



KS3.M-R8 Inverse Proportion

Calculators not allowed · about 60 minutes

Name: _____ Date: ____ / ____ / ____

Answer ALL questions. Show all your working.

- 1** State whether each pair of quantities is directly proportional, inversely proportional, or neither.
- (a) The time taken to fill a bath and the number of taps open (all taps are identical). (1)
- (b) The cost of 1 kg of apples and the number of kilograms bought when there is a fixed total budget of 6 pounds. (1)
-
- 2** Two quantities x and y are inversely proportional. When $x = 5$, $y = 12$. Find y when $x = 15$. (2)
-
- 3** In an inverse proportion $y = k/x$. Find the constant k for each case.
- (a) When $x = 2$, $y = 9$. (1)
- (b) When $x = 7$, $y = 3/7$. (1)
- _____
- _____

- 4** A job takes 6 workers 10 hours to finish. Assuming work completed is fixed and workers are equally efficient, how long would it take 15 workers?

(3)

- 5** The brightness of a lamp varies inversely with the square of the distance from the lamp. If brightness is 100 units at 2 m, find the brightness at 5 m. Give your answer as a fraction or a decimal.

(3)

- 6** If y is inversely proportional to x and $y = 8$ when $x = 1.5$, find x when $y = 12$.

(2)

- 7** A cyclist takes 2 hours to travel 30 miles at a steady speed. Assuming speed is inversely proportional to time for a fixed distance, find how long it takes to travel the same distance at 9 mph.

(3)

- 8** The pressure P of a gas varies inversely with its volume V at constant temperature, $P = k/V$. If pressure is 2.5 kPa when volume is 8 litres, find the pressure when volume is 5 litres.

(3)

- 9** Two machines working together complete a task in 4 hours. If one machine alone would take 6 hours, find how long the second machine would take alone. Assume each machine works at constant rate and rates add.

(2)

- 10** An electrical heating element gives a fixed amount of heat energy per second. The temperature rise per minute is inversely proportional to the mass of water heated. If 500 g of water heats up by 6 degrees in one minute, how many degrees does 750 g of water rise in one minute?

(3)

- 11** Solve the equation $7 = k/x$ given that $x = 0.5$. Find k , then state k/x when $x = 2.5$.

(3)

- 12** A photographer says the exposure is inversely proportional to shutter speed. If an exposure of $\frac{1}{60}$ s gives correct exposure at f-number fixed, what exposure corresponds to shutter speed $\frac{1}{240}$ s? State whether exposure increases or decreases.

(2)

-
- 13** Two variables a and b are inversely proportional. When $a = 10$, $b = 1.5$. When $a = 25$, what is b ? Show your working.

(3)

-
- 14** A pump fills a tank at a rate that is inversely proportional to the time taken. If the pump fills the tank in 2 hours at 90 litres per hour, what rate (in litres per hour) will fill the same tank in 6 hours?

(2)

-
- 15** A simple inverse proportion problem: The time t (in minutes) to boil water varies inversely with the power p (in units) of the kettle. When $p = 4$, $t = 9$. Calculate t when $p = 6$.

(3)

- 16** Stretch: The intensity I of light from a point source varies inversely with the square of the distance d . Two lamps give intensities I_1 and I_2 at distances d_1 and d_2 respectively. Lamp A at 3 m gives intensity 80 units. Lamp B at 6 m gives intensity 30 units. Are these two lamps likely to be identical point sources? Justify your answer with calculation.

(3)

-
- 17** Stretch: A recipe requires an amount of spice s that varies inversely with the number of servings n . A recipe uses 2 teaspoons for 8 servings. How many teaspoons are needed for 30 servings? Give your answer as a fraction and as a decimal to two decimal places.

(3)

-
- 18** Extension problem: A wind turbine's power output P varies approximately inversely with the cube of the time t taken for one revolution (so $P = k/t^3$). If a turbine produces 200 kW when $t = 2$ s, find the power when $t = 3$ s. Give your answer to 1 decimal place.

