1.1. I didn't specify the domains of these functions, but $f$ and $g$ are equal if they have the same domain. They are equal because for every input the output of the two functions is the same. The choice to use $x$ vs $t$ is irrelevant; all the notation is saying is that the output is the input plus the square of the input.

1.2: a) 3  
b) $-\frac{1}{3}$  
c) 0 and 3  
d) $-\frac{2}{3}$  
e) $[-2,4]$  
f) $[-1,3]$

1.3. There are of course many possible answers. Here are some.

a)  
\[
f(x) = \begin{cases} 
-1, & x < 0 \\
0, & x = 0 \\
1, & x > 0
\end{cases}
\]

b)  

c) $f: \mathbb{Q} \to \mathbb{Q}, f(x) = x$ (i.e. just restrict the domain to $\mathbb{Q}$)

1.4. Here, of course, I mean the largest possible domain contained in $\mathbb{R}$.

Considerations: I can't divide by 0, and I can't put a negative number under the square root. So my conditions are:

1) $1 - x > 0$ (because $\sqrt{1-x}$ appears) 
2) $2x = 3 \neq 0$ (because then I'd be dividing by 0) 
3) $\sqrt{1-x+1} \neq 0$ (because then I'd be dividing by 0)
Condition (1) means I need $x \leq 1$.
Condition (2) means I need $x + \frac{3}{2}$
Condition (3) is always satisfied, because $\sqrt{u} > 0$ for every $u$.

So overall the biggest domain possible is $(-\infty, 1]$.

2.1 a) $\text{5m}$ The rock is dropped at $t=0$, and $h(0) = 5$.

b) $t = 1s$. The rock hits the ground when $h(t) = 0$, and by inspection $h(1) = 0$.

c) $5 - 5t^2 = \frac{5}{2} \implies 1 - t^2 = \frac{1}{2} \implies t^2 = \frac{1}{2} \implies t = \frac{1}{\sqrt{2}}$. The other root, $t = -\frac{1}{\sqrt{2}}$, doesn't really make sense in this context.

d) 0.01s before the rock hits the ground is $t = 0.99$. Evaluating, $h(0.99) = 0.0995$.

2.2 a) $(x-2)(x-3)$ b) 2,3
c) $(x - \frac{1-\sqrt{5}}{2})(x - \frac{1+\sqrt{5}}{2})$
d) $\frac{-1+\sqrt{5}}{2}, \frac{-1-\sqrt{5}}{2}$

e) $(x - \frac{-b+\sqrt{b^2-4ac}}{2a})(x - \frac{-b-\sqrt{b^2-4ac}}{2a})$
f) $\frac{-b + \sqrt{b^2-4ac}}{2a}, \frac{-b - \sqrt{b^2-4ac}}{2a}$

2.3. You could multiply this out, but you can also just notice that $-b \pm \sqrt{b^2-4ac}$ are the roots of $x^2 + bx + c$, so the factor theorem tells us that multiplying out the expression in the question will give us something $(x^2 + bx + c)$, and then matching degrees and leading coefficients tells us that we get $x^2 + bx + c$ exactly.

3.1 a) If the length of a side of the square is $x$, then the length of the diagonal is $\sqrt{x^2 + x^2} = \sqrt{2}x$. The angle $\theta$ is $\frac{\pi}{4}$, since $x$ is the ratio of the length of the side opposite $\theta$ to the length of the hypotenuse, so $\sin \frac{\pi}{4} = \frac{x}{\sqrt{2}x} = \frac{1}{\sqrt{2}}$. Similarly for $\cos \frac{\pi}{4}$.

b) The angle $\theta$ is $\frac{\pi}{6}$, because $2\theta = \frac{\pi}{3}$. The height $h$ satisfies $h^2 + (\frac{h}{2})^2 = L^2$, so $h = \frac{\sqrt{3}}{2}L$. Thus $\sin \frac{\pi}{6} = \frac{1}{2}L = \frac{1}{2}$, and $\cos \frac{\pi}{6} = \frac{\sqrt{3}L}{2} = \frac{\sqrt{3}}{2}$. 


3.3. \( a) \cos^2 x + \sin^2 x = 1 \)

\( b) \sin(2x) = 2 \cos x \sin x \)

\( c) \cos(2x) = \cos^2 x - \sin^2 x \)