



2020 O Level Mathematics Paper 2 Suggested Answers

$$1.(a) \quad \frac{2x+1}{2} \geq \frac{5-4x}{3}$$

$$\frac{3(2x+1)}{6} \geq \frac{2(5-4x)}{6}$$

$$3(2x+1) \geq 2(5-4x)$$

$$6x+3 \geq 10-8x$$

$$14x \geq 7$$

$$x \geq \frac{1}{2}$$

$$1.(b) \quad 6x-3y=16 \quad \text{①}$$

$$9x+2y=11 \quad \text{②}$$

From ②,

$$2y=11-9x$$

$$y = \frac{11-9x}{2} \quad \text{③}$$

Sub ③ into ①

$$6x-3\left(\frac{11-9x}{2}\right)=16$$

$$12x-3(11-9x)=32$$

$$12x-33+27x=32$$

$$39x=65$$

$$x = \frac{5}{3}$$

$$y = \frac{11-9\left(\frac{5}{3}\right)}{2}$$

$$= -2$$



$$\begin{aligned} 1.(c) \quad & \frac{x}{(3-2x)^2} - \frac{5}{3-2x} \\ & = \frac{x}{(3-2x)^2} - \frac{5(3-2x)}{(3-2x)^2} \\ & = \frac{x - 5(3-2x)}{(3-2x)^2} \\ & = \frac{x - 15 + 10x}{(3-2x)^2} \\ & = \frac{11x - 15}{(3-2x)^2} \end{aligned}$$

$$\begin{aligned} 1.(d) \quad & \left(\frac{a^9}{27b^{15}}\right)^{-\frac{1}{3}} \\ & = \left(\frac{27b^{15}}{a^9}\right)^{\frac{1}{3}} \\ & = \frac{3b^5}{a^3} \end{aligned}$$

$$\begin{aligned} 1.(e) \quad & \frac{4x^2 - 16}{3x^2 + x - 10} \\ & = \frac{4(x-2)(x+2)}{(x+2)(3x-5)} \\ & = \frac{4(x-2)}{3x-5} \end{aligned}$$



$$2.(a) \quad 16 - 9 = 7 \text{ girls}$$

$$2.(b) \quad F = \begin{pmatrix} 30 \\ 26 \\ 24 \end{pmatrix}$$

$$2.(c) \quad M = \begin{pmatrix} 10 & 12 & 16 \\ 14 & 16 & 20 \end{pmatrix} \begin{pmatrix} 30 \\ 26 \\ 24 \end{pmatrix}$$

$$= \begin{pmatrix} 10(30) + 12(26) + 16(24) \\ 14(30) + 16(26) + 20(24) \end{pmatrix}$$

$$= \begin{pmatrix} 996 \\ 1316 \end{pmatrix}$$

2.(d) The total fees collected by the club in one morning and in one afternoon respectively.

$$2.(e) \quad \text{Total amount in one day} = 996 + 1316 \\ = \$2312$$

$$\text{Total amount in one week} = 2312 \times 5 \\ = \$11560$$



2. (f) P increases by 50%

$$\text{Morning} = 10 \times 150\% \\ = 15$$

$$\text{Afternoon} = 14 \times 150\% \\ = 21$$

Q increases by 50%

$$\text{Morning} = 12 \times 150\% \\ = 18$$

$$\text{Afternoon} = 16 \times 150\% \\ = 24$$

R decreases by 25%

$$\text{Morning} = 16 \times 75\% \\ = 12$$

$$\text{Afternoon} = 20 \times 75\% \\ = 15$$

$$\begin{pmatrix} 15 & 18 & 12 \\ 21 & 24 & 15 \end{pmatrix} \begin{pmatrix} 30 \\ 26 \\ 24 \end{pmatrix} = \begin{pmatrix} 1206 \\ 1614 \end{pmatrix}$$

