**1.**



Pictures **NOT** accurately drawn

A 20 Euro note is a rectangle 133 mm long and 72 mm wide.
A 500 Euro Note is a rectangle 160 mm long and 82 mm wide.

Show that the two rectangles are **not** mathematically similar.

**(Total 3 marks)**

**2.**

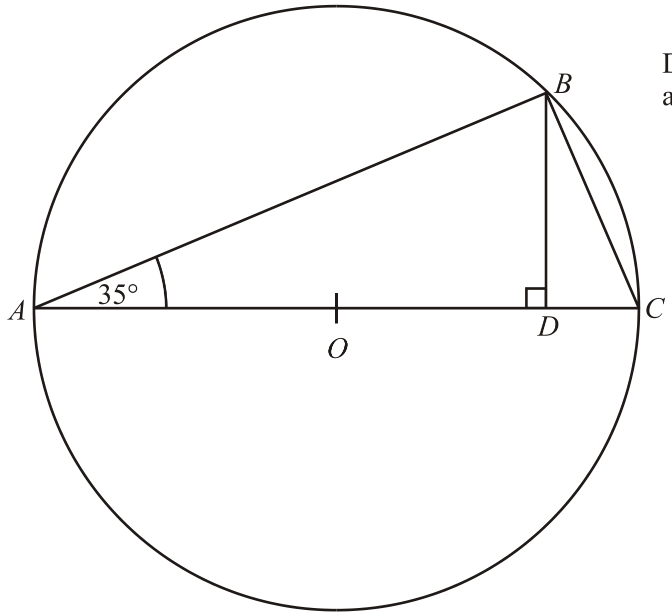



Diagram **NOT** accurately drawn

The diagram shows a circle, centre *O*.

*AC* is a diameter.
Angle *BAC* = 35°.
*D* is the point on *AC* such that angle *BDA* is a right angle.

(a) Work out the size of angle *BCA*.
Give reasons for your answer.

...................................°
**(2)**

(b) Calculate the size of angle *DBC*.

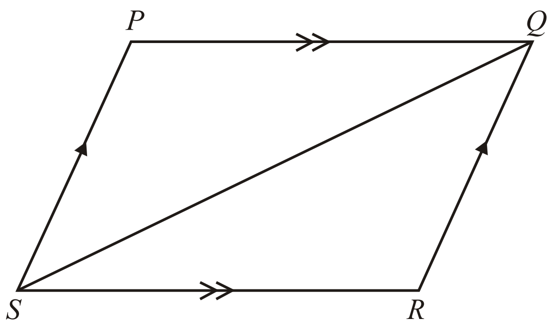
...................................°
**(1)**

(c) Calculate the size of angle *BOA*.

..................................°

**(2)**
**(Total 5 marks)**

**3.** *PQRS* is a quadrilateral.




*PQ* is parallel to *SR*.
*SP* is parallel to *RQ*.

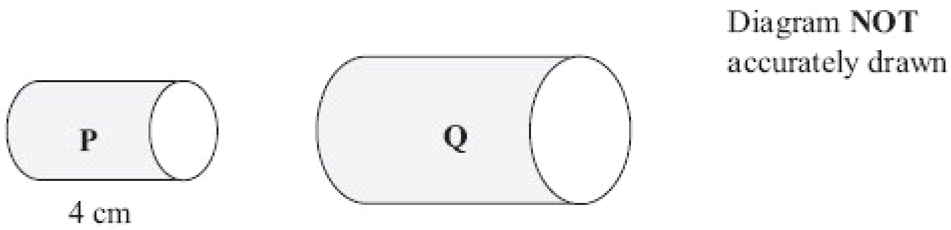
(a) Prove that triangle *PQS* is congruent to triangle *RSQ*.

**(3)**

(b) In quadrilateral *PQRS*, angle *SPQ* is obtuse.
Explain why *PQRS* cannot be a cyclic quadrilateral.

**(2)**
**(Total 5 marks)**

**4.**




Two cylinders, **P** and **Q**, are mathematically similar.

The total surface area of cylinder **P** is $90\pi$ cm$^2$.