(3)

Mark scheme · KS3.M-R8 Inverse Proportion

Question 1

- (a) **B1** Inversely proportional (oe)
- (a) Answer: **Inversely proportional**
- (b) **B1** Inversely proportional (oe)
- (b) Answer: **Inversely proportional**

Question 2

- **M1** use $k = x \cdot y = 5 \cdot 12 = 60$ or state $y = k/x$
- **A1** 4 cao
- Answer: **4**

Question 3

- (a) **B1** $k = 18$ cao
- (a) Answer: **18**
- (b) **B1** $k = 3$ cao
- (b) Answer: **3**

Question 4

- **M1** use inverse proportion: $k = \text{workers} \cdot \text{time} = 6 \cdot 10 = 60$ or state $\text{time} = k/\text{workers}$
- **M1** substitute: $\text{time} = 60/15$
- **A1** 4 hours cao
- Answer: **4 hours**

Question 5

- **M1** recognise brightness proportional to $1/d^2$ and find k : $k = \text{brightness} \cdot d^2 = 100 \cdot 4 = 400$
- **M1** substitute $d = 5$: $\text{brightness} = 400/25$
- **A1** 16 cao
- Answer: **16**

Question 6

- **M1** find $k = x \cdot y = 1.5 \cdot 8 = 12$ or state $y = k/x$
- **A1** $x = 1$ cao
- Answer: **1**

Question 7

- **M1** use $\text{distance} = \text{speed} \cdot \text{time}$; distance fixed = 30 miles
- **M1** $\text{time} = \text{distance}/\text{speed} = 30/9$
- **A1** $10/3$ hours or $3 \frac{1}{3}$ hours cao
- Answer: **$10/3$ hours**

Question 8

- **M1** find $k = P \cdot V = 2.5 \cdot 8 = 20.0$
- **M1** substitute $V=5$: $P = 20/5$
- **A1** 4 kPa cao
- Answer: **4 kPa**

Question 9

- **M1** use rates: $1/6 + 1/t = 1/4$ or state combined rate = $1/4$
- **A1** $t = 12/1 = 12$ hours cao
- Answer: **12 hours**

Question 10

- M1 recognise θ proportional to $1/\text{mass}$ and find k : $k = \theta * \text{mass} = 6 * 500 = 3000$
- M1 substitute $\text{mass} = 750$: $\theta = 3000/750$
- A1 4 degrees c
- Answer: **4 degrees**

Question 11

- M1 find k from $7 = k/0.5$ giving $k = 7 * 0.5 = 3.5$
- M1 substitute k and $x = 2.5$ to get value
- A1 1.4 c
- Answer: **1.4**

Question 12

- M1 use inverse proportion: $\text{exposure} * \text{shutter} = k$; $k = 1/60 * e$ where e is 1 at $1/60 \rightarrow k = 1/60$ or reason: change by factor $240/60$
- A1 exposure at $1/240$ is 4 times smaller, i.e. $1/240$ gives exposure $1/4$ of original, so exposure decreases (state decrease)
- Answer: **Exposure is 1/4 of the original; exposure decreases**

Question 13

- M1 find $k = 10 * 1.5 = 15$
- M1 compute $b = 15/25$
- A1 $3/5$ or 0.6 c
- Answer: **3/5**

Question 14

- M1 use $\text{rate} * \text{time} = \text{constant volume}$: $\text{volume} = 90 * 2 = 180$ litres
- A1 30 litres per hour c
- Answer: **30 litres per hour**

Question 15

- M1 find $k = p * t = 4 * 9 = 36$
- M1 substitute $p=6$: $t = 36/6$
- A1 6 minutes c
- Answer: **6 minutes**

Question 16

- M1 calculate k for lamp A: $k = I * d^2 = 80 * 9 = 720$
- M1 calculate k for lamp B: $k = 30 * 36 = 1080$
- A1 conclude not identical because k values differ (720 vs 1080) with correct justification
- Answer: **No; $k_A = 720$ and $k_B = 1080$, so they are not identical**

Question 17

- M1 find $k = s * n = 2 * 8 = 16$
- M1 compute $s = 16/30 = 8/15$
- A1 $8/15$ and 0.53 (0.533... rounded to 0.53) c
- Answer: **8/15; 0.53**

Question 18

- M1 find $k = P * t^3 = 200 * 8 = 1600$
- M1 compute $P = 1600/27$
- A1 59.3 kW ($1600/27 = 59.259... \rightarrow 59.3$ to 1 dp) c
- Answer: **59.3 kW**