Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | | | | | |

Candidate Number | | | | |

Mathematics

Advanced Subsidiary
Paper 2: Statistics and Mechanics

Wednesday 23 May 2018 – Morning
Time: 1 hour 15 minutes

Paper Reference
8MA0/02

You must have:
Mathematical Formulae and Statistical Tables, calculator

Total Marks

Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. Calculators must not have the facility for symbolic algebra 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.
- 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.

Turn over ▶

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P 5 8 3 4 7 A 0 1 2 8

Pearson

SECTION A: STATISTICS

Answer ALL questions. Write your answers in the spaces provided.

1. A company is introducing a job evaluation scheme. Points (x) will be awarded to each job based on the qualifications and skills needed and the level of responsibility. Pay (£y) will then be allocated to each job according to the number of points awarded.

Before the scheme is introduced, a random sample of 8 employees was taken and the linear regression equation of pay on points was $y = 4.5x - 47$

(a) Describe the correlation between points and pay.

(1)

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

(1)

(c) Explain why this model might not be appropriate for all jobs in the company.

(1)

1a) positive correlation - as points increase pay increases

b) For every additional point pay increases by £4.50

c) For points of 10 or less there would be a negative pay.
or we don't know the range of the sample and extrapolating is unreliable.

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2. A factory buys 10% of its components from supplier *A*, 30% from supplier *B* and the rest from supplier *C*. It is known that 6% of the components it buys are faulty.

Of the components bought from supplier *A*, 9% are faulty and of the components bought from supplier *B*, 3% are faulty.

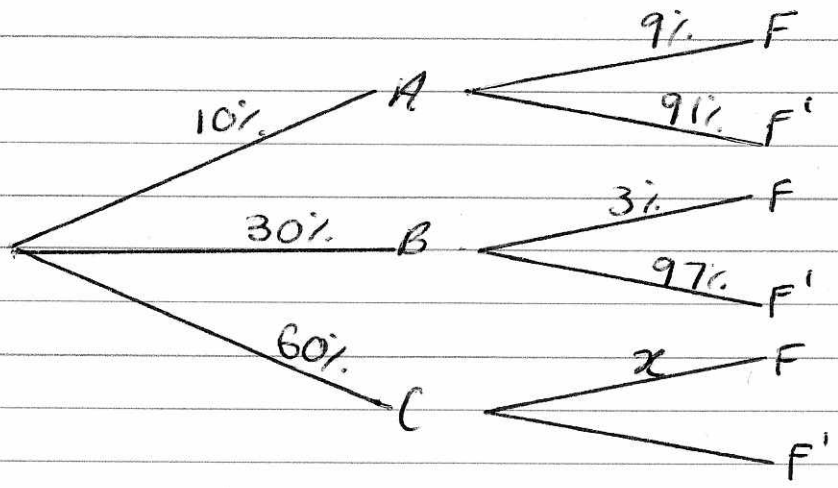
(a) Find the percentage of components bought from supplier *C* that are faulty.

(3)

A component is selected at random.

(b) Explain why the event "the component was bought from supplier *B*" is not statistically independent from the event "the component is faulty".

(1)



$0.1 \times 0.09 + 0.3 \times 0.03 + 0.6 \times x = 0.06$

$0.018 + 0.6x = 0.06$

$0.6x = 0.042$

$x = 0.07$

7%

b/ The probability of the component being faulty is different for each supplier.

If independent $P(A) \times P(B) = P(A \cap B)$

$P(\text{Supplier B}) \times P(\text{Faulty}) = P(\text{B and Faulty})$

$0.3 \times 0.06 = 0.3 \times 0.03$

$0.018 \neq 0.009$ ∴ Not independent.

3. Naasir is playing a game with two friends. The game is designed to be a game of chance so that the probability of Naasir winning each game is $\frac{1}{3}$

Naasir and his friends play the game 15 times.

(a) Find the probability that Naasir wins

(i) exactly 2 games,

(ii) more than 5 games.