The total surface area of cylinder **Q** is $810\pi$ cm$^2$.

The length of cylinder **P** is 4 cm.

(a) Work out the length of cylinder **Q**.

…………… cm

**(3)**

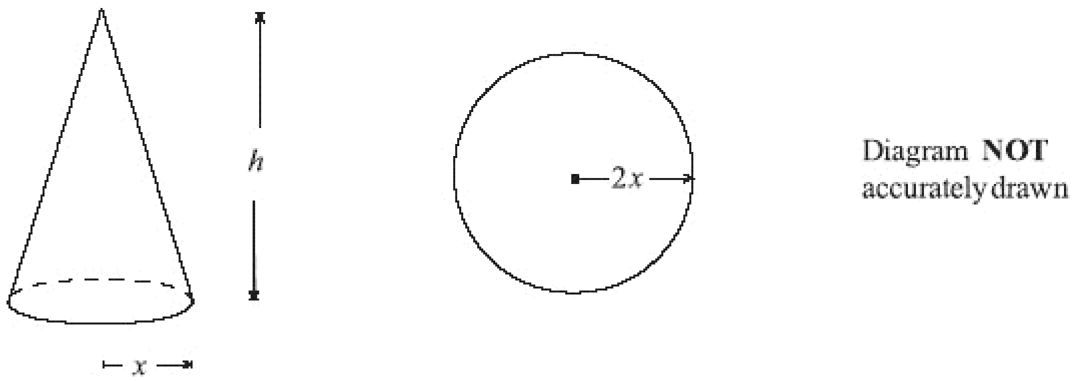
The volume of cylinder **P** is $100\pi$ cm$^3$.

(b) Work out the volume of cylinder **Q**.
Give your answer as a multiple of $\pi$.

…………… cm$^3$

**(2)**
**(Total 5 marks)**

**5.**




The radius of the base of a cone is $x$ cm and its height is $h$ cm.

The radius of a sphere is $2x$ cm.

The volume of the cone and the volume of the sphere are equal.

Express $h$ in terms of $x$.

Give your answer in its simplest form.

$h$ = ………………..

**(Total 3 marks)**

**6.**

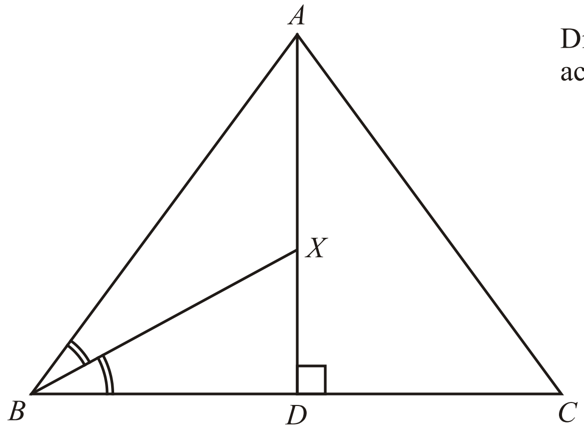



Diagram **NOT** accurately drawn

*ABC* is an equilateral triangle.
*AD* is the perpendicular bisector of *BC*.
*BX* is the angle bisector of angle *ABC*.

(a) Show that triangle *BXD* is similar to triangle *ACD*.

**(2)**

In triangle *ACD*,
$AC = 2$ cm,
$AD = \sqrt{3}$ cm.

(b) Show that $XD = \dfrac{1}{\sqrt{3}}$ cm.

**(3)**
**(Total 5 marks)**

**7.**

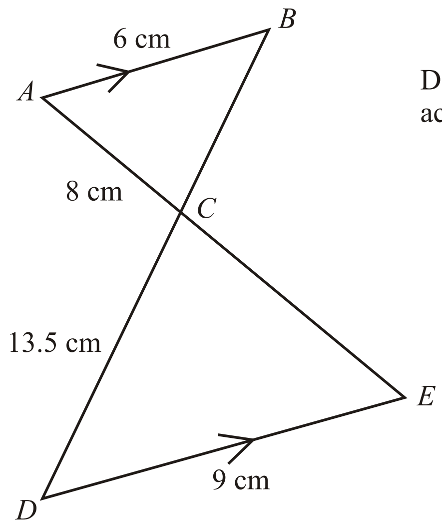



Diagram **NOT** accurately drawn

*AB* is parallel to *DE*.
*ACE* and *BCD* are straight lines.
$AB = 6$ cm,
$AC = 8$ cm,
$CD = 13.5$ cm,
$DE = 9$ cm.

