The Day Before Applied Livestream 2026

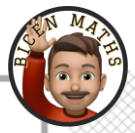
Questions written by the very talented A-Level Maths and Further Maths student, Gavin Arora, and co-edited with Mr Bicen

https://www.linkedin.com/in/gavin-arora/

£15 recordings
- Mechanics
- Statistics

See link in description

Question 1: Correlation and Regression



A sports scientist believes that there is a relationship between the cortisol level, c mcg/dL, and the testosterone level, t ng/dL, of **male** football players.

To gather data, the scientist visits the training ground of a local football team and tests the first 10 available players with odd-numbered shirts who volunteer.
The data collected is given in the table below.

c (mcg/dL)	12.1	14.5	9.8	16.2	11.0	15.1	13.4	8.5	17.0	12.4
t (ng/dL)	620	580	710	510	660	540	590	750	480	630

(a) State the sampling method used by the sports scientist to collect this data and give a disadvantage of using this sampling method.

(2)

The scientist plans to use a linear regression model based on the data collected to estimate the testosterone levels of **female** football players from the same team, based on their cortisol levels.

(b) Suggest, giving a reason, whether or not it is a good idea to use this model to to estimate the testosterone levels of female players.

(1)

The scientist attempts to calculate the product moment correlation coefficient, r, and obtains a value of -1.67.

(c) Explain how she should be able to identify that this is incorrect without carrying out any further calculations.

(1)

(d) Use your calculator to find the correct value of r for this sample. Stating your hypotheses clearly, test, at the 1% significance level, whether or not there is evidence that the product moment correlation coefficient is negative.

(3)

(e) Explain what your test in part (d) suggests about cortisol and testosterone levels of male football players.

(1)

Question 2: The Normal Distribution

The time taken for Maths students to improve by one grade under Gavin's tuition is normally distributed, with a mean of 6 hours and a standard deviation of 1 hour.

Gavin currently tutors a group of 10 Maths students.

(a) Estimate the number of these students who will require more than 6.5 hours of tuition to achieve their one-grade improvement.

(3)

The time taken, T hours, for Maths students to achieve the same one-grade improvement under Jerome's tuition is also normally distributed, with mean μ and standard deviation σ.

Given that $P(T < 5.8) = 0.1151$ and $P(T > 7.8) = 0.2119$,

(b) Find the value of μ and the value of σ.

(5)

Both tutors charge the exact same hourly rate for their sessions.

(c) Recommend which tutor a student should select if they want to minimise their total expenditure, giving a reason for your choice.

(2)

Question 3: Probability

Because of the last part! ★★★★★

A researcher at Bicen University wants to investigate student participation in extracurricular activities. They email a survey to all second-year students asking about their membership in various university societies.

The researcher wants to ensure that the data accurately reflects extracurricular participation across the entire student population.

(a) State how the researcher should alter their method of data collection to achieve this.

(1)

The survey data for the Anime Society (A) and the Baking Society (B) shows that no student is a member of both societies simultaneously.

The data also reveals that

- $\mathrm{P}(A' \cap B') = 0.3$
- $2\mathrm{P}(A) - 3\mathrm{P}(B) = 0.15$

(b) Determine the values of $\mathrm{P}(A)$ and $\mathrm{P}(B)$.

(3)

The survey also analyses participation in the Chess Club (C) and the Debate Society (D) among the second-year students.

$$\mathrm{P}(C|D) = 3\mathrm{P}(C)$$

where $\mathrm{P}(C) \neq 0$.

(c) Explain whether or not joining the Chess Club and joining the Debate Society are independent events.

(1)

Given also that for these two societies

$$P(C \cap D) = \frac{1}{2}P(C) \quad \text{and} \quad P(C' \cap D') = \frac{7}{10}$$

(d) Find $\mathrm{P}(C)$, showing your working clearly.

(7)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

Question 4: Distributions

A university careers department finds that due to automated resume filtering in a saturated job market, only 42% of all graduate applications successfully pass the initial screening phase.

The department first analyses a random sample of 20 applications submitted by one of their graduates.

(a) Assuming the baseline rate of 42% is accurate, calculate the probability that for this graduate

(i) exactly 8 of these applications pass the initial screening phase,

(1)

(ii) more than 7 of these applications pass the initial screening phase.

(2)

The careers department tracks a further random sample of 6 graduates.
Each graduate submits a batch of 20 independent applications.

(b) Calculate the probability that at least 2 of these 6 graduates have more than 7 of their applications pass the initial screening phase.

(3)

A national student union conducts a much larger study, tracking a random sample of 250 graduate applications from across the country.

(c) Assuming that the baseline screening success rate is still 42%, use a suitable approximation to find the probability that at most 95 of these 250 applications pass the initial screening phase.

(4)

A focused study on 250 applications submitted specifically by engineering graduates finds that 121 of them successfully passed the initial screening phase.

(d) Test, at the 5% significance level, whether there is evidence that the proportion of engineering applications passing the initial screening phase is different from the baseline rate of 42%. State your hypotheses clearly.

(4)

Question 5: ???

A particle P of mass 0.5 kg is moving in a vertical plane.

The origin O is a fixed point in the plane.

