

Proportion

Foundation and Higher tiers

Total marks: 159

Marks

- M** Method mark, for a correct method. It can be implied by a correct answer.
- A** Accuracy mark, for a correct answer. It needs the method mark before it.
- B** A mark for a correct value or statement, with or without working.
- ft** Follow through: the mark is given for using an earlier wrong answer correctly.
- oe** Or equivalent.
- [a, b]** Any value from a to b inclusive.

Questions

Q	Skill	Spec	Tier	Grade	Calculator	Marks
1	Recipes	R10	Foundation	3	No	4
2	Proportion as equal ratios	R7	Foundation	3	No	3
3	Recognising direct proportion	R10 R7	Foundation	4	No	2
4	Direct proportion graph	R10 R14	Common	4	No	4
5	Inverse proportion	R10	Foundation	5	No	4
6	Graphs of direct and inverse proportion	R14	Common	5	No	2
7	Inverse proportion: complete a table	R10 R13	Common	5	No	3
8	Inverse proportion in two stages	R10	Foundation	6	No	3
9	Direct proportion: a formula	R13	Higher	6	No	3
10	Inverse proportion to a square	R13	Higher	7	No	4
11	Proportion to a squared bracket	R13 A18	Higher	8	No	4
12	Graphs of proportion from equations	R14 R13 A12	Higher	8	No	3
13	Proportion: which power?	R13	Higher	8	No	4
14	Direct proportion with algebra	R13 R7 A17	Higher	8	No	3
15	Inverse square law in context	R10 R13	Higher	8	No	4
16	Proportion from a transformed graph	R14 R13	Higher	8	No	4

Q	Skill	Spec	Tier	Grade	Calculator	Marks
17	Proportion: cube and square laws	R13 G19	Higher	8	No	3
18	Inverse proportion to a root, with algebra	R13	Higher	8	No	4
19	Chained proportion	R13	Higher	9	No	5
20	Inverse square law with an unknown	R13 A17	Higher	9	No	4
21	Proportion to an unknown power	R13 N7	Higher	9	No	4
22	Inverse square law from two points	R13 R14 A17	Higher	9	No	4
23	Inverse square law: two sources	R13 A17	Higher	9	No	4
24	Inverse proportion leading to a quadratic	R10 A18	Higher	9	No	5
25	Pricing olives by mass, both ways	R10	Foundation	3	Yes	4
26	Best buys	R10	Foundation	4	Yes	3
27	Direct proportion with a rate	R10	Foundation	5	Yes	3
28	Direct proportion to a square root	R13	Higher	7	Yes	5
29	Percentage change in a proportion	R13	Higher	8	Yes	3
30	Testing a proportion model	R13 R10	Higher	8	Yes	5
31	Inverse cube law	R10 R13	Higher	8	Yes	3
32	Proportion to a square: a decision	R13	Higher	8	Yes	4
33	Cube law in context	R13 R11	Higher	8	Yes	6
34	Inverse square law: percentage changes	R13	Higher	9	Yes	5
35	Proportion between powers	R13 N7	Higher	9	Yes	5
36	Two proportions combined into a quadratic	R13 A18	Higher	9	Yes	6
37	Inverse square law: working together	R10 R13	Higher	9	Yes	5
38	Two proportions at once	R10 R13	Higher	9	Yes	5
39	Square law with a ratio	R13 R5	Higher	9	Yes	6
40	Where a line meets a proportion curve	R13 R14 A17	Higher	9	Yes	4
	Total					159

Question 1 R10 · Foundation · Grade 3 · 4 marks

Q	Answer	Mark	Comments
1(a)	$90 \div 12 \times 18$ or $90 \div 2 + 90$	M1	oe, or 7.5 or 45 seen
	135	A1	
1(b)	$400 \div 150 \times 12$ or $400 \div 12.5$	M1	oe, or 150 g for 12, 300 g for 24, 50 g for 4
	32	A1	

Question 2 R7 · Foundation · Grade 3 · 3 marks

Q	Answer	Mark	Comments
2(a)	18 : 27	B1	
2(b)	$15 \div 6$ or 2.5	M1	oe, or $8 \div 6 \times 15$ or $\frac{a}{15} = \frac{8}{6}$
	20	A1	