(i) Work out the length of *CE*.

..................................... cm

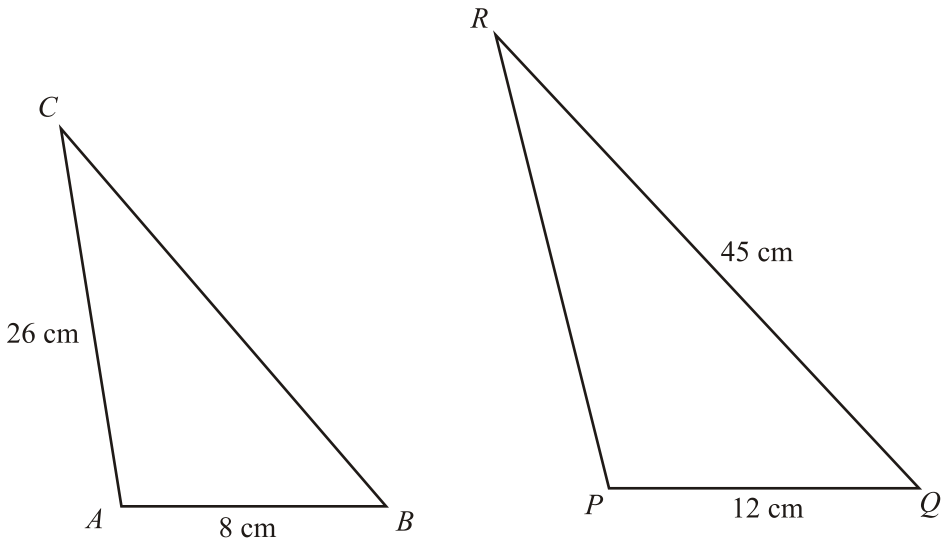
(ii) Work out the length of *BC*.

.....................................cm

**(Total 3 marks)**

**8.**

Diagrams **NOT** accurately drawn




The two triangles *ABC* and *PQR* are mathematically similar.

Angle *A* = angle *P*.
Angle *B* = angle *Q*.
*AB* = 8 cm.
*AC* = 26 cm.
*PQ* = 12 cm.
*QR* = 45 cm.

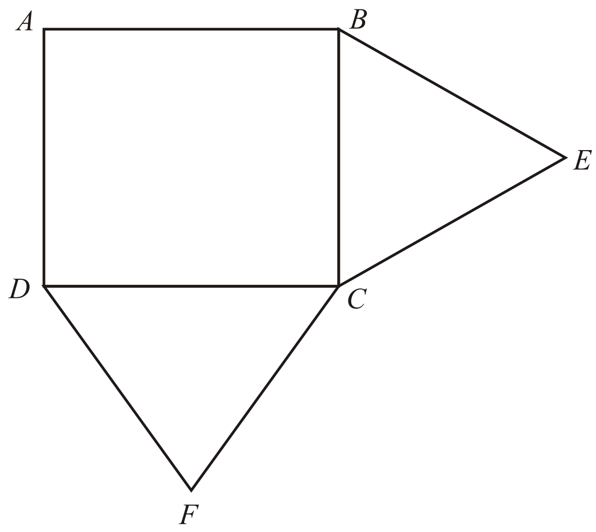
(a) Work out the length of *PR*.

………………………cm
**(2)**

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

………………………cm
**(2)**
**(Total 4 marks)**

**9.** Diagram **NOT** accurately drawn




*ABCD* is a square.
*BEC* and *DCF* are equilateral triangles.

(a) Prove that triangle *ECD* is congruent to triangle *BCF*.

