Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number

Candidate Number

Mathematics
Advanced
Paper 3: Statistics and Mechanics

Sample Assessment Material for first teaching September 2017
Time: 2 hours

Paper Reference
9MA0/03

You must have:
Mathematical Formulae and Statistical Tables, calculator

Total Marks

Candidates may use any calculator permitted by Pearson regulations. Calculators must not have the facility for algebraic manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- There are **two** sections in this question paper. Answer **all** the questions in Section A and **all** the questions in Section B.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Answers should be given to three significant figures unless otherwise stated.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 10 questions in this question paper. The total mark for this paper is 100.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- If you change your mind about an answer cross it out and put your new answer and any working out underneath.

Turn over

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SECTION A: STATISTICS

Answer ALL questions. Write your answers in the spaces provided.

1. The number of hours of sunshine each day, y, for the month of July at Heathrow are summarised in the table below.

Hours	$0 \leqslant y < 5$	$5 \leqslant y < 8$	$8 \leqslant y < 11$	$11 \leqslant y < 12$	$12 \leqslant y < 14$
Frequency	12	6	8	3	2

A histogram was drawn to represent these data. The $8 \leqslant y < 11$ group was represented by a bar of width 1.5 cm and height 8 cm.

(a) Find the width and the height of the $0 \leqslant y < 5$ group.

(3)

(b) Use your calculator to estimate the mean and the standard deviation of the number of hours of sunshine each day, for the month of July at Heathrow.
Give your answers to 3 significant figures.

(3)

The mean and standard deviation for the number of hours of daily sunshine for the same month in Hurn are 5.98 hours and 4.12 hours respectably.
Thomas believes that the further south you are the more consistent should be the number of hours of daily sunshine.

(c) State, giving a reason, whether or not the calculations in part (b) support Thomas' belief.

(2)

(d) Estimate the number of days in July at Heathrow where the number of hours of sunshine is more than 1 standard deviation above the mean.

(2)

Helen models the number of hours of sunshine each day, for the month of July at Heathrow by $N(6.6, 3.7^2)$.

(e) Use Helen's model to predict the number of days in July at Heathrow when the number of hours of sunshine is more than 1 standard deviation above the mean.

(2)

(f) Use your answers to part (d) and part (e) to comment on the suitability of Helen's model.

(1)

include 8 — don't include 11

(a) We are given that $8 \leq y < 11$ is 1.5 units wide $\therefore 11-8=3$ $\frac{1.5}{3}=\frac{1}{2}$ cm (on x axis)

The area of $8 \leq y < 11$ is $1.5 \times 8 = 12\text{cm}^2$ for 8 freq. → 12 : 8 $1\text{cm}^2 = \frac{8}{12} = \frac{2}{3}$ hour M1

For $0 \leq y < 5$:

$(5-0) \times \frac{1}{2} = 2.5\text{cm}$ width B1

Freq. 12 hours $\frac{12}{2/3} = 18\text{cm}^2$ area

$\frac{18}{2.5} = 7.2\text{cm}$ height M1

Question 1 continued

(b) Formula for mean:

$\bar{x} = \frac{\Sigma x}{n}$ $\bar{y} = \frac{205.5}{31} = 6.63$ B1

Formula for SD:

$\sigma = \sqrt{\frac{\Sigma x^2}{n} - \left(\frac{\Sigma x}{n}\right)^2}$ $\sigma = \sqrt{\frac{1785.25}{31} - \bar{y}^2} = \sqrt{13.6446...} = 3.69$ to 3sf M1A1

(c) Mean for Heathrow is higher than Hurn and standard deviation is smaller, hence Heathrow is more reliable. M1

Hurn is south of Heathrow ∴ his belief is not supported A1

(d) "1 standard deviation above the mean": $\bar{x} + \sigma$

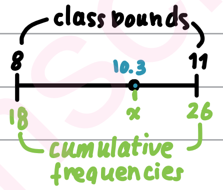
$= 5.98 + 4.12$

$= 10.3$ hours M1

We have to use linear interpolation

$8 \leq y < 11$
8

← It's within this class!



linear interpolation: $\frac{x - 5}{8} = \frac{11 - 10.3}{3}$ (# of days) $x = \left(\frac{11-10.3}{3}\right) \times 8 + 5$

