



5.2H Direct and Inverse Proportion: Higher Tier Practice

EDEXCEL Edexcel 1MA1 · Calculator allowed · about 80 minutes

Total Marks

Name: _____ Date: ____ / ____ / ____

Answer ALL questions. Show all your working.

- 1** A recipe for 6 portions uses 300 g of flour. Work out how much flour is needed for 15 portions, assuming the amount of flour is directly proportional to the number of portions.

(Total for Question 1 is 2 marks)

- 2** A car uses fuel at a rate directly proportional to its speed. At 40 mph the car uses 7 litres of fuel per hour. Work out the fuel used per hour at 70 mph.

(Total for Question 2 is 3 marks)

- 3** The time t (in hours) taken to fill a tank with a pump is inversely proportional to the pump's flow rate r (in litres per hour). A pump with flow rate 500 l/h fills the tank in 4 hours.
- (a) Find an expression for t in terms of r . (2 marks)
- (b) Using your expression, show that a pump with flow rate 750 l/h fills the tank in $\frac{8}{3}$ hours. (2 marks)

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(b) Using your expression, show that a pump with flow rate 750 l/h fills the tank in $\frac{8}{3}$ hours. (2)

(Total for Question 3 is 4 marks)

4 The brightness B of a lamp varies directly as the square of the current I through it. A particular lamp has brightness 400 units when the current is 2 A.

(a) Find the constant of proportionality k in $B = k I^2$. (2 marks)

(b) Use your k to find the current when the brightness is 225 units. Give your answer as a simplified surd if necessary. (2 marks)

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(b) Find the current when the brightness is 225 units. Give your answer as a simplified surd if necessary. (2)

(Total for Question 4 is 4 marks)

5 Two quantities x and y are related by $x = k / y^2$. When $y = 2$, $x = 9$.

(a) Find k . (1 mark)

(b) Write y in terms of x and k , giving y in simplest form. (3 marks)

(c) Hence or otherwise, find y when $x = 1$, giving an exact value. (1 mark)

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(b) Write y in terms of x and k , giving y in simplest form. (3)

(c) Hence or otherwise, find y when $x = 1$, giving an exact value. (1)

(Total for Question 5 is 5 marks)

- 6** A scientist measures that the pressure P of a gas varies directly as the temperature T and inversely as the volume V . This can be modelled as $P = k T / V$. For a sample, when $T = 300 \text{ K}$ and $V = 0.2 \text{ m}^3$ the pressure is 120 kPa .

(a) Find k . (2 marks)

(b) Using this k , calculate the pressure when $T = 450 \text{ K}$ and $V = 0.15 \text{ m}^3$. Give your answer to 3 significant figures. (4 marks)

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(b) Using this k , calculate the pressure when $T = 450 \text{ K}$ and $V = 0.15 \text{ m}^3$. Give your answer to 3 significant figures. (4)

(Total for Question 6 is 6 marks)

- 7** A cyclist rides so that the time t (hours) to travel a fixed route is inversely proportional to her speed v (mph), since the route length is fixed. Last week she rode at speed v and completed the route in t hours. This week her speed decreases by 4 mph and she takes 15 minutes longer.

(a) Express the new speed in terms of v . (1 mark)

(b) Write an equation linking t , v and the 15 minute increase and show that $16t = v - 4$. (3 marks)

(c) Hence find v in terms of t , simplifying fully, and find the value of v when $t = 1.5$ hours. (4 marks)

Note: 15 minutes = $\frac{1}{4}$ hour.

(a) Express the new speed in terms of v . (1)

(b) Write an equation linking t , v and the 15 minute increase and show that $16t = v - 4$. (3)

(c) Hence find v in terms of t , simplifying fully, and find the value of v when $t = 1.5$ hours. (4)

(Total for Question 7 is 8 marks)

8 A factory produces items at a rate directly proportional to the number of machines m and inversely proportional to the time h taken per shift. The production per shift P is modelled by $P = c m / h$. When the factory runs 12 machines and each shift lasts 8 hours, production is 480 items.

(a) Find c . (2 marks)

(b) The factory increases the number of machines by 50% and reduces shift length by 20%.

Calculate the new production per shift. (3 marks)

(c) The manager wants production per shift to be 900 items while keeping $h = 8$ hours. Find the required number of machines, giving an integer result and explaining any rounding. (3 marks)

(a) Find c . (2)

(b) The factory increases machines by 50% and reduces shift length by 20%. (3)
Calculate the new production per shift.

(c) Find the required number of machines to get $P = 900$ items per shift when $h = 8$ (3)
hours. Give an integer result and explain any rounding.

