DUNMAN SECONDARY SCHOOL

CANDIDATE NAME

CLASS

INDEX NUMBER

PRELIMINARY EXAMINATION 2025
SECONDARY 4 EXPRESS/ 5 NORMAL ACADEMIC

MATHEMATICS
Paper 1

4052/01

2 hours 15 minutes

Solutions

Qn	Answer
1(a)	Inconsistent y-axis scale
1(b)	The revenue growth appears to be more than doubled from 2020 compared to 2024 when in actual fact only increased from about $500 000 to $800 000.

Qn	Answer
2	In Italy, $830 \times 1.4893 = \$1236.119$ In Singapore, $830 \div 0.6747 = \$1230.176375$ Difference $= \$5.94$

Qn	Answer
3(a)	$\sin x = \dfrac{1}{3}$ $x = 19.47122\ldots$ or $160.5287\ldots$ $= 19.5°$ or $160.5°$ (1 d.p.)
3(b)	$26° = 0.45378\ldots = 0.454$ (3 s.f.)

Qn	Answer
4	Amount of liquid in bottles B and C $= 300 \div 15 \times 13 = 260\,\text{ml}$ Amount of liquid in bottle $A = 40$ ml Amount of liquid left in bottle A $= 260 \div 65 \times 7 = 28$ ml $n = 40 - 28 = 12$ **OR** $2 : 8 : 5$ is equivalent to $10 : 40 : 25$ 75 units rep. 300 ml 1 unit rep. 4 ml $n = 4 \times (10 - 7) = 12$

Qn	Answer
5(a)	$$\left(\frac{27a^{12}}{b^3}\right)^{-\frac{2}{3}}$$ $$=\left(\frac{b^3}{27a^{12}}\right)^{\frac{2}{3}}$$ $$=\frac{b^2}{9a^8}$$
5(b)	$13 \times 9^2 - 4 \times 3^4 = 3^p$ $13 \times 3^4 - 4 \times 3^4 = 3^p$ $3^4(13-4) = 3^p$ $3^4 \times 3^2 = 3^p$ $p = 6$

Qn	Answer
6	$$F = \frac{k}{r^2}$$ $$F_1 = \frac{k}{(3r)^2} = \frac{k}{9r^2} = \frac{1}{9}\left(\frac{k}{r^2}\right) = \frac{1}{9}F$$ He is not correct since the force should be $\frac{1}{9}$ instead.

Qn	Answer
7(a)	$300 \text{ km} \div 2 \text{hour} = 150$ km/h
7(b)	Since distance is rounded down and time is rounded up, this speed will be lower than the actual speed.
7(c)	227 km/h $= 227 \times 1000 \div 3600$ $= 63.1$ m/s

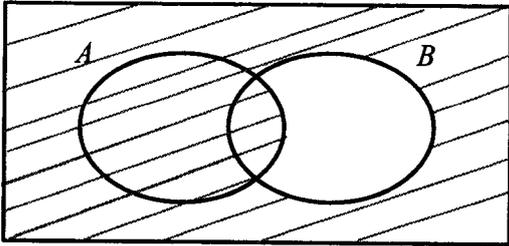| Qn	Answer
8(a)	$16a^2b - 8ab^2$ $= 8ab(2a-b)$
8(b)	$3c - 4d + 3cd - 4$ $= 3c(1+d) - 4(1+d)$ $= (3c-4)(1+d)$

BP-391

Qn	Answer
9	$29 \text{ cm}^2 : 728.6 \text{ km}^2$
	$\sqrt{29} \text{ cm} : \sqrt{728.6} \text{ km}$
	$5.3852 \text{ cm} : 26.993 \text{ km (5 s.f.)}$
	$1 \text{ cm} : 5.0124 \text{ km (5 s.f.)}$
	$1 : 501244$
	$1 : 5 \times 10^5$
	$n = 5 \times 10^5$

Qn	Answer
10	$\dfrac{5x}{18} - \dfrac{5x+12}{54} - \dfrac{2(x-1)}{27}$
	$= \dfrac{15x - 5x - 12 - 4(x-1)}{54}$
	$= \dfrac{10x - 12 - 4x + 4}{54}$
	$= \dfrac{6x - 8}{54}$
	$= \dfrac{3x - 4}{27}$

Qn	Answer
11	$OD = OB$ (radius of circle)
	$OC = OA$ (radius of circle)
	$CD = AB$ (equal chords)
	Therefore, triangles OAB and OCD are congruent by SSS congruency test.

