|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| q | r | (q ^ r) | (q v r) | (q ^ r) -> (q v r) |
| v | v | v | v | v |
| v | f | f | v | v |
| f | v | f | v | v |
| f | f | f | f | v |

4) a) (q ^ r) -> (q v r)

b) p ^ q -> p v q

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| p | q | (p ^q) | (p v q) | (p ^q) -> (p v q) |
| v | v | v | v | v |
| v | f | f | v | v |
| f | v | f | v | v |
| f | f | f | f | v |

c) ~ (p -> (~p -> q))

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| p | q | ~p | (~p -> q) | p -> (~p -> q) | ~ |
| v | v | f | v | v | f |
| v | f | f | v | v | f |
| f | v | v | v | v | f |
| f | f | v | f | v | f |

d) (p ^ q) -> (p <-> q)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| p | q | (p ^ q) | (p <-> q) | (p ^ q) -> (p <->q) |
| v | v | v | v | v |
| v | f | f | f | v |
| f | v | f | f | v |
| f | f | f | v | v |

e) p v ~p

|  |  |  |
| --- | --- | --- |
| p | ~p | P v ~p |
| v | f | v |
| f | v | v |