## Section A - Voting Methods

Consider the Preference Schedule:

<table>
<thead>
<tr>
<th>Number of Votes</th>
<th>10</th>
<th>6</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Choice</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>2nd Choice</td>
<td>C</td>
<td>D</td>
<td>B</td>
</tr>
<tr>
<td>3rd Choice</td>
<td>D</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>4th Choice</td>
<td>B</td>
<td>A</td>
<td>A</td>
</tr>
</tbody>
</table>

(1) How many voters participated?
(2) How many candidates are in the election?
(3) Who (if anyone) is the majority candidate?
(4) Who (if anyone) is the Condorcet candidate?
(5) What does this example prove about the relationship between a majority candidate and a Condorcet candidate?
(6) Who wins in a head-to-head comparison of A and D?
(7) How many points are available when this election is decided by pairwise comparisons?
(8) Find the Borda total for A.
(9) Who is first eliminated in plurality-with-elimination?
(10) Who wins a head-to-head comparison of A and B?
(11) Is the winner of the election by plurality-with-elimination the same as the winner of the a head-to-head comparison of A and B?
(12) Suppose D is found to be ineligible to run for election. Give the preference schedule after D drops out of the election.
(13) How many pairwise comparisons must be made in this election (after D was removed)?
(14) Who (if anyone) is the Condorcet candidate after D is removed?
(15) Who wins by the pairwise comparison voting method?
(16) What is the total number of points available when the Borda voting method is used on the above 3 candidate election?

## Section B - Fairness Criteria

(1) Which of the following fairness criteria are satisfied by the voting method of plurality?
   (a) The majority criterion.
   (b) The Condorcet criterion.
   (c) The monotonicity criterion.
   (d) The independence of irrelevant alternatives.
(2) Does every election have a majority candidate? (Y/N)
Section B - Fairness Criteria (continued)

(3) Suppose an election is held and C wins. Then a re-vote is held and all changes are favorable to only C. If C loses which of our 4 voting method was used and why?

(4) Which voting method satisfies all 4 Fairness criterion?

(5) Which Fairness criterion is violated by all 4 of the voting methods we studied?

(6) If a voting method satisfies the Majority criterion, does the candidate with the most first place votes always win?

Section C - Ranking, Ties and Voting Theory

(1) In an election with candidates A, B, C, D, and E and 77 voters, how many different preference ballots can be cast?

(2) Can an election with an odd number of voters end in a tie in all four of our voting methods? (Y/N)

(3) Can a head-to-head comparison be a tie when the number of voters is odd?

(4) Can an election which has a majority candidate result in a tie by the Borda voting method?

(5) Can an election with a majority candidate end in a tie by the plurality-with-elimination voting method?

(6) Can an election with a majority candidate end in a tie by the pairwise comparison voting method?

(7) In an election with \( N \) voters and 7 candidates, what is the total number of Borda points available?

(8) In an election with \( N \) voters and 7 candidates, what is the highest Borda point total a candidate can get?

(9) In an election with \( N \) voters and 7 candidates, what is the highest pairwise comparison point total a candidate can get?

(10) Give the pairwise comparison ranking for the following preference schedule.

<table>
<thead>
<tr>
<th>Number of Votes</th>
<th>3</th>
<th>2</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Choice</td>
<td>A</td>
<td>C</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>2nd Choice</td>
<td>B</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>3rd Choice</td>
<td>D</td>
<td>D</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>4th Choice</td>
<td>C</td>
<td>B</td>
<td>D</td>
<td>A</td>
</tr>
</tbody>
</table>

(11) Give the Plurality-with-Elimination ranking for the following preference schedule.

<table>
<thead>
<tr>
<th>Number of Votes</th>
<th>3</th>
<th>2</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Choice</td>
<td>A</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>2nd Choice</td>
<td>B</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>3rd Choice</td>
<td>D</td>
<td>D</td>
<td>A</td>
</tr>
<tr>
<td>4th Choice</td>
<td>C</td>
<td>B</td>
<td>D</td>
</tr>
</tbody>
</table>

(12) Give the Plurality ranking for the above preference schedule.