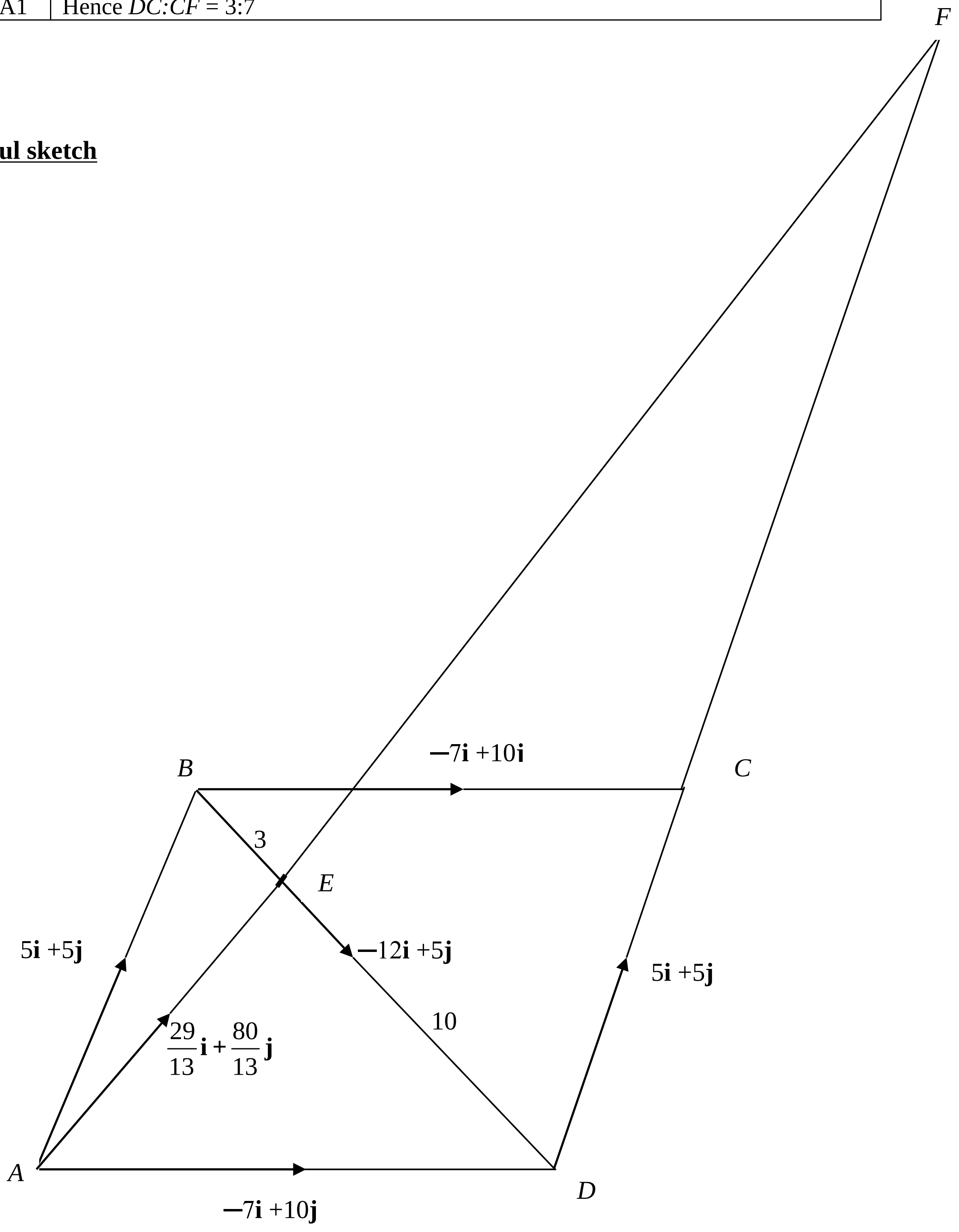
Question number	Scheme	Marks
10 (a) (i)	$\overrightarrow{DC} = \overrightarrow{DA} + \overrightarrow{AC}, = 7\mathbf{i} - 10\mathbf{j} - 2\mathbf{i} + 15\mathbf{j} = 5\mathbf{i} + 5\mathbf{j}$	M1,A1
(ii)	$\overrightarrow{DC} = \overrightarrow{AB}$ $\therefore$ *ABCD* is a parallelogram	M1 A1 [4]
(b)	$\overrightarrow{BD} = \overrightarrow{BA} + \overrightarrow{AD} = -5\mathbf{i} - 5\mathbf{j} - 7\mathbf{i} + 10\mathbf{j} = -12\mathbf{i} + 5\mathbf{j}$ unit vector $= (\pm)\dfrac{1}{13},(-12\mathbf{i} + 5\mathbf{j})$	M1A1 B1ft,B1 [4]
(c)	$\overrightarrow{BE} = \dfrac{3}{13}(-12\mathbf{i} + 5\mathbf{j})$ $\overrightarrow{AE} = \overrightarrow{AB} + \overrightarrow{BE} = \dfrac{29}{13}\mathbf{i} + \dfrac{80}{13}\mathbf{j}$	M1A1 [2]
(d)	$\overrightarrow{AF} = \lambda\overrightarrow{AE} = \lambda\left(\dfrac{29}{13}\mathbf{i} + \dfrac{80}{13}\mathbf{j}\right)$ or $\lambda'(29\mathbf{i} + 80\mathbf{j})$ $\overrightarrow{AF} = \overrightarrow{AC} + \mu\overrightarrow{DC} = -2\mathbf{i} + 15\mathbf{j} + \mu(5\mathbf{i} + 5\mathbf{j})$ $\dfrac{29}{13}\lambda = -2 + 5\mu \qquad \dfrac{80}{13}\lambda = 15 + 5\mu$ $\mu = \dfrac{7}{3} \quad \left(\lambda = \dfrac{13}{3}, \quad \lambda' = \dfrac{1}{3}\right)$ $DC : CF = 1 : \dfrac{7}{3} \quad (= 3 : 7)$	B1 M1A1 M1A1 A1 [6]
		Total 16 marks

