(1a) \((p \land q) \rightarrow q\)

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<table>
<thead>
<tr>
<th></th>
<th>T</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
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<td>F</td>
</tr>
<tr>
<td>q</td>
<td>T</td>
<td>T</td>
</tr>
</tbody>
</table>
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(1b) \((p \lor (q \lor r)) \rightarrow (p \land (q \lor r))\)

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</thead>
<tbody>
<tr>
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<td>T</td>
<td>F</td>
</tr>
<tr>
<td>q</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>r</td>
<td>T</td>
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</tr>
</tbody>
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(1c) \((p \land r) \iff (~r \lor ~q)\)

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<tbody>
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<tr>
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<td>T</td>
</tr>
<tr>
<td>q</td>
<td>T</td>
<td>F</td>
</tr>
</tbody>
</table>
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(1d) \((p \rightarrow q) \land (p \land r)\)

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<table>
<thead>
<tr>
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<th>F</th>
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</thead>
<tbody>
<tr>
<td>p</td>
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<td>F</td>
</tr>
<tr>
<td>q</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>r</td>
<td>T</td>
<td>T</td>
</tr>
</tbody>
</table>
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(1e) \(q \rightarrow ((r \lor p) \iff (r \land p))\)

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<table>
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<th></th>
<th></th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>p</td>
<td>T</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>r</td>
<td>T</td>
<td>T</td>
<td>T</td>
</tr>
</tbody>
</table>
```

(1f) \(( (p \leftrightarrow q) \leftrightarrow (r \leftrightarrow q) ) \vee \sim r\)

(1g) \(r \rightarrow ((\sim q \& p) \vee ((q \rightarrow r) \vee \sim (r \leftrightarrow p)))\)

(1h) \(((r \vee q) \leftrightarrow (q \leftrightarrow ((q \& r) \vee p))) \rightarrow \sim r\)
My apologies for an error in this exercise. The formula \( \neg(p \vee \neg q) \) should not be included here. The truth tables for the other two formulae are shown below. The two formulae have the same truth value for every possible combination of values for \( p \) and \( q \). In other words, these two formulae cannot have different truth values and therefore are equivalent. In addition, they are equivalent to \( p \rightarrow q \) (compare the truth table on p. 29).

\[
\begin{array}{c|c|c|c}
\text{p} & \text{q} & \neg p \vee q \\
\hline
T & T & T & \text{FvT gives T} \\
T & F & F & \text{FvF gives F} \\
F & T & T & \text{TvT gives T} \\
F & F & T & \text{TvF gives T} \\
\end{array}
\]

\[
\begin{array}{c|c|c|c}
\text{p} & \text{q} & \neg q \rightarrow \neg p \\
\hline
T & T & T & \text{F\rightarrow F gives T} \\
T & F & F & \text{T\rightarrow F gives F} \\
F & T & T & \text{F\rightarrow T gives T} \\
F & F & T & \text{T\rightarrow T gives T} \\
\end{array}
\]
Following on from exercise (2), we know that the two formulae \( \sim p \lor q \) and \( p \rightarrow q \) are equivalent. That is, on every possible combination of truth values for \( p \) and \( q \), these two formulae have the same truth value – either they are both true (line 1 in the truth table below), or they are both false (line 4). Therefore the whole formula \( (\sim p \lor q) \leftrightarrow (p \rightarrow q) \) is always true.

