Full marks are not necessarily awarded for a correct answer with no working. Answers must be supported by working and/or explanations. In particular, solutions found from a graphic display calculator should be supported by suitable working, for example if graphs are used to find a solution, you should sketch these as part of your answer. Where an answer is incorrect, some marks may be given for a correct method, provided this is shown by written working. You are therefore advised to show all working.

SECTION A

*Answer **all** questions in the boxes provided. Working may be continued below the lines if necessary.*

1. *[Maximum mark: 6]*

The following diagram shows triangle ABC.

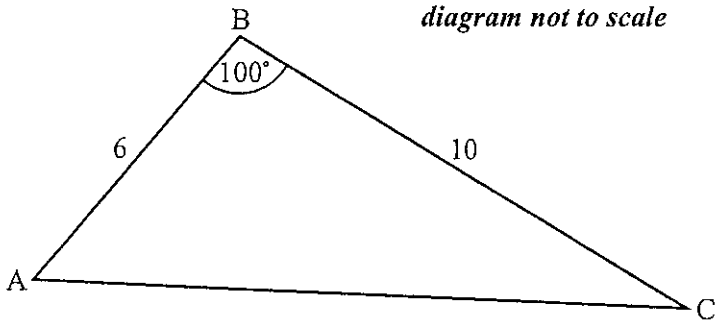


diagram not to scale

AB = 6 cm, BC = 10 cm, and $A\hat{B}C = 100°$.

(a) Find AC. *[3]*

(b) Find $B\hat{C}A$. *[3]*

(a) $(AC)^2 = (AB)^2 + (BC)^2 - 2(AB)(BC)\cos 100°$

$(AC)^2 = 6^2 + 10^2 - 2(6)(10)\cos 100°$

$(AC)^2 = 156.8377813$

$(AC) = 12.5$

* DEGREE MODE

(b) $\frac{\sin(B\hat{C}A)}{6} = \frac{\sin(100°)}{AC}$

$B\hat{C}A = 28.2°$

2. *[Maximum mark: 5]*

Consider the expansion of $(x+3)^{10}$.

(a) Write down the number of terms in this expansion. *[1]*

(b) Find the term containing x^3. *[4]*

(a) 11 TERMS

(b) $\binom{n}{r} a^{n-r} b^{r}$

$\binom{10}{7} x^{3} 3^{7}$ ← ON THE CALCULATOR

1) PRESS MATH

2) MOVE OVER TO "PROB"

3) CHOOSE nCr

4) $10 C_7$

$10 C_7 = 120$

↑

THIS IS THE COEFFICIENT

$\therefore 120 x^3 (3^7)$

$26\,2440 x^3$

3. *[Maximum mark: 7]*

The following table shows the average weights (y kg) for given heights (x cm) in a population of men.

Heights (x cm)	165	170	175	180	185
Weights (y kg)	67.8	70.0	72.7	75.5	77.2

(a) The relationship between the variables is modelled by the regression equation $y = ax + b$.

(i) Write down the value of a and of b.

(ii) Hence, estimate the weight of a man whose height is 172 cm. *[4]*

(b) (i) Write down the correlation coefficient.

(ii) State which **two** of the following describe the correlation between the variables. *[3]*

