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Candidate surname					Other names									
Pearson Edexcel					Centre Number					Candidate Number				
Level 3 GCE					<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>					<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>				
Type I and Type II Errors, Power														
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Statistics Advanced Topic Test														
You must have: Statistical formulae and tables booklet Calculator										Total Marks <input type="text"/>				

**Candidates may use any calculator allowed by Pearson regulations.
Calculators must not have retrievable mathematical formulae stored in them.**

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided
– *there may be more space than you need.*
- You should show sufficient working to make your methods clear.
Answers without working may not gain full credit.
- Unless otherwise stated, inexact answers should be given to three significant figures.
- Unless otherwise stated, statistical tests should be carried out at the 5% significance level.

Information

- A booklet ‘Statistical formulae and tables’ is provided.
- There are 5 questions in this question paper. The total mark for this paper is 50.
- The marks for **each** question are shown in brackets
– *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- If you change your mind about an answer, cross it out and put your new answer and any working underneath.

1. (a) State what is meant by a Type I error. (1)
 - (b) State what is meant by a Type II error. (1)
 - (c) State what is meant by the power of a hypothesis test. (1)
 - (d) State one method of decreasing the risk of making a Type I error.
Give one disadvantage of this method. (2)
 - (e) State one method of decreasing the risk of making a Type II error.
Give one disadvantage of this method. (2)
- In a particular hypothesis test, the probability of making a Type II error is 0.274
- (f) Calculate the power of this test. (1)
- (Total 8 marks)**
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2. The number of views in the first day following a social media influencer's posts may be modelled by a normal distribution with standard deviation 97.8 views.
During April, a post made by this influencer went viral. Before this viral post, the influencer was averaging 1902 "first day" views in the first day after a post. A random sample of 12 days after this viral post was analysed and the number of first day views were:
1931 1859 2146 1845 2002 1921 1890 2035 1926 2093 2035 2030
Assume that the standard deviation of first day views remains unchanged.
- (a) Test whether the average number of first day views has increased since the viral post. (6)
 - (b) Calculate the power of this hypothesis test if the mean number of first day views is actually 1950. (3)
 - (c) Interpret your answer to part (b) in context. (1)
- (Total 10 marks)**
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3. A group of job applicants claim that a particular company discriminated against them on the basis of gender during a recent recruitment process. The company denies discrimination and insists that its recruitment practices are fair. Out of the possible applicants, 48% were female and the rest were male.

The company appointed 25 people from these applicants of whom 7 were female.

A two-tailed test is carried out to determine whether there is significant evidence to support the accusation of discrimination.

- (a) Find the critical region for this test. The probability in each tail should be less than 2.5%.

Show your working clearly.

(4)

- (b) Using your result in (a), or otherwise, complete the hypothesis test.

(3)

- (c) Calculate the probability of making a Type I error for this test.

(1)

A solicitor acting for the company analyses previous recruitment data for the company and finds it has appointed females to 45% of posts filled in the last five years.

- (d) Calculate the probability of making a Type II error for the test carried out in part (b).

(3)

- (e) Write down the probability of the error which may have been made in the test carried out in part (b).

(1)

(Total 12 marks)

4. A wearable fitness device is a device which can monitor health measures such as steps, heart rate, calories burned and stress levels.

Many wearable fitness devices incorporate social connectivity features and “gamification” elements to enhance user engagement. This social aspect can create a sense of community and competition, motivating people to stay active and maintain a consistent fitness routine.

(Source: <https://fastercapital.com/content/Fitness-wearable-technology-How-Fitness-Wearable-Technology-is-Revolutionizing-the-Health-and-Wellness-Industry.html>)

Bethan is a sports scientist interested in the effect of gamified wearable fitness devices on the physical activity of the average person.

She obtains a sample of 240 volunteers and randomly assigns them either a standard wearable fitness device or a gamified wearable fitness device to wear in Week 2 of the experiment.

During Week 1 of the experiment, Bethan records the average number of steps per day for each volunteer using the standard wearable fitness device.

During Week 2 of the experiment, Bethan records the average number of steps per day for each volunteer wearing their allocated device.

The **increase** in the average number of steps is calculated for each volunteer and summarised in a spreadsheet.

Device	Number of volunteers	Average increase in steps	Variance
Standard	143	149.25	4622.25
Gamified	97	197.73	5241.83

- (a) Carry out a test to determine whether there is significant evidence of a higher mean increase in the average number of steps per day for those wearing the gamified device than the standard device.

(7)

- (b) (i) State, in context, the meaning of a Type I error.

(1)

- (ii) Write down the probability of making a Type I error for this test.

(1)

- (c) State, in context, the meaning of a Type II error.

(1)

If the difference in mean increase in the average number of steps between the two devices is actually 30,

- (d) calculate the probability of making a Type II error.

(3)

(Total 13 marks)

5. A car manufacturer uses a new quality control model which utilises real-time video feed and artificial intelligence (AI) to detect minor defects in the production of parts used in the construction of cars.

The manufacturer is hoping that timely detection of defects will lead to a decrease in costly product recalls.

(Source: <https://www.businessinsider.com/ford-uses-ai-cameras-in-factories-prevent-recalls-costly-rework-2025-8>)

The AI compares an image of a component with a predefined quality standard. If the image is consistent with the standard to within tolerance, the component passes inspection. Otherwise, the component is removed from the production process and subjected to further inspection.

The company have a performance target of passing at least 96% of components inspected.

During a particular day, the process is used to compare a sample of 20 000 images of components. A hypothesis test is carried out to determine whether there is significant evidence to suggest the performance target has not been achieved.

- (a) Find the critical region for this test such that the probability of a Type I error is less than 1%.

(3)

In reality, the performance target was not achieved as only 95.8% of components passed inspection.

- (b) Use a distributional approximation to estimate the power of this test.

(4)

(Total 7 marks)

TOTAL FOR PAPER: 50 MARKS