<table>
<thead>
<tr>
<th>( p )</th>
<th>( q )</th>
<th>( p \leftrightarrow q )</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>T</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>F</td>
<td>T</td>
<td>F</td>
</tr>
<tr>
<td>F</td>
<td>F</td>
<td>T</td>
</tr>
</tbody>
</table>

We can also construct the truth table for the formula:

<table>
<thead>
<tr>
<th>( p )</th>
<th>( q )</th>
<th>( (\sim p \lor q) \leftrightarrow (p \rightarrow q) )</th>
</tr>
</thead>
</table>
| T      | T      | \( (\sim T \lor T) \leftrightarrow (T \rightarrow T) \)
|        |        | \( (F \lor T) \leftrightarrow (T \rightarrow T) \)
|        |        | \( (F \lor T) \leftrightarrow (T \rightarrow T) \)
|        |        | \( (F \lor F) \leftrightarrow (F \rightarrow F) \)
| T      | F      | \( (\sim T \lor F) \leftrightarrow (T \rightarrow F) \)
|        |        | \( (F \lor T) \leftrightarrow (F \rightarrow F) \)
|        |        | \( (F \lor T) \leftrightarrow (F \rightarrow T) \)
|        |        | \( (F \lor F) \leftrightarrow (F \rightarrow F) \)
| F      | T      | \( (\sim F \lor T) \leftrightarrow (T \rightarrow T) \)
|        |        | \( (T \lor F) \leftrightarrow (T \rightarrow T) \)
|        |        | \( (T \lor T) \leftrightarrow (T \rightarrow T) \)
|        |        | \( (F \lor F) \leftrightarrow (F \rightarrow F) \)
| F      | F      | \( (\sim F \lor F) \leftrightarrow (F \rightarrow F) \)
|        |        | \( (F \lor F) \leftrightarrow (F \rightarrow F) \)
|        |        | \( (F \lor F) \leftrightarrow (F \rightarrow F) \)

4
(4) Baltimore is not in Singapore – Baltimore is in Maryland, USA, so the antecedent of both conditional sentences is false. Accordingly, the truth value for both these conditional sentences will be calculated from lines 3 and 4 of the truth table. Assume for the sake of argument that Elvis is dead. Then (a) is true according to line 3 and (b) is true according to line 4. (Alternatively, if we assume that Elvis is alive, then (a) is true on line 4 and (b) is true on line 3.)

\[
\begin{array}{ccc}
p & q & p \rightarrow q \\
line 1 & T & T & T \\
line 2 & T & F & F \\
line 3 & F & T & T \\
line 4 & F & F & T \\
\end{array}
\]

One way to describe the mismatch with natural language is that in a natural language conditional, we generally assume that the consequent 'follows from' the antecedent. We would generally not assume that two statements that contradict each other ('Elvis is dead', 'Elvis is alive') could follow from the same antecedent.

Another point about sentences like this in natural language is that an antecedent which is known to be false is usually signalled with the subjunctive form of the verb. Subjunctivity in English is expressed by using a different tense form, e.g.:

(c) If Baltimore was in Singapore then Elvis would be dead.
(d) If Baltimore was in Singapore then Elvis would be alive.

Even though (a) and (b) are both judged to be true as a material implication, notice that (c) and (d) really are contradictory. We will revisit this problem in Chapter 5.

(5) (a) (i) He got on his horse and rode into the sunset.
(ii) He rode into the sunset and got on his horse.
(b) (i) Jake stepped on a ball-bearing and nearly fell.
(ii) Jake nearly fell and stepped on a ball bearing.

We usually interpret sentences like these as narrating the events in the order of occurrence, and if plausible, with a causal link as well – e.g.:

(a)(i) 'Having mounted his horse, he rode his horse into the sunset.'
(a)(ii) 'He rode into the sunset somehow (by train?), and subsequently got on his horse.'
(b)(i) 'Jake stepped on a ball-bearing, which subsequently caused him to nearly fall (the ball made his foot slip).'
(b)(ii) 'For some reason Jake nearly fell, and while he was off balance he stepped on a ball-bearing.'

(Note that even the less plausible sequences in (ii) are still salient interpretations.)

The implicature of temporal sequence is information-strengthening, also called R-implicature or Informativeness 2. Given the implicature, we can still use logical conjunction as the literal meaning of and in these sentences.

(6) The truth values for the component propositions are:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ireland is surrounded by sea</td>
<td>T</td>
</tr>
<tr>
<td>Ireland is connected to Wales</td>
<td>F</td>
</tr>
<tr>
<td>Ireland is an island</td>
<td>T</td>
</tr>
</tbody>
</table>
Accordingly, the two conditional sentences, analysed as implication, are both true:

(a) Ireland is surrounded by sea → Ireland is an island

\[
\begin{array}{ccc}
T & \rightarrow & T \\
\hline \\
T & & \\
\end{array}
\]

(b) Ireland is connected to Wales → Ireland is an island

\[
\begin{array}{ccc}
F & \rightarrow & T \\
\hline \\
T & & \\
\end{array}
\]

Sentence (a) illustrates a common information-strengthening implicature (also called R-implicature) with conditional sentences, that what the antecedent describes is somehow the cause of what the consequent describes. In this case, the implicature is that Ireland is an island because it is surrounded by sea.

