Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number	Candidate Number

Hypothesis Test Identification

Statistics

Advanced

Topic Test

You must have:
Statistical formulae and tables booklet
Calculator

Total Marks

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 20 questions in this question paper. The total mark for this paper is 25.
- 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. In cognitive psychology, "Mind-wandering" occurs when a person's attention drifts away from a task they are performing.

Gian conducts an experiment where he asks a random sample of participants complete a 20-minute computer-based attention task.

Every two minutes, the participants are prompted to record how many times their mind wandered since the last prompt.

From previous studies, Gian believes that the number of times a participant's mind wandered in a fixed two-minute interval could be modelled by a Poisson distribution with mean 0.7.

State suitable null and alternative hypotheses for a hypothesis test to investigate Gian's belief.

(Total 2 marks)

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2. Flo is a researcher working for a news corporation. She is investigating whether different news sources can change audiences' trust levels.

She selects a random sample of participants who each complete a survey that produces a "trust score", measuring how much pre-existing trust they have in the quality of the news output provided by this news corporation.

Each participant then watches a 15-minute news report from the same news corporation, after which they complete the survey again and a second trust score is recorded.

Flo assumes that the differences between in trust scores before and after watching the news segment follow a normal distribution.

A hypothesis test is carried out to determine whether or not there is significant evidence to suggest a change in the mean trust score.

State the name of the statistical test used.

(Total 1 mark)

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3. A major consumer-electronics company produces three types of fast-charging systems for its smartphones:

- Standard fast charging
- Advanced fast charging
- Turbo charging

Reuben is working for a consumer magazine and wishes to investigate whether or not there is a difference in the average battery life-durations after a full charge between the three systems.

He records data for a selection of 50 smartphones and randomly assigns each smartphone to one of the above charging systems. The battery life (from switch-on to switch-off) is then recorded for each phone.

Reuben then carries out a hypothesis test for his investigation.

State the name of a suitable statistical test that Reuben should use for his investigation.

(Total 1 mark)

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4. A report into the 2016 US presidential election claims that, on average, American voters spent 19 minutes waiting in line to vote.

[Source: https://kinder.rice.edu/urbanedge/why-does-it-take-so-long-vote]

Caoimhe is a polling analyst who wishes to investigate whether this time spent waiting in line to vote had decreased by the 2024 US presidential election.

She has access to post-election voter surveys for the 2024 US presidential election where respondents report the time they arrived at the polling station and the time they cast their ballot.

Caoimhe samples 456 of these surveys and calculates the time spent waiting in line to vote for each to use in a hypothesis test for her investigation. She then calculates the mean time spent waiting in line to vote to be 17.6 minutes with a standard deviation of 3.5 minutes.

No further assumptions about the time spent waiting in line to vote are made.

(a) State the name of the test Caoimhe should carry out.

(1)

(b) Justify the use of this hypothesis test.

(2)

(Total 3 marks)

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5. In basketball, "free-throw routine time" is the number of seconds a player takes from receiving the ball to releasing the shot.

Percival is a sports scientist who believes that lengthening the routine may indicate fatigue, reduced confidence or physical issues.

For one such major league basketball player, the free-throw routine time has been stable at a median of 9 seconds.

Percival studies the free-throw routine time data from the latest season for this player, which may be regarded as a random sample of 24.

Analysis across a large number of players and a large number of years indicate that the free-throw routine times may follow a skewed (non-symmetrical) distribution.

State the name of an appropriate hypothesis test which may be used to determine whether or not the average free-throw routine time for this player has increased.

(Total 1 mark)

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6. A retail company wish to investigate what factors influence customer satisfaction scores during in-store purchases. The market research department of the company choose two factors to investigate:

- Store location (Urban, Suburban and Rural)
- Sales approach (Consultative selling and fast-transaction selling)

A random sample of 2 urban, 2 suburban and 2 rural stores are selected and a survey machine is placed at the exit of each store asking every customer to press a button from 1 to 10 in relation to how satisfied they are with their shopping experience.

The staff at one urban, one suburban and one rural store are instructed to take a consultative selling approach for one week. The staff at the remaining stores are instructed to take a fast-transaction selling approach.

The average satisfaction scores are then recorded for each store at the end of the week.

State the name of an appropriate hypothesis test that can be used to determine if there is a difference between the average satisfaction scores between the store locations.

(Total 1 mark)

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7. In nuclear physics, a "decay event" is a single instance of a radioactive atom breaking down and releasing radiation.

Tyrone is a nuclear physicist who is monitoring the time between decay events for Americium-241. Using specialist equipment, he records the time between each decay event and records the data in a grouped frequency table with classes of 1-second intervals.

The longest recorded time between decay events is 20 seconds.

Tyrone believes that decay events occur singly, randomly, independently and at a constant average rate. Using the data he has collected, he carries out a hypothesis test to test his belief.

(a) State the name of Tyrone's hypothesis test.

