1) a) 22 candidate 3-itemsets are there in total.

1) b)
We are given a transaction that contains items {1, 3, 5, 6, 8}.
The possible 3 candidate sets are listed below.

1,3,5	3,5,6	5,6,8
1,3,6	3,5,8	
1,3,8	3,6,8	
1,5,6		
1,5,8		
1,6,8		

Below hash tree leaf nodes are visited when finding the candidate 3-itemsets contained in the transaction.
L3, L4, L5, L8, L11, L12

1) c) Below candidate itemsets are contained in the transaction {1, 3, 5, 6, 8}
{1, 5, 8}, {1,6,8} {5,6,8} {3,5,6}

2) (a) False.
Given rule: $v \notin S$. If we keep on introducing items in ‘S’ then we can encounter a situation at some point where ‘v’ can be a member of S, means ‘v’ value can be present in ‘S’. This will violate the given rule $v \notin S$. So, this rule is antimonotonic (not monotonic).
Example:
Let v = 10, S = {1,2,3,4,5}
If we keep on adding items to ‘S’ then at some point it will end up having ‘v’ = 10 and it will become S = {1,2,3,4,5,6,7,8,9,10} add the rule is violated.

(b) True.
Given rule: $V \subset S$ which means all the items of V are in S. If we keep on introducing items in ‘S’ then we can encounter a situation at some point where all the items of ‘V’ are present in ‘S’, This will satisfies the given rule $V \subset S$. So, this rule is monotonic (not antimonotonic). The converse of the given rule will not be true which means, we can never encounter a situation where all the items of ‘S’ are present in ‘V’, if we keep on introducing items in ‘S’.
Example: V = {10,20}, S = {10,20,30,40}, This will satisfies the given rule $V \subset S$ at all the times.

(c) True.
Given rule: the avg(S) >= ‘v’.

If the items added to set are >= ‘v’ and it will make average of ‘S’ >= v. If an itemset ‘v’ satisfies a rule, so does itemsets ‘va’ and ‘vab’, which having ‘v’ as a prefix. And hence rule can be converted into a monotonic rule.

3) a) We are asked to consider seat belt as class label.
Seat belt:
YES - 8
NO - 4
|D| = 12
Info (D) = I(8,4) = -8/12*log(8/12) - 4/12*log(4/12) = 0.9182

Weather Condition:
Good = 7,
Bad = 5,
total = 12.
$Info_{wc}$ (D) = 7/12*(-5/7*log(5/7)-2/7*log(2/7)) + 5/12*(-3/5*log(3/5)-2/5*log(2/5))
= 0.9080

Gain(Weather Condition) = $Info_{wc}$ (D) - Info (D) = 0.9182 - 0.9080 = 0.0102

Driver's Condition:
Sober = 7,
AI = 5,
Total = 12
$Info_{dc}$ (D) = 7/12*(-5/7*log(5/7)-2/7*log(2/7)) + 5/12(-3/5*log(3/5)-2/5*log(2/5))
= 0.9080
Gain(Driver's Condition) = $Info_{dc}$ (D) - Info (D) = 0.9182 - 0.9080 = 0.0102

Traffic Violation:
None = 3,
DSS = 3,
DTS = 3,
ESL = 3,
Total = 12
$Info_{tv}$ (D) = 3/12*(-2/3*log(2/3)-1/3*log(1/3)) - (3/12*log(3/12))(0) +
3/12(-1/3*log(1/3)-2/3*log(2/3)) + 3/12(-2/3*log(2/3)-1/3*log(1/3))
= 0.6887

Gain(Traffic Violation) = 0.9182 - 0.6887 = 0.2295

Crash Severity:
Minor = 4,
Major = 8,
Total = 12
$Info_{cs}$ (D) = (-4/12*log(4/12))(0) - (8/12*(4/8*log(4/8)+4/8*log(4/8)))
= 0.6666

Gain(Crash Severity) = 0.9182 - 0.6666 = 0.2516

The attribute with highest information gain will be selected as the splitting attribute. In this case, Crash Severity is selected as splitting attribute of the first node in the tree because it has highest gain value.

3) b)
Weather Condition:
$SplitInfo_{wc}$ (D) = -7/12*log(7/12) - 5/12*log(5/12) = 0.9798
GainRatio(Weather Condition) = Gain(Weather Condition) / $SplitInfo_{wc}$ (D)
= 0.0102 /0.9798 = 0.0104

Driver's Condition:
$SplitInfo_{dc}$ (D) = -7/12*log(7/12) - 5/12*log(5/12) = 0.9798
GainRatio(Driver's Condition) = 0.0102/0.9798 = 0.0104

Traffic Violation:
$SplitInfo_{tv}$ (D) = -3/12*log(3/12) - 3/12*log(3/12) - 3/12*log(3/12) - 3/12*log(3/12) = 2
GainRatio(Traffic Violation) = 0.2295/2 = 0.1147

Crash Severity:
$SplitInfo_{cs}$ (D) = -4/12*log(4/12) - 8/12*log(8/12) = 0.9182
GainRatio(Crash Severity) = 0.2516/0.9182 = 0.2740

Crash Severity is selected as the splitting attribute of the first node in the tree because it has the maximum gain ratio. Here, in this case, the first level of the tree is not different from (a) part.

3) c)
Seat Belt:
possible choices are c_1 = yes, c_2 = no
Probability(Seat Belt = yes) = 8/12
Probability(Seat Belt = no) = 4/12

We are given the below conditions in the question.
weather condition = bad so,
Probability(weather condition = bad|yes) = 3/8
Probability(weather condition = bad|no) = 2/4

driver's condition = sober so,
Probability(driver's condition = sober|yes) = 5/8
Probability(driver's condition = sober|no) = 2/4

traffic violation = none so,
Probability(traffic violation = none|yes) = 2/8
Probability(traffic violation = none|no) = 1/4

crash severity = major so,
Probability(crash severity = major|yes) = 4/8
Probability(crash severity = major|no) = 4/4

Probability(X|seat belt = yes) = (3/8)(5/8)(2/8)(4/8) = 0.0292
Probability(X|seat belt = no) = (2/4)(2/4)(1/4)(4/4) = 0.0625

Probability(X|seat belt = yes)*Probability(seat belt = yes) = 0.0292*(8/12) = 0.0194
Probability(X|seat belt = no)*Probability(seat belt = no) = 0.0625*(4/12) = 0.0208

Probability is high for the case where seat belt is not used for the given attributes. And Naive Bayes will pick the highest probability. So in this case, probably seatbelt is not used.