Maths content in other A-levels

Exemplar questions

Version 1.0 – last updated 07/01/2016

General comments

- The Level 3 Certificate in Mathematical Studies (1350) covers a wide breadth of content, developing students' mathematical skills in a wide range of contexts. This in turn supports learning in other A-level subjects.
- This resource is designed to introduce you to some of the differing exam-based contexts you could face in this qualification.
- These questions (and accompanying mark schemes) have been written by subject experts in their respective fields, each providing a unique contextual setting for the specification content of the Level 3 Certificate in Mathematical Studies.
- Where figures appear in questions, these are labeled consecutively by subject, not throughout the document.
- The subjects covered are A-level **Chemistry (7405)**, **Physics (7408)**, **Biology (7402)**, **Psychology (7182)**, **Geography (7037)**, **Business Studies (7132)** and **Computer Science (7517)**.
- In the mark schemes, specification references are given to show how each question's content maps across between the Level 3 Certificate in Mathematical Studies and the relevant subject. Mathematical Studies specification references are given in **black**. The specification references for the matching A-level subject (e.g. Chemistry) are given in **red**.
- If other A-level subjects with a significant mathematical element are accredited, then we will aim to update this document with exemplar questions from that subject.

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Chemistry

1 A scientist was investigating the use of hydrogen gas as a possible clean fuel for use in cars.

One method of producing hydrogen is by reacting magnesium with hydrochloric acid. This reaction releases hydrogen gas according to the equation:

$$Mg_{(s)} + HCL_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$$

Several experiments were carried out in order to determine the rate of reaction for different concentrations of hydrochloric acid.

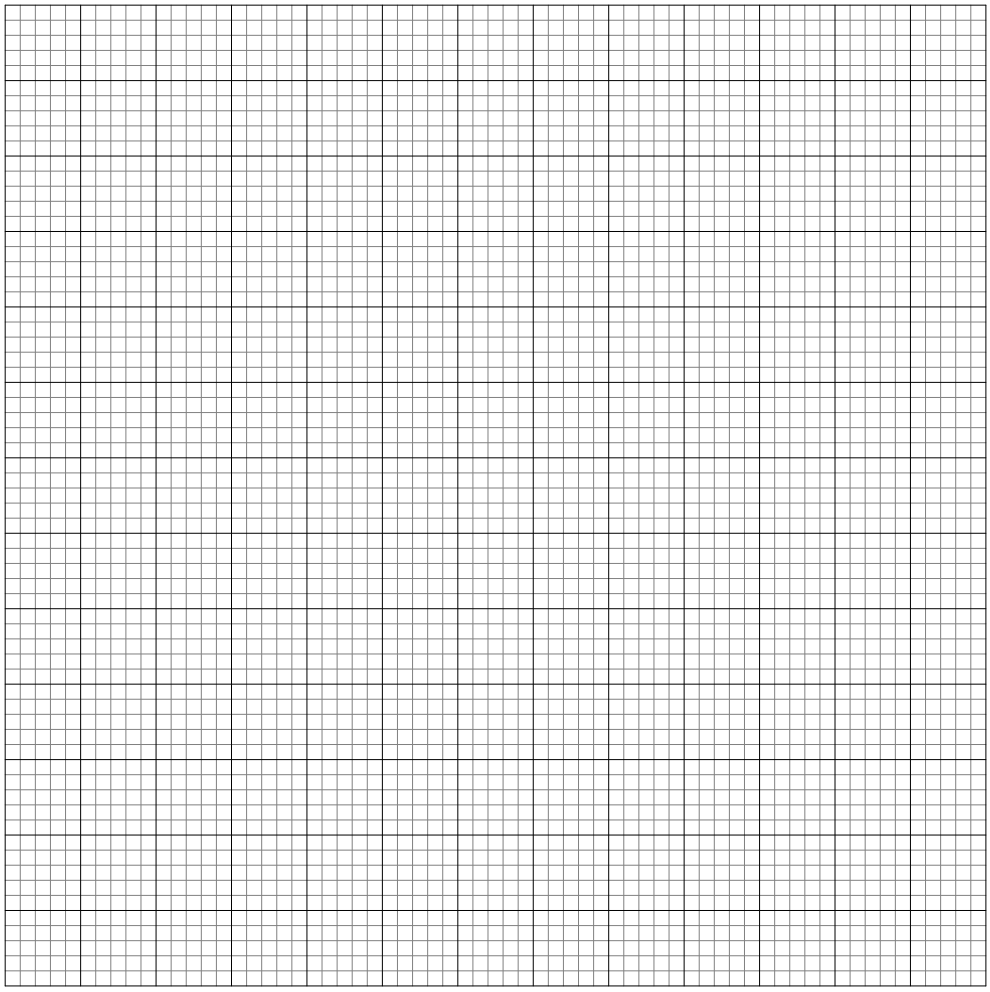
The scientist used two different concentrations of hydrochloric acid and measured the volume of hydrogen gas produced every 10 seconds. The results are show in **Table 1**.

Table 1

Time (seconds)	1 moldm^{-3}	0.5 moldm^{-3}
	Volume (cm^3)	Volume (cm^3)
0	0	0
10	16	8
20	31	15
30	48	24
40	55	31
50	59	40
60	62	43
70	62	52
80	62	58
90	62	62
100	62	62

1 (a) Plot a graph of time (x-axis) against volume of gas, showing both sets of results on the same axes.

[2 marks]



1 (b) Draw lines of best fit onto both graphs.

[2 marks]

1 (c) Draw tangents to the curves and use these to calculate the initial rates of reaction for both experiments.

[2 marks]

1 (d) State the effect that doubling the concentration of hydrochloric acid has on the rate of reaction.

[1 mark]

2 A chemist was preparing a sample of sodium nitrate ($NaNO3_3$), a compound often used in fertilisers. The sample was made by reacting nitric acid (HNO_3) with sodium carbonate ($NA_2\ CO_3$, as shown by the equation:

$$2HNO_{3(aq)} + Na_2CO_{3(aq)} \rightarrow 2NaNO_{3(aq)} + CO_{2(g)} + H_2O_{(l)}$$

The reaction also produced bubbles of carbon dioxide gas.

The Ideal Gas equation can be used to determine the properties of gases. The Ideal Gas equation is shown:

$$\mathbf{pV = nRT}$$

p is the pressure in Pacals

V is the volume of m^3

n is the number of moles of gas

R is the gas constant (8.31)

T is the temperature in Kelvin

The conditions in the laboratory were 301 Kelvin and 101 kPa. The chemist was using 4.8 mol of nitric acid in the experiment.

2 (a) Use the information provided, and the Ideal Gas equation, to determine the volume of gas, in m^3, that is produced by this reaction. Give your answer to an appropriate precision.

[3 marks]

The gas was then collected from the reaction and used to blow up a balloon.

2 (b) Calculate the diameter of the balloon.

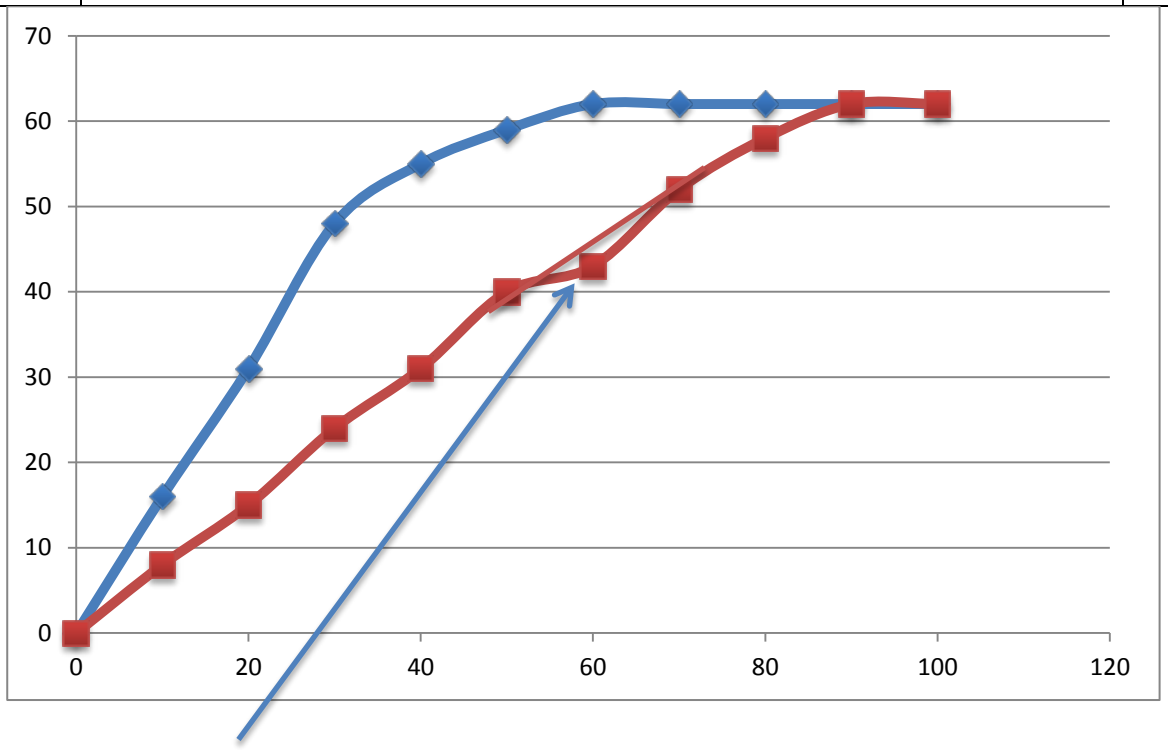
You can assume that the pressure inside the balloon was equal to atmospheric pressure and that the balloon was perfectly spherical.

If you are unable to calculate the volume of gas produced, you can assume that it is 0.086 m^3. This is not the correct value.

