2024 TKGS PRELIM MATH P2 MARK SCHEME

Qn		Solution	Content/Success Criteria	
1	(a)	$\frac{3-2x}{7}=\frac{1}{3}(2x-1)$ $3(3-2x)=7(2x-1)$ $9-6x=14x-7$ $20x=16$ $x=0.8\ /\ \frac{4}{5}$	I can multiply LCM to remove the denominators on both sides of a linear equation involving fractions. I can solve a linear equation.	
			Content	L
			Complexity	L
			Context	L
			Response Strategy	Simple
			Assessment Objective	AO1
	(b)	(i) $\frac{25a^2-9b^2}{15a-10ab+6b^2-9b}$ $=\frac{(5a)^2-(3b)^2}{5a(3-2b)+3b(2b-3)}$ $=\frac{(5a-3b)(5a+3b)}{5a(3-2b)-3b(3-2b)}$ $=\frac{(5a-3b)(5a+3b)}{(5a-3b)(3-2b)}$ $=\frac{5a+3b}{3-2b}$	I can factorise algebraic expressions by identity and grouping.	
			Content	L
			Complexity	L
			Context	L
			Response Strategy	Simple
			Assessment Objective	AO1
		(ii) $\frac{3c}{4ab}\div\frac{c^3}{12a^2b}$ $=\frac{3c}{4ab}\times\frac{12a^2b}{c^3}$ $=\frac{36a^2bc}{4abc^3}$ $=\frac{9a}{c^2}$	I can take reciprocal to convert division to multiplication. I can apply laws of indices to simplify algebraic expressions.	
			Content	L
			Complexity	L
			Context	L
			Response Strategy	Routine
			Assessment Objective	AO1

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Qn			Solution	Content/Success Criteria	
	(c)	(i)	$-x^2+9x-\frac{7}{2}=0$ $x^2-9x+\frac{7}{2}=0$ $\left(x-\frac{9}{2}\right)^2+\frac{7}{2}-\left(-\frac{9}{2}\right)^2=0$ $\left(x-\frac{9}{2}\right)^2-\frac{67}{4}=0$ $\left(x-\frac{9}{2}\right)^2=\frac{67}{4}$ $x=\sqrt[\pm]{\frac{67}{4}}+\frac{9}{2}$ $x=8.59268$ or 0.407324 $x=8.59$ or 0.41	I can complete the square. I can solve equation using complete the square method	
				Content	L
				Complexity	L
				Context	L
				Response Strategy	Routine
				Assessment Objective	AO1
		(ii)	$-x^2+9x-\frac{7}{2}=-(x-4.5)^2+16.75\,/\,\frac{67}{4}$ Since the maximum value of $y=-x^2+9x-\frac{7}{2}$ is $16.75/\frac{67}{4}<18$. There is no solution when $y=18$.	I know that $y=-x^2+9x-\frac{7}{2}$ has max. value. I can find max. value with complete square form of quadratic equation.	
				Content	L
				Complexity	M
				Context	M
				Response Strategy	Routine
				Assessment Objective	AO3
OR			$-x^2+9x-\frac{7}{2}=18$ $-x^2+9x-\frac{43}{2}=0$ Discriminant $=(9)^2-4(-1)\left(-\frac{43}{2}\right)$ $=-5$ Since discriminant < 0, $-x^2+9x-\frac{7}{2}=18$ has no solution.		

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Qn		Solution	Content/Success Criteria
2	(a)	P(man who passed test) $= \frac{1\times 3}{7\times 3} = \frac{3}{21}$ $\therefore$ the number of men who passed the test $= 3$ Let the number of women who failed the test be x P(both women failed the test) $= \frac{x}{21}\times\frac{x-1}{20} = \frac{1}{10}$ $x^2 - x = \frac{420}{10}$ $x^2 - x - 42 = 0$ $(x-7)(x+6) = 0$ $x = 7$ or -6 (rejected) Women who passed the test $= 21 - 9 - 7 - 3$ $= 2$	I can find the probability of a single event. I can use multiplication of probabilities for simple combined events.

