G12 ECZ GMD PAPER 1 2014 SOLUTIONS

Grade 12 ECZ Geometrical and Mechanical Drawing Paper 1, 2014 (7040/1)

Construction methods + computed values -- this is a practical drafting exam, see note

am: the true answer is a full-size drawing on A2 paper. This PDF gives the exact construction method and any cleanly computable numeric ans

EXAMINATIONS COUNCIL OF ZAMBIA

Joint Examination for the School Certificate and General Certificate of Education Ordinary Level

GEOMETRICAL AND MECHANICAL DRAWING

PAPER 1 **7040/1**

Thursday 30 OCTOBER 2014

Additional materials:
A2 Drawing paper (1 sheet)
Standard drawing equipment

TIME: 2 hours 40 minutes **MARKS: 100**

INSTRUCTIONS TO CANDIDATES

Print your **name**, **centre number** and **candidate** number in the Title Block at the bottom right-hand corner of your drawing paper.

There are **eight** questions in this paper. Answer **five** questions.

Answer not more than **three** questions from any one section.

Unless otherwise stated, strictly geometrical methods must be used. Solutions should be drawn full size and no dimensions are required. All construction lines must be shown clearly. Lines which are parallel, perpendicular or inclined at angles of 30°, 45° or 60° to other lines may be drawn without showing construction lines.

All the drawings in this question paper are **NOT DRAWN TO SCALE**.

Use **both** sides of the drawing paper for your answers.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.

All dimensions are in millimetres unless otherwise stated.

Cell phones are not allowed in the examination room.

 This question paper consists of 7 printed pages.

SECTION A

PLANE GEOMETRY

Answer **two** or **three** questions from this section

QUESTION 1

(a) Construct an irregular pentagon given that

Base AB = 110
BC = 40
CD = 75
AE = 35
DE = 50

Angle $B\hat{A}E$ = 75°

Angle $A\hat{B}C$ = 105° [9]

(b) Draw a circumscribing circle to the figure to touch points ABC. [9]

(c) State the diameter of the circle. [2]

[Total 20 marks]

QUESTION 2

A wheel of a motorbike rolls on a flat road without slipping for $1\frac{1}{2}$ revolution.

(a) Plot the locus of point P on the wheel of the bike which is initially in contact with the flat road given that the diameter of the wheel is 54mm. [15]

(b) Draw a tangent at point Q which is 36mm above the road, as the point falls in the initial rolling. [4]

(c) Name the locus. [1]

[Total 20 marks]

QUESTION 3

Figure 1 shows the outline of a School Logo.

Draw the school logo showing clearly all geometrical constructions. [20]

