Edexcel GCSE
Mathematics (Linear) – 1MA0
DIRECT & INVERSE PROPORTIONALITY

Materials required for examination
Ruler graduated in centimetres and millimetres, protractor, compasses, pen, HB pencil, eraser.
Tracing paper may be used.

Items included with question papers
Nil

Instructions

Use black ink or ball-point pen.
Fill in the boxes at the top of this page with your name, centre number and candidate number.
Answer all questions.
Answer the questions in the spaces provided – there may be more space than you need.
Calculators may be used.

Information

The marks for each question are shown in brackets – use this as a guide as to how much time to spend on **each** question.
Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed – you should take particular care on these questions with your spelling, punctuation and grammar, as well as the clarity of expression.

Advice

Read each question carefully before you start to answer it.
Keep an eye on the time.
Try to answer every question.
Check your answers if you have time at the end.

1. The weight of a piece of wire is directly proportional to its length.

A piece of wire is 25 cm long and has a weight of 6 grams.
Another piece of the same wire is 30 cm long.

Calculate the weight of the 30 cm piece of wire.

$W = kl$

$6 = 25k$

$k = 0.24$

$w = 0.24l$

$w = 0.24 \times 30$

$w = 7.2$

7.2 ..... grams

(Total 2 marks)

2. A ball falls vertically after being dropped.
The ball falls a distance d metres in a time of t seconds.
d is directly proportional to the square of t.

$d = kt^2$

The ball falls 20 metres in a time of 2 seconds.

(a) Find a formula for d in terms of t.

$20 = k \times 2^2$

$20 = 4k$

$k = 5$

$d =$ $5t^2$ .....

(3)

(b) Calculate the distance the ball falls in 3 seconds.

$d = 5 \times 3^2$

$d = 5 \times 9 = 45$

45 ..... m

(1)

(c) Calculate the time the ball takes to fall 605 m.

$d = 5t^2$

$605 = 5t^2$

$t^2 = 121$

$t = \pm 11$

(ignore -11 as time can't be -ve)

11 ..... seconds

(3)

(Total 7 marks)

3. The time, T seconds, it takes a water heater to boil some water is directly proportional to the mass of water, m kg, in the water heater.

When $m = 250$, $T = 600$

(a) Find T when $m = 400$

$T = km$

$600 = 250k$

$k = \frac{600}{250} = 2.4$

$T = 2.4m$

$T = 2.4 \times 400$

$T = 960$

$T =$ 960

(3)

The time, T seconds, it takes a water heater to boil a constant mass of water is inversely proportional to the power, P watts, of the water heater.

When $P = 1400$, $T = 360$

$T = \frac{k}{P}$

(b) Find the value of T when $P = 900$

$360 = \frac{k}{1400}$

$k = 360 \times 1400$

$k = 504{,}000$

$\therefore T = \frac{504000}{P}$

$T = \frac{504000}{900} = 560$

$T =$ 560

(3)

(Total 6 marks)

4. D is proportional to S^2.

$D = 900$ when $S = 20$

Calculate the value of D when $S = 25$

$D = kS^2$

$900 = k \times 20^2$

$900 = 400k$

$k = \frac{900}{400} = 2.25$

$D = 2.25S^2$

$D = 2.25 \times 25^2$

$D =$ 1406.25

(Total 4 marks)

5. In a spring, the tension (T newtons) is directly proportional to its extension (x cm).

When the tension is 150 newtons, the extension is 6 cm.

$T = kx$

(a) Find a formula for T in terms of x.

$150 = 6k$

$k = \frac{150}{6}$

$k = 25$

$T =$ $25x$

(3)

(b) Calculate the tension, in newtons, when the extension is 15 cm.

$T = 25 \times 15$

$T = 375$

375 newtons

(1)

(c) Calculate the extension, in cm, when the tension is 600 newtons.

$T = 25x$

$600 = 25x$

$x = \frac{600}{25}$

$x = 24$

24 cm

(1)

(Total 5 marks)

6. d is directly proportional to the square of t. $d = kt^2$

$d = 80$ when $t = 4$

(a) Express d in terms of t.

$80 = k \times 4^2$

$80 = 16k$

$k = 5$

$d = 5t^2$

.....

(3)

(b) Work out the value of d when $t = 7$

$d = 5 \times 7^2$

$d = 5 \times 49$

$d = 245$

$d =$ 245 .....

(1)

(c) Work out the positive value of t when $d = 45$

$d = 5t^2$

$45 = 5t^2$

$t^2 = 9$

$t = \pm 3$

(ignore the -ve solution)

$t =$ 3 .....

(2)

(Total 6 marks)

7. The distance, D, travelled by a particle is directly proportional to the square of the time, t, taken.

When $t = 40$, $D = 30$

$D = kt^2$

(a) Find a formula for D in terms of t.

$30 = k \times 40^2$

$30 = 1600k$

$k = 0.01875$

$D =$ $0.01875t^2$

(b) Calculate the value of D when $t = 64$

$D = 0.01875 \times 64^2$

$D = 76.8$

(1)

(c) Calculate the value of t when $D = 12$
Give your answer correct to 3 significant figures.

