Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number	Candidate Number

PRE DESIGN VERSION

Paper Reference **9MA0/31**

Mathematics

Advanced
Paper 31: Statistics

You must have:
Mathematical Formulae and Statistical Tables (Green), calculator

Total Marks

Candidates may use any calculator allowed by Pearson regulations. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

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- 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.
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- 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.
- Inexact answers should be given to three significant figures unless otherwise stated.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- The total mark for this part of the examination is 50. There are 5 questions.
- 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

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- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

Pearson

1. The partially completed table below summarises the times taken by 120 job applicants to complete a task.

Time, *t* (minutes)	$5 < t \leqslant 7$	$7 < t \leqslant 10$	$10 < t \leqslant 14$	$14 < t \leqslant 18$	$18 < t \leqslant 30$
Frequency	10	23	51		

A histogram is drawn.

The bar representing the $5 < t \leqslant 7$ has a width of 1 cm and a height of 5 cm.

(a) Given that the bar representing the group $14 < t \leqslant 18$ has a height of 4 cm, find the Frequency of this group.

(2)

(b) Showing your working, estimate the mean time taken by the 120 job applicants.

(3)

The lower quartile of the times is 9.6 minutes and the upper quartile of the times is 15.5 minutes.

For these data, an outlier is classified as any value greater than $Q_3 + 1.5 \times \text{IQR}$.

(c) Showing your working, explain whether or not any of the times taken by these 120 job applicants might be classified as outliers.

(2)

Candidates with the fastest 5% of times for the task are given interviews.

(d) Estimate the time taken by a job applicant, below which they might be given an interview.

(2)

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Question 1 continued

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2. A local sports centre has showers with two temperature settings, warm and hot.

On the warm setting, the water temperature may be modelled by a Normal distribution with mean 30 °C and standard deviation 2 °C

(a) Using the model, find the probability that the next time the shower is used on the warm setting ,the water temperature is

(i) exactly 31 °C

(ii) more than 31 °C

(2)

The sports centre manager thinks that a water temperature of more than 33 °C is too high for the warm setting.
She tests the water temperature on the warm setting on 5 randomly selected days.

Given that the probability of the water temperature being more than 33 °C is 0.0668

(b) find the probability of the water temperature being more than 33 °C

(i) on only the first of these 5 days, **(2)**

(ii) on more than 1 of these 5 days. **(3)**

On the hot setting, the water temperature may be modelled by a Normal distribution with standard deviation 1.5 °C

The probability that the water temperature is more than 42 °C is 0.0005

(c) Find the mean water temperature on this setting, giving your answer to 1 decimal place. **(4)**

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Question 2 continued

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Question 2 continued

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3. Sam is investigating the weather throughout the year in Hurn.

He uses the large data set to investigate the daily mean wind direction.

Sam believes that each cardinal wind direction is equally likely in Hurn.

(a) Assuming that Sam is correct,

(i) state the probability that the cardinal wind direction in Hurn on a randomly selected day is NNE,

(1)

(ii) state the distribution that Sam should use to model the probability of each cardinal wind direction in Hurn on a randomly selected day.

(1)

Sam decides to investigate the daily mean wind direction throughout the year.

(b) State a limitation of using the data for Hurn from the large data set as a sampling frame.

(1)

(c) Explain how to use simple random sampling to select 36 days from a year.

(2)

Sam defines the random variable X as the number of days out of 36 on which the daily mean wind direction in Hurn is between the bearings 135^o and 225^o

Sam collects data from 36 randomly selected days and finds that $x = 15$

Sam carries out a hypothesis test at the 10% level of significance.

(d) Given that $H_0 : p = 0.25$ and that the critical region is $\{X \leq 4 \cup X \geq 14\}$

(i) state the alternative hypothesis, H_1

(ii) giving a reason for your answer, explain what Sam should conclude about the daily mean wind direction in Hurn.

(3)

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Question 3 continued

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Question 3 continued

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4. A large number of cyclists take part in a cycling time trial.

A random sample of these cyclists are selected and their times, in minutes, are summarised in the following statistics

$$\sum x = 1680 \qquad \sum x^2 = 47654.4 \qquad n = 60$$

(a) Calculate, for this sample, the value of

(i) the mean time, **(1)**

(ii) the standard deviation of the times. **(2)**

Historically, the mean time for cyclists on this time trial has been 27 minutes and 30 seconds. Lucy is watching the time trial and believes that the mean time of cyclists in this time trial is greater than the mean time of cyclists in previous time trials.

The times of cyclists on this time trial are modelled by a Normal distribution with standard deviation 3 minutes.

