1. E $\int (x^3 - 3x)\,dx = \frac{1}{4}x^4 - \frac{3}{2}x^2 + C$

2. E $g(x) = 5 \Rightarrow g\left(f(x)\right) = 5$

3. B $y = \ln x^2;\ y' = \frac{2x}{x^2} = \frac{2}{x}$. At $x = e^2$, $y' = \frac{2}{e^2}$.

4. A $f(x) = x + \sin x;\quad f'(x) = 1 - \cos x$

5. A $\lim_{x\to-\infty} e^x = 0 \Rightarrow y = 0$ is a horizontal asymptote

6. D $f'(x) = \frac{(1)(x+1)-(x-1)(1)}{(x+1)^2},\ f'(1) = \frac{2}{4} = \frac{1}{2}$

7. B Replace x with $(-x)$ and see if the result is the opposite of the original. This is true for B.
$-(-x)^5 + 3(-x) = x^5 - 3x = -(-x^5 + 3x)$.

8. B Distance $= \int_1^2 \left| t^2 \right| dx = \int_1^2 t^2\,dt = \frac{1}{3}t^3 \Big|_1^2 = \frac{1}{3}(2^3 - 1^3) = \frac{7}{3}$

9. A $y' = 2\cos 3x \cdot \frac{d}{dx}\left(\cos 3x\right) = 2\cos 3x \cdot \left(-\sin 3x\right) \cdot \frac{d}{dx}\left(3x\right) = 2\cos 3x \cdot \left(-\sin 3x\right) \cdot \left(3\right)$
$y' = -6\sin 3x \cos 3x$

10. C $f(x) = \frac{x^4}{3} - \frac{x^5}{5};\ f'(x) = \frac{4x^3}{3} - x^4;\ f''(x) = 4x^2 - 4x^3 = 4x^2(1-x)$
$f'' > 0$ for $x < 1$ and $f'' < 0$ for $x > 1 \Rightarrow f'$ has its maximum at $x = 1$.

11. B Curve and line have the same slope when $3x^2 = \frac{3}{4} \Rightarrow x = \frac{1}{2}$. Using the line, the point of tangency is $\left(\frac{1}{2}, \frac{3}{8}\right)$. Since the point is also on the curve, $\frac{3}{8} = \left(\frac{1}{2}\right)^3 + k \Rightarrow k = \frac{1}{4}$.

12. C Substitute the points into the equation and solve the resulting linear system.
$3 = 16 + 4A + 2B - 5$ and $-37 = -16 + 4A - 2B - 5$; $A = -3$, $B = 2 \Rightarrow A + B = -1$.

13. D $v(t)=8t-3t^2+C$ and $v(1)=25 \Rightarrow C=20$ so $v(t)=8t-3t^2+20$.
$s(4)-s(2)=\int_2^4 v(t)\,dt=(4t^2-t^3+20t)\Big|_2^4=32$

14. D $f(x)=x^{1/3}(x-2)^{2/3}$
$f'(x)=x^{1/3}\cdot\frac{2}{3}(x-2)^{-1/3}+(x-2)^{2/3}\cdot\frac{1}{3}x^{-2/3}=\frac{1}{3}x^{-2/3}(x-2)^{-1/3}(3x-2)$
f' is not defined at $x=0$ and at $x=2$.

15. C Area $=\int_0^2 e^{\frac{x}{2}}\,dx=2e^{\frac{x}{2}}\Big|_0^2=2(e-1)$

16. C $\frac{dN}{dt}=3000e^{\frac{2}{5}t}$, $N=7500e^{\frac{2}{5}t}+C$ and $N(0)=7500\Rightarrow C=0$
$N=7500e^{\frac{2}{5}t}$, $N(5)=7500e^2$

17. C Determine where the curves intersect. $-x^2+x+6=4\Rightarrow x^2-x-2=0$
$(x-2)(x+1)=0\Rightarrow x=-1,\ x=2$. Between these two x values the parabola lies above the line $y=4$.
Area $=\int_{-1}^2\left((-x^2+x+6)-4\right)dx=\left(-\frac{1}{3}x^3+\frac{1}{2}x^2+2x\right)\Big|_{-1}^2=\frac{9}{2}$

