1. B: \[
\lim_{x \to -\infty} \frac{\sin(x - 2)}{x^2 + 2x - 8} = \lim_{x \to -\infty} \frac{\sin(x - 2)}{(x + 4)(x - 2)} = \lim_{x \to -\infty} \frac{\sin(x - 2)}{x + 4} = \frac{1}{6}
\]

2. D: \[f(x) = e^{-x^2}.
\]
By the chain rule, \[f'(x) = -2xe^{-x^2}.
\]
By the product and chain rule, \[f''(x) = 4x^2e^{-x^2} - 2e^{-x^2}.
\]
Hence \[f''(1) = 4e^{-1} - 2e^{-1} = 2e^{-1} = \frac{2}{e}.
\]

3. C: First we will find the tangent vector at \(t = \frac{\pi}{3}\) and then make it a unit vector by dividing by the magnitude:
\[r(t) = \langle 4 \cos t, 2 \sin t \rangle \quad \text{thus} \quad r'(t) = \langle -4 \sin t, 2 \cos t \rangle.
\]
Therefore \[r'\left(\frac{\pi}{3}\right) = \langle -2\sqrt{3}, 1 \rangle.
\]
The unit vector is \[
\frac{\langle -2\sqrt{3}, 1 \rangle}{\sqrt{(-2\sqrt{3})^2 + 1^2}} = \frac{\langle -2\sqrt{3}, 1 \rangle}{\sqrt{13}}.
\]

4. B: \[h(x) = xf(x^3),\]
thus by the product and chain rule, \[h'(x) = f(x^3) + 3x^2f'(x^3).
\]
Thus \[h'(2) = f(8) + 24f'(8) = 3 - 24 = -21.
\]

5. D: \[f(x) = \cos(2x).\]
The quadratic approximation for \(f(x)\) at \(x = 0\) is \[Q(x) = f(0) + f'(0)(x - 0) + \frac{f''(0)}{2}(x - 0)^2.
\]
Now \[f'(0) = -2 \sin(0) = 0, \ f''(0) = -4 \cos(0) = -4.
\]
Hence \[Q(x) = 1 - 2x^2.
\]

6. D: \[
\lim_{x \to -\infty} e^{1/(x+3)} = \lim_{x \to -\infty} e^{-1/(x+3)} = e^{-\infty} = 0
\]

7. B: \[x = t^2, \ y = \sqrt{t}.
\]
The parameter \(t = 4\ corresponds to the point \((21,2)\). Thus \[m = \frac{dy/dt}{dx/dt} = \frac{1}{2\sqrt{t}}.
\]
Therefore \[m = \frac{1}{2\sqrt{4}} = \frac{1}{4}.\]

8. B: \[s(t) = \cos t + \frac{1}{4} t^2.
\]
We want to solve \(a(t) = 0\), where \(a(t)\) is the acceleration. Now, \[s(t) = \cos t + \frac{1}{4} t^2, \text{ thus } v(t) = -\sin t + \frac{1}{2} t, \text{ so} \]
a(t) = \(-\cos t + \frac{1}{2}\). Now, a(t) = 0 if cos t = \(\frac{1}{2}\), and this is true if \(t = \frac{\pi}{3}\) or \(t = \frac{5\pi}{3}\).

9. E: \[x^3 + y^3 = 6xy.
\]
Differentiating implicitly, \[3x^2 + 3y^2 \frac{dy}{dx} = 6y + 6x \frac{dy}{dx},\]
Substitute \(x = 3, \ y = 3\ and solve for \[\frac{dy}{dx} = \frac{3(9) + 3(9) \frac{dy}{dx}}{6(3) + 6(3) \frac{dy}{dx}} = \frac{27 + 27 \frac{dy}{dx}}{18 + 18 \frac{dy}{dx}},\]
Thus \[9 = -9 \frac{dy}{dx}, \text{ hence } \frac{dy}{dx} = -1.
\]

10. E: \[s(t) = t^2 - 2t + 3.
\]
To find the total distance traveled in the first 3 seconds, we must first find where the velocity is positive and negative. \(v(t) = 2t - 2.\) Thus the particle changes direction at \(t = 1\), and more specifically, the particle is moving in the negative direction between \(t = 0\ and \ t = 1\ and the particle is moving in the positive direction between \(t = 1\ and \ t = 3\). Hence the total distance traveled in the first 3 seconds is \(|s(1) - s(0)| + s(3) - s(1)| = | -1 | + 4 = 5\) feet.

