G12 ECZ GMD PAPER 1 2016 SOLUTIONS

Grade 12 ECZ Geometrical and Mechanical Drawing Paper 1, 2016 (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 the School Certificate of Education Ordinary Level

GEOMETRICAL AND MECHANICAL DRAWING

PAPER 1 7040/1

Tuesday 22 November 2016 2 hours 30 minutes

Additional materials:
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 millimeters unless otherwise stated.

Cell phones are **not** allowed in the examination room.

This question paper consists of 8 printed pages .

SECTION A

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

QUESTION 1

(a) Construct a triangle whose perimeter is **180mm** and its base angles are **52½°** and **60°**. [8]

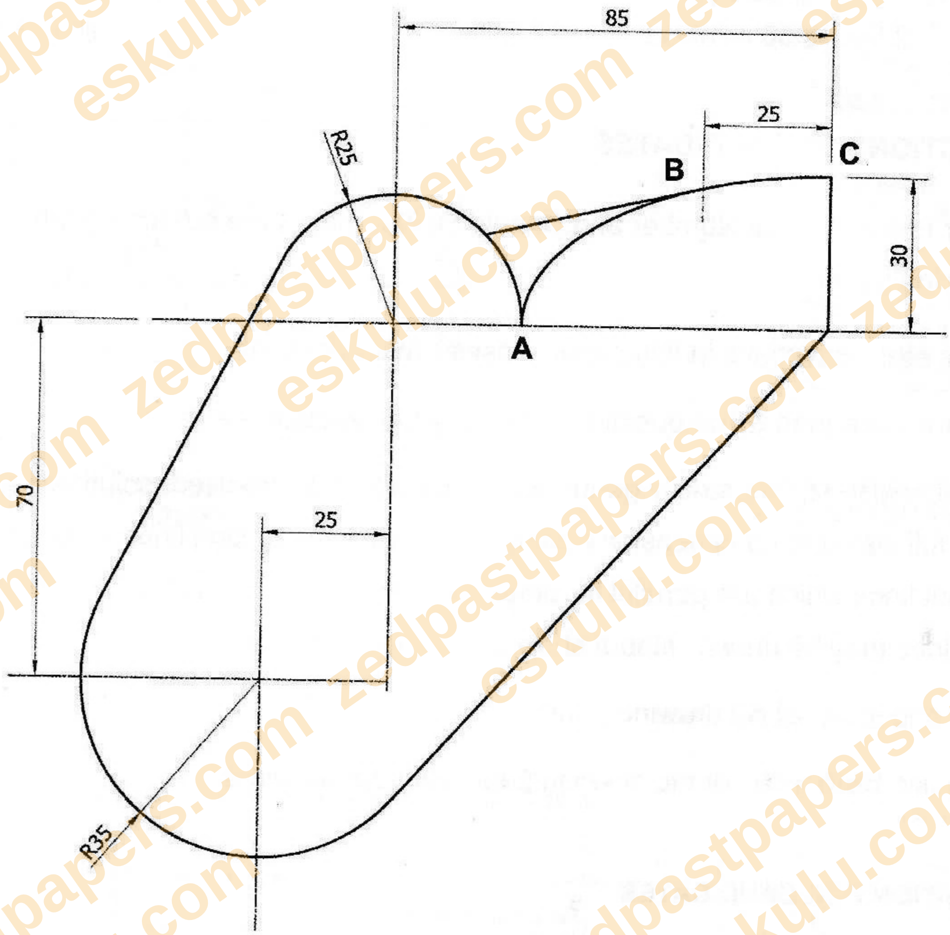
(b) Using geometrical methods, construct a square equal in area to the triangle drawn in **(a)** above. [8]

(c) Measure and state the length of the side of the square. [1]

(d) Circumscribe a circle to a square drawn in **(b)**. [3]

QUESTION 2

Figure 1 below shows the layout plan of a **LAWN**. Curve ABC is ¼ of an ellipse Draw the outline clearly showing all the arc centres and points of tangency.