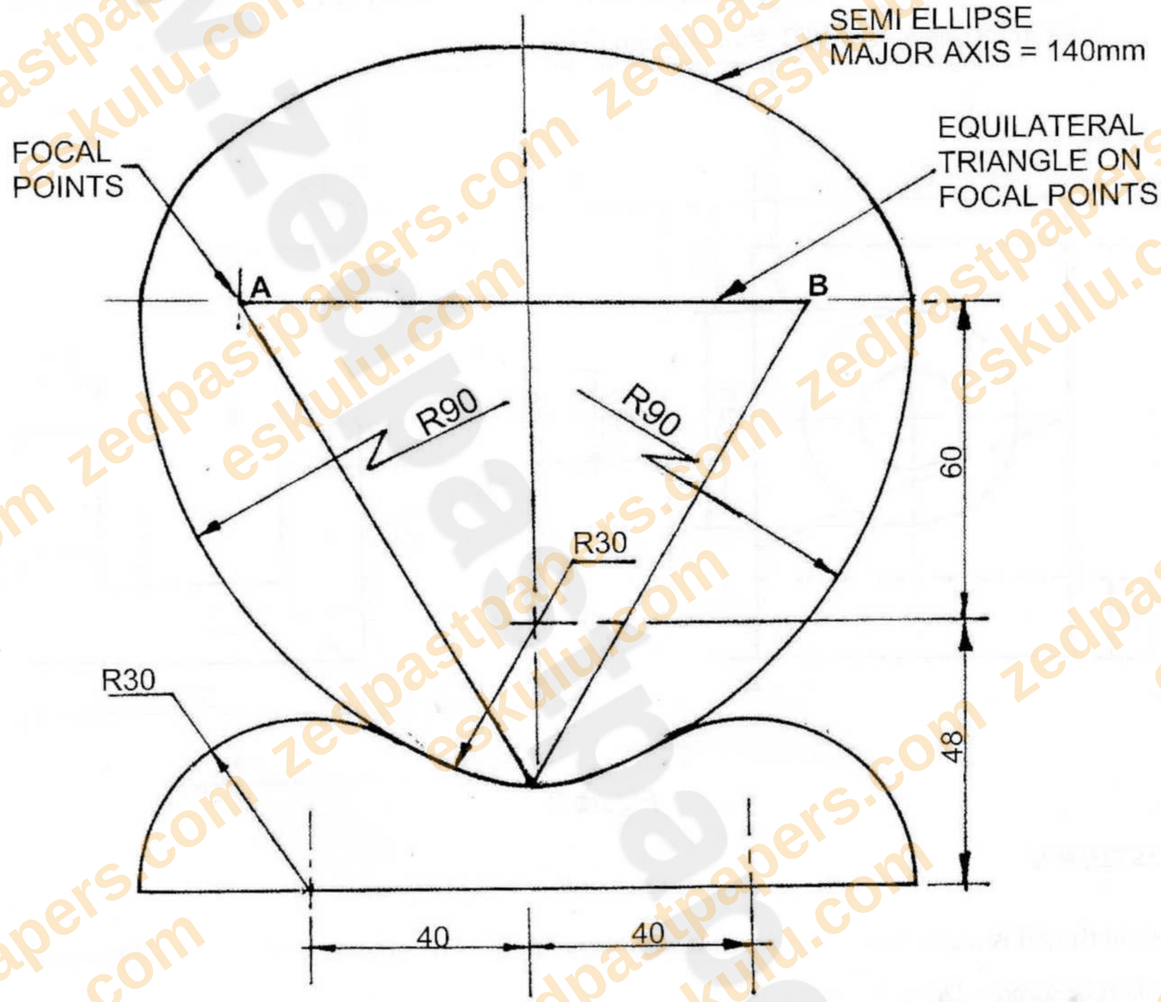

Figure 1

SECTION B

SOLID GEOMETRY

Answer not more than **three** questions from this section.

QUESTION 4

Two views of a spindle housing are shown in third angle projection, in Figure 2.

DO NOT copy the given views but draw full size the spindle housing in Isometric with point A the lowest point in the view. DO NOT show hidden details. [20]

