G12 ECZ GMD PAPER 1 2017 SOLUTIONS

Grade 12 ECZ Geometrical and Mechanical Drawing Paper 1, 2017 (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

Examination for School Certificate Ordinary Level

Geometrical and Mechanical Drawing 7040/1

Paper 1

Wednesday 15 NOVEMBER 2017

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

Time: 2 hours 30 minutes **Marks: 100**

Instructions To Candidates

Print your Name, Centre Number and Candidate Number 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 are to be drawn in full size and no dimensions are required. All construction lines must be shown clearly, but lines which are parallel to, perpendicular to or inclined at angles of **30°**, **45°** or **60°** to other lines may be drawn without showing construction lines.

Use only one sheet of A2 drawing paper.

You may 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.

SECTION A

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

QUESTION 1

Figure 1 shows a profile of a metal plate. Copy the profile full size, showing all constructions and tangential points.

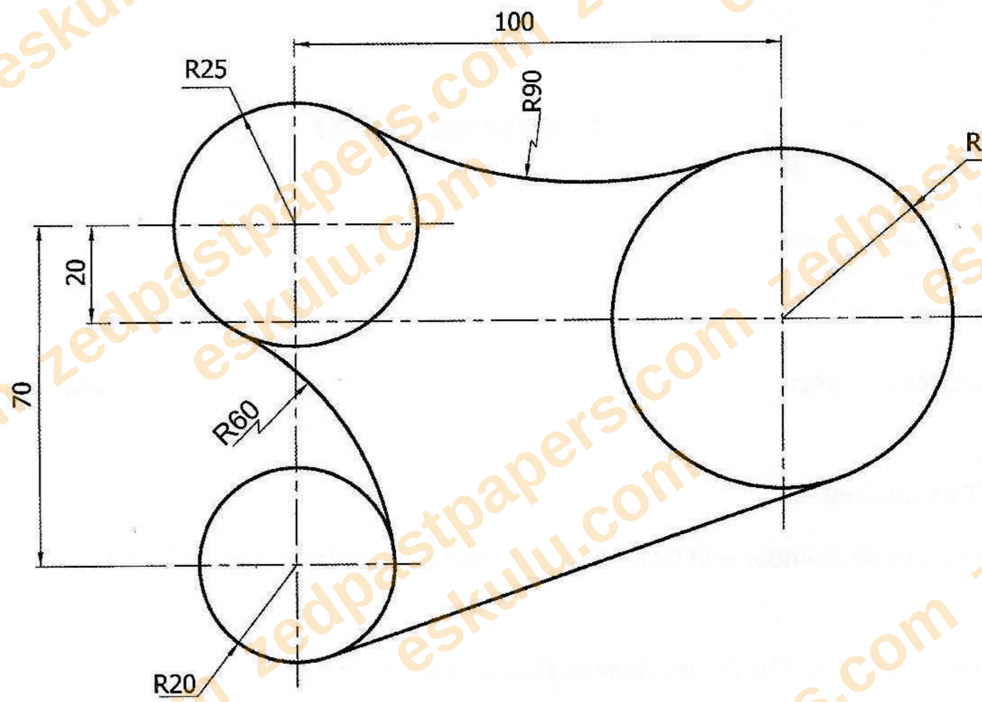


Figure 1

[20]

QUESTION 2

Triangle ABC is such that AB = 100, AC = 80 and Angle ACB = 45°.

(a) Construct the triangle.

(b) Transpose the triangle in (a) above to a square of equal area.

(c) Inscribe a circle in the resulting square.

(d) Measure and state the diameter of the circle.

[20]

QUESTION 3

Figure 2 shows a link mechanism in which crank **OA** rotates about a fixed centre **O**. The rod **AP** has a point **B** which is constrained to move along guide **OT**, and is pin-jointed to crank **OA**, at **A**.

