Question One

(a) All of the random variables except for Caught1.

<table>
<thead>
<tr>
<th>Cheat1</th>
<th>Caught1</th>
<th>Cheat2</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>T</td>
<td>T</td>
<td>14.09</td>
</tr>
<tr>
<td>T</td>
<td>T</td>
<td>F</td>
<td>14.59</td>
</tr>
</tbody>
</table>

(b) Cheat2 is a function of Cheat1 and Caught1:

<table>
<thead>
<tr>
<th>Cheat1</th>
<th>Caught1</th>
<th>Cheat2</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>T</td>
<td>F</td>
</tr>
</tbody>
</table>

(d) Cheat1 Caught1 value

<table>
<thead>
<tr>
<th>Cheat1</th>
<th>Caught1</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>T</td>
</tr>
</tbody>
</table>

(e) Caught1

(f) Cheat1 = T

(g) It is a factor of no variables, namely the number 81.69

(h) 83.18 – 81.69 = 1.49

(i) 83.97 – 81.69 = 2.28

Question Two


(a) For each $i$ would add arcs from $A_j$ and $S_j$ to $A_i$ for all $j < i$.

(b) There is a unique ordering:

<table>
<thead>
<tr>
<th>Variable Eliminated</th>
<th>How</th>
<th>Factors Removed</th>
<th>Factor added</th>
<th>Decision Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_3$</td>
<td>sum</td>
<td>$P(S_3</td>
<td>S_2, A_2)$ $V(S_3)$</td>
<td>$Q(S_2, A_2)$</td>
</tr>
<tr>
<td>$A_2$</td>
<td>max</td>
<td>$Q(S_2, A_2)$ $V(S_2)$</td>
<td>$V(S_2)$</td>
<td></td>
</tr>
<tr>
<td>$S_2$</td>
<td>sum</td>
<td>$P(S_2</td>
<td>S_1, A_1)$ $V(S_2)$</td>
<td>$Q(S_1, A_1)$</td>
</tr>
<tr>
<td>$A_1$</td>
<td>max</td>
<td>$Q(S_1, A_1)$ $V(S_1)$</td>
<td>$V(S_1)$</td>
<td></td>
</tr>
<tr>
<td>$S_1$</td>
<td>sum</td>
<td>$P(S_1</td>
<td>S_0, A_0)$ $V(S_1)$</td>
<td>$Q(S_0, A_0)$</td>
</tr>
<tr>
<td>$A_0$</td>
<td>max</td>
<td>$Q(S_0, A_0)$ $V(S_0)$</td>
<td>$V(S_0)$</td>
<td></td>
</tr>
<tr>
<td>$S_0$</td>
<td>sum</td>
<td>$P(S_0) V(S_0)$</td>
<td>$E$</td>
<td></td>
</tr>
</tbody>
</table>

where $E$ is the expected value.
(c) At the first decision, reset on 4, hold on 3, otherwise flip.
    At the second decision, same as the first decision, except reset on 2.
    At the 3rd decision, same as the first decision, except hold on 2.

(d) It does not affect the optimal policy (it is not even considered when optimizing the policy),
    but affects the expected utility.
    E.g, if it starts at 3 (with probability 1), it always holds with a value of 10. If it starts at
    4 (with probability 1), it has a value of 6.65. (These can be seen in $V(S_0)$.)

(e) At each stage it has to do a sum and a max.
    The sum uses time $O(s^2d)$ (which is the size of the probability), and space $(sd)$ to store
    the resulting factor, but the factor does not need to be kept, and so can be discarded after
    the max (and so the space does not need to be multiplied by $n$).
    The max takes time $O(sd)$, and creates a factor of size $s$, and a decision function of size
    $s$. The decision functions need to be stored forever, so it uses space $O(sn)$.
    So overall the time complexity $O(s^2dn)$. The space complexity is $O(sd + sn)$

**Question Three**

It should not have taken more than a few hours. Most of this should have been in understanding
the material and playing, not in doing busy work. I hope it was reasonable, and you learned
something.