**GCSE Mathematics**

**1MA1**

**Problem-solving questions 2**

**Higher Tier**

**Time: 2 hours**

You should have: Ruler graduated in centimetres and millimetres, protractor, pair of compasses, pen, HB pencil, eraser.

Calculator not permitted in questions with ˠ

Questions with \* could be seen on Foundation Tier

**\*1.** 150 students each visited one of the foreign countries France, Portugal or Italy last month.

36 male students visited one of these foreign countries.

15 male students visited France.

44 female students visited Portugal.

32 female students visited France.

(a) Complete the two-way table.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **France** | **Portugal** | **Italy** | **Total** |
| **Male** |  |  |  |  |
| **Female** |  |  |  |  |
| **Total** |  |  | 43 |  |

 **(2)**

(b) Write down the fraction of female students who visited Italy.

**(1)**

(c) Work out the percentage of female students who visited Italy.

Give answer correct to 3 significant figures.

**(1)**

**(Total for question 1 is 4 marks)**

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**2.** The *n*th term of an arithmetic sequence is given by *an* + *b* where *a* and *b* are integers.

The 5th term is 19 and the 11th term is 43

(a) (i) Write down an equation for the 5th term in terms of *a* and *b*.

(ii) Write down an equation for the 11th term in terms of *a* and *b*.

**(1)**

(b) Work out the values of *a* and *b*.

**(3)**

**(Total for question 2 is 4 marks)**

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**3.** Here is the list of the ingredients to make 12 chocolate cookies

**Chocolate cookies**

**Recipe for 12**

80 g of sugar

120 g of flour

30 g of cocoa

100 g of butter

Lisa has

500 g of sugar

650 g of flour

205 g of cocoa

500 g of butter

(a) Work out the number of chocolate cookies Lisa can make using

(i) 500 g of sugar

(ii) 650 g of flour

(iii) 205 g of cocoa

(iv) 500 g of butter

**(3)**

(b) Work out the greatest number of chocolate cookies she can make.

**(1)**

**(Total for question 3 is 4 marks)**

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**4.** There are two classes, A and B, in Year 11

The two classes sat a mathematics test.

Class A had revision sessions.

Class B did **not** have revision sessions.

The boxes show some information about the marks obtained in the test.

|  |  |
| --- | --- |
| **Class A** | **Class B** |
| 24 31 32 37 39 42 46 4950 50 56 58 61 68 74 | Lowest 20 Lower quartile 28Median 46 Upper quartile 49Highest 70   |

(a) For class A write down the

(i) median,

(ii) range.

**(2)**

(b) Compare the distribution of the marks obtained by class A with revision sessions to the distribution of the marks obtained by class B without revision sessions.

**(2)**

**(Total for question 4 is 4 marks)**

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**\*5.** Simon asked his employees how many minutes they each took to get to work from home.

The table shows this information*.*

|  |  |  |
| --- | --- | --- |
| **Time taken****(*t* minutes)** | **Frequency** | **Midpoint** |
|  0 < *t* ≤ 12 | 10 |  |
| 12 < *t* ≤ 24 | 12 |  |
| 24 < *t* ≤ 36 | 15 |  |
| 36 < *t* ≤ 48 | 3 |  |

(a) (i) Complete the midpoint column.

(ii) Work out an estimate for the mean time taken.

**(4)**

(b) Explain why your answer to part (a) is an estimate.

**(1)**

Simon realises he has missed an employee out.

This employee takes 38 minutes to get to work from home.

(c) How will this affect the mean?

Explain why.

**(1)**

**(Total for question 5 is 6 marks)**

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**6.** The diagram shows a rectangle *ABCD*.

*A*

*B*

*C*

*D*

*E*

80 m

48 m

The diagonals of the rectangle cross at *E*.

(a) Work out angle *ABD*.

**(2)**

(b) Write down the size of the angle *BAC*.

**(1)**

(c) Work out angle *AEB*.

**(1)**

**(Total for question 6 is 4 marks)**

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**7.** The Venn diagram gives information about the number of students in Year 11 who are studying Latin (L) or Spanish (S) or both or neither.

L

S

5

3

8

4

(a) Use the Venn diagram to complete the tree diagram.