For one complete revolution of crank **OA**, plot the locus of point **P**. **[20]**

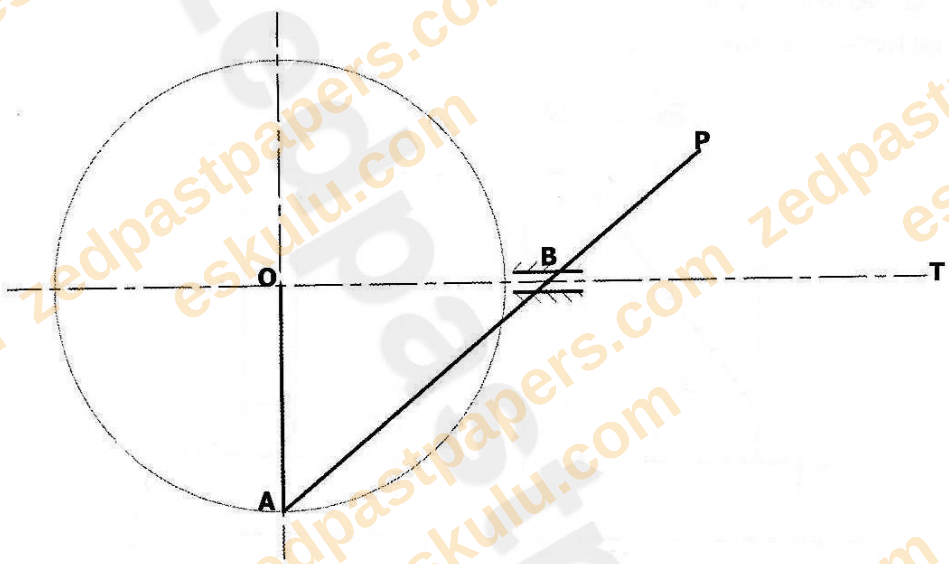


Figure 2

OA = 45

AP = 110

BP = 40

AB = 70

SECTION B SOLID GEOMETRY

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

QUESTION 4

Figure 3 shows three views of a bracket drawn in **First Angle Projection**.

DO NOT copy the given views, but draw full size the bracket in isometric projection with point **P** as the lowest point.
DO NOT show hidden details. **[20]**

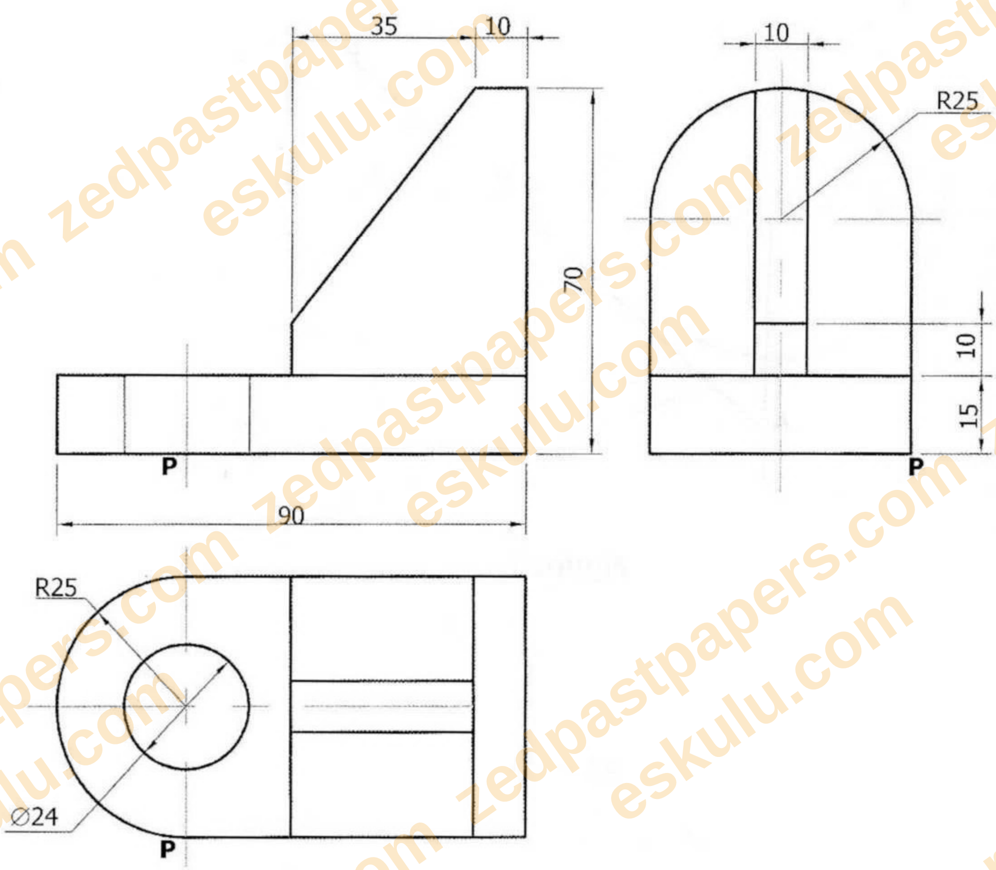


FIGURE 3

QUESTION 5

Figure 4 shows the elevation and incomplete plan of a Frustum of a right square pyramid.

