

AS Level Mathematics B (MEI)

H630/01 Pure Mathematics and Mechanics

Practice Paper – Set 1

Time allowed: 1 hour 30 minutes

You must have:

· Printed Answer Booklet

You may use:

· a scientific or graphical calculator

INSTRUCTIONS

- Use black ink. HB pencil may be used for graphs and diagrams only.
- Complete the boxes provided on the Printed Answer Booklet with your name, centre number and candidate number.
- Answer all the questions.
- Write your answer to each question in the space provided in the Printed Answer Booklet. If additional space is required, you should use the lined page(s) at the end of the Printed Answer Booklet. The question number(s) must be clearly shown.
- Do not write in the barcodes.
- You are permitted to use a scientific or graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.
- The acceleration due to gravity is denoted by $g \, \text{m} \, \text{s}^{-2}$. Unless otherwise instructed, when a numerical value is needed, use g = 9.8.

INFORMATION

- The total number of marks for this paper is 70.
- The marks for each question are shown in brackets [].
- You are advised that an answer may receive no marks unless you show sufficient detail
 of the working to indicate that a correct method is used. You should communicate your
 method with correct reasoning.
- The Printed Answer Booklet consists of 16 pages. The Question Paper consists of 8 pages.

Formulae AS Level Mathematics B (H630)

Binomial series

$$(a+b)^{n} = a^{n} + {}^{n}C_{1}a^{n-1}b + {}^{n}C_{2}a^{n-2}b^{2} + \dots + {}^{n}C_{r}a^{n-r}b^{r} + \dots + b^{n}$$
 ($n \in \mathbb{N}$),

where
$${}^{n}C_{r} = {}_{n}C_{r} = {n \choose r} = \frac{n!}{r!(n-r)!}$$

$$(1+x)^n = 1 + nx + \frac{n(n-1)}{2!}x^2 + \dots + \frac{n(n-1)\dots(n-r+1)}{r!}x^r + \dots \qquad (|x| < 1, \ n \in \mathbb{R})$$

Differentiation from first principles

$$f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$$

Sample variance

$$s^2 = \frac{1}{n-1} S_{xx}$$
 where $S_{xx} = \sum (x_i - \bar{x})^2 = \sum x_i^2 - \frac{(\sum x_i)^2}{n} = \sum x_i^2 - n\bar{x}^2$

Standard deviation, $s = \sqrt{\text{variance}}$

The binomial distribution

If
$$X \sim B(n, p)$$
 then $P(X = r) = {}^{n}C_{r}p^{r}q^{n-r}$ where $q = 1 - p$

Mean of X is np

Kinematics

Motion in a straight line

$$v = u + at$$

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

$$s = \frac{1}{2}(u+v)t$$

$$v^2 = u^2 + 2as$$

$$s = vt - \frac{1}{2}at^2$$

Answer all the questions.

1 Solve the equation $\cos 2\theta = 0.3$ for $0^{\circ} \le \theta < 360^{\circ}$.

[3]

2 James tries to solve the inequality $x^2 - 5x - 14 \ge 0$. He writes his answer as

$${x:x \le 2} \cup {x:x < 7}.$$

Correct all the errors in his answer.

[3]

A block of mass $5m \, \text{kg}$ is in equilibrium on a rough horizontal table. It is connected by horizontal light inextensible strings over smooth pulleys to particles of mass $m \, \text{kg}$ and $2m \, \text{kg}$ which hang freely, as shown in Fig. 3.

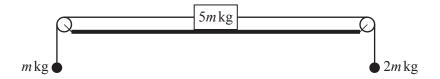


Fig. 3

Find the frictional force acting on the block, clearly indicating its direction.

[3]

- 4 A circle has centre C (-4, 3) and passes through the origin.
 - (i) Find the equation of the circle.

[3]

- (ii) The circle crosses the positive *y*-axis at the point A. The tangent to the circle at A meets the *x*-axis at B. Find the *x*-coordinate of B. [5]
- The spreadsheet in Fig. 5 shows a multiplication table. The numbers 35, 36, 35 in the shaded cells are of the form n^2-1 , n^2 , n^2-1 , where n=6. This pattern can also be seen for the other square numbers on the diagonal of the table in cells B2, C3, ..., I9.

