

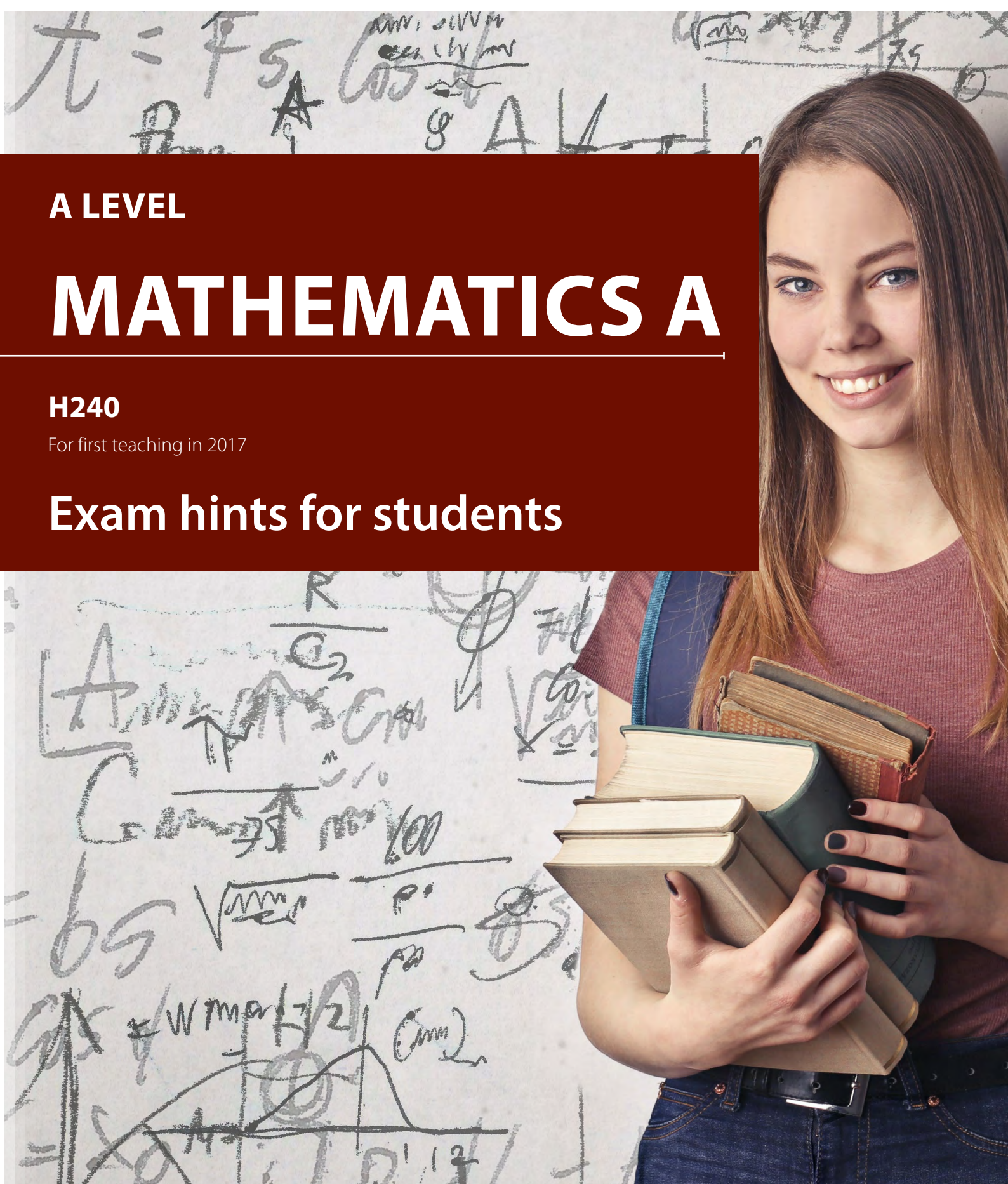
A LEVEL

MATHEMATICS A

H240

For first teaching in 2017

Exam hints for students



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General exam skills

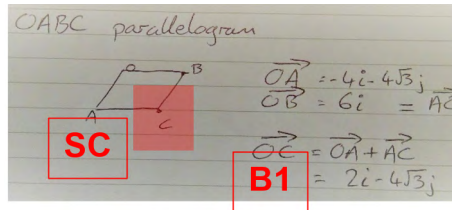
Crossing out

$$v = 100 \sin 25 + 9.8 \times 4.94$$

$$v = 35.18$$

Cross out mistakes and rewrite your answer. Trying to correct an answer by writing over it can make it unclear and may lose you marks.

