#1. Answer
$163\frac{1}{3}$

#2. Answer
8

#3. Answer
15

#4. Answer
$-\frac{2}{3}$

#5. Answer
2

#6. Answer
9

#7. Answer
2π

#8. Answer
31

#9. Answer
448

#10. Answer
e^3

#11. Answer
11

#12. Answer
7.5

#1. Solution:

$\int_2^k \left[x^2 - 2x\right] dx = \left[\frac{x^3}{3} - x^2\right]_2^k = \left(\frac{k^3}{3} - k^2\right) - \left(\frac{8}{3} - 4\right)$ Given $k = 9$, we have $\Rightarrow \frac{729}{3} - 81 + \frac{4}{3} \Rightarrow 163\frac{1}{3}$.

#2. Solution:

Since D and E are midpoints, $\overline{DE}$ is congruent and parallel to $\overline{FC}$. The change in x coordinates and y coordinates between D and E is the same for points F and C. Therefore $3 - (-4) = a - (-2)$ and $k - 1 = b - (-3)$. So $a = 5$ and given $k = 7$, then $b = 3$. Hence, $5 + 3 = 8$.

#3. Solution:

On a number line, x must be between -12 and k. So the distance between -12 and k will give us an infinite number of solutions for t. Since $k = 3$, the distance between -12 and 3 is 15, so $t = 15$.

#4. Solution:

Using Partial Fractions. $\frac{-2}{(n+1)(n+k)} = \frac{A}{n+1} + \frac{B}{n+k} = \frac{A(n+k)}{(n+1)(n+k)} + \frac{B(n+1)}{(n+1)(n+k)}$ $= \frac{An + kA + Bn + B}{(n+1)(n+k)} = \frac{(A+B)n + (kA+B)}{(n+1)(n+k)}$ $A + B = 0$ and $kA + B = 2$ Given $k = 2$, we have $A = -2$ and $B = 2$. $\sum_2^{\infty}\left(\frac{-2}{n+1} + \frac{2}{n+2}\right) = \left(\frac{-2}{3} + \frac{2}{4}\right) + \left(\frac{-2}{4} + \frac{2}{5}\right) + \left(\frac{-2}{5} + \frac{2}{6}\right) + \ldots$ This is a telescoping series with sum of $-\frac{2}{3}$.

#5. Solution:

$P(x) = \left(x^2 + k\right)\left(x^4 - 16\right) = \left(x^2 + k\right)\left(x^2 - 4\right)\left(x^2 + 4\right)$. If $k > 0$, then there are 2 real zeros. If $k < 0$, then there are 4 real zeros. Since $k = 36$, there are 2 real zeros.

#6. Solution:

The derivative of $f(x) - f(2x)$ is $f'(x) - 2f'(2x)$. Substitute $x = 1$, we get $f'(1) - 2f'(2) = 5$ as row 1. Substitute $x = 2$, we get $f'(2) - 2f'(4) = k$. as row 2. The derivative of $f(x) - f(4x)$ is $f'(x) - 4f'(4x)$. So we need $f'(1) - 4f'(4)$. We obtain this from row 1 add two lots of row 2. $\Rightarrow (f'(1) - 2f'(2)) + 2(f'(2) - 2f'(4)) = 5 + 2 \cdot k$. Given $k = 2$, we have $5 + 2 \cdot 2 = 9$.

#7. Solution:

$r = \cos(\theta)$ ia a circle with radius $\frac{1}{2}$ and center $\left(\frac{1}{2}, 0\right)$. $r = k\cos(\theta)$ is a circle with radius $\frac{k}{2}$ and center $\left(\frac{k}{2}, 0\right)$. The area between them is $\pi \cdot \left(\frac{k}{2}\right)^2 - \pi \cdot \left(\frac{1}{2}\right)^2$. Area $= \frac{\pi}{4}\left(k^2 - 1\right) = \frac{\pi}{4}(9 - 1) = \frac{8\pi}{4} = 2\pi$.

#8. Solution:

The 2 curves intersect at $(0, k)$ and $(1, 1 + k)$. Area = $\int_0^1 \left((x + k) - \left(x^2\right)\right) dx = \left[\frac{x^2}{2} + kx - \frac{x^3}{3}\right]_0^1$ $= \left(\frac{1}{2} - \frac{1}{3} + k - 0\right) = \frac{1}{6} + k$. Given $k = 4$, $= \frac{1}{6} + 4 = \frac{25}{6}$. So $a + b = 25 + 6 = 31$.

#9. Solution:

$(a + kb)^8 = a^8 + 8a^7(kb) + 28a^6(kb)^2 + 56a^5(kb)^3 + \ldots$ So the fourth term is $56a^5(kb)^3$. Given $k = 2$, the coefficient of a^5 is $56 \cdot (2)^3 b^3 \Rightarrow 448b^3$.

#10. Solution:

$\lim_{x \to 1} [k\ln(x) + 1]^{\frac{3}{k\ln(x)}}$. Let $y = k\ln(x)$. We must find $\lim_{y \to 0} (y + 1)^{\frac{3}{y}}$. Let $z = (y + 1)^{\frac{3}{y}}$. $\ln(z) = \frac{3}{y} \cdot \ln(y + 1)$ By L'hopital's Rule, $\lim_{y \to 0} 3 \cdot \frac{1}{y + 1} = 3\ln(z) = 3$ or $z = e^3$.

#11. Solution:

$-3 < (3x - k) < 3$ $-3 + k < 3x < 3 + k$. Given $k = 34$, we have $-3 + 34 < 3x < 3 + 34$. $31 < 3x < 37$. $\frac{31}{3} < x < \frac{37}{3}$. The smallest integer is $\frac{33}{3} = 11$.

#12. Solution:

$\overrightarrow{AB} = \begin{bmatrix} 3 \\ 2 \\ -2 \end{bmatrix}$. $\overrightarrow{AC} = \begin{bmatrix} 1 \\ n \\ 1 \end{bmatrix}$. $\overrightarrow{AB} \times \overrightarrow{AC} = \begin{bmatrix} 2 + 2n \\ -(3+2) \\ 3n - 2 \end{bmatrix} = \begin{bmatrix} 2 + 2n \\ -5 \\ 3n - 2 \end{bmatrix}$. Since $n = 4$, we have $\overrightarrow{AB} \times \overrightarrow{AC} = \begin{bmatrix} 10 \\ -5 \\ 10 \end{bmatrix}$. Area $= \frac{1}{2} \cdot \left| \overrightarrow{AB} \times \overrightarrow{AC} \right| = \frac{1}{2} \cdot \sqrt{100 + 25 + 100} = \frac{1}{2} \cdot \sqrt{225} = 7.5$.