Even though the antecedent in (b) is false, the same implicature (that the antecedent state of affairs causes the consequent state of affairs) still arises, giving the odd interpretation that, (even though Ireland is not connected to Wales in fact), if the two countries were connected, then Ireland would be an island because of the connection with Wales.

(7) The truth table for inclusive disjunction is:

<table>
<thead>
<tr>
<th>p</th>
<th>q</th>
<th>p v q inclusive</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>T</td>
<td>F</td>
<td>T</td>
</tr>
<tr>
<td>F</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>F</td>
<td>F</td>
<td>F</td>
</tr>
</tbody>
</table>

On line 1, inclusive or has the same truth value as p&q. Suppose the situation is that p and q are both true. In that case, the strongest, most specific statement one could make would be p&q, excluding the possibility of lines 2, 3, and 4, and pvq would be weaker because it leaves lines 1-3 in play as possibilities.

\[
\text{weak} < \text{pvq, p&q} \text{ strong}
\]

So if the speaker chooses not to say p&q, the hearer may infer, by scalar implicature, that p&q is not true. Then the hearer infers that the situation may be either of lines 2 or 3, but not line 1 or 4. In other words, or is interpreted to mean exclusive or:

<table>
<thead>
<tr>
<th>p</th>
<th>q</th>
<th>p v q exclusive</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>T</td>
<td>F</td>
</tr>
<tr>
<td>T</td>
<td>F</td>
<td>T</td>
</tr>
<tr>
<td>F</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>F</td>
<td>F</td>
<td>F</td>
</tr>
</tbody>
</table>

(8) The logical relationship between the antecedent and consequent is different in the two sentence pairs. Given the meanings of the words kill and dead, Cain killed Abel entails that Abel is dead, and Abel isn’t dead entails that nobody, including Cain, killed Abel. In contrast, the conditional in (bi) expresses a commonsense conjecture which could be shown to be wrong, if some unconsidered circumstance made humans' hands unavailable for
carrying things. Suppose that as we evolved to walk upright our forelegs degenerated into minimal limbs without digits. Then the conditional in (bii) would be false – our inability to carry things would not imply that we don’t walk upright.

(9)  (a) GIVE(j, ten dollars, m)  
     (b) GIVE(j, ten dollars, m)  
     (c) UNDER(t, the table)  
     (d) SHOW(c, the photos, m)  

In (a) and (b) we took the order of arguments for (a) as basic for expressing the proposition. SHOW is like GIVE; we take ‘Clive showed the photos to Maddy’ to be the basic sentence for semantic purposes, and (d) expresses the same proposition.

   (e) EAST(c, e)  
   (f) SURGEON(s)  
   (g) PAINT(b, the kitchen)  
   (h) PAINT(b)  
   (i) BUY(m, the painting)

(10)  (a) BROTHER(j, b)  
      (b) BROTHER(p, s)  
      (c) BROTHER(j, b) & BROTHER(b, j)  
      (d) EMBRACE(c, m) & EMBRACE(m, c)  
      (e) EMBRACE(the drunk, the lamppost) & EMBRACE(the lamppost, the drunk)  
           entails  EMBRACE(the lamppost, the drunk)  
           but the lamppost can't embrace anything, having no arms.  
