1. D: \( \lim_{x \to 2} \frac{\sin(x - 2)}{x^2 + x - 6} = \lim_{x \to 2} \frac{\sin(x - 2)}{(x + 3)(x - 2)} \)
\[ = \lim_{x \to 2} \frac{\sin(x - 2)}{x + 3} = \frac{1}{5} \]

2. B: \( f(x) = e^x \). By the chain rule, \( f'(x) = 2xe^x \). By the product and chain rule, \( f''(x) = 4x^2e^x + 2e^x \). Hence \( f''(1) = 4e + 2e = 6e \).

3. D: First we will find the tangent vector at \( t = \frac{\pi}{6} \) and then make it a unit vector by dividing by the magnitude:
\[
r(t) = \langle 4 \cos t, 2 \sin t \rangle \text{ thus } \\
r'(t) = \langle -4 \sin t, 2 \cos t \rangle. \text{ Therefore } \\
r'\left(\frac{\pi}{6}\right) = \langle -2, \sqrt{3}\rangle. \text{ The unit vector is } \\
\frac{\langle -2, \sqrt{3}\rangle}{|\langle -2, \sqrt{3}\rangle|} = \frac{\langle -2, \sqrt{3}\rangle}{\sqrt{(-2)^2 + (\sqrt{3})^2}} = \frac{\langle -2, \sqrt{3}\rangle}{\sqrt{7}} = \langle -\frac{2}{\sqrt{7}}, \frac{\sqrt{3}}{\sqrt{7}}\rangle.
\]

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

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

6. B: \( \lim_{x \to -3^+} e^{1/(x+3)} = \lim_{x \to -3^+} \frac{1}{e^{x+3}} = e^\infty = \infty \)

7. E: \( x = \sqrt{t}, y = t^2 + 5 \). The parameter \( t = 4 \) corresponds to the point \( (21) \). Thus \( m = \frac{dy/dt}{dx/dt} \)
evaluated at \( t = 4 \).
\[
m = \frac{2t}{\frac{1}{2\sqrt{t}}} = 4t\sqrt{t}. \text{ Thus when } t = 4, m = 32.
\]

8. C: \( s(t) = \sin t + \frac{1}{4}t^2 \). We want to solve \( a(t) = 0 \), where \( a(t) \) is the acceleration. Now,
\[
s(t) = \sin t + \frac{1}{4}t^2, \text{ thus } v(t) = \cos t + \frac{1}{2}t, \text{ so } \\
a(t) = -\sin t + \frac{1}{2}. \text{ Now, } a(t) = 0 \text{ if } \sin t = \frac{1}{2}, \text{ and this is true if } t = \frac{\pi}{6} \text{ or } t = \frac{5\pi}{6}.
\]

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

10. C: \( s(t) = t^2 - 2t + 3 \). 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 \( |s(1) - s(0)| + s(3) - s(1) = | - 1 | + 4 = 5 \text{ feet.} \)

11. A: The tangent line is horizontal when \( \frac{dy}{dt} = 0 \) and \( \frac{dx}{dt} \neq 0 \). Now \( x = t^2 - 2t + 4 \) and \( y = t^3 - 3t^2 \).
\[
\frac{dy}{dt} = 3t^2 - 6t = 3(t(t - 2), \frac{dy}{dt} = 0 \text{ if } t = 0 \text{ or } t = 2. \\
Note that \( \frac{dx}{dt} = 2t - 2 \neq 0 \) at these two values of \( t \).
\]
Now if \( t = 0, x = 4 \) and \( y = 0 \). If \( t = 2, x = 4 \) and \( y = -4 \). Hence the points are \((4,0)\) and \((4,-4)\).
12. (i) \( f(x) = x \cos^3(x^2) \). By the product and chain rule,
\[ f'(x) = (x) (3 \cos^2(x^2)(-\sin(x^2))(2x)) + \cos^3(x^2) \\
= -6x^2 \cos^2(x^2) \sin(x^2) + \cos^3(x^2). \]
(ii) \( g(t) = \frac{3}{\sqrt{4t - t^2}} = (4t - t^2)^{1/3} \). By the chain rule,
\[ g'(t) = \frac{1}{3} (4t - t^2)^{-2/3} (4 - 2t) \\
= \frac{4 - 2t}{3(4t - t^2)^{2/3}}. \]
(iii) \( h(x) = e^{\tan \sqrt{x}} \), thus by the chain rule,
\[ h'(x) = e^{\tan \sqrt{x}} \sec^2 \left( \frac{1}{2\sqrt{x}} \right). \]