(1)

(b) State suitable null and alternative hypotheses for this test.

(1)

(Total 2 marks)

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8. Two sites for an outdoor music festival are proposed: a coastal site and an inland rural farm site.

Huixan is a meteorologist hired by the festival organisers to investigate whether there is a difference between the wind speeds between the two sites. She collects data records the daily maximum wind speed for each of 28 days at each site.

Through previous research, there is evidence to suggest daily maximum wind speed does **not** follow a normal distribution.

Huixan carries out a hypothesis test to determine whether or not there is significant evidence of a difference in the average daily maximum wind speeds between the two sites.

State the name of Huixan's hypothesis test.

(Total 1 mark)

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9. Phoebe is an environmental scientist who has been hired by a city council to investigate whether traffic calming measures in the city result in lower air pollution.

To investigate this, Phoebe uses the local air quality monitoring station to record the concentration of fine particulate matter (in $\mu g/m^3$) in an urban area of the city where the traffic calming measures were recently implemented.

A higher concentration of fine particulate matter indicates a higher level of air pollution.

Phoebe uses 2 months of data (61 days) from the monitoring station for this area before the traffic calming measures were implemented and another 2 months of data (61 days) after the traffic calming measures were implemented. The results are summarised in the following table.

	Sample mean	**Sample variance**
Before	20.4	36.7
After	15.8	20.6

She then carries out a hypothesis test to determine whether or not the average concentration of fine particulate matter has decreased from before the traffic calming measures were implemented.

State the name of the hypothesis test Phoebe should use.

(Total 1 mark)

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10. It is reported that in a large scale study, the mean resting heart rate for the adult human population was 79.1 bpm.

[Source: https://www.nature.com/articles/s41746-019-0134-9.pdf]

Yusef is investigating whether or not people who work office jobs with predominantly sedentary activity (such as using computers for a prolonged period of time) have worse cardiovascular fitness, as indicated by a higher resting heart rate.

Yusef takes a random sample of 22 employees from an insurance company call centre who fit Yusef's criteria and records their resting heart rate.

He then carries out a hypothesis test to determine whether or not there is significant evidence to suggest that people who work office jobs with predominantly sedentary activity have, on average, a higher resting heart rate than the general population.

Yusef makes the assumption that the resting heart rates follow a normal distribution.

State the name of Yusef's hypothesis test.

(Total 1 mark)

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11. Fatima is an educational researcher who is investigating whether certain types of homework are associated with higher examination results.

She finds a study which reports that extension homeworks - where students must apply knowledge in new contexts – was a key factor in student success.

[Source: https://link.springer.com/article/10.1007/s10212-025-01031-8]

Fatima wishes to verify the result of this study and decides to ask Year 13 A Level Psychology students from a local school at the start of the academic year to complete a series of Psychology extension homeworks over the course of 9 months until the final examination.

When the results are released, Fatima receives 14 responses from the students at this school who inform her of the number of Psychology extension homeworks completed by each student over this time period as well as their final exam score out of 100.

Fatima decides that the discrete nature of the number of Psychology extension homeworks completed is **unlikely** to follow a normal distribution.

State the name of an appropriate hypothesis test Fatima can use to test the hypothesis that the **more** Psychology extension homeworks completed results in a **higher** examination score.

(Total 1 mark)

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12. Wiremu is a social scientist analysing crime statistics in a rural area. He believes there is an association between the type of crime committed and the time of day the crime is committed.

Wiremu is granted access to police incident reports in this area and records

- The type of crime committed (theft, vandalism, fly-tipping, trespassing), and
- The time of day the crime is committed (morning, afternoon, evening, night)

He then calculates the number of incidents that are in each category combination.

State the name of the test Wiremu should carry out to investigate his belief.

(Total 1 mark)

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13. Giulia is the quality control manager of a glass bottle manufacturer. She wishes to check whether the proportion of bottles produced with surface defects is in line with the tolerance specified by industry standards.

The industry standard states that no more than 2% of bottles produced should contain any visible imperfections.

Every hour, Giulia's team select a random sample of 200 bottles from the production line and inspect each bottle for any visible imperfections.

These data are reported to Giulia so she can carry out a hypothesis test to determine whether or not the manufacturing process conforms to the industry standards.

State the distribution of the number of defective bottles in the sample that should be used for this hypothesis test.

(Total 1 mark)

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14. Sato works for a food manufacturing facility and is investigating whether a new hand-washing training program has had an effect in reducing employee hand-surface contamination levels to a policy standard.

The facility uses ATP bioluminescence swabs to measure residual organic material, called the "ATP Level". The facility wishes the median ATP level to be 150.

A random sample of 20 employees at the facility have their ATP levels recorded after they have completed the new hand-washing training program.

It is assumed that the ATP levels follow a continuous uniform distribution.

State the name of an appropriate hypothesis test Sato may conduct to make conclusions from his investigation.

