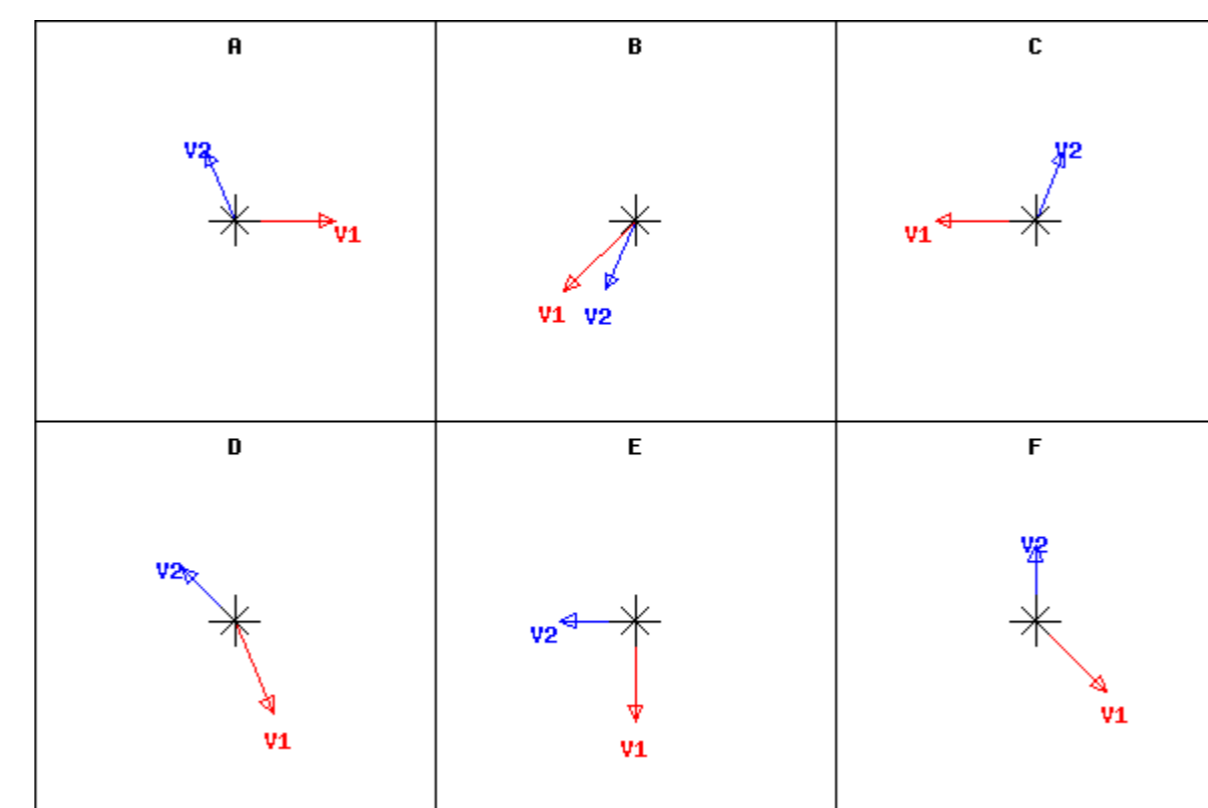
The order is (from greatest to least): _____

Remember that ranking tasks results are expressed in terms of greater than and equals relations such as $C > D = B > A$ etc.

