**Answer ALL the questions.**

**Write your answers in the spaces provided.**

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## SECTION A: STATISTICS

**1** Tanya is investigating the daily mean windspeeds in Leeming.

The grouped frequency table below summarises the daily mean windspeeds in Leeming from 22nd September to 31st October 1987.

| Windspeed (nearest kn) | Frequency |
|---|---|
| 0 – 4 | 17 |
| 5 – 8 | 14 |
| 9 – 12 | 7 |
| 13 – 18 | 2 |

**a)** Tanya says that the class width of the 5 – 8 category is 3 kn.
Explain why she is not correct.

**(1)**

**b)** Use the data to estimate the lower quartile ($Q_1$), upper quartile ($Q_3$) and interquartile range (IQR) for the daily mean windspeeds over this period.

**(4)**





*Leave blank*

**c)** Tanya considers any value outside the boundaries below to be an outlier:

Lower boundary = $Q_1 - (1.5 \times IQR)$ Upper boundary = $Q_3 + (1.5 \times IQR)$

Given that the lowest value in the data is 1 kn and the highest value is 18 kn, use these boundaries to determine whether either of these values are outliers.

**(2)**

**d)** Tanya uses her calculator to estimate the mean of the data.

Explain whether you think the mean or the median would be the better average to use to represent the data.

**(1)**

**e)** Rezan is investigating the daily mean windspeeds for Leuchars over the same period. He calculates the mean of his data, and compares it to the mean of Tanya's data.

The mean of Rezan's data is significantly higher than that of Tanya's data.
Rezan claims that this suggests that Scotland is generally windier than England.

Give two criticisms of Rezan's conclusion.

**(2)**

**2** A teacher surveys 100 students to find out whether they like watching reality TV, soaps and talent shows. The results are summarised below:

- 13 only like watching reality TV.
- 26 like watching soaps and reality TV.
- 40 like watching soaps.
- 17 do not like watching any of the shows.
- 11 enjoy just reality TV and talent shows.
- 5 enjoy just soaps and talent shows.
- 4 like just soaps and reality TV.

*Leave blank*

**a)** Draw a Venn diagram to show the number of elements in $R$, $S$ and $T$, where $R$ is {students that like reality TV}, $S$ is {students that like soaps}, and $T$ is {students that like talent shows}. **(4)**

**b)** A student is picked at random from the 100 students surveyed.

**i)** What is the probability that this student likes at least one of the three types of shows? **(2)**





**ii)** Given that the student likes soaps, what is the probability that they like talent shows? **(2)**

*Leave blank*

**iii)** Given that the student likes talent shows, what is the probability that they like reality TV but not soaps? **(2)**

**c)** The teacher says, "the probability that a student enjoys talent shows is not affected by whether or not they enjoy soaps."

Do the results of the survey support this claim? Show your working. **(3)**

**3** The scatter graph in Figure 1 shows the mean temperature ($T$ °C) and the maximum relative humidity ($H$%) for 10 days in Heathrow in 1987.

*Leave blank*

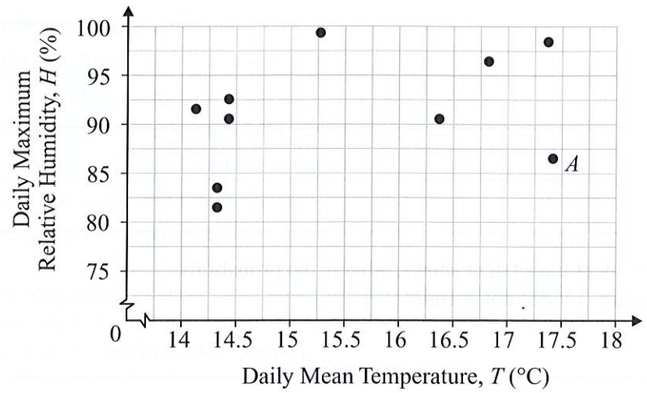


**Figure 1**

**a)** Describe the correlation shown in the scatter graph. **(1)**

**b)** The product moment correlation coefficient, $r$, is calculated to be 0.3850, correct to 4 d.p. Stating your hypotheses clearly, perform a hypothesis test at the 10% significance level to test whether the product moment correlation coefficient between daily mean temperature and daily maximum relative humidity in Heathrow in 1987 is non-zero. **(3)**