18. D $\frac{d}{dx}(\arcsin 2x)=\frac{1}{\sqrt{1-(2x)^2}}\cdot\frac{d}{dx}(2x)=\frac{2}{\sqrt{1-(2x)^2}}=\frac{2}{\sqrt{1-4x^2}}$

19. D If f is strictly increasing then it must be one to one and therefore have an inverse.

20. D By the Fundamental Theorem of Calculus, $\int_a^b f(x)\,dx=F(b)-F(a)$ where $F'(x)=f(x)$.

21. B $\int_0^1 (x+1)e^{x^2+2x}\,dx=\frac{1}{2}\int_0^1 e^{x^2+2x}\left((2x+2)\,dx\right)=\frac{1}{2}\left(e^{x^2+2x}\right)\Big|_0^1=\frac{1}{2}\left(e^3-e^0\right)=\frac{e^3-1}{2}$

22. B $f(x)=3x^5-20x^3$; $f'(x)=15x^4-60x^2$; $f''(x)=60x^3-120x=60x\left(x^2-2\right)$
The graph of f is concave up where $f''>0$: $f''>0$ for $x>\sqrt{2}$ and for $-\sqrt{2}<x<0$.

23. C $\lim_{h\to 0}\dfrac{\ln(2+h)-\ln 2}{h}=f'(2)$ where $f(x)=\ln x$; $f'(x)=\dfrac{1}{x}\Rightarrow f'(2)=\dfrac{1}{2}$

24. B $f(x)=\cos(\arctan x)$; $-\dfrac{\pi}{2}<\arctan x<\dfrac{\pi}{2}$ and the cosine in this domain takes on all values in the interval $(0,1]$.

25. B $\int_0^{\frac{\pi}{4}}\tan^2 x\,dx=\int_0^{\frac{\pi}{4}}(\sec^2 x-1)\,dx=(\tan x-x)\Big|_0^{\pi/4}=1-\dfrac{\pi}{4}$

26. E $\dfrac{dV}{dt}=4\pi r^2\cdot\dfrac{dr}{dt}=S\cdot\dfrac{dr}{dt}=100\pi(0.3)=30\pi$

27. E $\int_0^{1/2}\dfrac{2x}{\sqrt{1-x^2}}dx=-\int_0^{1/2}\left(1-x^2\right)^{-\frac{1}{2}}(-2x\,dx)=-2\left(1-x^2\right)^{\frac{1}{2}}\Big|_0^{\frac{1}{2}}=2-\sqrt{3}$

28. C $v(t)=8-6t$ changes sign at $t=\dfrac{4}{3}$. Distance $=\left|x(1)-x\left(\dfrac{4}{3}\right)\right|+\left|x(2)-x\left(\dfrac{4}{3}\right)\right|=\dfrac{5}{3}$.

Alternative Solution: Distance $=\int_1^2|v(t)|\,dt=\int_1^2|8-6t|\,dt=\dfrac{5}{3}$

29. C $-1\le\sin x\le 1\Rightarrow-\dfrac{3}{2}\le\sin x-\dfrac{1}{2}\le\dfrac{1}{2}$; The maximum for $\left|\sin x-\dfrac{1}{2}\right|$ is $\dfrac{3}{2}$.

30. B $\int_1^2\dfrac{x-4}{x^2}dx=\int_1^2\left(\dfrac{1}{x}-4x^{-2}\right)dx=\left(\ln x+\dfrac{4}{x}\right)\Big|_1^2=(\ln 2+2)-(\ln 1+4)=\ln 2-2$

