G12 ECZ GMD P1 2017 GCE SOLUTIONS

Grade 12 ECZ Geometrical and Mechanical Drawing Paper 1, 2017 GCE (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 General Certificate of Education Ordinary Level

Geometrical and Mechanical Drawing 7040/1

Paper 1

Thursday 13 JULY 2017

Additional Material(s):
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 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

You may answer **two** or **three** questions from this section.

Question 1

(a) Construct a regular octagon given that the diagonals are 80mm long. [6]

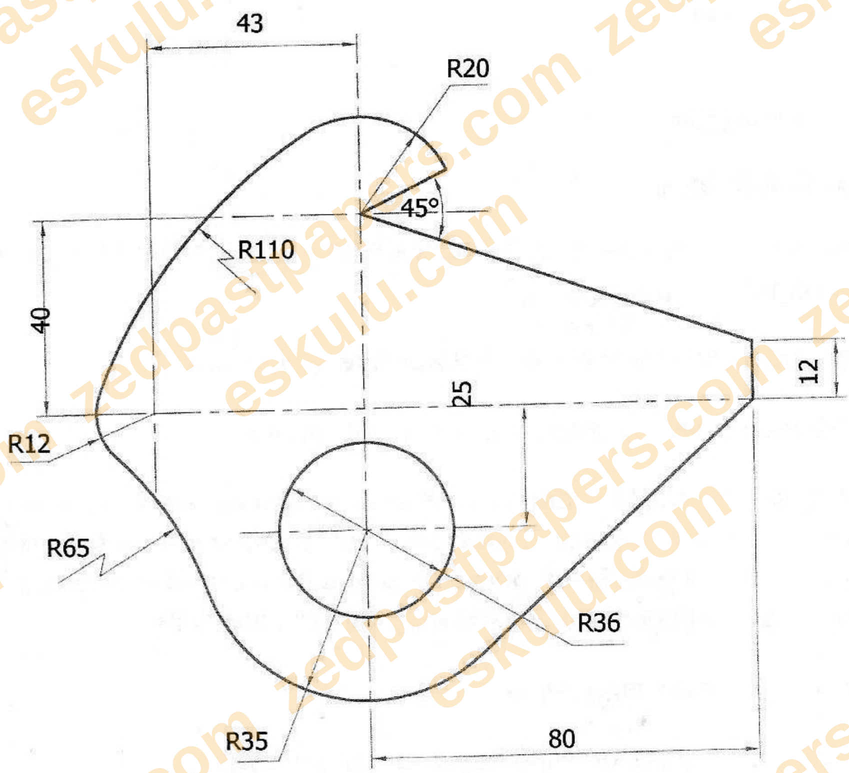
(b) Transpose the octagon constructed in (a) above into a square of equal area. [12]

(c) Measure and state the side of the square. [2]

[20]

Question 2

Figure 1 shows a drawing of a metal template. Construct full size the given template clearly showing all points of tangency.



[20]

Figure 1

Question 3

A wheel of diameter 60mm rolls on a flat surface without shipping.

(a) Plot the locus of point **P** initially in contact with the ground for one revolution of the wheel. [14]

(b) Construct a tangent at point **T** 40mm from the end of the locus. [5]

(c) Name the locus drawn in **(a)**. [1]

[20]

SECTION B SOLID GEOMETRY

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

Question 4

Figure 2 shows three views of a centre block in **First Angle Projection**.

Do not copy the given views but draw full size an isometric drawing making corner **E** the lowest point. **[20]**

