Section 1.1

10a) \( r \land q \)
b) \( p \land q \land r \)
c) \( r \rightarrow p \)
d) \( (p \land q) \land r \)
e) \( (p \land q) \rightarrow r \)
f) \( r \leftrightarrow (p \lor q) \)

22a) converse:
"If I stay home, then it will snow tonight"

Inverse:
"If it does not snow tonight, I will not stay home"

c.p.:
"If I do not stay home, then it will not snow tonight"

24d) \[
\begin{array}{c|c|c|c|c|c}
 p & q & p \land q & p \lor q & (p \land q) \rightarrow (p \lor q) \\
\hline
 T & T & T & T & T \\
 T & F & F & T & T \\
 F & T & F & T & T \\
 F & F & F & F & T \\
\end{array}
\]
z8 f) omitted

z9 c) omitted (it is a tautology)

Section 1.2

4a, b) omitted, but truth tables verify the identities.

5. omitted

6. omitted

8d. Tautology: omitted

22. \((p \Rightarrow q) \lor (p \Rightarrow r) \equiv (\neg p \lor q) \lor (\neg p \lor r)\)
   \equiv (\neg p \lor q) \lor (\neg q \lor r)
   \equiv \neg p \lor (q \lor r)
   \equiv p \Rightarrow (q \lor r)

Section 1.5

8a) \(p = "I\ play\ hockey"

q = "I\ am\ sore\ the\ next\ day"

r = "I\ use\ the\ whirlpool"

Then, the premises are:

\(p \Rightarrow q\)

\(q \Rightarrow r\)

\(\neg r\)

Therefore \((\vdash)\ \neg q\) by modus tollens

and \(p \Rightarrow q\) by modus tollens.
So, we conclude "I am not sore"
\[ \Rightarrow " \text{I do not play hockey (today)}" \]

8f) \( p = " \text{I am dreaming}\)"
\( q = " \text{I am hallucinating}\)"
\( r = " \text{I see elephants...}\)"

Then, the premises are:
\[ p \lor q \]
\[ \neg p \]
\[ q \Rightarrow r \]

\[ \therefore q \] by disjunctive syllogism
\[ \therefore r \] by modus ponens

Therefore, "I am hallucinating" and
"I see elephants..."

Section 2.5

2a) \((101000001)_2\)
   b) \((1111111111)_2\)
   c) \((110001001000110000)_2\)

4a) 27
   b) 693
   c) 958
   d) 31775
Bonus)

I) Ask one of the guards:
   "If you were the truth-teller, then would you ..."
   
   You can argue from a \( p \Rightarrow q \) question for either guard

\[ x = \text{some poem} \]
\[ I(x) = "x \text{ is interesting}" \]
\[ P(x) = "x \text{ is popular among people of taste}" \]
\[ M(x) = "x \text{ is modern}" \]
\[ \neg M(x) = "x \text{ is ancient}" \]
\[ Y(x) = "x \text{ is yours}" \]
\[ S(x) = "x \text{ is about soap bubbles}" \]
\[ A(x) = "x \text{ is affected}" \]

So, the premises and their contrapositives are

\[ \neg I(x) \Rightarrow P(x) \quad \neg A(x) \Rightarrow \neg I(x) \]
\[ M(x) \Rightarrow A(x) \quad \neg A(x) \Rightarrow \neg M(x) \]
\[ \neg Y(x) \Rightarrow S(x) \quad \neg S(x) \Rightarrow \neg Y(x) \]
\[ P(x) \Rightarrow \neg A(x) \quad \neg A(x) \Rightarrow \neg P(x) \]
\[ S(x) \Rightarrow M(x) \quad \neg M(x) \Rightarrow \neg S(x) \]

So, \[ \neg Y(x) \Rightarrow S(x) \Rightarrow M(x) \Rightarrow A(x) \Rightarrow \neg P(x) \Rightarrow \neg I(x) \]

Thus, if \( x \) is your poem, then it is affected, unpopular and uninteresting.
Ⅲ) 98 mice minimum are guaranteed to live. The reason is given in solution set #3.