	Passed	Failed
Men	3	**9**
Women	2	7

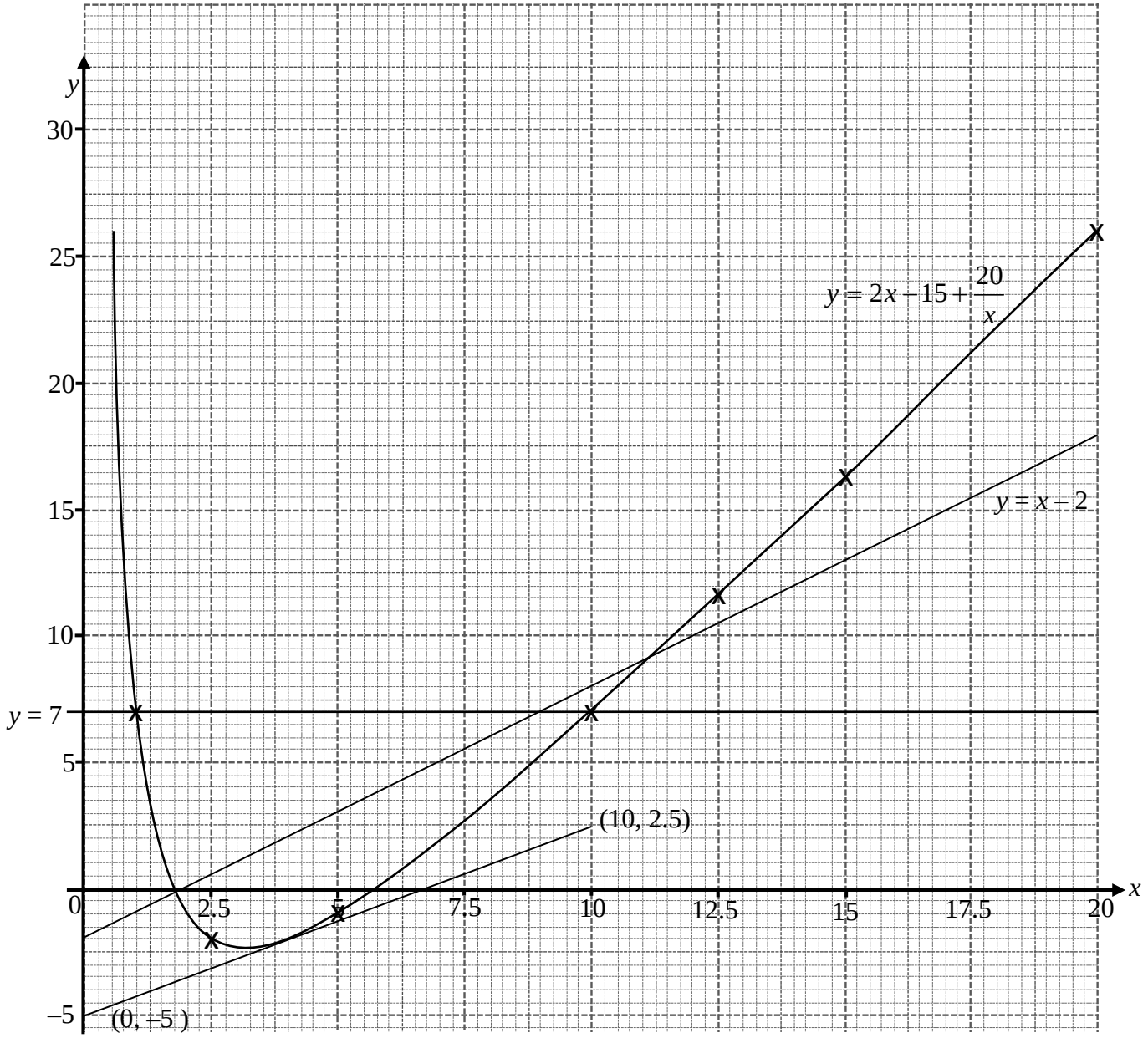
Content	M
Complexity	M
Context	M
Response Strategy	Unfamiliar
Assessment Objective	AO2