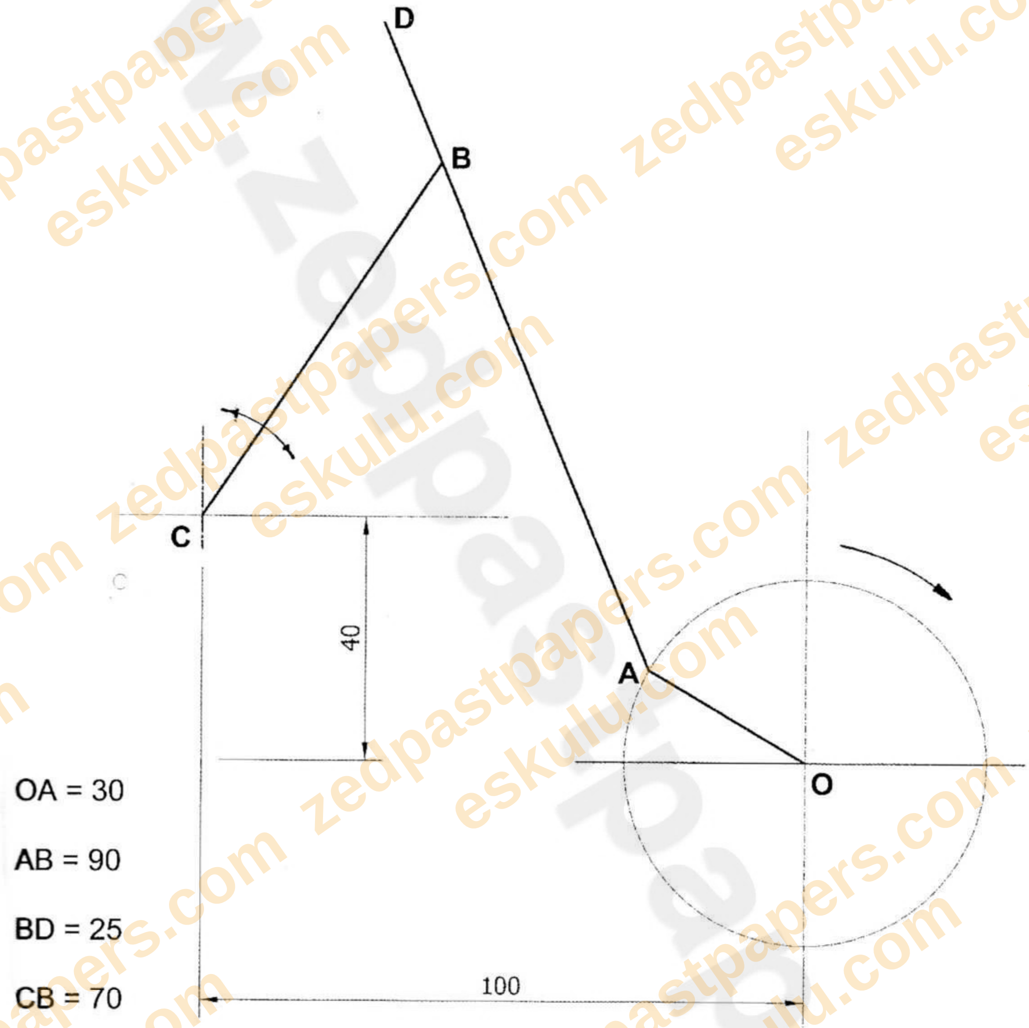
[20]

Figure 1

QUESTION 3

Figure 2 shows a layout of a link mechanism in which crank **OA** rotates clockwise about a fixed centre **O**. **CB** is a rod pin-jointed at **B** and oscillates about centre **C**. Rod **AD** is pin-jointed at **A** and **B**.

For one complete rotation of crank **OA**, plot the **LOCUS** of point **D**.



[20]