**c)** The point labelled $A$ is removed from the sample. What effect this will have on the value of $r$? **(1)**




**4** A confectionery company offers a prize to anyone who finds a gold-wrapped sweet in a packet of their boiled sweets. The company say that they have randomly selected 9 out of every 20 packets of sweets, and hidden one gold-wrapped sweet in each.

*Leave blank*

**a)** Veronica buys 50 packets of these sweets. $G$ is the number of gold-wrapped sweets in the 50 packets that she has bought. Give one way in which $G$ meets the conditions for following a binomial distribution and state the parameters of the distribution. **(2)**

After opening all 50 packets, Veronica finds that only 16 of them contained a gold-wrapped sweet. She claims that the confectionery company has lied, and that they must have put gold-wrapped sweets into fewer packets than they said.

**b)** Carry out a hypothesis test at the 5% significance level to determine whether Veronica's findings provide statistically significant evidence that her claim is true. State your hypotheses clearly. **(4)**

**5** It is known that 3% of the UK's population carry a certain disease. A test for the disease is available which always gives either a positive or a negative result. Given that the individual carries the disease, there is a 98% chance that the test will give a positive result. Given that the individual does not carry the disease, there is a 95% chance that the test will give a negative result.

*Leave blank*

**a) i)** Joey takes the test and gets a positive result.
Find the probability that he carries the disease. **(4)**

**ii)** State an assumption that you have made. **(1)**

**b)** Hiroshi claims that the test will give the correct result (98% + 95%) ÷ 2 = 96.5% of the time.
Is he correct? Show working to support your answer. **(2)**

**c)** Joey and Hiroshi disagree about whether the test is effective. By considering your answers to parts a) and b), explain whether you think this is a good test to see if people carry the disease. **(1)**




**6** A factory manufactures pencils and the plastic boxes that they are stored in. The lengths of the pencils made in the factory are normally distributed with mean 18 cm and standard deviation 0.1 cm.

*Leave blank*

The plastic boxes used to store the pencils are 18.2 cm long. 5 random pencils are put into each box. If any of the pencils do not fit in the box, the box will be damaged.

**a)** Find the probability that a box will be damaged.
You may assume that the sides of the box have negligible thickness. **(4)**

**b)** The factory produces 1000 boxes of pencils each day. Using a normal approximation, estimate the probability that more than 125 boxes will be damaged in a single day. **(4)**

## SECTION B: MECHANICS

*Leave blank*

*[Unless otherwise indicated, give your answers to either 2 or 3 significant figures, and take $g = 9.8\ ms^{-2}$.]*

**7** A non-uniform plank, *AB,* of length 4 m and weight $W$ N is modelled as a rigid rod. It rests on a support at its midpoint. A child (modelled as a particle) whose weight is $\frac{5}{8}$ the weight of the plank, sits at a point 1 m from $B$, as shown in Figure 2.

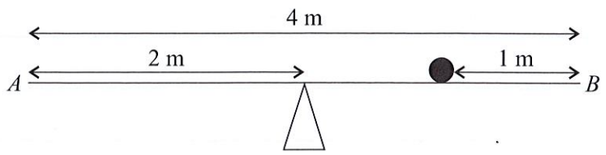


**Figure 2**

Given that the plank is in equilibrium, find:

**a)** the magnitude of the reaction force from the support, $R$, in terms of $W$, **(2)**

**b)** the distance of the plank's centre of mass from $A$. **(3)**





**8** *[In this question,* **i** *and* **j** *are horizontal unit vectors in the East and North directions respectively.]*

*Leave blank*

A large park area is used for leisure activities. At $t = 0$ seconds, a skateboarder sets off from the origin with constant velocity $(1.5\mathbf{i} - 2\mathbf{j})\ ms^{-1}$.