Question 3 R10 R7 · Foundation · Grade 4 · 2 marks

Q	Answer	Mark	Comments
3	Table A	B1	
	a correct reason	B1	e.g. each ticket costs £3.50 every time, or $2 \rightarrow 8$ is $\times 4$ and $7 \rightarrow 28$ is $\times 4$, or in Table B 2 hours cost £25 an hour but 8 hours cost £17.50 an hour

Question 4 R10 R14 · Common · Grade 4 · 4 marks

Q	Answer	Mark	Comments
4(a)	£21	B1	
4(b)	straight line and through the origin	B1	oe, both needed
4(c)	$30 \div 5$ or 6 per metre	M1	oe, or a correct reading used, e.g. 3 m costs £18 and $\times 6$
	£108	A1	

Question 5 R10 · Foundation · Grade 5 · 4 marks

Q	Answer	Mark	Comments
5(a)	6×5 or 30	M1	oe, the total in volunteer hours
	$30 \div 8$ or 3.75	M1	oe
	3 hours 45 minutes	A1	
5(b)	a correct assumption	B1	e.g. they all work at the same speed, or they all work the whole time

Question 6 R14 · Common · Grade 5 · 2 marks

Q	Answer	Mark	Comments
6(a)	D	B1	
6(b)	A	B1	

Question 7 R10 R13 · Common · Grade 5 · 3 marks

Q	Answer	Mark	Comments
7	$y = 12$ when $x = 5$; $y = 7.5$ when $x = 8$; $x = 15$ when $y = 4$	B3	B2 for two correct, B1 for one correct or for $xy = 60$ seen

Question 8 R10 · Foundation · Grade 6 · 3 marks

Q	Answer	Mark	Comments
8	8×15 or 120 or 8×3 or 24	M1	oe, in pump hours, or $\frac{3}{15}$ or $\frac{1}{5}$ of the job done
	$(120 - 24) \div 6$ or 16	M1	oe, the time for the rest
	19	A1	accept 19 hours

Question 9 R13 · Higher · Grade 6 · 3 marks

Q	Answer	Mark	Comments
9(a)	$e = km$ and $6 = 150k$	M1	oe
	$e = 0.04m$	A1	oe, e.g. $e = \frac{m}{25}$
9(b)	230	B1ft	ft their formula

Question 10 R13 · Higher · Grade 7 · 4 marks

Q	Answer	Mark	Comments
10(a)	$B = \frac{k}{d^2}$ and $64 = \frac{k}{2.5^2}$	M1	oe
	$k = 400$	M1	oe, or $16 = \frac{400}{d^2}$
	5	A1	Alternative: $B \div 4$ so $d^2 \times 4$ (M2), 5 (A1)
10(b)	No, it becomes $\frac{1}{4}$ of what it was	B1	oe, e.g. $2^2 = 4$ so it is divided by 4

Question 11 R13 A18 · Higher · Grade 8 · 4 marks

Q	Answer	Mark	Comments
11(a)	$y = k(x + 2)^2$ and $18 = k \times 3^2$	M1	oe
	$y = 2(x + 2)^2$	A1	oe
11(b)	$(x + 2)^2 = 25$ or $x + 2 = \pm 5$	M1	oe, ft their k
	3 and -7	A1	both needed

Question 12 R14 R13 A12 · Higher · Grade 8 · 3 marks

Q	Answer	Mark	Comments
12	$y^2 = 9x$: A , $xy = 6$: C , $\frac{y}{x} = 4$: E , $y = 0.2x^3$: D	B3	B2 for two or three correct, B1 for one correct

Question 13 R13 · Higher · Grade 8 · 4 marks

Q	Answer	Mark	Comments
13(a)	when x doubles, y is multiplied by 8, or $12 \div 2^3 = 1.5$ and $96 \div 4^3 = 1.5$	M1	oe, or tests two statements correctly
	$y \propto x^3$	A1	with correct working
13(b)	$y = 187.5$ when $x = 5$	B1	
	$x = 8$ when $y = 768$	B1	

Question 14 R13 R7 A17 · Higher · Grade 8 · 3 marks

Q	Answer	Mark	Comments
14	$\frac{12}{a} = \frac{27}{(a+5)}$ or $12 = ka$ and $27 = k(a + 5)$	M1	oe
	$12a + 60 = 27a$ or $5k = 15$	M1	oe
	4	A1	

