Year 1 Assessed Problems

Semester 1

Assessed Problems 4

SOLUTIONS TO BE SUBMITTED ON CANVAS BY

Wednesday 30th October

at 17:00

2 Assessed – Vectors 2

Problem 2.1 **Practice with scalar and vector products**

Let:

$$\begin{aligned} \mathbf{a} &= -2\,\hat{\mathbf{x}} + 3\,\hat{\mathbf{y}} + \hat{\mathbf{z}}\ , \\ \mathbf{b} &= -2\,\hat{\mathbf{x}} + \hat{\mathbf{y}} + 4\,\hat{\mathbf{z}}\ , \\ \mathbf{c} &= \hat{\mathbf{x}} + \hat{\mathbf{y}} - 3\,\hat{\mathbf{z}}\ . \end{aligned}$$

Evaluate:

(i) $\mathbf{b} \times \mathbf{c}$;

(ii) $\mathbf{a} \times (\mathbf{b} \times \mathbf{c})$;

(iii) $\mathbf{a} \cdot \mathbf{b}$;

(iv) $\mathbf{a} \cdot \mathbf{c}$;

(v) $(\mathbf{a} \cdot \mathbf{c})\mathbf{b} - (\mathbf{a} \cdot \mathbf{b})\mathbf{c}$.

probstat_ps2

October 18, 2024

1 Probability and statistics Assessed Problem Sheet 2

This question is about distributions and likelihoods.

A space telescope is monitoring a very faint star. The telescope counts the photons that it receives from that star only and there is no background noise. In a single 5 minute exposure, the telescope detects 7 photons.

1.1 Part 1

State which distribution is most appropriate for modelling the photons recieved by the telescope. [**1 Mark**]

1.2 Part 2

State the probability mass function of the Poisson distribution and define the variables. Using the same notation state the mean and the variance of the Poisson distribution. [**3 Marks**]

1.3 Part 3

Calculate the probability of detecting 7 photons assuming the mean number of expected events is 5. [**2 Marks**]

1.4 Part 4

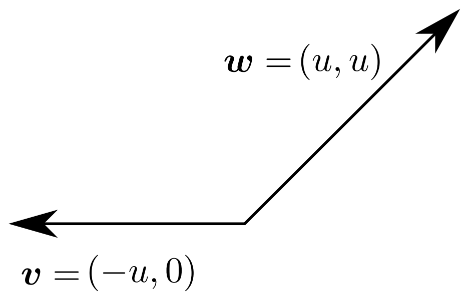
Calculate the probability of detecting 7 photons assuming the mean number of expected events is 12. [**1 Mark**]

1.5 Part 5

State, and justfy you answer, which number of mean events (5 or 12) is more likely to be observed in subsequent 5 minute exposures. [**1 Mark**] (you should assume that the faint star is not a variable star)

Estimate the most likely number of photons detected in further observations. [**2 Marks**]

Two spaceships have their velocities $\boldsymbol{v} = (v_x, v_y) = (-u, 0)$ and $\boldsymbol{w} = (w_x, w_y) = (u, u)$ in some reference frame Σ. Only the relevant $x-$ and $y-$ components are used. The velocity $u = c/2$.



Calculate the velocities $\boldsymbol{v}' = (v'_x, v'_y)$ and $\boldsymbol{w}' = (w'_x, w'_y)$ in the reference frame Σ' moving in the $x-$direction in which the second spaceship moves vertically, $w'_x = 0$.

[10]