(3)

Naasir claims he has a method to help him win more than $\frac{1}{3}$ of the games. To test this claim, the three of them played the game again 32 times and Naasir won 16 of these games.

(b) Stating your hypotheses clearly, test Naasir's claim at the 5% level of significance.

(4)

$N \sim B(15, \frac{1}{3})$

a i/ $x = 2$ Binomial PD

$N = 15$

$p = \cancel{0.3}\ \frac{1}{3}$

$P = 0.059946029 34$

ii $P(X > 5) = 1 - P(X \leq 5)$

Binomial CD $x = 5$

$N = 15$

$p = \frac{1}{3}$

$1 - 0.6183718414$

$= 0.3816281586$

b/ $H_0 : p = \frac{1}{3}$

$H_1 : p > \frac{1}{3}$

Question 3 continued

$P(X \geqslant 16) = 1 - P(X \leqslant 15)$

Binomial CD $x = 15$

$n = 32$

$p = \frac{1}{3}$

$P(X \leqslant 15) = 0.9623466642$

$P(X \geqslant 16) = 1 - Ans$

$= 0.03765333576$

$0.03765 < 0.05$ ∴ the result is significant and there is evidence at the 5% level of significance that $p > \frac{1}{3}$.

4. Helen is studying the daily mean wind speed for Camborne using the large data set from 1987. The data for one month are summarised in Table 1 below.

Windspeed	n/a	6	7	8	9	11	12	13	14	16
Frequency	13	2	3	2	2	3	1	2	1	2

Table 1

(a) Calculate the mean for these data.

(1)

(b) Calculate the standard deviation for these data and state the units.

(2)

The means and standard deviations of the daily mean wind speed for the other months from the large data set for Camborne in 1987 are given in Table 2 below. The data are not in month order.

Month	*A*	*B*	*C*	*D*	*E*
Mean	7.58	8.26	8.57	8.57	11.57
Standard Deviation	2.93	3.89	3.46	3.87	4.64

Table 2

(c) Using your knowledge of the large data set, suggest, giving a reason, which month had a mean of 11.57

(2)

The data for these months are summarised in the box plots on the opposite page.
They are not in month order or the same order as in Table 2.

(d) (i) State the meaning of the * symbol on some of the box plots.

(ii) Suggest, giving your reasons, which of the months in Table 2 is most likely to be summarised in the box plot marked *Y*.

(3)

a/ $\frac{6\times2 + 7\times3 + 8\times2 + 9\times2 + 11\times3 + 12\times1 + 13\times2 + 14\times1 + 16\times2}{18}$