Spanish

Not

Spanish

Latin

Not

Latin

Spanish

Not

Spanish

........

 ........ ........

 ........

**(3)**

A student is chosen at random.

(b) Work out the probability that the student does not study Latin and does not study Spanish.

**(2)**

**(Total for question 7 is 5 marks)**

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**\*8.** The diagram shows a garden in the shape of a square, *ABCD*, and four semicircles.

*A*

*B*

*C*

*D*

11.2 m

*AB*, *BC*, *CD* and *DA* are the diameters of the semicircles.

Daniel wants to cover the garden with gravel.

The table shows the price of gravel at two stores.

|  |  |
| --- | --- |
| **Store A** |  **Store B** |
| £4.40 per m2 | A tonne bag costs £43.49 and covers 10 m2 |

(a) (i) Work out the area of the square ABCD.

(ii) Work out the area of the four semi-circles.

(iii) Work out the area of the garden.

**(2)**

(b) (i) Work out the number of square metres of gravel needed from store A.

(ii) Work out the cost of gravel from store A.

**(1)**

(c) (i) Work out the number tonne bags needed from store B.

(ii) Work out the cost of gravel from store B.

**(1)**

Daniel wants to spend the least amount of money.

(c) Should he buy the gravel from store **A** or from store **B**?

 Explain why.

**(1)**

**(Total for question 8 is 5 marks)**

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**9.** Anjali, Ravina and Sandeep are going to share £21 156 between them.

Anjali is going to receive 20% more than Ravina.

the amount of money Ravina gets : the amount of money Sandeep gets = 3:2

(a) (i) Work out the ratio for Ravina.

(ii) Write down the ratio for the amount of money Ravina gets to the amount of money Ravina gets to the amount of money Sandeep gets.

**(1)**

(b) Work out the amount of money each of the three girls receives.

**(3)**

**(Total for question 9 is 4 marks)**

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**10.** The diagram shows a block of wood in the shape of a cuboid.

*x*

*x* + 2

*x* + 1

All measurements are in centimetres.

A piece in the shape of a cube of length *x* cm is cut from the block of wood.

The volume of the block of wood **without** the cube is 56 cm3.

(a) Write down an expression in terms of *x* for the volume of the

(i) cube,

(ii) block of wood,

(iii) block of wood **without** the cube

**(1)**

(b) Show that the equation in terms of *x* for the volume of the block of wood **without** the cube is 3*x*2 + 2*x −* 56 = 0

**(1)**

(c) Solve 3*x*2 + 2*x −* 56 = 0

**(1)**

(d) Write down the length of the cube.

**(1)**

(e) Work out the surface area of the cube.

**(1)**

**(Total for question 10 is 5 marks)**

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**11.** The diagram shows a motorway and two junctions.

North

Junction 11

22 miles

Penn

Junction 10

16 miles

Asha is driving on the motorway.

The motorway is closed between junctions 10 and 11

She leaves junction 10 as there is a diversion.

She drives 16 miles due East to Penn.

From Penn she drives on a bearing of 340° for 22 miles until she reaches junction 11

She drives at 60 miles per hour on this diversion.

Assume that Asha would have driven at 70 miles per hour along the motorway.

(a) (i) Work out the angle from junction 10 to Penn to junction 11,

(ii) Work out the distance from junction 10 to junction 11,

(iii) Work out the time taken, in hours, from junction 10 to junction 11

 **(2)**

(b) (i) Work out the distance travelled via the diversion,

(ii) Work out the time taken, in hours, via the diversion.

 **(1)**

(c) How many more minutes driving along the diversion were added to her journey?

**(3)**

**Total for question 11 is 6 marks)**

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**12.** For all values of *x ≠* 0

 f(*x*) = 2*x* g(*x*) = *x* + 3 h(*x*) = $\frac{1}{x}$

(a) (i) Write down fg(*x*).

 (ii) Write down gf(*x*).

 (iii) Show that there is no value of *x* for which

 fg(*x*) = gf(*x*)

**(3)**

(b) (i) Write down fh(*x*).

(ii) Work out the values of *x* for which

 fh(*x*) = gf(*x*)

**(4)**

**(Total for question 12 is 7 marks)**

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**13.** The diagram shows a solid shape *ABCDEF*.