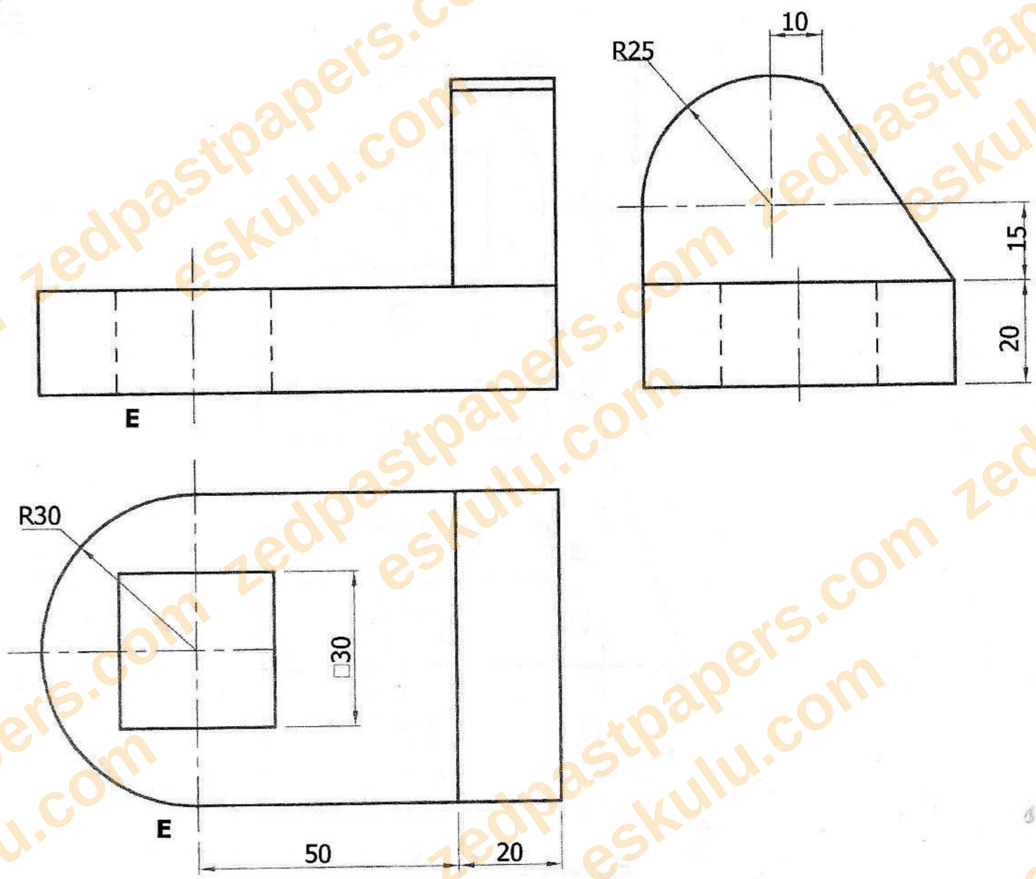


FIGURE 2

Question 5

Figure 3 shows the elevation of a right cone cut by a plane Y–Y parallel to the generator.

(a) Draw the given elevation and complete the plan viewed from arrow **P.** [10]

(b) Draw the true shape of the cut surface. [8]

(c) Name the shape produced in **(b).** [2]

[20]

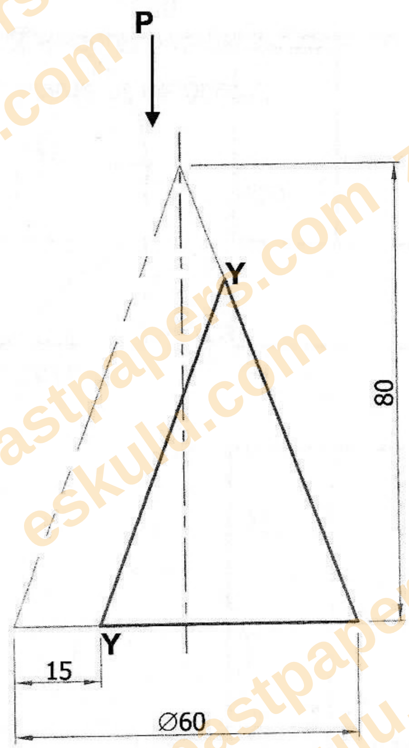


Figure 3

Question 6

Figure 4 shows the plan and elevation of a bracket in **First Angle Projection**.

(a) Draw the given views.

(b) Draw an auxiliary elevation viewed from arrow **E**.
NB: Show ALL hidden details.