Notes		
(a)	M1	For the correct vector statement for $\overrightarrow{DC}$ so $\overrightarrow{DC} = \overrightarrow{DA} + \overrightarrow{AC}$
	A1	For the correct simplified expression $\overrightarrow{DC} = 5\mathbf{i} + 5\mathbf{j}$
	M1	States $\overrightarrow{DC} = \overrightarrow{AB}$ — Condone lack of arrows on vectors if they are clearly using vectors. i.e accept $DC = AB$
	A1	Conclusion required, therefore *ABCD* is a parallelogram. Accept; a labelled diagram, shown, QED, or even a tick or # etc.
(b)	M1	For the correct vector statement for $\overrightarrow{BD} = \overrightarrow{BA} + \overrightarrow{AD}$ or $\overrightarrow{BD} = \overrightarrow{BC} + \overrightarrow{CD}$
	A1	For the correct simplified expression $\overrightarrow{BD} = -12\mathbf{i} + 5\mathbf{j}$
	B1ft	For the correct magnitude of their vector. So that for $\overrightarrow{BD} = a\mathbf{i} + b\mathbf{j} \Rightarrow \lvert\overrightarrow{BD}\rvert = \sqrt{a^2 + b^2}$, $\lvert\overrightarrow{BD}\rvert = 13$
	B1ft	Writes $'\frac{1}{13}'(a\mathbf{i} + b\mathbf{j})$ for their $\overrightarrow{BD}$
(c)	M1	For any correct path for $\overrightarrow{AE}$ with correct use of the ratio for $\overrightarrow{ED}$ or $\overrightarrow{BE}$
	A1	For $\overrightarrow{AE} = \frac{29}{13}\mathbf{i} + \frac{80}{13}\mathbf{j}$ oe
Method 1 using triangle *ACF* (they may use any letters for μ and λ)		
(d)	B1	States $\overrightarrow{AF} = \lambda\overrightarrow{AE}$ or $\overrightarrow{AF} = \lambda'\left(\frac{29}{13}\mathbf{i} + \frac{80}{13}\mathbf{j}\right)'$
	M1	$\overrightarrow{AF} = \overrightarrow{AC} + \mu\overrightarrow{DC}$
	A1	For the fully correct expression which need not be simplified $\overrightarrow{AF} = -2\mathbf{i} + 15\mathbf{j} + \mu'(5\mathbf{i} + 5\mathbf{j})'$
	M1	Sets $\lambda'\left(\frac{29}{13}\mathbf{i} + \frac{80}{13}\mathbf{j}\right)' = -2\mathbf{i} + 15\mathbf{j} + \mu'(5\mathbf{i} + 5\mathbf{j})'$ and equates coefficients of $\mathbf{i}$ and $\mathbf{j}$ to form two equations in λ and μ. Condone **i** and **j** in their equations.
	A1	For finding $\mu = \frac{7}{3}$
	A1	$DC : CF = 1 : \frac{7}{3}$ or $DC : CF = 3 : 7$
Method 2 using triangle *ADF* (they may use any letters for μ and λ)		
	B1	States $\overrightarrow{AF} = \lambda\overrightarrow{AE}$ or $\overrightarrow{AF} = \lambda'\left(\frac{29}{13}\mathbf{i} + \frac{80}{13}\mathbf{j}\right)'$
	M1	$\overrightarrow{AF} = \overrightarrow{AD} + \mu\overrightarrow{DC}$
	A1	For a fully correct expression which need not be simplified $\overrightarrow{AF} = -7\mathbf{i} + 10\mathbf{j} + \mu'(5\mathbf{i} + 5\mathbf{j})'$
	M1	Sets $\lambda'\left(\frac{29}{13}\mathbf{i} + \frac{80}{13}\mathbf{j}\right)' = -7\mathbf{i} + 10\mathbf{j} + \mu'(5\mathbf{i} + 5\mathbf{j})'$ and equates coefficients of $\mathbf{i}$ and $\mathbf{j}$ to form two equations in μ and λ. Condone **i** and **j** in their equations.
	A1	For finding $\mu = \frac{10}{3}$

