1.
$f'(x) = 6x^2 - 4x$

$f(x) = \int 6x^2 - 4x \, dx$

$\boxed{f(x) = 2x^3 - 2x^2 + C}$

BUT WHEN $x=1$, $y=3$

$3 = 2\times1^3 - 2\times1^2 + C$

$3 = 2 - 2 + C$

$C = 3$

$\therefore \; f(x) = 2x^3 - 2x^2 + 3$

2.
$A = W \times L$

$\Rightarrow 6+3\sqrt{7} = W \times (5+2\sqrt{7})$

$\Rightarrow \dfrac{6+3\sqrt{7}}{5+2\sqrt{7}} = W$

$\Rightarrow W = \dfrac{(6+3\sqrt{7})(5-2\sqrt{7})}{(5+2\sqrt{7})(5-2\sqrt{7})}$

$\Rightarrow W = \dfrac{30 - 12\sqrt{7} + 15\sqrt{7} - (6\times7)}{25 - \cancel{10\sqrt{7}} + \cancel{10\sqrt{7}} - (4\times7)}$

$\Rightarrow W = \dfrac{-12+3\sqrt{7}}{-3}$

$W = 4 - \sqrt{7}$

3. a) (I) $8^{\frac{1}{3}} + 8^{-\frac{1}{3}} = \sqrt[3]{8} + \dfrac{1}{\sqrt[3]{8}} = 2 + \dfrac{1}{2} = \dfrac{5}{2}$

(II) $8^{-4} \times 2^{11} = (2^3)^{-4} \times 2^{11} = 2^{-12} \times 2^{11} = 2^{-1} = \dfrac{1}{2}$

b) $\dfrac{\sqrt{9x^6y^4}}{(3x^2y^3)^2} = \dfrac{\cancel{3}x^3y^2}{\cancel{9}_3 x^4 y^6} = \dfrac{1}{3}x^{-1}y^{-4} = \dfrac{1}{3xy^4}$

NOTE $\sqrt{x^6} = (x^6)^{\frac{1}{2}} = x^3$

$\sqrt{y^4} = (y^4)^{\frac{1}{2}} = y^2$

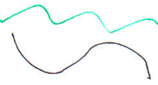
4.
MIN OF A QUADRATIC CURVE IS $(-1, 2)$