FIGURE 2

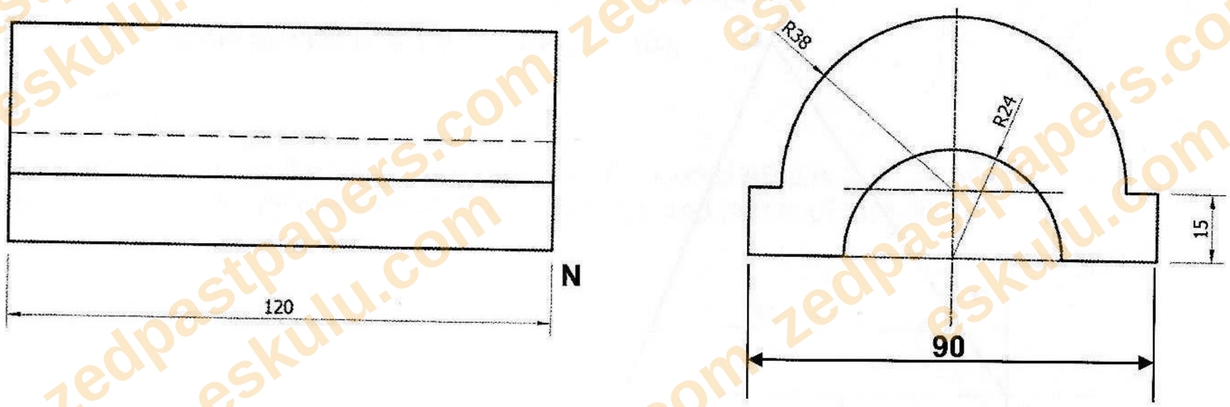
[Turn over

SECTION B SOLID GEOMETRY

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

QUESTION 4

Two views of a coping stone are given below in **Figure 3**.
Do not copy the given views but with the use of instruments draw an Isometric View making point '**N**' the lowest point.
DO NOT SHOW HIDDEN DETAILS



[20]

FIGURE 3

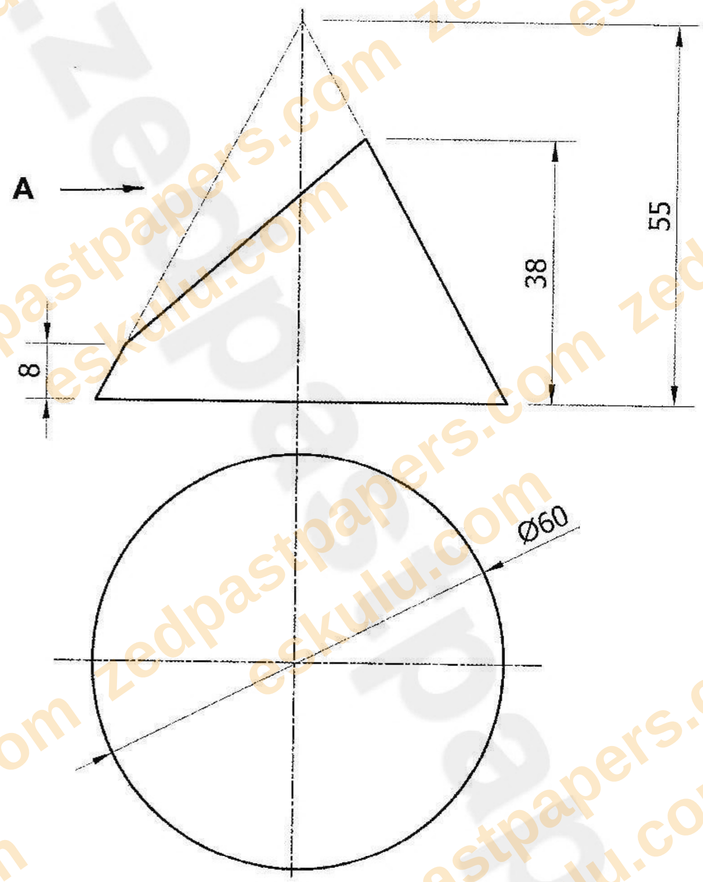
QUESTION 5

Two views of a truncated cone are given in **Figure 4.**

(a) Draw the given views. [3]

(b) Project a true shape of the cut surface [11]

(c) Project an end view looking in the direction of **arrow A.** [6]



[20]