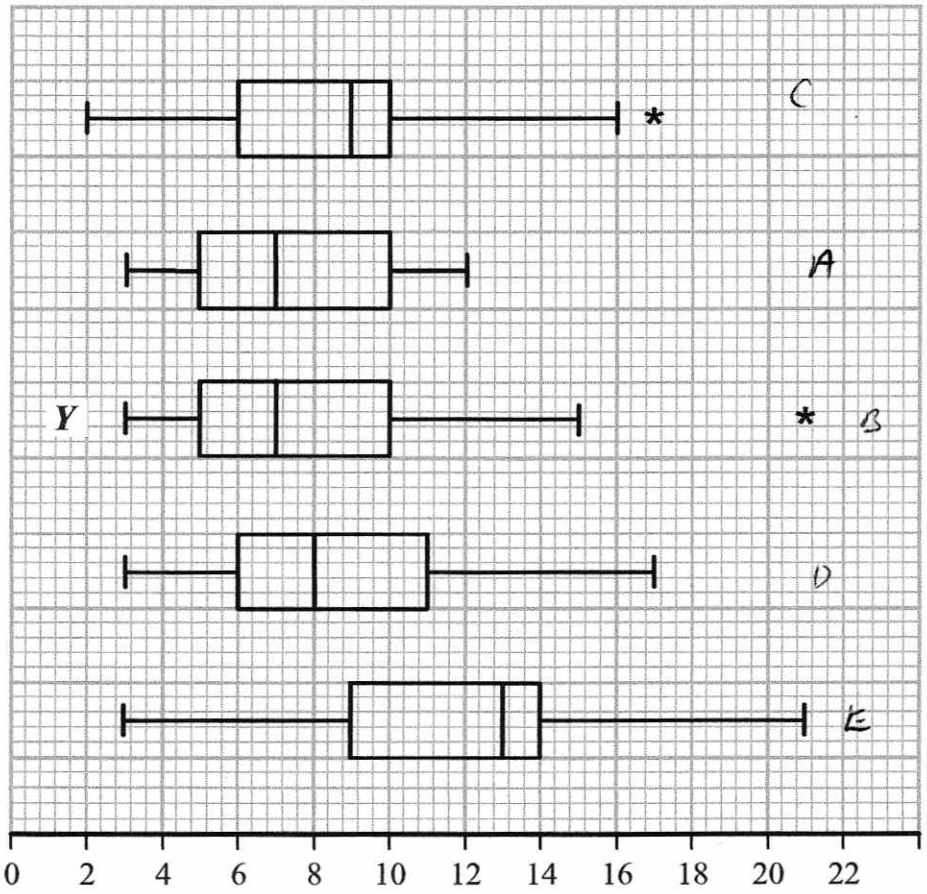
$= \frac{92}{9} = 10.\dot{2}$

b/ $\Sigma fx^2 = 6^2\times2 + 7^2\times3 + 8^2\times2 + 9^2\times2 + 11^2\times3 + 12^2\times1 + 13^2\times2 + 14^2\times1 + 16^2\times2$

$= 2062$

$\sigma = \sqrt{\frac{2062}{18} - (10.\dot{2})^2} = 3.172022761$ knots

Question 4 continued



c) October because it is windier in autumn.

d) i) outliers.

ii) Y has the joint lowest median so it will have one of the lower means.
- bigger ~~range~~ highest value than other lowest so not 7.58(A)
Y has one of the larger IQR's - it should have a larger s.d than the top two box plots.

B

(Total for Question 4 is 8 marks)

5. A biased spinner can only land on one of the numbers 1, 2, 3 or 4. The random variable X represents the number that the spinner lands on after a single spin and $P(X = r) = P(X = r + 2)$ for $r = 1, 2$

Given that $P(X = 2) = 0.35$

(a) find the complete probability distribution of X.

(2)

Ambroh spins the spinner 60 times.

(b) Find the probability that more than half of the spins land on the number 4
Give your answer to 3 significant figures.

(3)

The random variable $Y = \frac{12}{X}$

(c) Find $P(Y - X \leqslant 4)$

(3)

a/

x	1	2	3	4
$P(X=x)$	0.15	0.35	0.15	0.35

b/

$$P(X > 30) = 1 - P(X \leqslant 30)$$

Binomial CD

$x = 30$
$N = 60$
$p = 0.35$

$P(X \leqslant 30) = 0.994\,110\,1019$

$P(X > 30) = 1 - \text{Ans}$
$= 0.005\,889\,898\,1015$

c/

x	1	2	3	4
y	12	6	4	3
$y - x$	11	4	1	−1
$P(X=x)$	0.15	0.35	0.15	0.35

$P(y - x) \leqslant 4 = 0.35 + 0.15 + 0.35 = \underline{0.85}$

SECTION B: MECHANICS

Unless otherwise indicated, wherever a numerical 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.

Answer ALL questions. Write your answers in the spaces provided.

6. A man throws a tennis ball into the air so that, at the instant when the ball leaves his hand, the ball is 2 m above the ground and is moving vertically upwards with speed $9\,\text{m s}^{-1}$

The motion of the ball is modelled as that of a particle moving freely under gravity and the acceleration due to gravity is modelled as being of constant magnitude $10\,\text{m s}^{-2}$

The ball hits the ground T seconds after leaving the man's hand.