31. D $\log_a\left(2^a\right)=\dfrac{a}{4}\Rightarrow\log_a 2=\dfrac{1}{4}\Rightarrow 2=a^{\frac{1}{4}}$; $a=16$

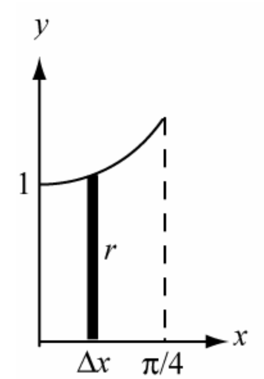
32. D $\int\dfrac{5}{1+x^2}dx=5\int\dfrac{1}{1+x^2}dx=5\tan^{-1}(x)+C$

33. A $f(-x)=-f(x)\Rightarrow f'(-x)\cdot(-1)=-f'(x)\Rightarrow f'(-x)=-f'(x)$ thus $f'(-x_0)=-f'(x_0)$.

34. C $\frac{1}{2}\int_0^2 \sqrt{x}\,dx = \frac{1}{2}\cdot\frac{2}{3}x^{\frac{3}{2}}\Big|_0^2 = \frac{1}{3}\cdot 2^{\frac{3}{2}} = \frac{2}{3}\sqrt{2}$

35. C Washers: $\sum \pi r^2 \Delta x$ where $r = y = \sec x$.

Volume $= \pi\int_0^{\frac{\pi}{4}} \sec^2 x\,dx = \pi \tan x\Big|_0^{\pi/4} = \pi(\tan\frac{\pi}{4} - \tan 0) = \pi$



36. A $y = e^{nx}$, $y' = ne^{nx}$, $y'' = n^2e^{nx}, \cdots, y^{(n)} = n^n e^{nx}$

37. A $\frac{dy}{dx} = 4y$, $y(0) = 4$. This is exponential growth. The general solution is $y = Ce^{4x}$. Since $y(0) = 4$, $C = 4$ and so the solution is $y = 4e^{4x}$.

38. B Let $z = x - c$. Then $5 = \int_1^2 f\left(x-c\right)dx = \int_{1-c}^{2-c} f\left(z\right)dz$

39. B Use the distance formula to determine the distance, L, from any point $(x, y) = (x, \frac{1}{2}x^2)$ on the curve to the point $(4,1)$. The distance L satisfies the equation $L^2 = \left(x-4\right)^2 + \left(\frac{1}{2}x^2 - 1\right)$. Determine where L is a maximum by examining critical points. Differentiating with respect to x, $2L\cdot\frac{dL}{dx} = 2(x-4) + 2\left(\frac{1}{2}x^2 - 1\right)x = x^3 - 8$. $\frac{dL}{dx}$ changes sign from positive to negative at $x = 2$ only. The point on the curve has coordinates $(2,2)$.

40. E $\sec^2(xy)\cdot(xy' + y) = 1$, $xy'\sec^2(xy) + y\sec^2(xy) = 1$, $y' = \frac{1 - y\sec^2(xy)}{x\sec^2(xy)} = \frac{\cos^2(xy) - y}{x}$

41. D $\int_{-1}^{1} f(x)\,dx = \int_{-1}^{0}(x+1)\,dx + \int_0^1 \cos(\pi x)\,dx = \frac{1}{2}(x+1)^2\Big|_{-1}^{0} + \frac{1}{\pi}\sin(\pi x)\Big|_0^1$

$= \frac{1}{2} + \frac{1}{\pi}\left(\sin\pi - \sin 0\right) = \frac{1}{2}$

42. D $\Delta x = \frac{1}{3};\ T = \frac{1}{2}\cdot\frac{1}{3}\left(1^2 + 2\left(\frac{4}{3}\right)^2 + 2\left(\frac{5}{3}\right)^2 + 2^2\right) = \frac{127}{54}$

43. E Solve $\frac{x}{2} = -1$ and $\frac{x}{2} = 2;\ x = -2,\ 4$

44. B Use the linearization of $f(x) = \sqrt[4]{x}$ at $x = 16$. $f'(x) = \frac{1}{4}x^{-\frac{3}{4}}$, $f'(16) = \frac{1}{32}$

$L(x) = 2 + \frac{1}{32}(x - 16);\ f(16 + h) \approx L(16 + h) = 2 + \frac{h}{32}$

45. C This uses the definition of continuity of f at $x = x_0$.