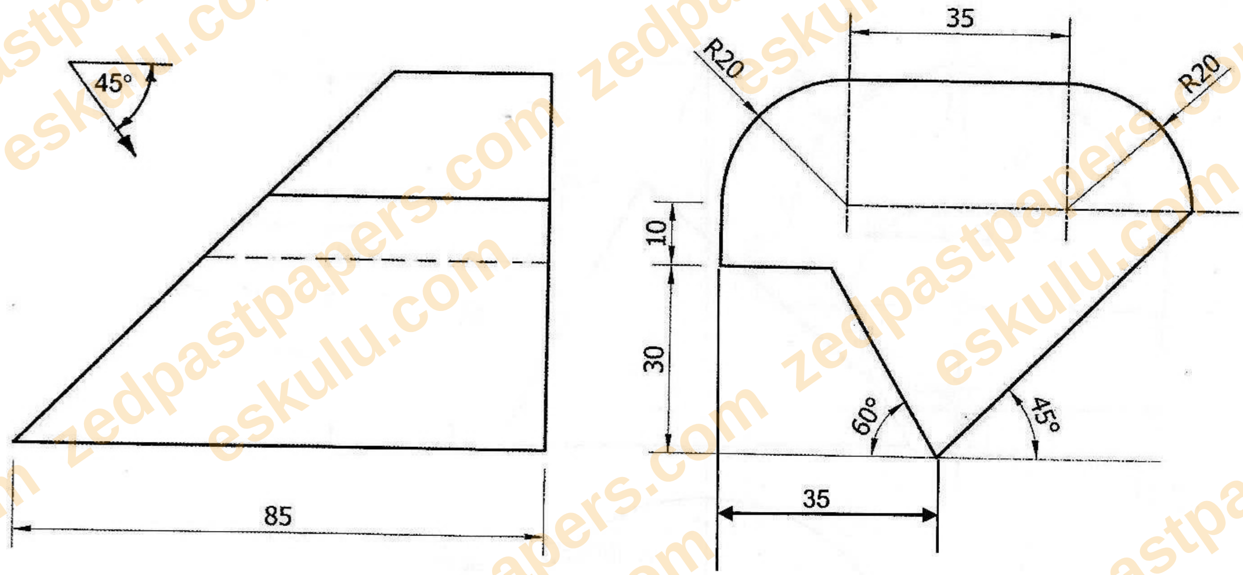
Figure 4

QUESTION 6

Figure 5 shows a block shaped for an engineering work drawn in **FIRST ANGLE PROJECTION**.

(a) Copy the two views. [5]

(b) Project an Auxiliary Plan viewed from arrow **Y**. [15]



[20]

FIGURE 5

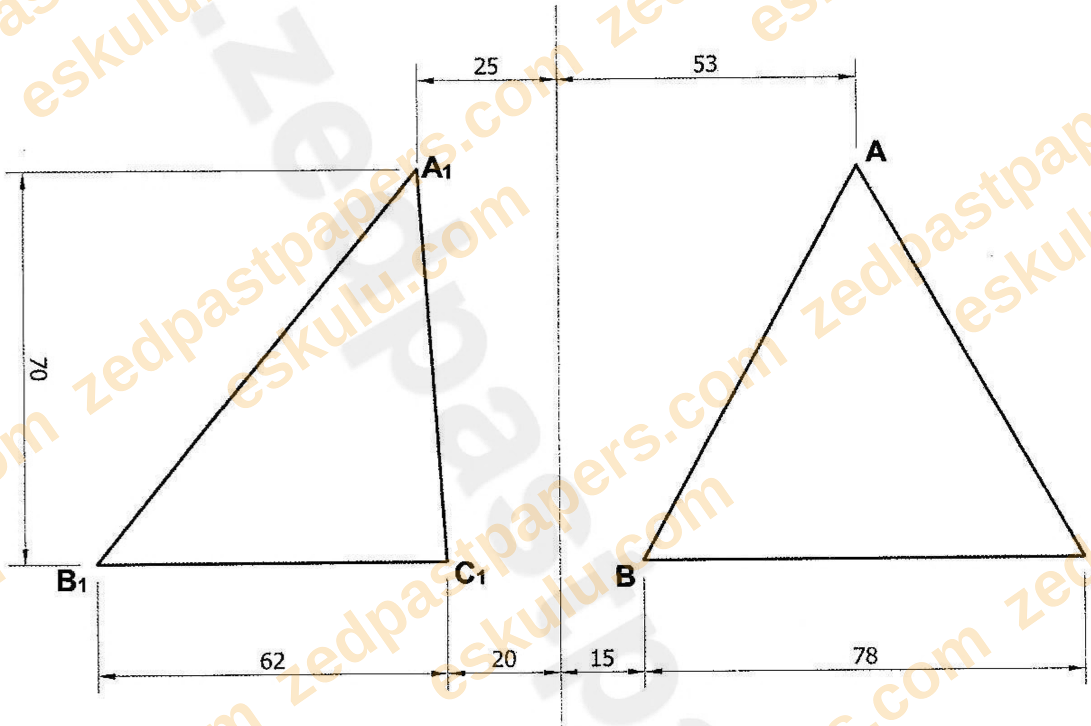
QUESTION 7

Figure 6 below shows a triangular **Lamina**

(a) Copy the given views. [6]