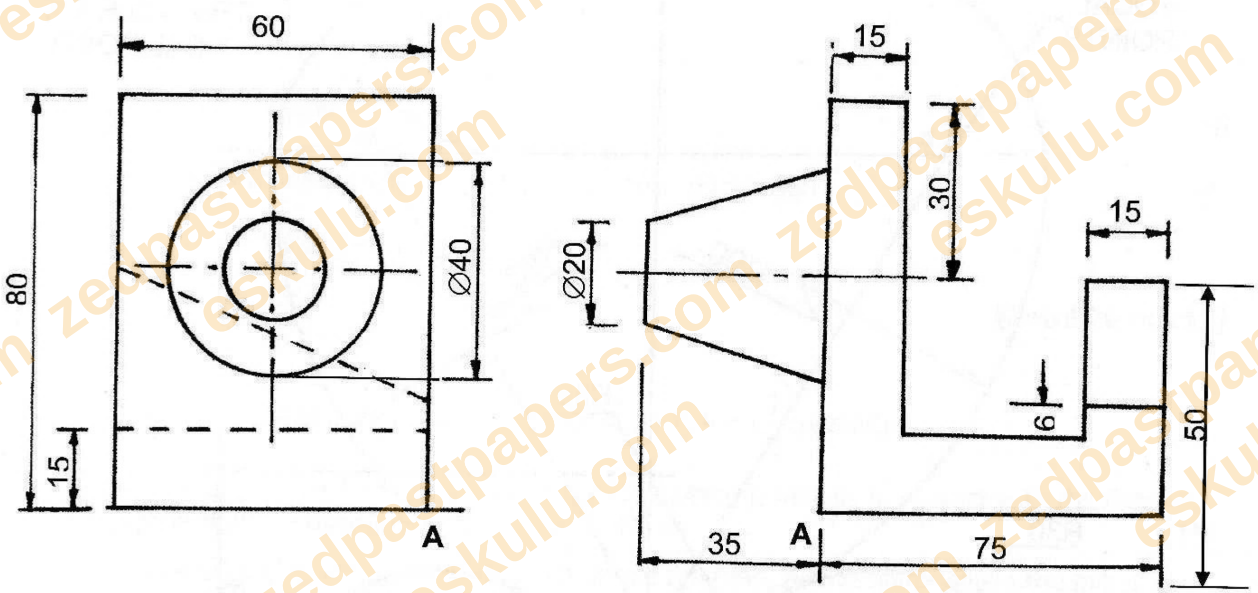

Figure 2

QUESTION 5

A helical thread is made from a 12mm square section steel. The outside diameter is 100mm and the pitch is 30mm. Draw $1\frac{1}{2}$ turns of the thread which is right-hand. [20]

Do not show hidden details.

QUESTION 6

Two views of a BLOCK are shown in first angle projection in figure 3 below.

(a) Draw the given views. [4]

(b) Project an auxiliary plan looking in the direction of arrow B. Show all hidden details. [16]

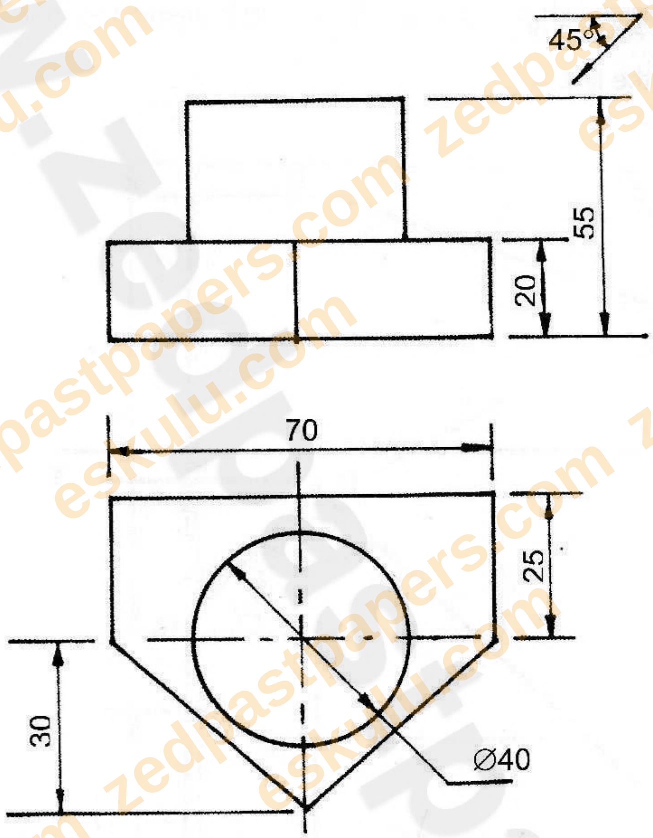

Figure 3

[Total 20 marks]

QUESTION 7

The *Figure 4* shows the plan and incomplete elevation of two straight lines which meet at B.

