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C2, IYGB, PAPER U

1. a) WORK IN MINUTES: PAPER 1 $\rightarrow$ $3h-20' = 200$ MINUTES
PAPER 2 $\rightarrow$ $3h-15' = 195$ MINUTES

$$\text{COMMON RATIO} = \frac{195}{200} = 0.975$$

$u_n = ar^{n-1}$

$\Rightarrow u_6 = 200 \times 0.975^5$

$\Rightarrow u_6 \simeq 176.249\ldots$

I.E APPROX 176 MINS

$S_n = \dfrac{a(1-r^n)}{1-r}$

$\Rightarrow S_{12} = \dfrac{200(1-0.975^{12})}{1-0.975}$

$\Rightarrow S_{12} = 2096.01\ldots$) $\div 60$

$\Rightarrow S_{12} = 34.933\ldots$

I.E APPROX 35 hours

b) $u_n < 120$

$\Rightarrow ar^{n-1} < 120$

$\Rightarrow 200 \times (0.975)^{n-1} < 120$

$\Rightarrow 0.975^{n-1} < 0.6$

$\Rightarrow \log(0.975)^{n-1} < \log(0.6)$

$\Rightarrow (n-1)\log(0.975) < \log(0.6)$

DIVIDING BY NEGATIVE REVERSES INEQUALITY

$\Rightarrow n-1 > 20.17\ldots$

$\Rightarrow n > 21.17\ldots$

$\therefore n = 22$

2. a) $(2x-4)^5 = \binom{5}{0}(2x)^0(-4)^5 + \binom{5}{1}(2x)^1(-4)^4 + \binom{5}{2}(2x)^2(-4)^3 + \binom{5}{3}(2x)^3(-4)^2$
$+ \binom{5}{4}(2x)^4(-4)^1 + \binom{5}{5}(2x)^5(-4)^0$

$= -1024 + 2560x - 2560x^2 + 1280x^3 - 320x^4 + 32x^5$

$= 32x^5 - 320x^4 + 1280x^3 - 2560x^2 + 2560x - 1024$

b) I) $\left(\dfrac{y+16}{4}\right)^5 = \left[\frac{1}{4}y + 4\right]^5$

THIS IS THE SAME AS THE EXPANSION OF PART (A) WITH $x = \frac{1}{8}y$ AND ALL THE SIGNS "PLUS"

$2x = \frac{1}{4}y$
$x = \frac{1}{8}y$

$\therefore \ldots + 2560\left(\frac{1}{8}y\right)^2 + \ldots \quad \therefore 40y^2 \quad \therefore 40$

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II) $(\sqrt{2}z-2)^5(\sqrt{2}z+2)^5 = [(\sqrt{2}z-2)(\sqrt{2}z+2)]^5$
$= (2z^2-4)^5$

THIS IS THE SAME EXPANSION AS PART (a) WITH $x=z^2$

THUS .... $-320(z^2)^4$ ... $-320z^8$

$\therefore -320$

3. METHOD A

$$\begin{cases} \log_2(xy^2)=0 \\ \log_2(x^2y)=3 \end{cases}$$

$$\begin{cases} \log_2 x + \log_2 y^2 = 0 \\ \log_2 x^2 + \log_2 y = 3 \end{cases}$$

$$\begin{cases} \log_2 x + 2\log_2 y = 0 \\ 2\log_2 x + \log_2 y = 3 \end{cases}$$

$$\left.\begin{cases} X + 2Y = 0 \\ 2X + Y = 3 \end{cases}\right\} \Rightarrow \boxed{X=-2Y}$$

$-4Y + Y = 3$

$-3Y = 3$

$\boxed{Y=-1}$ & $\boxed{X=2}$

$\log_2 y = -1$ $\quad$ $\log_2 x = 2$

$y = 2^{-1}$ $\quad$ $x = 2^2$

$y = \frac{1}{2}$ $\quad$ $x = 4$

METHOD B

$$\begin{cases} \log_2(xy^2)=0 \\ \log_2(x^2y)=3 \end{cases}$$

$$\begin{cases} xy^2 = 2^0 \\ x^2y = 2^3 \end{cases}$$

$$\begin{cases} xy^2 = 1 \\ x^2y = 8 \end{cases}$$

$$\begin{cases} x^2y^4 = 1 \\ x^2y = 8 \end{cases}$$ DIVIDE

$y^3 = \frac{1}{8}$

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

$x^2y = 8$

$\frac{1}{2}x^2 = 8$

$x^2 = 16$

$x = +4$ $\quad \begin{cases} x>0 \\ y>0 \end{cases}$

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4. a) $f(x) = x^3 + (a+2)x^2 - 2x + b$

$f(2) = 0 \Rightarrow 8 + 4(a+2) - 4 + b = 0$
$f(-a) = 0 \Rightarrow -a^3 + (a+2)(-a)^2 - 2(-a) + b = 0$ $\Rightarrow$