[3 marks]

Mark scheme (Chemistry)

Q	Answer	Mark	Comments
1(a) F5.1 D1.1 MS3.1 MS3.2	Suitable axes for both *x* and *y*	1	Plotted points should take up at least half the grid
	All points plotted correctly to ±1 small square	1	
	Additional Guidance		



Line of best fit should avoid this anomalous point.

1(b) G2.1 S7.3 MS3.2	Lines of best fit should be smooth curves	1	
	Line of best fit avoids the anomalous point at 60 seconds	1	
	Additional Guidance		

1(c) **G3.1** **G3.2** **G3.3** **3.1.9.2** **MS3.3** **MS3.4** **MS3.5**	Draws two correct tangents to the line at 0 seconds	**1**	
	Calculates the gradients of each line	**1**	
	Additional Guidance		

1(d) **G3.3** **3.1.5.4** **MS3.1**	Correct quantitative statement describing the relationship (as the concentration of hydrochloric acid doubles, the rate of reaction also doubles)	**1**	
	Additional Guidance		

2(a) **F1.1, F1.3** **3.1.2.3** **3.1.2.2** **MS0.0** **MS0.1** **MS1.1** **MS2.2** **MS2.3** **MS2.4**	Correct rearrangement of equation: $V = nRT/p$	**1**	
	Correct conversion of pressure and ratio of mols from equation p = 101000 Pa <u>and</u> T = 301 K <u>and</u> n = 4.8/2	**1**	
	V = ((4.8/2) 8.31 x 301)/101000 V = 0.059 m^3	**1**	
	Additional Guidance		

2(b) **F1.1, F1.3** **MS0.0** **MS0.1** **MS1.1** **MS4.3** **MS2.2** **MS2.3** **MS2.4**	Correct rearrangement of equation: $v = \frac{4}{3}\ \pi r^3$ $r^3 = 3v / 4\pi$ $r = \sqrt[3]{3v / 4\pi}$	**1**	
	r = 0.38 m	**1**	
	Diameter = $2r$ = 0.77 m	**1**	
	Additional Guidance		

Physics

1 A capacitor is used to store electrical charge. When a capacitor is connected to a resistor the charge leaks away. The charge remaining on the capacitor is given by the equation:

$Q = Q_0 e^{-t/\tau}$ where Q = charge remaining in coulombs

Q_0 = initial charge in coulombs

t = time in seconds

τ = time constant in seconds

1 (a) Show that the fraction of the initial charge remaining on the capacitor after a period of time period equal to the time constant is 0.37 to two significant figures.

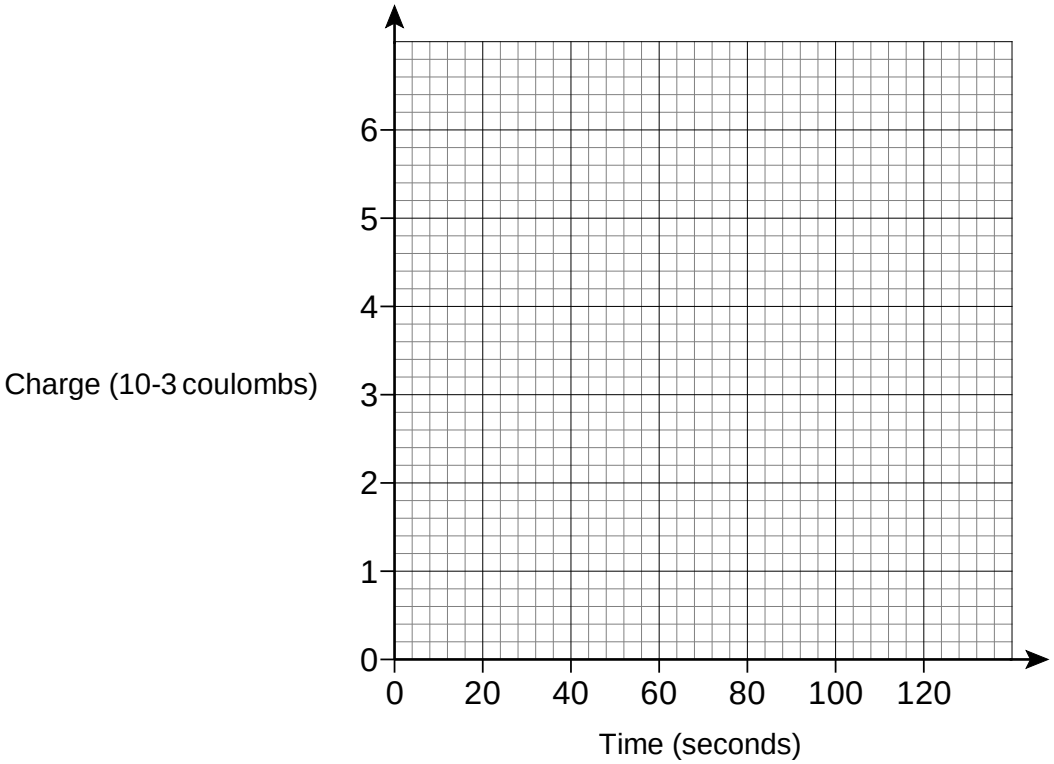
[1 mark]

1 (b) A particular capacitor has an initial charge of 6.0×10^{-3} coulombs and is discharged with a time constant of 40 seconds.

1 (b)(i) On the grid shown in **Figure 1,** plot 4 points for times 0, 40, 80 and 120 seconds and draw a graph for the discharge of this capacitor.

[3 marks]

Figure 1



1 (b)(ii) Calculate the time it takes for the charge on the capacitor to fall to 2.0% of its initial value.

[3 marks]

1 (c) The current passing through the capacitor is found from the gradient of the charge against time graph.

Describe the shape of the current against time graph for a discharging capacitor.

[3 marks]

2 The table gives a series of measured values of R the radius of the nucleus for nucleon number A, which is an integer with no units or error.

element	A	R / 10^{-15} m	$A^{1/3}$
iron	56	4.8 ± 0.3	
strontium	88	5.3 ± 0.3	
caesium	133	6.1 ± 0.3	
holmium	165	6.6 ± 0.3	
lead	208	7.2 ± 0.3	

A and R are related by the equation $R = r_0 A^{\frac{1}{3}}$ where r_0 is constant.

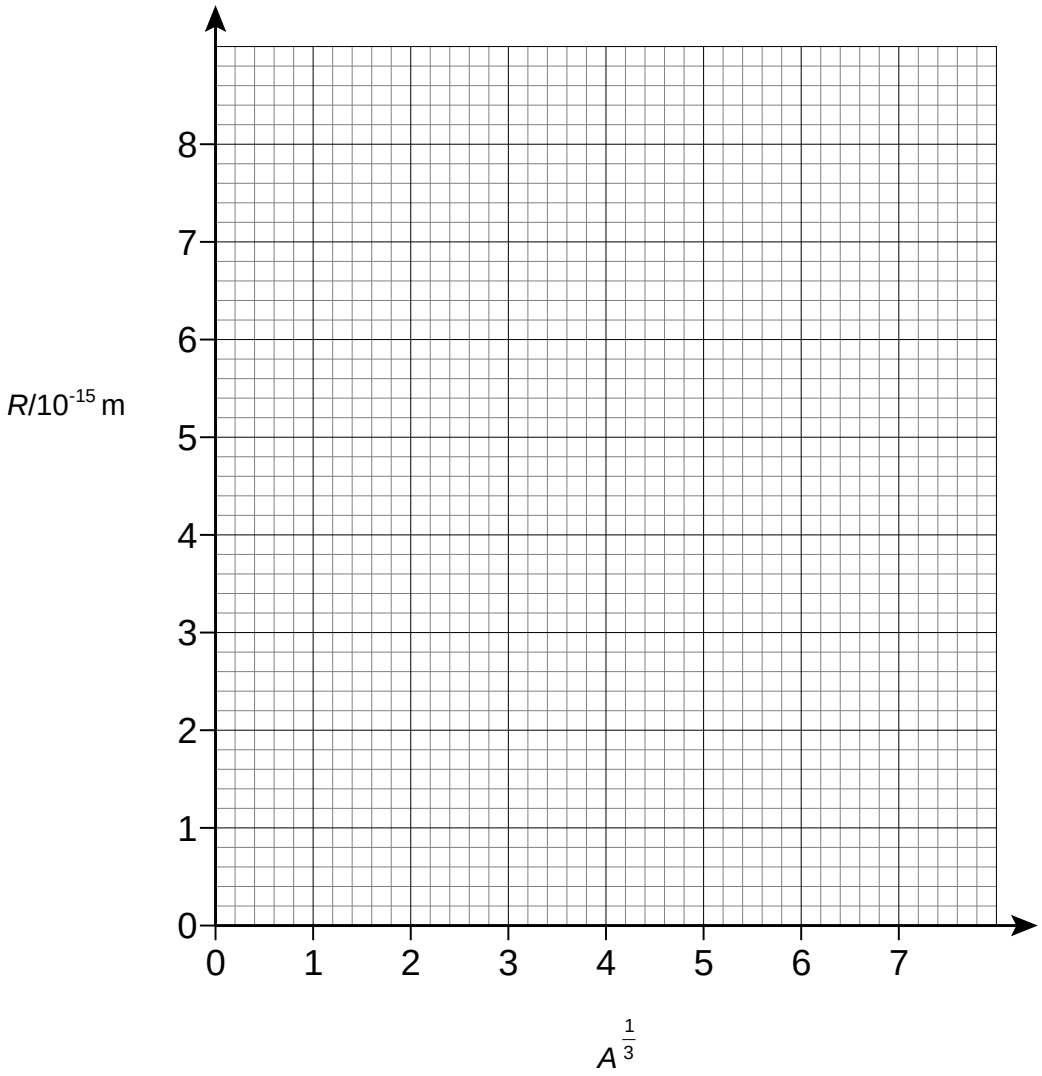
2 (a) Calculate and record values for $A^{\frac{1}{3}}$ in the table.