(b) Draw the **true shape** of the triangular **lamina.** [12]

(c) Measure and state the true lengths of sides **AB** and **AC**. [2]



[20]

FIGURE 6

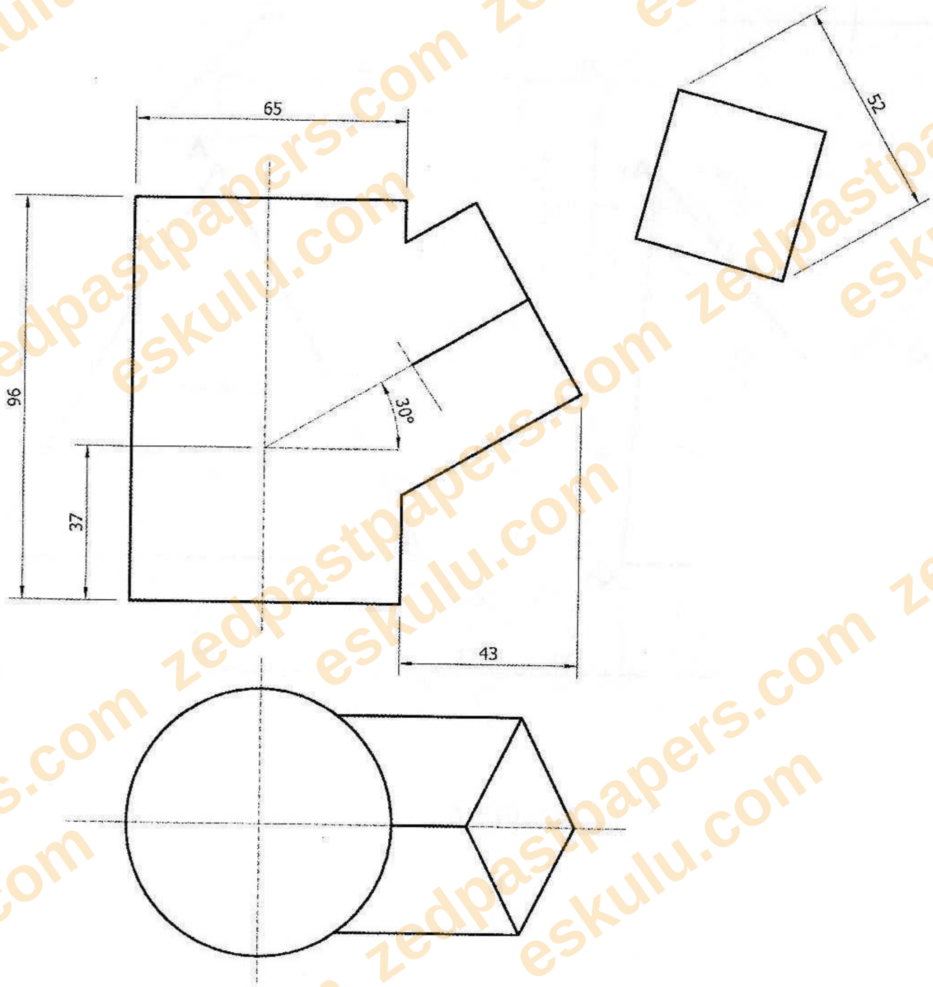
QUESTION 8

Figure 7 below shows a Plan and an incomplete **Front Elevation** of a cylinder penetrated by a regular square duct in **First Angle Projection**.

(a) Copy the given views. [6]

(b) Complete the front elevation showing the curves of intersection between the cylinder and square prism. [8]

(c) Draw a surface development of the square duct, when given the seam at **S-S**. [6]



[20]

Figure 7

Question 1. SECTION A, Q1 [20]. (a) Construct a triangle of perimeter 180mm with base angles 52.5 and 60 degrees. (b) Construct a square equal in area to the triangle. (c) State the side of the square. (d) Circumscribe a circle to the square.