strong	zero	positive
negative	no correlation	weak

(a)(i) $a = 0.486$, $b = -12.41$

(ii) $y = 0.486x - 12.41$

$y = 0.486(172) - 12.41$

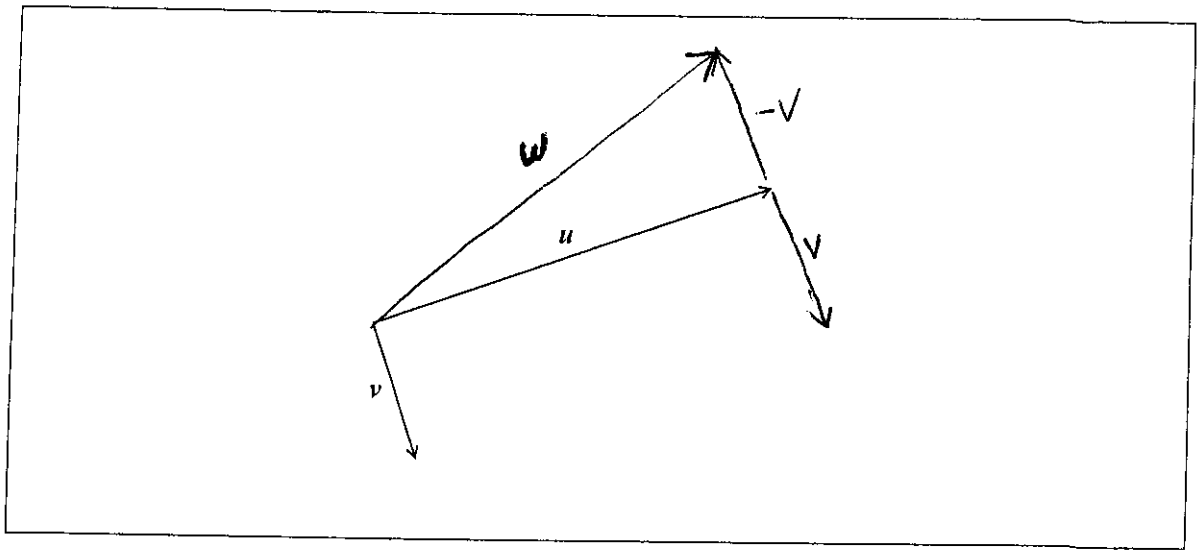
71.2 kg

(b) (i) $r = 0.997$

(ii) STRONG POSITIVE

4. *[Maximum mark: 6]*

The following diagram shows two perpendicular vectors $\boldsymbol{u}$ and $\boldsymbol{v}$.



(a) Let $\boldsymbol{w} = \boldsymbol{u} - \boldsymbol{v}$. Represent $\boldsymbol{w}$ on the diagram above. *[2]*

(b) Given that $\boldsymbol{u} = \begin{pmatrix} 3 \\ 2 \\ 1 \end{pmatrix}$ and $\boldsymbol{v} = \begin{pmatrix} 5 \\ n \\ 3 \end{pmatrix}$, where $n \in \mathbb{Z}$, find n. *[4]*

(b) $\begin{pmatrix} 3 \\ 2 \\ 1 \end{pmatrix} \cdot \begin{pmatrix} 5 \\ n \\ 3 \end{pmatrix} = 0$

$3(5) + 2n + 1(3) = 0$

$18 + 2n = 0$

$2n = -18$

$n = -9$

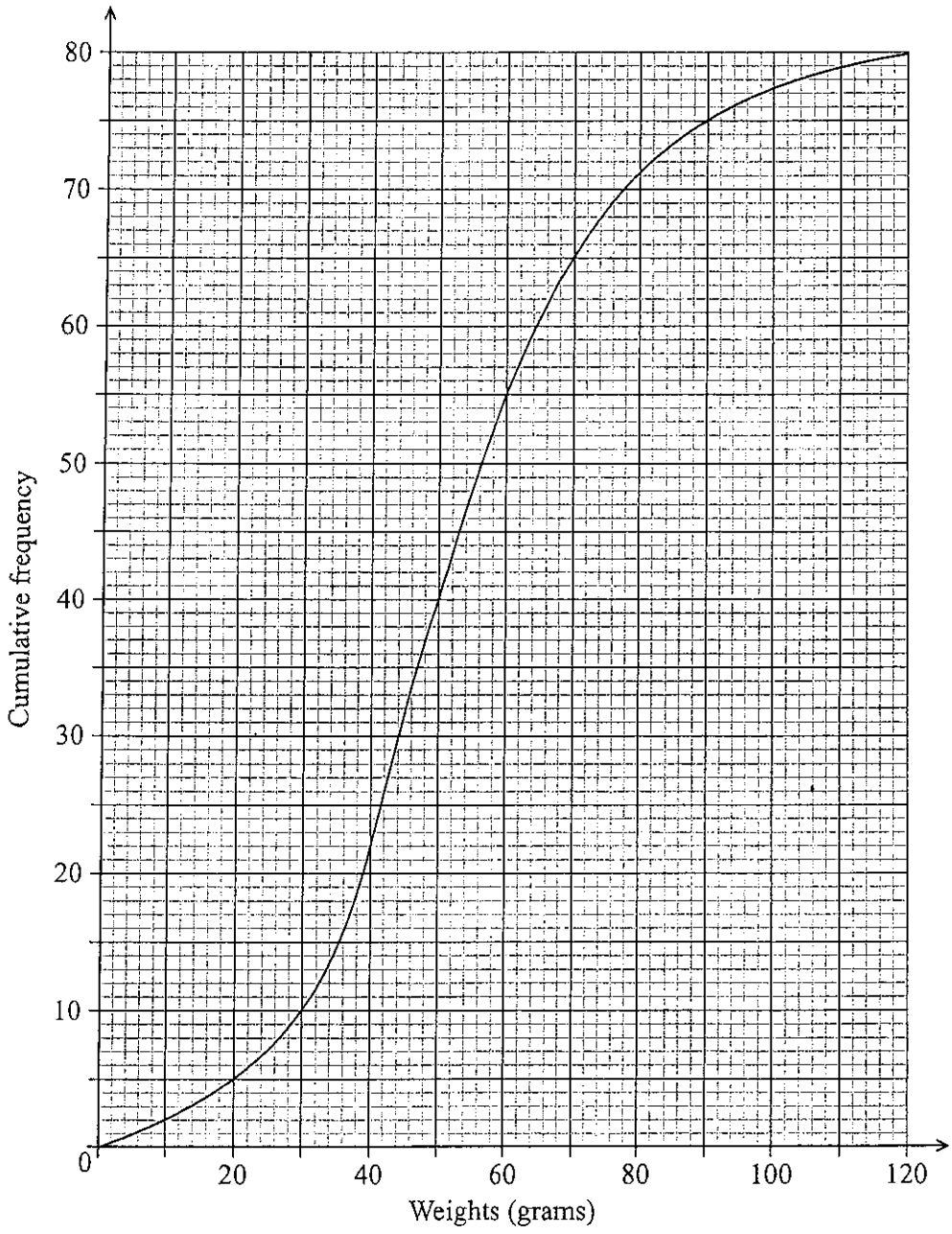
*Do **NOT** write solutions on this page.*

