Question Number	Scheme	Marks
6 (i) (a)	Uses $\sin^2\theta+\cos^2\theta=1$ with $\cos\theta=\frac{1}{\sqrt{5}}\Rightarrow\sin^2\theta=\frac{4}{5}$	M1
	$\Rightarrow\sin\theta=-\frac{2}{\sqrt{5}}$	A1
(b)	Uses $\tan\theta=\frac{\sin\theta}{\cos\theta}$ with $\cos\theta=\frac{1}{\sqrt{5}}$ and their $\sin\theta=-\frac{2}{\sqrt{5}}$	M1
	$\Rightarrow\tan\theta=-2$	A1 **(4)**
(ii) (a)	1 (m)	B1 **(1)**
(b)	$30t-40=180\Rightarrow t=7.33$ Hence 7:20 **am**	M1, A1, A1 **(3)**
(c)	$4+3\cos(30T-40)°=3.5\Rightarrow\cos(30T-40)°=-\frac{1}{6}$	M1
	$\Rightarrow 30T-40=99.6, 260.4, \underline{\underline{459.6}}$	A1
	$\Rightarrow T=\frac{"459.6"+40}{30}=16.65$	dM1, A1 **(4)** **(12 marks)**

(i)

Clear use of trigonometric identities must be shown. Answers without method don't score marks

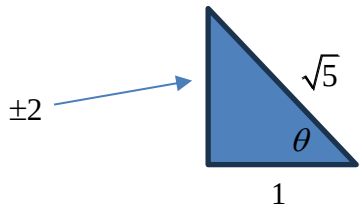
Look for work within the body of the script which may be common

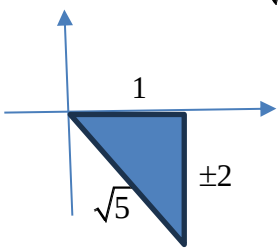
(a)

M1: Uses $\sin^2\theta+\cos^2\theta=1$ with $\cos\theta=\frac{1}{\sqrt{5}}\Rightarrow\sin^2\theta+\frac{1}{5}=1$ o.e.

Alternatively shows a 'triangle' method and uses Pythagoras' theorem to reach $\sin\theta=\pm\frac{2}{\sqrt{5}}$

E.g.





A1: $\sin\theta=-\frac{2}{\sqrt{5}}$ or simplified equivalent such as $-\frac{2\sqrt{5}}{5}$ following the award of the M1. ISW after a correct answer. Note that $\sin\theta=-\sqrt{\frac{4}{5}}$ is A0 as it is not simplified

(b)

M1: Uses $\tan\theta = \dfrac{\sin\theta}{\cos\theta}$ with $\cos\theta = \dfrac{1}{\sqrt{5}}$ and either $\sin\theta = \dfrac{2}{\sqrt{5}}$ or $\sin\theta = -\dfrac{2}{\sqrt{5}}$ from (a) which must have been awarded from a correct method.

Alternatively, from a triangle method, shows the opposite side = 2 in a right-angled triangle and takes the correct ratio

A1: $\tan\theta = -2$ following the award of the M1 in both (i) and (ii)

(ii)(a)

B1: 1 (m) Units are not necessary here but incorrect units e.g. 1 cm would be B0

(ii)(b)

M1: Sets $30t - 40$ equal to any value in degrees where the cosine is -1

So $30t - 40 = 180(2n+1)$, for any $n \in \mathrm{Z}$ is acceptable. Condone $30t - 40 = (2n+1)\pi$,

Condone the result obtained from differentiation with $\sin(30t-40) = 0 \Rightarrow 30t - 40 = 180(2n+1)$

A1: $30t - 40 = 180 \Rightarrow t = 7\dfrac{1}{3}$ or 7.33 but condone 7.3. It must follow the award of the M mark

A1: Achieves 7:20 am or 07:20 or any other acceptable way of establishing the exact **time of day** time in hours and minutes. So 7 hours 20 minutes after midnight is fine. **Condone 7:20 but 7:20pm is A0 and 7 hours 20 minutes without reference to after midnight is A0. It must follow correct working and cannot be rounded from a different time value such as 7:19.5**

(ii)(c) Radian attempts can only usually score the first M1.