**(3)**

*G* is the point such that *BEGF* is a parallelogram.

(b) Prove that *ED* = *EG*

**(2)**
**(Total 5 marks)**

**10.**

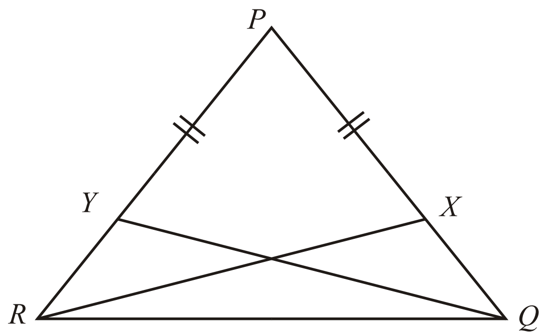



Diagram **NOT** accurately drawn

Triangle *PQR* is isosceles with *PQ* = *PR*.
*X* is a point on *PQ*.
*Y* is a point on *PR*.
*PX* = *PY*.

Prove that triangle *PQY* is congruent to triangle *PRX*.

**(Total 3 marks)**

**11.**

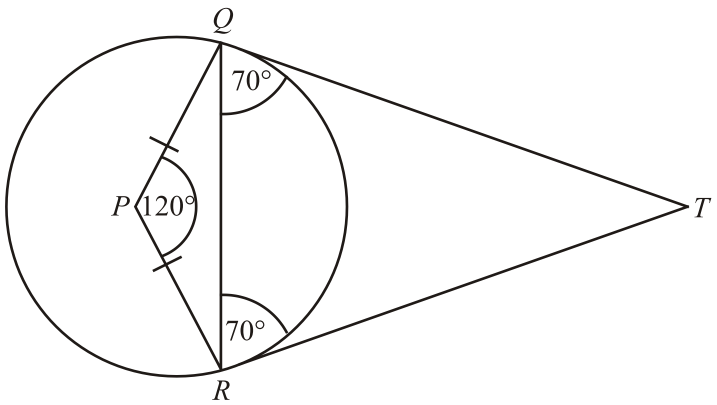



Diagram **NOT** accurately drawn

In the diagram $Q$ and $R$ are points on the circumference of a circle.
$TQ$ and $TR$ are tangents to the circle.
$PQ = PR$.
Angle $RQT$ = angle $QRT = 70°$.
Angle $RPQ = 120°$.

Explain why $P$ is not the centre of the circle.

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

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

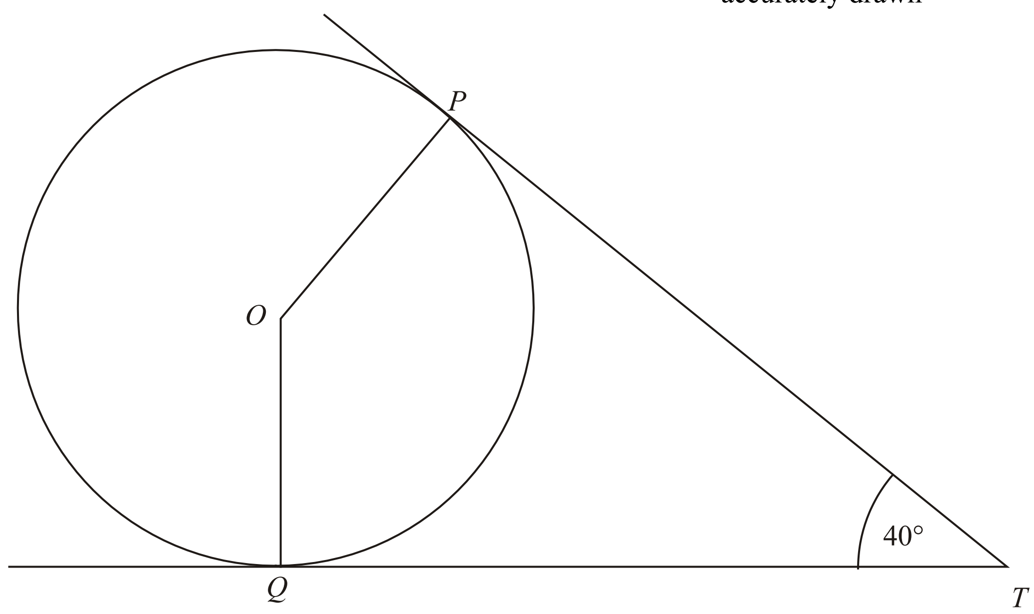
.....................................................................................................................................

