1a)

$$\lim_{x \to -1} \frac{x^2 - x - 2}{x^2 - 1} = \frac{0}{0} \Rightarrow \text{D.N.E.}$$

1b)

$$\lim_{t \to 1} \frac{\sqrt{t^2+8} - 3}{t-1} = \frac{\sqrt{t^2+8} - 3}{t-1} \frac{\sqrt{t^2+8} + 3}{\sqrt{t^2+8} + 3} = \frac{t^2+8-9}{t-1} \frac{1}{\sqrt{t^2+8}+3} = \frac{0}{0} \frac{1}{\sqrt{t^2+8}+3} \Rightarrow \text{D.N.E.}$$

1c)

$$\lim_{x \to 0^-} \frac{1}{x} - \frac{1}{|x|} = \lim_{x \to 0^-} \frac{1}{x} - \lim_{x \to 0^-} \frac{1}{|x|}$$
$$-\infty - \infty = -\infty$$

2a) $$\frac{d}{dx}\left(\frac{x^4 + x^{7/2}}{x^2}\right) = \frac{d}{dx}\left(x^2 + \frac{x^{7/2}}{x^{4/2}}\right) = \frac{d}{dx}\left(x^2 + x^{3/2}\right) = 2\text{x} + \frac{3}{2} x^{3/2-1}$$

2b)

$$y = x^2 \cos(x)$$
$$y' = 2\text{x} \cos(x) + x^2 \sin(x)$$
$$y'' = 2\text{x} \sin(x) + 2\cos(x) - x^2 \cos(x) + 2\text{x} \sin(x)$$
$$y'' = 4\text{x} \sin(x) + (2 - x^2)\cos(x)$$

2c)

$$y = x \sin(\sqrt{x} + x)$$
$$y' = \sin(\sqrt{x} + x) + x \cos(\sqrt{x} + x)(\frac{1}{2} x^{-0.5} + 1)$$

2d)

e

[NOTE: this is what I would expect a student to guess if they didn't know what to put... so even if its correct, it may not show understanding, and hence is problematic...]

3a)

To find horizontal asymptotes I need to figure out what happens near infinity.

$$\lim_{x\to\infty}\frac{\sqrt{x^2+1}}{3\text{x}+5}$$

$$\lim_{x\to\infty}\frac{\sqrt{\frac{x^2}{x}+\frac{1}{x}}}{3+\frac{5}{x}}$$

$$\lim_{x\to\infty}\frac{\sqrt{x+\frac{1}{x}}}{3+\frac{5}{x}}$$

$$\frac{\sqrt{\infty}}{3}$$

3b)
vertical asymptote when we divide by zero.

This happens when $3\text{x}+5=0$

Thus, vertical asymptote at $x=-5/3$

For x> -5/3 the top is postive and the bottom is positive, so we are positive, hence +infinity.

For x<-5/3 the top is positive and the bottom is negative, hence -infinity.

4)
A function is continuous if the function on one side of the piece lines up with the other side.

Part 2 of our function is a straight line, as is part 3.

Thus they must be the same straight line.

Thus a=5 and b =-3

5)
We need the intermediate value theorem here- because we are trying to show that a solution exists.

We can use the intermediate value theorem, because the function is continuous.

6)
[honestly, a student which did as bad as this one wouldn't even reach this part of the exam... oh well...]

Tangent lines need slopes

$y' = 2x + 6$

Okay, so that line will never pass through the point (2,1) because

$1 = 2 \times 2 + 6$ is not true.