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PAPER 1

1 (a) B and C
(b) A
(c) C

2 (a) $\int_{-1}^{5} f(x)\,dx = 4$
$\therefore a = -1, b = 5$

(b) $\int_{-1}^{5} f(x)\,dx + \left|\int_{5}^{9} f(x)\,dx\right| = 12$

$$4 + \left|\int_{5}^{9} f(x)\,dx\right| = 12$$

$$\left|\int_{5}^{9} f(x)\,dx\right| = 8$$

$$\int_{5}^{9} f(x)\,dx = -8$$

3 (a) $|-\overrightarrow{BA}| = \sqrt{3^2 + 4^2} = 5$ units

(b) (i) $\overrightarrow{BC} = \overrightarrow{BA} + \overrightarrow{AC} = -\underset{\sim}{b} + \underset{\sim}{c} = \underset{\sim}{c} - \underset{\sim}{b}$

(ii) $\overrightarrow{AD} = \overrightarrow{AB} + \overrightarrow{BD}$

$= \underset{\sim}{b} + 2\overrightarrow{BC}$

$= \underset{\sim}{b} + 2(\underset{\sim}{c} - \underset{\sim}{b}) = 2\underset{\sim}{c} - \underset{\sim}{b}$

4 $\underset{\sim}{p} = m\underset{\sim}{q}$

$$\begin{pmatrix} 3 \\ 4 \end{pmatrix} = m\begin{pmatrix} k - 1 \\ 2 \end{pmatrix}$$

$$\begin{pmatrix} 3 \\ 4 \end{pmatrix} = \begin{pmatrix} mk - m \\ 2m \end{pmatrix}$$

From the above equation, $mk - m = 3$ .... ①
$2m = 4$ .... ②

From ②: $2m = 4$
$m = 2$

Substitute $m = 2$ into ①: $2k - 2 = 3$
$2k = 3 + 2$
$2k = 5$
$k = \frac{5}{2}$

5 $\frac{25^{h+3}}{125^{p-1}} = 1$

$25^{h+3} = 125^{p-1}$

$(5^2)^{h+3} = (5^3)^{p-1}$

$5^{2h+6} = 5^{3p-3}$

$2h + 6 = 3p - 3$

$3p = 2h + 9$

$p = \frac{2h + 9}{3}$

6 $\log_m 324 - \log_{\sqrt{m}} 2m = 2$

$\log_m 324 - \frac{\log_m 2m}{\log_m m^{\frac{1}{2}}} = 2$

$\log_m 324 - 2\log_m 2m = \log_m m^2$

$\log_m 324 - \log_m (2m)^2 = \log_m m^2$

$\log_m \frac{324}{4m^2} = \log_m m^2$

$\frac{324}{4m^2} = m^2$

$4m^4 = 324$

$m^4 = 81 = (\pm 3)^4$

$m = \pm 3$ (-3 is rejected)

Thus, $m = 3$.

7 (a) $k = 0, k = 1, k = -1$
(Any one of these answers.)

(b) $T_n = \frac{3}{2} r^{n-1}$

$T_1 = \frac{3}{2} r^{1-1}$

$= \frac{3}{2} r^0 = \frac{3}{2}$

8 $S_n = \frac{n}{2}[13 - 3n]$

$S_{n-1} = \frac{n-1}{2}[13 - 3(n - 1)]$

$= \frac{1}{2}(n - 1)(16 - 3n)$

$T_n = S_n - S_{n-1}$

$= \frac{n}{2}(13 - 3n) - \frac{1}{2}(n - 1)(16 - 3n)$

$= \frac{13}{2}n - \frac{3}{2}n^2 - \frac{1}{2}(16n - 3n^2 - 16 + 3n)$

$= \frac{13}{2}n - \frac{3}{2}n^2 - \frac{19}{2}n + \frac{3}{2}n^2 + 8$

$= 8 - 3n$

9 (a) 4

(b) $f(x) = |1 - 2x|$

$f(3) = |1 - 2(3)|$

$= |1 - 6|$

$= |-5|$

$= 5$

(c) When $x = -2$, $f(x) = 5$.
When $x = 3$, $f(x) = 5$.
Domain: $-2 \leq x \leq 3$