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

**(Total 2 marks)**

**12.**

Diagram **NOT** accurately drawn




$P$ and $Q$ are two points on a circle centre $O$.

The tangents to the circle at $P$ and $Q$ intersect at the point $T$.

(a) Write down the size of angle $OQT$.

..............................°

**(1)**

(b) Calculate the size of the obtuse angle $POQ$.

......................°

**(2)**

(c) Give reasons why angle *PQT* is 70°

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

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

**(2)**
**(Total 5 marks)**

**1.** 1.84.. ≠ 1.95..
1.20.. ≠ 1.13.. 3

$\frac{133}{72} = 1.8472$ , $\frac{160}{82} = 1.9512$
OR
$\frac{72}{133} = 0.54135, \frac{82}{160} = 0.5125$
OR
$\frac{160}{133} = 1.203....,\frac{82}{72} = 1.1388....$
OR
$\frac{133}{160} = 0.83125....,\frac{72}{82} = 0.878$

*M1 for* $\frac{133}{72}$ *(= 1.8472…) oe Accept 1.8, 1.85*
*M1 for* $\frac{160}{82}$ *(= 1.9512…) oe consistent pairing*
*Accept 2.0, 1.9*
***OR*** *M1 for* $\frac{160}{133}$ *(= 1.203…) oe*
*M1 for* $\frac{82}{72}$ *(= 1.1388) oe*
*A1 for enough decimal places to show that the ratios are not equal; since the scale factors are different the shapes cannot be similar.*
*NB Do Not need conclusion*

**[3]**

**2.** (a) 55º 2

90 –35 = 55º
Angle in a semi-circle = 90º

*B1 for 55º*
*B1 for (angle in) a* ***semi-circle*** *= 90º*

(b) 35º 1

90 – "55"

*B1 for 35º ft*

(c) 110º 2

180 – 2 × 35 = 110º

*M1 for complete method or for twice "(a)"*
*A1 cao*
*Candidates may choose to use Isosceles triangles or Angle subtended at centre is twice angle subtended at circumference*

**[5]**

**3.** (a) Angle PQS = QSR
Angle RQS = PSQ
SQ is common
Triangles are congruent ASA 3

*B1 for 1 condition + reason*
*B1 for 2nd condition + reason*
*B1 for 3rd condition + reason + statement of congruency*

(b) Opposite angles of parallelograms are equal.
2 obtuse angle added are > 180º therefore they cannot add up to 180 therefore the shape cannot be cyclic 2

*B1 for states P and R are both obtuse*
*B1 sum greater than 180 for angles P and R or less than 180 for angles Q and S*

**[5]**

**4.** (a) 12 — 3

$\frac{810\pi}{90\pi}$ or 9

$\sqrt{9}$ or 3

*M1 for $\frac{810\pi}{90\pi}$ or 9 or $\frac{1}{9}$ or 1:9 oe*

*M1 for $\sqrt{\frac{810\pi}{90\pi}}$ or $\sqrt{9}$ or 3 or $\frac{1}{3}$ or $\sqrt{9}$ : $\sqrt{1}$ oe*

*A1 cao*

*SC:B1 for answer of 36*

(b) $2700\pi$ — 2

$3^3$ or 27 or 2700

*M1 for "3"$^3$ or 27 or $\left(\sqrt{9}\right)^3$ : $\left(\sqrt{81}\right)^3$ oe or $9^3$ or 2700–*