Question 15 R10 R13 · Higher · Grade 8 · 4 marks

Q	Answer	Mark	Comments
15	$2400 \times \frac{15^2}{20^2}$ or $2400 \times 225 \div 400$	M1	oe
	1350 tiles	A1	
	£7680 and £7425	M1	oe, ft their number of tiles
	20 cm tiles, by £255	A1	

Question 16 R14 R13 · Higher · Grade 8 · 4 marks

Q	Answer	Mark	Comments
16(a)	a straight line through the origin	B1	oe, both needed
16(b)	$\frac{60}{400}$ or 0.15 or $F = 0.15v^2$	M1	oe, from a correct reading
	135	A1	
16(c)	10	B1	

Question 17 R13 G19 · Higher · Grade 8 · 3 marks

Q	Answer	Mark	Comments
17	$54 \div 2$ or 27	M1	oe
	$\sqrt[3]{27}$ or 3, or 3^2 or 9	M1	oe, the scale factor for height or for the cost
	£135	A1	

Question 18 R13 · Higher · Grade 8 · 4 marks

Q	Answer	Mark	Comments
18(a)	3	B1	
18(b)	30	B1	
18(c)	y is multiplied by 3 so $\sqrt{x}$ is divided by 3	M1	oe, or $k = 6\sqrt{a}$ and $18 = \frac{6\sqrt{a}}{\sqrt{x}}$
	$\frac{a}{9}$	A1	oe

Question 19 R13 · Higher · Grade 9 · 5 marks

Q	Answer	Mark	Comments
19(a)	$q = \frac{c}{\sqrt{r}}$ and $c = 6$	M1	oe
	$p = kq^2$ and $k = 2$	M1	oe
	$p = 2 \times \frac{36}{r} = \frac{72}{r}$ so p is inversely proportional to r	A1	oe, with a conclusion
19(b)	$50 = \frac{72}{r}$ or $q = 5$ and $5 = \frac{6}{\sqrt{r}}$	M1	oe, ft their formula
	1.44	A1	

Question 20 R13 A17 · Higher · Grade 9 · 4 marks

Q	Answer	Mark	Comments
20	$\frac{k}{(x+2)^2} = 0.64 \times \frac{k}{x^2}$	M1	oe
	$\frac{x^2}{(x+2)^2} = 0.64$	M1	oe, k cancelled
	$\frac{x}{(x+2)} = 0.8$ or $x = 0.8x + 1.6$	M1	oe
	8	A1	

Question 21 R13 N7 · Higher · Grade 9 · 4 marks

Q	Answer	Mark	Comments
21(a)	$4^n = 8$ or $\frac{192}{24} = (\frac{16}{4})^n$	M1	oe
	1.5	A1	oe, e.g. $\frac{3}{2}$
21(b)	$y = 3x^{1.5}$ or $24 \times 9^{1.5}$ or 24×27	M1	oe, ft their n
	648	A1	

Question 22 R13 R14 A17 · Higher · Grade 9 · 4 marks

Q	Answer	Mark	Comments
22(a)	$p = \frac{k}{9}$ and $p - 12 = \frac{k}{36}$	M1	oe, or y at 6 is $\frac{1}{4}$ of y at 3
	$\frac{p}{4} = p - 12$ or $\frac{k}{9} - 12 = \frac{k}{36}$	M1	oe, a correct equation in one unknown
	16	A1	
22(b)	12	B1ft	ft their p

Question 23 R13 A17 · Higher · Grade 9 · 4 marks

Q	Answer	Mark	Comments
23	$\frac{9k}{x^2} = \frac{k}{(12-x)^2}$	M1	oe, x the distance AP
	$\frac{3}{x} = \frac{1}{(12-x)}$ or $x^2 = 9(12-x)^2$	M1	oe
	$36 - 3x = x$	M1	oe, or $8x^2 - 216x + 1296 = 0$
	9	A1	and no other answer

Question 24 R10 A18 · Higher · Grade 9 · 5 marks

Q	Answer	Mark	Comments
24	$\frac{720}{n}$ and $\frac{720}{(n+8)}$	M1	oe, the cost for each person
	$\frac{720}{n} - \frac{720}{(n+8)} = 4.5$	M1	oe
	$5760 = 4.5n(n+8)$ or $n^2 + 8n - 1280 = 0$	M1	oe, fractions cleared
	$(n+40)(n-32) = 0$	M1	oe, or a correct use of the formula
	32	A1	with -40 rejected or not given