Using the model, find the value of T.

(4)

$s = -2$

$u = 9$

v

$a = -10$

$t = T$

$s = ut + \frac{1}{2}at^2$

$-2 = 9T + \frac{1}{2}(-10)T^2$

$-2 = 9T - 5T^2$

$0 = 5T^2 - 9T - 2$

$0 = (5T + 1)(T - 2)$

$T = -\frac{1}{5} \quad T = 2$

T cannot be negative $\therefore$ $T = 2$

7. A train travels along a straight horizontal track between two stations, A and B.

In a model of the motion, the train starts from rest at A and moves with constant acceleration $0.3\,\text{m s}^{-2}$ for 80 s.
The train then moves at constant velocity before it moves with a constant deceleration of $0.5\,\text{m s}^{-2}$, coming to rest at B.

(a) For this model of the motion of the train between A and B,

(i) state the value of the constant velocity of the train,

(ii) state the time for which the train is decelerating,

(iii) sketch a velocity-time graph.

(3)

The total distance between the two stations is 4800 m.

(b) Using the model, find the total time taken by the train to travel from A to B.

(3)

(c) Suggest one improvement that could be made to the model of the motion of the train from A to B in order to make the model more realistic.

(1)

a i/ $v = u + at$

$v = 0 + 0.3 \cdot 80$

$= 24\ \text{ms}^{-1}$

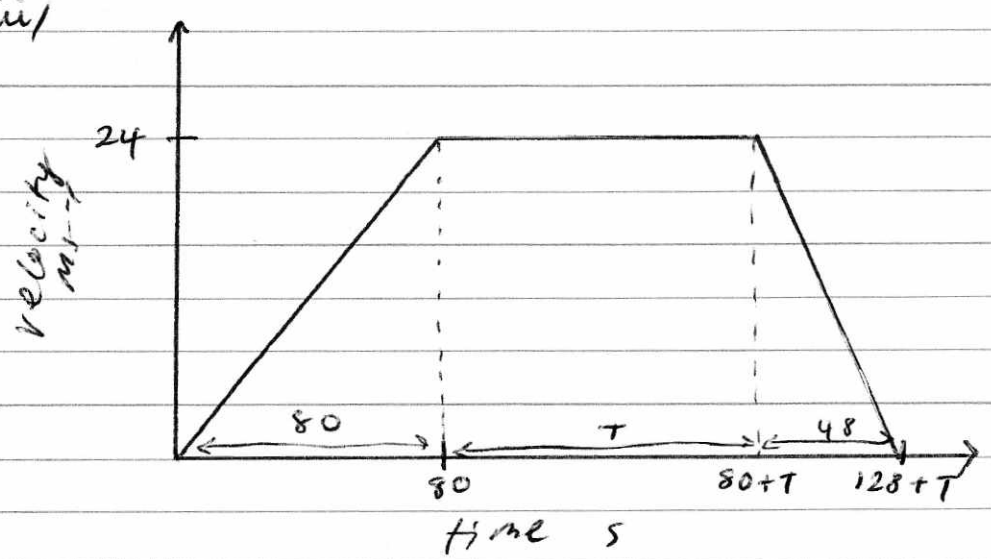
ii/ $v = u + at$

$0 = 24 + -0.5t$

$-24 = -0.5t$

$t = 48$ seconds

iii/



Question 7 continued

Distance = Area under graph.

$$4800 = \frac{128 + T + T}{2} \times 24$$

$$4800 = (64 + T)\,24$$

$$200 = 64 + T$$

$$T = 136$$

Total time = 136 + 80 + 48

= 264 seconds

c/ The acceleration / deceleration could be changed to a variable rate.

or// there could be a smooth change from acceleration to constant velocity.

8. A particle, P, moves along the x-axis. At time t seconds, $t \geqslant 0$, the displacement, x metres, of P from the origin O, is given by $x = \frac{1}{2}t^2(t^2 - 2t + 1)$

(a) Find the times when P is instantaneously at rest.