[20]

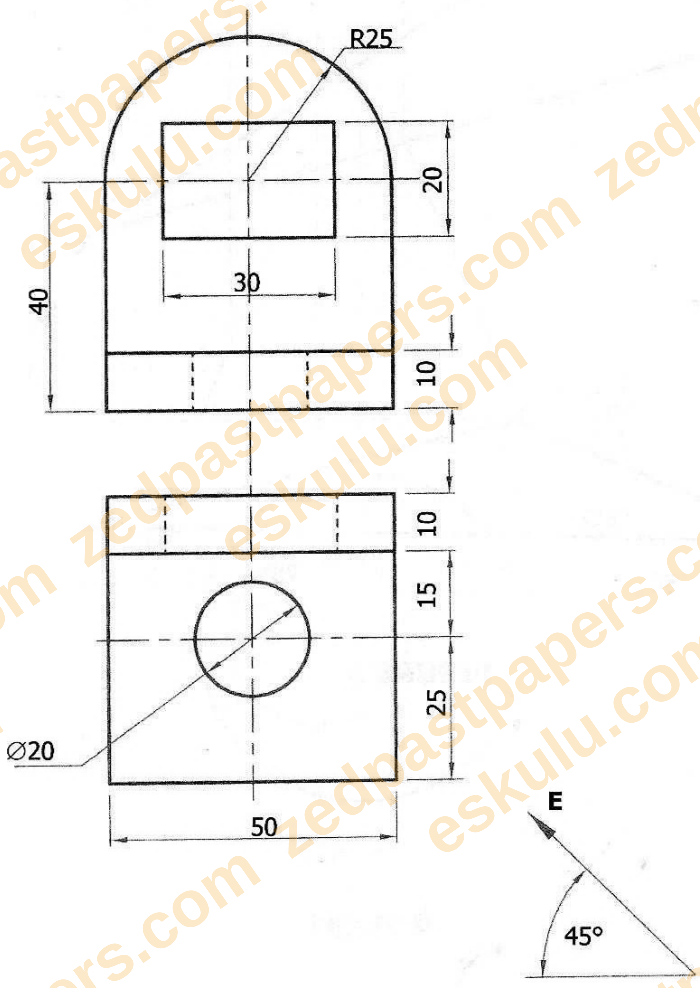


FIGURE 4

Question 7

Figure 5 shows the plan and elevation of a triangular Lamina.

(a) Copy the given views. [8]

(b) Find the true lengths of each side and draw the true shape of the Lamina. [12]

[20]