[1 mark]

2 (b) Plot R against $A^{\frac{1}{3}}$ on the grid of **Figure 2.** Include error bars for R.

[2 marks]

Figure 2



2 (b)(i) Draw the line of best fit and label it B.

[2 marks]

2 (b)(ii) Draw a line of worst acceptable fit and label it W.

[1 mark]

2 (c)(i) Determine the gradient of your graph labelled B.

[2 marks]

2 (c)(ii) State the value of r_0 and determine the error in the stated value.

[2 marks]

r_0 = _____ m

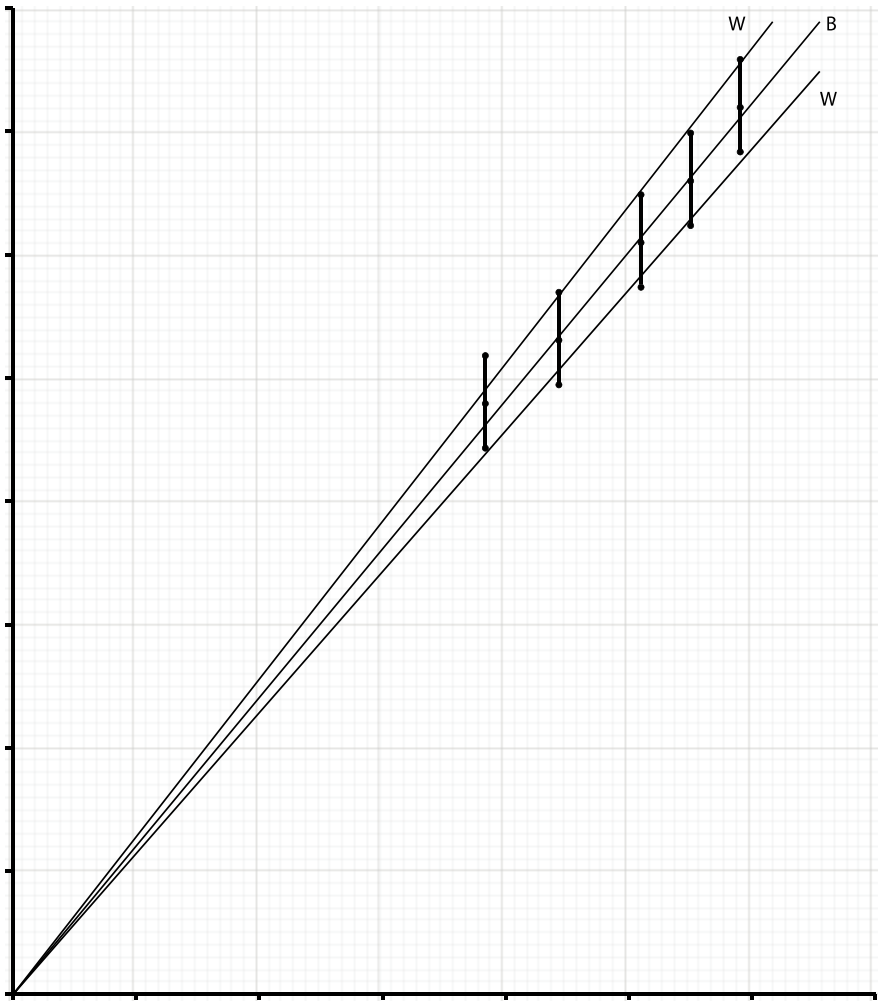
Δr_0 = _____ m

Mark scheme (Physics)

Q	Answer	Mark	Comments
1(a) G8.2 MS0.2 MS0.5 MS2.2	(substituting into $Q = Q_0 e^{-t/\tau}$ with $t = \tau$) $Q = Q_0 e^{-1}$ $\frac{Q}{Q_0}$ = (0.368) = 0.37 (2 sig. fig.)	1	substitution and calculation must be shown
	Additional Guidance		
1(b)(i) G2.1 MS2.3 MS3.2 MS3.12	Graph beginning at 6×10^{-3} C decreasing with decreasing gradient	1	The points expected to be marked are 6.0 x 10^{-3} C : 0 s 2.2 x 10^{-3} C : 40 s 0.8 x 10^{-3} C : 80 s 0.3 x 10^{-3} C : 120 s allow ± 1 division
	Passing through point 2.2 x 10^{-3} C : 40 s	1	
	4 plotted points and graph finishing at 0.3 x 10^{-3} C : 120 s	1	
	Additional Guidance		
1(b)(ii) G6.2 MS0.3 MS0.5	$0.020 = e^{-t/\tau}$ $\ln(0.020) = \frac{-t}{\tau}$ $t = -\tau \times \ln(0.020)$ $t = 156.5$ $t = 160$ seconds	3	1 mark each for taking log to base e making t the subject answer to two (or more) sig. fig
	Additional Guidance		

1(c) **G3.2** **G7.1** **MS3.1** **MS3.9**	The current is negative and decreasing in magnitude with an exponential shape	**3**	each point scores a mark
	Additional Guidance		

2(a) **G6.1** **MS0.5**	$A^{1/3}$	**1**	Values may be rounded to two sig fig
	3.86		
	4.45		
	5.10		
	5.48		
	5.92		
	Additional Guidance		


W
B
W

2(c)(i) **G3.3** **MS3.4**	Gradient = ΔR / $\Delta A^{1/3}$ = (7.9 – 0) $\times$ 10^{-15} / (6.6 – 0) = 1.20 $\times$ 10^{-15}	**2**	1 mark for showing substituted values for the gradient that use more than half the graph. 1 mark for a value between 1.17 – 1.23 $\times$ 10^{-15}
	Additional Guidance		
2(c)(ii) **S9.1** **S9.4** **3.2.1**	r_0 = 1.20 $\times$ 10^{-15} m Δr_0 = 0.06 $\times$ 10^{-15} m	**2**	1 mark for giving the same value to r_0 as answer (c)(i) 1 mark for Δr_0 in range 0.04 – 0.08 $\times$ 10^{-15} m {calculations of the gradients of the two W graphs gives 1.27 $\times$ 10^{-15} and 1.14 $\times$ 10^{-15}}
	Additional Guidance		

1 A student investigated osmosis in a potato.

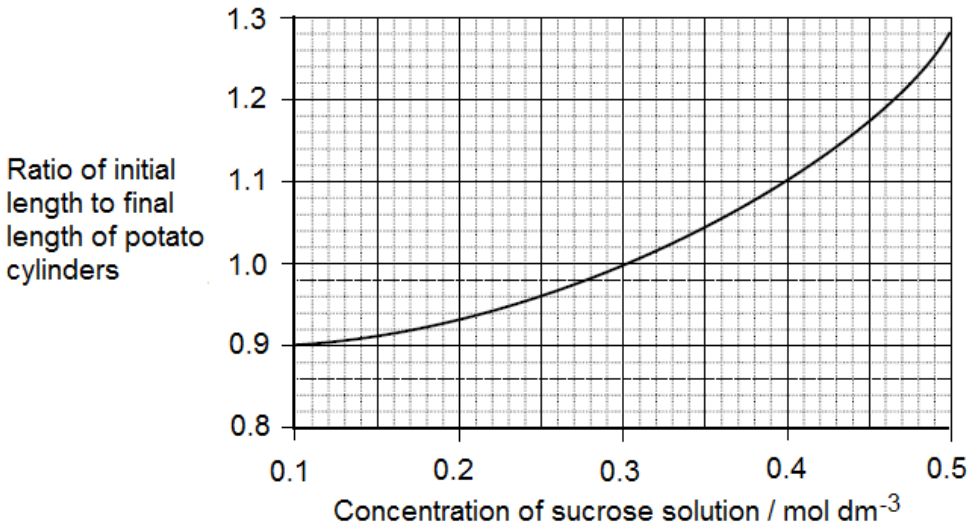
The student cut five cylinders of potato 25 mm in length and 6 mm in diameter.

The cylinders were placed in sucrose solutions of different concentrations for 24 hours.

The lengths of the cylinders were measured after immersion in the sucrose solutions.

Figure 1 shows the effect of the sucrose solution on the length of potato cylinders.

Figure 1



1 (a)(i) Calculate the final length of the cylinder in the 0.4 mol dm^{-3} sucrose solution.

Show your working.

[2 marks]

Final length _____ mm

1 (a)(ii) Use your answer to **1(a)(i)** to calculate the percentage change in length of the cylinder in the 0.4 mol dm^{-3} sucrose solution.

[1 mark]

Answer _____ %

1 (a)(iii) On **Figure 1**, mark with an **N** a point on the curve where the potato cells had no net change in size.

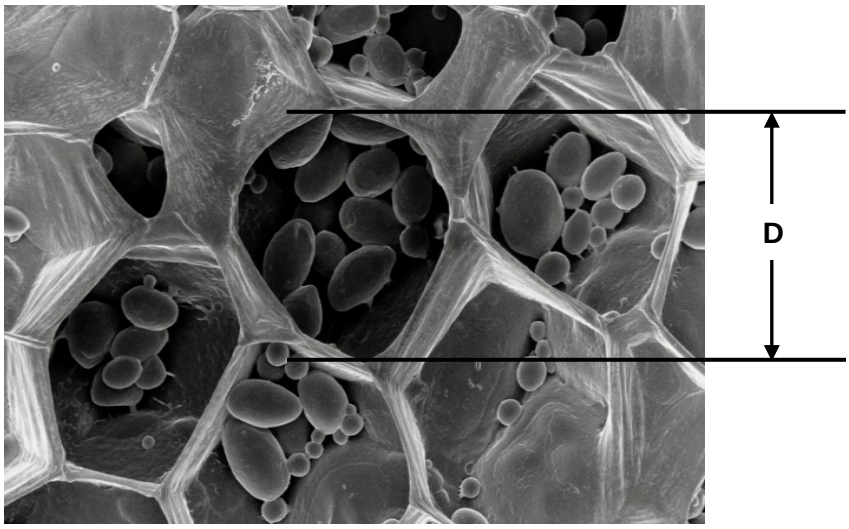
[1 mark]

1 (b) The student wanted to calculate how many potato cells were in each cylinder of potato.