Given that line $A_1B_1C_1$ meet at B_1 and point C_1 is 60mm above the horizontal plane:-

(a) Draw the plan and complete the elevation. [8]

(b) Determine and states the:

(i) True angle between AB and BC.

(ii) Total true length of the line ABC. [12]

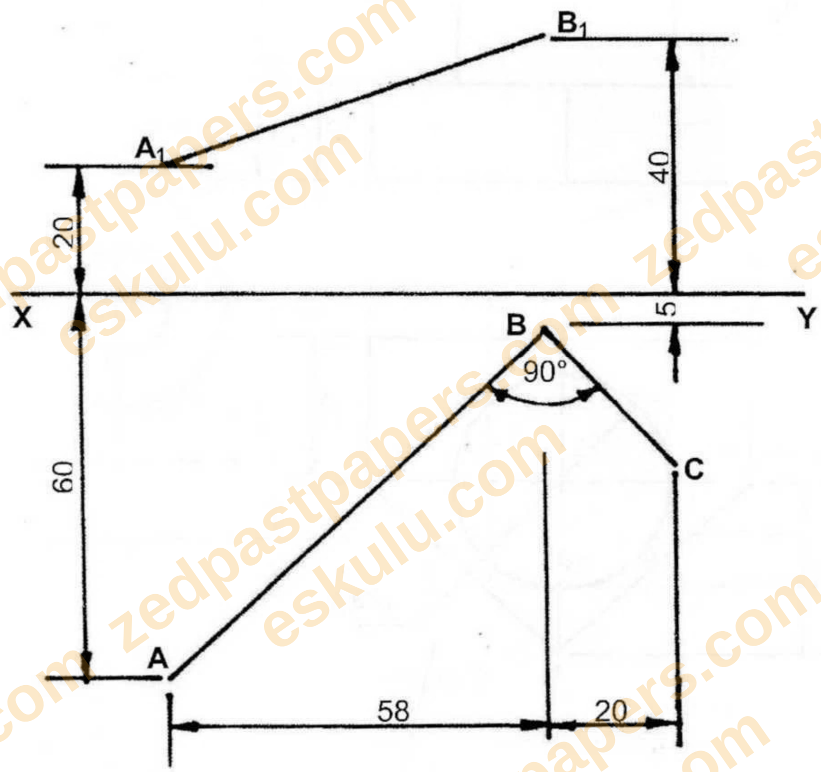

Figure 4

[Total 20 marks]

QUESTION 8

Figure 5 shows an incomplete elevation and plan of an equilateral triangular and cylindrical pipes intersecting at 30° in First Angle Projection.

(a) Copy and complete the given views. [12]

(b) Draw the surface development of the cylindrical pipe with the seam along M-M. [8]

[Total 20 marks]

