A-LEVEL MATHS QUESTIONS

Mechanics and Statistics - Day 7

COMPLETE ALL QUESTIONS

1. A series of measurements are made of the mass and height of a species of tree. It is found that the product moment correlation coefficient is 0.231. Given that the sample size is 50, perform a hypothesis test on the correlation coefficient at a 1% level stating your null and alternate hypotheses carefully.

2. A particle of mass $2kg$ experiences a continuous force of magnitude $20N$ in a constant direction. The particle experiences a non-constant resistive force of magnitude $0.1v^2$ in the direction opposite to the motion of the particle, where v is the velocity of the particle. Determine a differential equation in linking $\frac{dv}{dt}$ and v.

Solve this equation to find v in terms of t, given that the initial velocity of the particle was $1m/s$

3. Solve the differential equation

$$\frac{dN}{dt} = -0.2N$$

Given that $N = 100$ when $t = 0$

4. A ladder of mass M rests against a smooth wall, making an angle of θ with the horizontal. The coefficient of friction between the wall and floor is 0.2. For what values of θ will the ladder remain stationary?

5. A light beam AB of length 2m rests on two pivots, each positioned 50cm from the respective ends of the beam. Masses of 3kg and 4kg rest a distance $D_A < 1$ and $D_B < 1$ from the endpoints A and B. Determine, in terms of D_A and D_B, the reaction forces at both pivots.

6. Find the general solution to the differential equation

$$\frac{dv}{dt} = t(v-1)(v-2)$$

7. A sproket^{TM} machine makes sprokets^{TM} with a mean mass of $0.5kg$ and a variance of $0.01kg^2$. A sample of 30 sprokets^{TM} is taken and their mean weight is found to be $0.49kg$. Perform a 1-tailed test at the 5% significance level to determine if there has been a decrease in sproket mass.