13. Let \( A \) be the area, \( h \) be the height, and \( b \) be the base of the triangle at time \( t \).

We are given \( \frac{dh}{dt} = -2 \text{ cm/min} \) and \( \frac{dA}{dt} = \frac{1}{2} \text{ cm}^2/\text{min} \). We want to find \( \frac{db}{dt} \) when \( h = 6 \text{ cm} \)
and \( A = 60 \text{ cm}^2 \). The Area of a triangle is \( A = \frac{1}{2} bh \).

Differentiate implicitly with respect to time using the product rule:
\[ \frac{dA}{dt} = \frac{1}{2} \frac{db}{dt} h + \frac{1}{2} b \frac{dh}{dt} \]
Now, when \( h = 6 \text{ cm} \) and \( A = 60 \text{ cm}^2 \), \( b = 20 \text{ cm} \). Hence if we substitute \( db/dt \) = \(-2\text{ cm/min}\), \( dA/dt = \frac{1}{2} \text{ cm}^2/\text{min} \), \( h = 6 \text{ cm} \), \( A = 60 \text{ cm}^2 \) and \( b = 20 \text{ cm} \), we obtain
\[ \frac{1}{2} = \frac{1}{2} \frac{db}{dt} (6) + \frac{1}{2} (20)(-2) \]
Thus \( \frac{db}{dt} = \frac{1}{2} \text{ cm/min}. \]

14. To find \( \frac{dy}{dx} \), or equivalently, \( y' \), differentiate
\[ \sin(7y + 5x) = 3x^2 + y^3 \text{ implicitly with respect to } x \]
using the product rule and chain rule:
\[ \cos(7y + 5x)(7y' + 5) = 6x + 3y^2 y' \]
\[ 7 \cos(7y + 5x)y' + 5 \cos(7y + 5x) = 6x + 3y^2 y' \]
\[ y'(7 \cos(7y + 5x) - 3y^2) = 6x - 5 \cos(7y + 5x) \]
\[ y' = \frac{6x - 5 \cos(7y + 5x)}{7 \cos(7y + 5x) - 3y^2}. \]

15. Recall if \( g \) is the inverse of \( f \), then
\[ g'(a) = \frac{1}{f'(g(a))}. \text{ Thus } g'(2) = \frac{1}{f'(g(2))}. \]
Since \( f(0) = 2, g(2) = 0. g'(2) = \frac{1}{f'(0)}. \) Now
\[ f'(x) = 2e^{2x} + 4, \text{ hence } f'(0) = 6. \]
Therefore \( g'(2) = \frac{1}{f'(0)} = \frac{1}{6}. \)

16. \( y = \frac{2x + 1}{4 - x} \). To find \( f^{-1}(x) \), first interchange \( x \) and \( y \):
\[ x = \frac{2y + 1}{4 - y} \]
\[ x(4 - y) = 2y + 1 \]
\[ 4x - xy = 2y + 1 \]
\[ 4x - 1 = y(2 + x), \text{ thus } f^{-1}(x) = \frac{4x - 1}{2 + x}. \]

17. (a) The linear approximation for \( f(x) \) at \( x = a \) is
\[ L(x) = f(a) + f'(a)(x - a). \] Here, \( a = 9, \) hence
\[ L(x) = f(9) + f'(9)(x - 9). \] Now \( f(x) = \sqrt{x}, \) thus
\[ f(9) = 3, f'(x) = \frac{1}{2\sqrt{x}}, \text{ thus } f'(9) = \frac{1}{6}. \]
\[ L(x) = 3 + \frac{1}{6}(x - 9), \text{ or } L(x) = \frac{1}{6}x + \frac{3}{2}. \]
(b) Now, \( f(x) \approx L(x) \) for \( x \) near \( a.\) Thus
\[ \sqrt{x} \approx \frac{1}{3}x + \frac{3}{2} \text{ for } x \text{ near } 9. \]
Thus \( \sqrt{9.1} \approx \frac{1}{3}(9.1) + \frac{3}{2} = \frac{181}{60}. \)