She prepared a sample of potato cells and viewed them under an electron microscope.

Figure 2 shows what she saw. The distance **D** represents the mean diameter of a potato cell.

Figure 2



x600 magnification

The following equation can be used to work out the actual diameter of the potato cell in **Figure 2**.

image diameter = actual diameter x magnification

1 (b)(i) Use the equation to work out the actual diameter of the potato cell in **Figure 2**.

Show your working.

Present your answer in standard form.

[3 marks]

Actual diameter _____ mm

1 (b)(ii) Assuming the potato cell in **Figure 2** is spherical, calculate the number of potato cells in each of the potato cylinders the student cut.

Show your working.

[3 marks]

Number of potato cells per cylinder of potato _____ mm

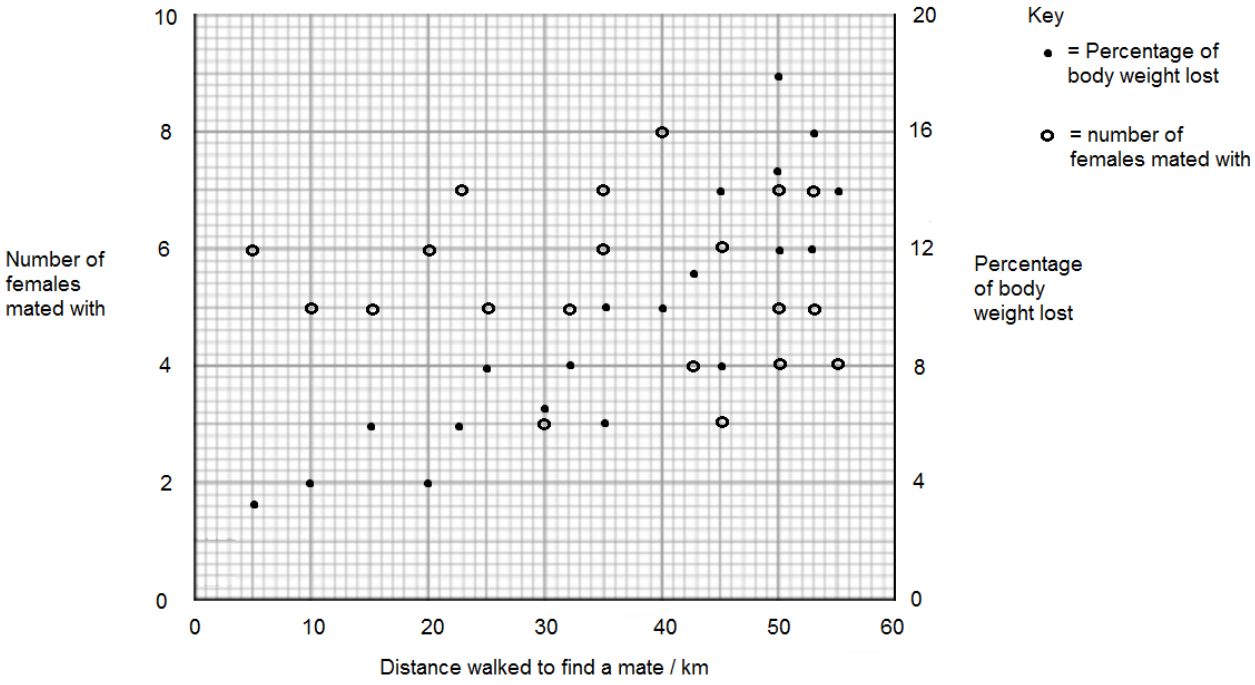
2 An ecologist was studying a population of wild boar in the New Forest National Park.

Male wild boar walk long distances to find a mate, each male can mate with up to 10 females, and during mating season the males can lose up to 20% of their body weight.

The ecologist wanted to find out if there was a correlation between these variables.

He tracked 20 wild boars. His findings can be seen in **Figure 3**.

Figure 3



2 (a) Identify the correlations in **Figure 3.**

[1 mark]

2 (b) The ecologist investigated the correlation between the number of wild boar piglets born to each female and the weight of each piglet.

He calculated the product moment correlation (pmcc) and performed statistical tests to see whether the correlation was significant. The pmcc was -0.86 with a probability value of $p<0.01$

Explain what this means about the correlation between the number of wild boar piglets born to each female and the weight of each piglet.

[3 marks]

2 (c) It is found that the population of wild boar was increasing at a rate of 5% per year.

The relationship between initial population (I), final population size (F) and time (t) is

$$F = I \times e^{0.05t}$$

The initial population was 1000.

Calculate how many years it will take the population to double.

[5 marks]

Q	Answer	Mark	Comments
1(a)(i) G2.1 3.2.3	22.7 or 22.73	2	Allow 1 mark for answer that clearly shows 2.5 ÷ 1.1
	Additional Guidance		
1(a)(ii) F2.5 3.2.3	9.09% or 9.1%	1	Allow acceptable range of 9.08% to 9.20% Allow correct calculations from incorrect answer to **1(a)(i)**
	Additional Guidance		
1(a)(iii) E1.3 G2.1 3.2.3	**N** at 0.3 mol dm^{-3}	1	
	Additional Guidance		
1(b)(i) F1.1 3.2.1.1 3.2.1.3	5.5 x 10^{-2}	3	Allow 1 mark for answer that clearly show 33 ÷ 600 Allow 2 marks for an answer of 0.055
	Additional Guidance		
1(b)(ii) E1.1 3.2.1.1 3.2.1.3	8 114 200	3	Allow acceptable range of 8 114 200 to 8 117 107 Allow 1 mark for correct calculation of cylinder volume = 707mm^3 Allow 1 mark for correct calculation of cell volume = 8.71 x $10^{-5}mm^3$
	Additional Guidance		

2(a) **S7.1** **3.4.7**	No correlation for number of females mated with **and** positive correlation got percentage of body weight lost;	**1**	
	Additional Guidance		

2(b) **S7.1** **S8.1** **S8.2** **S8.3** **R4.1** **3.4.7**	1. (Correlation is) negative **and** strong; 2. Correlation is significant; 3. Probability of correlation being due to chance less than 0.01/1%/1 in 100;	**3**	2. and 3. Reject references to results being significant once
	Additional Guidance		

2(c) **F1.1** **F1.2** **G7.1** **G8.1** **G8.2** **3.4.7**	13.9	**5**	Allow 1 mark for correct substitution into equation, $2000 = 1000 \times e^{0.05t}$ Allow 1 mark for division by 1000 to produce $2 = e^{0.05t}$ Allow 1 mark for taking the natural log of both sides producing $\ln(2) = 0.05t$ Allow 1 mark for correct rearrangement of equation to produce $t = \frac{\ln(2)}{0.05}$
	Additional Guidance		

1 A researcher developed a new Computer Aptitude Test for 17 year olds. The test was piloted on a sample of thirty students from a local school.

The test contained 50 questions each worth 1 mark. The scores were:

16	7	25	31	41	8	11	27	31	44
37	32	25	15	11	12	27	46	35	29
13	20	26	34	37	13	25	28	24	25

1 (a) Calculate the mean for the Computer Aptitude Test scores.

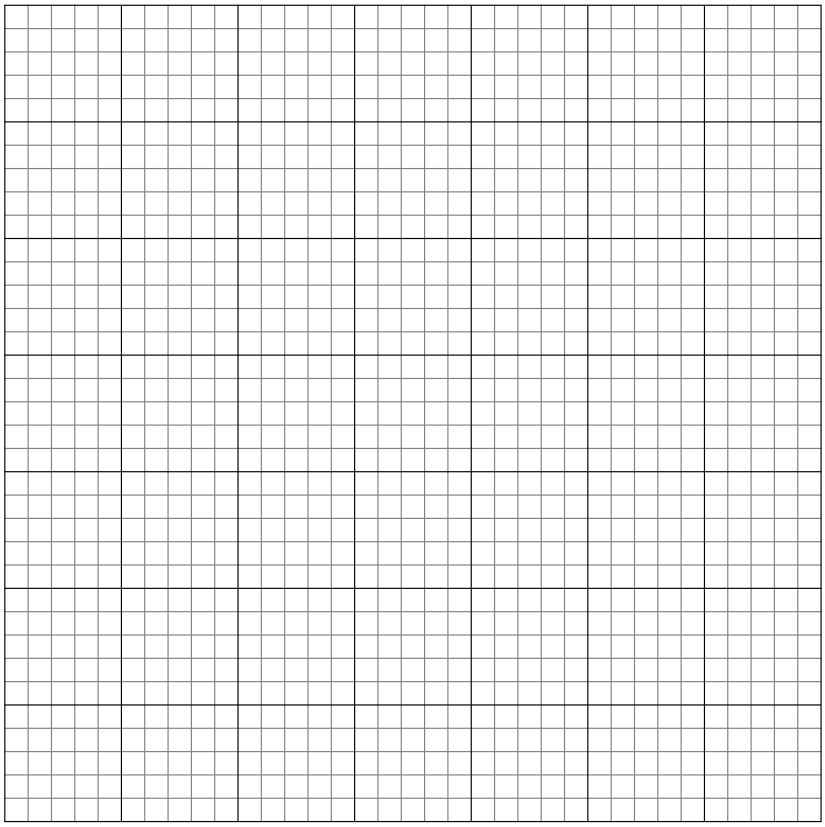
Show your calculations.

[2 marks]

1 (b) Draw and label a histogram to display the test score data.