11. B: The tangent line is vertical when \(\frac{dx}{dt} = 0\ and \ \frac{dy}{dt} \neq 0.\) Now \(x = t^2 - 2t + 4 \text{ and } y = t^3 - 3t^2.\ \frac{dy}{dt} = 2t - 2, \ \text{ thus } \frac{dx}{dt} = 0 \text{ if } t = 1. \text{ Note that } \frac{dy}{dt} = 3t^2 - 6t \neq 0 \text{ at } t = 1. \text{ Now if } t = 1, x = 3 \text{ and } y = -2. \text{ Hence the point is } (3, -2). \)
12. (i) \( f(x) = x \cos^4(x^3) \). By the product and chain rule,
\[
f'(x) = (x) (4 \cos^3(x^3)(- \sin(x^3))(3x^2)) + \cos^4(x^3) = -12x^3 \cos^3(x^3) \sin(x^3) + \cos^4(x^3).
\]
(ii) \( g(t) = \frac{3 \sqrt{6t - t^2}}{(6t - t^2)^{1/3}} \). By the chain rule,
\[
g'(t) = \frac{1}{3} \frac{6 - 2t}{(6t - t^2)^{2/3}}
\]
(iii) \( h(x) = e^{\sec \sqrt{x}} \), thus by the chain rule,
\[
h'(x) = e^{\sec \sqrt{x}} \sec \sqrt{x} \tan \sqrt{x} \frac{1}{2\sqrt{x}}
\]
13. Let \( A \) be the area, \( h \) be the height, and \( b \) be the base of the triangle at time \( t \).

We are given \( \frac{dh}{dt} = -12 \text{ cm/min} \) and \( \frac{dA}{dt} = 2 \text{ cm}^2/\text{min} \).

We want to find \( \frac{db}{dt} \) when \( h = 6 \text{ cm} \) and \( A = 30 \text{ cm}^2 \).

Differentiate implicitly with respect to time using the product rule:
\[
\frac{dA}{dt} = \frac{1}{2} \frac{db}{dt} h + \frac{1}{2} \frac{dh}{dt} b
\]
Now, when \( h = 6 \text{ cm} \) and \( A = 30 \text{ cm}^2 \), \( b = 10 \text{ cm} \).

Hence if we substitute \( \frac{dh}{dt} = -12 \text{ cm/min} \), \( \frac{dA}{dt} = 2 \text{ cm}^2/\text{min} \), \( h = 6 \text{ cm} \), \( A = 30 \text{ cm}^2 \), and \( b = 10 \text{ cm} \), we obtain
\[
2 = \frac{1}{2} \frac{db}{dt} (6) + \frac{1}{2} \frac{(-12)}{10} \frac{(-1)}{2}
\]
Thus \( \frac{db}{dt} = \frac{3}{2} \text{ cm/min} \).

14. To find \( \frac{dy}{dx} \), or equivalently, \( y' \), differentiate
\[
\sin(5y + 7x) = 4x^2 + y^3
\]
implicitly with respect to \( x \) using the product rule and chain rule:
\[
\cos(5y + 7x)(5y' + 7) = 8x + 3y^2 y'
\]
\[
5 \cos(5y + 7x) y' + 7 \cos(5y + 7x) = 8x + 3y^2 y'
\]
\[
y'(5 \cos(5y + 7x) - 3y^2) = 8x - 7 \cos(5y + 7x)
\]
\[
y' = \frac{8x - 7 \cos(5y + 7x)}{5 \cos(5y + 7x) - 3y^2}
\]
15. Recall if \( g \) is the inverse of \( f \), then
\[
g'(a) = \frac{1}{f'(g(a))}
\]
Thus \( g'(2) = \frac{1}{f'(g(2))} \).

Since \( f(0) = 2 \), \( g(2) = 0 \), \( g'(2) = \frac{1}{f'(0)} \). Now \( f'(x) = 3e^{3x} + 6 \), hence \( f'(0) = 9 \). Therefore \( g'(2) = \frac{1}{9} \).

16. \( y = \frac{3x + 1}{5 - x} \). To find \( f^{-1}(x) \), first interchange \( x \) and \( y \):
\[
x = \frac{3y + 1}{5 - y}
\]
\[
x(5 - y) = 3y + 1
\]
\[
5x - xy = 3y + 1
\]
\[
5x - 1 = y(3 + x), \text{ thus } f^{-1}(x) = \frac{5x - 1}{3 + x}
\]
17. (a) The linear approximation for \( f(x) \) at \( x = a \) is
\[
L(x) = f(a) + f'(a)(x - a)
\]
Here, \( a = 4 \). Hence
\[
L(x) = f(4) + f'(4)(x - 4)
\]
Now \( f(x) = \sqrt{x} \), thus
\[
f(4) = 2, \text{ } f'(4) = \frac{1}{2\sqrt{x}} \text{, thus } f'(4) = \frac{1}{4}.
\]
\[
L(x) = 2 + \frac{1}{4}(x - 4), \text{ or } L(x) = 1 + \frac{1}{4}x
\]
(b) Now, \( f(x) \approx L(x) \) for \( x \) near \( a \). Thus
\[
\sqrt{x} \approx 1 + \frac{1}{4}x \text{ for } x \text{ near } 4.
\]
Thus \( \sqrt{4.1} \approx 1 + \frac{1}{4}(4.1) = \frac{81}{40} = 2.025 \).