Qn			Solution	Content/Success Criteria
2	(b)	(i)	A set of students who only listen to pop music but not classical music.	I can represent elements of set notation in words. I can find the number of elements in any sets.
		(ii)	10	
		(iii)	4	
		(iv)	9	

Content	L
Complexity	M
Context	M
Response Strategy	Simple
Assessment Objective	AO2

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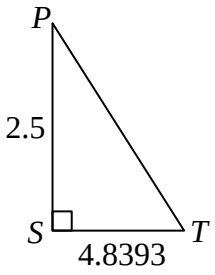
Qn		Solution	Content/Success Criteria	
3	**(a)**	–2	I can find the value by substitution.	
	(b)	See graph below	I can draw graph that passes through all points plotted smoothly.	
			Content	L
			Complexity	L
			Context	L
			Response Strategy	Routine
			Assessment Objective	AO1



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Qn		Solution	Content/ Success Criteria	
	(c)	$2x+\frac{20}{x}<22$ $2x+\frac{20}{x}-15<22-15$ $2x+\frac{20}{x}-15<7$ Draw a line of $y=7$ on the graph $\therefore\ 1<x<10$	I can solve inequality using graph.	
			Content	M
			Complexity	M
			Context	L
			Response Strategy	unfamiliar
			Assessment Objective	AO2
	(d)	Draw a tangent at $x=4$ gradient $=\frac{2.5-(-5)}{10-0}$ $=0.75$ (accept ± 0.2)	I know how to find tangent on a graph.	
			Content	L
			Complexity	L
			Context	L
			Response Strategy	Routine
			Assessment Objective	AO1
	(e)	$x^2-13x+20=0$ $\frac{x^2}{x}-\frac{13x}{x}+\frac{20}{x}=\frac{0}{x}$ $x-13+\frac{20}{x}=0$ $2x-15+\frac{20}{x}=x-2$ Draw $y=x-2$ on the graph $x=1.783$ or 11.217 (accept ± 0.15)	I can solve quadratic equation using graph.	
			Content	L
			Complexity	M
			Context	M
			Response Strategy	Routine
			Assessment Objective	AO2

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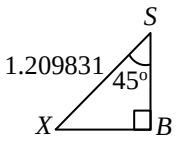
Qn		Solution	Content/Success Criteria	
4	(a)	Using sine rule, $ST = \frac{7.5}{\sin 95^\circ} \times \sin 40^\circ$ **Essential step** $= 4.83932$ $SX = \frac{1}{4} ST$ $= 1.209831$ $= 1.21$ m	I can use sine rule to find unknown length	
			Content	L
			Complexity	L
			Context	L
			Response Strategy	simple
			Assessment Objective	AO1
	(b)	$\angle RSX = 180^\circ - 40^\circ - 95^\circ$ (angle sum of triangle) $= 45^\circ$ Using cosine rule, **Essential step** $XR = \sqrt{1.209831^2 + 7.5^2 - 2(1.209831)(7.5)\cos 45^\circ}$ $= 6.69937$ $= 6.70$ m	I can apply cosine rule to find unknown length	
			Content	L
			Complexity	L
			Context	L
			Response Strategy	simple
			Assessment Objective	AO1
	OR	Using sine rule, $TR = \frac{7.5 \times \sin 45^\circ}{\sin 95^\circ}$ **Essential step** $= 5.3236$ m $XT = \frac{3}{4} \times 4.83932$ $= 3.62949$ m Using cosine rule, **Essential step** $XR = \sqrt{3.62949^2 + 5.3236^2 - 2(3.62949)(5.3236)\cos 95^\circ}$ $= 6.69937$ $= 6.70$ m		
	(c)	By Pythagoras' Theorem, $PT = \sqrt{2.5^2 + 4.8393^2}$ $= 5.4469$ $= 5.45$ m  	I can use Pythagoras' Theorem to find unknown length	
			Content	L
			Complexity	L
			Context	L
			Response Strategy	simple
			Assessment Objective	A01

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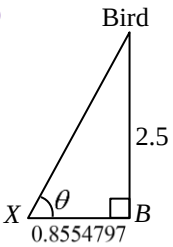
<table>
<tr><th colspan="2">Qn</th><th>Solution</th><th colspan="2">Content/Success Criteria</th></tr>
<tr><td></td><td>(d)</td><td>Let the point directly below the bird be B.