(a) Draw the given elevation and complete the plan.

(b) Draw the true shape of the cut surface.

[20]

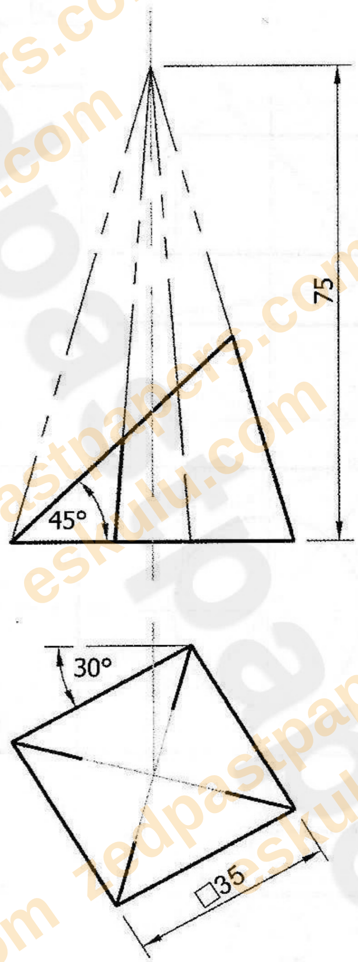


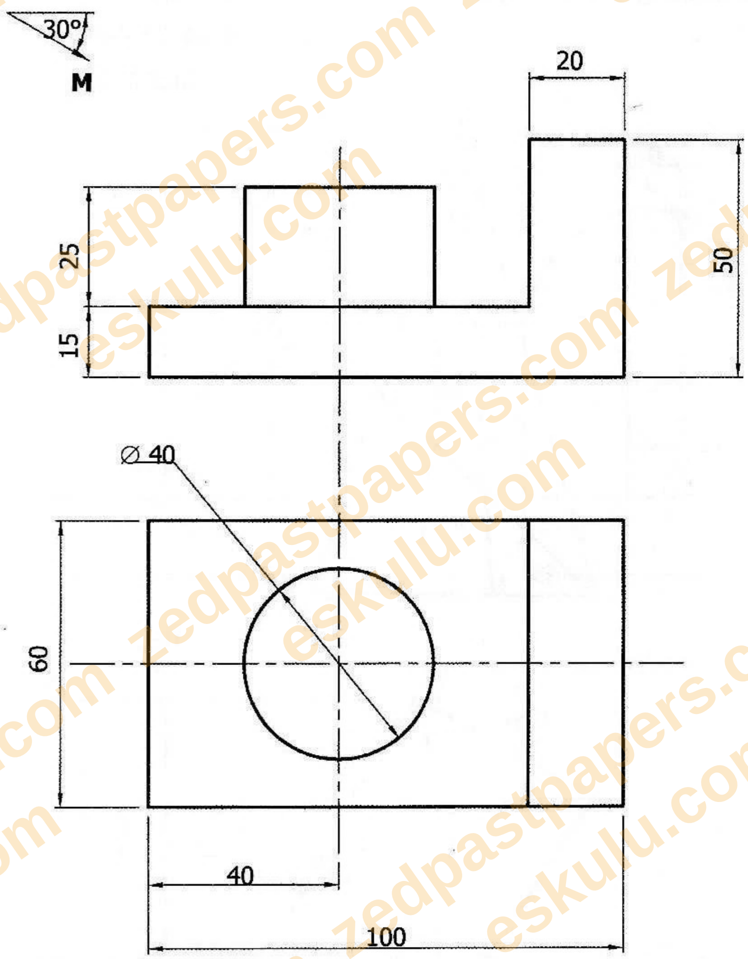
Figure 4

QUESTION 6

Figure 5 shows two views of a block in **First Angle Projection**.

(a) Draw the given views.

(b) Project an auxiliary plan viewed from arrow **M**, showing all hidden details.



[20]

Figure 5

QUESTION 7

Two views of a Lamina are shown in **Figure 6** below in **First Angle Projection**.

(a) Draw the given views.

(b) Determine and state the true angle of inclination the Lamina makes with the vertical plane.

(c) Draw the true shape of the Lamina.