$$\text{Total amount in one day} = 1206 + 1614 \\ = \$2820$$

$$\text{percentage change} = \frac{2820 - 2312}{2312} \times 100$$

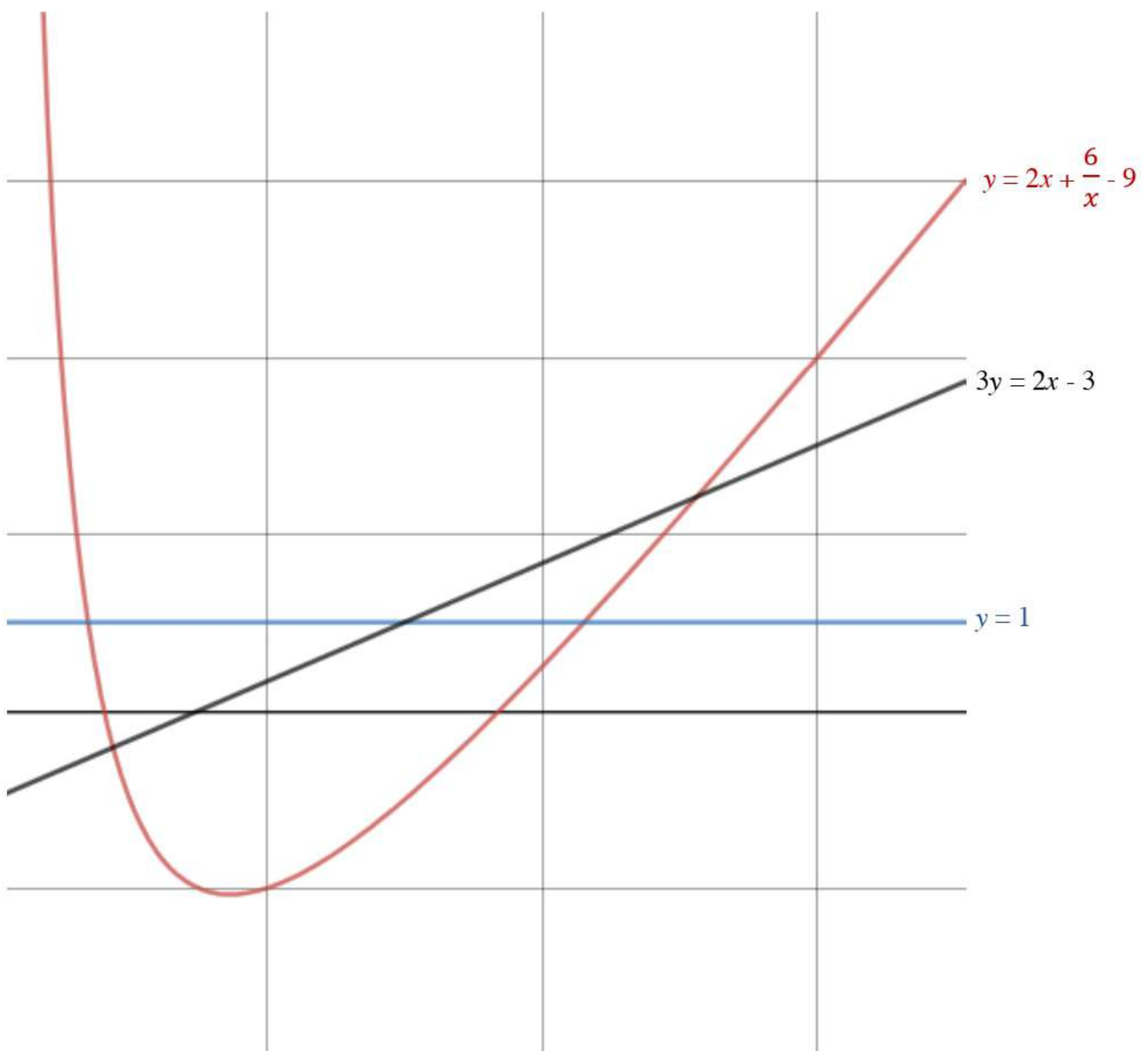
$$= 21.97$$

$$\approx 22.0\% \text{ (3sf) increase}$$



$$\begin{aligned} 3.(a) \quad y &= 2x + \frac{6}{x} - 9 \\ y &= 2(7) + \frac{6}{(7)} - 9 \\ &= 5.86 \\ &\approx 5.9 \text{ (1 dp)} \end{aligned}$$

