# Question writing task A: stationary points

## Task

Ask the student to find and classify the stationary points of a multinomial $f(x,y)$.

## Things to think about

- How do you generate the multinomial? How do you represent it in question variables?
- How many stationary points does $f$ have?
- How many steps are there in the process?
- Watch out for errors entering the product $xy$.
- If you ask the student to enter an equation, how do you mark it?

# Question writing task B: Hypothesis test

## Task

Generate a random sample of measurements from a normal distribution.

Ask the student to calculate summary statistics, including mean and standard deviation.

Ask the student to perform a test for the hypothesis that the population mean is a certain value.

## Things to think about

- How will you generate the sample data? Look at the statistical functions extension
- How will you present the data? In a table? On one line?
- Will the student do the computation by hand, or with a computer? Can you make it easier to copy the data into the software they use?
- How precise should the student's statistics be? How do rounding errors affect further calculations?
- What are the possible outcomes of the test? How can the student enter their decision?
- Add some context to the question - where are the data collected from? What dimension are they? What real-world meaning does the hypothesis have?

# Question writing task C: Multiple choice questions

## Task

Ask the student some multiple choice questions about UK geography (or somewhere else!)

- Given a list of territories in the British Isles, say which belong to the UK (or Great Britain, etc.)
- Say which of England, Wales, Scotland or Northern Ireland some cities belong to.
- Ask some questions with one correct answer and multiple distractors.

## Things to think about

- What can be randomised? Use the different variable data types effectively.
- Add pictures! If you're really ambitious, embed Google Maps or OpenStreetMap.
- What's a good number of distractor options to offer?
- Use the display columns option to control the layout of options in the "choose one from a list" part.
- When is it appropriate to shuffle the choices/answers? Think about what happens if a student runs a question multiple times.
- When you can't shuffle the choices, use a custom marking matrix to change the correct answer based on question variables.
- Try substituting variables into choice/answer text.
- Use distractor messages to give the student feedback about wrong answers.
- Look at how negative marking works, for a "match choices with answers" part.

# Question writing task D: Matrix arithmetic

## Task

Ask the student to write a $2 \times 2$ matrix representing a certain affine transformation in the plane (i.e., a combination of rotation, scale and shear transformations)

Ask the student to apply the transformation to some points in the plane.

Ask the student to find the inverse of the transform, and apply that to some points.

## Things to think about

- If you include a translation, the transform can't be represented as a single matrix.
- How will you generate the transformation? If you start with a combination of rotations and scales, can you calculate the associated matrix? If you start with a matrix, can you find the associated transformations?
- Make sure your matrix is always invertible
- Make good use of the built-in vector and matrix data types, and the "matrix entry" part type.
- Would it help the student if you added some real-world context, e.g. naming the shape being transformed?



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# Question writing task E: Graphs

## Task

Ask the the student to find a quadratic function which passes through a given set of points. Use the JSXGraph extension to plot the student's answer.

Ask the student to find the value of the function at one or more other points.

## Things to think about

- How many points do you need to give?
- How does the student give their answer - an algebraic expression, or just the coefficients? How do you assign marks?
- You could just give points on the $x$ axis, or you could put the points anywhere in the plane - but make sure a quadratic can go through them!
- If you want the student to find the value of the function by looking at the graph, how precise does their answer need to be?
- Ask the student questions to test their understanding before they do any calculation: how many roots does the quadratic have; what does it tend to at infinity?

# Question writing task F: Mechanics

## Task

Set up a model of a car lying (or moving) on a slope, with friction.

Ask the student to calculate the car's position at a given time.

## Things to think about

- What can you randomise: angle of the slope, initial position of the car, coefficient of friction, etc.
- Can you get the student to give the car's position as a function of time?
- Try to test the student's conceptual understanding - can you ask them what forces are acting on the car? What will the car do as time goes on - will it stop, or keep moving?
- Try to include a force diagram - either static, or dynamically generated.
- Can you ask the student to specify their units?
- How precise must the student's answer be? Look at the precision marking options.
- Would it help to embed a GeoGebra worksheet?
- Expand the question: how much thrust does the car need to produce to stay stationary, or accelerate up the hill?



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