**a)** Find the skateboarder's position vector, relative to the origin, after 7 seconds. **(2)**

**b)** After 7 seconds, the skateboarder continues to move at the same velocity and a cyclist sets off from point $A$ with initial velocity $(-4.5\mathbf{i} + 6\mathbf{j})\ ms^{-1}$ and constant acceleration $(-0.3\mathbf{i} + 0.4\mathbf{j})\ ms^{-2}$. The two continue to move in this way and collide 6 seconds later.

Find the position vector, relative to the origin, of:

**i)** the point where they collide, **(2)**

**ii)** point $A$. **(3)**

**9** *[In this question, give your answers to 2 significant figures.]*

*Leave blank*

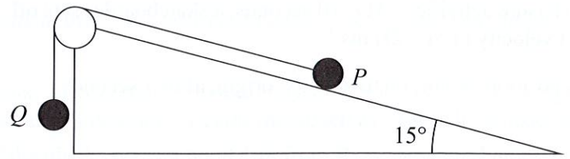


**Figure 3**

Figure 3 shows two particles, $P$ and $Q$, of mass 2 kg and 4 kg respectively. The particles are connected by a light, inextensible string which passes over a smooth pulley at the top of the plane. The section of the string which connects $P$ to the pulley is parallel to the line of greatest slope of the plane. The plane is smooth and inclined at 15° to the horizontal.

Particle $P$ is initially held at rest while particle $Q$ hangs freely. Particle $P$ is then released.

**a)** Find the magnitude of the acceleration of the system. **(5)**

**b)** The tension in the string exerts a force, $F$, on the pulley.
Find the magnitude of the vertical component of $F$. **(3)**





**10** A particle moves with velocity $\mathbf{v} = \begin{pmatrix} 5t - 6t^2 \\ 6 - t^3 \end{pmatrix}$ ms$^{-1}$, where $t$ is the time, given in seconds.
When $t = 0$, the position vector of the particle relative to the origin, is $\begin{pmatrix} 6 \\ 2 \end{pmatrix}$ m.

*Leave blank*

**a)** Find the position vector of the particle after 3 seconds. **(4)**

**b)** Find the magnitude of the acceleration of the particle when $t = 1$ second. **(4)**

**c)** Given that the particle has a mass of 5 kg, find the value of $k$ when the resultant force on the particle is equal to $\begin{pmatrix} -20 \\ k \end{pmatrix}$ N. **(3)**

**11** A bullet is fired upwards, at an angle of $\theta°$ with the horizontal, from a height of 3.5 m above the horizontal ground. The initial speed of the bullet is 203 $ms^{-1}$ and it hits the ground after 5 seconds.

*Leave blank*

**a)** By modelling the bullet as a particle moving freely under gravity, find $\theta$. **(3)**

**b)** Find the angle between the horizontal and the direction of the bullet's motion as it hits the ground. **(4)**

**c)** After how many seconds was the bullet travelling at its minimum speed? **(2)**





**12** A particle with mass 2 kg is held at rest on a rough sloping plane.
The angle between the line of greatest slope of the plane and the horizontal is 20°.
When released, the particle moves down the plane with an acceleration of $0.15g$ $ms^{-2}$.

*Leave blank*

**a)** Find the coefficient of friction, $\mu$, between the particle and the plane, giving your answer correct to 2 d.p. **(6)**

**b)** The plane is then adjusted so that the angle between its line of greatest slope and the horizontal is $\theta°$. When the particle is released, it remains in equilibrium. Find the range of possible values of $\theta$. **(4)**

**END OF QUESTIONS**