$8 + 4a + 8 - 4 + b = 0$
$-a^3 + a^3 + 2a^2 + 2a + b = 0$ $\Rightarrow$

$b = -4a - 12$
$b = -2a^2 - 2a$ $\Rightarrow$ $-4a - 12 = -2a^2 - 2a$

$2a^2 - 2a - 12 = 0$
$a^2 - a - 6 = 0$
$(a+2)(a-3) = 0$
$a = 3, \cancel{-2}$

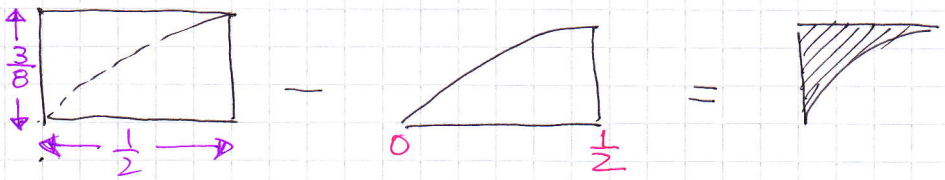
$\therefore b = -4 \times 3 - 12$
$b = -24$

b) $f(x) = x^3 + 5x^2 - 2x - 24$
$f(x) = (x-2)(x+3)(x+4)$
$\therefore x = 2, -3, -4$

5. $y = x - 2x^4$
$\frac{dy}{dx} = 1 - 8x^3$
Set RHS Zero.
$1 - 8x^3 = 0$
$8x^3 = 1$
$x^3 = \frac{1}{8}$
$x = \frac{1}{2}$ $y = \frac{1}{2} - 2\left(\frac{1}{2}\right)^4 = \frac{3}{8}$ $M\left(\frac{1}{2}, \frac{3}{8}\right)$

C2 IYGB PAPER U

Now



$\frac{1}{2} \times \frac{3}{8} = \frac{3}{16}$

$\int_0^{\frac{1}{2}} x - 2x^4 \, dx = \left[\frac{1}{2}x^2 - \frac{2}{5}x^5\right]_0^{\frac{1}{2}}$

$= \left(\frac{1}{8} - \frac{1}{80}\right) - (0) = \frac{9}{80}$

$\therefore$ REQUIRED AREA $= \frac{3}{16} - \frac{9}{80} = \frac{3}{40}$

6. a) $P = 16\sqrt{t} + \frac{27}{t}$

When $t = 2\frac{1}{4} = \frac{9}{4} \Rightarrow P = 16\sqrt{\frac{9}{4}} + \frac{27}{\frac{9}{4}} = 36$

$\therefore$ 36000

b) $P = 16t^{\frac{1}{2}} + 27t^{-1}$

$\frac{dP}{dt} = 8t^{-\frac{1}{2}} - 27t^{-2}$

INCREASING $\Rightarrow \frac{dP}{dt} > 0$

$8t^{-\frac{1}{2}} - 27t^{-2} > 0$

$\frac{8}{t^{\frac{1}{2}}} > \frac{27}{t^2}$

$\frac{t^2}{t^{\frac{1}{2}}} > \frac{27}{8}$ $\quad t^2, t^{\frac{1}{2}} > 0$

$t^{\frac{3}{2}} > \frac{27}{8}$

$\left(t^{\frac{3}{2}}\right)^{\frac{2}{3}} > \left(\frac{27}{8}\right)^{\frac{2}{3}}$

$t > \frac{9}{4}$

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7. a) $f(x) = \sqrt{3} - \tan(2x - \alpha)$

$\Rightarrow -2 = \sqrt{3} - \tan(2\times 52.5 - \alpha)$

$\Rightarrow -2 = \sqrt{3} - \tan(105 - \alpha)$

$\Rightarrow \tan(105 - \alpha) = 2 + \sqrt{3}$

$\arctan(2+\sqrt{3}) = 75°$

$\Rightarrow 105° - \alpha = 75° \pm 180n \quad n = 0,1,2,3,..$

$\Rightarrow -\alpha = -30° \pm 180n$

$\Rightarrow \alpha = 30° \pm 180n$

$\therefore \alpha = 30°$ // $(0 < \alpha < 90)$

b) $f(x) = 0$

$\Rightarrow 0 = \sqrt{3} - \tan(2x - 30)$

$\Rightarrow \tan(2x - 30) = \sqrt{3}$

$\arctan(\sqrt{3}) = 60°$

$\Rightarrow 2x - 30° = 60 \pm 180n \quad n = 0,1,2,3..$

$\Rightarrow 2x = 90 \pm 180n$

$\Rightarrow x = 45 \pm 90n$

$\therefore B(45, 0)$

$C(135, 0)$ //

c) when $x = 0 \quad f(0) = \sqrt{3} - \tan(-30) = \frac{4}{3}\sqrt{3}$

$x = 180 \quad f(180) = \sqrt{3} - \tan(330) = \frac{4}{3}\sqrt{3}$

$\therefore A(0, \frac{4}{3}\sqrt{3}) \quad D(180, \frac{4}{3}\sqrt{3})$ //

d) PERIOD IS 90° //

$\tan(x + \phi)$ HAS PERIOD 180

$\tan(2x + \phi)$ HAS PERIOD 90

e) $\tan x$ HAS ITS FIRST ASYMPTOTE FOR WHICH $x > 0$ AT $x = 90$

- $\tan(x - 30)$ HAS ITS FIRST ASYMPTOTE AT $x = 90 + 30 = 120$
- $\tan(2x - 30)$ HAS ITS FIRST ASYMPTOTE AT $x = \frac{120}{2} = 60$