$x = 6.86 \longrightarrow 7$ days (round up) A1

(e) $H \longrightarrow$ # of hours define variable

$P(H > 10.3) = 0.15865$ M1

to get # of days in July: $31 \times 0.15865 = 4.9$ ∴ 5 days A1

(f) $4.9 < 6.6$ so the model may not be suitable as the mean we got is not the one she used B1

(Total for Question 1 is 13 marks)

2. A meteorologist believes that there is a relationship between the daily mean windspeed, w kn, and the daily mean temperature, t °C. A random sample of 9 consecutive days is taken from past records from a town in the UK in July and the relevant data is given in the table below.

t	13.3	16.2	15.7	16.6	16.3	16.4	19.3	17.1	13.2
w	7	11	8	11	13	8	15	10	11

The meteorologist calculated the product moment correlation coefficient for the 9 days and obtained $r = 0.609$

(a) Explain why a linear regression model based on these data is unreliable on a day when the mean temperature is 24 °C

(1)

(b) State what is measured by the product moment correlation coefficient.

(1)

(c) Stating your hypotheses clearly test, at the 5% significance level, whether or not the product moment correlation coefficient for the population is greater than zero.

(3)

Using the same 9 days a location from the large data set gave $\bar{t} = 27.2$ and $\bar{w} = 3.5$

(d) Using your knowledge of the large data set, suggest, giving your reason, the location that gave rise to these statistics.

(1)

(a) It would be extrapolation as 24°C is not within data range B1

(b) The linear association between w and t B1

(c) Hypotheses

$H_0: \rho = 0$ from tables critical value: ±0.5822 M1

$H_1: \rho > 0$ B1 $0.582 < 0.602$ hence there is sufficient evidence to reject H_0. There is evidence that the PMCC is larger than 0. A1

(d) The higher mean $\bar{t}$ suggests the location is overseas and not Perth. However the wind speed $\bar{w}$ is lower, suggesting it's not close to an ocean. ∴ Beijing

B1

Question 2 continued

(Total for Question 2 is 6 marks)

3. A machine cuts strips of metal to length L cm, where L is normally distributed with standard deviation 0.5 cm.

Strips with length either less than 49 cm or greater than 50.75 cm **cannot** be used.

Given that 2.5% of the cut lengths exceed 50.98 cm,

(a) find the probability that a randomly chosen strip of metal **can** be used.

(5)

Ten strips of metal are selected at random.

(b) Find the probability fewer than 4 of these strips **cannot** be used.

(2)

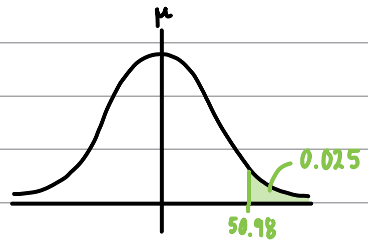
A second machine cuts strips of metal of length X cm, where X is normally distributed with standard deviation 0.6 cm

A random sample of 15 strips cut by this second machine was found to have a mean length of 50.4 cm

(c) Stating your hypotheses clearly and using a 1% level of significance, test whether or not the mean length of all the strips, cut by the second machine, is greater than 50.1 cm

(5)

(a) $L \sim N(\mu, 0.5^2)$



Given that

$P(L > 50.98) = 0.025$ A1

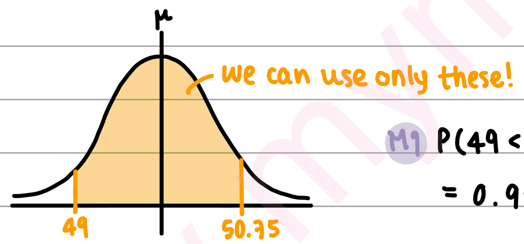
Let's convert to standard normal, $N(0,1^2)$:

$\frac{50.98-\mu}{0.5} = \text{Inv}(0.025) = 1.96$ M1

solve for μ

$\mu = 50.98 - 0.5(1.96)$

$\mu = 50$ A1



M1 $P(49 < L < 50.75)$ using $N(50, 0.5^2)$

$= 0.9104 \longrightarrow$ 0.910 to 3sf A1

(b) $S \rightarrow$ # of strips that can't be used   define variable

→ In (a) we got $p = 0.910$ that a strip can be used!

