1. revenue was 138 billion for Acme Comps
   net profit was 8 billion for Acme Comps

   87b for Nadir Soft
   5b of net for Nadir Soft

   111b for Medcle
   13b of net for Medcle

   a) F b) T c) T d) T e) T

2. p — it's below freezing
   q — it's snowing

   a) $p \wedge q$
   b) $p \wedge \neg q$
   c) $\neg p \wedge \neg q$
   d) $p \vee q$
   e) $p \rightarrow q$
   f) $(p \vee q) \wedge (p \rightarrow \neg q)$
   g) $p \leftrightarrow q$

3. a) 2
    b) 16
    c) 64
    d) 16

4. $p \wedge \neg q$

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

$p \vee \neg q$

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

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

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

$(p \lor q) \to (p \land q)$

p	q	$p \lor q$	$p \land q$	$(p \lor q) \to (p \land q)$
T	F	T	F	F
T	T	T	T	T
F	F	F	F	T
F	T	T	F	F

5. p - first prof.

     q - second prof.

      z - third prof.

    $p = T$ or F

     $q = T$ or F

      $z = T$

6. $p \land q$ $\neg(p \land q) = \neg p \lor \neg q$ — Jon isn't rich or Jon isn't happy

     $p \lor q$ $\neg(p \lor q) = \neg p \land \neg q$ — Carlos won't bicycle and he won't run

7. $(p \land q) \to p \equiv \neg(p \land q) \lor p \equiv (\neg p \lor \neg q) \lor p \equiv$

$\neg p \lor \neg q \lor p = \neg q \lor T = T$

$p \to (p \lor q) = \neg p \lor (p \lor q) = \neg p \lor p \lor q = T \lor q = T$

$\neg p \to (p \to q) = \neg p \to (\neg p \lor q) = p \lor (\neg p \lor q) =$

$= p \lor \neg p \lor q = q \lor T = q$

$(p \wedge q) \rightarrow (p \rightarrow q) = (p \wedge q) \rightarrow (\neg p \vee q) =$

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

$= \neg p \vee \neg q \vee \neg p \vee q = \neg p \vee T = T$

$\neg(p \rightarrow q) \rightarrow p = (p \rightarrow q) \vee p = (\neg p \vee q) \vee p = \neg p \vee q \vee p =$

$= T \vee q = T$

8. $P(x)$ — x can speak English V — domain of all students

   $Q(x)$ — x knows $C++$ at school

a) $\exists x (P(x) \wedge Q(x))$

b) $\exists x (P(x) \wedge \neg Q(x))$

c) $\forall x (P(x) \vee Q(x))$

d) $\forall x (\neg P(x) \wedge \neg Q(x))$

9. a) T

   b) F

   c) T

   d) F

10. domain: $0, 1, 2, 3, 4$

   a) $P(0) \vee (P(1)) \vee P(2) \vee P(3) \vee P(4)$

   b) $P(0) \wedge P(1) \wedge P(2) \wedge P(3) \wedge P(4)$

   c) $\neg P(0) \vee \neg P(1) \vee \neg P(2) \vee \neg P(3) \vee \neg P(4)$

   d) $\neg P(0) \wedge \neg P(1) \wedge \neg P(2) \wedge \neg P(3) \wedge \neg P(4)$

   e) $\neg(P(1) \wedge P(2) \wedge P(3) \wedge P(4))$

   f) $\neg(P(1) \vee P(2) \vee P(3) \vee P(4))$

11.

	the class	the universe
a)	$\exists x\, P(x)$	$\exists x\,(S(x) \wedge P(x))$
b)	$\forall x\, Q(x)$	$\forall x\,(S(x) \rightarrow Q(x))$
c)	$\exists x\, \neg J(x)$	$\exists x\,(S(x) \wedge \neg J(x))$
d)	$\exists x\, Z(x)$	$\exists x\,(S(x) \wedge Z(x))$
e)	$\forall x\, \neg F(x)$	$\forall x\,(S(x) \rightarrow \neg F(x))$

12. $M(x,y)$ — x sent e-mail to y

$T(x,y)$ - x telephoned to y

domain — all students in class

a) $\neg M(\text{Chaa}, \text{Kono})$

b) $\neg M(\text{Arlene}, \text{Sarah}) \wedge \neg T(\text{Arlene}, \text{Sarah})$

c) $\neg M(\text{Deborah}, \text{Jose})$

d) $\forall x\, M(x, \text{Ken})$

e) $\forall x\, \neg T(x, \text{Nino})$

f) $\forall x\,(M(x, \text{Avi}) \vee T(x, \text{Avi}))$

g) $\exists x\, \forall y\,(x \neq y \rightarrow M(x,y))$

h) $\exists x\, \forall y\,(x \neq y \rightarrow (M(x,y) \vee T(x,y)))$

i) $\exists x\, \exists y\,(x \neq y \wedge M(x,y) \wedge M(y,x))$

j) $\exists x\, M(x,x)$

k) $\exists x\, \forall y\,(x \neq y \rightarrow \neg(M(y,x) \wedge T(y,x)))$

l) $\forall x\, \exists y\,(x \neq y \wedge (M(x,y) \vee T(x,y)))$

m) $\exists x\, \exists y\,(x \neq y \wedge M(x,y) \wedge T(y,x))$

n) $\exists x \exists y (x \neq y \land \forall z (z \neq x \land z \neq y \rightarrow (M(x,z) \lor M(y,z) \lor T(x,z) \lor T(y,z))))$