	A1	$DC:DF=1:\frac{10}{3} \quad \Rightarrow \quad DC:CF=1:\frac{7}{3}$ or $DC:CF=3:7$
Method 3 using similar triangles		
(d)	B1	States triangles *AEB* and *DEF* are similar. Can be implied from correct work.
	M1	$BE:ED=3:10$ (given)
	A1	So therefore correspondingly $AB:DF=3:10$
	M1	*AB* = *DC* parallelogram
	A1	So *DC:DF* = 3:10
	A1	Hence *DC:CF* = 3:7

Useful sketch

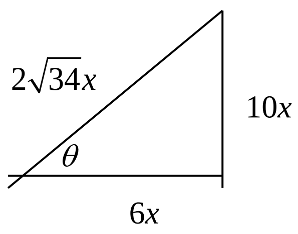


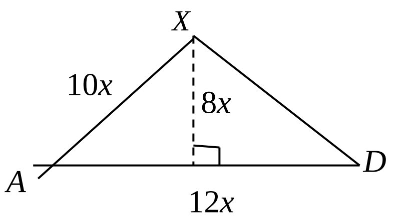
Question number	Scheme	Marks
11 (a)	$AC = 20x$ or $AX = 10x$ $EX = AX \tan 45° = 10x$	B1 M1A1 [3]
(b)	$EA = \dfrac{EX}{\sin 45°} = \dfrac{10x}{\sin 45°}, = \sqrt{200}x = \left(10\sqrt{2}x\right)$ Or use ΔEAC which is right-angled and isosceles	M1A1 [2]
(c)	$\tan\theta = \dfrac{EX}{\frac{1}{2}AD} = \dfrac{10}{6}$ $\theta = 59.0°$	M1A1ft A1 [3]
(d)	Reqd angle is $AXD\left(=\phi\right)$ $\tan\frac{1}{2}\phi = \dfrac{6}{8}$ $\phi = 73.7°$ must be acute **ALT**: Use cosine rule in triangle *AXD*	M1A1 A1 [3]
(e)	*Y* is midpoint of *AD* $EY = x\sqrt{\left(10\sqrt{2}\right)^2 - 6^2}$ $\left(= x\sqrt{164} \text{ or } 2x\sqrt{41}\right)$ Area $\Delta AED = 6x^2\sqrt{164} = 250$ $x = 1.8037... = 1.804$	M1 M1 A1 [3]
		Total 14 marks

In this question penalise ROUNDING of angles only once in parts (c) and (d).

This applies only if both answers are correct but over-accurate, i.e. they would both round to the correct angle to 1 decimal place. For example; for an angle in (c) given as 59.04° award M1A1A0, but if the angle in (d) is then given as 73.74° do not penalise the angle in (d), and award M1A1A1.

If however the answer given in (c) is 59° without 59.04° seen, this is M1A1A0, and because it is under-accurate, if they then give the angle in (d) as 73.74°, then this is awarded M1A1A0 as well.