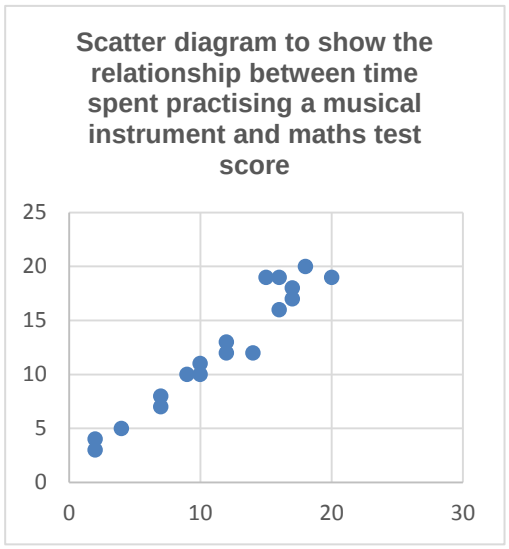
Interpret the type of distribution found on your graph.

[6 marks]



2 A child psychologist decided to investigate whether or not there was a relationship between musical ability and mathematical ability in children.

She randomly selected twenty children from Hilltop School. The number of hours per week spent practising a musical instrument was plotted on a scatter diagram against each child's score (out of twenty) on a maths test.



The product moment correlation (pmcc) for the data was 0.92

2 (a) Identify the type of correlation from the above scatter diagram.

Explain what is meant by 'the correlation coefficient was 0.92'.

[3 marks]

2 (b) Outline how a random sample of children could have been selected for this study.

Explain **one** advantage of random sampling.

[3 marks]

2 (c) The psychologist concluded that playing a musical instrument improved a child's ability in mathematics.

Critically evaluate this conclusion.

[2 marks]

Mark scheme (Psychology)

Q	Answer	Mark	Comments
1(a) **D3.1** **3.2.3.2** **4.2.3.2**	Correct answer with workings (eg. total scores (755) divided by number of scores (30) = 25.17).	**2**	1 mark for correct answer without workings. 1 mark for partial workings (eg. total time (755) divided by …) with incorrect answer.
	Additional Guidance		

1(b) **D4.1** **S1.1** **3.2.3.2** **4.2.3.2**	5-6 marks: The histogram is drawn and labelled clearly and accurately with appropriate categories; *x*-axis and *y*-axis are labelled appropriately and a suitable heading is provided. The interpretation of the distribution (normal) is stated accurately for full marks. 3-4 marks: The drawing and labelling of the histogram is clear but some detail is missing/inaccurate. There may be no (or an inaccurate) interpretation. 1-2 marks: The drawing and/or labelling of the histogram lacks detail and clarity – although it is still evidently a histogram. The interpretation may be missing/inaccurate.	**6**	
	Additional Guidance		

2(a) **S7.1** **S8.1** **S8.2** **S8.3** **3.2.3** **3.2.3.1** **4.2.3** **4.2.3.2**	This is a positive correlation	**1**	
	A correlation coefficient of 0.92 refers to the strength of the relationship and as 0.92 is close to the highest positive correlation of 1	**1**	
	This indicates that there is a **strong** positive correlation between music practise and maths ability ie. those who practise more often will attain higher maths marks and vice versa.	**1**	
	Additional Guidance		

2(b) **S4.1** **S4.2** **D2.1** **D2.2** **3.2.3** **3.2.3.1** **3.2.3.2** **4.2.3** **4.2.3.2**	All the names of the 9-10 year old children form Hilltop School could have been placed into a box	**1**	Accept alternative techniques eg. random number generator
	20 names randomly pulled out of the box to create a sample	**1**	
	One advantage of random sampling is that it eliminates bias as each member of the target population has an equal chance of being selected	**1**	
	Additional Guidance		

2(c) **C1.1** **S7.2** **3.2.3** **3.2.3.1** **3.2.3.2** **4.2.3** **4.2.3.2**	As this is only a correlation there is not necessarily a causal relationship between music practise and mathematical ability	**1**	
	There may be another variable (such as parental encouragement) that is causing the effect noted	**1**	
	Additional Guidance		

Geography

1 A student wanted to compare the annual discharges of two small drainage basins. The basins were of similar size and were only a few kilometres from each other.

Figure 1 shows the mean daily flow for the two basins in 2014.

Figure 1

	Basin A mean daily flow cubic metres per second	**Basin B** mean daily flow cubic metres per second
January		10.1
February	8.8	7.2
March	12.9	11.1
April	10.8	8.0
May	7.8	5.3
June	6.9	4.2
July	5.8	3.6
August	14.8	7.0
September	3.2	2.6
October	8.6	7.9
November	10.9	10.1
December	15.4	11.2
Mean annual flow	9.82	
Median annual flow	9.8	

1 (a) Complete **Figure 1** by calculating the mean and median annual flow for Basin B.

[2 marks]

1 (b) Calculate the range of values of daily mean flow (cubic metres per second) for Basin A and Basin B.

[2 marks]

Basin A _____

Basin B _____

1 (c) The interquartile range for mean daily flow for Basin A is 5.05 cubic metres per second.

Calculate the interquartile range for Basin B.

Show your working.

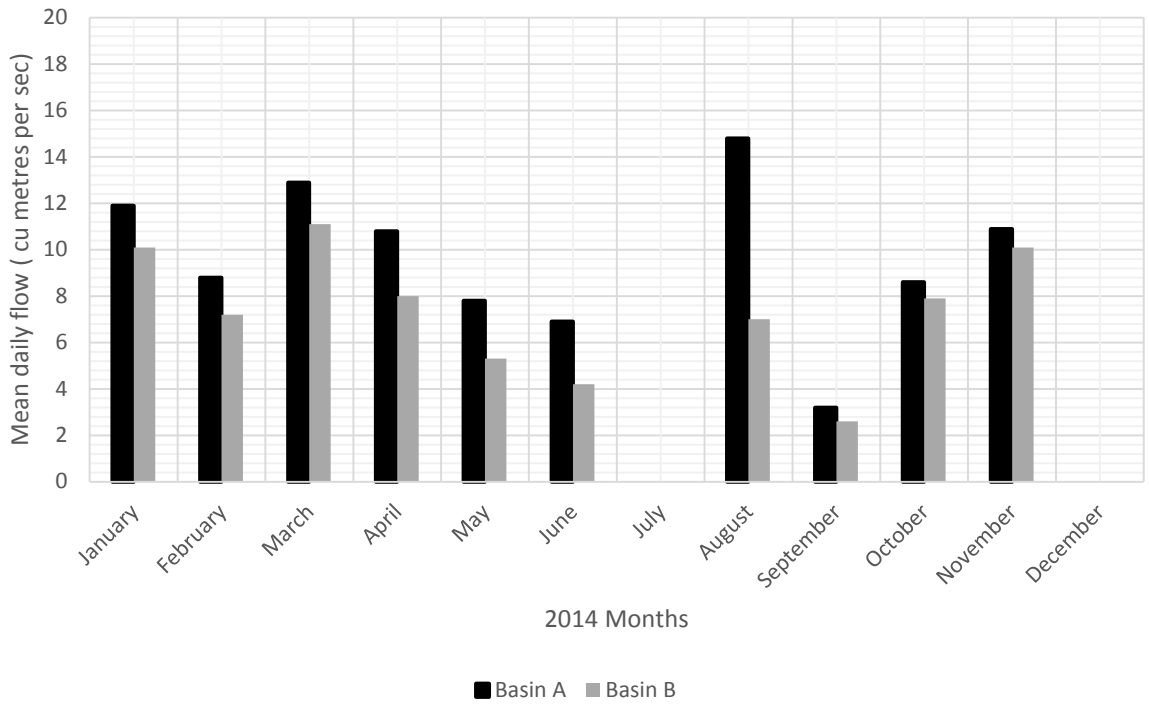
[3 marks]

1 (d) Summarise what is shown about Basins A and B by the data for range and interquartile range.

[2 marks]

The student then represented the data in **Figure 1** by constructing **Figure 2**, which is not yet complete.

Figure 2



1 (e)(i) Complete **Figure 2** by constructing the bars for the July and December data.

[2 marks]

1 (e)(ii) Give **one** other graphical method that could have been used to represent these data.

[1 mark]

1 (f) Compare and comment on the flow patterns of the two basins shown by **Figure 2**.

[4 marks]

2 A student wanted to study patterns of deprivation within her home city in North East England, using information from the 2011 census. She followed an urban transect across the city.

Figure 3 shows some of the census information that she obtained for the wards along the transect.

Figure 3

Selected variables by ward

Ward	Distance from city centre to centre of ward (km)	Unemploy-ment Rate (%)	Population Density (per sq.km)	Population Change (2001-2011) (%)	Car ownership (%)	Detached houses (%)
A	1.7	5.7	630	– 7.9	33	3.2
B	2.7	6.8	798	– 1.8	42	2.1
C	3.4	3.8	659	– 0.3	51	4.4
D	4.8	3.6	480	+ 1.6	64	20.4
E	5.6	4.1	422	+ 1.1	68	19.7
F	6.7	2.8	388	+ 5.7	79	34.2
G	7.3	2.4	240	+ 4.8	81	23.1
H	8.8	1.9	113	+ 13.8	93	83.1

Source: National Census 2011

2 (a) The student carried out her investigation in 2015.

Explain how this limits the value of the census data she obtained.