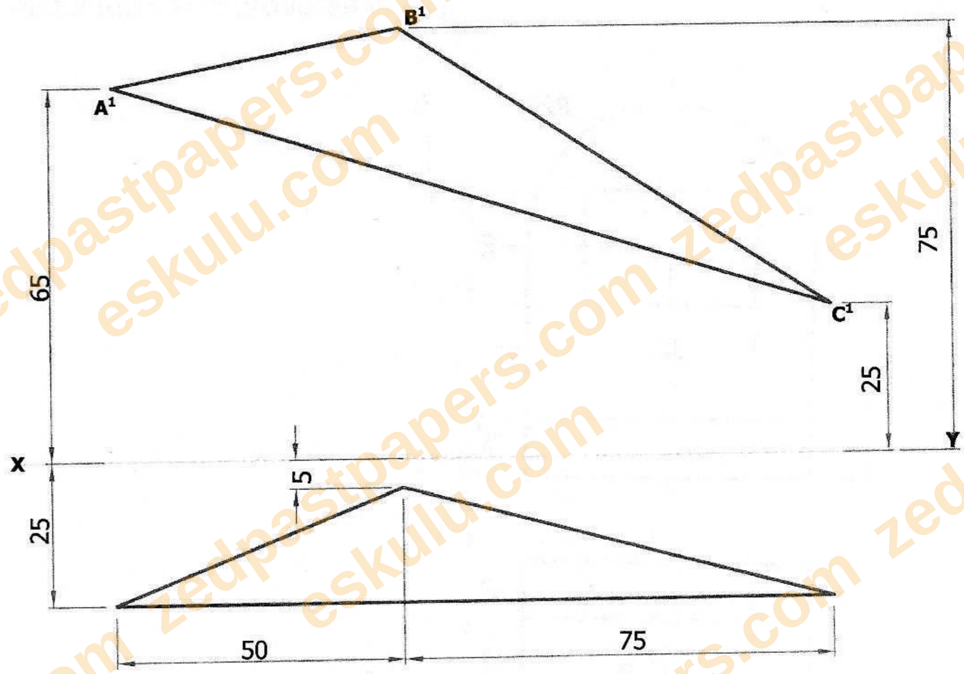


FIGURE 5

Question 8

Figure 6 below shows the Plan and an incomplete elevation of a junction piece between a right cone and cylinder in **First Angle Projection**.

(a) Draw the given views and complete the elevation. [14]

(b) Draw the surface development of the cylinder taking the seam along **P – P**. [6]

[20]

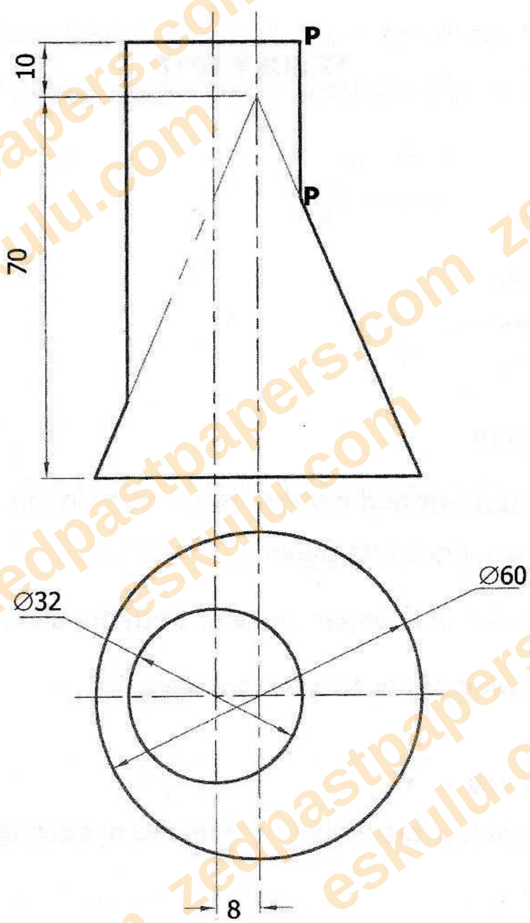


Figure 6

Question 1. SECTION A, Q1 [20]. (a) Construct a regular octagon given that the diagonals are 80mm long. (b) Transpose the octagon to a square of equal area. (c) State the side of the square.

(a) Construction method: the 'diagonal' of a regular octagon connecting two OPPOSITE vertices is the diameter of its circumscribed circle, so the circumradius R=40mm exactly. Draw a circle of radius 40mm, then step around it with a compass set to the octagon's own side length (see computed value below) to mark all 8 vertices, or alternatively use the standard square-plus-corner-cuts method (draw a square circumscribing the circle, then cut equal 45-degree corners).

Answer: (a) Computed exactly: octagon side = 2 x R x sin(22.5 deg) = 2 x 40 x sin22.5 = 30.61mm.

(b) 'Transposing' to a square by GEOMETRICAL method: divide the octagon into 8 triangles from its centre, convert to an equal-area rectangle via the standard running-total/mean-proportional method, then that rectangle to a square using Euclid's mean-proportional (semicircle) construction.

Answer: (c) Computed exactly (regular-octagon area formula = 2(1+sqrt2) x side^2 = 2 x 2.4142 x 30.61^2 = 4525.48 mm-squared): the equal-area square's side = sqrt(4525.48) = 67.27mm (approximately 67mm).

Question 2. SECTION A, Q2 [20]. Figure 1 shows a metal template profile: tangent arcs R12, R65, R110, R20 (at 45 degrees), R35, and R36 around a central circle, with 43/40/25/80/12mm references. Construct full size, showing all points of tangency.