Clear working



Show clear working for calculations. You may still gain marks for valid mathematical workings even if the final answer is incorrect.

Layout

$$= \lim_{h \rightarrow 0} \frac{2(x^3 + 3x^2h + 3ah^2 + h^3) - 2x^3 - 3x}{h}$$

$$= \lim_{h \rightarrow 0} \frac{2x^3 + 6x^2h + 6ah^2 + 2h^3 - 2x^3 - 3x}{h}$$

$$= \lim_{h \rightarrow 0} \frac{6x^2h + 6ah^2 + 2h^3 - 3x}{h} = \lim_{h \rightarrow 0} (6x^2 + 6ah + 2h^2 - \frac{3x}{h})$$

Try not to include too many calculations in a single line of working. This will make your workings more difficult to read which could cause you to introduce errors. Method marks can only be awarded for valid mathematical expressions.

Rounding and accuracy

$$\frac{\sin 36}{13.5} = \frac{\sin x}{8.2}$$

$$\frac{8.2 \sin 36}{13.5} = 0.36$$

$$x = \sin^{-1}(0.36) = 21.1$$

It's always more accurate to round once, for the final answer, and work with unrounded values on the calculator. Give final answers to 3 significant figures unless stated otherwise.

Simplify

$$(1+3x)^{-5} = 1 + 0.5 \cdot 3x + \frac{0.5 \cdot 0.5 \cdot 3x^2}{2} + \frac{0.5 \cdot 0.5 \cdot 1.5 \cdot 3x^3}{3!}$$

$$= 1 + 1.5x - \frac{2.25x^2}{2} + \frac{10.125x^3}{6}$$

Simplify fractions, algebraic expressions, logarithms and surds when giving final answers even when the question does not explicitly ask you to do so.

Sign errors

$$1 + (-ax)(-3) + \frac{-3(-3-1)}{2} (-ax)^2$$

$$1 + 3ax - 6a^2x^2 + \dots$$

Double check all algebraic manipulation as it is easy to make errors with signs when multiplying out brackets.

Calculator checking

$$\frac{\sin \theta}{1 - \cos \theta} = \frac{1}{\sin \theta} = 3 \tan \theta \quad 0 \leq \theta < \pi$$

$$\cot \theta = 3 \tan \theta$$

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

$$1 = 3 \tan^2 \theta$$

$$\tan^2 \theta = \frac{1}{3}$$

$$\tan \theta = \pm \frac{1}{\sqrt{3}}$$

$$\theta = \frac{\pi}{6}, \frac{5\pi}{6}$$

Avoid arithmetic errors by checking with a calculator, for example, that the decimal approximation given by the calculator matches your 'exact' answer.

Calculator use

(a) Calculate an estimate of the mean time per day

3(a) midpoints: 0, 5, 1.5, 2.5, 3.5, 5, 7

using calculator, $\bar{x} = 2.81$ 3.s.f

= 2.81 hours per day to 3.s.f

Write down any expressions, including integrals, that you use the calculator to evaluate as well as the values of any parameters or variables that you input.

Mathematical notation

(b) Give details of a sequence of two transformations

10(b)

$$SEC = \frac{1}{\cos}$$

$$\frac{1}{\cos} \rightarrow \frac{1}{\sqrt{3} \cos(x + \frac{\pi}{4})}$$

stretch left in x direction (-1.29, 0)

stretch - scale factor $\frac{1}{\sqrt{3}}$ in y axis

Use the correct mathematical notation and terminology rather than 'calculator notation' or informal descriptions. Incorrect notation may result in loss of marks.

Answer the Q being asked

(a) Find an expression for θ in terms of r .

$$\frac{1}{2} 12\theta = 36.288$$

$$12\theta = 72.576$$

$$12 = \frac{72.576}{\theta}$$

$$r = \frac{72.576}{\theta}$$

Consider whether your numerical answer is reasonable and realistic in relation to the question being asked and that your final answer is what the question actually asked for.

No extra responses

(d) Explain why a country like Germany, with a higher median age than Cyprus, might also be expected to have a higher crude death rate than Cyprus. [1]

Germany has a much larger population than Cyprus and therefore will have more deaths (and death rate). Also, the median age of Germany is higher so Germany has an older population. Elderly people are more likely to die increasing crude death rate.

If correct responses are contradicted, marks can be lost. Avoid writing down everything you can think of; state only what is relevant.