(Total 1 mark)

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15. A "musical mode" is a scale pattern in the composition of music in order to suggest different moods in a piece of music.

Ianto is a music lecturer who believes that students taught using the "movable-do solfège" method are more likely to correctly identify musical modes than students who are taught using different methods.

To investigate this, Ianto takes a random sample of 100 first-year music students at his university and randomly allocates them to two groups of equal size.

- Group A follow a course which uses the "movable-do solfège" method.
- Group B follow a course which uses a standard pattern-recognition approach.

At the end of the course, Ianto then asks all students to sit an exam consisting of 20 musical excerpts. The pass mark for the exam is to identify the musical mode of at least 80% of the excerpts.

He finds that 43 students in Group A passed the exam, while 38 students in Group B passed the exam.

State suitable null and alternative hypotheses for a hypothesis test that Ianto can carry out to investigate his belief.

(Total 1 mark)

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16. Aaradhya is a doctor at a respiratory clinic who wishes to investigate whether forced vital capacity (FVC) is correlated with peak expiratory flow (PEF) in patients recovering from mild asthma attacks.

For a particular patient at the clinic, she obtains permission to collect FVC measurements using a calibrated spirometer and PEF using a peak flow meter for each of 14 days after admission.

Aaradhya makes the assumption that the underlying population of FVC and PEF measurements follow a bivariate normal distribution.

State suitable null and alternative hypotheses for a hypothesis test Aaradhya can carry out for her investigation.

(Total 1 mark)

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17. Dmytro works for a city's environmental department who is interested in the public opinion of how the city's parks should look.

Two styles are proposed during a public consultation:

- "Traditional mowing" which involves maintaining short grass and a tailored appearance,
- "Wildflower management" which involves maintaining higher biodiversity.

A survey was created for the public consultation where respondents were asked to rank on a scale from 1 to 10 (10 indicating a higher preference) for each type of style.

From a sample of 28 respondents, 15 indicated a higher preference for Wildflower management, 9 indicated a higher preference for Traditional mowing and the remainder of the respondents ranked them both equally.

Dmytro carries out a hypothesis test to determine whether or not, on average, Wildflower management received a higher preference score than Traditional mowing.

No assumptions are made about the differences between preference scores.

State the name of Dmytro's hypothesis test.

(Total 1 mark)

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18. John is a chemist working at a university who is researching whether a new solid acid catalyst improves the percentage yield of ethyl ethanoate produced from a chemical reaction.

He prepares a number of test tubes of ethanoic acid required for this chemical reaction, with some tubes containing the new catalyst and the rest containing an existing catalyst.

After John runs the experiments, he finds 28 of the test tubes containing the new catalyst yielded ethyl ethanoate and 26 of the test tubes containing the old catalyst yielded ethyl ethanoate. The remainder of the test tubes were considered failed experiments and discarded.

For each of the remaining test tubes, the percentage yield of ethyl ethanoate was measured.

John conducts a hypothesis test for his investigation, under the assumption that the percentage yields of ethyl ethanoate under each catalyst are independent and normally distributed.

(a) State the name of the hypothesis test John carries out.

(1)

(b) State one further assumption regarding the underlying populations required.

(1)

(Total 2 marks)

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19. In photography, "noise" is described as the random, unwanted variation in brightness in colour that can make a photo appear grainy or blurry.

Yi-Seo is a photography editor who is trialling whether a new noise reduction algorithm can significantly reduce the noise in photos.

She scans 25 photos from a wide range of landscapes taken from the same camera.

For each photo, she runs a standard noise reduction algorithm and saves the photo digitally.

She then repeats the process on the original photo using the new noise reduction algorithm and saves the photo digitally.

The two digital photos are then analysed by specialist photo-editing software to produce a "noise level" which is a continuous numerical value.

Yi-Seo then carries out a hypothesis test to determine whether there is significant evidence to suggest, on average, the new noise reduction algorithm is better at reducing noise than the standard noise reduction algorithm.

It is assumed that the differences in noise levels between the two algorithms are symmetrically, but not normally, distributed.

State the name of Yi-Seo's hypothesis test.

(1)

(Total 1 mark)

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20. A logistics warehouse measures the time it takes for workers to package a standard order. The time is measured by timestamping when the order is received by a worker and again when the order is confirmed as packaged.

Over many years, the timestamp data confirms that the time taken to package a standard order may be modelled as a normal distribution and the standard deviation is consistent over the years, throughout the year and across worker groups. The timestamp data shows the standard deviation to be consistent at 16.2 seconds and the mean time to be 185 seconds.

Suzy is a manager at this warehouse and wishes to determine if a new recruit, after two days of training, is meeting the benchmark average time of 185 seconds to package a standard order.

She prepares 18 standard orders for this recruit to package and the time taken to package the orders are recorded for each one. Suzy then carries out a hypothesis test for her investigation.

State the name of Suzy's hypothesis test.

(Total 1 mark)

TOTAL FOR PAPER: 25 MARKS