At time $t = 0$, P passes through O, moving with velocity $(4\mathbf{i} + 3\mathbf{j})$ ms^{-1}

At time t seconds, a variable force F acts on P in the direction of the vertical plane, where

$$F = [6t\mathbf{i} + (2t + 4)\mathbf{j}] \text{ N}$$

(a) Find the velocity of P at $t = 2$

(6)

(b) Find the distance of P from O at $t = 2$

(4)

Question 6: Moments

A uniform rod AB, of mass 5 kg and length 8 m, has its end B resting on a rough horizontal ground.

The rod is held in limiting equilibrium at an angle α to the horizontal, where $\tan(\alpha) = 0.75$, by a rope attached to the rod at C. The distance $AC = 1\text{m}$.

The rope is in the same vertical plane as the rod, and is perpendicular to the rod, as shown in **Figure 1**.

The coefficient of friction between the rod and ground is μ and the vertical component of the force exerted on the rod at B by the ground is R N.

(a) Find the tension acting in the rope.

(2)

(b) Find the value of R.

(3)

(c) Find the value of μ.

(3)

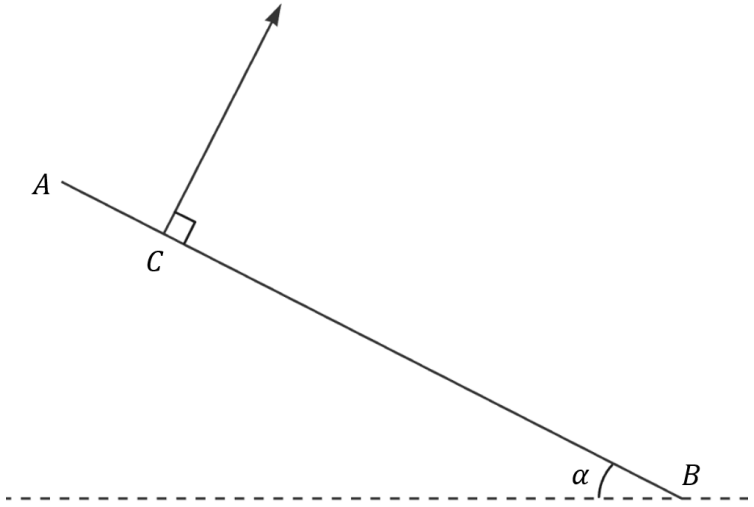


Figure 1

Question 7: Projectiles

A particle moves in a straight line with constant acceleration a.
The initial velocity of the particle is u and its velocity at time t is v.

(a) By using calculus, and the formula $v = u + at$, prove that the displacement, s, of the particle from its starting position at time t is given by

$$s = ut + \frac{1}{2}at^2$$

(3)

A player is practicing a table tennis serve.
The path of the ball is modelled as a particle moving freely under gravity in a vertical plane.

The origin O is taken at the point where the ball strikes the server's side of the horizontal table surface. The model considers only the motion of the ball **after** this bounce, where it is projected upwards from O with an initial speed of $4.5\ \text{ms}^{-1}$ at an angle of $24°$ above the horizontal.

The net is located at a horizontal distance of exactly 0.9 m from O. The ITTF (International Table Tennis Federation) mandates a net height of 15.25 cm abovethe table surface.

(b) Given that $g = 9.8\ \text{ms}^{-2}$, use the result in part (a) to determine if the ball passes over the net.

(5)

(c) State two limitations of the model.

(2)

Question 8: Connected Particles

Because it looks hard! ★★★★★

Figure 2 shows two fixed inclined planes meeting at a peak.
A small smooth pulley is fixed at the peak.

Block A of mass m rests of the left incline, which is tilted at an angle of $2\theta°$ to the horizontal.

Block B, also of mass m, rests on the right incline, which is tilted at an angle of $\theta°$ to the horizontal.

The two blocks are connected by a light, inextensible string which passes over the pulley.
The segments of the string are parallel to the lines of greatest slope of their respective inclines.

The left inclined plane is rough, with a coefficient of friction μ between block A and the plane.
The right inclined plane is smooth.

The system is released from rest and is observed to be in limiting equilibrium, on the verge of slipping down the left plane.

(a) Show that

$$\mu = \frac{\sin 2\theta - \sin \theta}{\cos 2\theta}$$

(6)

(b) State how you have used the assumption that the pulley is smooth in part (a).

(1)

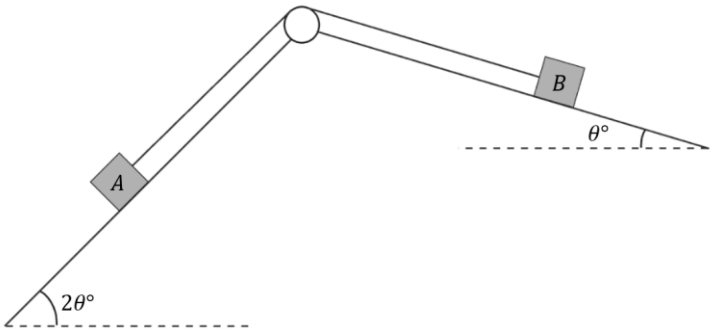


Figure 2