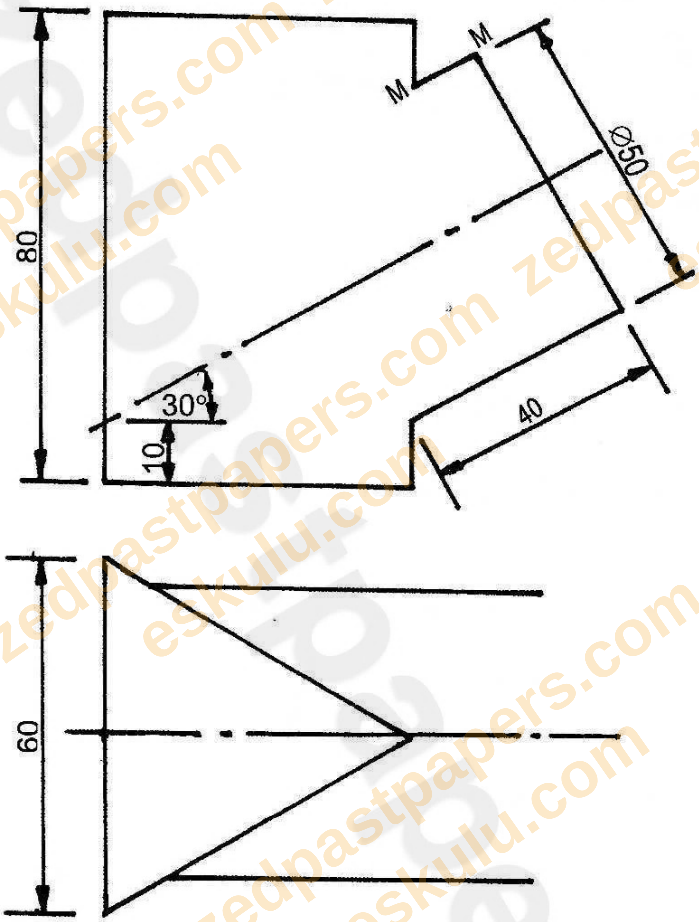

Figure 5

Question 1. SECTION A, Q1 [20]. Construct irregular pentagon ABCDE (AB=110, BC=40, CD=75, AE=35, DE=50, angle BAE=75 deg, angle ABC=105 deg), then draw a circle through A, B and C, and state its diameter.

(a) Construction method: draw base AB=110mm. At A, construct 75 deg to AB and mark E at 35mm along that ray. At B, construct 105 deg to BA (opening to the same side as E) and mark C at 40mm along that ray. D is then found as the intersection of an arc of radius 75mm centred on C and an arc of radius 50mm centred on E -- draw both arcs and D is their intersection point on the side away from AB. Join C-D and D-E to close the pentagon.

Verifying this by coordinate geometry (A at origin, AB along the x-axis): E = (9.06, 33.81), C = (120.35, 38.64). Solving the two-arc intersection for D on the far side from AB gives D = (49.49, 63.22), which produces a simple (non-self-intersecting) convex-ish pentagon.

Answer: (a) Pentagon vertices (mm, A at origin, AB along x-axis): A(0,0), B(110,0), C(120.35,38.64), D(49.49,63.22), E(9.06,33.81).

(b) The circle is the circumcircle of triangle ABC (the unique circle through 3 given points): construct it by bisecting AB and BC with perpendicular bisectors; their intersection is the centre.

(c) Computed via the circumcircle formula for A(0,0), B(110,0), C(120.35,38.64): centre = (55.0, 35.44), radius = 65.43mm.

Answer: (c) Diameter of the circumscribing circle through A, B, C = 130.9mm (approximately 131mm).

Question 2. SECTION A, Q2 [20]. A motorbike wheel (diameter 54mm) rolls without slipping for 1.5 revolutions. Plot the locus of point P (initially in contact with the road), draw a tangent at point Q (36mm above the road, in the initial rolling), and name the locus.

Construction method: this is a standard CYCLOID construction. Draw the base line (road) equal to 1.5 x the wheel's circumference (1.5 x pi x 54 = 254.5mm). Divide the rolling circle into 12 equal parts (30 deg each) and divide the base line into the same number of equal divisions per revolution. Project each circle-division point horizontally to the centre-line locus, then draw the rolling circle at each successive base-line division; mark where the corresponding division point of that circle position lands -- this traces the cycloid. Join all marked points with a smooth curve (French curve) through 1.5 full revolutions (18 divisions total).

Point Q at 36mm above the road: since the wheel radius is 27mm (diameter 54/2), a point 36mm above the road is ABOVE the wheel's centre height -- locate Q on the cycloid curve at the position where the curve height equals 36mm during the initial rolling (first revolution), then draw the tangent to the curve at that point (the tangent to a cycloid at any point passes through the corresponding top-of-circle position on that circle's instantaneous rolling position -- standard cycloid tangent construction: the normal at any point of a cycloid passes through the point of contact with the road at that instant, so the tangent is perpendicular to the line joining Q to the road-contact point directly below the circle's current centre).