(a) Construction method: the third (apex) angle = 180 - 52.5 - 60 = 67.5 degrees. Using the sine rule, with k = perimeter/(sinA+sinB+sinC), the three sides work out to a=55.28mm (opposite the 52.5 deg angle), b=60.34mm (opposite the 60 deg angle) and c=64.38mm (opposite the 67.5 deg apex angle, i.e. the base) -- construct the base c=64.38mm, then the 52.5 deg and 60 deg angles at its two ends, the intersection of the two angled rays gives the apex.

(b) 'Squaring the triangle' by GEOMETRICAL methods (not calculation) uses the standard mean-proportional / semicircle construction: convert the triangle to an equal-area rectangle first (base = triangle's base, height = half the triangle's altitude), then convert that rectangle to a square using Euclid's mean-proportional method (draw the rectangle's two adjacent sides end-to-end on one line, describe a semicircle on their combined length, and erect a perpendicular at their junction up to the semicircle -- that perpendicular's length is the square's side).

Answer: (c) Computed exactly (Heron's formula, verifying the geometric construction): triangle area = 1540.96 mm-squared, so the square's side = sqrt(1540.96) = 39.26mm (approximately 39mm).

Answer: (d) The circle circumscribing a SQUARE passes through all 4 corners, so its diameter equals the square's diagonal = side x sqrt(2) = 39.26 x 1.4142 = 55.52mm (approximately 55.5mm); construction: draw the square's two diagonals, their intersection is the circle's centre, and the circle's radius is half the diagonal (27.76mm).

Question 2. SECTION A, Q2 [20]. Figure 1 shows a lawn outline: curve ABC is 1/4 of an ellipse, blended with R25 and R35 arcs into a closed shape (85/25mm and 70/25mm reference divisions). Draw the outline, showing all arc centres and points of tangency.

Construction method: construct the quarter-ellipse ABC first using the auxiliary-circle (or trammel) method for an ellipse whose relevant semi-axes match the 85mm and 30mm (=height between the AB reference and C) dimensions given -- plot enough points on the quarter between A (on the major-axis line) and C (the corner near the 25mm/30mm offset) via the ordinate method, with B falling on the curve partway between.

The R25 arc at the top-left blends tangentially between the quarter-ellipse (near A) and the main outline's upper-left curve -- its centre lies on the perpendicular to the ellipse's tangent at that point, at a distance of 25mm. The R35 arc at the bottom forms the rounded lower-left of the outline, tangent to the two adjacent straight/curved edges, its centre similarly found 35mm along the perpendiculars to each tangent line. Mark and label every arc centre and every point of tangency clearly, as the question explicitly requires.

Answer: Answer: construction method as above (quarter-ellipse via the auxiliary-circle/ordinate method for curve ABC; R25 and R35 blend-arc centres each located on the perpendicular to their tangent lines/curves at a distance equal to their own radius; all centres and tangent points labelled).

Question 3. SECTION A, Q3 [20]. Figure 2 shows a link mechanism: crank OA=30 rotates clockwise about fixed O, rod AB=90 and BD=25 form one rigid link pin-jointed to the crank at A (with D beyond B), and rod CB=70 oscillates about fixed C, pin-jointed at B. Plot the locus of point D for one revolution of OA.

Construction method (four-bar-linkage extended-coupler-point locus, same family of construction as the 2015 Q3 mechanism): divide the crank circle (centre O, radius OA=30mm) into 12 equal 30-degree divisions, giving 12 positions of point A.

For each position of A, find B by intersecting an arc of radius AB=90mm (centred on that position of A) with an arc of radius CB=70mm (centred on the fixed point C) -- their intersection (on the side consistent with the mechanism's actual assembly, matching the figure) gives that position of B. Then locate D on the straight extension of the rigid link beyond B, at BD=25mm from B, in line with A and B (i.e. D, B and A stay collinear at every crank position since ABD is one rigid rod).

Repeat for all 12 crank positions, plot the resulting 12 positions of D, and join them with a smooth curve through a French curve -- this traces the extended-coupler-point locus (a closed curve, generally egg/kidney-shaped, not a simple named curve).

Answer: Answer: construction method as above -- 12 crank positions (radius 30 from O), each giving a B position via the 90mm/70mm two-arc intersection with C, and each giving a D position by extending the rigid line AB by a further 25mm beyond B; the 12 D points joined by a smooth curve form the locus.