Problem Code = PERL+

```
Generic preamble
Context("Ordering");
Context()->flags->set(tolerance => 1E-7, tolType => 'absolute');
$items=8; # number of items, between 2 and 9
$keystring="ABCDEFGH"; #string for the 9 labels A..I
for ($count = 0; $count < $items; $count++){
    $case=random(1,4,1);
    $thiskey=substr($keystring,$count,1);
    if(abs($case-1)<=.5){ #floating point
        $rankingtask{$thiskey}=random(-1,1,2)*random(1,10,.25)*10**random(0,3,1);
        $riist[$count]=$thiskey." = ".sprintf($rankingtask{$thiskey})." ";
    }elseif(abs($case-2)<=.5){ #large Scientific Notation
        $rankingtask{$thiskey}=random(-1,1,2)*random(1,10,.25)*10**random(6,10,1);
        $riist[$count]=$thiskey." = ".sprintf("%4.2E ",$rankingtask{$thiskey})." ";
    }elseif(abs($case-4)<=.5){ #medium Scientific Notation
        $rankingtask{$thiskey}=random(-1,1,2)*random(1,10,.25)*10**random(0,3,1);
        $riist[$count]=$thiskey." = ".sprintf("%4.2E ",$rankingtask{$thiskey})." ";
    }else{ #small Scientific Notation
        $rankingtask{$thiskey}=random(-1,1,2)*random(1,10,.25)/(10**random(2,5,1));
        $riist[$count]=$thiskey." = ".sprintf("%4.2E ",$rankingtask{$thiskey})." ";
    }
}
$ans = Ordering(%rankingtask);
BEGIN_TEXT
Consider the following number assignments:$BR
$riist[0] $BR
$riist[1] $BR
$riist[2] $BR
$riist[3] $BR
$riist[4] $BR
$riist[5] $BR
$riist[6] $BR
$riist[7] $BR
The order is (from greatest to least): \{ ans_rule(40) \} $BR
Remember that ranking tasks results are expressed in terms of greater than and equals relations such as  $C > D = B > A$  etc.
END_TEXT
ANS($ans->cmp);
```

Vector Addition



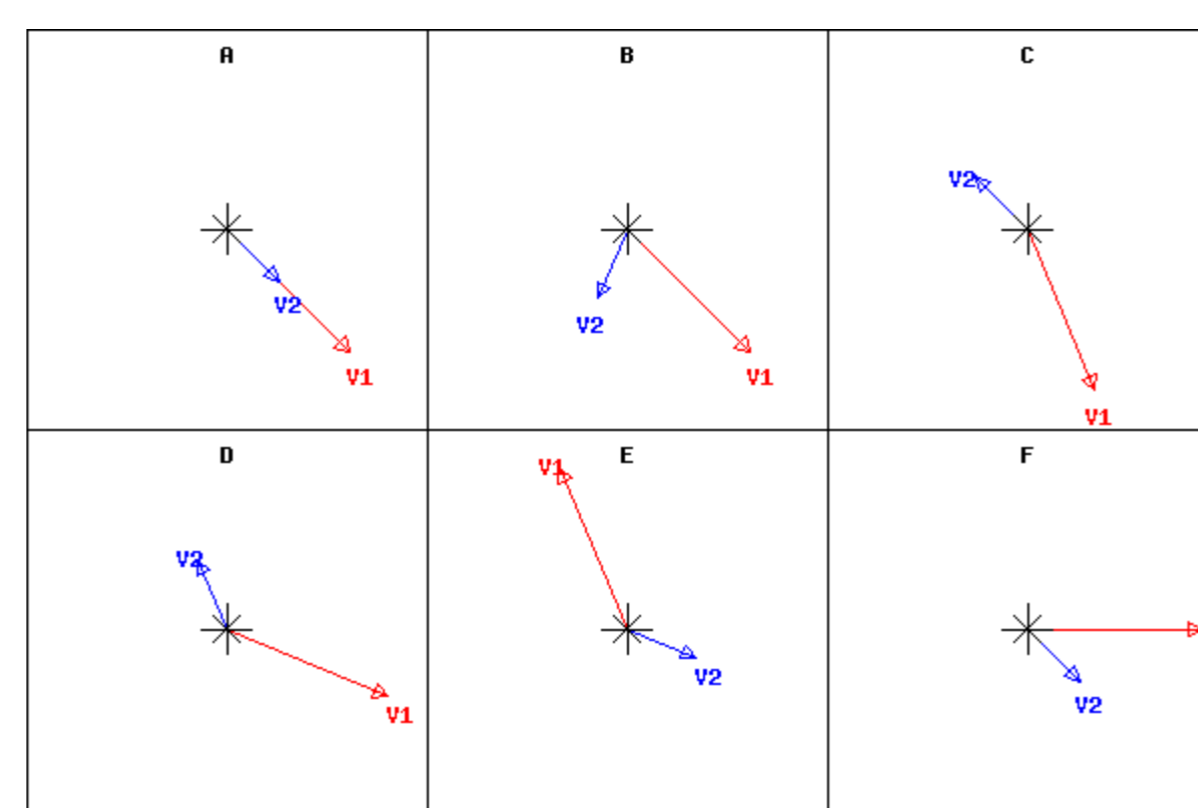
The figure above shows 6 scenarios for the vectors V_1 and V_2 . The magnitude of V_1 is 2 units and the magnitude of V_2 is 1.5 units.

