1. D $y' = x^2 + 10x$; $y'' = 2x + 10$; y'' changes sign at $x = -5$

2. B $\int_{-1}^{4} f(x)dx = \int_{-1}^{2} f(x)dx + \int_{2}^{4} f(x)dx$

$= \text{Area of trapezoid(1)} - \text{Area of trapezoid(2)} = 4 - 1.5 = 2.5$

3. C $\int_{1}^{2} \frac{1}{x^2} dx = \int_{1}^{2} x^{-2} dx = -x^{-1}\Big|_{1}^{2} = \frac{1}{2}$

4. B This would be false if f was a linear function with non-zero slope.

5. E $\int_{0}^{x} \sin t\, dt = -\cos t\Big|_{0}^{x} = -\cos x - (-\cos 0) = -\cos x + 1 = 1 - \cos x$

6. A Substitute $x = 2$ into the equation to find $y = 3$. Taking the derivative implicitly gives $\frac{d}{dx}\left(x^2 + xy\right) = 2x + xy' + y = 0$. Substitute for x and y and solve for y'.

$4 + 2y' + 3 = 0;\; y' = -\frac{7}{2}$

7. E $\int_{1}^{e} \frac{x^2 - 1}{x} dx = \int_{1}^{e} x - \frac{1}{x} dx = \left(\frac{1}{2}x^2 - \ln x\right)\Big|_{1}^{e} = \left(\frac{1}{2}e^2 - 1\right) - \left(\frac{1}{2} - 0\right) = \frac{1}{2}e^2 - \frac{3}{2}$

8. E $h(x) = f(x)g(x)$ so, $h'(x) = f'(x)g(x) + f(x)g'(x)$. It is given that $h'(x) = f(x)g'(x)$. Thus, $f'(x)g(x) = 0$. Since $g(x) > 0$ for all x, $f'(x) = 0$. This means that f is constant. It is given that $f(0) = 1$, therefore $f(x) = 1$.

9. D Let $r(t)$ be the rate of oil flow as given by the graph, where t is measured in hours. The total number of barrels is given by $\int_{0}^{24} r(t)dt$. This can be approximated by counting the squares below the curve and above the horizontal axis. There are approximately five squares with area 600 barrels. Thus the total is about $3,000$ barrels.

10. D $f'(x) = \frac{(x-1)(2x) - (x^2 - 2)(1)}{(x-1)^2}$; $f'(2) = \frac{(2-1)(4) - (4-2)(1)}{(2-1)^2} = 2$

11. A Since f is linear, its second derivative is zero. The integral gives the area of a rectangle with zero height and width $(b - a)$. This area is zero.

12. E $\lim_{x\to 2^-} f(x) = \ln 2 \neq 4\ln 2 = \lim_{x\to 2^+} f(x)$. Therefore the limit does not exist.

13. B At $x = 0$ and $x = 2$ only. The graph has a non-vertical tangent line at every other point in the interval and so has a derivative at each of these other x's.

14. C $v(t) = 2t - 6$; $v(t) = 0$ for $t = 3$

15 D By the Fundamental Theorem of Calculus, $F'(x) = \sqrt{x^3+1}$, thus $F'(2) = \sqrt{2^3+1} = \sqrt{9} = 3$.

16. E $f'(x) = \cos(e^{-x})\cdot\frac{d}{dx}(e^{-x}) = \cos(e^{-x})\left(e^{-x}\cdot\frac{d}{dx}(-x)\right) = -e^{-x}\cos(e^{-x})$

17. D From the graph $f(1) = 0$. Since $f'(1)$ represents the slope of the graph at $x = 1$, $f'(1) > 0$. Also, since $f''(1)$ represents the concavity of the graph at $x = 1$, $f''(1) < 0$.

18. B $y' = 1 - \sin x$ so $y'(0) = 1$ and the line with slope 1 containing the point $(0,1)$ is $y = x + 1$.

19. C Points of inflection occur where f'' changes sign. This is only at $x = 0$ and $x = -1$. There is no sign change at $x = 2$.

20. A $\int_{-3}^{k} x^2\,dx = \frac{1}{3}x^3\Big|_{-3}^{k} = \frac{1}{3}\left(k^3 - (-3)^3\right) = \frac{1}{3}\left(k^3 + 27\right) = 0$ only when $k = -3$.

21. B The solution to this differential equation is known to be of the form $y = y(0)\cdot e^{kt}$. Option (B) is the only one of this form. If you do not remember the form of the solution, then separate the variables and antidifferentiate.
$\frac{dy}{y} = k\,dt$; $\ln|y| = kt + c_1$; $|y| = e^{kt+c_1} = e^{kt}e^{c_1}$; $y = ce^{kt}$.

22. C f is increasing on any interval where $f'(x) > 0$. $f'(x) = 4x^3 + 2x = 2x(2x^2+1) > 0$. Since $(x^2+1) > 0$ for all x, $f'(x) > 0$ whenever $x > 0$.

23. A The graph shows that f is increasing on an interval (a,c) and decreasing on the interval (c,b), where $a < c < b$. This means the graph of the derivative of f is positive on the interval (a,c) and negative on the interval (c,b), so the answer is (A) or (E). The derivative is not (E), however, since then the graph of f would be concave down for the entire interval.