Question 25 R10 · Foundation · Grade 3 · 4 marks

Q	Answer	Mark	Comments
25(a)	$4.62 \div 600 \times 420$ or 4.62×0.7	M1	oe, such as the price of 1 g (0.0077) or of 10 g (7.7p)
	£3.23	A1	
25(b)	$4 \div 4.62 \times 600$ or 519.4...	M1	oe, or 510 g for £3.93 and 520 g for £4.004
	510	A1	not 519 or 520

Question 26 R10 · Foundation · Grade 4 · 3 marks

Q	Answer	Mark	Comments
26	a correct method to compare two bags	M1	e.g. $2.85 \div 0.75 = 3.80$ or $6.90 \div 2 = 3.45$ or $18.25 \div 5 = 3.65$, or grams per £1: 263, 290, 274
	£3.80, £3.45 and £3.65 per kg	A1	oe, all three comparable values
	Medium	A1	with correct values

Question 27 R10 · Foundation · Grade 5 · 3 marks

Q	Answer	Mark	Comments
27	6.2×3.4 or 21.08	M1	oe, the litres used
	their 21.08×148.9 or $\times 1.489$	M1	oe
	£31.39	A1	accept 3139p

Question 28 R13 · Higher · Grade 7 · 5 marks

Q	Answer	Mark	Comments
28(a)	$v = k\sqrt{d}$ and $4.5 = k \times \sqrt{2.25}$	M1	oe
	$k = 3$	M1	oe
	2.4	A1	Alternative: $\sqrt{(\frac{0.64}{2.25})} \times 4.5$ (M2)
28(b)	$6.3 = 3\sqrt{d}$ or $\sqrt{d} = 2.1$	M1	oe, ft their k
	4.41	A1	

Question 29 R13 · Higher · Grade 8 · 3 marks

Q	Answer	Mark	Comments
29	1.2^3 or 1.728	M1	oe, or an example, e.g. radius 10 and 12 with 1000 and 1728
	$1.728 - 1$ or 0.728 or 172.8%	M1	oe
	72.8	A1	

Question 30 R13 R10 · Higher · Grade 8 · 5 marks

Q	Answer	Mark	Comments
30(a)	$T \div \sqrt{L}$ for at least three pendulums	M1	e.g. 0.201, 0.200, 0.212, 0.200
	72 cm	A1	with all four values, or a correct comparison of each
30(b)	1.70	B1	accept [1.69, 1.70]
30(c)	$\frac{2.5}{0.2}$ squared or $2.5 = 0.2\sqrt{L}$	M1	oe, with their constant from a correct pendulum
	156	A1	accept [155, 157]

Question 31 R10 R13 · Higher · Grade 8 · 3 marks

Q	Answer	Mark	Comments
31	1500×4.5^3 or 136 687.5 or $(\frac{4.5}{6})^3$ or 0.421875	M1	oe
	$\frac{136\,687.5}{6^3}$ or 632.8	M1	oe
	632	A1	do not accept 633

Question 32 R13 · Higher · Grade 8 · 4 marks

Q	Answer	Mark	Comments
32	$k = \frac{1}{250} \div 16$ or 0.00025	M1	oe, or $(\frac{N}{4})^2 \times \frac{1}{250}$ used
	t for at least one setting in the list, or $N^2 = \frac{1}{60} \div 0.00025$ or 66.6...	M1	oe, e.g. $t = 0.016$ for 8
	$N = 8.16...$ or 0.016 and 0.030... compared with 0.0166...	M1	oe
	8	A1	

Question 33 R13 R11 · Higher · Grade 8 · 6 marks

Q	Answer	Mark	Comments
33(a)	$P = kv^3$ and $1.2 = k \times 8^3$	M1	oe, or $\frac{3}{1.2}$ or 2.5
	$\sqrt[3]{(\frac{3}{0.00234375})}$ or $\sqrt[3]{1280}$ or $8 \times \sqrt[3]{2.5}$	M1	oe
	10.9	A1	accept 10.9 or [10.85, 10.86]
33(b)	0.644 or 3.293	M1	oe, the power at one wind speed, ft their k
	their 0.644×2.5 + their 3.293×1.5	M1	oe
	6.5	A1	accept 6.5 or [6.54, 6.55]