8 cm

*ABF* and *CDE* are cones each with a height of *h* cm.

*BCEF* is a cylinder with a diameter of 8 cm.

*AD* = 18 cm.

The mass of the solid shape is 512π grams.

The density of the solid is 3.2 g/cm3.

(a) Find the volume of the solid shape *ABCDEF*. Leave your answer in exact form.

**(1)**

(b) (i) Find the volume of the cylinder *BCEF* in terms of *h*. Leave your answer in exact form.

(ii) Find the volume of the cone *ABF* in terms of *h*. Leave your answer in exact form.

(iii) Write down the volume of the two cones, *ABF* and *CDE*, in terms of *h*. Leave your answer in exact form.

**(1)**

(c) Show that the equation of the solid shape *ABCDEF* is written as

 *h* + 16(18 – 2*h*) = 160

**(1)**

(d) Work out the value of *h*, in cm.

**(2)**

**(Total for question 13 is 5 marks)**

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**14.** *ABCDEF* is a regular hexagon.

*x*

*y*

*O*

*A*

*B*

*C*

*D*

*E*

*F*

 *A* is the point (0,0)

*B* is the point (2,  )

(a) (i) Write down the size of angle *BAG*.

(ii) Work out the length of *AB*.

(iii) Work out the area of triangle *ABG*.

**(1)**

(b) Show that the area of the hexagon is  where *a* is an integer to be found.

**(2)**

**(Total for question 14 is 3 marks)**

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**15.** Fred runs from his house to the park at an average speed of *x* miles per hour.

He runs back from the park to his house at an average speed of *y* miles per hour.

The distance from his house to the park is *m* miles.

(a) (i) Write down the time taken from the house to the park in terms of *x* and *m*.

(ii) Write down the time taken from the park to the house in terms of *y* and *m*.

(iii) Work out the total time taken by Fred to run from his house to the park and back to his house.

**(2)**

(b) Write down the total distance ran by Fred from his house to the park and back to his house.

(c) Work out, in terms of *x* and *y*, his average speed from his house to the park and back to his house.

 Give your answer in its simplest form.

**(2)**

**(Total for question 15 is 4 marks)**

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**16.** There are 15 beads in a box.

There are *x* red beads in the box.

The rest of the beads are green.

A bead is taken at random and not replaced.

Another bead is chosen at random.

The probability of taking one bead of each colour is 

The number of red beads is less than the number of green beads.

(a) Write down an expression in terms of *x* for taking a

(i) red bead followed by a green bead,

(ii) green bead followed by a red bead.

**(1)**

(b) Write down an expression for taking one bead of each colour.

**(1)**

(c) Show that an equation of taking one bead of each colour is *x*² − 15*x* + 54 = 0

**(1)**

(d) Solve *x*² − 15*x* + 54 = 0

**(1)**

(e) Work out the ratio of the number of red beads to the number of green beads.

**(1)**

**(Total for question 16 is 5 marks)**

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ˠ**17.**

*P*(*a*, *a*)

*x*

*y*

*O*

The diagram shows a circle, centre *O*.

It also shows a tangent to the circle at the point *P*(*a*, *a*).

The radius of the circle is  cm.

(a) Write down the equation of the circle.

**(1)**

(b) Work out the coordinates of *P*.

 You must show your working.

**(2)**

**(Total for question 17 is 3 marks)**

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ˠ**18.** The diagram shows three circles.

*l* cm

*B*

*A*

*C*

The circle with centre *A* has a radius 4 cm.

The circle with centre *B* has a radius 8 cm.

The circle with centre *C* has a radius 4 cm.

(a) (i) Write down the length of *BC*.

(ii) Write down the length of *BD*.

(iii) Work out the length of *DC*.

**(3)**

(b) Write down the length of *AC*.

(c) Work out the length, *l*, in cm.

Give your answer in the form  where *a* and *b* are integers.

**(2)**

**(Total for question 18 is 5 marks)**

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

ˠ**19.** The diagram shows a rectangle *ABCD*.

*A*

*B*

*C*

*D*

m

The area of the rectangle is 2 m2.

*AB* is m.

(a) Work out the length of *BC*.