(b)





$$3.(c) \quad 2x + \frac{6}{x} = 10$$

$$2x + \frac{6}{x} - 9 = 10 - 9$$

$$2x + \frac{6}{x} - 9 = 1$$

From the graph, when $y=1$,

$$x = 0.7 \quad \text{and} \quad x = 4.3$$

3.(d)

(ii) From the graph,

$$x = 0.9 \quad \text{and} \quad x = 5.1$$

$$(iii) \quad 3y = 2x - 3$$

$$\Rightarrow y = \frac{2x - 3}{3}$$

$$2x + \frac{6}{x} - 9 = \frac{2x - 3}{3}$$

$$6x + \frac{18}{x} - 27 = 2x - 3$$

$$\begin{array}{l} \div 2 \quad \left\{ \begin{array}{l} 4x + \frac{18}{x} - 24 = 0 \\ 2x + \frac{9}{x} - 12 = 0 \end{array} \right. \\ \times x \quad \left\{ \begin{array}{l} 2x^2 - 12x + 9 = 0 \\ A = -12 \quad B = 9 \end{array} \right. \end{array}$$

$$\begin{aligned}
 4.(a) \quad AC^2 &= AB^2 + BC^2 - 2(AB)(BC) \cos \angle ABC \\
 &= 660^2 + 950^2 - 2(660)(950) \cos 80^\circ \\
 &= 1120.3
 \end{aligned}$$

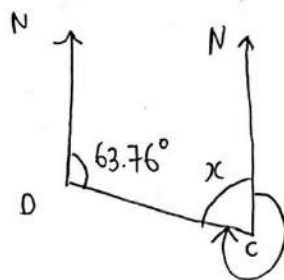
$$\begin{aligned}
 AC &= \sqrt{1120.3} \\
 &= 1058.5 \\
 &\approx 1060 \text{ m (3sf)}
 \end{aligned}$$

$$4.(b) \quad \frac{\sin \angle ADC}{AC} = \frac{\sin \angle ACD}{AD}$$

$$\frac{\sin \angle ADC}{1058.5} = \frac{\sin 24^\circ}{480}$$

$$\sin \angle ADC = 0.8969$$

$$\angle ADC = 63.76^\circ \text{ or } 180 - 63.76 = 116.24$$



$$\begin{aligned}
 x &= 180^\circ - 116.24^\circ \\
 &= 63.76^\circ \text{ (interior angles)}
 \end{aligned}$$

Bearing of D from C

$$= 360^\circ - 63.76^\circ$$

$$= 296.24^\circ$$

$$\approx 296.2^\circ \text{ (1dp)}$$



$$\begin{aligned} 4.(c) \text{ Total distance} &= 660 + 950 + 1058.5 \\ &= 2668.5 \text{ m} \\ &= 2.6685 \text{ km} \\ \text{Total time} &= \frac{2.6685}{9.5} \\ &= 0.28089 \text{ h} \\ &= 16.854 \text{ min} \\ &= 16 \text{ min } 51.2 \text{ s} \\ &\approx 16 \text{ min } 50 \text{ s} \end{aligned}$$

$$\begin{aligned} 5.(a) \text{ slanted length of glass} &= \sqrt{8^2 + \left(\frac{11}{2}\right)^2} \\ &= 9.708 \text{ cm} \end{aligned}$$

$$\begin{aligned} \text{Curved surface area} &= \pi \left(\frac{11}{2}\right) (9.708) \\ &= 167.7 \\ &\approx 168 \text{ cm}^2 \text{ (3sf)} \end{aligned}$$