		Notes
(a)	B1	For using Pythagoras theorem to find either $AC = 20x$ or $AX = 10x$ **Do not accept** $AC = 20$ or $AX = 10$
	M1	For $EX = AX \tan 45° = (10x)$ Ft their AX but **not** if they use their AC If there is no x in their working it is M0 **UNLESS** they put x into their final answer.
	A1	For $10x$
ALT		
	M1	Triangle AEC is isosceles with $\angle EAX = \angle ECX = 45°$ Hence triangle AEX is also isosceles with $\angle EAX = \angle AEX = 45°$ If there is no x in their working it is M0 **UNLESS** they put x into their final answer.
	A1	Hence $AX = EX$ so $EX = 10x$
Accept $EX = 10x$ just stated without working.		
(b)	M1	Uses Pythagoras theorem or any acceptable trigonometry to find length AE $AE = \sqrt{(10x)^2 + (10x)^2} = \left(\sqrt{200}x\right)$ $AE = \dfrac{10x}{\sin 45°} = \left(\sqrt{200}x\right)$ or $AE = \dfrac{10}{\cos 45°} = \left(\sqrt{200}x\right)$ If there is no x in their working it is M0 UNLESS they put x into their final answer.
	A1	$AE = 10x\sqrt{2}$ or $\sqrt{200}x$ Also accept $14.1x$ or better Accept unsimplified answers. Even accept answers given as $AE = \dfrac{10x}{\sqrt{2}/2}$
(c)	M1	Uses their EX to find $\tan\theta = \dfrac{'EX'}{\frac{1}{2}AD} = \dfrac{'10x'}{6x} \Rightarrow \theta = ...$ (Or any other complete method for the **required** angle)  Accept working without x's as this is a ratio, but do not accept an x in the numerator or denominator only.
	A1ft	A correct value of θ for their EX
	A1	$\theta = 59.0°$ rounded correctly

(d)	M1	 Angle required is AXD $\tan\left(\frac{1}{2}\angle AXD\right)=\frac{\frac{1}{2}\times AD}{\frac{1}{2}\times CD}=\frac{6x}{8x}\Rightarrow\angle AXD=.....$ $\sin\left(\frac{1}{2}\angle AXD\right)=\frac{\frac{1}{2}\times AD}{'10x'}=\frac{6x}{10x}\Rightarrow\angle AXD=.....$ $\cos\left(\frac{1}{2}\angle AXD\right)=\frac{\frac{1}{2}\times CD}{'10x'}=\frac{8x}{10x}\Rightarrow\angle AXD=.....$ Accept working without x's as this is a ratio, but do not accept x in the numerator or denominator only.
	A1	Uses correct values for their method
	A1	$\angle AXD=73.7°$ (must be acute) **Note: Do not isw if both angles are given and the acute angle not identified.**
ALT (using cosine rule)		
(d)	M1	$\angle AXD=\cos^{-1}\left(\frac{(10x)^2+(10x)^2-(12x)^2}{2\times 10x\times 10x}\right)=\frac{56x^2}{200x^2}=....$ Accept working without x's as this is a ratio, but do not accept x^2 in the numerator or denominator only.
	A1	Uses the correct value for AX
	A1	$\angle AXD=73.7°$ (must be acute) **Note: Do not isw if both angles are given and the acute angle not identified.**
(e)	M1	Finds the length of E to the midpoint of AD (Y) $EY=x\sqrt{('10\sqrt{2}')^2-6^2}\ \left(=x\sqrt{164}\text{ or }2x\sqrt{41}\right)$ ft their AE Any working without x is M0.
	M1	Equates area of 250 cm^2 to $\frac{1}{2}\times AD\times EY=\frac{1}{2}\times 12x\times x\sqrt{164}\Rightarrow x=...$
	A1	$x=1.804$ rounded correctly
ALT cosine rule and $\frac{1}{2}ab\sin C$		
(e)	M1	Finds angle AED $\angle AED=\cos^{-1}\left(\frac{('10\sqrt{2}x')^2+('10\sqrt{2}x')^2-(12x)^2}{2\times('10\sqrt{2}x')\times('10\sqrt{2}x')}\right)=50.208...^{\circ}$ Any working without x is M0.
	M1	Equates area of 250 cm^2 to expression for area of triangle: $250=\frac{1}{2}\times AE\times ED\sin\angle AED=\frac{1}{2}\times 10\sqrt{2}x\times 10\sqrt{2}x\sin 50.208^{\circ}\Rightarrow x^2=3.2536...^{\circ}$ $\Rightarrow x=1.8037...$
	A1	x = 1.804 rounded correctly