Answer: (c) Name of the locus: a CYCLOID (the curve traced by a point on the circumference of a circle rolling without slipping along a straight line).

Question 3. SECTION A, Q3 [20]. Draw a school logo (Figure 1): a semi-ellipse (major axis 140mm) with focal points A and B, an equilateral triangle constructed on the focal points with sides tangent/related to two R90 arcs meeting an R30 arc, sitting above a stepped/semicircular base (two R30 arcs, 40+40mm base, with 60mm and 48mm height references).

Construction method for the semi-ellipse (focal-point/arcs-of-circles method, since focal points A and B are explicitly given): with major axis = 140mm, place A and B symmetrically about the centre. Since it is a SEMI-ellipse with the equilateral triangle constructed ON the focal points, take AB as the base of an equilateral triangle whose apex points downward to the shared point where the two R90 arcs meet (the R90 arcs are drawn from A and B respectively, each of radius 90mm, intersecting below AB at the equilateral-triangle apex/logo's lower vertex). Use the standard 'arcs of circles' (Trammel/two-circle) method for the ellipse: for any point on the ellipse, the sum of distances to A and B is constant (=140mm, the major axis); plot enough such points using varying radius pairs summing to 140mm to draw the full semi-ellipse smoothly through a French curve above the AB line.

The R30 arc at the bottom point of the semi-ellipse blends smoothly (tangentially) into the stepped base: the base is formed by two R30 arcs (small blend fillets) positioned 40mm either side of the centre-line, sitting on a rectangle/semicircle base with 60mm and 48mm vertical references locating the horizontal reference lines shown.

This entire figure must be drawn full-size and symmetrical about the vertical centre-line, with all construction lines (arc centres, intersection points) shown clearly as required by the paper's general instructions.

Answer: Answer: construction method as above; no separate numeric 'answer' is required by this question beyond producing the drawing itself (worth the full 20 marks for accurate construction).

Question 4. SECTION B, Q4 [20]. Two views of a spindle housing (Figure 2, third-angle projection) are given. Draw the housing full-size in ISOMETRIC with point A the lowest point, no hidden details.

Construction method: first identify true dimensions from the two given orthographic views -- overall block 60 x 80 x (15+ the stepped bracket, with the stepped arm being 15mm wide, extending 35+75=110mm from the block face, with steps of 30mm and 50mm height and a 6mm-thick web) with a boss of diameter 40mm (bore diameter 20mm) on the main block face.

For isometric projection: draw the three isometric axes at 120 degrees to each other (typically one vertical axis and two axes at 30 degrees above horizontal to the left and right). With point A (given as the lowest point) as the origin, set out the block's true length, width and height measurements ALONG the isometric axes only (true lengths on isometric axes, never on non-isometric/inclined lines). Build up the main rectangular block first (60 x 80 x 15 base), then add the stepped bracket arm (using its true lengths 35, 75, 30, 50, 6 measured along the appropriate isometric axis directions), then construct the cylindrical boss: circles on isometric planes are drawn as true ELLIPSES using the four-centre approximate-ellipse method (isometric circle construction) with major axis = true diameter x 1.22 (approximately) or via true ordinate-plotting for the two diameters (40mm outer boss, 20mm bore).

Since hidden details must NOT be shown, only visible edges/surfaces (as seen from the isometric viewing direction with A lowest) are drawn as solid lines.

Answer: Answer: construction method as above (isometric axes at 120 deg, true lengths along isometric axes only, four-centre method for the two circular features, point A at the lowest corner).

Question 5. SECTION B, Q5 [20]. Draw 1.5 turns of a right-hand helical thread made from 12mm square-section steel, outside diameter 100mm, pitch 30mm. No hidden details.