$$5.(b) \text{ Height of water} = 8 - 2 = 6 \text{ cm}$$

$$(i) \left(\frac{6}{8}\right)^3 = \left(\frac{3}{4}\right)^3 \neq 75\%$$

$$\begin{aligned} (ii) \left(\frac{3}{4}\right)^3 &= 0.421875 \\ &= 42.1875\% \end{aligned}$$



$$5.(b) \text{ Volume of water} = \frac{1}{3} \pi \left(\frac{11}{2}\right)^2 (8) \times 0.421875$$

$$(iii) = 106.9 \text{ cm}^3$$

$$\text{Volume of cylindrical water} = \pi r^2 (2.5) = 106.9$$

$$r^2 = 13.6125$$

$$r = 3.6895$$

$$\hat{=} 3.69 \text{ cm}$$

$$6.(a) \angle BFD = \angle CFE \text{ (vertically opposite angles)}$$

$$(i) DF = EF \text{ (tangents from circle to external point)}$$

$$BF = CF \text{ (tangents from circle to external point)}$$

$$\therefore \triangle BDF \cong \triangle CEF \text{ (SAS)}$$

$$(ii) (a) \angle OBA = \angle OAB = x^\circ \text{ (isos. triangle)}$$

$$\angle CBA = 90^\circ \text{ (angle in semi-circle)}$$

$$\angle OBC = (90 - x)^\circ$$

$$(b) \angle BOC = \angle BAC \times 2$$

$$= 2x$$

$$\angle OBF = \angle OCF = \angle PDF = \angle PEF = 90^\circ \text{ (tangent } \perp \text{ radius)}$$

$$\angle BFC = \angle DFE \text{ (vertically opposite angles)}$$

$$\angle DPE + 90^\circ + 90^\circ + \angle DFE = \angle BOC + 90^\circ + 90^\circ + \angle BFC$$

(angles in a quadrilateral)

$$\angle DPE = \angle BOC = 2x$$



$$6. (b) \text{ Reflex } LKM = 2\pi - 1.8$$

$$(i) \text{ Major arc } LM = (12)(2\pi - 1.8) \\ = 53.798 \\ \approx 53.8 \text{ cm}$$

$$(ii) \text{ Segment } LM = \text{sector } LKM - \text{triangle } LKM \\ = \frac{1}{2}(12)^2(1.8) - \frac{1}{2}(12)^2 \sin 1.8 \\ = 59.48$$

$$\frac{59.48}{\pi(12)^2} \times 100 = 0.13149 \\ \approx 13.1\% \text{ (3sf)}$$

$$7 (a) \frac{\sum fx}{\sum f} = \frac{0(p) + 1(10) + 2(13) + 3(9) + 4(6) + 5(q) + 6(2)}{50} \\ = \frac{99 + 5q}{50} = 2.68$$