Draw a diagram

5

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

$$4000 = 0 + at$$

$$4000 - 800 = 1200 \times a$$

$$3200 = 1200a$$

$$a = \frac{8}{3} \text{ ms}^{-2}$$

$$v = u + at$$

$$v = 0 + \frac{8}{3} \times 9$$

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

Drawing a diagram may help you get started on a problem and the evidence in your diagram may help to secure marks. A visual aid can also prompt you to check that all possible solutions have been identified.

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In context

(a) Find Sam's salary in the tenth year. [2]

$$a_1 = 16000 \quad a_2 = 17200 \quad d = 1200$$

$$a_{10} = 16000 + 1200(9) = 26800$$

B1

B0

If questions are set in a context then make sure your response is also in context when:

- offering explanations,
- discussing assumptions,
- suggesting improvements, or
- selecting appropriate units to express the answer in.

Extended response (5+marks)

Extended response questions generally involve some problem solving. Try to use all the given information in your response as this may warrant some method marks or lead you to the final answer.

Exact answers

12(b)

$$\frac{dy}{dx} = 6xa^{3x} \ln a$$

$$x=1, \frac{dy}{dx} = 6a^3 \ln a$$

line: $y = (6a^3 \ln a)x + c$

$$(1, a^3) = (6a^3 \ln a)(1) + c$$

$$(0, 1) = (6a^3 \ln a)(0.5) + c \quad c = -3a^3 \ln a$$

$$a^3 = 6a^3 \ln a - 3a^3 \ln a$$

$$a^3 = 3a^3 \ln a$$

$$1 = 3 \ln a$$

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

$$a = e^{\frac{1}{3}}$$

If a question asks for an exact answer it means not in rounded form and it may not be possible to get the answer directly from your calculator.

Determine

3(c) If all times were at the top of the class:

$$\frac{\sum x}{n} = \frac{590}{173} = 3.41 > 3 \therefore \text{is possible}$$

If you are asked to determine, you need to justify any results found; you can't just state the answer, even if you can generate it from the calculator.

Quadratic equations

$$3\cos^2\theta + 5\cos\theta - 2 = 0$$

let $X = \cos\theta$

$$3X^2 + 5X - 2 = 0$$

$$X = \frac{1}{3}, -2$$

$$\cos\theta = \frac{1}{3} \quad \cos\theta \neq -2$$

$$\theta = 1.107, 5.005$$

Calculators can be used to solve complex quadratic equations, but you must clearly show how you have manipulated the given equation into $ax^2 + bx + c$, stating any substitutions used. Any invalid roots should be explicitly rejected.

Trial and improvement

Standard methods should be used but marks may be awarded for trial and improvement if you show the calculations rejecting values on both sides of the solution.

Detailed reasoning

1. In this question you must show detailed reasoning.

Show that $\int_4^9 (2x + \sqrt{x}) dx = \frac{233}{3}$.

$$\int_4^9 (2x + \sqrt{x}) dx = \frac{2x^2}{2} + \frac{2x^{3/2}}{3/2} \Big|_4^9$$

$$= \left[x^2 + \frac{4}{3}x^{3/2} \right]_4^9$$

$$= \left(9^2 + \frac{4}{3} \times 9^{3/2} \right) - \left(4^2 + \frac{4}{3} \times 4^{3/2} \right)$$

$$= (81 + 18) - (16 + \frac{16}{3}) = 99 - \frac{64}{3} = \frac{233}{3}$$

It's always good practice to show workings but the statement 'In this question you must show detailed reasoning.' emphasises there are marks allocated for workings. You can still use your calculator to check the answer though.

Verify

13(b)(i) Area = πr^2 . when $y=0$ the cross sectional area needs to be modelled by C3.1 so set $y=0$

$$\text{Area} = \frac{\pi r^2 (h^2 - 0)}{h^2} = \frac{\pi r^2 h^2}{h^2} = \pi r^2 \text{ as required.}$$

If you are asked to verify a statement is correct then you need to show the substitution into the required calculation clearly.

Formulae and identities

7 The area of a sector of a circle is 36.288 cm^2 .

7(a)

$$36.288 = \frac{\theta}{360} \pi r^2$$

$$\theta = \frac{36.288 \times 360}{\pi r^2}$$

You are expected to recall a number of mathematical formulae and identities. These are listed in section 5d of the specification.

Further Maths knowledge

Further Maths techniques can be used in A Level Maths exams, but it is unlikely that a question will be set that can be answered more efficiently using these techniques.