[20]

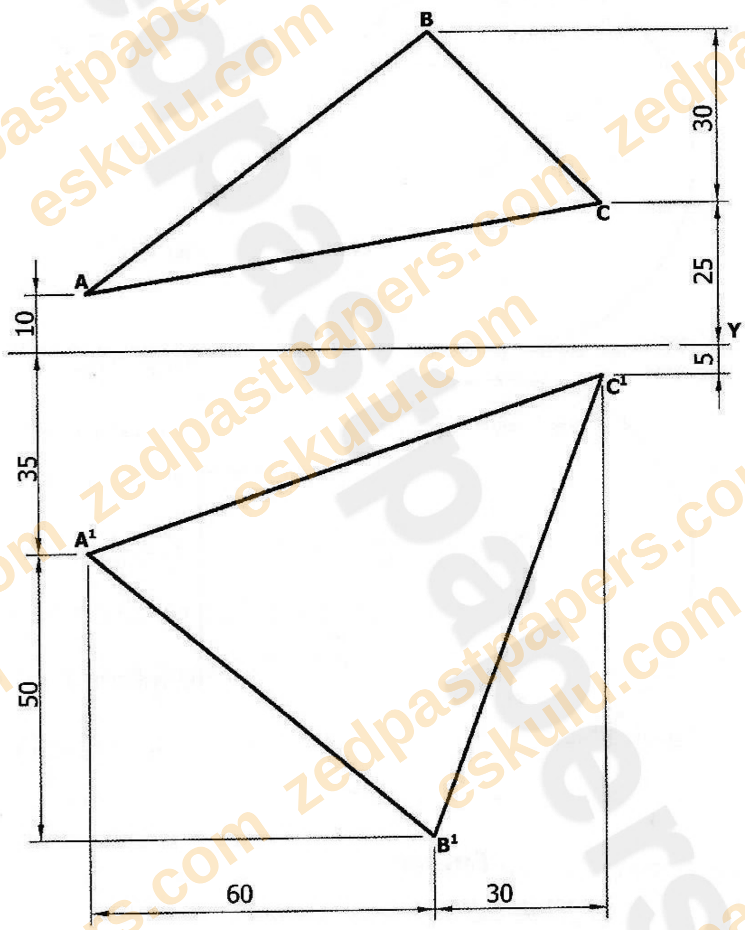


FIGURE 6

QUESTION 8

Figure 7 shows an incomplete plan and elevation of a junction between a cylinder and a sphere in **First Angle Projection.**

(a) Draw and complete the given views.

(b) Draw the surface development of the cylindrical part with the seam along **XX**.

[20]

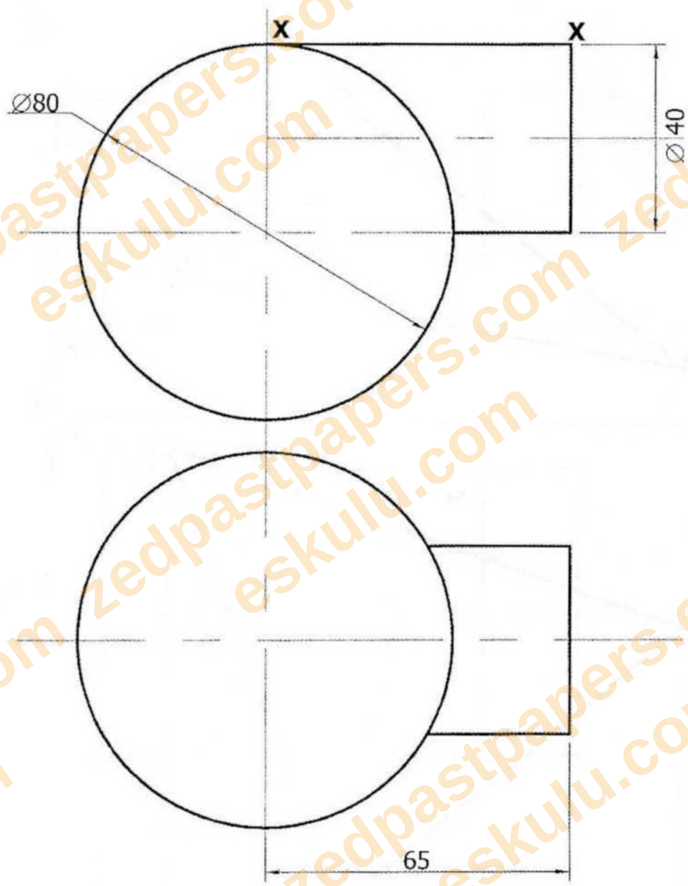


Figure 7

Question 1. SECTION A, Q1 [20]. Figure 1 shows a metal-plate profile: 3 circles (R25 top-left, R35 large right, R20 bottom-left) joined by common-tangent lines and an R90 and R60 blend arc (100/70/20mm references). Copy the profile full size, showing all constructions and tangential points.

