Ex 1

b

Ex 2

c

Ex 3

a

Ex 4

$$\neg p \vee \neg q \vee r$$
$$\neg q \vee \neg p \vee r$$

T

$\neg(p \vee q) \vee r$

$(\neg p \wedge \neg q) \vee r$

$\underset{F}{\neg p \vee r} \wedge \underset{T}{\neg q \vee r}$

F

$r = F$
$q = F$
$p = T$

② $\exists x \forall z \neg P(\cdot\ \cdot)$

① $\neg(\neg p \vee q) \vee r$

$\equiv (p \wedge \neg q) \vee r$

$\equiv p \vee r \wedge \neg q \vee r$

$q = T$
$r = F$
$p = F$

$p \rightarrow (q \rightarrow r)$

$\equiv \neg p \vee (\neg q \vee r)$

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

$\equiv (\neg p \vee q) \wedge (\neg p \vee r)$ ①

$\equiv \neg p \vee \neg p \wedge r \vee q \wedge \neg p \vee q \wedge r$

$\equiv \neg p \vee q \wedge r$

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

$\equiv (\neg p \vee r) \wedge (\neg q \vee r)$

$\equiv \neg p \wedge \neg q \vee \neg p \wedge r \vee r \wedge \neg q \vee r \wedge r$

$$\equiv \neg p \wedge \neg q \vee r \wedge (\neg q \vee \neg p \vee T)$$

$$\equiv \neg p \wedge \neg q \vee r$$

$$\neg(p \vee q) \vee r$$

$$\neg p \wedge \neg q \vee r$$

Ex 6.

1. $(s \lor g) \to (h \land r)$
2. $s \to h \land r$ (equivalence)
3. $s \to h$ (simplification)
4. $s \to r$
5. $\neg r$ (premise)

---

6. $\neg s$. M.T

2

$\forall x\,(P(x) \vee Q(x))$ 1 Premise

$P(a) \vee Q(a)$ 2 U.I. 1

$\forall x\,(\neg Q(x) \vee S(x))$ 3 Premise

$\neg Q(a) \vee S(a)$ 4 U.I 2

$P(a) \vee S(a)$ 5 Resolução 2 4

$\exists x\, \neg P(x)$ 6 Premise

$\neg P(c)$ 7 E.I. 6

$S(c)$ 8 Disjunct. Syll. 5 7

$\forall x\,(R(x) \to \neg S(x))$ 9

$R(c) \to \neg S(x)$ (10) U. I. (9)

$S(c) \to \neg R(c)$ (11) Contrapositive (10)

$\neg R(c)$ (12) M. P. (8) (11)

$\exists x \neg R(x)$ E. G (12)

$p \to (q \to p)$

$\neg p \vee (q \to p)$ (condit. eq.)

$\neg p \vee \neg q \vee p$

$(\neg p \vee p) \vee \neg q$ (asociat.)

$T \vee \neg q$ (negation law)

T (domination)

$$\boxed{\sum_{k=1}^{10} k = 55}$$

We can make 10 groups of 3 consecutive integers once they are placed.

Let's assume their sum is for all < 17.

$$16 \cdot 10 = \underline{160}$$

We also know that each elements appear in 3 diff groups

$$3 \cdot \sum_{k=1}^{10} k = 3 \cdot 55$$
$$= \underline{165.}$$

$$165 > 160$$