$\angle SBX = 90^\circ$ for XB to be the shortest distance

$XB = \sin 45^\circ \times 1.209831$ Essential step
$= 0.8554797$ m



$\tan\theta = \dfrac{2.5}{0.8554797}$ Essential step
$\theta = \tan^{-1}\left(\dfrac{2.5}{0.8554797}\right)$
$= 71.10947$
$= 71.1^\circ$ (1 d.p)


</td><td colspan="2">I know that shortest distance gives largest angle of elevation
I can use trigo ratio to find unknown angle
<table><tr><td>Content</td><td>L</td></tr><tr><td>Complexity</td><td>M</td></tr><tr><td>Context</td><td>M</td></tr><tr><td>Response Strategy</td><td>taught</td></tr><tr><td>Assessment Objective</td><td>A02</td></tr></table></td></tr>
<tr><td colspan="2">OR</td><td>$\frac{1}{2} \times 7.5 \times h = \frac{1}{2} \times 1.20983 \times 7.5 \times \sin 45^\circ$
$h = 0.85547$
$\theta = \tan^{-1}\left(\dfrac{2.5}{0.8554797}\right)$
$= 71.10947$
$= 71.1^\circ$ (1 d.p)</td><td></td><td></td></tr>
</table>

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Qn			Solution	Content/Success Criteria	
5	(a)	(i)	$\angle ABD = \angle ACD$ ($\angle s$ in same segment) $= 30^\circ$	I can apply circle properties to find angle	
		(ii)	$\angle ACB = \angle OBC$ (base $\angle s$ of isosceles Δ) $= 40^\circ$ $\angle BCD = 40^\circ + 30^\circ$ $= 70^\circ$ $\angle BAD = 180^\circ - 70^\circ$ ($\angle s$ in opposite segments) $= 110^\circ$	I can apply circle properties to find angle	
				Content	L
				Complexity	L
				Context	L
				Response Strategy	taught
				Assessment Objective	AO1
		(iii)	Let r be the radius of the circle, $\angle DOB = 140^\circ$ ($\angle$ at centre = 2$\angle$ at circumferene) $\frac{140^\circ}{360^\circ} \times 2\pi r = 11$ $r = \frac{11}{\frac{7}{18} \times 2\pi}$ $= 4.5$	I can find radius given angle	
				Content	L
				Complexity	L
				Context	M
				Response Strategy	taught
				Assessment Objective	AO2
OR			Let r be the radius of the circle, $\angle DOB = 140^\circ$ ($\angle$ at centre = 2$\angle$ at circumferene) $r\theta = 11$ $r = \frac{11}{140 \times \frac{\pi}{180}}$ $= 4.5$		
	(b)	(i)	$\angle BTC = \angle BCD = 70^\circ$ (found in (a(ii)) $\angle OBT = 90^\circ$ (tan $\perp$ radius) $\angle CBT = 90^\circ - 40^\circ$ $= 50^\circ$ $\angle BOC = 180^\circ - (40^\circ \times 2)$ (base $\angle$s of isosceles Δ) $= 100^\circ$ $\angle BDC = \frac{100^\circ}{2}$ ($\angle$ at centre = 2$\angle$at circumference) $= 50^\circ$ $\therefore \angle CBT = \angle BDC = 50^\circ$ $\therefore \Delta CTB$ is similar to ΔBCD by AA similary test	I can apply circle properties to find angle to prove similarity	
				Content	L
				Complexity	M
				Context	M
				Response Strategy	taught
				Assessment Objective	AO2