∴ p that a strip can't be used is $1 - 0.910 = 0.09$

$S \sim B(10, 0.09)$ M1

$P(S \leq 3) = 0.99116 \longrightarrow$ 0.991 to 3sf A1

Question 3 continued

(c) This part talks about "mean" ∴ we will use $\bar{X}$ (sample mean) variable

Formula for Sample mean:

$X \sim N(\mu, \sigma^2) \longrightarrow \bar{X} \sim N(\mu, \frac{\sigma^2}{n})$

Apply the formula.

enter $\frac{0.6}{\sqrt{15}} = \sigma$ into your calculator!

$X \sim N(50.1, 0.6^2) \longrightarrow \bar{X} \sim N(50.1, \frac{0.6^2}{15})$ M1

found value — significance level

Hypotheses

$H_0: \mu = 50.1$ B1

$H_1: \mu > 50.1$

$P(\bar{X} > 50.4) = 0.0264 > 0.01$ A1 A1

∴ 50.4 does fall in the critical region and there is insufficient evidence to reject H_0 and that the mean length of strips is greater than 50.1. A1

(Total for Question 3 is 12 marks)

4. Given that

$$P(A) = 0.35 \qquad P(B) = 0.45 \qquad \text{and} \qquad P(A \cap B) = 0.13$$

find

(a) $P(A' \mid B')$ **(2)**

(b) Explain why the events A and B are not independent. **(1)**

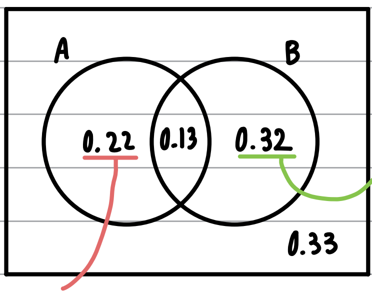
The event C has $P(C) = 0.20$

The events A and C are mutually exclusive and the events B and C are statistically independent.

(c) Draw a Venn diagram to illustrate the events A, B and C, giving the probabilities for each region. **(5)**

(d) Find $P([B \cup C]')$ **(2)**

(a)

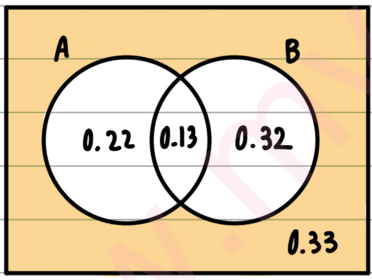


$P(B) - P(A \cap B)$

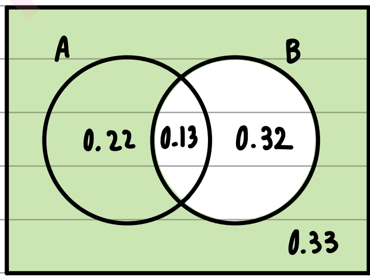
$P(A) - P(A \cap B)$

Formula for "Given":

$$P(A \mid B) = \frac{P(A \cap B)}{P(B)}$$



$P(A' \cap B') = 0.33$



$P(B') = 0.55$

$$P(A' \mid B') = \frac{P(A' \cap B')}{P(B')}$$

$$= \frac{0.33}{0.55} \quad \text{M1}$$

$$= \frac{3}{5} \quad \text{A1}$$

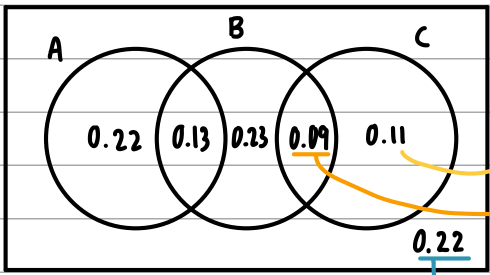
(b) Formula for independent events:

$$P(A) \times P(B) = P(A \cap B)$$

$$P(A) \times P(B) = \frac{7}{20} \times \frac{9}{20} = \frac{63}{400} \neq P(A \cap B) = \frac{52}{400} \quad \text{B1}$$

Question 4 continued

(c)



As B and C are Independent

Formula for independent events:

P(A) × P(B) = P(A ∩ B)

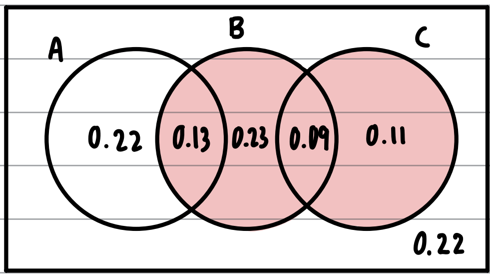
0.2 − 0.09 = 0.11

P(B) × P(C) = P(B ∩ C)

0.45 × 0.2 = 0.09 = P(B ∩ C) M1A1

B1M1A1 1 − 0.22 − 0.13 − 0.23 − 0.09 − 0.11 = 0.22

(d)



P(B∪C) is shaded in red.