*A1 cao*

**[5]**

**5.** $32x$ — 3

$\frac{1}{3}\pi x^2 h = \frac{4}{3}\pi(2x)^3$

$x^2 h = 4 \times 8x^3$

*M1 for substitution in correct formulae*

*M1 (dep.) for correct unsimplified expression eg*

$$h = \frac{\frac{4}{3}\pi(2x)^3}{\frac{1}{3}\pi x^2} \text{ oe or } h = 8x \text{ oe}$$

*1 for 32x cao*

**[3]**

**6.** (a) Angle *BDX* = angle *ADC* = 90°

Angle *BXD* = angle *ACD* = 60°

Hence similar — 2

*B2 for 2 of (Angle BDX = angle ADC, Angle BXD = angle ACD, angle DAC = angle DBX)*

*B1 for 1 of the above*

(b) $\frac{XD}{DC} = \frac{BD}{AD}, DC = BD = 1$ 3

*M1* $\frac{XD}{DC} = \frac{BD}{AD}$ *or* $\frac{XD}{BD} = \frac{DC}{AD}$ *or a statement that ACD is an enlargement of BDX, scale factor* $\sqrt{3}$

*A1* $\frac{XD}{1} = \frac{1}{\sqrt{3}}$

*A1* $XD = \frac{1}{\sqrt{3}}$

**[5]**

**7.** $\frac{CE}{8} = \frac{9}{6} \text{ or } \frac{CE}{9} = \frac{8}{6} \Rightarrow CE = \frac{8 \times 9}{6}$

$\frac{BC}{13.5} = \frac{6}{9} \text{ or } \frac{BC}{6} = \frac{13.5}{9} \Rightarrow BC = \frac{13.5 \times 6}{9}$

(i) 12 3

(ii) 9

*M1 for scale factor* $\frac{9}{6}\left(\text{or } \frac{6}{9}\right) \text{ or } \frac{8}{6}\left(\text{or } \frac{6}{8}\right) \text{ or } \frac{13.5}{9}\left(\text{or } \frac{9}{13.5}\right)$ *oe*

*A1 cao for 12*
*A1 cao for 9*

**[3]**

**8.** (a) SF = 1.5
39 cm 2

*M1 SF =* $\frac{12}{8}, \frac{8}{12}$*, 1.5, 0.6 … oe*
*A1 cao*

(b) $45 \times \frac{8}{12}$
30cm 2

*M1* $45 \times \frac{8}{12}$*,* $45 \div \frac{12}{8}$ *oe*
*A1 cao*

**[4]**

**9.** (a) $BC = CE$ equal sides
$CF = CD$ equal sides
$BCF = DCE = 150°$
$BFC$ is congruent to $ECD$ **(SAS)** 3

*B1 for either BC = CD or BC = CE*
*CF = CE or CF = CD*
*B1 for BCF = DCE = 150° or correct reason*
*B1 for proof of congruence*

(b) So $BF=ED$ (congruent triangles)
BF = $EG$ (opp sides of parallelogram) 2

*B1 BF = EG or BF = ED*
*B1 fully correct proof*

**[5]**

**10.** $PQ = PR$ given
$PY = PX$ given
Angle $P$ common
SAS 3

*M1 for PQ = PR with reason or PY = PX with reason*
*M1 for P identified as a common angle*
*A1 for completion of proof and SAS*

**[3]**

**11.** ½(180 – 120) = 30° 2
Angle $PQR$ = 30° so $PQ$ is not a radius

*M1 for angle between tangent and radius is 90° **or** sight of right angle marked on diagram*
*A1 for angle PQR = 30° not 20° **or** angle PQT = 100° not 90° **or** QTR = 40° not 60°*

**[2]**

**12.** (a) 90 1

*B1 cao*

(b) 140 2

*M1 for sight of 20°*
*or 360 – 90 – 90 – 40*
*A1 for 140°*
*SC: Award B1 for an answer or 220*

(c) 2

*B1 for Angle between tangent and radius = 90°*
*or Tangents from a point to a circle are equal*
*B1 for Isosceles triangle POQ so angle OQP = 20°*
*or Angles in a triangle add up to 180°*

**[5]**

1. **Mathematics A**

**Paper 4**

Most answers showed no understanding of mathematical similarity, most making some comparison of areas or perimeters, or subtracted the lengths of the sides. Of those who did attempt a division, most gained the full marks, since they were then able to justify their results in the context of the question.