Α	В	С	D	Е	F	G	Н	I	J
1	2	3	4	5	6	7	8	9	10
2	4	6	8	10	12	14	16	18	20
3	6	9	12	15	18	21	24	27	30
4	8	12	16	20	24	28	32	36	40
5	10	15	20	25	30	35	40	45	50
6	12	18	24	30	36	42	48	54	60
7	14	21	28	35	42	49	56	63	70
8	16	24	32	40	48	56	64	72	80
9	18	27	36	45	54	63	72	81	90
10	20	30	40	50	60	70	80	90	100
	1 2 3 4 5 6 7 8	1 2 2 4 3 6 4 8 5 10 6 12 7 14 8 16 9 18	1 2 3 2 4 6 3 6 9 4 8 12 5 10 15 6 12 18 7 14 21 8 16 24 9 18 27	1 2 3 4 2 4 6 8 3 6 9 12 4 8 12 16 5 10 15 20 6 12 18 24 7 14 21 28 8 16 24 32 9 18 27 36	1 2 3 4 5 2 4 6 8 10 3 6 9 12 15 4 8 12 16 20 5 10 15 20 25 6 12 18 24 30 7 14 21 28 35 8 16 24 32 40 9 18 27 36 45	1 2 3 4 5 6 2 4 6 8 10 12 3 6 9 12 15 18 4 8 12 16 20 24 5 10 15 20 25 30 6 12 18 24 30 36 7 14 21 28 35 42 8 16 24 32 40 48 9 18 27 36 45 54	1 2 3 4 5 6 7 2 4 6 8 10 12 14 3 6 9 12 15 18 21 4 8 12 16 20 24 28 5 10 15 20 25 30 35 6 12 18 24 30 36 42 7 14 21 28 35 42 49 8 16 24 32 40 48 56 9 18 27 36 45 54 63	1 2 3 4 5 6 7 8 2 4 6 8 10 12 14 16 3 6 9 12 15 18 21 24 4 8 12 16 20 24 28 32 5 10 15 20 25 30 35 40 6 12 18 24 30 36 42 48 7 14 21 28 35 42 49 56 8 16 24 32 40 48 56 64 9 18 27 36 45 54 63 72	1 2 3 4 5 6 7 8 9 2 4 6 8 10 12 14 16 18 3 6 9 12 15 18 21 24 27 4 8 12 16 20 24 28 32 36 5 10 15 20 25 30 35 40 45 6 12 18 24 30 36 42 48 54 7 14 21 28 35 42 49 56 63 8 16 24 32 40 48 56 64 72 9 18 27 36 45 54 63 72 81

Fig. 5

The spreadsheet can be extended to include larger numbers. Prove that the pattern holds for all integers n > 1.

6 In this question you must show detailed reasoning.

A boy plays on a path that runs north-south through an origin O. His displacement x metres north of O at time t seconds is given by

$$x = -0.7t^2 + 4t$$
 for $0 \le t \le 10$.

- (i) Determine the direction in which he is moving when t = 7. [3]
- (ii) Find the furthest distance from O reached by the boy for $0 \le t \le 10$. [5]
- OACB is a parallelogram. O is the origin and point A has coordinates (5, 6). Point B has position vector $\mathbf{b} = -2\mathbf{i} 7\mathbf{j}$.
 - (i) Find the coordinates of point C. [3]

M is the midpoint of AB.

(ii) Prove that
$$\overrightarrow{OM} = \overrightarrow{MC}$$
.

(iii) Find the exact distance MC. [2]

8 In this question you must show detailed reasoning.

Find the total area of the shaded regions shown in Fig. 8, bounded by the line x = -1, the x-axis and the curve $y = x^3(x-3)$.

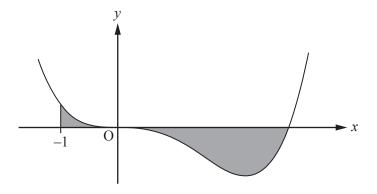


Fig. 8

- 9 (i) Sketch the curve $y = e^{2x}$. [2]
 - (ii) Describe fully the transformation that maps the curve $y = e^x$ onto the curve $y = e^{2x}$. [2]
 - (iii) Find the equation of the tangent to $y = e^{2x}$ at the point where x = 3, giving your answer in the form $y = e^{a}(bx + c)$ where a, b and c are integers. [6]

Dorothy and Harold push a wheelbarrow of mass 20 kg. They both push in the direction of motion. The wheelbarrow moves 10m from rest on a straight horizontal path. Dorothy applies a force of 90 N. Harold applies a force of 90 N for the first 3 m, and then reduces the force to 80 N for the remaining 7 m. The resistance to motion is 170 N throughout.

Find the time taken for the wheelbarrow to move the 10 m.

[9]

[2]

11 Cheung wishes to model the fuel consumption of a car. He tries the quadratic model

$$y = a(v - b)^2 + c$$

where y is the fuel needed in litres per $100 \,\mathrm{km}$ and v is the speed in $\mathrm{km}\,\mathrm{h}^{-1}$.

Travelling as a passenger, he notices that the minimum fuel consumption displayed on the dashboard is 10 litres per 100 km and occurs at 80 km h^{-1} .

(i) Write down the values of b and c for which Cheung's model fits this information.

At 30 km h⁻¹ the fuel consumption displayed is 12 litres per 100 km.

- (ii) Find the value of a for which Cheung's model fits this information. [2]
- (iii) Use this model to predict the fuel consumption at $110 \,\mathrm{km}\,\mathrm{h}^{-1}$. [2]
- (iv) Sketch the graph of the model for speeds between $30 \,\mathrm{km} \,\mathrm{h}^{-1}$ and $110 \,\mathrm{km} \,\mathrm{h}^{-1}$.

Later in the journey, Cheung notices that fuel consumption of 12 litres per $100 \,\mathrm{km}$ is displayed at $30 \,\mathrm{km}\,\mathrm{h}^{-1}$ and also at $110 \,\mathrm{km}\,\mathrm{h}^{-1}$. The minimum fuel consumption still occurs at $80 \,\mathrm{km}\,\mathrm{h}^{-1}$.

(v) Give a reason why a quadratic model cannot fit all the information Cheung has found. [1]

END OF QUESTION PAPER

BLANK PAGE

BLANK PAGE



Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

 $For queries \ or \ further \ information \ please \ contact \ the \ Copyright \ Team, \ First \ Floor, 9 \ Hills \ Road, \ Cambridge \ CB2 \ 1GE.$

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.