1:

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

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

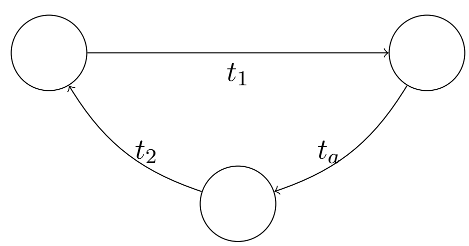
This is how you can define a piece-wise linear function:

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

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: prove that $f(x) = x^2$ is one-to-one but not onto for $\mathbb{N}$ and that $f(x) = x + x mod 2$ is onto but not one-to-one for $\mathbb{Z}$

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 $(a-c)mod3=0$ 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