1a:

p	Q	p→Q	$\bar{p}$	$\bar{p}$ V Q	E
0	0	1	1	1	1
0	1	1	1	1	1
1	0	0	0	0	1
1	1	1	0	1	1

$E = (p \to Q) \equiv (\bar{p} \vee Q)$

The expression is always true. Tautology.

1b.

p	Q	r	$\bar{p}$	A	B	C
0	0	0	1	1	1	1
0	1	0	1	1	1	1
0	0	1	1	1	1	1
0	1	1	1	1	1	1
1	0	0	0	0	1	1
1	1	0	0	0	0	0
1	0	1	0	1	1	1
1	1	1	0	1	1	1

$A = (r \vee \bar{p})$

$B = (Q \to (r \vee \bar{p}))$

$C = (p \to (Q \to (r \vee \bar{p})))$

1c.

p	Q	p V Q	p ∧ Q	E
0	0	0	0	1
0	1	1	0	0
1	0	1	0	0
1	1	1	1	1

$E = (p \vee Q) \to (P \wedge Q)$

2a.

p	Q	⊗
0	0	0
0	1	1
1	0	1
1	1	0

2b. $p \otimes Q \equiv Q \otimes p$
so $p \otimes Q$ is commutative.

To show it's associative, assume $p \otimes (Q \otimes r)$. It doesn't matter which order the XOR is performed and $p \otimes (Q \otimes r) \equiv Q \otimes (p \otimes r)$ so it's also associative.

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3. sum-of-products 1

a:

row 1: $\bar{p}\bar{Q}r$

row 4: $p\bar{Q}\bar{r}$

row 5: $p\bar{Q}r$

row 6: $pQ\bar{r}$

row 7: pQr

b:

row 0: $\bar{p}\bar{Q}\bar{r}$

row 1: $\bar{p}\bar{Q}r$

row 2: $\bar{p}Q\bar{r}$

a: $\bar{p}\bar{Q}r + p\bar{Q}\bar{r} + p\bar{Q}r + pQ\bar{r} + pQr$

b: $\bar{p}\bar{Q}\bar{r} + \bar{p}\bar{Q}r + \bar{p}Q\bar{r}$

4. product of sums 0

a:

row 0: $(\bar{p} + \bar{Q} + \bar{r})$

row 2: $(\bar{p} + Q + \bar{r})$

row 3: $(\bar{p} + Q + r)$

b:

row 3: $(\bar{p} + Q + r)$

row 4: $(p + \bar{Q} + \bar{r})$

row 5: $(p + \bar{Q} + r)$

row 6: $(p + Q + \bar{r})$

row 7: $(p + Q + r)$

a: $(\bar{p} + \bar{Q} + \bar{r})(\bar{p} + Q + \bar{r})(\bar{p} + Q + r)$

b: $(\bar{p} + Q + r)(p + \bar{Q} + \bar{r})(p + \bar{Q} + r)(p + Q + \bar{r})(p + Q + r)$

z:

row 0: $(\bar{x} + \bar{y} + \bar{c})$

row 3: $(\bar{x} + y + c)$

row 5: $(x + \bar{y} + c)$

row 6: $(x + y + \bar{c})$

z: $(\bar{x} + \bar{y} + \bar{c})(\bar{x} + y + c)(x + \bar{y} + c)(x + y + \bar{c})$

5. PQ

a:

rs \ PQ	00	01	11	10
00	0	1	1	1
01	1	1	1	1
11	1	1	0	1
10	1	1	1	1

b: PQ

rs \ PQ	00	01	11	10
00	1	1	1	1
01	1	1	0	1
11	1	0	0	0
10	1	1	0	1

c: PQ

rs \ PQ	00	01	11	10
00	0	1	0	1
01	1	0	1	0
11	0	1	1	1
10	1	0	1	0

d: PQ

rs \ PQ	00	01	11	10
00	1	1	1	1
01	1	1	1	1
11	1	1	1	1
10	1	1	0	1

e: PQ

rs \ PQ	00	01	11	10
00	1	1	0	1
01	1	1	0	1
11	1	1	0	0
10	1	1	0	0

Scanned with CamScanner

6.

a: $r\bar{s} + \bar{p}s + \bar{r}s + Qr + p\bar{Q}$

b: $\bar{p}\bar{r} + \bar{p}\bar{Q} + \bar{p}\bar{Q}$

c: $pQS + rSQ$

d: $\bar{Q}\bar{S} + S + \bar{p}r$

e: $\bar{p}\bar{Q} + \bar{p}Q + \bar{r}p\bar{Q}$

We use all the prime implicants to create sums above.

7a: tautology

7b: Tautology

p	Q	r	p→Q	Q→r	+	p→r	E
0	0	0	1	1	1	1	1
0	1	0	1	0	0	1	1
0	0	1	1	1	1	1	1
0	1	1	1	1	1	1	1
1	0	0	0	1	0	0	1
1	1	0	1	0	0	0	1
1	0	1	0	1	0	1	1
1	1	1	1	1	1	1	1

7c. <u>NOT</u> a tautology

p	Q	p→Q	E
0	0	1	0
0	1	1	0
1	0	0	1
1	1	1	0

p	Q	r	Q+r	p≡Q+r	pr	Q→pr	E
0	0	0	0	1	0	1	1
0	1	0	1	0	0	0	1
0	0	1	1	0	0	1	1
0	1	1	1	0	0	0	1
1	0	0	0	0	0	1	1
1	1	0	1	1	0	0	0
1	0	1	1	1	1	1	1
1	1	1	1	1	1	1	1

7d. <u>NOT</u> a tautology

8. DeMorgan's law

$\neg(p \vee Q) \equiv \neg p \wedge \neg Q$

$\neg(P \wedge Q) \equiv \neg p \vee \neg Q$

8a: $\overline{(pQ + \bar{p}r)}$

$\overline{pQ} \wedge \cancel{\overline{\overline{pr}}}$

$\boxed{(\bar{p} + \bar{Q})(pr)}$

8b. $\overline{\bar{p} + Q(\overline{r+\bar{s}})}$

$(\bar{\bar{p}})(\overline{Q(\overline{r+\bar{s}})})$

$(p)(\bar{Q} + \cancel{\overline{\overline{(r+\bar{s})}}})$

$\boxed{(p)(Q + r + \bar{s})}$