We want everything except this area.

∴ 1 − P(B∪C) = 1 − (0.13 + 0.23 + 0.09 + 0.11) M1

= 1 − 0.56

= 0.44 A1

(Total for Question 4 is 10 marks)

5. A company sells seeds and claims that 55% of its pea seeds germinate.

(a) Write down a reason why the company should not justify their claim by testing all the pea seeds they produce.

(1)

A random selection of the pea seeds is planted in 10 trays with 24 seeds in each tray.

(b) Assuming that the company's claim is correct, calculate the probability that in at least half of the trays 15 or more of the seeds germinate.

(3)

(c) Write down two conditions under which the normal distribution may be used as an approximation to the binomial distribution.

(1)

A random sample of 240 pea seeds was planted and 150 of these seeds germinated.

(d) Assuming that the company's claim is correct, use a normal approximation to find the probability that at least 150 pea seeds germinate.

(3)

(e) Using your answer to part (d), comment on whether or not the proportion of the company's pea seeds that germinate is different from the company's claim of 55%

(1)

(a) The seeds would be destroyed by this process so they would have none left to sell B1

(b) S → # of seeds that germinate *define variable*

$S \sim B(24, 0.55)$

T → # of trays with at least 15 germinating *define second variable*

$T \sim B(10, p)$ M1

$p = P(S \geq 15) = 1 - P(S \leq 14)$ *15-1 so that 15 is included*

$= 0.29914$ A1

$P(T \geq 5) = 0.1487... \rightarrow 0.149$ to 3sf A1

(c) n is large and p close to 0.5 B1

(d) $Y \sim B(240, 0.55)$

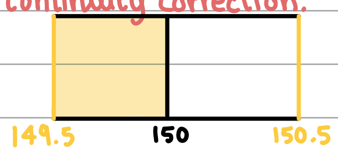
mean formula for binomial: np $\quad 240 \times 0.55 = 132$

variance formula for binomial: $np(1-p)$ $\quad 132(1-0.55) = 59.4$ *this is σ^2 ∴ $\sigma = \sqrt{59.4}$*

$X \sim N(132, \sqrt{59.4}^2)$ B1

$P(X \geq 149.5) = 0.01158 \longrightarrow 0.0116$ to 3sf M1 A1

continuity correction:



Question 5 continued

(e) the probability is very small, ∴ there is an indication that their claim is incorrect B1

(Total for Question 5 is 9 marks)

TOTAL FOR SECTION A IS 50 MARKS

SECTION B: MECHANICS

Answer ALL questions. Write your answers in the spaces provided.

Unless otherwise indicated, whenever a numerical value of g is required, take $g = 9.8$ m s^{-2} and give your answer to either 2 significant figures or 3 significant figures.

6. At time t seconds, where $t \geqslant 0$, a particle P moves so that its acceleration $\mathbf{a}$ m s^{-2} is given by

$$\mathbf{a} = 5t\mathbf{i} - 15t^{\frac{1}{2}}\mathbf{j}$$

When $t = 0$, the velocity of P is $20\mathbf{i}$ m s^{-1}

Find the speed of P when $t = 4$

(6)

To get velocity from acceleration we need to integrate M1

$$v = \int a\,dt = \int 5ti - 15t^{\frac{1}{2}}j$$

★ Simple Integration: $\int x^n\,dx = \frac{1}{n}x^{n+1} + c$

$$= \frac{5}{2}t^2 i - \frac{15}{\frac{3}{2}}t^{\frac{3}{2}} j + c \quad \text{A1}$$

$$= \frac{5}{2}t^2 i - 10t^{\frac{3}{2}} j + c$$

Substitute $t=0$, $v = 20i$

$$20i = \frac{5}{2}(0)^2 i - 10(0)^{\frac{3}{2}} j + c$$

$$c = 20i \quad \text{A1}$$

$$\therefore \quad v = \left(\frac{5}{2}t^2 + 20\right)i - 10t^{\frac{3}{2}} j$$

Substitute $t=4$:

$$v = \left(\frac{5}{2}(4)^2 + 20\right)i - 10(4)^{\frac{3}{2}} j$$

$$v = 60i - 80j \quad \text{M1}$$

To get the speed we need to calculate the magnitude, $|v|$, using the Pythagoras' Theorem

$$|v| = \sqrt{60^2 + (-80)^2} \quad \text{M1}$$

$$\text{speed} = 100\text{ms}^{-1} \quad \text{A1}$$

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Question 6 continued

(Total for Question 6 is 6 marks)