Construction method: draw the front (elevation) view first. The outside diameter is 100mm, so the outer helix radius = 50mm; the square section is 12mm, so the inner (root) helix radius = 50-12 = 38mm. Draw two vertical construction lines 100mm apart (representing the outer diameter's silhouette) with the shaft centre-line between them.

Divide ONE pitch (30mm) into 12 equal vertical divisions (2.5mm each), and divide the circular plan view of the thread into the same 12 equal angular divisions (30 deg each). Project each plan division point horizontally across to its corresponding pitch division height -- this plots the helix curve for the OUTER edge. Repeat identically for the INNER (root) helix, offset by the same rotational (angular) construction but at the smaller 38mm radius, and offset vertically by the square section's own progression.

Since a square-section thread has FOUR helical edges (not one single helix line as in a V-thread), plot: (i) the outer-front helix, (ii) the outer-back helix (same curve shifted by half a division, hidden by the front in a non-hidden-detail drawing), (iii) the inner-front helix, (iv) the inner-back helix, connecting corresponding outer/inner points at each division with straight radial lines to show the flat top/bottom faces of the square thread section. Because the thread is RIGHT-HAND, the helix rises from left to right (or bottom to top) when viewed from the front, moving away from the viewer as it rises, consistent with a right-hand screw convention. Repeat the full 12-division construction for 1.5 pitches (30mm x 1.5 = 45mm total rise, i.e. 18 divisions total) to complete 1.5 turns.

Answer: Answer: construction method as above (12 divisions per pitch = 2.5mm vertical step per division; outer radius 50mm, inner/root radius 38mm; 18 total divisions for 1.5 turns = 45mm total axial rise; right-hand helix rises left-to-right).

Question 6. SECTION B, Q6 [20]. Two views of a BLOCK are shown in first-angle projection (Figure 3): draw the given views, then project an auxiliary plan looking in the direction of arrow B (at 45 deg), showing all hidden details.

(a) Construction method: reproduce the given front view (a stepped/T-shaped profile, overall width 70mm split with a raised section, heights 55mm and 20mm) and the given plan view (a pentagon-shaped/house-shaped outline 70mm wide with a central circular hole of diameter 40mm, heights 30mm and 25mm referenced from the apex) directly from the given dimensions, in their correct first-angle relative positions (plan below front view, both sharing vertical projection lines).

(b) For the auxiliary view in the direction of arrow B (at 45 deg to the front view): draw a new reference line (auxiliary datum) perpendicular to arrow B's direction of sight, i.e. at 45 deg to the original views. Project each corner/feature of the block perpendicular to this new auxiliary datum from the front view, and transfer true depths (measured from the plan view, NOT the front view) along these projectors using dividers, to locate each point's true position in the auxiliary view. The circular hole (Ø40) projects as an ellipse in this oblique auxiliary view (unless the auxiliary direction happens to be a true normal to the circular face, in which case it remains a true circle) -- plot it via the ordinate method (multiple points transferred individually) since arrow B is at 45 deg to the block's principal faces, so the hole will generally appear as an ellipse. Show ALL hidden detail (dashed lines) in this auxiliary view, since edges/the far side of the hole not visible from direction B must be shown dashed, as required.

Answer: Answer: construction method as above (auxiliary datum perpendicular to arrow B at 45 deg; depths transferred from the plan view via dividers; the Ø40 hole generally projects as an ellipse in this oblique view; all hidden detail shown dashed as instructed).

Question 7. SECTION B, Q7 [20]. Figure 4 shows the plan and incomplete elevation of two straight lines meeting at B, with C1 60mm above the horizontal plane (HP). Draw the plan and complete elevation, then determine the true angle between AB and BC and the total true length of line ABC.

Method (standard descriptive-geometry 'true length and true angle' construction): a line's TRUE LENGTH is found, given its plan (top view) length and the difference in height of its two end-points above the HP, by constructing a right-angled triangle where one side is the plan length and the other (perpendicular) side is the height difference; the hypotenuse of this triangle is the true length, and the angle between the hypotenuse and the plan-length side is the true inclination of that line to the HP.