[2 marks]

Using **Figure 3**, state;

2 (b)(i) a variable showing a perfect positive correlation with distance from city centre

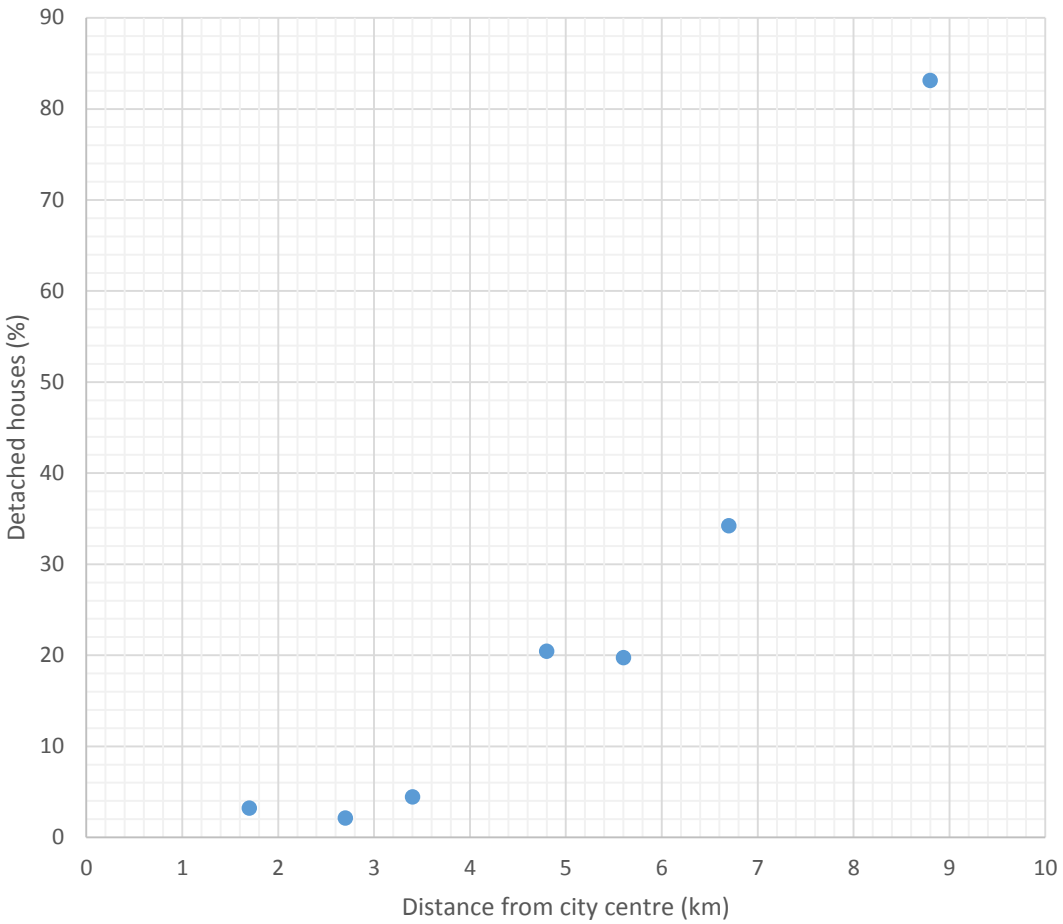
[1 mark]

2 (b)(i) a variable showing a perfect negative correlation with distance from city centre

[1 mark]

Study **Figure 4**, a scatter graph showing the link between distance from city centre and the percentage of houses that are detached.

Figure 4



2 (c) Plot the data for Ward G in **Figure 3** on **Figure 4** and draw the line of best fit.

[2 marks]

2 (d) Describe and comment on the link between distance from city centre and percentage of houses that are detached.

[4 marks]

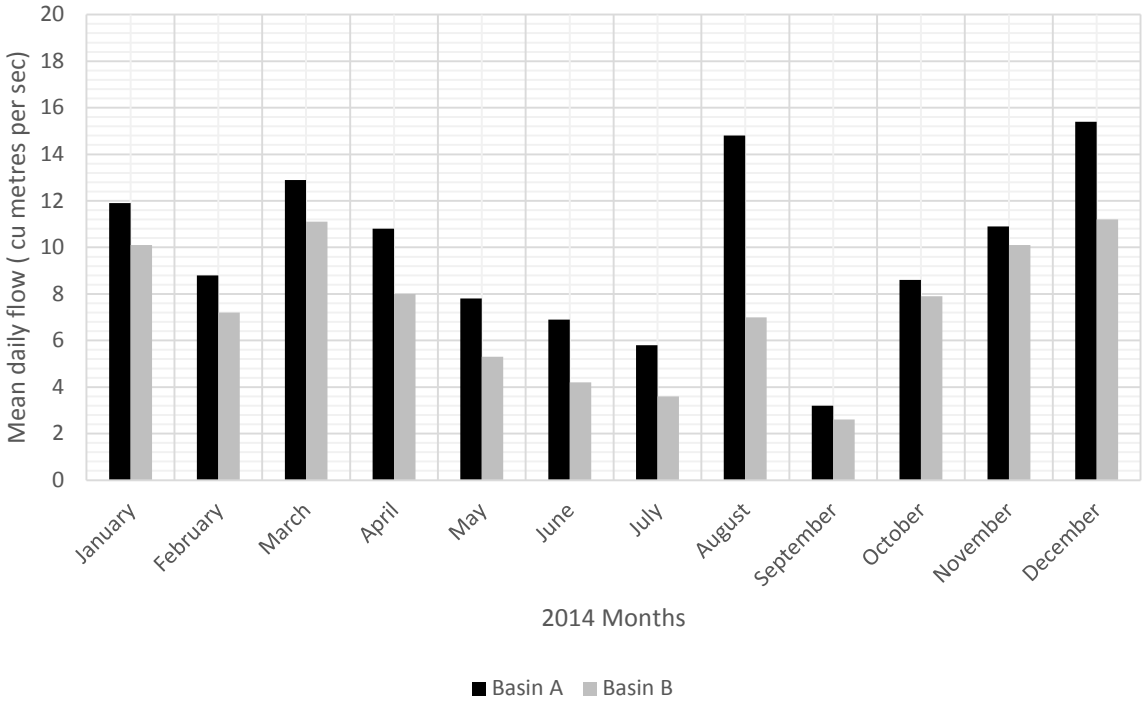
Geography (Mark scheme)

Q	Answer	Mark	Comments
1(a) D3.1 3.4.2.4	Mean for Basin B= 7.36 (cumecs).	1	Allow answers in range 7.35-7.37
	Median for Basin B= 7.55 (cumecs).	1	
	Additional Guidance		
1(b) D3.1 3.4.2.4	Range for Basin A= 12.2 (cumecs)	1	
	Range for basin B= 8.6 (cumecs)	1	
	Additional Guidance		
1(c) D3.1 3.4.2.4	Correct upper quartile	1	The interquartile range can be calculated by subtracting the lower quartile from the upper quartile ie 10.1-4.75 = 5.35. (The upper quartile (UQ) may be calculated using the formula uq = n+1/4 th position in the rank order. The lower quartile (LQ) my be calculated using the formula 3(n+1)/4 th position in the rank order, assuming that highest ranking value is 1).
	Correct lower quartile	1	
	Correct interquartile range: 5.35	1	
	Additional Guidance		

1(d) **D3.2** **3.4.2.4**	The data shows that basin A has a larger range of values for mean daily flow than basin B.	**1**	Credit the idea that daily flows in Basin A may have greater fluctuation or that the stream is more “flashy” in response to rainfall than in Basin B
	However the data for interquartile range are similar, suggesting that the values for the middle 50% of readings are equally clustered around the median	**1**	
	Additional Guidance		

1(e)(i) **D4.1** **3.4.2.3**	1 mark for each correct pair of bars	**2**	Maximum 1 mark if no shading to distinguish between the 2 sets of data.
	Additional Guidance		

Figure 2



1(e)(ii) **D4.1** **3.4.2.3**	Line graph (accept dispersion graph or valid alternative	**1**	
	Additional Guidance		

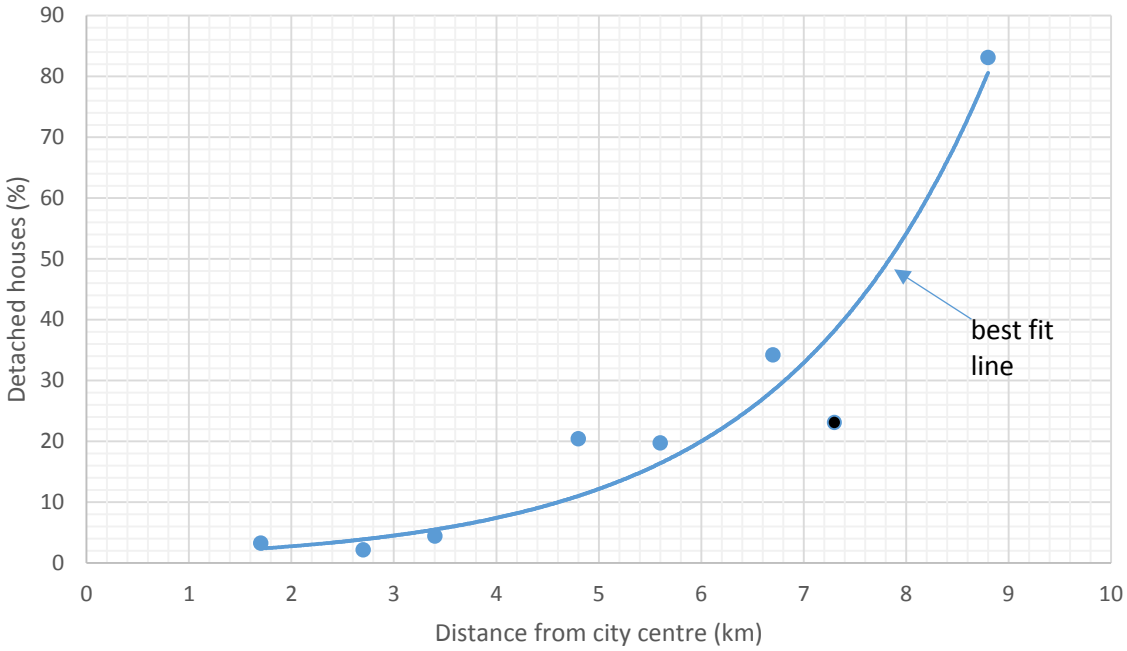
1(f) **D4.1** **3.1.1.2** **3.4.2.3**	3-4 marks: Demonstrates thorough comparison between the two flow patterns, using data to support similarities and/or differences. Appropriate comment about possible reasons for differences, applying knowledge and understanding to the source. 1-2 marks: Makes limited or no comparison between the two flow patterns. May describe one pattern only. Random use of data to support comparison or generalised description only. Limited comment about possible reasons for differences	**4**	
	Additional Guidance		
	Indicative content Comparison: Throughout the year mean daily flows are higher in basin A than in basin B. Differences are most pronounced in August when the flow in basin A is approximately double that of basin B. Flow rates for both basins are greater in winter than summer, with the exception of August. Between September and November differences in flow between the 2 basins are minimal. Comment: As the two basins are close to each other rainfall is likely to be very similar, so this would not explain differences in flow. It may be that there are differences in geology, with one basin (B) consisting of more permeable rock. Steeper slopes in basin A might account for higher flows. Alternatively, there may be differences in vegetation and land use. A forested catchment (B) would absorb more water, and slow the rate of surface runoff. If much of the catchment is urbanised (A), water would reach the stream more rapidly, increasing mean flow rates.		