      (f) PARTNER(m, l) & PARTNER(c, g) & PARTNER(d, b)

(11)  a.  (CAPITAL(s, a) v CAPITAL(c, a)) & ~(CAPITAL(s, a) & CAPITAL(c, a))  
      b.  ~LAUGH(a) & ~LAUGH(b)  
           ~(LAUGH(a) v LAUGH(b))  
      c.  ~(RICH(f) & GENEROUS(f))  
      d.  MARRY(g, l) v MARRY(g, f)  
      e.  ~LAUGH(a) & ~LAUGH(b)  
           ~(LAUGH(a) v LAUGH(b))  
      f.  TRUST(a, e) → STUPID(a)  
      g.  ~(LAUGH(a) & ~LAUGH(b))  
           ~(LAUGH(a) v LAUGH(b))  
      h.  DIE(l) → RICH(s)

(12)  a.  (GO(a, to Motueka) & VISIT(a, r)) v INTERVIEW(a, c)  
           (Rangi is in Motueka)  
           GO(a, to Motueka) & (VISIT(a, r)) v INTERVIEW(a, c)  
           (Rangi and Cameron are both in Motueka)  
      b.  BROTHER(d, a) → (AUNT(f, d) v UNCLE(b, d))  
           (BROTHER(d, a) → AUNT(f, d)) v UNCLE(b, d)  
      c.  LEAVE(l, t) → (HIRE(c, b) & RESIGN(e))  
           HIRE(c, b) & (LEAVE(l, t) → RESIGN(e))

(13)  a.  RING UP(j, the hospital)  
      b.  RUN(j, up the ramp)  
      c.  PUSH(j, the cart, up the ramp)  
      d.  LOOK(o, after the departing train)  
      e.  LOOK AFTER(o, the baby)  
      f.  WIND(g, the rope, around the bollard)
(14) a. RUN(g, down the new running track)  
    Giles took a run along the track. 
    RUN DOWN(g, the new running track)  
    Giles criticized the track. 

b. DECIDE(i)  
    Imogen made a decision (on the train is a locative adverbial) 
    DECIDE ON(i, the train)  
    Imogen chose the train. 

(15) The underlined sequences are arguments of the verb. 
   a. They dwelt in marble halls. 
   b. The theremin echoes marvellously in marble halls. 
   c. Jones behaved impeccably. 
   d. Harriet carelessly lost the car keys. 
   e. Simon carefully planned the weekend that night. 
   f. Simon carefully planned that night. 
   g. The meetings lasted all day. 
   h. The elephants were upset and nervous all day. 

(16) a. Jackson arrived [to clean the pool]. 
   b. Jackson intended [to clean the pool]. 
   c. Edith paid Lucas [for felling the tree]. 
      yes, if the verb pay entails the exchange of money for goods or services. There is also a use of pay for the giving of money according to an agreement or obligation (i.e. not a gift), such as paying a fine or an allowance. The first pay is in (c). 
   d. Edith criticised Lucas [for felling the tree]. 

(17) My apologies for an unclear instruction in this exercise. The instruction should say 'one of each pair of sentences in (ii) and (iii) is generally agreed to be odd'. 

Sentence (iib) is odd compared to (iia), and (iiib) is odd compared to (iiia). 

The difference shows that 'sat on the bed' and 'sat on the hillside' are different kinds of predicate, even though they look alike. 

The main clue to the difference between 'sat on the bed' and 'sat on the hillside' is the normal interpretation triggered by the sentence forms of (iib) and (iiib). Both sentences evoke an image of a small hillside being sat on, and possibly squashed, by a person almost the same size as the hillside. For example, suppose a person sits on a small papier-maché hill which is part of a model train panorama. The hill is likely to suffer some damage. Both (iib) and (iiib) are appropriate forms to describe this. 

More generally, (ii) and (iii) are appropriate sentence forms to describe an action which has an effect on the thing sat on – it isn't just a location, but is a kind of argument of the verb, e.g.: 
(i)  

a. John sat on the bed.  \( \text{SIT}(j, \text{the bed}) \)

b. John sat on the hillside.  \( \text{SIT}(j) \)

Further comment:
The sentences in (ii) are in the passive voice (see p. 178). A general rule of thumb for English is that only an argument expression can be the surface subject of a passive sentence. Examples like 'The bed had been sat on' don't contradict this rule, because the bed in such a sentence is interpreted as a kind of argument of 'sitting on'. The most salient interpretation is that the bed is crumpled from being sat on.
The sentences in (iii) show the do to frame (X did Y to Z), which is generally considered to show that X and Z are arguments of the verb represented by 'did Y to'. For example, the well-formedness of *All John did to the glass was tap it* shows that John and the glass are arguments of tap in *John tapped the glass*. More specifically, the X did Y to Z frame shows that X is an agent argument and Z is a patient argument – see Chapter 10 for these argument types.