(Total for Question 8 is 8 marks)

Mark scheme · 5.2H Direct and Inverse Proportion: Higher Tier Practice

Question 1

- **M1** use direct proportion: $300/6 * 15$ or equivalent method
- **A1** 750 g cao
- **Answer: 750 g (grams).** This is $300/6 * 15 = 50 * 15 = 750$ g.
Working check: 6 portions -> 300 g, so per portion 50 g; 15 portions -> 750 g.

Question 2

- **M1** identify direct proportion: fuel/hour = $k * \text{speed}$ and find $k = 7/40$
- **M1** calculate fuel at 70 mph: $(7/40) * 70$
- **A1** 12.25 litres per hour (or 12.3 to 3 s.f.) cao
- **Answer: 12.25 litres per hour.**
Working check: $k = 7/40 = 0.175$; $0.175 * 70 = 12.25$.

Question 3

- (a) **M1** set up inverse proportion $t = k/r$ and use $t=4$ when $r=500$ to find $k = 2000$
- (a) **A1** $t = 2000 / r$ cao
- (a) **Answer: $t = 2000 / r$**
- (b) **M1** substitute $r = 750$ into $t = 2000/r$ giving $2000/750$
- (b) **A1** $8/3$ hours cao
- (b) **Answer: $2000/750 = 8/3$ hours.**
Working check: $2000/750$ simplifies to $8/3 = 2.666...$ hours.

Question 4

- (a) **M1** substitute $B=400$, $I=2$ into $B = k I^2$ to get $400 = k * 4$
- (a) **A1** $k = 100$ cao
- (a) **Answer: $k = 100$**
- (b) **M1** use $225 = 100 I^2$ so $I^2 = 225/100 = 9/4$
- (b) **A1** $I = 3/2$ A cao
- (b) **Answer: $I = 3/2$ A.**
Working check: $I^2 = 9/4$ so $I = 3/2$ (positive current).

Question 5

- (a) **B1** $k = 36$ cao
- (a) **Answer: $k = 36$**
- (b) **M1** rearrange $x = k / y^2$ to $y^2 = k / x$ or equivalent
- (b) **M1** take positive square root for y : $y = \sqrt{k / x}$
- (b) **A1** $y = \sqrt{k/x}$ cao
- (b) **Answer: $y = \sqrt{k / x}$**
- (c) **B1** $y = 6$ cao
- (c) **Answer: $y = 6$**

Question 6

- (a) **M1** substitute values into $P = k T / V$ and rearrange: $k = P V / T$
- (a) **A1** $k = 0.08$ (units $\text{kPa} \cdot \text{m}^3/\text{K}$) cao
- (a) **Answer: $k = 0.08$**
- (b) **M1** substitute k and values: $P = k T / V$
- (b) **M1** calculate numeric value
- (b) **A1** $P = 0.08 * 450 / 0.15 = 240$ kPa cao
- (b) **A1** answer given to 3 s.f. 240.0 kPa or 240 kPa cao
- (b) **Answer: 240 kPa**

Question 7

- (a) **B1** new speed = $v - 4$ cao
- (a) **Answer: $v - 4$**
- (b) **M1** use fixed distance $d = vt$ and write new time = $vt / (v - 4)$
- (b) **M1** set $vt/(v-4) = t + 1/4$, multiply both sides by $(v-4)$ and expand the right-hand side
- (b) **A1** correctly cancel the vt terms and rearrange to reach $16t = v - 4$ cao
- (b) **Answer: $16t = v - 4$ (shown).**
- (c) **M1** rearrange $16t = v - 4$ to make v the subject
- (c) **A1** $v = 16t + 4$ cao
- (c) **M1** substitute $t = 1.5$ into $v = 16t + 4$
- (c) **A1** $v = 28$ mph cao
- (c) **Answer: $v = 16t + 4$. When $t = 1.5$, $v = 16(1.5) + 4 = 28$ mph.**

Question 8

- (a) **M1** substitute $P=480$, $m=12$, $h=8$ into $P = c m / h$ and rearrange
- (a) **A1** $c = 320$ cao
- (a) **Answer: $c = 320$**
- (b) **M1** find new $m = 1.5 * 12 = 18$ and new $h = 0.8 * 8 = 6.4$
- (b) **M1** substitute into $P = 320 * 18 / 6.4$
- (b) **A1** $P = 900$ cao
- (b) **Answer: 900 items**
- (c) **M1** rearrange $P = c m / h$ to $m = P h / c$ and substitute $P=900$, $h=8$, $c=320$
- (c) **M1** calculate $m = 900 * 8 / 320 = 7200 / 320 = 22.5$
- (c) **A1** $m = 23$ machines, since machines must be whole and 22 machines produce only $22 * 320 / 8 = 880 < 900$ so round up
- (c) **Answer: 23 machines. Calculation gives 22.5, so at least 23 machines are needed; rounding up because machines must be whole.**