Prove

5 Assume there is a largest prime number, list all the primes $p_1, p_2, p_3, \dots, p_n$. p_n is the largest prime.

$$q = p_1 \times p_2 \times p_3 \times \dots \times p_n + 1$$

The number q is the number = multiply all the primes and add 1

So q is larger than p_n

As there is no largest prime number, q is the next prime number should be q is not divisible by any of the primes so it is a new prime.

However, there is a remainder 1. The number is not divisible by any of the primes so it is a new prime.

So there is no largest prime number.

If you are asked to prove a mathematical statement, you will need to:

- clearly define variables,
- provide a valid mathematical argument with the correct algebraic manipulation, and
- state a concise conclusion.

Show that

(a) Show that $V = \frac{1}{3} \pi \sqrt{16r^2 - r^6}$.

5(a)

$$4r = \sqrt{r^2 - 1} \quad \frac{4}{r} = \sqrt{1 - \frac{1}{r^2}} \Rightarrow \frac{16}{r^2} = 1 - \frac{1}{r^2}$$

$$\frac{16}{r^2} - \frac{1}{r^2} = 1 - \frac{1}{r^2} - \frac{1}{r^2} = 1 - \frac{2}{r^2}$$

$$V = \frac{1}{3} \pi r^2 \sqrt{16 - \frac{2}{r^2}} \quad r^2 = r^2 \times \frac{16r^2 - 2}{16r^2}$$

$$= \frac{1}{3} \pi r^2 \times \frac{16r^2 - 2}{16r^2}$$

$$= \frac{1}{3} \pi \sqrt{16r^2 - 2}$$

If you are asked to show that a given result is true, your response must clearly show the steps to get from the starting statement to the given answer.

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Find, Solve, Calculate

(i) Find the probability that

9(a)(i) 0.761

If you are asked to find, solve or calculate, you will be awarded full marks for the correct answer without any justification. The solution could be obtained using the calculator or from a graph.

Plot

If you are asked to plot, you must mark points accurately on a graph. You may also need to join them with a curve or straight line or draw a line of best fit through them.

Give, State, Write down

(a) Write down the value of k . [1]

11(a) $k = -4$

The instruction to give, state or write down indicates that neither working nor justification is required. Fewer marks are likely to be available for these questions.

Explain

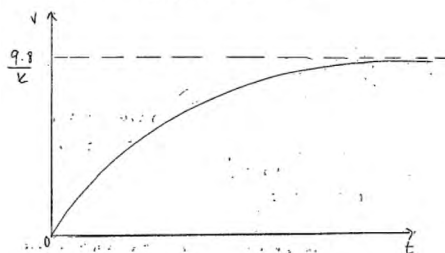
(b) Explain why model A is likely to underestimate the time taken.

16(b) there will be friction which will cause a to be lower therefore velocity will be less and \therefore taking more time.

Questions asking for explanations are looking for concise but sufficiently detailed statements. If two (or more) reasons are required then make sure you are not just writing the same thing in a different way.

Sketch

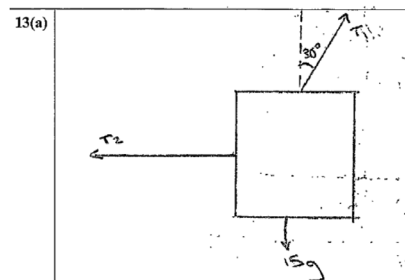
(b) Sketch the graph of v against t .



A sketch does not need to be to scale but it should show the main features. This could include turning points, asymptotes, x- and y-axes intersections and behaviour for large x .

Draw

(a) Draw a diagram showing the forces acting on the box.



If you are asked to draw a diagram, it should be to an appropriate accuracy for the problem. Include any labels, annotations, lengths or angles as these may justify marks.

Mechanics

Define variables

9(a) $t = 0.4$ $u = 0$ $0.5g \sin \theta - T = 0.5a$
 $s = 0.3$
 $a = ?$ $0.5g \sin \theta - T = 0.5 \times 3.75$
 $s = ut + \frac{1}{2}at^2$
 $0.3 = 0 + \frac{1}{2}a(0.4)^2$ $T = 0.5g \sin \theta - 15f$
 $0.3 = \frac{1}{2}a \times 0.16$ $= 0.5g \sin \theta (36.87) - 15f$
 $a = 0.3 \div \frac{1}{2} \times 0.16$ $= 1.065 \text{ N}$
 $= \frac{15f}{0.16} = 3.75 \text{ m s}^{-2}$ $= 1.07 \text{ N}$ (3 s.f.)
 $\tan \theta = \frac{3}{4} \Rightarrow \theta = \tan^{-1}(\frac{3}{4}) = 36.87$

Variables should be carefully defined to prevent unnecessary mistakes.