M1: Sets $4 + 3\cos(30T - 40)°$ equal to 3.5 and proceeds to $\cos(30T - 40)° = k, \quad |k| < 1$

A1: Achieves $30T - 40$ equal to any of $99.6, 260.4, 459.6$

dM1: Proceeds from $30T - 40$ equal to any of awrt $100, 260, 460$ AND uses correct order of operations and working leading to a value for *T*.

For example, allow for $30T - 40 =$ awrt $100 \Rightarrow T = \dfrac{140}{30}$ or awrt 4.7

$30T - 40 =$ awrt $260 \Rightarrow T =$ awrt 10

$30T - 40 =$ awrt $460 \Rightarrow T = \dfrac{500}{30}$ or awrt 16.7

A1: awrt 16.65 following the award of M1, A1 dM1

ISW after a correct answer for *T*. Ignore any attempts to convert the *T* value to a time.

A clear method must be shown here, so solutions produced entirely from a calculator will not score.

E.g. $4 + 3\cos(30T - 40)° = 3.5 \Rightarrow T = 16.65$ is 0 marks

A minimal acceptable response for 4 marks would be

$$4 + 3\cos(30T - 40)° = 3.5 \Rightarrow \cos(30T - 40)° = -\frac{1}{6}$$

$$\Rightarrow 30T - 40 = 459.6$$

$$\Rightarrow T = 16.65$$

Question Number	Scheme	Marks
7 (a)	States either $kn=-24$ (1) or $\frac{n(n-1)}{2}k^2=270$ (2)	M1
	States both $kn=-24$ (1) and $\frac{n(n-1)}{2}k^2=270$ (2)	A1
	Substitutes $k=-\frac{24}{n}$ in equation (2) $\Rightarrow \frac{n(n-1)}{2}\left(-\frac{24}{n}\right)^2=270\Rightarrow n=...$	M1
	$n=16$	A1
	Uses their $n=16$ in $kn=-24\Rightarrow k=-\frac{24}{16}=-\frac{3}{2}$	dM1, A1
		(6)
(b)	$p=\frac{n(n-1)(n-2)}{3!}k^3=\frac{16\times15\times14}{6}\times\left(-\frac{3}{2}\right)^3=...$	M1
	$=-1890$	A1
		(2)
		(8 marks)

(a)

M1: States either $kn=-24$ (1) or $\frac{n(n-1)}{2}k^2=270$ (2) accepting equivalents but see note below

This mark cannot be awarded from $\binom{n}{1}k=-24$ or ${}^nC_2(kx)^2=270x^2$, with factorials

$\frac{n!}{(n-2)!}k^2=540$

or indeed versions including *x* terms such as $knx=-24x$ unless followed by a correct $kn=-24$

A1: States both $kn=-24$ (1) and $\frac{n(n-1)}{2}k^2=270$ (2) accepting equivalents

M1: Forms an equation in one variable leading to a value for *k* or *n*

It is dependent upon having achieved $kn=\pm24$ and $\frac{n(n-1)}{...}k^2=270$

The process of forming the equation must be credible so look for $k=\frac{\pm24}{n}$ being substituted and

NOT $k=\pm24-n$ FYI the equation in *k* is $\Rightarrow -\frac{24}{k}\left(-\frac{24}{k}-1\right)\times\frac{k^2}{2}=270\Rightarrow k=...$

A1: For either $n=16$ following a correctly solved equation in *n*.

or $k=-\frac{3}{2}$ if the equation in *k* was formed.

Look for correct working leading to the value for *n*. For example, forming a linear equation is sufficient. $\frac{n(n-1)}{2}\left(-\frac{24}{n}\right)^2=270\Rightarrow\frac{288(n-1)}{n}=270\Rightarrow288n-288=270n\Rightarrow n=16$

dM1: Uses $k=\pm\frac{24}{n}$ o.e. with their $n='16'$ to find *k* or their $k='-\frac{3}{2}'$ to find *n*