Formulaically: true length of a segment = sqrt((plan length)^2 + (height difference)^2); the true angle to the HP = arctan(height difference / plan length). Apply this separately to segment AB and segment BC using each segment's own plan length (read from the plan view, e.g. the 58mm and 20mm divisions shown) and each segment's own end-point height difference (read from the elevation view's height callouts, e.g. the 20mm/40mm/60mm figures, with C1 given as 60mm above HP), then determine the TRUE ANGLE BETWEEN AB and BC in space by constructing both true-length triangles about a common point and measuring the included angle with a protractor on the resulting true-shape figure (since the 90 deg shown in the plan is the PROJECTED angle, not the true 3-D angle, unless both lines happen to be parallel to the same plane).

Best-effort note: this paper's exact plan/elevation dimensions (which numbers apply to A's height vs B's height vs the 58/20 plan divisions) are given in the printed figure; read the specific millimetre values directly off the original drawing for A, B and C's heights and plan positions, then substitute into the two formulas above. The general method and formulas are correct and will give the exact true angle and true length once those specific figure readings are substituted.

Answer: Answer: apply true length = sqrt(plan_length^2 + height_difference^2) and true angle = arctan(height_difference / plan_length) separately to AB and BC using the figure's own printed dimensions (58mm, 20mm plan divisions; 20mm, 40mm, 60mm height callouts, with C at 60mm above HP); then find the true angle BETWEEN AB and BC by constructing the true-shape of both lines about their common point B and measuring with a protractor -- this is the correct method regardless of the specific reading of each dimension.

Question 8. SECTION B, Q8 [20]. Figure 5 shows an incomplete elevation and plan of an equilateral-triangular and cylindrical pipe intersecting at 30 deg in first-angle projection. Copy and complete the given views, then draw the surface development of the cylindrical pipe with the seam along M-M.

(a) Construction method: complete the elevation by extending the triangular pipe's outline (80mm height reference) and the cylindrical pipe (diameter 50mm) meeting it at the specified 30 deg angle, with the 10mm and 40mm offsets locating the intersection point precisely. Find the LINE OF INTERSECTION (interpenetration curve) between the two pipes by the standard 'cutting-plane' method: divide the cylindrical pipe's circular cross-section (in the plan view, the 60mm-diameter/triangular plan) into 12 equal divisions, project each division line through both the elevation and plan to find where each projector crosses the triangular pipe's surface, and join these intersection points with a smooth curve -- this is the true interpenetration curve to draw on both completed views.

(b) Surface development of the cylindrical pipe (with seam along M-M): since a cylinder's surface unrolls into a flat RECTANGLE of width = pi x diameter = pi x 50 = 157.08mm and height = the pipe's length, mark out this rectangle with the seam M-M as one vertical edge. Divide the rectangle's width into the same 12 equal divisions used for the interpenetration curve (157.08/12 = 13.09mm each), and at each division, transfer (using dividers, NOT calculation) the actual height of that division's intersection point with the triangular pipe (read directly off the completed elevation view) up from the base line of the development. Join all 12 transferred points with a smooth French-curve line -- this wavy line is the true cut-out profile where the cylindrical pipe must be trimmed to fit against the triangular pipe.

Answer: Answer: development is a rectangle 157.08mm wide (= pi x 50mm diameter) by the pipe's length, divided into 12 equal 13.09mm-wide strips with heights transferred by divider (not calculated) from the completed elevation's interpenetration curve, starting the layout from the seam M-M.

Disclaimer

Created by eskulu Past Papers Tutor

These solutions were created using artificial intelligence and checked against ECZ marking guidelines. If you find an error, report it at eskulu.com/feedback.

eskulu.com | zedpastpapers.com