10 (*a*) Let $y = g(x)$

$= 2x - 8$

$2x - 8 = y$

$2x = y + 8$

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

Thus, $g^{-1}(x) = \frac{x + 8}{2}$

(*b*) $g(x) = 2x - 8$

$g^2(x) = g[g(x)]$

$= g(2x - 8)$

$= 2(2x - 8) - 8$

$= 4x - 16 - 8$

$= 4x - 24$

$g^2\left(\frac{3p}{2}\right) = 4\left(\frac{3p}{2}\right) - 24 = 30$

$6p - 24 = 30$

$6p = 54$

$p = 9$

11 (*a*) $f(x) = x^2 + 4x + h$

$= x^2 + 4x + (2)^2 - (2)^2 + h$

$= (x + 2)^2 - 4 + h$

(*b*) Minimum value = 8

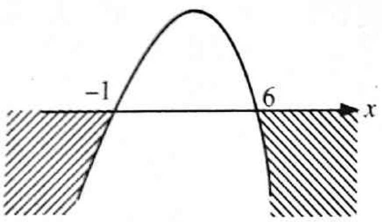
$-4 + h = 8$

$h = 8 + 4 = 12$

12 $f(x) < 0$

$6 + 5x - x^2 < 0$

$(6 - x)(x + 1) < 0$



$x < -1, x > 6$

13 (*a*) $x^2 + (p + 3)x - p^2 = 0$

$a = 1, b = p + 3, c = -p^2$

Root 1 = α, Root 2 = $-\alpha$

Sum of the roots $= -\frac{b}{a}$

$\alpha + (-\alpha) = -\frac{(p + 3)}{1}$

$-(p + 3) = 0$

$p + 3 = 0$

$p = -3$

Product of roots $= \frac{c}{a}$

$= \frac{-p^2}{1}$

$= -(-3)^2 = -9$

(*b*) $mx^2 - 5nx + 4m = 0$

$a = m, b = -5n, c = 4m$

$b^2 = 4ac$

$(-5n)^2 = 4m(4m)$

$25n^2 = 16m^2$

$\frac{m^2}{n^2} = \frac{25}{16}$

$\left(\frac{m}{n}\right)^2 = \left(\frac{5}{4}\right)^2$

$m : n = 5 : 4$

14 (*a*) (i) When $x = 0, y = 2$

$m \cos 0 - 1 = 2$

$m(1) - 1 = 2$

$m = 3$

(ii) When $x = \pi, y = 2$

$3 \cos p\pi - 1 = 2$

$3 \cos p\pi = 3$

$\cos p\pi = 1$

$\cos 2\pi = 1$

$\therefore p = 2$

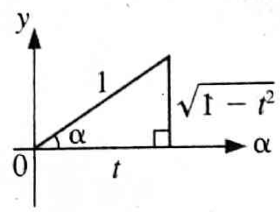
(*b*) $m \cos px = -3$

$m \cos px - 1 = -3 - 1$

$y = -4$

Number of solutions = 1

15 $\cos \alpha = t$



$\sin \alpha = \sqrt{1 - t^2}$

(*a*) $\sin (180° + \alpha) = \sin 180 \cos \alpha + \cos 180 \sin \alpha$

$= 0 - \sin \alpha$

$= - \sin \alpha$

$= - \sqrt{1 - t^2}$

(*b*) $\sec 2\alpha = \frac{1}{\cos 2\alpha}$

$= \frac{1}{2 \cos^2 \alpha - 1} = \frac{1}{2t^2 - 1}$

16 Length of major arc $AOD = 2r \times 7\alpha = 14r\alpha$

Length of minor arc $BOC = r \times 2\alpha = 2r\alpha$

Perimeter of whole diagram = 50

$14r\alpha + 2r\alpha + r + r = 50$

$16r\alpha + 2r = 50$

$8r\alpha + r = 25$

$r(8\alpha + 1) = 25$

$r = \frac{25}{8\alpha + 1}$

17 $\int \frac{5}{(2x+3)^n}\,dx = \int 5(2x+3)^{-n}\,dx$

$$= \frac{5(2x+3)^{-n+1}}{(-n+1)\times 2} + c$$

$$= \frac{5}{2(1-n)} \times \frac{1}{(2x+3)^{n-1}} + c$$

$$= \frac{5}{2(1-n)(2x+3)^{n-1}} + c$$

Compare $\frac{5}{2(1-n)(2x+3)^{n-1}}$ with $\frac{p}{(2x+3)^5}$:

$n - 1 = 5$

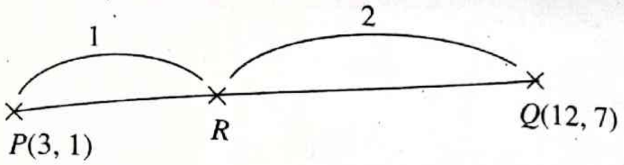
$n = 6$

$$\frac{5}{2(1-n)} = p$$

$$\frac{5}{2(-5)} = p$$

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

18



$2PQ = 3RQ$

$\frac{PQ}{RQ} = \frac{3}{2}$

$R = \left(\frac{1(12) + 2(3)}{1+2}, \frac{1(7) + 2(1)}{1+2}\right)$

$= \left(\frac{18}{3}, \frac{9}{3}\right) = (6, 3)$

19 $y = x + \frac{r}{x^2}$

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

$Y = mX + C$

$m = r, c = 0$

$$\frac{5p - 0}{\frac{h}{2} - 0} = r$$

$$5p = \frac{1}{2}hr$$

$$hr = 10p$$

$$h = \frac{10p}{r}$$

20 (*a*) $4 + 10 + x + 8 + 7 = 40$

$x + 29 = 40$

$x = 11$

Modal class = 40 − 59

(*b*) The top ten placings are $T_{31}, T_{32}, T_{33}, \ldots T_{40}$

$T_{31} = 59.5 + \frac{5}{8}(79.5 - 59.5)$

$= 59.5 + 12.5 = 72$

A student has to achieve a minimum mark of 72.

Erica qualifies for the reward because her marks > 72 marks.

21 $P(1) + P(2) + P(3) + P(4) + P(5) + P(6) = 1$

$$x + x + x + \frac{1}{16} + x + x = 1$$

$$5x = \frac{15}{16}$$

$$x = \frac{3}{16}$$

$P(\text{Same numbers}) = P(1, 1) + P(2, 2) + P(3, 3) + P(4, 4) + P(5, 5) + P(6, 6)$

$= (x \times x) + (x \times x) + (x \times x) + \left(\frac{1}{16} \times \frac{1}{16}\right) + (x \times x) + (x \times x)$

$= 5x^2 + \frac{1}{256}$

$= 5\left(\frac{3}{16}\right)^2 + \frac{1}{256}$

$= \frac{23}{128}$

$P(\text{Two different numbers}) = 1 - \frac{23}{128} = \frac{105}{128}$

22 (*a*) Number of different ways $= {}^{14}C_3$

$= 364$

(*b*) (BR), (A), (C), (D), (E)

Number of ways (Blue cup and red cup are next to each other) = 5! × 2! = 240

Number of different ways = 6! − 240

= 720 − 240

= 480

23 $\Sigma x = 2 + 3 + 4 + 5 + 6 = 20$

$\Sigma x^2 = 2^2 + 3^2 + 4^2 + 5^2 + 6^2 = 90$

Mean $= \frac{20}{5} = 4$

Variance $= \frac{\Sigma x^2}{n} - (\bar{x})^2$

$= \frac{90}{5} - 4^2 = 2$

New mean = 17

$4m + n = 17$ .... ①

New standard deviation = 4.242

$m\sqrt{2} = 4.242$

$m = \frac{4.242}{\sqrt{2}} = 2.9995 \approx 3$

Substitute m = 3 into ①: $4(3) + n = 17$

$n = 5$

24 (*a*) $P(X = 0) + P(X = 1) + P(X = 2) + P(X = 3) = 1$

$P(X = 0) + a + b + P(X = 3) = 1$

$P(X = 0) + P(X = 3) = 1 - a - b$

$P(X = 0) + P(X > 2) = 1 - a - b$

(*b*)
$$P(X = 0) = \frac{27}{343}$$
$$^3C_0\,(p^0)\,(1 - p)^3 = \frac{27}{343}$$
$$1 \times 1 \times (1 - p)^3 = \left(\frac{3}{7}\right)^3$$
$$1 - p = \frac{3}{7}$$
$$p = \frac{4}{7}$$

25 (*a*) $P(X < h) = 0.5 - 0.2881$

$P(X < h) = 0.2119$

$P(X < -0.8) = 0.2119$

$h = -0.8$

(*b*) $X = 58.8$
$$\frac{X - \mu}{\sigma} = \frac{58.8 - \mu}{\sigma}$$
$$Z = \frac{58.8 - \mu}{4}$$
$$h = \frac{58.8 - \mu}{4}$$
$$-0.8 = \frac{58.8 - \mu}{4}$$
$$-3.2 = 58.8 - \mu$$
$$\mu = 58.8 + 3.2 = 62$$