2(a) **D2.1** **3.3.2** **3.4**	Explanation of one limit (see comments)	**2**	The data may be out of date as 4 years have elapsed since the census was recorded Some of the variables may have changed significantly, notably the unemployment rate and rate of population change There may have been investment in certain areas by government e.g. in housing, which may have changed the social and economic conditions in some of the wards
	Additional Guidance		

2(b)(i) **S7.1** **3.4.1**	Car ownership %	**1**	
	Additional Guidance		
2(b)(ii) **S7.1** **3.4.1**	One of: Unemployment rate (%), Population density (per sq. km), Population change (2001-2011 %)	**1**	
	Additional Guidance		

2(c) **S9.1** **3.4.2.3**	Correct data plot	**1**	An exponential shape is most likely but accept an appropriate linear best fit line.
	Appropriate best fit line	**1**	
	Additional Guidance		

Figure 4


90
80
70
60
50
40
30
20
10
0
Detached houses (%)
0
1
2
3
4
5
6
7
8
9
10
Distance from city centre (km)
best fit line

2(d) **S7.1** **3.4.2.3**	3-4 marks: Demonstrates thorough interpretation of the graph, recognising that there is a trend to the points, and making clear reference to data. Shows clear understanding of possible reasons for the positive correlation between the two variables. 1-2 marks: Shows some interpretation of the graph, with basic recognition of a trend. Limited use of evidence to support description. Shows limited or partial understanding of the possible reasons for the link between the two variables.	**4**	
	Additional Guidance		
	Indicative content Description. There is a positive correlation between distance from the city centre and percentage of detached housing. The relationship is exponential, with a significant increase beyond 8 km from the centre. There are some anomalous readings such as ward G (lower than expected). Comment. The percentage of houses that are detached increases outwards from the city centre, partly because of the greater space available for building. Land prices are generally cheaper than in the CBD and inner city, although the desirability of housing can make some areas expensive. People with higher incomes can afford to commute and are able to purchase detached housing in the suburbs. The increase in percentage is not consistent however-some areas may have been developed for council housing, or private estates with flats, semi-detached and terraced houses.		

Business Studies

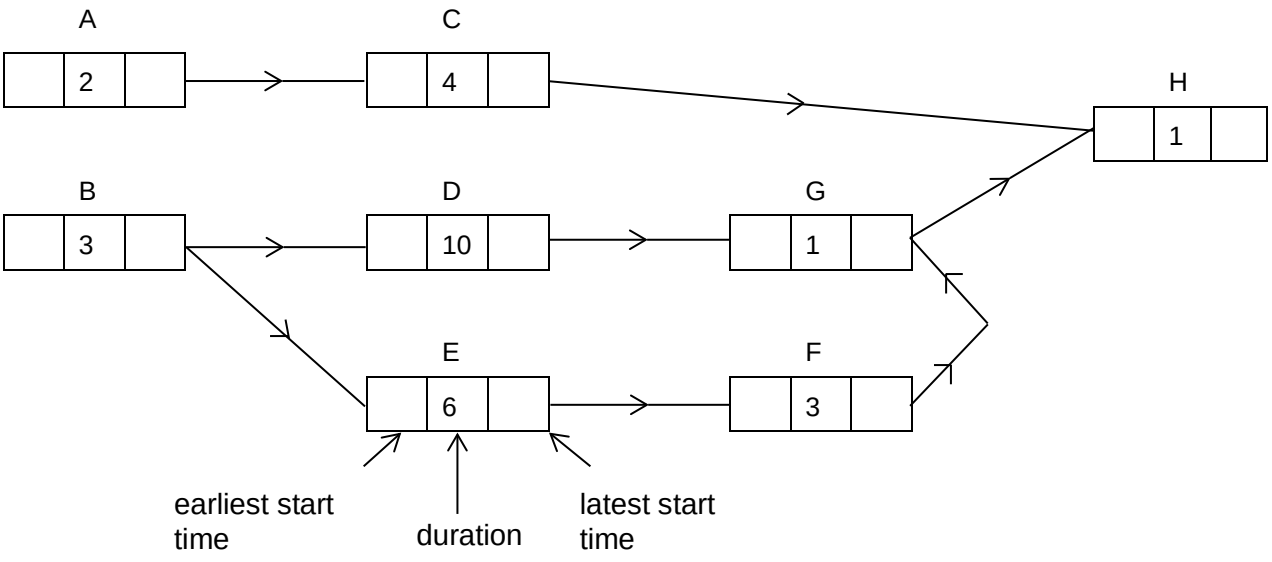
1 A business is planning to launch a new product. The Chief Executive insists that the product should be launched within 16 weeks.

Table 1 shows the duration (in weeks) of each activity. **Figure 1** shows the activities as a network.

Table 1: Activities and their duration

Activity	Description	Duration (weeks)
A	Plan marketing	2
B	Plan production	3
C	Implement marketing campaign	4
D	Install production line	10
E	Recruit production staff	6
F	Train production staff	3
G	Produce first batch of items	1
H	Launch product	1

Figure 1: Network and their activities



1 (a) Complete the diagram showing the earliest start time (EST) and the latest start (LST) for each activity.

[4 marks]

1 (b) Which activities are on the critical path?

[1 mark]

Difficulties with recruitment mean that the recruitment of production staff will now take 8 weeks rather than 6 weeks.

1 (c) How will this affect the critical path and its duration?

[2 marks]

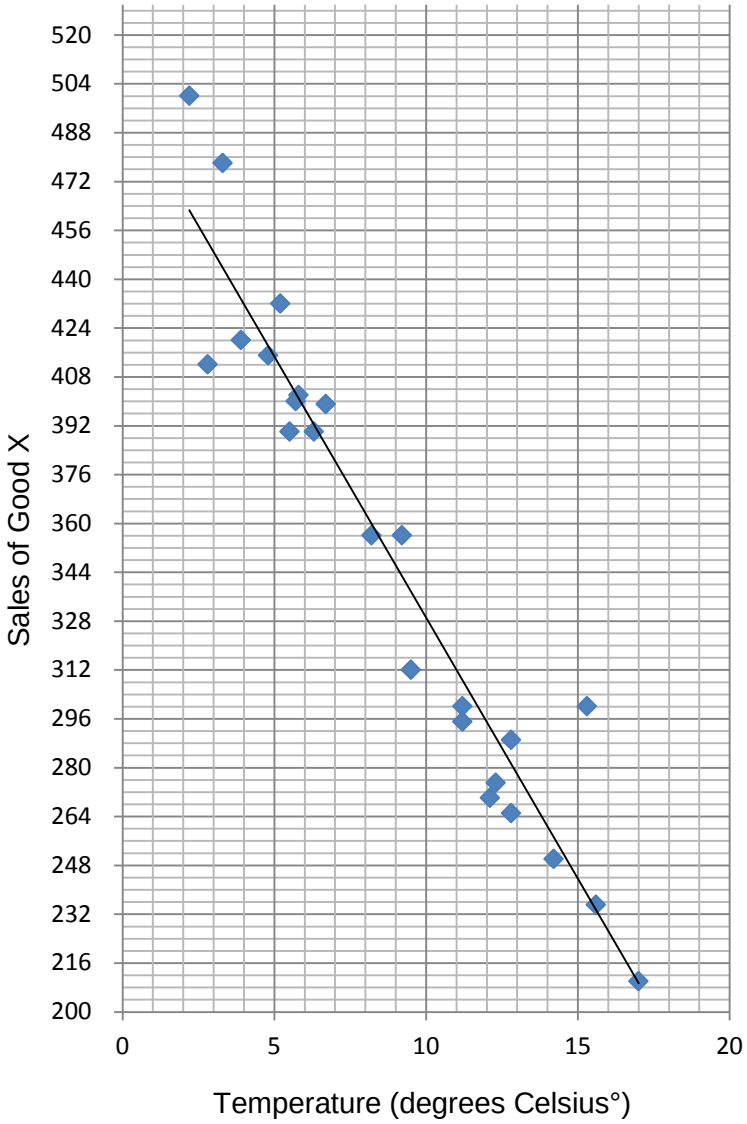
1 (d) After this delay, will the product be launched within the 16 week limit imposed by the Chief Executive?

[1 mark]

2 A business is investigating the link between average temperatures and sales of one of its products: “Good X”.

Figure 2 is a scatter diagram showing average monthly temperatures and sales of “Good X” over the last 24 months. The regression line is shown in black.

Figure 2



The product moment correlation coefficient (pmcc) for the data is -0.96

2 (a) Explain the significance of:

2 (a)(i) The numerical value of the product moment correlation coefficient (pmcc);

[2 marks]

2 (a)(ii) The negative value of the product moment correlation coefficient (pmcc).

[1 mark]

2 (b) Use **Figure 2** to predict the level of sales for "Good X" when the temperature is:

2 (b)(i) 10° Celsius;

[1 mark]

2 (b)(ii) 0° Celsius.

[1 mark]

2 (c) Does the coefficient of -0.96 confirm that changes in temperature cause changes in the sales of "Good X"?