Construction method: draw the central circle (implied by the R36 label, tangent internally to the main outline) and the main outline's key reference points from the given dimensions first. Draw each tangent arc (R12, R65, R110, R20, R35) in turn, locating each arc's centre on the perpendicular to whichever line or curve it must be tangent to, at a distance equal to its own radius from the point of tangency -- for arc-to-arc tangency, the centre-to-centre distance equals the SUM of the two radii (external/convex tangency) or the DIFFERENCE (internal/concave tangency), matching how the arcs curve relative to each other in the figure. The R20 arc meets its neighbour at the explicitly given 45-degree angle, which fixes its centre's direction directly from that vertex.

Answer: Answer: construction method as above (each arc centre located via the standard sum/difference-of-radii tangency rule, or via the explicit 45-degree angle for the R20 arc; all points of tangency marked clearly, as required).

Question 3. SECTION A, Q3 [20]. A wheel of diameter 60mm rolls on a flat surface without slipping. (a) Plot the locus of point P (initially in contact with the ground) for one revolution. (b) Construct a tangent at point T, 40mm from the end of the locus. (c) Name the locus.

(a) Construction method: this is the standard CYCLOID construction. Draw a base line equal to the wheel's circumference (pi x 60 = 188.5mm). Divide the wheel into 12 equal 30-degree divisions and the base line into 12 equal parts. Project each circle-division point horizontally to the centre-line locus, then draw the wheel at each successive base-line position and mark where the corresponding division point lands -- join all 12 points with a smooth curve (French curve).

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).

(b) At point T (40mm measured along the curve/base from the end of the locus, i.e. near the completion of the revolution): the NORMAL to a cycloid at any point passes through the corresponding point of contact between the wheel (at that instant) and the base line, directly below the wheel's centre at that position; the TANGENT is perpendicular to this normal, drawn through T.

Answer: (b) Construction: identify the wheel position corresponding to T (40mm from the end, found by interpolating between the plotted division points), draw the normal from T down to that wheel position's point of contact with the base line, then draw the tangent through T perpendicular to this normal.

Question 4. SECTION B, Q4 [20]. Figure 2 shows three views of a centre block (50/20mm plan divisions, R30 rounded end, 30mm square boss, 10/20/15mm heights, R25 rounded top). Draw an isometric drawing, corner E the lowest point, no hidden details.

Construction method: draw the three isometric axes at 120 degrees from origin E (the given lowest point). Set out the block's overall base (50+20=70mm) and heights (10+20+15=45mm total, with the R25 rounded top) along the isometric axes using TRUE lengths only. Build up the stepped base first, then the raised boss (a 30mm square, per the plan) and the rounded R25/R30 features, each circular/rounded feature constructed via the four-centre approximate-ellipse method appropriate to isometric projection. Show only visible edges (no hidden detail, per the instruction).

Answer: Answer: construction method as above (isometric axes at 120 deg from E; true lengths along isometric axes; four-centre method for the R25/R30 rounded features; no hidden lines).

Question 5. SECTION B, Q5 [20]. Figure 3 shows the elevation of a right cone (base Ø60, height 80mm) cut by a plane Y-Y PARALLEL TO A GENERATOR (starting 15mm from the base edge). (a) Draw the given elevation and complete the plan viewed from arrow P. (b) Draw the true shape of the cut surface. (c) Name the shape produced in (b).

Reference value computed exactly: the cone's slant height (apex to base edge) = sqrt(30^2 + 80^2) = 85.44mm.

(a) Construction method: draw the given elevation (isoceles triangle, apex at 80mm, base Ø60) and complete the plan (a circle of radius 30mm, viewed from arrow P looking straight down) by dividing the base circle into 12 equal divisions and projecting each generator up into the elevation.