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<table>
<tr><th colspan="3">Qn</th><th>Solution</th><th colspan="2">Content/Success Criteria</th></tr>
<tr><td></td><td></td><td>(ii)</td><td>$\frac{CT}{BC} = \frac{BC}{DB}$ (corresponding sides of similar triangles)
$CT = \frac{BC}{DB} \times BC$
$CT = \frac{x}{y} \times x$
$= \frac{x^2}{y}$</td><td colspan="2">I can use ratios of corresponding sides of similar triangles to solve unknown</td></tr>
<tr><td colspan="3" rowspan="5"></td><td rowspan="5"></td><td>Content</td><td>L</td></tr>
<tr><td>Complexity</td><td>M</td></tr>
<tr><td>Context</td><td>M</td></tr>
<tr><td>Response Strategy</td><td>taught</td></tr>
<tr><td>Assessment Objective</td><td>AO2</td></tr>
</table>

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Qn			Solution	Content/Success Criteria	
6	(a)	(i)	median $= 17\,\text{min}$	I know how to read CFC and find median and IQR. I know the meaning of percentile.	
		(ii)	interquartile $= 20 - 13$ $= 7\,\text{min}$		
		(iii)	number of customers $= \frac{35}{100} \times 60$ $= 21$ From the graph, 35th percentile $= 15\,\text{min}$	Content	L
				Complexity	L
				Context	L
				Response Strategy	simple
				Assessment Objective	AO1
	(b)		If 20 % waited <u>more than</u> x minutes, then $100\% - 20\% = 80\%$ waited <u>less than or equal to</u> x minutes $\frac{80}{100} \times 60 = 48$ customers From the graph, $x = 21.5\,\text{min}$	I can interpret the 'more than' CFC.	
				Content	L
				Complexity	L
				Context	L
				Response Strategy	taught
				Assessment Objective	AO1
	(c)	(i)	median $= \frac{15 + 17}{2}$ $= 16\,\text{min}$	I know how to find median and IQR for discrete data.	
		(ii)	interquartile $= 18 - 14$ $= 4\,\text{min}$	Content	L
				Complexity	L
				Context	L
				Response Strategy	taught
				Assessment Objective	AO1
	(d)		The sample sizes are not the same. **OR** Sample size for restaurant B is not large enough.	Content	M
				Complexity	M
				Context	M
				Response Strategy	unfamiliar
				Assessment Objective	AO3

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Qn			Solution	Content/Success Criteria	
7	(a)	(i)	$\frac{h}{h+16} = \sqrt{\frac{5}{125}}$ $\frac{h}{h+16} = \sqrt{\frac{1}{25}}$ $h = \frac{1}{5}(h+16)$ $h = \frac{1}{5}h + \frac{16}{5}$ $\frac{4}{5}h = \frac{16}{5}$ $h = 4$ (shown)	I can use ratio of the areas of similar figures to solve for unknown	
				Content	L
				Complexity	M
				Context	M
				Response Strategy	taught
				Assessment Objective	AO2
		(ii)	Vol. of large pyramid $= \frac{1}{3} \times (125) \times (16+4)$ $= 833\frac{1}{3}$ cm^3 Vol. of small pyramid $= \frac{1}{3} \times (5) \times (4)$ $= 6\frac{2}{3}$ cm^3 Vol. of frustum $= 833\frac{1}{3} - 6\frac{2}{3}$ $= 826\frac{2}{3}$	I can apply the formula to find volume of pyramid	
				Content	L
				Complexity	L
				Context	L
				Response Strategy	taught
				Assessment Objective	AO1
		(iii)	% removed $= \left(\frac{4}{20}\right)^3 \times 100$ $= \frac{1}{125} \times 100$ $= \frac{4}{5}\%$ / 0.8%	I can apply ratio of volumes of similar pyramid to find percentage	
				Content	L
				Complexity	L
				Context	M
				Response Strategy	simple
				Assessment Objective	AO1
	(b)		$\frac{\text{Volume of cone } A}{\text{Volume of cone } B} = \frac{\frac{1}{3}\pi(3r)^2 h}{\frac{1}{3}\pi(2r)^2 h}$ $\frac{\text{Volume of cone } A}{240} = \frac{9}{4}$ Volume of cone $A = \frac{9}{4} \times 240$ $= 540$ cm^3	I know how to find unknown volume when figures are not similar	
				Content	L
				Complexity	M
				Context	M
				Response Strategy	taught
				Assessment Objective	AO2