(b) Test, at the 5% level of significance, whether or not this sample provides evidence to support Lucy's belief. You should state your hypotheses and show your working clearly.

(5)

Speedy Wheels cycling club entered its 5 fastest riders and 5 beginners to take part in the time trial.
The fastest 20% of the cyclists in the time trial are invited to compete in a race the following week.

(i) Explain, with specific reference to the parameter p, why the distribution B(10,0.2) might not be reasonable to model the number of these *Speedy Wheels* cycling club members who are invited to compete in the race. **(2)**

(ii) Suggest how to improve the model for the number of these *Speedy Wheels* cycling club members invited to compete in the race. **(1)**

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Question 4 continued

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5. (i) Two events A and B are mutually exclusive.

Given that $\mathrm{P}(B) = p \neq 0$ and

$$\mathrm{P}(A) = 3 \times P(B)$$

(a) draw a Venn diagram to illustrate this information,

(b) find the possible values of $P(B)$

(3)

(ii) Two events C and D are such that

$$\mathrm{P}(\mathrm{C} \mid \mathrm{D}) = 3 \times P(C) \text{ where } \mathrm{P}(C) \neq 0$$

(a) Explain whether or not events C and D could be independent events.

(1)

Given also that

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

(b) find $\mathrm{P}(C)$, showing your working clearly.

(7)

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Question 5 continued

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TOTAL FOR PAPER IS 50 MARKS

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Pearson Edexcel Level 3 GCE

Centre Number	Candidate Number

PRE DESIGN VERSION

Paper Reference **9MA0/32**

Mathematics

Advanced
Paper 32: Mechanics

You must have:
Mathematical Formulae and Statistical Tables (Green), calculator

Total Marks

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Information

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- Unless otherwise stated, whenever a value of g is required, take $g = 9.8\ \text{m s}^{-2}$ and give your answer to either 2 significant figures or 3 significant figures.

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.

Turn over ▶

Pearson

1. At time t seconds $(t \geqslant 0)$, a particle P is modelled as having velocity $\mathbf{v}\ \text{m s}^{-1}$, where

$$\mathbf{v} = (3t^2 - 12t)\mathbf{i} + (9t^2 - 3t)\mathbf{j}$$

and having acceleration $\mathbf{a}\ \text{m s}^{-2}$

(a) Find $\mathbf{a}$ in terms of $\mathbf{i}$, $\mathbf{j}$ and t. **(2)**

When $t = 0$, P is at the origin O.

At time t seconds $(t \geqslant 0)$, P has position vector $\mathbf{r}$ metres relative to O.

(b) Find $\mathbf{r}$ in terms of $\mathbf{i}$, $\mathbf{j}$ and t. **(2)**

At the instant when $\mathbf{a} = \lambda\mathbf{j}$, where λ is a constant, P is at the point A.

(c) Find the position vector of A relative to O. **(4)**

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Question 1 continued

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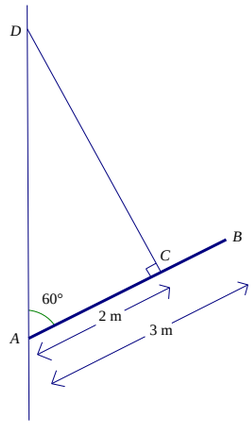

Figure 1

A beam *AB* has weight 40 N and length 3 m.
The beam is freely hinged at the end *A* to a vertical wall.
The beam is held in equilibrium at an angle of $60°$ to the wall by a rope.

One end of the rope is attached to the point *C* on the beam, where $AC = 2$ m.
The other end of the rope is attached to a point *D* on the wall, where *D* is vertically above *A*.
The rope is perpendicular to the beam, as shown in Figure 1.
The rope and the beam lie in a vertical plane that is perpendicular to the wall.

The beam is modelled as a uniform rod and the rope as a light inextensible string.

Using the model, find

(a) the tension in the rope, **(3)**

(b) the magnitude of the resultant force acting on the beam at *A*. **(6)**

If the rope was not modelled as being light,

(c) state how this would affect the tension along the rope, explaining your answer.

