1. Which of the following sets are equal to the set of all integers that are even. There may be more than one or none.
(a) f2njn 2 Rg
(b) f2njn 2 Zg
(c) fn 2 Zjn = 2k and k 2 Zg
(d) f2ng
(e) f0; 2; 4; 6; : : : g
2. Suppose A = fa; b; cg and B = fb; fcg; fa; cgg. True or false.
(a) B _ A
(b) ; 2 B
(c) fb; fcgg _ A \ B
(d) fb; fcgg _ B
(e) fcg 2 B
(f) jA [Bj = 5
(g) jA \ Bj = 3
(h) ffcg; fa; cgg _ B □ A
3. Suppose A = N and B = fx 2 Rj □ 4 _ x _ 5g. True or false.
(a) (4; 6) 2 B _ A
(b) jA [Bj = 1
(c) jA \ Bj = 1
4. Given f : [0;1) ! [0;1), f(x) = 2
p
x, _nd
(a) The image of f4; 9; 16g.
(b) The preimage of f4; 9; 16g.
5. Let g : R ! [0;1) be de_ned by g(x) = dx2e. Let A = fx 2 [0;1)j3:2 < x < 8:9g.
(a) domain
(b) codomain
(c) range
(d) Find g(A).
(e) Find g□1(A).
6. Let g : N ! R be de_ned by g(x) = bx□2
3 c. Let A = fx 2 Nj4 _ x _ 10g.
(a) domain
(b) codomain
(c) range
(d) Find g(A).
(e) Find g□1(A).
7. Let E = f4njn 2 Ng and consider the characteristic function _E : Z ! Z. What is the . . .
(a) domain
(b) codomain
(c) range
(d) _E(f2njn 2 Ng)
(e) _□1
E (f2njn 2 Ng)

8. Circle all of the following statements that are equivalent to \If x is even, then y is odd"? There may be more than one or none.
(a) y is odd only if x is even.
(b) x is even is su_cient for y to be odd.
(c) x is even is necessary for y to be odd.
(d) If x is odd, then y is even.
(e) x is even and y is even.
(f) x is odd or y is odd.
9. Which of the following is the negation of the statement \If you go to the beach this weekend, then you should bring your books and study"?
(a) If you do not go to the beach this weekend, then you should not bring your books and you should not study.
(b) If you do not go to the beach this weekend, then you should not bring your books or you should not study.
(c) If you do not go to the beach this weekend, then you should bring your books and study.
(d) You will not go to the beach this weekend, and you should not bring your books and you should not study.
(e) You will not go to the beach this weekend, and you should not bring your books or you should not study.
(f) You will go to the beach this weekend, and you should not bring your books and you should not study.
(g) You will go to the beach this weekend, and you should not bring your books or you should not study.
10. Which of the following is the negation of the statement \You will go to the beach this weekend or you will not go swimming"?
(a) You will not go to the beach this weekend or you will go swimming.
(b) You will not go to the beach this weekend or you will not go swimming.
(c) You will not go to the beach this weekend and you will go swimming.
(d) You will not go to the beach this weekend and you will not go swimming.
11. p is the statement \I will prove this by cases", q is the statement \There are more than 500 cases," and r is the statement \I can _nd another way."
(a) State (:r _ :q) ! p in simple English.
(b) State the converse of the statement in part (a) in simple English.
(c) State the inverse of the statement in part (a) in simple English.
(d) State the contrapositive of the statement in part (a) in simple English.
(e) State the negation of the statement in part (a) in simple English. Do not use the expression \It is not the case."
12. Make a truth table for (p _ :r) _ (:q ! (p _ r)). Is this statement a tautology, contradiction, or neither of these?
13. Prove or disprove
(a) [(p ! q) ! r] , [p ! (q ! r)]
(b) [(p ^ q) ! r] , [p ! (q ! r)]
14. Prove [(p ! r) _ (q ! r)] , [(p ^ q) ! r] by using. . .
(a) a truth table,
(b) a verbal (cases) argument,

(c) propositional equivalences.
15. Circle all of the following that is equivalent to :(p ! r) ! :q? There may be more than one or none.
(a) :(p ! r) _ q
(b) (p ^ :r) _ q
(c) (:p ! :r) _ q
(d) q ! (p ! r)
(e) :q ! (:p ! :r)
(f) :q ! (:p _ r)
(g) :q ! :(p ! r)
16. Let P(n;m) be the predicate mn > 0, where the domain for m and n is the set of integers. Which of the following statements are true? There may be more than one or none.
(a) P(□3; 2)
(b) 8mP(0;m)
(c) 9nP(n;□3)
(d) 9n8mP(n;m)
(e) 8n9mP(n;m)
(f) 9!mP(2;m)
17. Let P(x; y) be the predicate 2x + y = xy, where the domain of discourse for x is fu 2 Zju 6= 1g and for y is fu 2 Zju 6= 2g. Determine the truth value of each statement. Show work or briey explain.
(a) P(□1; 1)
(b) 9xP(x; 0)
(c) 9yP(4; y)
(d) 8yP(2; y)
(e) 8x9yP(x; y)
(f) 9y8xP(x; y)
(g) 8x8y[((P(x; y)) ^ (x > 0)) ! (y > 1)]
18. True or false. Mark true if it is true for all possible predicates, false otherwise.
(a) 8x8yP(x; y) , 8y8xP(x; y)
(b) 8x9yP(x; y)) 9y8xP(x; y)
(c) 8x9yP(x; y) , 8y9xP(y; x)
(d) 8x[P(x) ^ Q(x)] , [(8xP(x)) ^ (8xQ(x))]
(e) 9x[P(x) ^ Q(x)]) [(9xP(x)) ^ (9xQ(x))]
(f) :9x8yP(x; y) , 8y9x:P(x; y)
(g) 8x9y[P(x; y) ! :Q(x; y)]) :9x8y[P(x; y) ^ Q(x; y)]
19. Suppose S(x; y) is the predicate \x saw y," L(x; y) is the predicate \x liked y," and C(y) is the predicate \y is a comedy." The universe of discourse of x is the set of people and the universe of discourse for y is the set of movies. Write the following in proper English. Do not use variables in your answers.
(a) 8y:S(Margaret; y)
(b) 9y8xL(x; y)
(c) 9x8y[C(y) ! S(x; y)]
(d) Give the negation for part 19c in symbolic form with the negation symbol to the right of all quanti_ers.

(e) state the negation of part 19c in English without using the phrase "it is not the case."

20. Suppose the universe of discourse for x is the set of all ASU students, the universe of discourse for y is the set of courses o_ered at ASU, A(y) is the predicate \y is an advanced course," F(x) is \x is a freshman," T(x; y) is \x is taking y," and P(x; y) is \x passed y." Use quanti_ers to express the statements

(a) No student is taking every advanced course.

(b) Every freshman passed calculus.

(c) Some advanced course(s) is(are) being taken by no students.

(d) Some freshmen are only taking advanced courses.

(e) No freshman has taken and passed linear algebra.

21. Write using predicates and quanti_ers.

(a) For every m; n 2 N there exists p 2 N such that m < p and p < n.

(b) For all nonnegative real numbers a, b, and c, if $a^2 + b^2 = c^2$, then a + b _ c.

(c) There does not exist a positive real number a such that $a + \frac{1}{a} < 2$:

(d) Every student in this class likes mathematics.

(e) No student in this class likes mathematics.

(f) All students in this class that are CS majors are going to take a 4000 level math course.

22. Give the negation of each statement in example 21 using predicates and quanti_ers with the negation to the right of all quanti_ers.

23. Give the negation of each statement in example 21 using an English sentence.