$\therefore$ ASYMPTOTES ARE $x = 60°$

$x = 150°$ // ← +90 ONE PERIOD LATER

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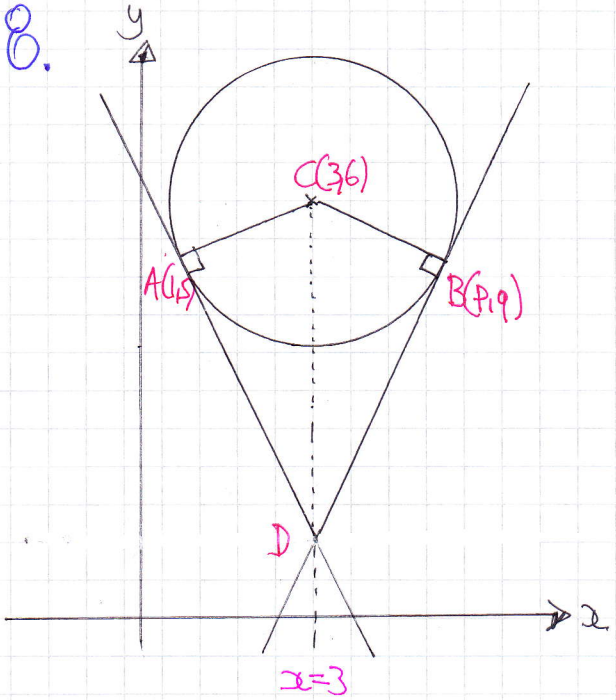
8.



a) RADIUS $= |AC| = \sqrt{(6-5)^2+(3-1)^2}$

$= \sqrt{1+4}$

$= \sqrt{5}$

b) $p = 5$ ← SYMMETRICAL ABOUT $x=3$

$q = 5$ ← SAME "HEIGHT" AS A

c) GRAD $AC = \frac{6-5}{3-1} = \frac{1}{2}$

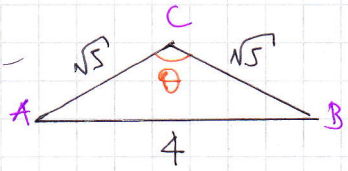
TANGENT GRADIENT $= -2$ PASSING THROUGH $A(1,5)$

$y-5 = -2(x-1)$

$y-5 = -2x+2$

$y+2x = 7$

d)



BY THE COSINE RULE $\Rightarrow 4^2 = \sqrt{5}^2 + \sqrt{5}^2 - 2\sqrt{5}\sqrt{5}\cos\theta$

$\Rightarrow 16 = 5+5-10\cos\theta$

$\Rightarrow 10\cos\theta = -6$

$\cos\theta = -\frac{3}{5}$

$\theta \simeq 2.214^c$

ALTERNATIVE SPLIT ABOUT INTO TWO RIGHT ANGLED TRIANGLES

THEN $\sin\phi = \frac{2}{\sqrt{5}}$

$\phi \simeq 1.1071\ldots$

$\theta \simeq 2\phi \simeq 2.214^c$

e) • $y+2x = 7$

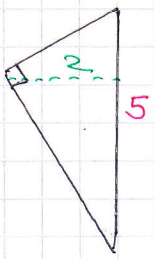
$y+2\times 3 = 7$

$y = 1$

$\therefore D(3,1)$

• $|CD| = 5$

•



AREA $= \frac{1}{2}\times 5\times 2 = 5$

• AREA OF KITE

$2\times 5 = 10$

• AREA OF SECTOR

$\frac{1}{2}r^2\theta = \frac{1}{2}(\sqrt{5})^2 \times 2.214^c$

$\simeq 5.5357\ldots$

• REQUIRED AREA

$10 - 5.5357\ldots$

$\simeq 4.64$

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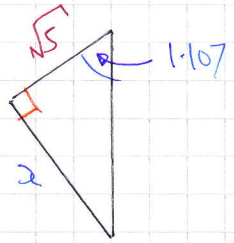
ALTERNATIVE FOR PART OF PART (c)



$$\frac{x}{\sqrt{5}} = \tan(1.107)$$

$$x = 2\sqrt{5}$$

$$\text{AREA} = \frac{1}{2} \times \sqrt{5} \times 2\sqrt{5} = 5 \quad \text{(AS BEFORE)}$$