7. A rough plane is inclined to the horizontal at an angle α, where $\tan\alpha = \frac{3}{4}$.

A particle of mass m is placed on the plane and then projected up a line of greatest slope of the plane.

The coefficient of friction between the particle and the plane is μ.

The particle moves up the plane with a constant deceleration of $\frac{4}{5}g$.

(a) Find the value of μ.

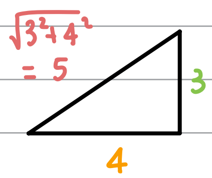
(6)

The particle comes to rest at the point A on the plane.

(b) Determine whether the particle will remain at A, carefully justifying your answer.

(2)

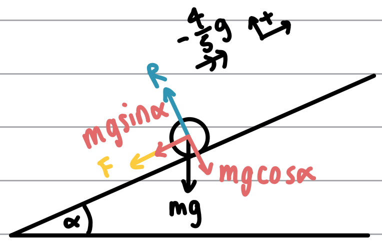
$\tan\alpha = \frac{3}{4}$



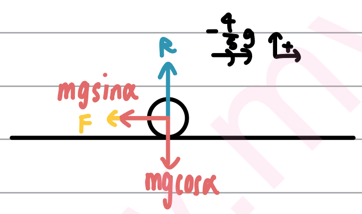
$\therefore \cos\alpha = \frac{4}{5}$

$\sin\alpha = \frac{3}{5}$

(a) Diagram



↓ turn axis



Resolve Vertically. As it's not moving in the y-axis we use

$\Sigma F_y = 0$

$R = mg\cos\alpha = \frac{4}{5}mg$ B1

Resolve horizontally. Since it's accelerating use $\Sigma F_x = ma$

$-F - mg\sin\alpha = -\frac{4}{5}mg$ M1A1

Since it's moving, F is maximum $\therefore$ $F = \mu R$

$F = \mu \times \frac{4}{5}mg$ M1

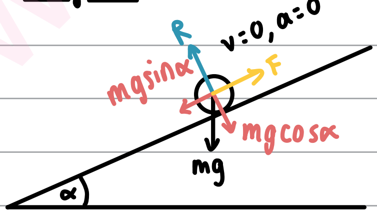
Substitute: $-F - mg\sin\alpha = -\frac{4}{5}mg$

$-\frac{4}{5}\mu mg - \frac{3}{5}mg = -\frac{4}{5}mg$ cancel mg

$-\frac{4}{5}\mu = -\frac{1}{5}$ M1

$\mu = \frac{1}{4}$ value of μ A1

(b) Diagram at Point A



At Point A, the friction will act upwards since friction opposes the tendency to move and at A the particle will tend to slide down due to the horizontal component of the weight.

$F = \frac{1}{4}mg \times \frac{4}{5} = \frac{mg}{5}$ friction

$mg\sin\alpha = \frac{3}{5}mg$ M1

Since $\frac{3}{5}mg > \frac{mg}{5}$ the force down the plane is larger than friction and the particle slides down (does not remain at A) A1

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Question 7 continued

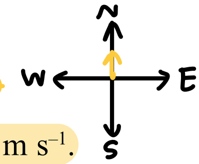
(Total for Question 7 is 8 marks)

8. [*In this question* **i** *and* **j** *are horizontal unit vectors due east and due north respectively*]

A radio controlled model boat is placed on the surface of a large pond.

The boat is modelled as a particle.

At time $t = 0$, the boat is at the fixed point O and is moving due north with speed 0.6 m s^{-1}.



Relative to O, the position vector of the boat at time t seconds is **r** metres. d

At time $t = 15$, the velocity of the boat is $(10.5\mathbf{i} - 0.9\mathbf{j})$ m s^{-1}. v

The acceleration of the boat is constant.