Construction method: draw the three given circles at their correct centre positions first (R25 and R20 circles 70mm apart vertically per the figure, R35 circle 100mm to the right). The straight-line sections are DIRECT COMMON TANGENTS between circle pairs -- construct each by drawing the line joining the two centres, then (for an external/direct common tangent between circles of different radii) drawing a construction circle of radius = (larger radius - smaller radius) centred on the larger circle, finding the tangent point on this construction circle from the smaller circle's centre, and projecting that tangent line out to both actual circles.

The R90 arc blends tangentially between the R25 and R35 circles (its centre 90mm from each, on the correct side); the R60 arc blends tangentially between the R25 and R20 circles similarly (centre 60mm from each). In all cases: a blending arc's centre lies on the line joining it to each circle it touches, at a distance equal to the SUM (external tangency) or DIFFERENCE (internal tangency) of the two radii, as appropriate to how the arcs curve relative to each other in the figure.

Answer: Answer: construction method as above (direct common tangents between circle pairs via the radius-difference construction circle method; R90 and R60 blend arcs located via the sum/difference-of-radii rule; all centres and tangent points shown).

Question 2. SECTION A, Q2 [20]. Triangle ABC: AB=100, AC=80, angle ACB=45 degrees. (a) Construct the triangle. (b) Transpose to a square of equal area. (c) Inscribe a circle in the square. (d) State the diameter of the circle.

(a) Construction method: this is an SSA (ambiguous-case) construction -- draw AC=80mm, construct the 45-degree angle at C, then swing an arc of radius AB=100mm from A to find where it crosses the ray from C; use the geometrically valid (larger, positive) intersection to locate B.

Answer: (a) Computed exactly (law of cosines, solving the resulting quadratic for BC, taking the valid positive root): BC = 139.03mm. So the triangle has AB=100, AC=80, BC=139.03, angle C=45 degrees.

(b) 'Transposing' the triangle to a square by GEOMETRICAL method: convert the triangle to an equal-area rectangle first (base = one side, height = the corresponding altitude, itself found via the standard triangle-altitude construction), then convert that rectangle to a square using Euclid's mean-proportional/semicircle construction.

Answer: (b)-(c) Computed exactly (verifying the geometric construction): triangle area = 0.5 x AC x BC x sin(45 deg) = 0.5 x 80 x 139.03 x 0.7071 = 3932.38 mm-squared, so the equal-area square's side = sqrt(3932.38) = 62.71mm. (c) The circle INSCRIBED in a square touches all 4 sides at their midpoints, so its diameter equals the square's side exactly.

Answer: (d) Diameter of the inscribed circle = 62.71mm (approximately 62.7mm), i.e. the same as the square's own side length.

Question 3. SECTION A, Q3 [20]. Figure 2 shows a link mechanism: crank OA=45 rotates about fixed O; rod AP=110 has a point B (with AB=70, BP=40) constrained to slide along a fixed guide line OT, pin-jointed to the crank at A. Plot the locus of point P for one revolution of OA.

Construction method (this is a 'slider-crank with overhung point' locus, a different family from the pure four-bar-linkage loci in other GMD papers, since B slides along a FIXED STRAIGHT guide OT rather than swinging about a fixed pivot): divide the crank circle (centre O, radius OA=45mm) into 12 equal 30-degree divisions, giving 12 positions of A.

For each position of A, find B by the constraint that B must lie simultaneously (i) on the fixed guide line OT, AND (ii) at a fixed distance AB=70mm from the current position of A -- this is found by swinging an arc of radius 70mm from A and finding where it crosses the line OT (there may be two intersections; use the one consistent with the mechanism's actual assembly as shown in the figure). Once B is found, P lies on the straight extension of the same rigid rod AP beyond B, at BP=40mm from B, in line with A and B (since A, B, P are collinear on one rigid rod of total length AP=110=AB+BP=70+40).

