



Mark Scheme (Results)

Summer 2018

Pearson Edexcel GCE A Level Mathematics
Statistics & Mechanics (9MA0/03)

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General Marking Guidance

- x All candidates must receive the same treatment. Examiners must mark the last candidate in exactly the same way as they mark the first.
- x Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- x Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- x All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award marks for good answers that are not fully in line with the mark scheme. Examiners should mark according to the mark scheme.
- x Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification/indicative content will not be exhaustive.
- x When examiners are in doubt regarding the application of the mark scheme, they should refer to the mark scheme and consult the relevant subject leader before a mark is awarded.
- x Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

PEARSON EDEXCEL GCE MATHEMATICS

General Instructions for Marking

1. The total number of marks for the paper is 100.
2. These mark schemes use the following types of marks:

x M PDUNV 0HWKRG PDUNV DUH DZDUGHG IRU μNQRZLQJ D PH
 DSSO\ LW¶ XQOHVV RWKHUZZLVH LQGLFDWHG

- x A marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- x B marks are unconditional accuracy marks (independent of M marks)
- x Marks should not be subdivided.

3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes.

- x bod ±benefit of doubt
- x ft ±follow through
- x the symbol √ will be used for correct ft
- x cao ±correct answer only
- x cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- x isw ±ignore subsequent working
- x awrt ±answers which round to
- x SC: special case
- x o.e. ±or equivalent (and appropriate)
- x d or dep ±dependent
- x indep ±independent
- x dp decimal places
- x sf significant figures
- x ¿ The answer is printed on the paper or ag - answer given

4. All M marks are follow through.

\$ PDUNV DUH μFRUUHFW D)QmZShwRQfO e%ampLe As A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but answers that GRQ¶W ORJLFD00\ PDNH VHQVH H J a p r o b a b l y B e 1 v z + 0 U J L Y H Q I R should never be awarded A marks.

5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

6. Where a candidate has made multiple responses and indicates which response they wish to submit, examiners should mark this response.
If there are several attempts at a question which have not been crossed out, examiners should mark the final answer which is the answer that is the most complete.

7. Ignore wrong working or incorrect statements following a correct answer.

8. Mark schemes will firstly show the solution judged to be the most common response expected from candidates. Where appropriate, alternatives answers are provided in the notes. If examiners are not sure if an answer is acceptable, they will check the mark scheme to see if an alternative answer is given for the method used. If no such alternative answer is provided but the response is deemed to be valid, examiners must escalate the response for a senior examiner to review.

Section A: STATISTICS

Qu 1	Scheme										Marks	AO
(a)	c	0	1	2	3	4	5	6	7	8	B1 B1ft	1.2 1.2
	P(C = c)											
(b)	P(C < 4) = (accept 0.444 or better)										(2) B1	3.4
(c)	Probability lower than expected suggests model is not good										(1) B1ft	3.5a
(d)	e.g. Cloud cover will vary from month to month and place to place So e.g. use a non-uniform distribution										(1) B1	3.5c
											(5 marks)	
Notes												
(a)	<p>1st B1 for a correct set of values for Allow 2nd B1ft for correct prob from their values for, consistent with discrete X Q L I R U P G L Maybe as a prob. function. Allow $P(x) =$ for provided $x \in \{0, 1, 2, 3, 4, 5, 6, 7, 8\}$ clearly defined somewhere.</p>											
(b)	<p>B1 for using correct model to get (o.e.) SC 6 D P S O H V S D F H scored B0 B1 in (a) for this allow $P(C < 4) =$ to score B1 in (b)</p>											
(c)	<p>B1ft for comment that states that the model proposed is not a good one based on their model in part (a) and their probability in (b) (b) $\pm 0.315 > 0.05$ \$ O O R Z H J ³ L W L V Q R W V X L W D E O H ³ L V (b) $\pm 0.315 > 0.05$ Allow a comment that suggests it is suitable No prob in (b) Allow a comparison that mentions 50% or 0.5 and rejects the model No prob in (b) and no 50% or 0.5 or (b) > 1 scores B0 Ignore any comments about location or weather patterns.</p>											
(d)	<p>B1 for a sensible refinement considering variations in month or location - X V W V D \ L Q J ³ Q R W X Q L I R U P ³ L V % & R Q W H [W - X Q L I R U P ³ Allow mention of different locations, months and non-uniform or use more locations to form a new distribution with probabilities based on frequency & R Q W H [W ³ Allow mention of different locations, months and binomial Just refined model Model must be outlined and discrete non-uniform e.g. higher probabilities for more cloud cover or lower probabilities for less cloud cover Continuous model Any model that is based on a continuous distribution. e.g. normal is B0</p>											