Qn	Answer
12	$\dfrac{2x^2+7x-15}{16x^4-81}$ $= \dfrac{(2x-3)(x+5)}{(4x^2)^2-9^2}$ $= \dfrac{(2x-3)(x+5)}{(4x^2-9)(4x^2+9)}$ $= \dfrac{(2x-3)(x+5)}{(2x-3)(2x+3)(4x^2+9)}$ $= \dfrac{x+5}{(2x+3)(4x^2+9)}$

Question	Answer
13(a)	$7-10x+x^2$ $= x^2-10x+7$ $= (x-5)^2-5^2+7$ $= (x-5)^2-18$
13(b)	$x=5$

Question	Answer
14(a)(i)	1, 4, 6, 8, 9, 10, 12, 14
14(a)(ii)	Since perfect squares have more than 2 factors, they will never be prime numbers. Hence, $X \cap Y = \phi$
14(b)	

Question	Answer
15	

Question	Answer
16	$\frac{4}{3}\pi(2r)^3 = 2\times\frac{1}{3}\pi\left(\frac{2}{3}r\right)^2\times10h$ $\frac{32\pi r^3}{3} = \frac{80\pi r^2 h}{27}$ $32r\times27 = 3\times80h$ $864r = 240h$ $\frac{h}{r} = \frac{864}{240}$ $h:r = 18:5$

Question	Answer
17	angle $ABC = 108°$ angle $FBC = 360°-108°-100°$ ($\angle s$ at a point) $\qquad = 152°$ $\quad$ exterior angle $= 180°-152° = 28°$ for regular polygon $= \dfrac{360°}{28°}$ $\qquad\qquad = 12.85...$ not whole number For a regular polygon, they have equal angles. Hence, $360°$ is not divisible by $28°$, the second polygon is not regular.

Question	Answer
18(a)	$\sqrt{(-4)^2 + (-3)^2} = 5$
18(b)	gradient $= \dfrac{-3}{-4} = \dfrac{3}{4}$ Equation: $y = \dfrac{3}{4}x + c$ $-5 = \dfrac{3}{4}(2) + c$ $c = -\dfrac{13}{2}$ $y = \dfrac{3}{4}x - \dfrac{13}{2}$ or $-6\dfrac{1}{2}$ or -6.5
18(c)	x-coordinates $= 2 + \dfrac{3}{4}(4) = 5$ y-coordinates $= -5 + \dfrac{3}{4}(3) = -2\dfrac{3}{4}$ $R = (5, -2.75)$

Question	Answer
19	$16 = ka^0 \Rightarrow k = 16$ $64 = 16a^{-2}$ $a^2 = \dfrac{1}{4}$ $a = \dfrac{1}{2}$ (rej. -ve)

Question	Answer
20	$\dfrac{A_1}{A_2} = \left(\dfrac{l_1}{l_2}\right)^2$ $\dfrac{4}{5} = \left(\dfrac{l_1}{30}\right)^2$ $\sqrt{\dfrac{4}{5}} = \dfrac{l_1}{30}$ $l_1 = 30 \times \sqrt{\dfrac{4}{5}} = 26.832$ cm (5 s.f.) length $= 30 - 26.832 = 3.17$ (3 s.f.)