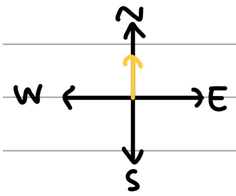
(a) Show that the acceleration of the boat is $(0.7\mathbf{i} - 0.1\mathbf{j})$ m s^{-2}.
(2)

(b) Find **r** in terms of t.
(2)

(c) Find the value of t when the boat is north-east of O.
(3)

(d) Find the value of t when the boat is moving in a north-east direction.
(3)

(a) at $t=0$, velocity:



$\therefore$ parallel to j (i-comp = 0!) + speed = 0.6ms^{-1}

Hence at $t=0$, $v = (0.6\mathbf{j})$ ms^{-1}

Now use suvat

s
$u = (0.6\mathbf{j})$ms^{-1}
$v = (10.5\mathbf{i} - 0.9\mathbf{j})$ms^{-1}
$a = (p\mathbf{i} + q\mathbf{j})$ms^{-1} ← define this unknown
$t = 15$

Use formula:

$v = u + at$

$(10.5\mathbf{i} - 0.9\mathbf{j}) = (0.6\mathbf{j}) + (p\mathbf{i} + q\mathbf{j}) \times 15$ M1

Equate components:

i: $10.5\mathbf{i} = 0 + 15p\mathbf{i}$

$p = \frac{10.5}{15} = 0.7$

j: $-0.9\mathbf{j} = 0.6\mathbf{j} + 15q\mathbf{j}$

$-0.15\mathbf{j} = +15q\mathbf{j}$

$q = -0.1$

Hence $a = (p\mathbf{i} + q\mathbf{j})$ms^{-2} = $(0.7\mathbf{i} - 0.1\mathbf{j})$ms^{-2} shown A1

Question 8 continued

(b) Use suvat

$r = r$ (s)

$u = (0.6j)\,ms^{-1}$

$v = (10.5i - 0.9j)\,ms^{-1}$

$a = (0.7i - 0.1j)\,ms^{-1}$

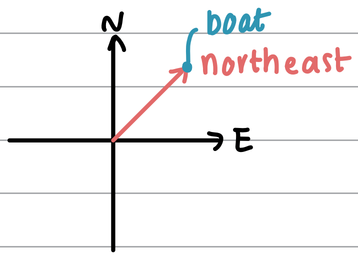
$t = 15$

Use formula

$s = ut + \frac{1}{2}at^2$ M1

$r = 0.6jt + \frac{1}{2}(0.7i - 0.1j)t^2$ A1

(c)



Equate i and j components of r to get t: M1

$\frac{1}{2}(0.7)t^2 = 0.6t - 0.05t^2$ A1

$0.35t^2 = 0.6t - 0.05t^2$

$0.4t^2 - 0.6t = 0$

$t(0.4t - 0.6) = 0$

$t = 0$, $t = 1.5$ s A1

(d) As now it's moving in the north-east direction, we have to get an equation for v at time t.

Use suvat

$r = r$ (s)

$u = (0.6j)\,ms^{-1}$

$v = v$ ms^{-1}

$a = (0.7i - 0.1j)\,ms^{-1}$

$t = t$

Use formula

$v = u + at$

$v = (0.6j) + (0.7i - 0.1j)t$ M1

Equate i and j components of v to get t: M1

$0.7it = 0.6j - 0.1jt$

$0.7t + 0.1t = 0.6$

$0.8t = 0.6$

$t = \frac{3}{4} = 0.75$ A1

(Total for Question 8 is 10 marks)

9.

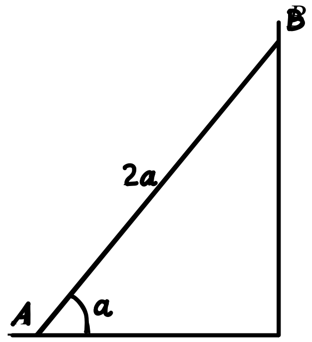


Figure 1

center of mass at middle

A uniform ladder AB, of length $2a$ and weight W, has its end A on rough horizontal ground.

The coefficient of friction between the ladder and the ground is $\frac{1}{4}$. μ

The end B of the ladder is resting against a smooth vertical wall, as shown in Figure 1.

A builder of weight $7W$ stands at the top of the ladder.
To stop the ladder from slipping, the builder's assistant applies a horizontal force of magnitude P to the ladder at A, towards the wall.
The force acts in a direction which is perpendicular to the wall.