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Qn			Solution	Content/Success Criteria	
8	(a)	(i)	Since $\overrightarrow{AB}$ // $\overrightarrow{CD}$,	I can use scalar multiples to find unknown given parallel vectors.	
			$n\begin{pmatrix}-3\\9\end{pmatrix}=\begin{pmatrix}d\\4\end{pmatrix}$	Content	L
			$\begin{pmatrix}-3n\\9n\end{pmatrix}=\begin{pmatrix}d\\4\end{pmatrix}$	Complexity	M
			$9n=4$ and $d=-3n$	Context	M
			$n=\frac{4}{9}$ and $d=-3\left(\frac{4}{9}\right)$	Response Strategy	Simple
			$d=-\frac{4}{3}$	**Assessment Objective**	AO2
		(ii)	$\overrightarrow{AC}=\overrightarrow{AB}+\overrightarrow{BC}$	I can find the magnitude of vectors	
			$\overrightarrow{AC}=\begin{pmatrix}-3\\9\end{pmatrix}+\begin{pmatrix}2\\5\end{pmatrix}$	Content	M
			$=\begin{pmatrix}-1\\14\end{pmatrix}$	Complexity	L
			$\left\|\overrightarrow{AC}\right\|=\sqrt{(-1)^2+(14)^2}$	Context	L
			$=\sqrt{197}$	Response Strategy	Simple
			$=14.0$ unit	**Assessment Objective**	AO2
	(b)	(i)	$\overrightarrow{RM}=\overrightarrow{PM}-\overrightarrow{PR}$	I can express a vector in the form of 2 other vectors.	
			$=\frac{1}{2}\mathbf{a}-\mathbf{b}$		
			$\overrightarrow{PS}=\overrightarrow{PR}+\overrightarrow{RS}$	Content	M
			$=\mathbf{b}+k\left(\frac{1}{2}\mathbf{a}-\mathbf{b}\right)$	Complexity	H
				Context	H
			$=\mathbf{b}+\frac{1}{2}k\mathbf{a}-k\mathbf{b}$	Response Strategy	Unfamiliar
			$=\frac{1}{2}k\mathbf{a}+(1-k)\mathbf{b}$ (there should only be one **a** & one **b** in the final answer)	**Assessment Objective**	AO3
		(ii)	$\overrightarrow{QR}=\overrightarrow{PR}-\overrightarrow{PQ}$	I can express a vector in the form of 2 other vectors.	
			$=\mathbf{b}-\mathbf{a}$	Content	M
			$\overrightarrow{PT}=\overrightarrow{PQ}+\overrightarrow{QT}$	Complexity	H
			$=\mathbf{a}+h(\mathbf{b}-\mathbf{a})$	Context	H
			$=\mathbf{a}+h\mathbf{b}-h\mathbf{a}$	Response Strategy	Unfamiliar
			$=(1-h)\mathbf{a}+h\mathbf{b}$ (there should only be one **a** & one **b** in the final answer)	**Assessment Objective**	AO3

