A unit vector perpendicular to the triangle PQR is given by

$$\frac{i+2j+k}{|i+2j+k|} = \frac{i+2j+k}{\sqrt{1^2+2^2+1^2}} = \frac{1}{\sqrt{6}}(i+2j+k)$$ ✓ 2/2

It could have been $\pm$ your answer

c) $\Delta PQR = \frac{1}{2}|\vec{PQ} \times \vec{PR}|$

$= \frac{1}{2}|(2-2t+t^2)(i+2j+k)|$

$= \frac{1}{2}|(i+2j+k)||(2-2t+t^2)|$ 2/2

$= \pm\frac{\sqrt{6}}{2}|(2-2t+t^2)|$ units^2

0/1

whereas you could have used $\pm$ for the unit vector, you cannot do so here as the Δ must be +ve ie $(2-2t+t^2) > 0$ for the + sign - check $(2-2t+t^2)$ $= (t-1)^2 - 1 + 2$ $= (t-1)^2 + 1$ > 0 for all t

hence $\Delta = +\frac{\sqrt{6}}{2}(2-2\ldots$ etc

d) ΔPQR is minimum (or maximum) when

not a common notation, $\frac{d\Delta PQR}{dt}$ might be better

$\dot{\Delta PQR} = 0$

ie $\frac{\sqrt{6}}{2}(-2+2t) = 0$ which implies $t = 1$ ✓ 2/2

$t=1$, $\Delta\ddot{PQR} = \frac{\sqrt{6}}{2} \times 2 = \sqrt{6} > 0$ ✓ hence this is a minimum ✓ 1/1

for ΔPQR. ✓

The minimum value of ΔPQR is

$\frac{\sqrt{6}}{2}|2-2\times1+1^2| = \frac{\sqrt{6}}{2}$ units^2 ✓ 1/1

e) For any two of P, Q or R to collide, at some time the area of the triangle PQR would have to be zero. ✓ This is not the case as we have just established that the minimum area of PQR is $\frac{\sqrt{6}}{2}$ units$^2 > 0$ ✓ yes

I would also have said that $(2-2t+t^2)$ has no real roots, or that since $|\vec{PQ} \times \vec{PR}|$ is never equal to zero, ✓ none of the particles ever coincide, and in fact never form a straight line, or that from (b) since the triangle has a normal ✓ which is always a line (not a plane) the area of the triangle is never zero ✓ 2/2

how does this affect your comment?

4)