Rank the six scenarios above by the corresponding magnitude of their vector sum.

The order is (from greatest to least): _____

Remember that ranking tasks results are expressed in terms of greater than and equals relations such as $C > D = B > A$ etc.

Vector Product



The figure above shows 6 scenarios for the vectors V_1 and V_2 . The magnitude of V_1 is 3.5 units and the magnitude of V_2 is 1.5 units.

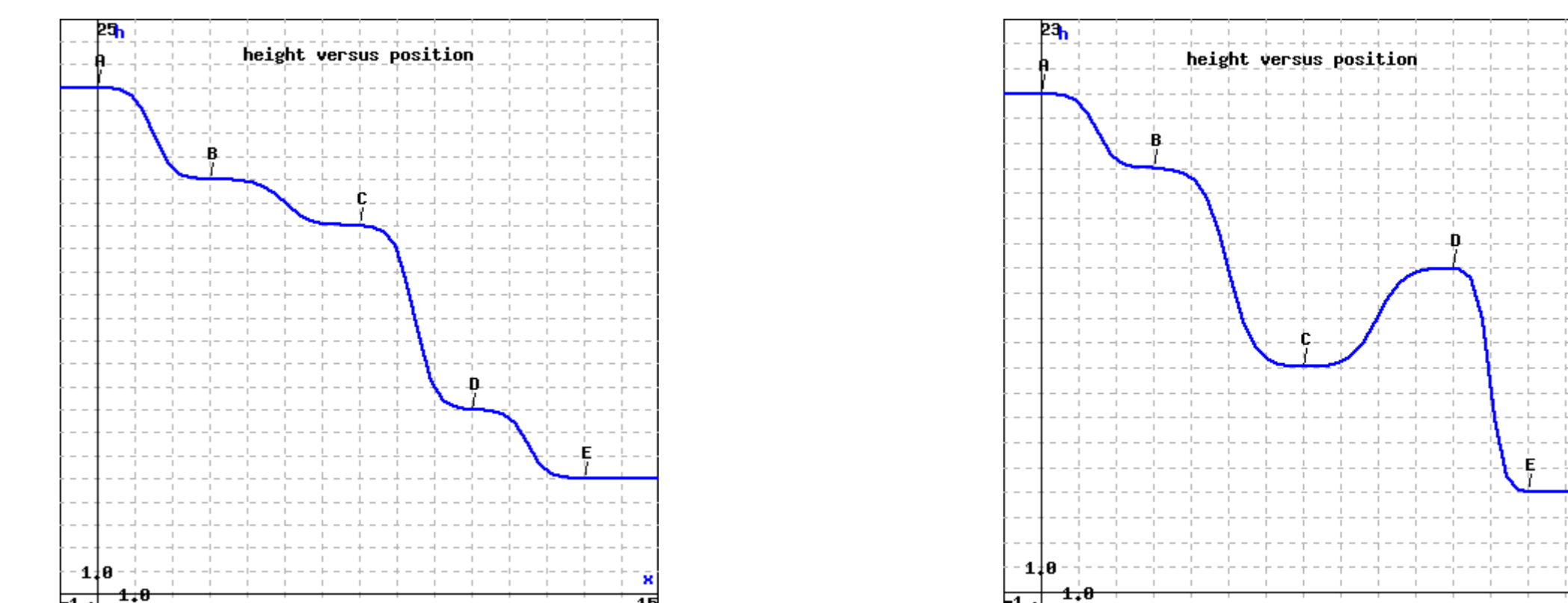
The vector product (a.k.a. the cross product) is in part a measure of how perpendicular two vectors are. Rank the six scenarios above by the corresponding magnitude of their cross products.