The ladder rests in equilibrium in a vertical plane perpendicular to the wall and makes an angle α with the horizontal ground, where $\tan\alpha = \frac{5}{2}$.

The builder is modelled as a particle and the ladder is modelled as a uniform rod.

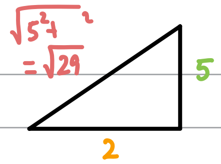
(a) Show that the reaction of the wall on the ladder at B has magnitude $3W$.
S
(5)

(b) Find, in terms of W, the range of possible values of P for which the ladder remains in equilibrium.
(5)

Often in practice, the builder's assistant will simply stand on the bottom of the ladder.

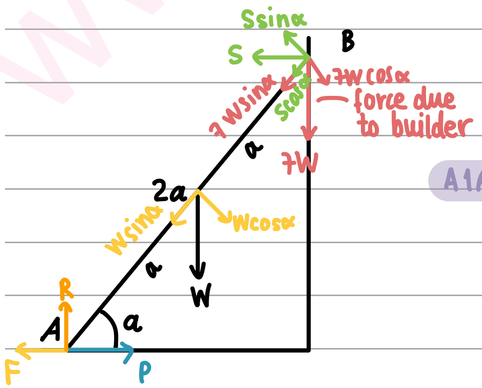
(c) Explain briefly how this helps to stop the ladder from slipping.
(3)

$\tan\alpha = \frac{5}{2}$



$\therefore \cos\alpha = \frac{2}{\sqrt{29}}$
$\sin\alpha = \frac{5}{\sqrt{29}}$

(a) Diagram



We will take moments about A: ☆ We take moments about A because this way, the perpendicular distance to R, F and P is 0. So we don't need to consider R, F and P, making our moments equation much simpler.

$\Sigma M_A = 0$ M1

$aW\cos\alpha + 2a\,7W\cos\alpha = 2aS\sin\alpha$

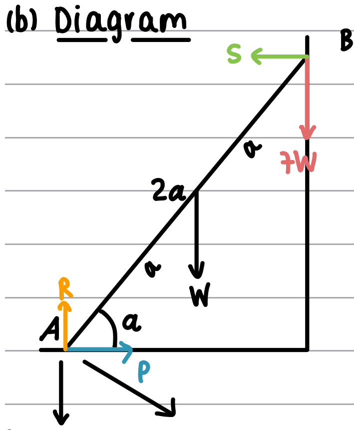
A1A1 $W \times \frac{2}{\sqrt{29}} + 2\,7W \times \frac{2}{\sqrt{29}} = 2S \times \frac{5}{\sqrt{29}}$

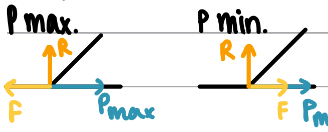
$2W + 28W = 10S$ M1

A1 $\frac{30}{10}W = S$ $S = 3W$ hence shown

Question 9 continued

(b) Diagram





when F acts towards the wall

When F is away from the wall

$\Sigma F_y = 0$

$R = W + 7W$

$R = 8W$ B1

At limiting equilibrium $F = \mu R$

$F = \frac{1}{4} \times 8W = 2W$ M1

$\Sigma F_x = 0$

P_{max}: $S + F = P_{max}$

$3W + 2W = P_{max}$ M1

$P_{max} = 5W$ A1

P_{min}: $S - F = P_{min}$

$3W - 2W = P_{min}$

$P_{min} = W$

Hence the range of values of P:

$W \leq P \leq 5W$ A1

(c) M(A) does not change as in either case P's perpendicular distance from A is 0. M1

R will increase as there are more forces downwards now $(P + W + 7W)$. M1

As $R\uparrow$, F_{max} also increases, so the ladder doesn't slip. M1

Question 9 continued

Question 9 continued

(Total for Question 9 is 13 marks)

10.