Qu 2	Scheme	Marks	AO
<p>(a)</p> <p>Critical value: ± 0.6215 (Allow any cv in range $0.5 < cv < 0.75$) $r < \pm 0.6215$ so significant result and there is evidence of a negative correlation between w and t</p> <p>(b) e.g. As temperature increases people spend more time on the beach and time shopping(o.e.)</p> <p>(c) Sincer is close to ± 1, it is consistent with the suggestion</p> <p>(d) t will be the explanatory variable since sales are likely to depend on the temperature</p> <p>(e) Every degree rise in temperature leads to a drop in weekly earnings of $\pounds 1$</p>		B1	2.5
		M1	1.1a
		A1	2.2b
		(3)	
		B1	2.4
(1)			
B1	2.4		
(1)			
B1	2.4		
(1)			
B1	2.4		
(1)			
B1	3.4		
(1)			
(7 marks)			
Notes			
<p>(a)</p> <p>(b)</p> <p>(c)</p> <p>(d)</p> <p>(e)</p>	<p>B1 for both hypotheses in terms of M1 for the critical valuesight of ± 0.6215 or any cv such that $0.5 < cv < 0.75$ A1 must reject H_0 on basis of comparing ± 0.915 with ± 0.6215 (if $\pm 0.915 < 0.6215$ is seen then H_0 but may use o.e. which is fine) <u>and P H Q W L R Q ³ Q H J D W L Y H ³ F R U U H O V D V L Q R Q ³ U H O D W</u></p> <p>B1 for a suitable reason to explain negative correlation using the context given. H J As temperature drops people are more likely to go shopping to the beach) H J ³ \$ V W H P S H U D W X U H L Q F U H D V Q V L Q H R K S P O S H Z L C A mere description in context of negative correlation is B0 SO H J ³ \$ <u>earnings</u> F U H D V H V S H R S O H G R Q ¹ W Z D Q W W R H J ³ / H V V F O R W K H V Q H H G H G D V W H P S L Q F U H D V</p> <p>B1 for a suitable reason e.g. strong correlation close to 1 <u>and saying it is consistent with the suggestion</u> \$ O O R Z ³ \ H V ³ I R O O R Z H</p> <p>B1 For identifying and giving a suitable reason 1 H H G L G <u>Depends on</u> W or <u>responds to</u> or <u>affects</u> w R H Allow t (temperature) affects the other variable etc - X V W V D L V Q W K ³ H L Q G H S <u>to explain</u> change in D <u>is</u> B0 H ³ 1 % 6 X J J H V W L Q J F <u>because</u> W R Q G H V <u>is</u> H D W H ³</p> <p>B1 for a description that conveys the idea of rate per degree 0 X V W K D Y H F R Q G R Q H P L V V L Q J ³ ... ³ V L J Q</p>	B1	2.5
		M1	1.1a
		A1	2.2b
		(3)	
		B1	2.4
(1)			
B1	2.4		
(1)			
B1	2.4		
(1)			
B1	3.4		
(1)			
(7 marks)			