Question 34 R13 · Higher · Grade 9 · 5 marks

Q	Answer	Mark	Comments
34(a)	$\frac{1}{1.25^2}$ or 0.64	M1	oe, or an example such as $d = 4$ and 5 with $\frac{k}{16}$ and $\frac{k}{25}$
	36	A1	
34(b)	$1.5 = \frac{1}{m^2}$ or $m^2 = \frac{1}{1.5}$ or $\frac{2}{3}$	M1	oe, m the multiplier for the distance
	$\sqrt{(\frac{1}{1.5})}$ or 0.8165...	M1	oe
	18.4	A1	accept 18.4 or [18.35, 18.36]

Question 35 R13 N7 · Higher · Grade 9 · 5 marks

Q	Answer	Mark	Comments
35(a)	$T^2 = kd^3$ and $365.25^2 = k \times 149.6^3$	M1	oe, or $(\frac{227.9}{149.6})^3 = 3.535...$
	$k = 0.03985...$ or $T^2 = 471\,649...$	M1	oe
	687	A1	accept [686, 687]
35(b)	$d^3 = \frac{4333^2}{k}$ or $149.6 \times (\frac{4333}{365.25})^{\frac{2}{3}}$	M1	oe, ft their k
	778	A1	accept [777, 779]

Question 36 R13 A18 · Higher · Grade 9 · 6 marks

Q	Answer	Mark	Comments
36(a)	$15 = 20a$ or $32 = 20^2b$	M1	oe
	$a = 0.75$ and $b = 0.08$ shown	A1	oe, e.g. $\frac{15}{20}$ and $\frac{32}{400}$
36(b)	$0.08v^2 + 0.75v = 85$	M1	oe
	$\frac{-0.75 \pm \sqrt{(0.75^2 - 4 \times 0.08 \times -85)}}{2 \times 0.08}$	M1	oe, a correct use of the formula
	28.244...	M1	oe, or trials either side of the answer to 1 decimal place
	28.2	A1	accept 28.24; the negative solution rejected or not given

Question 37 R10 R13 · Higher · Grade 9 · 5 marks

Q	Answer	Mark	Comments
37	$40 \times (\frac{2.5}{3.2})^2$ or 24.41...	M1	oe, the time for pipe B on its own
	$\frac{1}{40} + \frac{1}{24.41}$	M1	oe, the fraction filled in one minute, ft their time for B
	$1 \div$ their sum	M1	oe
	15.16...	A1	minutes
	15 minutes 10 seconds	B1ft	ft their time in minutes

Question 38 R10 R13 · Higher · Grade 9 · 5 marks

Q	Answer	Mark	Comments
38(a)	$0.085 \times \frac{4}{2.5}$ or 0.136	M1	oe, the effect of the length
	$\times (\frac{0.8}{0.5})^2$ or $\times 2.56$	M1	oe, the effect of the diameter
	0.348	A1	accept 0.3482
38(b)	$0.8^2 \times \frac{0.085 \times 4}{0.2}$ or $0.8 \times \sqrt{1.7}$	M1	oe, e.g. $0.085 \times 4 = 0.34$ for 10 m of 0.8 mm wire
	1.04	A1	accept 1.04 or [1.043, 1.044]

Question 39 R13 R5 · Higher · Grade 9 · 6 marks

Q	Answer	Mark	Comments
39(a)	0.48 and 0.72	M1	the masses of the pieces
	$k = \frac{1850}{0.7^2}$ or 3775.51...	M1	oe, or a scale factor such as $(\frac{1.2}{0.7})^2$
	£5436.73 and £869.88 and £1957.22	M1	oe, all three values
	£2609.63	A1	accept [£2609.61, £2609.65]
39(b)	$k(\frac{m}{2})^2$ or $\frac{km^2}{4}$	M1	oe, the value of one piece
	$2 \times \frac{km^2}{4} = \frac{km^2}{2}$, which is half of km^2	A1	oe, with a conclusion

Question 40 R13 R14 A17 · Higher · Grade 9 · 4 marks

Q	Answer	Mark	Comments
40	$y = \frac{k}{x^2}$ and $12.5 = \frac{k}{1.6^2}$	M1	oe
	$k = 32$	M1	oe
	$x = \frac{32}{x^2}$ or $x^3 = 32$	M1	oe
	(3.17, 3.17)	A1	accept 3.17 or [3.174, 3.175] for each