1.1) $f(x) = \ln\left(\frac{x+2}{x-1}\right)$

Need $\frac{x+2}{x-1} > 0$,

Case 1: If $x > 1$, then $x-1 > 0$, so we need $x+2 > 0$, so $x > -2$.

Case 2: If $x < 1$, then $x-1 < 0$, so need $x+2 < 0$, so $x < -2$

$\Rightarrow$ Domain is $(-\infty, -2) \cup (1, \infty)$

1.2) Yes. Because the function is one-to-one.

1.3) Horizontal asymptote at $y=0$

Because $\lim_{x\to\infty} f(x) = 0$, $\lim_{x\to-\infty} f(x) = 0$

Vertical asymptote at $x=-2$ and $x=1$.

Because $\lim_{x\to -2} f(x) = -\infty$, $\lim_{x\to 1} f(x) = \infty$.

2) $f(x) = 2^x - \frac{x^2}{4}$

$f(-2) = 2^{-2} - \frac{4}{4} = \frac{1}{4} - 1 = -0.75 < 0$

$f(-1) = 2^{-1} - \frac{1}{4} = \frac{1}{2} - \frac{1}{4} = \frac{1}{4} > 0.$

f is continuous between $(-2, -1)$.

So $f(x) = 0$ for some $-2 < x < -1$ by the IVT.

3.1) $\lim_{x \to \frac{\pi}{2}} \frac{100}{\tan(x)}$, $\lim_{x \to \frac{\pi}{2}^-} \tan(x) = +\infty$, $\lim_{x \to \frac{\pi}{2}^+} \tan(x) = -\infty$.

So $\lim_{x \to \frac{\pi}{2}^+} \frac{100}{\tan(x)} = \lim_{x \to \frac{\pi}{2}^-} \frac{100}{\tan(x)} = 0.$

So the limit exists and is 0.

3.2) $\lim_{x \to 0} \arcsin\left(e^x - \frac{1}{2}\right)$, $e^0 - \frac{1}{2} = \frac{1}{2}$,

arcsin is continuous at $\frac{1}{2}$, so the limit equals

$\arcsin\left(\lim_{x \to 0} e^x - \frac{1}{2}\right) = \arcsin\left(\frac{1}{2}\right) = \frac{\pi}{6}$

4.1) $g(x) = f(2(x-1)) - 1$

- Stretch horizontally by $\frac{1}{2}$
- Shift right by 1
- Shift down by 1

4.2) Only need to check $\lim_{x \to 1} f(x)$

$$\lim_{x \to 1^-} f(x) = \lim_{x \to 1^-} \sqrt{2-2x} = 0$$

$$\lim_{x \to 1^+} f(x) = \lim_{x \to 1^+} c+x = c+1$$

For continuity: $\lim_{x \to 1^+} f(x) = \lim_{x \to 1^-} f(x) = f(1)$

$$\Rightarrow \quad 0 = c+1, \quad \boxed{\text{so } c = -1.}$$