**Paper 6**

Candidates did well on this unusual question. There were many successful approaches involving the calculation of appropriate scale factors and showing that they were not equal. Almost as popular was to calculate a scale factor from say 160/133 and then multiplying 72 by this and showing the answer was not equal to 82.

**Mathematics B Paper 17**

The great majority of candidates did not understand the concept of similarity. Many simply worked out the areas of the two notes, offering no explanation. Some tried to use the monetary value of the notes to disprove similarity. A few did calculate ratios and explain their findings well.

2. **Paper 3**

In part (a) many candidates worked out the size of angle *BCA as* 55° but very few gave a valid reason. Part (b) was often done well, even after an incorrect part (a). Part (c) was answered less well with many candidates failing to realise that they were dealing with an isosceles triangle. A significant number of candidates did not appear to be familiar with angle notation and did not appreciate which angle they were expected to find in each part of this question.

**Paper 5**

There was an improvement in the performance of candidates in this circle geometry question. 80% of candidates were able to calculate the missing angle in part (a) and about half of these candidates were able to correctly state a reason for their answer. Part (b) was also well answered with again 80% of candidates able to work out the correct answer. Part (c) was not so well answered as candidates had to make two steps in their solution. Only 57% of candidates were successful in this part.

**3.** Only 7% of candidates were able to give a full solution to proving that the two triangles were congruent in part (a); they often took for granted what they were trying to prove. In part (b) candidates did not give sufficient reasons as to why two obtuse angles had a swn of greater than 180° though 20% of candidates gave a complete solution and a further 10% a partial solution,

**4.** **Specification A**

Most candidates attempted this question but only the best were able to achieve full marks. By far the most common answer to part (a) was 36, and to part (b) was 900π.
In part (b), some candidates were able to score a mark for cubing the scale factor they derived in part (a). A small number of candidates calculated the radius of *P* to deduce the radius, and hence the volume, of *Q*. A significant proportion of those candidates getting as far as the volume 2700π did not understand the demand of the question and omitted to include the π in their final answer.

**Specification B**

The most commonly seen answer to this question was 36 in (a) and 900π in (b). These were both incorrect solutions and occurred when candidates mistakenly used the area scale factor as the length and then volume scale factor. A small minority of candidates were able to often fully correct solutions although the omission of π from the answer to (b) resulted in some candidates failing to gain the final accuracy mark. There was evidence of some poor arithmetic in this question with 810 divided by 90 being evaluated as 90.

**5.** **Specification A**

Although there were few completely correct answers to this question, many candidates scored at least one mark for correctly using the equations for the cone and sphere.
A typical candidate substituted $x$ into the equation for the cone, $2x$ into the equation for the sphere, forgot to cube the 2 and, after rearrangement, arrived at an answer $8x$.

There were a surprising number of candidates who, having started correctly with $\frac{1}{3}\pi x^2 h = \frac{4}{3}\pi(2x)^3$, than incorrectly subtract the fractions to get $\pi x^2 h = 1\pi(2x)^3$.

**Specification B**

Approximately two thirds of candidates were able to substitute the given radii into the correct formulae. The formula for the surface area of a sphere was sometimes used instead of the formula for the volume. The most common error on substituting the radii was to give $\frac{4}{3}p2x^3$ instead of the correct $\frac{4}{3}p(2x)^3$. Candidate who made this error lost one mark out of the available three provided they managed to make $h$ the subject of their formula using correct algebraic processes. The level of algebra was generally very poor with very few candidates being able to carry out what should have been a straightforward division. The most common error here was to subtract $\frac{1}{3}$ from either side of the equation rather than multiply by 3.

**6.** There was a great deal of confusion between conditions for similarity and conditions for congruence., with such 'explanations' as 'Angle, angle, side' or 'right angle, hypotenuse and angle' being quoted. It was a pleasure to see good attempts at part (b), mainly using the similarity established in part (a) but with a few using the fact that tan 30° = $\frac{1}{\sqrt{3}}$ which can be obtained from triangle *ADC*.