The order is (from greatest to least): _____

Remember that ranking tasks results are expressed in terms of greater than and equals relations such as $C > D = B > A$ etc.

Examples

Energy Conservation



The graph above represents the the height of a (frictionless) ski slope. The skier starts at A essentially at rest. For the positions indicated on the graph, rank them in decreasing order of Potential Energy. Take the heights as being on the nearest height grid line.

The order is (from greatest to least): _____

Remember that ranking tasks results are expressed in terms of greater than and equals relations such as $C > D = B > A$ etc.

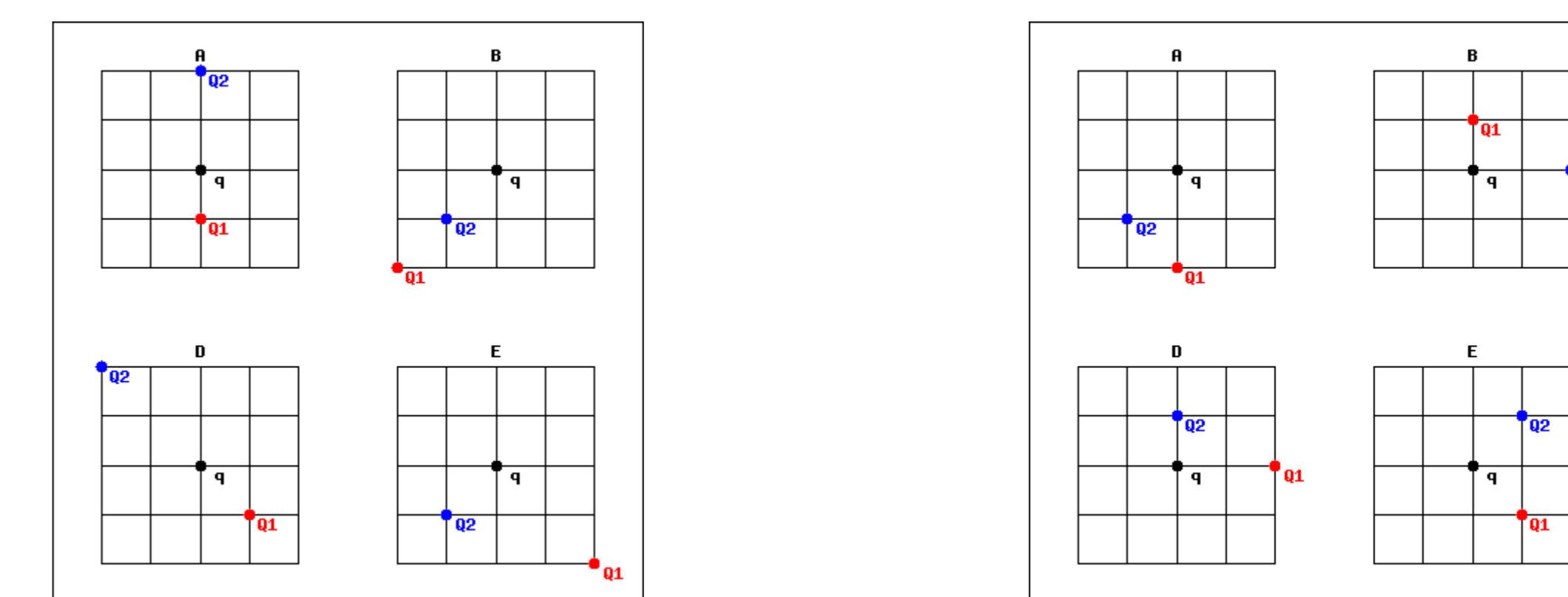
Now rank the positions in decreasing order of Kinetic Energy.

The order is (from greatest to least): _____

Now rank the positions in decreasing order of Total Energy.

The order is (from greatest to least): _____

Electric Force



The figure above shows 6 scenarios two charges Q_1 and Q_2 . Q_1 has a charge of $-3 \mu\text{C}$ and Q_2 has a charge of $-12 \mu\text{C}$. These charges exert an electric force on a test charge q ($3 \mu\text{C}$) located at the origin in each figure. The distance between the lines in the figure is 0.5 cm.