Question	Answer
21(a)	Probability $= \dfrac{5}{9} \times \dfrac{4}{8} + \dfrac{4}{9} \times \dfrac{3}{8} = \dfrac{4}{9}$
21(b)	Probability $= \dfrac{5}{9} \times \dfrac{4}{8} + \dfrac{4}{9} \times \dfrac{5}{8} = \dfrac{5}{9}$

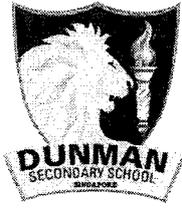| Question	Answer
22(a)	mean $=$ $\dfrac{15 \times 4.25 + 29 \times 4.75 + 12 \times 5.25 + 34 \times 5.75 + 10 \times 6.25}{100}$ $= 5.225$ mean $= \$5225$
22(b)	Standard deviation $= \$637.87$ or $\$638$
22(c)	Mean remains unchanged, standard deviation becomes smaller

Question	Answer
23(a)	Angle NAB $= 52°$ Angle N_1BA $= 180° - 52° = 128°$ (interior angles, NA // N_1B) Bearing of A from B $= 360° - 128° = 232°$
23(b)	BP $= 2.1$ cm

Question	Answer
24(a)	$5y = 6x - 2 \times 2$: $10y = 12x - 4$ -- (1) $2y = 5x - 6 \times 5$: $10y = 25x - 30$ -- (2) (2) - (1): $13x - 26 = 0$ $\qquad\qquad x = 2, y = 2$ $\therefore$ (2, 2)
24(b)	For $py = 3x - 1$ not to intersect with $5y = 6x - 2$, **they must be parallel.** $y = \dfrac{3}{p}x - \dfrac{1}{p}$ $\dfrac{3}{p} = \dfrac{6}{5} \Rightarrow p = \dfrac{5}{2}$ $l_3 : y = \dfrac{6}{5}x - \dfrac{2}{5}$ Since line l_1 and l_3 have the same equation, they will intersect. Therefore, it is not possible to find a value of p that the lines will not intersect.

Question	Answer
25(a)	$\mathbf{Q} = \begin{pmatrix} 1.20 \\ 1.50 \\ 1.80 \end{pmatrix}$
25(b)	$\mathbf{T = PQ}$ $= \begin{pmatrix} 60 & 80 & 50 \\ 50 & 90 & 70 \end{pmatrix} \begin{pmatrix} 1.20 \\ 1.50 \\ 1.80 \end{pmatrix}$ $= \begin{pmatrix} 72 + 120 + 90 \\ 60 + 135 + 126 \end{pmatrix}$ $= \begin{pmatrix} 282 \\ 321 \end{pmatrix}$
25(c)	282 and 321 represents the total revenue by Class A and class B respectively.
25(d)	$\mathbf{D} = \begin{pmatrix} 0.8 & 0.9 \end{pmatrix}$

Question	Answer
26(a)	$2 \times 3^3 = 54$ and $2^3 \times 3^2 = 72$
26(b)(i)	All prime factors have even indices/powers Or $2^4 \times 3^6 = \left(2^2 \times 3^3\right)^2$ and therefore, a perfect square
26(b)(ii)	$11664 \div \dfrac{6}{m}$ $= 2^4 \times 3^6 \div \dfrac{6}{m}$ $= 2^4 \times 3^6 \times \dfrac{m}{6}$ $= 2^3 \times 3^5 \times m$ $m = 3$

