Name: _____

Directions: Solve the following problems. Give supporting work/justification where appropriate.

1. **[6 parts, 1 point each]** We define the following statements and open sentences.

P: 5 is greater than 8. $Q(x)$: x is odd.

$R(x)$: x is negative. $S(A)$: A is a finite set.

Decide whether the following are true or false; indicate your answer by writing the entire word "true" or the entire word "false". Give brief justifications for partial credit.

(a) $\sim P$

(b) $\sim Q(4) \wedge \sim P$

(c) $(\sim P \vee S(\mathbb{N})) \wedge (R(-1) \vee Q(8))$

(d) $P \implies 1 = 2$

(e) $\sim (R(5) \iff Q(6))$

(f) $\sim S(\{1, 2, 4, 8, 16, 32, \ldots\}) \iff (R(-1) \implies Q(0))$

2. **[2 parts, 1 point each]** Truth tables and logical equivalence.

   (a) Write a truth table for $(P \iff Q) \implies P$

   (b) Give a simple statement which is logically equivalent to $(P \iff Q) \implies P$.

3. **[2 parts, 1 point each]** Let P, Q, and R be statements. Use the standard logical operands $\sim, \vee, \wedge, \implies, \iff$ to express the following statements.

   (a) P, Q, and R all have the same truth value.

   (b) Q is a necessary condition for P, and R is a sufficient condition for P.