**(2)**

(b) Work out the perimeter of *ABCD*.

Give your answer in the form $a\sqrt{b}$ where *a* and *b* are integers.

**(2)**

**(Total for question 19 is 4 marks)**

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**20.**

*A*

*B*

*C*

*D*

*X*

*Y*

*AXB*, *AYC* and *BCD* are straight lines.

*X* is the midpoint of *AB*.

*C* is the midpoint of *BD*.

$\vec{AB}=12p$$\vec{AC}=12q$$\vec{AY}=λq$

*XYD* is a straight line.

(a) Write down the length of $\vec{XY}$ in terms of **p** and **q**.

**(1)**

(b) Write down the length of $\vec{XYD}$ in terms of **p** and **q**.

**(1)**

(c) Write down an equation of the form $\vec{XY}=λ\vec{XYD}$ in terms of **p** and **q**.

**(1)**

(d) Work out the value of *λ*.

**(1)**

(e) Work out the ratio *AY : YC* in its simplest form.

**(1)**

**(Total for question 20 is 5 marks)**

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| **Qn** | **Answer** | **Mark** | **Notes** |
| --- | --- | --- | --- |
| **\*1(a)** | Correct table | 2 | P1 process to enumerate the two-way table by using the given figures, e.g. 36, 15, 44, 32 and 150 correct P1 process to find the total number of students who visited a foreign country, e.g. 150 – 36 = 114 |
| **(b)** |  | 1 | P1 process to find the fraction of female students who visited Italy, e.g. (“114” – 44 – 32)/114 |
| **(c)** | 22% | 1 | A1 To find the percentage of female students who visited Italy, e.g. “38” ÷ 114 × 100 = 22 |
| **2(a)(i) and (ii)** | 2 correct equations | 1 | P1 process to set up two equations, e.g. 5*a* + *b* = 19 and 11*a* + *b* = 43   |
| **(b)** | *a* = 4*b* = −1 | 3 | P1 process to eliminate a variable, e.g. 11*a*  – 5*b* = 43 – 19 P1 process to find the second variable, e.g. 5(“4”) + *b* = 19 and 11(“4”) + *b* = 43 A1 cao  |
| **3(a)** | 75, 65, 82 and 60 | 3 | P1 process to find the amount of one ingredient required for one cookie or to find the number of groups of 12 cookies that are possible with the amount of one ingredient available, e.g. 80 ÷ 12 (= 6.6… ) or 500 ÷ 80 (= 6.25)P1 (dep) process to consider all ingredients in this way, e.g. 80 ÷ 12 (= 6.6… ), 120 ÷ 12 (= 10), 30 ÷ 12 (= 2.5 ) and 100 ÷ 12 (= 8.3... ) or 500 ÷ 80 (= 6.25), 650 ÷ 120 (= 5.4….) and 205 ÷ 30 (= 6.8…) and 500 ÷ 100 (= 5)P1 process to find the number of cookies that can be made from each ingredient or for all multipliers, e.g. 500 ÷ (80 ÷ 12) (= 75), 650 ÷ (120 ÷ 12) (= 65) , 205 ÷ (30 ÷ 12) (= 82), 500 ÷ (100 ÷ 12) (= 60)or 500 ÷ 80 × 12 (= 75), 650 ÷ 120 × 12 (= 65), 205 ÷ 30 × 12 (= 82) and 500 ÷ 100 × 12 (= 60) |
| **(b)** | 60 | 1 | A1 60 |
| **4(a)(i) and (ii)** | 4921 | 2 | P1 process to find the median for class A, e.g.  (16)th value = 49P1 process to find the range/IQR for class A and class B, e.g. IQR: “58” – “37” = 21 and 49 – 28 = 21 |
| **(b)** | Correct statements | 2 | C1 correct conclusion using the correct median, e.g.: The median of class A is greater than the median of class B oeOn average class A did better than class B oeC1 correct conclusion using the correct range/IQR, e.g. The IQR’s are equal for class A and class B orThe spread of data is the same for class A and class B oe**Note:** To award the final 2 marks one of the C marks must be in context |