Question	Answer
27(a)	acceleration $= \dfrac{5-3}{10-8} = 1$ m/s^2
27(b)(i)	Distance $= \dfrac{1}{2}(T+10) \times 5 = 25 + 2.5T$ OR Distance $= 5 \times 10 + \dfrac{1}{2} \times 5 \times (T-10) = 25 + 2.5T$
27(b)(ii)	Acceleration after 8 seconds $= 1$ m/s^2 Let speed of B at $T = s$ m/s $\dfrac{s-3}{T-8} = 1$ $s = T - 5$ Distance travelled by B $= 3 \times 8 + \dfrac{1}{2}(3+s)(T-8)$ $= 24 + \dfrac{1}{2}(3+T-5)(T-8)$ $= 24 + \dfrac{1}{2}(T-2)(T-8)$ When A and B meet, $24 + \dfrac{1}{2}(T-2)(T-8) = 25 + 2.5T$ $\dfrac{1}{2}(T-2)(T-8) = 2.5T + 1$ $T^2 - 10T + 16 = 5T + 2$ $T^2 - 15T + 14 = 0$ (shown)
27(b)(iii)	$(T-14)(T-1) = 0$ $T = 14$ or $T = 1$ (rej.)

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PRELIMINARY EXAMINATION 2025
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MATHEMATICS
Paper 2

4052/02

2 hours 15 minutes

Solutions

Question	Answer
1(a)	$2x-1 < \dfrac{5+9x}{2}$ $4x-2 < 5+9x$ $-7 < 5x$ $x > -\dfrac{7}{5}$ or $x > -1.4$
1(b)(i)	$b = \dfrac{2\left(n-5p^2\right)}{n-p^2}$ $b = 12\dfrac{2}{3}$
1(b)(ii)	$b = \dfrac{2\left(n-5p^2\right)}{n-p^2}$ $b\left(n-p^2\right) = 2\left(n-5p^2\right)$ $bn - bp^2 = 2n - 10p^2$ $10p^2 - bp^2 = 2n - bn$ $p^2\left(10-b\right) = 2n - bn$ $p^2 = \dfrac{2n-bn}{10-b}$ $p = \pm\sqrt{\dfrac{2n-bn}{10-b}}$
1(c)	$\dfrac{3x}{2x-1} - \dfrac{2}{5-x} = 7$ $\dfrac{3x(5-x)-2(2x-1)}{(2x-1)(5-x)} = 7$ $15x - 3x^2 - 4x + 2 = 7\left(10x - 2x^2 - 5 + x\right)$ $-3x^2 + 11x + 2 - 77x + 14x^2 + 35 = 0$ $11x^2 - 66x + 37 = 0$ $x = \dfrac{-(-66) \pm \sqrt{(-66)^2 - 4(11)(37)}}{2(11)}$ $= \dfrac{66 \pm \sqrt{2728}}{22}$ $= 5.37$ (3 s.f.) or 0.626 (3 s.f.)

Question	Answer
2(a)(i)	Difference = $(3.553 - 3.3064)$ million tonnes $= 0.2466 \times 10^6$ $= 2.47 \times 10^5$ tonnes
2(a)(ii)	percentage increase $= \dfrac{3.553 - 3.040}{3.040} \times 100\%$ $= 16.875\%$ $= 16.9\%$ (3 s.f.)
2(a)(iii)	amount of waste in 2022 $= 3.553 \times 10^6 \div 84.8 \times 100$ $= 4.19 \times 10^6$ (3 s.f.)
2(b)(i)	deposit $= 20\% \times 120000 = 24000$ total monthly payment $= 84 \times 1400 = 117600$ total amount $= 24000 + 117600 = 141600$
2(b)(ii)	value of car 5 years later $= 120000 \times 0.85^5 = 53244.6375$ percentage decrease $= \dfrac{120000 - 53244.6375}{120000} \times 100\%$ $= 55.6\%$ (3 s.f.)

