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| **Pearson Edexcel Level 3** |
| **GCE Mathematics** **Advanced Subsidiary** **Paper 2: Statistics and Mechanics** |
| **Sample assessment material for first teaching September 2017** **Time: 1 hour 15 minutes** | **Paper Reference(s)** |
| **8MA0/02** |
| **You must have:** **Mathematical Formulae and Statistical Tables, calculator** |

**Candidates may use any calculator permitted by Pearson regulations. Calculators must not have the facility for algebraic manipulation, differentiation and integration, or 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.

• There are **two** sections in this question paper. Answer **all** the questions in Section A and **all** the questions in Section B.

• 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.

• There are 9 questions in this question paper. The total mark for this paper is 60.

• 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.

**SECTION A: STATISTICS**

**Answer ALL questions.**

**1.** Sara is investigating the variation in daily maximum gust, *t* kn, for Camborne in June and July 1987.

She used the large data set to select a sample of size 20 from the June and July data for 1987. Sara selected the first value using a random number from 1 to 4 and then selected every third value after that.

(*a*) State the sampling technique Sara used.

**(1)**

(*b*) From your knowledge of the large data set, explain why this process may not generate a sample of size 20.

**(1)**

The data Sara collected are summarised as follows

*n* = 20 ∑ *t* = 374 ∑ *t* 2 = 7600

(*c*) Calculate the standard deviation.

**(2)**

**(Total for Question 1 is 4 marks)**

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**2.** The partially completed histogram and the partially completed table show the time, to the nearest minute, that a random sample of motorists were delayed by roadworks on a stretch of motorway.

Frequency density

Time (minutes)



|  |  |
| --- | --- |
| **Delay (minutes)** | **Number of motorists** |
| 4 – 6 | 6 |
| 7 –8 |  |
| 9 | 17 |
| 10 – 12 | 45 |
| 13 – 15 | 9 |
| 16 – 20 |  |

 Estimate the percentage of these motorists who were delayed by the roadworks for between 8.5 and 13.5 minutes.

**(5)**

**(Total for Question 2 is 5 marks)**

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**3.** The Venn diagram shows the probabilities for students at a college taking part in various sports.

 *A* represents the event that a student takes part in Athletics.

 *T* represents the event that a student takes part in Tennis.

 *C* represents the event that a student takes part in Cricket.

 *p* and *q* are probabilities.

*A*

*T*

*q*

*p*

0.40

*p*

0.05

*C*

 The probability that a student selected at random takes part in Athletics or Tennis is 0.75.

(*a*) Find the value of *p*.

**(1)**

(*b*) State, giving a reason, whether or not the events *A* and *T* are statistically independent. Show your working clearly.

**(3)**

(*c*) Find the probability that a student selected at random does not take part in Athletics or Cricket.

**(1)**

**(Total for Question 3 is 5 marks)**

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**4.** Sara was studying the relationship between rainfall, r mm, and humidity, *h* %, in the UK. She takes a random sample of 11 days from May 1987 for Leuchars from the large data set.

 She obtained the following results.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *h* | 93 | 86 | 95 | 97 | 86 | 94 | 97 | 97 | 87 | 97 | 86 |
| *r* | 1.1 | 0.3 | 3.7 | 20.6 | 0 | 0 | 2.4 | 1.1 | 0.1 | 0.9 | 0.1 |

 Sara examined the rainfall figures and found

*Q*1 = 0.1 *Q*2 = 0.9 *Q*3 = 2.4

 A value that is more than 1.5 times the interquartile range (IQR) above *Q*3 is called an outlier.

(*a*) Show that *r* = 20.6 is an outlier.

**(1)**

(*b*) Give a reason why Sara might (i) include

 (ii) exclude

this day’s reading.

**(2)**

Sara decided to exclude this day’s reading and drew the following scatter diagram for the remaining 10 days’ values of *r* and *h*.

Rainfall (mm)

Humidity (%)

(*c*) Give an interpretation of the correlation between rainfall and humidity.

**(1)**

The equation of the regression line of *r* on *h* for these 10 days is *r* = −12.8 + 0.15*h*.

(*d*) Give an interpretation of the gradient of this regression line.

**(1)**

(*e*) (i) Comment on the suitability of Sara’s sampling method for this study.

(ii) Suggest how Sara could make better use of the large data set for her study.

**(2)**

**(Total for Question 4 is 7 marks)**

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**5.** The discrete random variable *X* ~ B(40, 0.27).

 (*a*) Find P(*X* ≥ 16).