Connected particles

9(a) $\tan \theta = \frac{3}{4}$ $\cos \theta = \frac{4}{5}$ $\sin \theta = \frac{3}{5}$
 $0.3 = 0.75$ $a = 0.75$ 1.875 m s^{-2}
 $F = Ma$
 $0.2 \times 1.875 = T - F$
 $0.5 \times 1.875 = \frac{3}{5} \times 0.5g - T$
 $T = \frac{3}{10}g - 1.875 \times 0.5 = 2.94 - 0.9375 = 2.0025 \text{ N}$

When angles are given as an exact trig ratio, use Pythagoras' Theorem to determine the other ratios to avoid introducing rounding errors.

Connected particle questions are generally best solved by applying $F = ma$ to each particle separately rather than attempting to apply the equation to the whole system.

Vector and force diagrams

9(a) $T - fr = 0.2a$ (1) $s = 0.3$
 $T - 0.5g \sin \theta = 0.5a$ (2) $t = 0.4$
 $T - fr = 0.2(3.75)$ (1) $a = ?$
 $T - 0.5g(\frac{3}{5}) = 0.5(3.75)$ (2)
 $(1) - (2) \Rightarrow -fr + 0.5g(\frac{3}{5}) = -\frac{1}{8}$ $0.3 = 0(0.4) + \frac{1}{2}a(0.4)^2$
 $f = 4.065$ $a = 3.75$
 $T = 4.815$

When resolving vector quantities, draw a diagram, clearly labelling the directions and angles of the forces and the direction of motion/acceleration to minimise the risk of errors with sine/cosine.

Acceleration due to gravity

$V = u + at$
 $100 \sin 25 + (-9.8)t = 0$

Use $g = \pm 9.8 \text{ m s}^{-2}$ for acceleration due to gravity, unless otherwise stated in the question. Take care with direction to avoid sign errors.

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Statistics

Statistical tables

$$P(X < 120) = 0.0349 \text{ 4.d.p.}$$

Make sure you know how to use the statistical functions on your calculator to access probabilities from the binomial and normal distributions because only a table of the percentage points of the normal distribution are provided in the exams.

Summary statistics

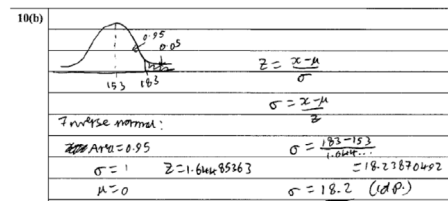
(b) Calculate the mean and standard deviation of these heights.

$$\begin{aligned} \text{8(b)} \quad & \text{mean} = 69 \\ & \text{standard deviation} = 10.5 \text{ (to 3sf)} \end{aligned}$$

Make sure you know how to use the statistical functions on your calculator to compute summary statistics and also which value to quote. There are two standard deviations listed on the calculator, S_x and σ_x .

Normal distribution

(b) Use the information above to find the standard deviation



When finding probabilities using the normal distribution, it can be useful to draw a sketch of the distribution to check the probabilities generated from the calculator are sensible.

Hypotheses

$$\begin{aligned} \text{12(b)} \quad & H_0: p = 0.06 \\ & H_1: p \neq 0.06 \end{aligned}$$

where p is the probability that a random jaguar selected in this population is a black panther.

Hypotheses should be stated in terms of parameter values (where relevant), which should be clearly defined.

Hypothesis test conclusion

Not signif. cant. \therefore Do not reject H_0 .
 \therefore There is insufficient evidence at the 5% significance level to suggest that the percentage of black panthers in this population is not 6%.

A hypothesis test conclusion is based only on the evidence suggested by that specific set of data and is not a statement of fact. The language used must acknowledge the uncertainty involved and be given in context.

Pre-release data set

All four show data by Local Authority District (LAD), or Unitary Authority (UA), for England and Wales. Each LAD/UA is also labelled with its region and its nine character geography code introduced from January 2011. The first three characters of the code provide information about the level of geography.

- 1 E00 Unitary authority in England
- 2 E07 Non-metropolitan district in England
- 3 E08 Metropolitan borough in England
- 4 E09 London borough
- 5 W00 Unitary authority in Wales

Make sure you are familiar with all the data categories in the large data set. Explanations are given in the information worksheet of the spreadsheet.

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