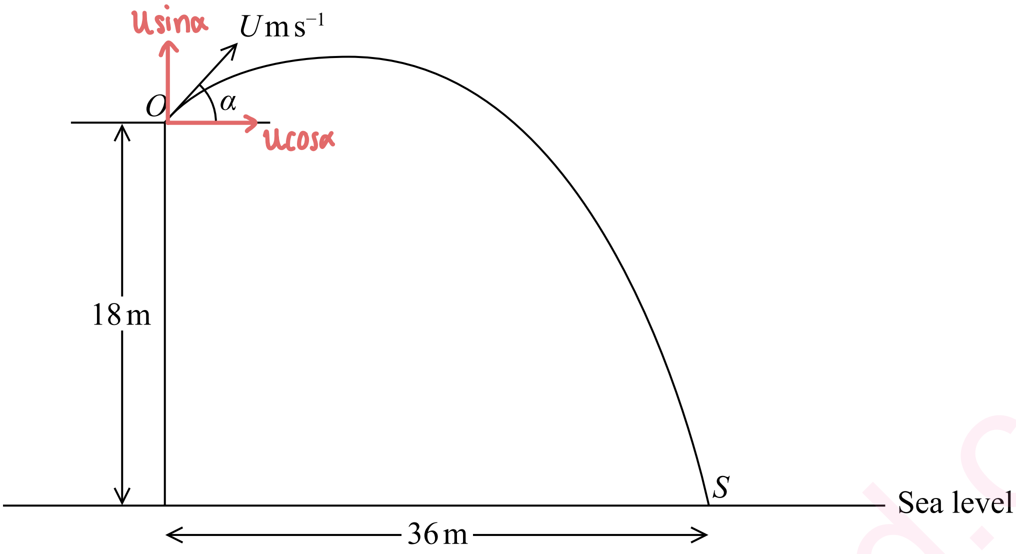


Figure 2

A boy throws a stone with speed U m s^{-1} from a point O at the top of a vertical cliff.
The point O is 18 m above sea level.

The stone is thrown at an angle α above the horizontal, where $\tan\alpha = \frac{3}{4}$.

The stone hits the sea at the point S which is at a horizontal distance of 36 m from the foot of the cliff, as shown in Figure 2.
The stone is modelled as a particle moving freely under gravity with $g = 10$ m s^{-2}

Find

(a) the value of U,

(6)

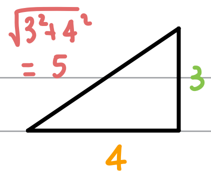
(b) the speed of the stone when it is 10.8 m above sea level, giving your answer to 2 significant figures.

(5)

(c) Suggest two improvements that could be made to the model.

(2)

$\tan\alpha = \frac{3}{4}$



$\therefore \cos\alpha = \frac{4}{5}$
$\sin\alpha = \frac{3}{5}$

Question 10 continued

(a) Horizontal motion $\overset{+}{\rightarrow}$ Vertical motion ↑+

$s = ut$ M1 $s = -18$ Use formula

$36 = Ut\cos\alpha$ A1 $u = u\sin\alpha$ $s = ut + \frac{1}{2}at^2$ M1

$36 = \frac{4}{5}ut$ $a = -10$

$\frac{45}{u} = t$ $t = t$ $-18 = tu\sin\alpha + \frac{1}{2}(-10)t^2$ A1

substitute →

$-18 = \frac{3}{5}ut - 5t^2$ M1

$-18 = \frac{3}{5}u\left(\frac{45}{u}\right) - 5\left(\frac{45}{u}\right)^2$

$-18 = 27 - 5\left(\frac{45^2}{u^2}\right)$

$\frac{45}{5} = \frac{45^2}{u^2}$

$u^2 = 5\left(\frac{45^2}{45}\right)$

$u^2 = 5 \times 45$

$u^2 = 225$

$u = \pm 15$

$\therefore$ Value of $u = 15$ A1

(b) To get the speed we need to get both components

Horizontal motion $\overset{+}{\rightarrow}$ Vertical motion ↑+

Velocity: $s = -7.2$ Use formula

$u\cos\alpha = 15 \times \frac{4}{5} = 12\text{ms}^{-1}$ $u = u\sin\alpha = 15 \times \frac{3}{5} = 9$ $v^2 = u^2 + 2as$

B1 $v = v$ $v^2 = 9^2 - 2(10)(-7.2)$ M1

$a = -10$ $v = 15\text{ms}^{-1}$ A1

Use Pythagoras' Theorem to get the speed from the two velocities:

$|v| = \sqrt{12^2 + 15^2}$ M1

$= \sqrt{369}$

$= 19\text{ms}^{-1}$ to 2sf A1

(c) → Include wind effect B1B1

→ Consider air resistance

→ consider shape of the stone

→ consider spin of the stone

Question 10 continued

Question 10 continued

(Total for Question 10 is 13 marks)

TOTAL FOR SECTION B IS 50 MARKS
TOTAL FOR PAPER IS 100 MARKS