## Opgave 5.31

(g) 
$$p \wedge (q \vee r) \vdash (p \wedge q) \vee (p \wedge r)$$

| 1  | $p \wedge (q \vee r)$                         | ass                  |
|----|---|----------------------|
| 2  | p   | $\wedge E$ , 1       |
| 3  | $(q \lor r)$                                  | $\wedge E$ , 1       |
| 4  | <u> </u>                                      | ass                  |
| 5  | $(p \land q)$ $(p \land q) \lor (q \lor r)$   | $\wedge I, 2, 4$     |
| 6  |   | $\vee I, 5$          |
| 7  |   | ass                  |
| 8  | $(p \wedge r)$                                | $\land I, 2, 7$      |
| 9  | $(p \wedge r)$ $(p \wedge q) \vee (q \vee r)$ | ∨I, 8                |
| 10 | $(p \land q) \lor (q \lor r)$                 | $\forall I, 1, 6, 9$ |
|    |   |                      |

# Opgave 5.32

(2) 
$$p \wedge (q \wedge r) \vdash r \wedge p$$

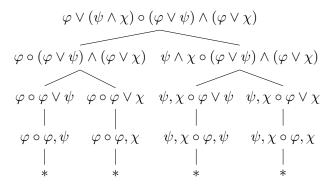
(3) 
$$p \to (q \land r), q \to s, p \vdash s$$

$$\begin{array}{c|cccc} 1 & p \rightarrow (q \wedge r) & \text{ass} \\ 2 & q \rightarrow s & \text{ass} \\ 3 & p & \text{ass} \\ 4 & (q \wedge r) & \Rightarrow \text{E, 1, 3} \\ 5 & q & \wedge \text{E, 4} \\ 6 & s & \Rightarrow \text{E, 2, 5} \end{array}$$

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#### Opgave 5.33

(2) 
$$\varphi \lor (\psi \land \chi); (\varphi \lor \psi) \land (\varphi \lor \chi)$$



#### Opgave 5.37

(2) 
$$\varphi \leftrightarrow \psi$$
;  $(\varphi \rightarrow \psi) \land (\psi \rightarrow \varphi)$ 

$$\varphi \leftrightarrow \psi \circ (\varphi \to \psi) \land (\psi \to \varphi)$$

$$\varphi, \psi \circ (\varphi \to \psi) \land (\psi \to \varphi) \qquad \circ \varphi, \psi, (\varphi \to \psi) \land (\psi \to \varphi)$$

$$\varphi, \psi \circ \varphi \to \psi \quad \varphi, \psi \circ \psi \to \varphi \quad \circ \varphi, \psi, \varphi \to \psi \quad \circ \varphi, \psi, \psi \to \varphi$$

$$| \qquad \qquad | \qquad \qquad | \qquad \qquad |$$

$$\varphi, \psi \circ \psi \qquad \varphi, \psi \circ \varphi \qquad \varphi \circ \varphi, \psi \qquad \psi \circ \varphi, \psi$$

$$| \qquad \qquad | \qquad \qquad | \qquad \qquad |$$

$$* \qquad * \qquad * \qquad *$$

(3) 
$$\varphi \to \psi; \neg \psi \to \neg \varphi$$

$$\varphi \rightarrow \psi \circ \neg \psi \rightarrow \neg \varphi$$

$$| \neg \psi, \varphi \rightarrow \psi \circ \neg \varphi$$

$$| \varphi \rightarrow \psi \circ \neg \varphi, \psi$$

$$| \varphi, \varphi \rightarrow \psi \circ \psi$$

$$\varphi \circ \varphi, \psi \circ \varphi, \psi \circ \psi$$

$$| | | | |$$

$$*$$

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### Opgave 5.38

$$(3) \ ((p \rightarrow q) \land (q \rightarrow r)) \rightarrow (p \rightarrow r)$$

$$\circ \ ((p \rightarrow q) \land (q \rightarrow r)) \rightarrow (p \rightarrow r)$$

$$| \qquad \qquad | \qquad \qquad |$$

$$(p \rightarrow q) \land (q \rightarrow r) \circ p \rightarrow r$$

$$| \qquad \qquad | \qquad \qquad |$$

$$p, p \rightarrow q, q \rightarrow r \circ r$$

$$p, q \rightarrow r \circ p, r$$

$$| \qquad \qquad | \qquad \qquad |$$

$$p, q \rightarrow r \circ r \qquad p \circ p, q, r \quad p, r \circ p, r$$

$$| \qquad \qquad | \qquad \qquad |$$

$$| \qquad |$$

$$| \qquad |$$

$$| \qquad \qquad |$$

$$| \qquad |$$

#### Opgave 5.53

Geef de semantische tableauregels voor de Quine dolk †.

 $\bullet$  † - links

$$\phi \dagger \psi \circ \\
| \\
\circ \phi, \psi$$

 $\bullet$  † - rechts

$$\phi \circ \phi \dagger \psi$$
 $\phi \circ \psi \circ$ 

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