(b) True shape of the cut: this is the KEY geometric fact for this question -- when a cutting plane is drawn PARALLEL TO EXACTLY ONE GENERATOR of a right cone (as explicitly stated here, plane Y-Y parallel to a generator), the resulting conic-section cut is always a PARABOLA (this is one of the three classic conic sections obtained from a cone: a plane crossing ALL generators gives an ellipse or circle; a plane parallel to the axis gives a hyperbola; a plane parallel to exactly one generator gives a parabola -- this is a general geometric theorem, not something that depends on the specific 15mm/60mm/80mm figures here, though those figures determine the parabola's exact size). Project the true shape via the standard auxiliary-view method: divide the base circle into 12 divisions, project each generator's crossing-point with the Y-Y plane into the elevation, then set up a new auxiliary reference line parallel to Y-Y and project each point perpendicular to it, transferring true depths from the plan by dividers to plot the true parabolic curve.

Answer: (c) Name of the shape: a PARABOLA (confirmed by the general theorem: any plane section of a cone cut parallel to exactly one generator is a parabola).

Question 6. SECTION B, Q6 [20]. Figure 4 shows the plan and elevation of a bracket (Ø20 hole, R25 rounded top, 50/30mm widths, 10/15/25/20/40mm divisions, arrow E at 45 degrees). (a) Draw the given views. (b) Draw an auxiliary elevation viewed from arrow E, showing ALL hidden details.

(a) Construction method: reproduce the given elevation (a rounded-top profile, R25 arch over a 30mm rectangular collar, stepped 10mm/40mm base) and the given plan (a 50mm-wide rectangle with a central Ø20 hole, 15/25mm divisions) directly from the given dimensions, in correct first-angle relative position.

(b) Auxiliary elevation from arrow E (at 45 degrees): draw a new auxiliary reference line parallel to arrow E's direction of sight (at 45 degrees to the plan's reference line). Project each corner of the bracket's profile and the Ø20 hole's centre perpendicular to this new datum, transferring true heights (from the ORIGINAL elevation, via dividers) to correctly locate every point. Since the question explicitly requires ALL hidden details to be shown, draw dashed lines for every edge and for the far side of the Ø20 hole (and the R25 arch's inner surface, if applicable) that would be hidden from the arrow-E viewing direction -- unlike most GMD auxiliary-view questions which say NOT to show hidden detail, this one explicitly requires it.

Answer: Answer: construction method as above (auxiliary datum parallel to arrow E's 45-degree direction; heights transferred by dividers from the original elevation; ALL hidden detail shown dashed, per the explicit instruction).

Question 7. SECTION B, Q7 [20]. Figure 5 shows the plan and elevation of a triangular lamina: elevation heights (above XY) are A1=65mm, B1=75mm, C1=25mm; plan base divisions are 50mm+75mm=125mm total, with the apex offset 5mm and 25mm deep. (a) Copy the given views. (b) Find the true lengths of each side and draw the true shape of the lamina.

Setting up coordinates from the given data: plan positions A=(0,0), C=(125,0) [the two base corners, 50+75=125mm apart], B=(55,25) [the apex, offset 5mm from the 50mm midpoint, 25mm 'deep' in the plan direction]; heights above HP are zA=65, zB=75, zC=25 (read from the elevation).

Method: for each side, true length = sqrt((plan length)^2 + (height difference)^2) -- the standard true-length right-triangle construction, applied once per side using each side's own plan length and its own pair of end-point heights.

Answer: (b) Computed exactly: plan lengths AB=60.42mm, BC=74.33mm, CA=125mm (the full base). True lengths: AB = sqrt(60.42^2 + (75-65)^2) = sqrt(3750) = 61.24mm; BC = sqrt(74.33^2 + (25-75)^2) = sqrt(8025) = 89.58mm; CA = sqrt(125^2 + (65-25)^2) = sqrt(17225) = 131.24mm.

True shape construction: draw one side at its true length (e.g. CA=131.24mm) as a base line, then draw an arc of radius AB(true)=61.24mm centred on A, and an arc of radius BC(true)=89.58mm centred on C; their intersection gives the true position of B. Joining A, B (new position) and C gives the TRUE SHAPE of the lamina.

Answer: Answer: true lengths AB=61.24mm, BC=89.58mm, CA=131.24mm (computed exactly by coordinate/Pythagorean method); true shape is the triangle with these three side lengths, constructed by the base-plus-two-arcs method above.

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