Question	Answer
3(a)	$h = 0.15$
3(b)	
3(c)	3.5 hours
3(d)(i)	Gradient = -0.5 ($\pm$ 0.1)
3(d)(ii)	Since gradient is negative, the daily growth rate decreases with additional sunlight.
3(e)(i)	Straight line passing through (0, 0) and (4, 2)
3(e)(ii)	$\dfrac{1}{6}t^2(4-t) = \dfrac{t}{2}$ $4t^2 - t^3 = 3t$ $t^3 - 4t^2 + 3t = 0$

Question	Answer
4(a)(i)	$\overrightarrow{AB} = -2\mathbf{a} + 3\mathbf{b}$ $\overrightarrow{AX} = \dfrac{1}{4}(-2\mathbf{a} + 3\mathbf{b})$ $= -\dfrac{1}{2}\mathbf{a} + \dfrac{3}{4}\mathbf{b}$

4(a)(ii)	$\overrightarrow{OX} = 2\mathbf{a} - \dfrac{1}{2}\mathbf{a} + \dfrac{3}{4}\mathbf{b}$ $= \dfrac{3}{2}\mathbf{a} + \dfrac{3}{4}\mathbf{b}$
4(b)	$\overrightarrow{BY} = 3(2\mathbf{a}) = 6\mathbf{a}$ $\overrightarrow{XY} = \overrightarrow{XB} + \overrightarrow{BY}$ $= \dfrac{3}{4}(-2\mathbf{a} + 3\mathbf{b}) + 6\mathbf{a}$ $= \dfrac{9}{2}\mathbf{a} + \dfrac{9}{4}\mathbf{b}$
4(c)	$\overrightarrow{OX} = \dfrac{1}{3}\overrightarrow{XY}$ Since OX is parallel to XY, and X is a common point, O, X and Y lie on a straight line.
4(d)	$\dfrac{\text{Area of triangle } OBX}{\text{Area of triangle } OAB} = \dfrac{BX}{AB} = \dfrac{3}{4}$ $\dfrac{\text{Area of triangle } OAB}{\text{Area of triangle } ABC} = \dfrac{OA}{BC} = \dfrac{2}{3} = \dfrac{4}{6}$ $\dfrac{\text{Area of triangle } OBX}{\text{Area of triangle } OABC} = \dfrac{3}{4+6} = \dfrac{3}{10}$
4(e)	$\overrightarrow{OC} = 3\mathbf{a} + 3\mathbf{b}$ $\overrightarrow{OW} = \dfrac{2}{5}(3\mathbf{a} + 3\mathbf{b})$ $= \dfrac{6}{5}\mathbf{a} + \dfrac{6}{5}\mathbf{b}$

Question	Answer
5(a)	$3^2 = 8^2 + 7^2 - 2(8)(7)\cos \angle EFI$ $$\cos \angle EFI = \frac{8^2 + 7^2 - 3^2}{2(8)(7)}$$ $$= \frac{13}{14}$$ $$\angle EFI = \cos^{-1}\left(\frac{13}{14}\right) = 21.7867... = 21.8°$$
5(b)	$$\text{vol of prism} = \left(8 \times 3 + \frac{1}{2} \times 7 \times 8 \times \sin 21.7867°\right) \times 12$$ $$= 412.70717..$$ $$= 412.71 \text{m}^3$$
5(c)	$\text{height} = 3 + 7\sin 21.8°$ $= 5.5995...$ $= 5.60 \text{ m (3 s.f.)}$
5(d)	Let X be the point vertically below J. $CX = 7\cos 21.8° = 6.4994...$ $BX = \sqrt{12^2 + 6.4994^2} = 13.647...$ $$\tan \angle JBX = \frac{5.5995}{13.647}$$ $$\angle JBX = \tan^{-1}\left(\frac{5.5995}{13.647}\right)$$ $$= 22.3° \text{ (1 d.p.)}$$