THUS $y = (x+1)^2 + 2$

$y = x^2 + 2x + 1 + 2$

$y = x^2 + 2x + 3$

ie $a = 2$
$b = 3$

5. (a) $-x^3$ 

$x=0 \quad y=0 \qquad (0,0)$

$y=0 \qquad 0 = 6x - 2x^2 - x^3$

$$x^3 + 2x^2 - 6x = 0$$

$$x(x^2 + 2x - 6) = 0$$

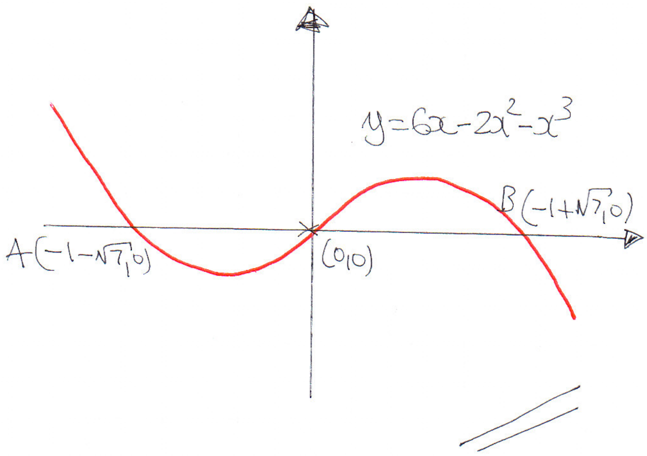
EITHER $x=0$ OR $x^2+2x-6=0$

$$(x+1)^2 - 1 - 6 = 0$$

$$(x+1)^2 = 7$$

$$x+1 = \pm\sqrt{7}$$

$$x = -1 \pm \sqrt{7}$$



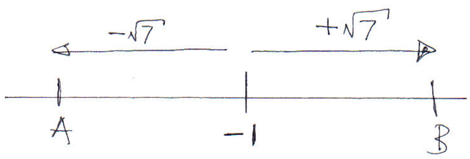
(b) EITHER

$$(-1+\sqrt{7}) - (-1-\sqrt{7})$$

$$= -1 + \sqrt{7} + 1 + \sqrt{7}$$

$$= 2\sqrt{7}$$

OR



$\therefore$ REQUIRED DISTANCE $2\sqrt{7}$

6. (a) $\boxed{3x - 2y + 18 = 0}$

WHEN $x=0$

$$-2y + 18 = 0$$

$$18 = 2y$$

$$y = 9$$

$\therefore P(0,9)$

ie $p=9$

(b) REARRANGE EQUATION TO GET GRADIENT

$$3x + 18 = 2y$$

$$y = \frac{3}{2}x + 9$$

$\therefore$ GRADIENT OF l_2 IS $-\frac{2}{3}$ & PASSES THROUGH $(0,9)$

$$y = -\frac{2}{3}x + 9$$

OR $y - y_0 = m(x - x_0)$

$$y - 9 = -\frac{2}{3}(x - 0)$$

$$y = -\frac{2}{3}x + 9$$

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(c) TO FIND Q

$3x-2y+18=0$

$3x+0+18=0$

$3x=-18$

$x=-6$

$\therefore \boxed{Q(-6,0)}$

TO FIND R

$y=-\frac{2}{3}x+9$

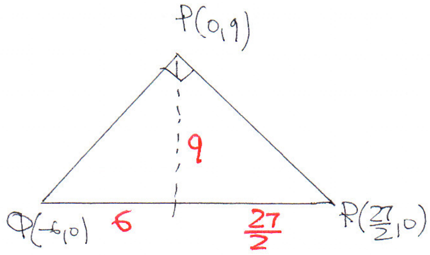
$0=-\frac{2}{3}x+9$

$\frac{2}{3}x=9$

$2x=27$

$x=\frac{27}{2}$

$\therefore \boxed{R(\frac{27}{2},0)}$



$\text{AREA} = \frac{1}{2}\times 9\times\left(6+\frac{27}{2}\right)$

$= \frac{1}{2}\times 9\times\left(\frac{12}{2}+\frac{27}{2}\right)$

$= \frac{1}{2}\times 9\times\frac{39}{2}$

$= \frac{9\times 39}{4} = \frac{270+81}{4}$

$= \frac{351}{4} = \frac{320+28+3}{4}$

$= 80+7+\frac{3}{4} = 87.75$

7. (a) $\underbrace{12+24+36+\dots+240}_{20}$

$a=12$
$d=12$
$n=20$
$L=240$

$S_n=\frac{n}{2}[a+L]$

$S_{20}=\frac{20}{2}[12+240]$

$S_{20}=10\times 252$

$S_{20}=2520$

(b) $\sum_{r=1}^{20} 4(3r+1) = 16+28+40+\dots+244$

$= (12+4)+(24+4)+(36+4)+\dots+(240+4)$

$= 2520+4\times 20$

$= 2520+80$

$= 2600$

OR

$S_n=\frac{20}{2}[16+244]$

$S_{20}=10[260]$

$S_{20}=2600$

8. $\boxed{3(k+2)}x^2 \boxed{-(5k+7)}x + \boxed{3k+1} = 0$

$b^2 - 4ac > 0$ (FOR 2 DISTINCT REAL ROOTS)

$(-(5k+7))^2 - 4 \times 3(k+2)(3k+1) > 0$

$25k^2 + 70k + 49 - 12(3k^2 + k + 6k + 2) > 0$

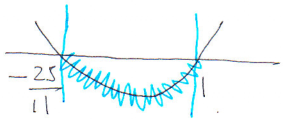
$25k^2 + 70k + 49 - 36k^2 - 12k - 72k - 24 > 0$

$-11k^2 - 14k + 25 > 0$

$11k^2 + 14k - 25 < 0$

$(11k + 25)(k - 1) < 0$

C.V = 1, $-\frac{25}{11}$



$\therefore -\frac{25}{11} < k < 1$ // AS REQUIRED

9. $u_{n+} = 4u_n + k u_n$ $u_2 = 4$, $u_3 = 12$, $u_5 = 178$

$\left.\begin{aligned} u_4 &= 4u_3 + ku_2 \\ u_5 &= 4u_4 + ku_3 \end{aligned}\right\} \Rightarrow \left.\begin{aligned} u_4 &= 48 + 4k \\ 178 &= 4u_4 + 12k \end{aligned}\right\} \Rightarrow$

$\Rightarrow 178 = 4(48 + 4k) + 12k$

$\Rightarrow 178 = 192 + 16k + 12k$

$\Rightarrow -14 = 28k$

$\Rightarrow k = -\frac{1}{2}$ //

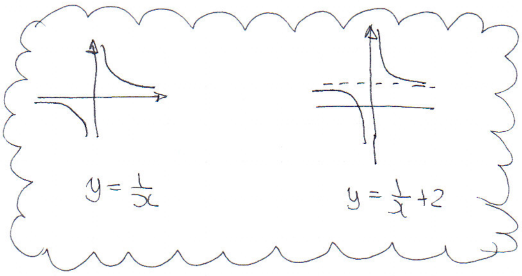
& $u_4 = 48 + 4k$

$u_4 = 48 - 2$

$u_4 = 46$ //

10. a) y AXIS OR $x=0$

$y=2$



b) $y=0$

$0=2+\frac{1}{x}$

$-2=\frac{1}{x}$

$-2x=1$

$x=-\frac{1}{2}$

$\therefore A\left(-\frac{1}{2},0\right)$

c) $y=2+\frac{1}{x}=2+x^{-1}$

$\frac{dy}{dx}=-x^{-2}=-\frac{1}{x^2}$

$\left.\frac{dy}{dx}\right|_{x=-\frac{1}{2}}=-\frac{1}{\left(-\frac{1}{2}\right)^2}=-\frac{1}{\frac{1}{4}}=-4$

NORMAL GRADIENT IS $\frac{1}{4}$, $A\left(-\frac{1}{2},0\right)$

$y-y_0=m(x-x_0)$

$y-0=\frac{1}{4}\left(x+\frac{1}{2}\right)$

$y=\frac{1}{4}x+\frac{1}{8}$

$8y=2x+1$ AS REQUIRED

d) SOLVING SIMULTANEOUSLY

$\left.\begin{array}{l} y=2+\frac{1}{x} \\ 8y=2x+1 \end{array}\right\} \Rightarrow 8\left(2+\frac{1}{x}\right)=2x+1$

$\Rightarrow 16+\frac{8}{x}=2x+1$

$\Rightarrow 15+\frac{8}{x}=2x$

$\Rightarrow 15x+8=2x^2$

$\Rightarrow 0=2x^2-15x-8$

$\Rightarrow (2x+1)(x-8)$

$\therefore x = \begin{cases} -\frac{1}{2} & \leftarrow \text{POINT A} \\ 8 & \leftarrow \text{POINT B} \end{cases}$

$y=2+\frac{1}{x}$

$y=2+\frac{1}{8}$

$y=2\frac{1}{8}=\frac{17}{8}$

$\therefore B\left(8,\frac{17}{8}\right)$