Qu 3	Scheme	Marks	AO										
(a)	The probability of a dart hitting the target is constant (from child to child and for each throw by each child) (o.e.)	B1	1.2										
	The throws of each of the darts are independent (o.e.)	B1	1.2										
		(2)											
	[$P(H = 4) = 1 - P(H = 3) = 1 - 0.9872 = 0.012795..$] awrt <u>0.0128</u>	B1	1.1b										
		(1)											
	(c) $P(F = 5) = \dots, = 0.06561$ $= \text{awrt } \underline{0.0656}$	M1, A1	3.4 1.1b										
		(2)											
	(d) <table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <td>n</td> <td>1</td> <td>2</td> <td>«</td> <td>10</td> </tr> <tr> <td>$P(F = n)$</td> <td>0.01</td> <td>$0.01 + D$</td> <td>«</td> <td>$0.01 + 9D$</td> </tr> </table> Sum of probs = 1 [i.e. $5(0.02 + 9D) = 1$ or $0.1 + 45D = 1$] so $D = \underline{0.02}$	n	1	2	«	10	$P(F = n)$	0.01	$0.01 + D$	«	$0.01 + 9D$	M1 M1A1 A1	3.1b 3.1a 1.1b 1.1b
	n	1	2	«	10								
	$P(F = n)$	0.01	$0.01 + D$	«	$0.01 + 9D$								
		(4)											
(e) $P(F = 7) = 0.09$	B1ft	3.4											
	(1)												
(f) <u>3 H W D P</u> assumes the probability of hitting target is constant (o.e.) and <u>Thomas</u> model assumes this probability increases with each attempt (o.e.)	B1	3.5a											
	(1)												
	(11 marks)												
	Notes												
(a)	1 st B1 for stating that the probability (or possibility or chance) is constant (or fixed or same) 2 nd B1 for stating that throws are independent > ³ W U L D O V ' D U H L Q G H S H Q												
(b)	B1 for awrt 0.0128 (found on calculator)												
(c)	M1 for a probability expression of the form where $0 < p < 1$ A1 for awrt 0.0656 SC Allow M1A0 for answer only of 0.066												
(d)	1 st M1 for setting up the distribution of with at least 3 correct values of n and $P(F = n)$ in terms of D (Can be implied by 2 nd M1 or 1 st A1) 2 nd M1 for use of sum of probs = 1 and clear summation or use of arithmetic series formula (allow 1 error or missing term) (Can be implied by 1 st A1) 1 st A1 for a correct equation for D 2 nd A1 for $D = 0.02$ (must be exact and come from correct working)												
(e)	B1ft for value resulting from $0.01 + 4 \times$ their D (provided D and the answer are probs) Beware If their answer is the same as their (c) (or a rounded version of their (c)) score												
(f)	B1 for a suitable comment about the probability of hitting the target ALT \$ O O R Z L G H D W K D W 3 H W D 1 V P R G H O V X J J H V W V W K H it will hit at least once (in the first 10 throws)												

Qu 4	Scheme	Marks	AO
(a)	Convenience or opportunity [sampling]	B1 (1)	1.2
(b)	Quota [sampling] e.g. Take 4 people every 10 minutes	B1 B1 (2)	1.1a 1.1b
(c)	Census	B1 (1)	1.2
(d)	[58 ±26 =] 32 (min)	B1 (1)	1.1b
(e)	« awrt 43.5 (min)	B1 M1 A1 (3)	1.1b 1.1b 1.1b
(f)	There are outliers in the data (or data is skew) which will affect mean and sd Therefore use median and IQR	B1 dB1 (2)	2.4 2.4
(g)	Value of 20, LQ at 26 and outliers will not change or state that median and upper quartile are the values that do change More values now below 40 than above Q ₂ or Q ₃ will change and be lower Both Q ₂ and Q ₃ will be lower	B1 M1 A1 (3)	1.1b 2.1 2.4
(13 marks)			
Notes			
(b)	1 st B1 for quota (sampling mentioned) 3 6 W U D W L I L H G ' R U 3 V \ V W H P D W 2 nd B1 for a description of how such a system might work, requires suitable strata or categories e.g. time slots, departments, gender, age groups, distance travelled etc Suggestion of randomness B0		
(e)	B1 for a correct mean (awrt 43.5) M1 for a correct expression for the (including) of their mean A1 for awrt 15.4 (Allow s « D Z U W		
(f)	1 st B1 for acknowledging outliers or skewness are a problem for mean and sd 3 H [W U H P H Y D O X H K M a y b e i m p l i e d b y s a y i n g m e d i a n a n d I Q R n o t a f f e c t e d We need to see mention of R X W O L H U V ' 3 V N H Z Q H V V ' D Q G W K H S P H G L D Q D Q G , 4 5 ' L V % X Q O H V V P H Q W L R Q W o r D e a n W I D Q G V W D Q G D U G G H Y L b y W e p o s i t i v e s t a t e E H 3 L Q I O D W H G 2 nd dB1 dep on 1 st B1 for therefore choosing median and IQR		
(g)	B1 for identifying 2 of these 3 groups of unchanged values or stating only Q ₂ and Q ₃ change M1 for explaining that median or UQ should be lower E.g. the 2 values have moved to below 40 (50) and therefore more than 50% below 40 (more than 75% below 50) or an argument to show that the other 3 values are the same (i.e.) Allow arrows on box plot provided statement in words about increased % below 40 or 50 etc A1 for stating median and UQ are both lower with clear evidence of M1 scored [If lots of values on 40 then median might not change but, since two values change then UQ would change. If this meant that 92 became an outlier then we would have a new value upper whisker and an extra outlier so effectively 3 values are altered. So median change		