$12 = 0.01875t^2$

$t^2 = 640$

$t = 25.3$

(2)

(Total 6 marks)

8. M is directly proportional to L^3.

When $L = 2$, $M = 160$

Find the value of M when $L = 3$

$M = kL^3$

$160 = k \times 2^3$

$160 = 8k$

$k = 20$

$M = 20L^3$

$M = 20 \times 3^3$

$M = 20 \times 27$

$M = 540$

540

.....

(Total 4 marks)

9. p is inversely proportional to m.
$p = 48$ when $m = 9$

$p = \frac{k}{m}$

Calculate the value of p when $m = 12$

$48 = \frac{k}{9}$

$k = 48 \times 9$

$k = 432$

$P = \frac{432}{m}$

$P = \frac{432}{12}$

$P = 36$

36

.....

(Total 2 marks)

10. r is inversely proportional to t.
$r = 12$ when $t = 0.2$

Calculate the value of r when $t = 4$.

$r = \frac{k}{t}$

$12 = \frac{k}{0.2}$

$k = 12 \times 0.2$

$k = 2.4$

$r = \frac{2.4}{t}$

$r = \frac{2.4}{4}$

$r = 0.6$

0.6

.....

(Total 3 marks)

11. f is inversely proportional to d.

When $d = 50$, $f = 256$

Find the value of f when $d = 80$

$f = \frac{k}{d}$

$256 = \frac{k}{50}$

$k = 256 \times 50 = 12800$

$f = \frac{12800}{d}$

when $d = 80$:

$f = \frac{12800}{80} = 160$

$f =$ 160

(Total 3 marks)

12. y is inversely proportional to x^2.

$y = \frac{k}{x^2}$

Given that $y = 2.5$ when $x = 24$,

(i) find an expression for y in terms of x

$2.5 = \frac{k}{24^2}$

$k = 2.5 \times 24^2 = 1440$

$y = \frac{1440}{x^2}$

(ii) find the value of y when $x = 20$

$y = \frac{1440}{20^2}$

$y = \frac{1440}{400} = 3.6$

$y = 3.6$

(iii) find a value of x when $y = 1.6$

$1.6 = \frac{1440}{x^2}$

$1.6x^2 = 1440$

$x^2 = 900$

$x = \pm 30$

You would get the marks if you just wrote 30

$x = \pm 30$

(Total 6 marks)

13. P is inversely proportional to d^2.

$P = \frac{k}{d^2}$

$P = 10\,000$ when $d = 0.4$

Find the value of P when $d = 0.8$

$10000 = \frac{k}{0.4^2}$

$k = 10000 \times 0.4^2$

$k = 1600$

$P = \frac{1600}{d^2}$

$P = \frac{1600}{0.8^2} = 2500$

$P = 2500$

(Total 3 marks)

14. The shutter speed, S, of a camera varies inversely as the square of the aperture setting, f.

When $f = 8$, $S = 125$

$S = \frac{k}{f^2}$

(a) Find a formula for S in terms of f.

$125 = \frac{k}{8^2}$

$k = 125 \times 64$

$k = 9000$

$S = \frac{9000}{f^2}$

.....

(3)

(b) Hence, or otherwise, calculate the value of S when $f = 4$

$S = \frac{9000}{4^2} = 500$

$S =$ 500

(1)

(Total 4 marks)

15. q is inversely proportional to the square of t.

$q = \frac{k}{t^2}$

When $t = 4$, $q = 8.5$

(a) Find a formula for q in terms of t.

$8.5 = \frac{k}{4^2}$

$k = 8.5 \times 16$

$k = 136$

$q =$ $\frac{136}{t^2}$

(3)

(b) Calculate the value of q when $t = 5$

$q = \frac{136}{5^2}$

$q = \frac{136}{25}$

$q = 5.44$

5·44

(1)

(Total 4 marks)

16. P is inversely proportional to V.

$P = \frac{k}{V}$

When $V = 8$, $P = 5$

(a) Find a formula for P in terms of V.

$5 = \frac{k}{8}$

$k = 5 \times 8$

$k = 40$

$P =$ $\frac{40}{V}$

(3)

(b) Calculate the value of P when $V = 2$

$P = \frac{40}{2}$

$P = 20$

20

(1)

(Total 4 marks)

17. The force, F, between two magnets is inversely proportional to the square of the distance, x, between them.

$F = \frac{k}{x^2}$

When $x = 3$, $F = 4$.

(a) Calculate F when $x = 2$.

$4 = \frac{k}{9}$

$k = 36$

$F = \frac{36}{x^2}$

$F = \frac{36}{2^2}$

$F = \frac{36}{4} = 9$

$F = 9$

(4)

(b) Calculate x when $F = 64$.

$F = \frac{36}{x^2}$

$64 = \frac{36}{x^2}$

$64x^2 = 36$

$x^2 = \frac{36}{64}$

$x = \pm \frac{6}{8}$

$x = \frac{3}{4}$

(2)

(Total 6 marks)