**7. Intermediate Tier**

This question was answered poorly. Candidates either have very little understanding of similar triangles or fail to recognize them when they appear. Many gave the two lengths as 13.5 cm and 8 cm (assuming the triangles to be isosceles) and some attempted to use Pythagoras' theorem. About 10% of candidates got at least one length correct but few wrote down a scale factor.

**Higher Tier**

Many candidates did well on this question. Most were able to match the triangles to derive the appropriate ratios. Generally candidates who could do (i) could also do (ii). There were a relatively small number of candidates who attempted to use Pythagoras' theorem or the cosine rule for the lengths.

**8. Specification A**

**Intermediate Tier**

The common approach to this question was to assume that values were added on to give the enlarged triangle, rather than the adoption of an approach which involved factors. A few attempted to apply Pythagoras. Credit was available for finding factors alone, but there was little evidence to substantiate the award of these method marks. It was clear that most candidates failed to associate "similar" with scale factors.

**Higher Tier**

Many candidates scored full marks on this question, and there were relatively few incorrect methods involving Pythagoras' theorem. Common mistakes occurred in simplifying the scale factor $\frac{12}{8}$ to $\frac{4}{3}$ or 1.4; and in part (b), errors in calculating 45 ÷ 1.5. Some of the weaker candidates, not understanding the need for a scale factor, simply added 4 (derived from the difference of *PQ* and *AB*) to *AC* to obtain *RP* = 30.

**Specification B**

**Intermediate tier**

It was disappointing to see so many candidates merely adding or subtracting 4 cm from the given lengths to give answers of *PR* = 30 (26 + 4) and *BC* = 41 (45 − 4). A small number used RQ in (a) instead of (b), and AC likewise; they then contrived to get the desired results by wrongly manipulating the measurements given on the diagram. This gained no marks. Few candidates quoted any scale factor of enlargement although some did use the "once and a half again" method, usually to good effect. Very few quoted the equivalence of the ratios of corresponding sides. Quite a few tried to use Pythagoras ignoring that the question did not have right angled triangles.

**9.** Setting out these proofs was not done well. Many used very wordy explanations rather than concise mathematical reasons and failed to identify the key stages required. About half the candidates were able to score at least one mark in part (a), usually for identifying a pair of equal sides in the triangles. Candidates often failed to give a reason for the equal angles (this was merely stated as fact), and some failed to identify the appropriate congruence. Generally part (b) was done a little better than part (a), but many candidates identified EDG as an equilateral triangle, or stated that EDF and EGF were identical isosceles triangles, without supporting evidence or explanation.

**10.** Few candidates understood the nature of proof. This question was very poorly done. it is important that candidates do recognise that they must qualify any statements they make. It was not sufficient to write *PR* = *PQ* without including that this was because triangle *PQR* was isosceles or that the information was given.

**11.** This question was very poorly answered with 80% of candidates scoring no marks. It was a pleasant surprise when candidates knew what they were talking about and managed to convey their ideas across…if not always eloquently. The tangent/ radius connection was often stated in about 10% of cases and most went on to discuss the 20º/30º situation, though some did get confused expecting the 70º to be 90º. Only 10% of candidates were able to produce a fully reasoned argument.

**12.** It was disappointing to find that only just over half the candidates realised that angle *OQT* was 90°. This, in turn, went on to affect their calculations in part (b) as they could then have gone on to use the sum of the angles of the quadrilateral in an attempt to work out the size of angle *POQ* or recognise that *OPQ* was an isosceles triangle with the acute angles being 20° each. The mean mark for this part of the question was just under 1. Candidates often struggle to provide mathematical reasons for the size of an angle and this year was no exception with 0.37 being the mean mark for this part. Those who did score one of the marks tended to score it for mention of an isosceles triangle or for stating that the sum of the angles of a triangle is 180°. The few that did mention tangent theorems tended to talk about the angle between the tangent and the circle rather than the tangent and the radius.