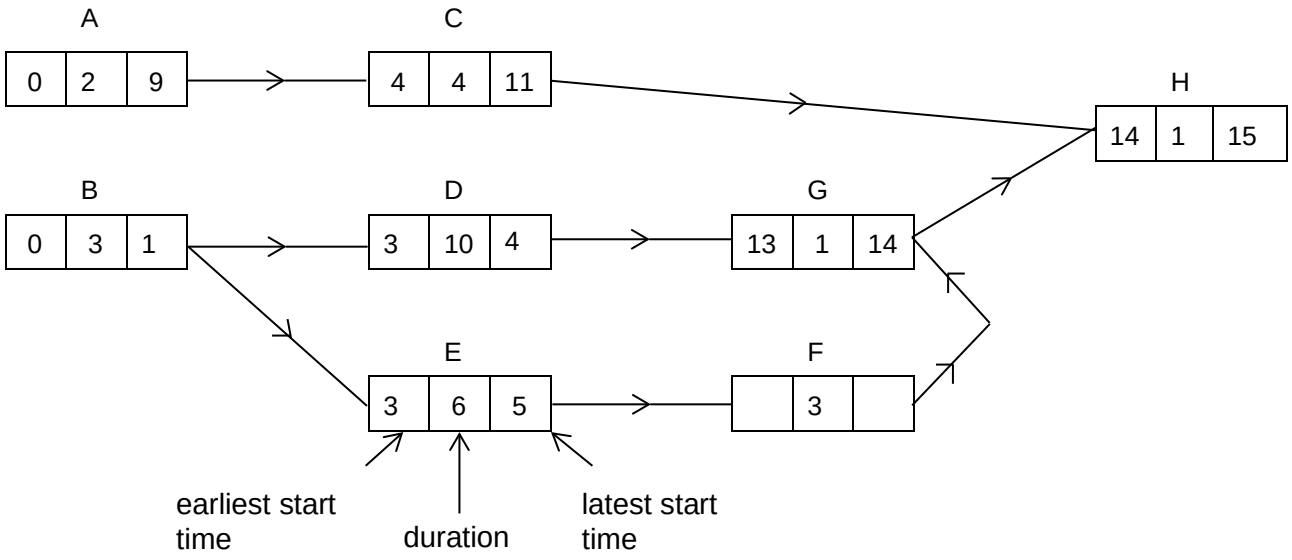
[2 marks]

2 (d) Explain **one** potential problem with using extrapolation to predict sales of "Good X" based on the average monthly temperature.

[3 marks]

Mark scheme (Business Studies)

Q	Answer	Mark	Comments
1(a) R1.1 R1.2 R2.1 3.10.3	Correct ESTs	2	Award 1 mark if there is one error (apply own figure rule if an incorrect EST leads to an incorrect EST that is logically correct, based on the earlier error).
	Correct LSTs	2	Award 1 mark if there is one error (apply own figure rule if an incorrect LST leads to an incorrect LST that is logically correct, based on the earlier error).
	Additional Guidance		



1(b) R1.1 R1.2 R2.1 3.10.3	Critical path is: BDGH	1	
	Additional Guidance		

1(c) **R1.1** **R1.2** **R2.1** **3.10.3**	New critical path is: BEFGH	**1**	
	New duration is 3 + 8 + 3 + 1 + 1 = 16 weeks	**1**	
	Additional Guidance		

1(d) **R1.1** **R1.2** **R2.1** **3.10.3**	Yes: the launch takes 16 weeks, which is exactly equal to the Chief Executive's target	**1**	
	Additional Guidance		

2(a)(i) **S7.1** **S8.1** **S8.2** **3.3.2**	The maximum numerical value of a correlation coefficient is 1.0**.** 0.96 is very close to perfect correlation.	**1**	
	The coefficient suggests that the two sets of data are very strongly correlated.	**1**	
	Additional Guidance		

2(a)(ii) **S7.1** **S8.3** **3.3.2**	The negative value shows that as one set of data increases in value the other set of data tends to decrease. There is an inverse relationship between the two factors.	**1**	1 mark for notion of inverse relationship, but without repeating the word negative.
	Additional Guidance		

2(b)(i) **S9.4** **3.3.2**	£328 million	**1**	+ or – some margin of error for reading from the graph
	Additional Guidance		

2(b)(ii) **S9.5** **3.3.2**	£500 million	**1**	+ or – some margin of error for reading from the graph
	Additional Guidance		

2(c) **S7.2** **3.3.2**	Strong correlation does **not** prove that the temperature causes sales to change. A logical reason must be deduced separately, because this might be a good that is seasonal for other reasons.	**2**	1 mark for “No” + 1 mark for the explanation.
	Additional Guidance		

2(d) **S9.5** **3.3.2**	1. Extrapolation cannot show changes in the relationship (for example, the link may cease to be linear at very high temperatures) 2. There is no actual evidence of behaviour beyond the parameters of the data (for example, the figures do not show if the relationship continues at temperatures such as 0° Celsius. 3. Other variables that are not measured numerically may be influencing sales. 4. A 3rd variable may be causing the two sets of changes. 5. Monthly average temperatures can distort the actual weather pattern (such as two weeks of very high and two weeks of very low temperatures suggesting average weather patterns for a month)	**3**	**1 mark** for identifying point; **1 mark** for a generic explanation; **1 mark** for linking explanation to this set of data.
	Additional Guidance		

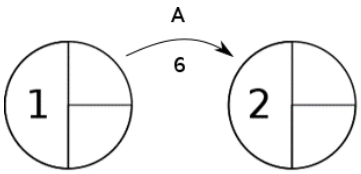
Computer Science

*These activity networks are displayed as they would be in a Computer Science exam. For the Mathematical Studies specification, please see the Teacher's Guide on how activity networks will be displayed.
** Computer Science, compared other A-level subjects, contains the least commonality in terms of content with Level 3 Mathematical Studies. As such, only one question has been provided.

1 An activity network is represented on a computer by a table known as an 'adjacency matrix'. Each cell in the table stores the activity identifier and completion time between the two nodes.

	1	2
1	-	A, 6
2	-	-

The above table shows that there is an activity, A, linking node 1 to node 2 that takes 6 days to complete. Where the nodes have no linking activity, - is given. There are no links from 1 to 1, 2 to 1 and 2 to 2. The above table creates the following activity network.

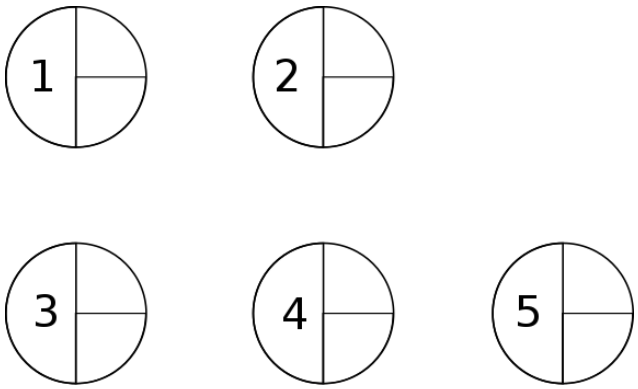


The table below represents a network diagram outlining the activities needed for a company to build their corporate website.

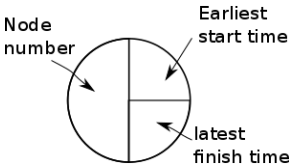
	1	2	3	4	5
1	-	A, 3	B, 10		-
2	-	-	C, 3	-	D,12
3	-	-	-	E, 7	-
4	-	-	-	-	F, 8
5	-	-	-	-	-

1 (a) Using the table, add the activities and activity durations to the nodes shown below.

[2 marks]



Key:



1 (b) Using the node diagram above, for each activity node, add the earliest start times and the latest finish times.

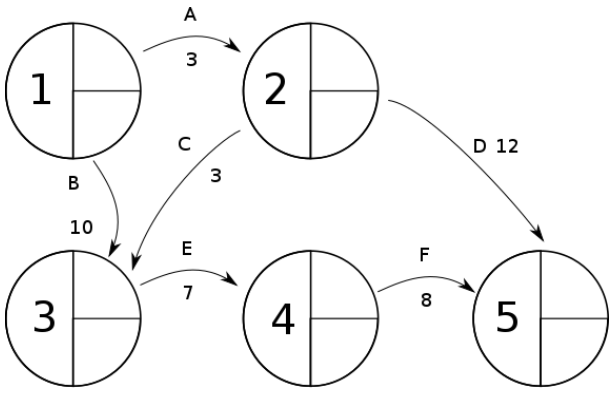
[3 marks]

1 (c) Identify the critical path activities.

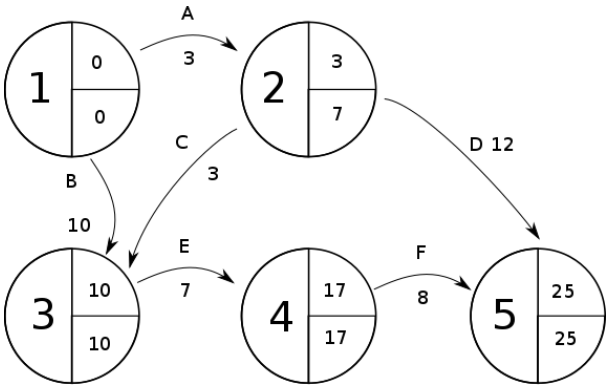
[1 mark]

Q	Answer	Mark	Comments

1(a) **R1.1** **R1.2** **R2.1** **3.4.1.2** **4.4.1.2** **4.2.4.1** **4.11.1**	For correct arrow directions	**1**	
	For correct labelling of arrows	**1**	
	Additional Guidance		



1(b) **R1.1** **R1.2** **R2.1** **3.4.1.2** **4.4.1.2** **4.2.4.1** **4.11.1**	For correct earliest start times	**1**	
	For correct latest start times	**2**	
	Additional Guidance		



1(c)	B – E – F	**1**	
R1.1 **R1.2** **R2.1** **3.4.1.2** **4.4.1.2** **4.2.4.1** **4.11.1**	**Additional Guidance**		