Repeat for all 12 crank positions, plot the resulting 12 positions of P, and join them with a smooth curve through a French curve -- this traces the locus of P (a closed curve, NOT a simple named curve like a circle or ellipse, since it results from this slider-crank-with-extension mechanism).

Answer: Answer: construction method as above -- 12 crank positions (radius 45 from O), each giving a B position via the 70mm-arc/OT-line intersection, and each giving a P position by extending the rigid rod AB by a further 40mm beyond B (since AP=110=AB+BP); the 12 P points joined by a smooth curve form the locus.

Question 4. SECTION B, Q4 [20]. Figure 3 shows three views of a bracket (90mm base, 35/10mm top divisions, 70mm height, R25/Ø24 boss). Draw an isometric view, point P the lowest point, no hidden details.

Construction method: draw the three isometric axes at 120 degrees from origin P (the given lowest point). Set out the bracket's base length (90mm) and heights (70mm to the wedge top) along the isometric axes using TRUE lengths only. Build up the base/wedge shape first, then the raised rounded boss (R25 outer, Ø24 bore) using the four-centre approximate-ellipse method for the circular features on the isometric plane. Show only visible edges (no hidden detail, per the instruction).

Answer: Answer: construction method as above (isometric axes at 120 deg from P; true lengths along isometric axes; four-centre method for the R25/Ø24 circular boss; no hidden lines).

Question 5. SECTION B, Q5 [20]. Figure 4 shows the elevation and incomplete plan of a frustum of a right square pyramid (base 35x35mm square, full height 75mm, cut at 45 degrees). (a) Draw the given elevation and complete the plan. (b) Draw the true shape of the cut surface.

Reference values computed exactly for the FULL (untruncated) pyramid: base side 35mm gives a half-diagonal (centre to corner) = 35 x sqrt(2)/2 = 24.75mm; with full height 75mm, the true slant EDGE length (apex to a base corner) = sqrt(24.75^2 + 75^2) = 78.98mm.

(a) Construction method: draw the given elevation (isoceles-triangle silhouette, apex at 75mm, 45-degree cut line shown) and complete the plan (a 35x35mm square, rotated 30 degrees per the plan's own reference angle) by projecting each of the elevation's 4 edges down using the square's known corner positions.

(b) True shape of the cut: since the 45-degree cutting plane is oblique to the pyramid's axis, it crosses each of the 4 slant edges at a different height (a square pyramid's 4 edges are not symmetric about a single axis of revolution the way a cone's generators are). Project the true shape by the standard auxiliary-view method: mark where the 45-degree cutting plane crosses each of the 4 slant edges in the elevation, transfer these points to the plan, then set up a new auxiliary reference line parallel to the cutting plane (edge-on in the elevation) and project each of the 4 points perpendicular to it, transferring true depths from the plan by dividers to plot the true (generally irregular quadrilateral) shape of the cut.

Answer: Answer: full-pyramid half-diagonal = 24.75mm, slant edge = 78.98mm (both computed exactly); true shape of the cut found via the 4-point auxiliary-projection method described above (generally an irregular quadrilateral, since the oblique cut meets the 4 edges at different heights).

Question 6. SECTION B, Q6 [20]. Figure 5 shows a first-angle block (100/40mm plan width, Ø40 hole, 50/60mm heights, 25/15/20mm step divisions). (a) Draw the given views. (b) Project an auxiliary plan viewed from arrow M, showing all hidden details.

(a) Construction method: reproduce the given front elevation (a stepped profile, 15mm base then 25mm middle step then a further right-hand step to 50mm) and the given plan (100mm x 60mm rectangle with a central Ø40 hole positioned 40mm from one edge) directly from the given dimensions, in correct first-angle relative position.

(b) Auxiliary plan from arrow M (at 30 degrees): draw a new auxiliary reference line perpendicular to arrow M's direction of sight (i.e. at 30 degrees to the original vertical reference). Project each corner of the stepped block and the Ø40 hole's centre perpendicular to this new datum, transferring true depths (from the plan, via dividers) to correctly locate every point. Since the question explicitly requires ALL hidden details to be shown in this auxiliary view, draw dashed lines for every edge and for the far side of the Ø40 hole that is obscured from the arrow-M viewing direction -- the hole will generally project as an ellipse in this oblique view, plotted via the ordinate method, with both its near and far (hidden) edges shown.