(5)

(b) Find the total distance travelled by P in the time interval $0 \leqslant t \leqslant 2$

(3)

(c) Show that P will never move along the negative x-axis.

(2)

a/ $x = \frac{1}{2}t^4 - t^3 + \frac{1}{2}t^2$

$v = 2t^3 - 3t^2 + t$

instantaneous rest when $v = 0$

$2t^3 - 3t^2 + t = 0$

$t(2t^2 - 3t + 1) = 0$

$t(2t - 1)(t - 1) = 0$

$t = 0 \quad t = \frac{1}{2} \quad t = 1$

b/ when $t = 0 \quad x = 0$

$t = \frac{1}{2} \quad x = \frac{1}{2}\left(\frac{1}{2}\right)^2\left(\left(\frac{1}{2}\right)^2 - 2\left(\frac{1}{2}\right) + 1\right)$

$= \frac{1}{32}$

$t = 1 \quad x = \frac{1}{2}(1)^2((1)^2 - 2(1) + 1)$

$= 0$

$t = 2 \quad x = \frac{1}{2}(2)^2((2)^2 - 2(2) + 1)$

$= 2$

Question 8 continued

Total distance $= \frac{1}{32} + \frac{1}{32} + 2$

$= \frac{33}{16}$ m

c/ x can not be negative

$x = \frac{1}{2}t^2(t^2 - 2t + 1)$

$= \frac{1}{2}t^2(t-1)(t-1)$

$= \frac{1}{2}t^2(t-1)^2$

t^2 is squared so always positive

$(t-1)^2$ is squared so always positive

$\frac{1}{2}$ is positive

positive × positive × positive = positive.

9.

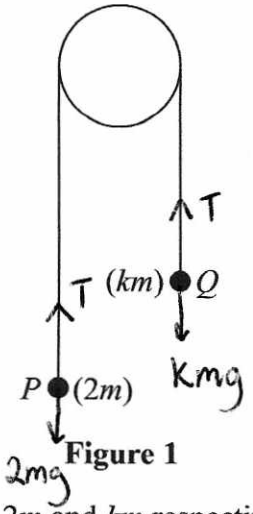


Figure 1

Two small balls, P and Q, have masses $2m$ and km respectively, where $k < 2$.
The balls are attached to the ends of a string that passes over a fixed pulley.
The system is held at rest with the string taut and the hanging parts of the string vertical, as shown in Figure 1.

The system is released from rest and, in the subsequent motion, P moves downwards with an acceleration of magnitude $\frac{5g}{7}$

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

Using the model,

(a) find, in terms of m and g, the tension in the string,

(3)

(b) explain why the acceleration of Q also has magnitude $\frac{5g}{7}$

(1)

(c) find the value of k.

(4)

(d) Identify one limitation of the model that will affect the accuracy of your answer to part (c).

(1)

a/ P: $F = ma$

$2mg - T = 2m\left(\frac{5g}{7}\right)$

$2mg - \frac{10}{7}mg = T$

$T = \frac{4}{7}mg$

Question 9 continued

b/ The string is modelled as inextensible.

c/ Q: $F = ma$

$$T - kmg = km a$$

$$\frac{4}{7}mg - kmg = km\left(\frac{5g}{7}\right)$$

$$mg\left(\frac{4}{7} - k\right) = mg\left(k \cdot \frac{5}{7}\right)$$

$$\frac{4}{7} = \frac{12}{7}k$$

$$k = \frac{4}{12}$$

$$= \frac{1}{3}$$

d/ Any one of: pulley may not be smooth
pulley may not be light
particles may experience air resistance.
balls may not be particles
string may not be light
string may not be inextensible

(Total for Question 9 is 9 marks)

TOTAL FOR SECTION B IS 30 MARKS
TOTAL FOR PAPER IS 60 MARKS