**(2)**

Past records suggest that 30% of customers who buy baked beans from a large supermarket buy them in single tins. A new manager suspects that there has been a change in the proportion of customers who buy baked beans in single tins. A random sample of 20 customers who had bought baked beans was taken.

(*b*) Write down the hypotheses that should be used to test the manager’s suspicion.

**(1)**

(*c*) Using a 10% level of significance, find the critical region for a two-tailed test to answer the manager's suspicion. You should state the probability of rejection in each tail, which should be less than 0.05

**(3)**

(*d*) Find the actual significance level of a test based on your critical region from part (*c*).

**(1)**

One afternoon the manager observes that 12 of the 20 customers who bought baked beans, bought their beans in single tins.

(*e*) Comment on the manager’s suspicion in the light of this observation.

**(1)**

Later it was discovered that the local scout group visited the supermarket that afternoon to buy food for their camping trip.

(*f*) Comment on the validity of the model used to obtain the answer to part (*e*), giving a reason for your answer.

**(1)**

**(Total for Question 5 is 9 marks)**

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**TOTAL FOR SECTION A IS 30 MARKS**

**SECTION B: MECHANICS**

**Answer ALL questions.**

Unless otherwise indicated, whenever a numerical value of *g* is required, take *g* = 9.8 m s–2 and give your answer to either 2 significant figures or 3 significant figures.

**6.**

*v*

*T*

*U*

*O*

*t*

**Figure 1**

 A car moves along a straight horizontal road. At time *t* = 0, the velocity of the car is *U* m s–1. The car then accelerates with constant acceleration *a* m s–2 for *T* seconds. The car travels a distance *D* metres during these *T* seconds.

 Figure 1 shows the velocity-time graph for the motion of the car for 0 ≤ *t* ≤ *T*.

 Using the graph, show that *D* = *UT* + *aT* 2 .

 (No credit will be given for answers which use any of the kinematics (*suvat*) formulae listed under Mechanics in the AS Mathematics section of the formulae booklet.)

**(4)**

**(Total for Question 6 is 4 marks)**

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**7.** A car is moving along a straight horizontal road with constant acceleration. There are three points *A*, *B* and *C*, in that order, on the road, where *AB* = 22 m and *BC* = 104 m. The car takes 2 s to travel from *A* to *B* and 4 s to travel from *B* to *C*. Find

(i) the acceleration of the car,

(ii) the speed of the car at the instant it passes *A*.

**(7)**

**(Total for Question 7 is 7 marks)**

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**8.** A bird leaves its nest at time *t* = 0 for a short flight along a straight line.

 The bird then returns to its nest.

 The bird is modelled as a particle moving in a straight horizontal line.

 The distance, s metres, of the bird from its nest at time t seconds is given by

*s* = (*t* 4 – 20*t* 3 + 100*t* 2), where 0 ≤ *t* ≤ 10.

(*a*) Explain the restriction 0 ≤ *t* ≤ 10

**(3)**

(*b*) Find the distance of the bird from the nest when the bird first comes to instantaneous rest.

**(6)**

**(Total for Question 8 is 9 marks)**

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**9.**

*B* (1.5 kg)

*P*

1 m

*A* (2.5 kg)

**Figure 2**

A small ball *A* of mass 2.5 kg is held at rest on a rough horizontal table.

The ball is attached to one end of a string.

The string passes over a pulley *P* which is fixed at the edge of the table. The other end of the string is attached to a small ball *B* of mass 1.5 kg hanging freely, vertically below *P* and with *B* at a height of 1 m above the horizontal floor.

The system is released from rest, with the string taut, as shown in Figure 2.

The resistance to the motion of *A* from the rough table is modelled as having constant magnitude 12.7 N. Ball *B* reaches the floor before ball *A* reaches the pulley.

The balls are modelled as particles, the string is modelled as being light and inextensible and the pulley is modelled as being small and smooth.

(*a*) (i) Write down an equation of motion for *A*.

 (ii) Write down an equation of motion for *B*.

**(4)**

(*b*) Hence find the acceleration of *B*.

**(2)**

(*c*) Using the model, find the time it takes, from release, for *B* to reach the floor.

**(2)**

It was found that it actually took 2.3 seconds for ball *B* to reach the floor.

(*d*) Using this information,

 (i) comment on the appropriateness of using the model to find the time it takes ball *B* to reach the floor, justifying your answer.

 (ii) suggest one improvement that could be made in the model.

**(2)**

**(Total for Question 9 is 10 marks)**

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**TOTAL FOR SECTION B IS 30 MARKS**

**TOTAL FOR PAPER IS 60 MARKS**