1:

This is an inline equation: $x + y = 3$.
This is a displayed equation:

$$x + \frac{y}{z - \sqrt{3}} = 2.$$

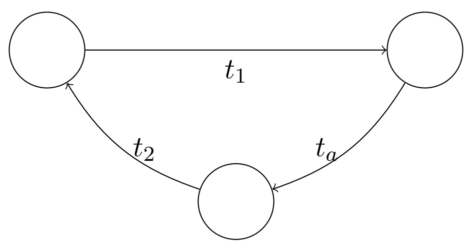
This is how you can define a piece-wise linear function:

$$f(x) = \begin{cases} 3x + 2 & \text{if } x < 0 \\ 7x + 2 & \text{if } x \geq 0 \text{ and } x < 10 \\ 5x + 22 & \text{otherwise.} \end{cases}$$

This is a matrix:

9	9	9	9
6	6	6	
3		3	3

This is a figure incorporated in a LaTeX file



2: consider the function $f(x) = \begin{cases} x/2 & \text{if } x \text{ is even} \\ -\frac{x+1}{2} & \text{if } x \text{ is odd} \\ 0 & \text{if } x = 0 \end{cases}$ where $x \in \mathbb{N}$ and $f(x) \in \mathbb{Z}$. This function is a bijection between $\mathbb{N}$ and $\mathbb{Z}$, and since there is a bijection between them they must be equinumerious.

3: assume that if a set S is infinte that there can not exist a function f such that $f : S \to S$ and f is surjective but not injective, or injective but not surjective. consider the function $g(x) = x^2$ over the the infinite set $f : \mathbb{N} \to \mathbb{N}$. the element 3 in the set $\mathbb{N}$ is a counter example to $g(x)$ being onto since $\sqrt{3}$ is not in $\mathbb{N}$. assume that there is some $x \neq y$ where $g(x) = g(y)$, that would mean that $x^2 = y^2$, but there are not values in $\mathbb{N}$ for which this is true since they are all positive proving that g is one-to-one by contradicton. This makes g an example of a function from and infinite set to itself that is one-to-one yet not onto. Now consider the function $h = x + 2\lfloor x/2 \rfloor$ for $h : \mathbb{R} \to \mathbb{R}$ this function is not one-to-one and $x = 1$ and $x = 2$ are a counter example. It is onto though because every value in the range has two values in the domain that equal it. This makes h and example of a function that is onto, but not one-to-to. proving that an infinite set S can have a fuction $f : S \to S$ that is injective but not surjective, and surjective but not injective by contradiction.

4: R is reflexive since if $m = n$ then $m - n = 0$ and $0 mod 3$ will always be 0.
R can be shown to be symetric by direct proof.
assume that for some random values $m, n \in \mathbb{N}$ where $(m - n) mod 3 = 0$ then $(n - m) mod 3$ must also equal 0 since $n - m = -(m - n)$ so $(n, m) \in R$ if $(m, n) \in R$
R can be shown to be transitive by direct proof
assume that from some rand values $a, b, c \in \mathbb{N}$ $(a, b) \in R$ and $(b, c) \in R$. this mean that $a - b = 3n$ and $b - c = 3m$ where m and n are unknown constants. this means that $a - c = 3n + 3m = 3(n + m)$. which means that $(a - c) mod 3 = 0$ and $(a, c) \in R$.
since R is relexive symetic and transitive it is an Equivalence relation, and its Equivalence classes are $\{0, 3, 6, 9, ...3n\}, \{1, 4, 7, ...3n + 1\}, \{2, 5, 8, ...3n + 2\}$ where $n \in \mathbb{N}$

5: Proof by induction on n.
Basis: when n = 1 $\sum_{i=1}^{1} i^2 = 1$ and $(2(1) + 1)(1 + 1)(1)/6 = 1$
Induction hypothesis: Assume that this holds true for all n up to some value m
Inductive step:

$$\sum_{i=1}^{n+1} i^2 = \frac{(2(n+1)+1)(n+1+1)(n+1)}{6} \tag{1}$$

$$(n+1)^2 + \sum_{i=1}^{n} i^2 = \frac{(2n+3)(n+2)(n+1)}{6} \tag{2}$$

$$(6n^2 + 12n + 6) + (2n+1)(n+1)n = (2n+3)(n+2)(n+1) \tag{3}$$

$$2n^3 + 9n^2 + 13n + 6 = 2n^3 + 9n^2 + 13n + 6 \tag{4}$$

which shows the property holds for $n + 1$ proving $\sum_{i=1}^{n} i^2 = \frac{(2n+1)(n+1)n}{6}$ by induction