| **\*5 (a)** | 21.3 | 4 | M1 for finding *fx* with *x* consistent within intervals (allow end points)M1 (dep on first M1) for $\sum\_{}^{}fx÷\sum\_{}^{}f$ (= 852 ÷ 40)A1 cao |
| **(b)** |  | 1 | C1 The data is grouped |
| **(c)** |  | 1 | C1 The mean will increase because 38 ˃ “21.3”Allow follow through |
| **6(a)** | 30.96° | 2 | P1 process to find or angle *ABD* e.g. tan *ABD* = (48÷80) or tan *BAC* = (48÷80)P1 process to find an angle, e.g. angle *ABD* = angle *BAC* = 30.96 |
| **(b)** | 118° | 2 | P1 process to find angle *AEB*, e.g. 180 – “30.96” – “30.96” A1 118° |
| **7 (a)** | Correct probabilities on branches | 3 | P1 process to interpret the Venn diagram for Latin, e.g.  or seen P1 process to interpret the Venn diagram for Spanish, e.g.  or  or  or  seen A1 correct tree diagram with and  on first branch and , ,  and  on second branches |
| **(b)** |  | 2 | P1 process to find the number of students who do not study Latin or Spanish, e.g. 4 or × A1  oe |
| **\*8(a)** | 322.48..... | 2 | P1 process to find the area of the garden, e.g. (11.2 × 11.2) = 125.44 or π × 5.62 (= 98.52....) or π × 5.62 ÷ 2 (= 49.26....) P1 process to find the total area of the garden, e.g. “125.44” + 2(“98.52....”) = 322.48..... |
| **(b)** | 1421.20 | 1 | P1 process to find the cost of gravel from store Ae.g. “323” × 4.40 = 1421.20  |
| **(c)** | 1435.17 | 1 | P1 process to find the cost of gravel from store B e.g. “330” ÷ 10 × 43.49 = 1435.17  |
| **(d)** | Store **A**and correct reason | 1 | A1 Store **A,** 1421.20 is less than 1435.17 |
| **9(a)** | 3.63.6:3:2 | 1 | P1 process to find the ratio for Ravina, e.g. 3 × 1.2 = 3.6 |
| **(b)** | 8856, 7380 and 4920 | 3 | P1 process to start the problem with the three ratios, e.g. 21 156 ÷ (“3.6” + 3 +2)(= 2460) or 3.6*x* + 3*x* + 2*x* = 21 156P1 process to find each share, e.g. “2460” × 3.6 or “2460” × 3 or “2460” × 2A1 8856, 7380 and 4920 |
| **10(a)** | *x*3 + 3*x*2 + 2*x**x*33*x*2 + 2*x* | 1 | P1 process to find the volume of the block of wood without the cube, e.g. *x*(*x* + 1)(*x* + 2) − *x*3 = *x*3 + 3*x*2 + 2*x* − *x*3 = 3*x*2 + 2*x* |
| **(b)** | 3*x*2 + 2*x −* 56 = 0 | 1 | P1 process to form an equation using 56, e.g. 3*x*2 + 2*x* = 56 |
| **(c)** |  and 4 | 1 | P1 beginning to process the algebra and solve the quadratic equation, e.g. (3*x* + 14)(*x* – 4) seen |
| **(d)** | 4 | 1 | B1 for 4 |
| **(e)** | 96 | 1 | A1 for cao |
| **11(a)** | 0.319 | 2 | P1 process to find the distance between junction 10 and 11, e.g. = 22.34318…P1 process to find the time taken between junction 10 and 11, e.g. “22.34318...” ÷ 70 = 0.319.....hours |
| **(b)** | 0.6333 | 1 | P1 process to find the time taken via the diversion, e.g. (22 + 16) ÷ 60 = 0.6333....hours |
| **(c)** | 19 | 3 | P1 process to find the difference in the times taken, e.g. “0.6333..”. – “0.319...” = 0.3141....P1 process to convert hours to minutes, e.g. “0.3141....” × 60A1 19 |
