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1a) For every object J, if J is a square then J has four sides.

- i. All squares have four sides.
- ii. Every square has four sides.
- iii. If an object is a square, then it has four sides.
- iv. If J is square, then J has four sides.
- v. For every square J, has four sides.

b) Every positive number has a positive square root.

- i. All Positive numbers have a positive square root.
- ii. For every positive number e, there is a positive square root for e
- iii. For every positive number e there is a positive number r such that r is the square root to e.

c)

- i. . There is a real number r such that the product of r leaves the number unchanged.
- ii. There is a real number r with the property that for every real number s, the product of s and r leaves s unchanged.

2.  $A \{w,x,y,z\} * B\{a,b\} = 4 * 2 = 8$  there are 8 elements.

$\{w,a\} \{w,b\} \{x,a\}, \{x,b\} ,\{y,a\} \{y,b\} \{z,a\} \{z,b\}$

$B\{a,b\} * A \{w,x,y,z\} = 2 * 4 = 8$  there are 8 elements.

$\{a,w\} \{a,x\} \{a,y\}, \{a,z\} \{b,w\} \{b,x\} \{b,y\}, \{b,z\}$

$A \{w,x,y,z\} * A\{w,x,y,z\} = 4 * 4 = 16$  there are 16 elements.

$\{w,w\} \{w,x\} \{w,y\}, \{w,z\} \{x,w\} \{x,x\} \{x,y\}, \{x,z\} \{y,w\} \{y,x\} \{y,y\}, \{yz\} \{z,w\} \{z,x\} \{z,y\}, \{z,z\}$

$B\{a,b\} * B\{a,b\} = 2 * 2 = 4$  there are 4 elements.

$\{a,a\} \{a,b\} \{b,a\} \{b,a\}$

3.

$\{0001\} \{0010\} \{0100\} \{1000\} \{0000\}$

4. (a) if you have the flu then you miss the final examination.

b) if you miss the final examination then you will not pass the course.

c) You have the flu or you miss the final examination or you pass the course

d) if you have the flu then you do not pass the course or if you miss the final examination then you do not pass the course.

e) you have the flu and you miss the final examination or you do not miss the examination and you pass the course.

5.

5 a)

$p$	$\neg p$	$p \wedge \neg p$
T	F	F
F	T	F

b)

$p$	$\neg p$	$p \vee \neg p$
T	F	T
F	T	T

c)

$p$	$q$	$r$	$\neg q$	$p \vee \neg q$	$(p \vee \neg q) \rightarrow r$
T	T	T	F	T	T
T	T	F	F	T	F
T	F	T	T	T	T
T	F	F	T	T	F
F	T	T	F	F	T
F	T	F	F	F	T
F	F	T	T	T	T
F	F	F	T	T	F

(e)

$p$	$q$	$p \rightarrow q$	$q \rightarrow p$	$(p \rightarrow q) \rightarrow (q \rightarrow p)$
T	T	T	T	T
T	F	F	T	F
F	T	T	F	F
F	F	T	T	T

(d)

$p$	$q$	$(p \vee q)$	$(p \wedge q)$	$(p \vee q) \rightarrow (p \wedge q)$
T	T	T	T	T
T	F	T	F	F
F	T	T	F	F
F	F	F	F	T

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6.

$$6.a) (\neg \vee (\neg p \wedge q)) \equiv \neg p \wedge \neg q$$

$$\neg(p \vee (\neg p \wedge q)) \quad \text{De Morgan's law}$$

$$\neg p \wedge (\neg \vee \neg q) \quad \text{Distributive law}$$

$$(\neg p \wedge \neg q) \vee (\neg p \vee \neg q) \quad \text{Negation law}$$

$$\neg \vee (\neg p \vee \neg q) \quad \text{Identity}$$

$$\neg \vee \neg q \quad \text{Ans}$$

$$b) (p \wedge q) \rightarrow (p \vee q) \equiv \neg \vee$$

$$\neg(p \vee q) \vee (p \vee q) \quad \text{Demorgan}$$

$$(\neg p \vee \neg q) \vee (p \vee q) \quad \text{Associate-law}$$

$$\neg p \vee \neg q \vee p \vee q \quad \text{Commutative law}$$

$$p \vee \neg p \vee q \vee \neg q \quad \text{Negation law}$$

$$\neg \vee \vee \vee \quad \text{Idempotent law}$$

$$\boxed{\neg \vee}$$

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

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

$$\neg p \vee (q \vee r) \quad \text{Associative law}$$

$$(\neg p \vee q) \vee r \quad \text{De Morgan}$$

$$\boxed{\neg(p \wedge \neg q) \vee r} \quad \text{Ans}$$

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

$$\neg p \vee (\neg q \vee r) \quad \text{Associative law}$$

$$(\neg p \vee \neg q) \vee r \quad \text{De Morgan}$$

$$\boxed{\neg(p \wedge q) \vee r} \quad \text{Ans}$$