$\boxed{b)}$ $N((a,u)(b,v)) = N((ab - u\cdot v,\ av + bu + u\times v))$

$$= (ab - u\cdot v)^2 + (av + bu + u\times v)\cdot(av + bu + u\times v)$$

$$= a^2 b^2 + (u\cdot v)^2 \cancel{- 2ab(u\cdot v)} + a^2|v|^2 + b^2|u|^2 + (|u\times v|)^2 + \cancel{2a\, v\cdot(u\times v)} + \cancel{2b\, u\cdot(u\times v)} \cancel{+ 2ab\, u\cdot v}$$

0 (orthogonal)

$$(u\cdot v)^2 = |u|^2|v|^2\cos^2\theta$$

$$+|u\times v|^2 = |u|^2|v|^2\sin^2\theta$$

$$= |u|^2|v|^2$$

$$= a^2b^2 + |u|^2|v|^2 + a^2|v|^2 + b^2|u|^2$$

$$N((a,u))\cdot N((b,v)) = (a^2 + |u|^2)(b^2 + |v|^2)$$

$$= a^2b^2 + a^2|v|^2 + b^2|u|^2 + |u|^2|v|^2 \checkmark$$

$\boxed{a}$ $\big((a,u)(b,v)\big)(c,w) = (ab - u\cdot v,\ av + bu + u\times v)(c,w)$

$$= \big(cab - c\,u\cdot v - w\cdot(av + bu + u\times v),$$
$$(ab - u\cdot v)w + c(av + bu + u\times v) + (av + bu + u\times v)\times w\big)$$

$$= \big(cab - c\,\vec{u}\cdot\vec{v} - a\,\vec{v}\cdot\vec{w} - b\,\vec{u}\cdot\vec{w} - \vec{w}\cdot(\vec{u}\times\vec{v}),$$
$$ab\,\vec{w} - (\vec{u}\cdot\vec{v})\vec{w} + ca\vec{v} + cb\vec{u} + c\,\vec{u}\times\vec{v} + a\,\vec{v}\times\vec{w} + b\,\vec{u}\times\vec{w} + (\vec{u}\times\vec{v})\times\vec{w}\big)$$

vs.:

$$(a,u)(bc - v\cdot w,\ bw + cv + \vec{v}\times\vec{w})$$

$$= \big(abc - a\,\vec{v}\cdot\vec{w} - \vec{u}\cdot(b\vec{w} + \vec{v} + \vec{v}\times\vec{w}),$$
$$ab\vec{w} + ac\vec{v} + a\,\vec{v}\times\vec{w} + bc\vec{u} - (\vec{v}\cdot\vec{w})\vec{u} + b\,\vec{u}\times\vec{w} + c\,\vec{u}\times\vec{v} + \vec{u}\times(\vec{v}\times\vec{w})\big)$$

Green: $\vec{u}\cdot(\vec{v}\times\vec{w}) \overset{?}{=} \vec{w}\cdot(\vec{u}\times\vec{v})$ ✓

(Standard identity)

Now: Does $\vec{u} \times (\vec{v} \times \vec{w}) - (\vec{v} \cdot \vec{w})\vec{u}$

$$\overset{?}{=} (\vec{u} \times \vec{v}) \times \vec{w} - (\vec{u} \cdot \vec{v})\vec{w}$$

Recall: $\vec{u} \times (\vec{v} \times \vec{w}) = (\vec{u} \cdot \vec{w})\vec{v} - (\vec{u} \cdot \vec{v})\vec{w}$

and: $\vec{a} \times \vec{b} = -\vec{b} \times \vec{a}$

So: $(\vec{u} \times \vec{v}) \times \vec{w} = -\vec{w} \times (\vec{u} \times \vec{v})$

$$= -\left((\vec{w} \cdot \vec{v}) \cdot \vec{u} - (\vec{w} \cdot \vec{u}) \cdot \vec{v}\right)$$

$$= (\vec{w} \cdot \vec{u}) \cdot \vec{v} - (\vec{w} \cdot \vec{v})\vec{u}$$

$\square$

So yes, associative.