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<table>
<tr><th colspan="2">Qn</th><th colspan="2">Solution</th><th colspan="2">Content/Success Criteria</th></tr>
<tr><td></td><td></td><td>(iii)</td><td>Since P, S and T are collinear,
$\frac{\frac{1}{2}k}{1-h} = \frac{1-k}{h}$
$\left(\frac{1}{2}k\right)h = (1-h)(1-k)$
$\frac{1}{2}hk = 1-h-k+hk$
$hk = 2-2h-2k+2hk$
$2h+2k = hk+2$
$2(h+k) = hk+2$ (shown)</td><td colspan="2">I know that for collinear point, the ratio of the scalar multiples of 2 parallel lines are equal.</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Content</td><td>M</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Complexity</td><td>H</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Context</td><td>H</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Response Strategy</td><td>Unfamiliar</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Assessment Objective</td><td>AO3</td></tr>
<tr><td></td><td></td><td>(iv)</td><td>$\frac{\left\lvert\overrightarrow{PS}\right\rvert}{\left\lvert\overrightarrow{PT}\right\rvert} = \frac{\frac{1}{2}\left(\frac{4}{5}\right)}{1-\frac{1}{3}} = \frac{3}{5}$
$PS : ST = 3 : 5-3$
$PS : ST = 3 : 2$</td><td colspan="2">I can find the ratio of 2 line segments using vectors.</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Content</td><td>M</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Complexity</td><td>L</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Context</td><td>L</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Response Strategy</td><td>Simple</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Assessment Objective</td><td>AO2</td></tr>
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<table>
<tr><th colspan="2">Qn</th><th>Solution</th><th colspan="2">Content/Success Criteria</th></tr>
<tr><td rowspan="5">9</td><td rowspan="5">(a)</td><td rowspan="5">$\text{Area} = 11 \times 17$
$= 187 \text{ inch}^2$
$= 187 \times 2.54^2 \text{ cm}^2$
$= \dfrac{1206.4492}{100^2} \text{ m}^2$
$= 0.12064492 \text{ m}^2$
$= 0.121 \text{ m}^2$</td><td colspan="2">I can convert inches to metres</td></tr>
<tr><td>Content</td><td>L</td></tr>
<tr><td>Complexity</td><td>L</td></tr>
<tr><td>Context</td><td>L</td></tr>
<tr><td>Response Strategy</td><td>routine</td></tr>
<tr><td></td><td>(b)</td><td>Total area of 1200 bulletin posters $= 1200 \times 0.12064492$
$= 144.774 \text{ m}^2$
Since the area > 120 m^2, there is an additional 5% charge.

$\text{Total cost} = 2 \times 1200 + \dfrac{5}{100} \times 2 \times 1200$
= \$2520</td><td colspan="2">I can calculate the cost</td></tr>
<tr><td>Content</td><td>L</td></tr>
<tr><td>Complexity</td><td>M</td></tr>
<tr><td>Context</td><td>M</td></tr>
<tr><td>Response Strategy</td><td>taught</td></tr>
<tr><td></td><td>(c)</td><td>Let the time taken by the new printer to print 1 bulletin posters be t.
The time taken by the old printer to print 1 bulletin posters will be $t+15$.

$\dfrac{6 \times 60 \times 60}{t} + \dfrac{6 \times 60 \times 60}{t+15} = 1200$
$\dfrac{21600(t+15) + 21600t}{t(t+15)} = 1200$
$21600(t+15) + 21600t = 1200t(t+15)$
$21600t + 324000 + 21600t = 1200t^2 + 18000t$
$1200t^2 - 25200t - 324000 = 0$
$t^2 - 21t - 270 = 0$
$t = 30 \quad \text{or} \quad -9 \text{ (reject)}$

$\text{Number of posters printed by the old printer} = \dfrac{21600}{30+15}$
$= 480$
$\text{Total area printed by old printer} = 480 \times 0.21064 \text{ m}^2$
$= 57.91 \text{ m}^2$

Since the older printer only printed 57.9 m^2 < 60 m^2. It will need to be serviced.</td><td colspan="2">I can solve problem using various heuristics</td></tr>
<tr><td>Content</td><td>M</td></tr>
<tr><td>Complexity</td><td>H</td></tr>
<tr><td>Context</td><td>H</td></tr>
<tr><td>Response Strategy</td><td>unfamiliar</td></tr>
<tr><td>Assessment Objective</td><td>AO2 / AO3</td></tr>
<tr><td colspan="2">OR</td><td>To print an area of 60m^2, printer must print $\dfrac{60}{0.12064492} = 497.33$ posters.

Since the older printer only printed 480 posters < 495.86 posters, it will need to be serviced.</td><td colspan="2"></td></tr>
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