| **12 (a)** | Show no values of *x* | 3 | P1 process to find fg(*x*) or gf(*x*), e.g. 2(*x* + 3) or 2*x* + 3P1 process to solve the equation, e.g. 2(*x* + 3) = 2*x* + 3A1 correct conclusion |
| **(b)** | 0.5 and −2 | 4 | P1 process to find fh(*x*)and gf(*x*) and form an equation, e.g. P1 Process to reduce the equation to *ax*² + *bx* + *c* = 0, e.g. 2*x*² + 3*x* – 2 = 0 oe P1 Process to solve quadratic equation, e.g. (2*x* – 1)(*x* + 2) = 0A1 *x* = 0.5 and *x* = − 2 |
| **13(a)** | 160*π* | 1 | P1 process to find the volume of the shape, e.g. 512*π* ÷ 3.2 = 160*π* |
| **(b)** | *π*4²*h* and *π*4²(18 – 2*h*) | 1 | P1 process to find the volume of the cone or the cylindere.g. *π*4²*h* or *π*4²(18 – 2*h*)  |
| **(c)** | AG | 1 | P1 process to set up the equation, e.g. *π*4²*h* + *π*4²*h* + *π*4²(18 – 2*h*) = “160*π*”  |
| **(d)** | 6 | 2 | P1 process to solve the equation, e.g. (16)*h* + 16(18 – 2*h*) = 160 or 384 = 64*h*A1 cao |
| **14(a)** | 60°, 4 and  | 1 | P1 process to find the area of the triangle, e.g. 0.5 × “” × “4” × sin 60 =  |
| **(b)** |  | 2 | P1 process to find the area of the hexagon, e.g. 6 × “”A1 cao |
| **15(a)** |  | 2 | P1 process to find the time taken from house to park or park to house, e.g.  or P1 process to find the total time taken, e.g.   |
| **(b) and (c)** |  | 2 | P1 process to find the average speed, e.g. 2*m* ÷ ””A1  oe |
| **16(a)** | Correct expressions | 1 | P1 process to find the probability of a red bead and a green bead or vice versa, e.g.  or  |
| **(b)** | Correct expression | 1 | P1 process to set up the equation, e.g.  |
| **(c)** | AG | 1 | P1 process to reduce the equation to *ax*² + *bx* + *c* = 0, e.g. 2*x*² − 30*x* + 108 = 0 oe  |
| **(d)** | 9 and 6 | 1 | P1 process to solve quadratic equation, e.g. (*x* – 9)(*x* – 6) = 0 |
| **(e)** | 2:3 | 1 | A1 for 2 : 3 oe  |
| ˠ**17(a)** | Equation of circle  | 1 | P1 process to use the coordinates of *P*, e.g.  |
| **(b)** | (6, 6) | 2 | P1 process to solve the equation, e.g. 2*a*2 = 72 A1 for (6, 6) ; accept *a* = 6  |
| ˠ**18(a)** |  | 3 | P1 process to find the length of *AB*, e.g. 8 + 4 = 12P1 process to find a horizontal length, e.g. P1 process to simplify the surd, e.g.  |
| **(b)** |  | 2 | P1 process to find *AC* or *l*, e.g. 2 × “” =  or 2 × “” + 4 + 4 or 2 × “” or 2 × “” + 4 + 4A1 cao; accept *a* = 8 and *b* = 16 |
| ˠ**19(a)** | – 1 | 2 | P1 process to start to find the length of *BC* or *AD*, e.g. 2 ÷ (1 +)P1 process to rationalise the denominator, e.g. = – 1 |
| **(b)** |  | 2 |  P1 process to work out the perimeter of the shape, e.g. – 1 ”+ – 1 ” ++ 1 +A1 cao |
| **20(a)** | − 6**p** + *λ***q** | 1 | P1 process to find $\vec{XY}$, e.g. − 6**p** + *λ***q** |
| **(b)** | 24**q** – 18**p** | 1 | P1 process to find $\vec{XYD}$, e.g. 6**p** + 2(12**q** – 12**p**) = 24**q** – 18**p** |
| **(c)** | An equation in terms of *λ* | 1 | P1 process to set up an equation involving multiples, e.g. − 6**p** + *λ***q** = *k*[24**q** – 18**p**] |
| **(d)** | 8 | 1 | P1 process to work out *λ*, e.g. −6 = −18*k* and *λ* = 24*k* = 24 × “” = 8 |
| **(e)** | 2:1 | 1 | A1 cao |