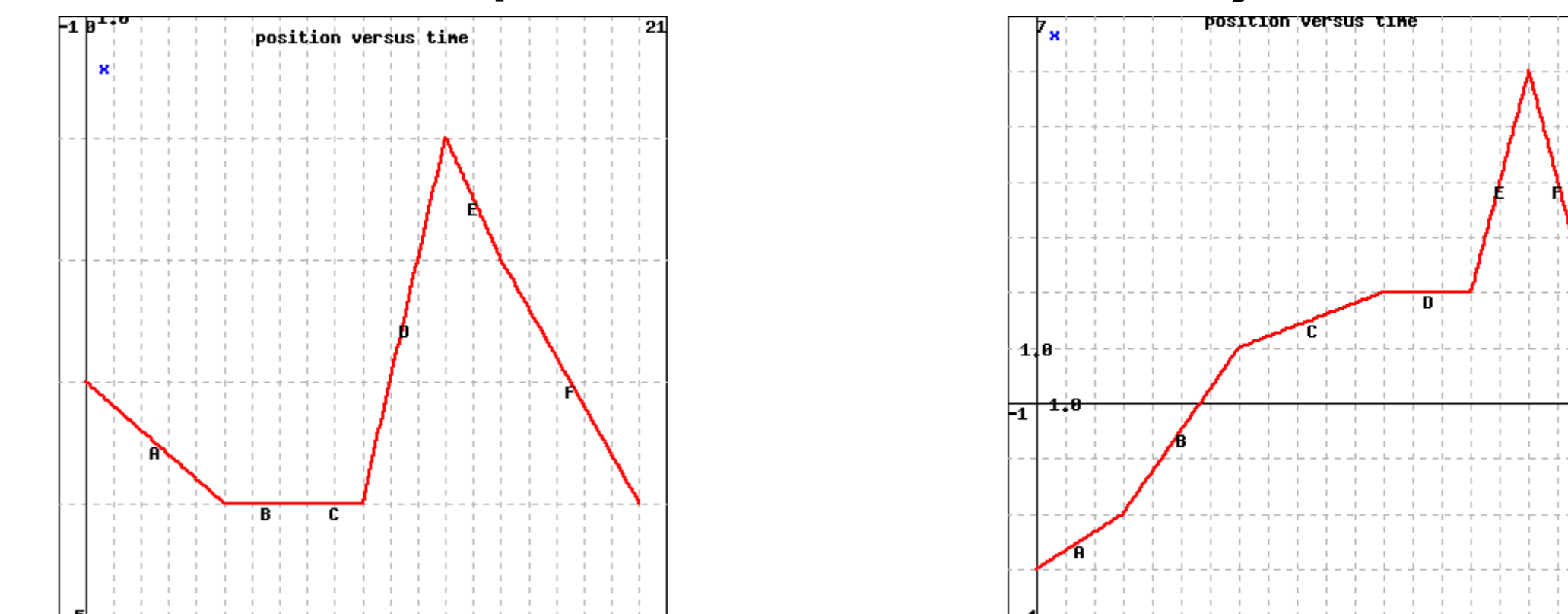
Rank the six scenarios above by magnitude of the electric force on the charge at the center of the figure.

The order is (from greatest to least): _____

Remember that ranking tasks results are expressed in terms of greater than and equals relations such as $C > D = B > A$ etc.

Hint: try drawing in (to scale) the electric field contributions from each charge on each figure. You may not need a calculator to do these comparisons.

Graphical Evaluation of Velocity



The graph above represents the position of an object as a function of time. Over the intervals indicated rank the velocities over the intervals from greatest to least.

The order is (from greatest to least): _____

Remember that ranking tasks results are expressed in terms of greater than and equals relations such as $C > D = B > A$ etc.

How are These New Types of Questions?

Anecdotally,

- I hear complaints
 - The questions are harder, weird, different
- I don't see a disproportionate amount of questions/errors/time wasted etc from students