Question	Answer
6(a)	$\angle OCT = 90°$ (tangent $\perp$ radius) $\angle AOC = 360° - 90° - 90° - 32°$ ($\angle$ sum of quadrilateral) $\quad = 148°$ $\angle ADC = 148° \div 2$ ($\angle$at centre $= 2\angle$at circumference) $\quad = 74°$
6(b)	$\angle CBA = 180° - 74°$ ($\angle s$ in opposite segment) $\quad = 106°$ $\angle OCA = \dfrac{180° - 148°}{2}$ (base $\angle s$ of isosceles triangle) $\quad = 16°$ $\angle OCB = 16° + 38°$ (base $\angle s$ of isosceles triangle) $\quad = 54°$ $\angle OCB + \angle CBA = 106° + 54°$ $\quad\quad\quad = 160° \neq 180°$ Therefore, by converse of interior angles, OC is not parallel to AB.
6(c)	$\angle AOB = 38° \times 2$ ($\angle$at centre $= 2\angle$at circumference) $\quad = 76°$ Area of sector $= \dfrac{76}{360} \times \pi\left(10^2\right) = \dfrac{190}{9}\pi$ Area of triangle $= \dfrac{1}{2}(10)(10)\sin 76° = 48.5147...$ Area of shaded region $= \dfrac{190}{9}\pi - 48.5147 = 17.8$ cm^2 (3 s.f.)

Question	Answer
7(a)(i)	$n+20$
7(a)(ii)	Product of top left and bottom right $= n(n+20) = n^2 + 20n$ Product of top right and bottom left = $(n+2)(n+18) = n^2 + 20n + 36$ Difference $= (n^2 + 20n + 36) - (n^2 + 20n) = 36$
7(a)(iii)	Sum $= n + (n+2) + (n+10) + (n+18) + (n+20) = 5n + 50$ Let $5n + 50 = 1715 \Rightarrow n = 333$ If $n = 333$, the cross will be $333 \ldots 335$ $\ldots\ 343\ \ldots$ $351 \ldots 353$ However, $333 = 9 \times 37$, the first number will be in the last column of the number grid, therefore, the sum cannot be 1715.
7(b)(i)	$T_{10} = 2(10)^2 - 10 + 3 = 193$
7(b)(ii)	$T_{n+1} = 2(n+1)^2 - (n+1) + 3$ $\qquad = 2(n^2 + 2n + 1) - n - 1 + 3$ $\qquad = 2n^2 + 3n + 4$ $D = 2n^2 + 3n + 4 - (2n^2 - n + 3)$ $\qquad = 4n + 1$
7(b)(iii)	Since D is a linear expression in n and the coefficient of n is 4, it means that the difference increases by 4 each time n increases by 1.

Question	Answer
8(a)(i)	7.5 hours (± 0.1)
8(a)(ii)	Q1 = 6, Q3 = 9.4 IQR = 9.4 − 6 = 3.4 (± 0.1)
8(b)	32 students spent 5 hours or less. 168 students spent at least 5 hours. Probability = $\dfrac{168}{200} = \dfrac{21}{25} = 0.84$
8(c)	In general, teenagers in Country X spent less daily screen time with median of 6.5 hours compared to Singapore's median of 7.5 hours. The amount of daily screen time spent by teenagers in Country X has a larger spread with an IQR of 5.2 hours as compared to that of Singapore with IQR of 3.4 hours.

Question	Answer
9(a)	Arc length = $2\pi(2) \times \dfrac{1}{5} = \dfrac{4}{5}\pi = 2.513... = 2.5$ m (1 d.p.)
9(b)	Volume of air = $\pi(2.5)^2 \times 0.5 \times 50 \div 60 = 8.1812... = 8.18$ (3 s.f.)
9(c)	<u>For air circulation</u> Minimum airflow requirement $= 30 \times 20 \times 8 \div 5 = 960$ m^3/min VFR = $\pi(3)^2 \times 0.6 = 5.4\pi = 16.9646...$ Total airflow per minute of fans = VFR $\times 70 \times 2 = 756\pi = 2375.044...$ Therefore, $2375.044... > 960$, **minimum airflow requirement is met.** <u>For comfortable cooling environment</u> VPS = $5.4\pi \times 45 \div 60 = 4.05\pi$ Air velocity = $4.05\pi \div \pi(3)^2 = 0.45$ m/s > 0.3 m/s Therefore, **comfortable cooling environment is met.** Hence, the **recommendation is suitable.**