Qu 5	Scheme	Marks	AO
(a)	$P(L > \dots)$	awrt 0.691	B1 (1) 1.1b
(b)	$P(L > 20 L > 16) = \dots$		M1 3.1b A1ft, A1 1.1b 1.1b
	For calc to work require	awrt <u>0.0396</u>	dM1 2.1 A1 1.1b (5)
(c)	Require: \dots	awrt <u>0.199</u> (*)	M1 1.1a A1ft 1.1b A1cso* 1.1b (3)
(d)	\dots $= P(Z > \dots)$ (0.0899 > 5%) or (19.2 < 19.5) or 1.34 < 1.6449 so not significant , Q V X I I L F L H Q W H Y L G H Q F H (or better: X S S R U W \$ O L		B1 2.5 M1 3.3 A1 3.4 A1 1.1b A1 3.5a (5)
Notes			
(a)	B1 for evaluating probability using their calculator (awrt 0.691) Accept 0.6915		
(b)	1 st M1 for a first step of identifying a suitable conditional probability (either form) 1 st A1ft for a ratio of probabilities with numerator = awrt 0.3091 ±(a) and denom = their (a) 2 nd A1 for awrt 0.446 (o.e.) Accept 0.4465 (from = 0.44645...) NB « V F R U H V 0 \$ \$ Z K H Q W K H \ G R «		
	2 nd M1 (dep on 1 st M1) for 2 nd correct step L H W K H L or X a % « 3 X B 4 3 rd A1 for awrt 0.0396		
(c)	1 st M1 for a correct approach to solving the problem (May be implied by A1ft) 1 st A1ft for $P(L > 4) = \text{awrt } 0.9998$ used and ft their 0.4462 in correct expression If use $P(L > 20) = 0.3085..$ as 0.446.. in (b) then M1 for ; A1ft as above		
*	2 nd A1cso for 0.199 or better with clear evidence of M1 [NB (0.4662..) is M0A0A0] Must see M1 scored by correct expression in symbols or values (M1A1ft)		
(d)	B1 for both hypotheses in terms of M1 for selecting a suitable model (Sight of normal mean 18, sd (o.e.) or variance = 0.8 1 st A1 for using the model correctly. Allow awrt 0.0899 or 0.09 from correct prob. statement		
ALT	CR ! « D F F H S Word V W .6449 (or better: calc. 6448536..) 2 nd A1 for correct non-contextual conclusion Wrong comparison or contradictions A0 Error giving 2 nd A0 implies 3 rd A0 but just a correct contextual conclusion can score A1A1 3 rd A1 dep on M1 and 1 st A1 for a correct contextual conclusion mentioning \$ O L F H ↑ W e l f e C or there is insufficient evidence that the mean lifetime is more than 18 hours		

