

Solutions

2.1 C. The edge cross product has magnitude 6. Triangle area is half the spanned parallelogram area. The cross-product norm is six, so six is the parallelogram area and twelve doubles it; one and two fail the same half-base-times-height calculation.

2.2 B. Multiply $(1,0)$ by the coefficient $((3,4) \cdot (1,0))/((1,0) \cdot (1,0))=3$. $(0,4)$ is the orthogonal residual; $(1,0)$ is a direction rather than the projected length; the unit version of v projects onto no stated line; five is a scalar norm, not a vector projection.

2.3 $v \cdot u = 14$ and $u \cdot u = 5$, so the vector projection is $(14/5)u = (14/5, 0, 28/5)$. The residual is $(-4/5, 3, 2/5)$, whose dot product with u is zero. The cross product is $u \times v = (-6, -2, 3)$ with norm seven. Triangle area is half the parallelogram area, or $7/2$. Both edge vectors start at O ; crossing unrelated position vectors would not generally compute the requested triangle.

3.1 Order their directions around the circle. Every consecutive gap must exceed $\pi/2$: if a gap were at most $\pi/2$, that pair would have nonnegative dot product. Four such gaps would sum to more than 2π , impossible. Therefore not all six products can be strictly negative. With nonpositive products, $e_1, e_2, -e_1, -e_2$ works: consecutive pairs are perpendicular and opposite pairs have negative products. A zero vector cannot satisfy strict negativity.

Local four-mark guidance for each written task: choose and justify the method; carry through the reasoning; give every requested result; check the relevant restriction, hypothesis or boundary case. These are classroom marks, not GRE scoring.