$$99 + 5q = 134$$

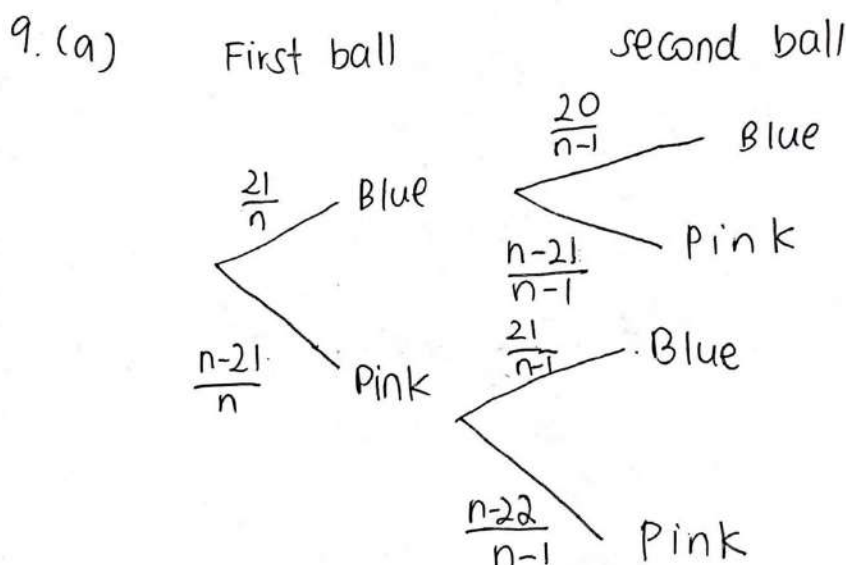
$$5q = 35$$

$$q = 7$$

$$p = 50 - 10 - 13 - 9 - 6 - 7 - 2 \\ = 3$$

$$\begin{aligned}
 7. (b) & \sqrt{\frac{\sum fx^2}{50} - (\bar{x})^2} \\
 & = \sqrt{\frac{3(0)^2 + 10(1)^2 + 13(2)^2 + 9(3)^2 + 6(4)^2 + 7(5)^2 + 2(6)^2}{50} - (2.68)^2} \\
 & = \sqrt{2.5376} \\
 & = 1.593 \\
 & \approx 1.59
 \end{aligned}$$

- (c) 1 The number of movies watched by the adults is lower than the number of movies watched by the students (as the mean is lower).
- 2 The number of movies watched by the adults is less consistent than the number of movies watched by the students (as the standard deviation is higher).





$$9(b) \left(\frac{n-21}{n}\right) \left(\frac{n-22}{n-1}\right) = \frac{1}{8}$$

$$\frac{(n-21)(n-22)}{n(n-1)} = \frac{1}{8}$$

$$8(n-21)(n-22) = n(n-1)$$

$$8(n^2 - 21n - 22n + 462) = n^2 - n$$

$$8n^2 - 344n + 3696 = n^2 - n$$

$$7n^2 - 343n + 3696 = 0$$

$$n^2 - 49n + 528 = 0$$

$$(c) \quad n = \frac{-(-49) \pm \sqrt{(-49)^2 - 4(1)(528)}}{2(1)}$$

$$n = 16 \quad \text{or} \quad n = 33$$

(d) As the number of pink balls is $n-21$, n must be larger than 21. Therefore 16 must be rejected.

$$(e) \quad P(B,P) + P(P,B) \\ = \frac{21}{33} \times \frac{12}{32} + \frac{12}{33} \times \frac{21}{32} \\ = \frac{21}{44}$$



10. (a)

(i) $£1 = \$1.824$

(ii) Lowest cost = $\$1.796 \times 217$
 $= \$389.732$

Highest cost = $\$1.86 \times 217$
 $= \$403.62$

Difference = $\$403.62 - \389.732
 $= \$13.888$
 $\approx \$13.89$ (nearest cent)



$$10.(b) \text{ Total living costs a week} = 60 + 57 + 25 + 15 \\ = \text{£}157$$

$$\text{Total living costs a year} = \text{£}157 \times 52 \\ = \text{£}8164$$

$$\text{Total accommodation cost a year} = \text{£}217 \times 52 \\ = \text{£}11284$$

$$\text{Total cost for student pass} = \text{£}56.90 \times 12 \\ = \text{£}682.80$$

$$\text{Total cost a year} = 8164 + 11284 + 682.80 \\ = \text{£}20130.80$$

Average exchange rate for past 12 months

$$= \frac{(0.576 + 0.566 + 0.556 + 0.564 + 0.562 + 0.568 \\ + 0.556 + 0.557 + 0.558 + 0.555 + 0.548 + 0.542)}{12}$$

$$= \text{£}0.559 \text{ per dollar}$$

$$\text{Total cost a year} = \frac{20130.80}{0.559} = \$36012.165$$

$$115\% \text{ of total cost} = 115\% \times \$36012.165 \\ = \$41413.989 \\ \approx \$41500$$