SECTION B

*Answer **all** questions in the answer booklet provided. Please start each question on a new page.*

8. *[Maximum mark: 16]*

The weights in grams of 80 rats are shown in the following cumulative frequency diagram.



(This question continues on the following page)

*Do **NOT** write solutions on this page.*

(Question 8 continued)

(a) (i) Write down the median weight of the rats. 50 g

(ii) Find the percentage of rats that weigh 70 grams or less. $\frac{65}{80} = 0.813$ or 81.3% *[4]*

The same data is presented in the following table.

Weights w grams	$0 \leq w \leq 30$	$30 < w \leq 60$	$60 < w \leq 90$	$90 < w \leq 120$
Frequency	p	45	q	5

(b) (i) Write down the value of p. $p = 10$

(ii) Find the value of q. $q = 20$ *[4]*

(c) Use the values from the table to estimate the mean and standard deviation of the weights. *[3]*

Assume that the weights of these rats are normally distributed with the mean and standard deviation estimated in part (c).

(d) Find the percentage of rats that weigh 70 grams or less. *[2]*

(e) A sample of five rats is chosen at random. Find the probability that at most three rats weigh 70 grams or less. *[3]*

(c)

WEIGHT	15	45	75	105
FREQ	10	45	20	5

MEAN $(\bar{x}) = 52.5$

S.D. $(\sigma x) = 22.5$

(d) normalcdf(-1e99, 70, 52.5, 22.5)

0.782 or 78.2%

(e) binomcdf(5, .7816, 3)

0.301

10. *[Maximum mark: 14]*

Let $f(x) = \frac{3x}{x-q}$, where $x \neq q$.

(a) Write down the equations of the vertical and horizontal asymptotes of the graph of f. *[2]*

$x = q \quad y = 3$

The vertical and horizontal asymptotes to the graph of f intersect at the point $Q(1, 3)$.

(b) Find the value of q. *[2]*

$q = 1$

(c) The point $P(x, y)$ lies on the graph of f. Show that $PQ = \sqrt{(x-1)^2 + \left(\frac{3}{x-1}\right)^2}$. *[4]*

(d) Hence find the coordinates of the points on the graph of f that are closest to $(1, 3)$. *[6]*

(c) $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

$\sqrt{(x-1)^2 + (y-3)^2}$

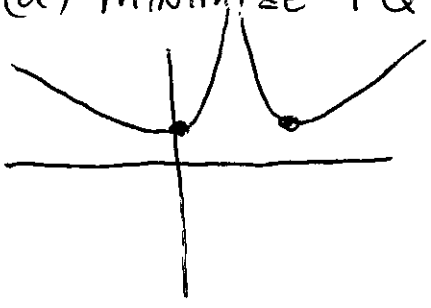
$\sqrt{(x-1)^2 + \left(\frac{3x}{x-1} - 3\right)^2}$

$\sqrt{(x-1)^2 + \left(\frac{3x - 3(x-1)}{x-1}\right)^2}$

$\sqrt{(x-1)^2 + \left(\frac{3x-3x+3}{x-1}\right)^2}$

$PQ = \sqrt{(x-1)^2 + \left(\frac{3}{x-1}\right)^2}$

(d) MINIMIZE PQ



$(-0.732, 2.449)$

$(2.732, 2.449)$