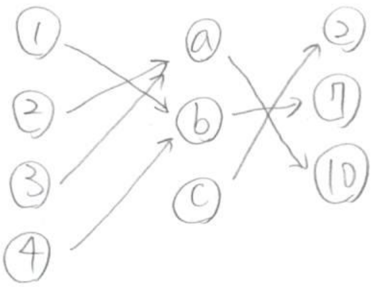
110054809 易頡

19. a) $f \circ g$

$A \xrightarrow{g} B \xrightarrow{f} C$

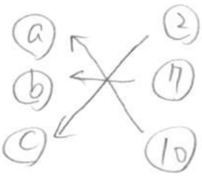


$f \circ g : A \to C$

$\{(1,7),(2,10),(3,10),(4,2)\}$

b) f^{-1}

$B \leftarrow C$



$f^{-1}(2) = c$

$f^{-1}(7) = b$

$f^{-1}(10) = a$

20. $[p \wedge (p \to q)] \to p \equiv \neg[p \wedge (p \to q)] \vee q$ by the conditional-disjunction equivalence

$\equiv [\neg p \vee \neg(p \to q)] \vee q$ by a De Morgan's law

$\equiv (\neg p \vee q) \vee \neg(p \to q)$ by commutativity and associativity

$\equiv (\neg p \vee q) \vee \neg(\neg p \vee q)$ by the conditional-disjunction equivalence

$\equiv T$ by a negation law

21.

Step		Reason
1	$\neg t$	Hypothesis
2	$s \to t$	Hypothesis
3	$\neg s$	Modus tollens using (1) and (2)
4	$(\neg r \vee \neg f) \to (s \wedge l)$	Hypothesis
5	$(\neg(s \wedge l) \to \neg(\neg r \vee \neg f)$	contrapositive of (4)
6	$(\neg s \vee \neg l) \to (r \wedge f)$	De Morgan's law and double negative
7	$\neg s \vee \neg l$	Addition, using (3)
8	$r \wedge f$	Modus ponens using (6) and (7)
9	r	simplification using (8)