Section B: MECHANICS

Question	Scheme	Marks	AOs
6.	Integrate v w.r.t. time	M1	1.1a
		A1	1.1b
	Substitute $a = 4$ and $t = 1$ into their	M1	1.1b
	or $(4, 32); (2, 2)$	A1	1.1b
		M1	1.1b
		A1	1.1b
		(6)	
(6 marks)			
Notes: Allow column vectors throughout			
<p>M1: At least one power increasing by 1. A1: Any correct (unsimplified) expression M1: Must have attempted to integrate $a = 4$ and $t = 1$ into their to produce 2 vectors (or 2 points if just working with coordinates). A1: $(4, 32)$ and $(2, 2)$. These can be seen or implied. M1: Attempt at distance of form $\sqrt{a^2 + b^2}$ for their points. Must have 2 non zero terms. A1: $\sqrt{16 + 4}$ or any equivalent surd (exact answer needed)</p>			

Question	Scheme	Marks	AOs
7(a)	Resolve vertically	M1	3.1b
		A1	1.1b
	Resolve horizontally	M1	3.1b
		A1	1.1b
	$F = 0.14R$	B1	1.2
	$a = 0.396$ or $0.40 \text{ (m}^{-2}\text{)}$	A1	2.2a
		(6)	
(b)	Pushing will increase R which will increase available F	B1	2.4
	Increasing F will <u>decrease</u> a * GIVEN ANSWER	B1*	2.4
		(2)	
(8 marks)			
Notes:			
<p>(a)</p> <p>M1: Resolve vertically with usual rules applying</p> <p>A1: Correct equation Neither g nor m need to be substituted</p> <p>M1: Apply $F = ma$ horizontally, with usual rules</p> <p>A1: Neither F nor m need to be substituted</p> <p>B1: $F = 0.14R$ seen (e.g. on a diagram)</p> <p>A1: Either answer</p>			
<p>(b)</p> <p>B1: Pushing increases R which produces an increase in available (limiting) friction</p> <p>B1: F increase produces <u>a decrease</u> (need to see this)</p> <p>N.B. It is possible to score 0% EXW IRU WKH % VRPH ³ H [S Of Doc W L R Q ' increased e.g. by pushing into the ground.</p>			

Question	Scheme	Marks	AOs
8(a)	Use of \int :	M1	3.1b
		A1	1.1b
		M1	1.1b
	$= 2.5 \text{ m s}^{-2} * \text{ GIVEN ANSWER}$	A1*	2.1
		(4)	
(b)	Use of \int =	M1	3.1b
	=	A1	1.1b
	\int = and	M1	3.1b
	$t = 2.5 \text{ (s)}$	A1	1.1b
		(4)	

(8 marks)

Notes: Allow column vectors throughout

(a)

No credit for individual component calculations

M1: Using a complete method to obtain the acceleration. N.B. Equation, in a only, could be obtained by two integrations

ALTERNATIVE

M1: Use velocity at half time ($t = 1$) = Average velocity over time period

So $at = 1$, so

N.B. could see as first line of working

A1: Correct a vector

M1: Attempt to find magnitude of \vec{v} using form

A1*: Correct GIVEN ANSWER obtained correctly

(b)

M1: Using a complete method to obtain the velocity \vec{v} by use of \int with $t = 2$ and $\vec{u} = 2\hat{i} - 3\hat{j}$ and their \vec{a}

OR: by use of

OR: by integrating \vec{a} , with addition of $\vec{C} = 2\hat{i} - 3\hat{j}$, and putting $t = 2$

A1: correct vector

M1: Complete method to find equation in t only

e.g. by using $\mathbf{v} = v_x \mathbf{i} + v_y \mathbf{j}$, with their i and j components

OR: by integrating (4+ 8.8), with addition of a constant, and equating i and j components

N.B. Must be equating i and j components of a velocity vector and must be their velocity \mathbf{A} to give an equation in t only for this M mark

A1: 2.5(s)

Question	Scheme	Marks	AOs
9(a)	Moments about A (or any other complete method)	M1	3.3
		A1	1.1b
	* GIVEN ANSWER	A1*	2.1
		(3)	
(b)	OR	M1	3.1b
		A1	2.2a
		(2)	
(c)	Resolve vertically OR Moments about B	M1	3.1b
	Or:	A1ft	1.1b
	N.B. May use $R \sin$ for Y and/or $R \cos$ for X throughout	A1	1.1b
	or =	M1	3.4
	=	A1	2.2a
		(5)	
(d)	and solve for x	M1	2.4
		A1	2.4
	Or just: , if no incorrect statement seen. N.B. If the correct inequality is not found, their comment must mention μ	B1 A1	2.4
		(3)	
			(13marks)

Notes:

(a)

M1: Using $M(A)$, with usual rules or any other complete method to obtain an equation in x and T only.