(2)

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Question 2 continued

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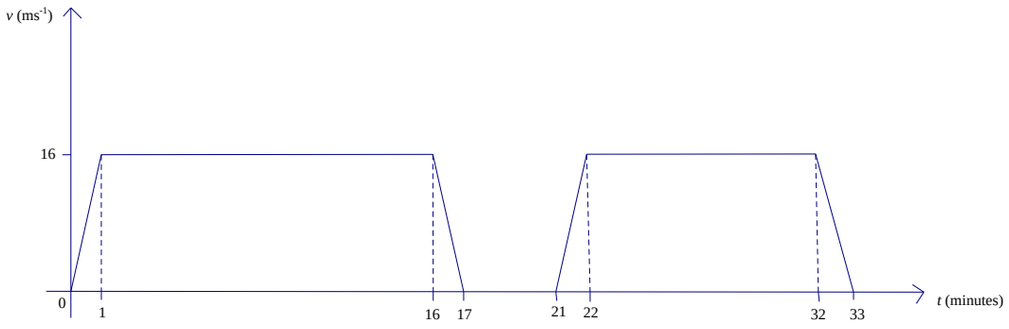

Figure 2

A train *X* runs on a straight horizontal track that connects stations *A* and *C*.
Station *B* lies between *A* and *C*.
Figure 2 shows the graph of the speed, $v\,\text{m s}^{-1}$, of train *X* against the time, *t* minutes, after noon.
Train *X* leaves *A* at noon and accelerates uniformly from rest until $t = 1$, when it is moving with speed $16\,\text{m s}^{-1}$
Train *X* then continues to move along the track at constant speed for 15 minutes, before decelerating uniformly and coming to rest at *B* at time $t = 17$
Train *X* leaves *B* at time $t = 21$ and accelerates uniformly for one minute, reaching a speed of $16\,\text{m s}^{-1}$
Train *X* then moves along the track at a constant speed of $16\,\text{m s}^{-1}$ for 10 minutes, before decelerating uniformly and coming to rest at *C* at time $t = 33$

(a) Find the distance of *C* from *A*, stating the units of your answer. **(3)**

A second train, *Y*, leaves *A* at *T* minutes after noon and moves in the same direction as train *X* on a parallel straight horizontal track.
Train *Y* accelerates uniformly from rest for 2 minutes, reaching a speed of $24\,\text{m s}^{-1}$
Train *Y* then moves along the track at a constant speed of $24\,\text{m s}^{-1}$ and passes *C* at this speed.

Train *Y* passes *C* at the instant train *X* stops at *C*.

(b) Find the value of *T*. **(5)**

(c) State one assumption made in your working that could affect the accuracy of your answer to part (b).

(1)

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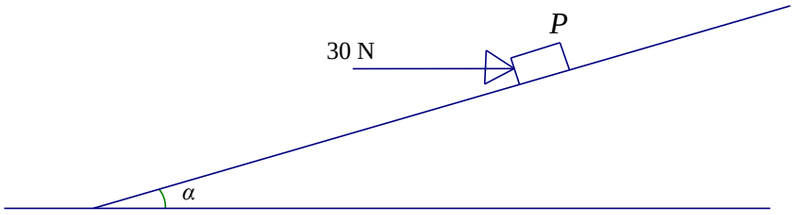

Figure 3

A package *P* of weight 20 N is moving up an inclined plane under the action of a horizontal force of magnitude 30 N, as shown in Figure 3.
The force is acting in a vertical plane through a line of greatest slope of the plane.
The coefficient of friction between *P* and the plane is μ

The plane is inclined at angle α to the horizontal, where $\tan\alpha = \frac{5}{12}$

Package *P* is modelled as a particle.

(a) Find the magnitude of the normal reaction of the plane on *P* **(2)**

(b) Find the range of possible values of μ **(4)**

The horizontal force is now removed and *P* continues to slide up the plane until *P* comes to instantaneous rest.

Package *P* then slides back down the plane.

Given that $\mu = \frac{1}{3}$

(c) find the acceleration of *P* as it slides down the plane. **(5)**

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5. A small ball is projected with speed u from a point O on horizontal ground.
The angle of projection is θ to the horizontal, where $0 < \theta < 90°$
The ball hits the ground at the point A.

The ball is modelled as a particle moving freely under gravity.

(a) Show that, according to the model, $OA = \dfrac{u^2 \sin 2\theta}{g}$ **(5)**

A golfer hits a golf ball with speed $25\,\text{m s}^{-1}$ from a point X on horizontal ground.
The golf ball hits the ground at the point Y.
The angle of projection is θ to the horizontal, where $0 < \theta < 90°$
The golfer requires the distance XY to be at least 40 m.

The golf ball is modelled as a particle moving freely under gravity.

(b) Find, according to the model, the size of the largest possible angle θ **(2)**

Given that $\theta = 30°$ and that the golf ball is more than 3 m above the ground for T seconds,

(c) find the value of T. **(4)**

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