Answer: Answer: construction method as above (auxiliary datum perpendicular to arrow M at 30 deg; depths transferred by dividers; Ø40 hole generally projects as an ellipse; ALL hidden detail shown dashed, per the explicit instruction, unlike most other GMD auxiliary-view questions which say NOT to show hidden detail).

Question 7. SECTION B, Q7 [20]. Figure 6 shows two views of a lamina ABC (elevation with heights 10/25/30mm above XY for A/C/B respectively; plan with depths 35/50mm and base divisions 60/30mm). (a) Draw the given views. (b) Determine the true angle of inclination to the vertical plane (VP). (c) Draw the true shape of the lamina.

Construction method (true angle to VP and true shape of an inclined lamina): reproduce the given elevation (showing each vertex's height above HP: A=10mm, C=25mm, B=25+30=55mm per the stacked height references) and plan (showing each vertex's depth from the VP/XY line: per the 35mm and 50mm references) exactly as given, aligned by shared vertical projectors.

To find the TRUE ANGLE that the whole lamina (plane) makes with the VP: identify a line in the plan that represents the TRUE LENGTH of the lamina's intersection with a plane parallel to the VP (i.e. a line drawn in the plan parallel to XY, since any line drawn on the lamina parallel to XY in plan is a true-length line seen edge-on from the front) -- then, using the elevation, measure the angle between the lamina's edge-view (seen as a straight line in a suitably chosen auxiliary elevation looking along that true-length line's direction) and the vertical XY-perpendicular reference; this angle is the lamina's true inclination to the VP.

For the TRUE SHAPE (part c): use the same right-triangle true-length method applied to each of the 3 sides individually (true length = sqrt(plan_length^2 + height_difference^2), using each side's own plan length and its own pair of end-point heights read from the elevation), then construct the true-shape triangle from these 3 true lengths using the standard base-plus-two-arcs method (draw one true length as a base, then intersect arcs of the other two true lengths from its two ends).

Answer: Best-effort note: the exact true angle to the VP and the 3 true side lengths depend on precisely reading each vertex's plan depth and elevation height from the printed figure (the 10mm/25mm/30mm elevation heights and the 35mm/50mm/60mm/30mm plan divisions) -- apply the methods above using those figure-specific readings for exact numeric answers; the METHODS themselves are correct and standard, and will give the exact true angle and true shape once the specific vertex coordinates are confirmed from the original drawing.

Question 8. SECTION B, Q8 [20]. Figure 7 shows an incomplete plan and elevation of a junction between a sphere (Ø80) and a cylinder (Ø40, offset 65mm from the sphere's centre). (a) Draw and complete the given views. (b) Draw the surface development of the cylindrical part, seam along XX.

(a) Construction method: complete the elevation and plan using the given dimensions (sphere Ø80 centred at the origin, cylinder Ø40 projecting from the sphere's surface, its axis offset per the 65mm reference). Find the curve where the cylinder meets the sphere by the standard cutting-plane method: divide the cylinder's circular cross-section (Ø40) into 12 equal divisions, and for each division, find where its generator line (parallel to the cylinder's axis) crosses the sphere's surface -- since the sphere is symmetric about its centre, each such crossing can be found by intersecting the generator line with the sphere's radius (80/2=40mm) using a simple right-triangle/Pythagorean calculation at each of the 12 division points, or graphically via a series of horizontal 'cutting circles' sliced through the sphere at each division's height. Join the resulting 12 points with a smooth curve to show the true junction curve in both the elevation and plan.

(b) Surface development of the cylindrical part (with seam along XX): since a cylinder's surface always unrolls into a flat RECTANGLE, the development's width is exactly pi x diameter = pi x 40 = 125.66mm (computed exactly here), and its height is the cylinder's own length (as given/measured in the elevation). Mark out this rectangle with the seam XX as one vertical edge, divide the width into the same 12 equal divisions used for the junction curve (125.66/12 = 10.47mm each), and at each division, transfer (by dividers, not calculation) the actual height of that division's junction point with the sphere (read directly off the completed elevation) up from the development's base line. Join the 12 transferred points with a smooth curve -- this is the true cut-out profile where the cylinder must be trimmed to fit against the sphere.

Answer: Answer: cylinder development is a rectangle exactly 125.66mm wide (= pi x 40mm diameter, computed exactly) by the cylinder's own length, divided into 12 equal 10.47mm-wide strips with heights transferred by divider (not calculated) from the completed elevation's sphere-junction curve, starting the layout from the seam XX.

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