A1: Correct equation

A1*: Correct PRINTED ANSWER correctly obtained, need to see $\frac{1}{2}Mg$ used.

(b)

M1: Using an appropriate strategy to find x . e.g. Resolve horizontally with usual rules applying OR Moments about C . Must use the given expression for T .

A1: Accept $0.6\bar{3}$ or better

(c)

M1: Using a complete method to find Y (or $R\sin\theta$) e.g. resolve vertically or Moments about B , with usual rules

A1 ft: Correct equation with their x substituted in T expression or using

A1: Y (or $R\sin\theta$) = $\frac{1}{2}Mg$ or $2.5Mg$ or $2.50Mg$

M1: For finding an equation in $\tan\theta$ only using $\frac{1}{2}Mg$ or $2.5Mg$

This is independent but must have found a

A1: Accept $\frac{1}{2}$ if it follows from their working.

(d)

M1: Allow $T = 5Mg$ or $T < 5Mg$ and solves for x , showing all necessary steps ($0 < T < 5Mg$)

A1: Allow $x = 0$ or $x = 1$. Accept $1.7a$ or better

B1: Treat as A1. For any appropriate equivalent fully correct comment or statement. E.g. maximum value of x is 1

Question	Scheme	Marks	AOs
10(a)	Using the model and vertical motion:	M1	3.3
	* GIVEN ANSWER	A1*	2.2a
		(2)	
(b)	Using the model and horizontal motion or ut	M1	3.4
		A1	1.1b
	Using the model and vertical motion:	M1	3.4
		A1	1.1b
	sub fort:	M1 (I)	3.1b
	sub for	M1(II)	3.1b
		A1(I)	1.1b
		M1(III)	1.1b
	or better	A1(II)	2.2a
		(9)	
	N.B. For the last 5 marks, they may set up a quadratic by substituting for U_{sin} first, then solve the quadratic to find the value, then use to find . The marks are the same but earned in a different order. Enter on ePen in the corresponding M and A boxes above, as indicated below.		
	Sub for U_{sin} to give equation in t only	M1(II)	
		A1(I)	
	Solve for t	M1(III)	
	and use	M1(I)	
	or better	A1(II)	
(b)	ALTERNATIVE		

	Using the model and horizontal motion on ut	M1	3.4
		A1	1.1b
	A to top: <u>and</u> top to T:		
	=> <u>and</u> => Total time t =	M1	3.4
	=	A1	1.1b
	(sub. fort)	M1	3.1b
	(sub. forU)	M1	3.1b
		A1	1.1b
	Solve for	M1	1.1b
	or better	A1	2.2a
		(9)	
(c)	The target will have dimensions so in practice there would be a range of possible values of Or There will be air resistance Or The ball will have dimensions Or Wind effects Or Spin of the ball	B1	3.5b
		(1)	
(d)	Find U using their e.g. U =	M1	3.1b
	Use (or use vertical motion equation)	A1 M1	1.1b
		B1 A1	1.1b
		(3)	
(d)	ALTERNATIVE		

N.B. If they quote the equation of the trajectory oeAND put in values for
and, could score first 5 marks, M1A1M1A1M1 (nothing for the equation only); wrong value loses first A
mark and wrong value loses second A mark

(c)

B1: Give one limitation of the model: the ball will have dimension or there will be air resistance
wind effects or spin

N.B. B0 if any incorrect extra(s) but ignore extra consequences.

(d)

M1: Using their U to find a value for t

A1: Treat as M1: Using their U to find a value for t

B1: Treat as A1 : $t = 1.1$ or 1.10 (since depends on $g = 9.8$)

(d) ALTERNATIVE

M1: Using their U to find a value for t

A1: Treat as M1: Using their U to find a value for t

B1: Treat as A1 : $t = 1.1$ or 1.10 (since depends on $g = 9.8$)