Question 4. SECTION B, Q4 [20]. Figure 3 shows two views of a coping stone (120mm long profile with a stepped/sloped top, and a semicircular arch shape R38/R24 with a 90mm base and 15mm step). Draw an isometric view, point N the lowest point, no hidden details, using instruments.

Construction method: draw the three isometric axes at 120 degrees to each other from origin N (the given lowest point). Set out the coping stone's overall length (120mm) and the arch block's width (90mm) along the isometric axes using TRUE lengths only. Build up the stepped/sloped upper profile of the long coping-stone block first (using the given step heights), then construct the semicircular archway block (R38 outer arch, R24 inner arch, 15mm step) using the four-centre approximate-ellipse method for each circular arc, since true circles/arcs on isometric planes project as ellipses (or ellipse-arcs).

Show only visible edges as solid lines (no hidden detail, per the instruction), with the whole isometric view constructed WITH instruments this time (unlike the P2 freehand-sketch questions), so all measurements should be taken accurately with a scale rule and the ellipse arcs constructed geometrically (not sketched).

Answer: Answer: construction method as above (isometric axes at 120 deg from N; true lengths along isometric axes; four-centre method for the R38/R24 arch arcs; no hidden lines; drawn with instruments, to accurate scale).

Question 5. SECTION B, Q5 [20]. Figure 4 shows a truncated cone (base Ø60, apex-side heights 55mm main / 38mm cut point / 8mm offset). (a) Draw the given views [3]. (b) Project the true shape of the cut surface [11]. (c) Project an end view looking in the direction of arrow A [6].

(a)-(b) The full (untruncated) cone has base radius 30mm and height 55mm, giving an exact slant height L = sqrt(30^2+55^2) = 62.65mm, and (for reference, useful if a development were also asked) a full-cone development sector angle = 360 x 30/62.65 = 172.39 degrees. The cutting plane is oblique (per the 38mm/8mm figure references), so each of the cone's generator lines is cut at a DIFFERENT height/length -- the true shape of this cut surface is therefore generally an ELLIPSE (a plane section of a cone at an angle to its axis, cutting all the way across, produces an ellipse, provided the cutting angle is shallower than the cone's own half-angle; here the cone's half-angle = arctan(30/55) = 28.6 degrees, so confirm the actual cut angle read off the drawing against this before assuming a closed ellipse rather than a parabola/hyperbola-like open curve).

Project the true shape by the standard auxiliary-view (rotation) method: divide the base-circle plan into 12 equal divisions, project each division's generator up to the elevation to find where the (given, incomplete) cutting plane crosses it, then set up a new auxiliary reference line parallel to the cutting plane (as seen edge-on in the elevation) and project each of the 12 cut points perpendicular to this new line, transferring each point's true offset (from the plan) by dividers to plot the true curve.

(c) End view from arrow A: this is a simple projection along the cone's own axis (or close to it, per arrow A's shown direction) -- in such an end view the full (untruncated) base appears as a true circle of Ø60, with the cut edge's projection appearing as a curve inside it (an ellipse-arc, projected from the same 12 division points used above, transferred via the standard projection lines to this new viewing direction).

Answer: Answer: full-cone slant height = 62.65mm computed exactly; the cone's own half-angle = 28.6 degrees (compare against the actual printed cutting angle to confirm the cut is a closed ellipse); true shape found by the 12-point auxiliary-projection method described above; end view from arrow A shows the base as a true Ø60 circle with the cut curve projected inside it.

Question 6. SECTION B, Q6 [20]. Figure 5 shows a first-angle engineering block (85mm long wedge/ramp profile at 45 degrees, plus a kite-shaped profile with R20 fillets, 60/45 degree angles, 35mm divisions). (a) Copy the two views [5]. (b) Project an auxiliary plan viewed from arrow Y [15].

(a) Construction method: reproduce the given front elevation (a wedge/ramp shape rising at 45 degrees over 85mm) and the given end/side view (a kite-shaped profile with two R20 rounded corners at the top, and a 60/45-degree angled point at the bottom, 35mm symmetric divisions) directly from the given dimensions, in correct first-angle relative position.

(b) Auxiliary plan from arrow Y: draw a new auxiliary reference line perpendicular to arrow Y's direction of sight. Project each edge/corner of the block (the 45-degree wedge top, the R20 fillets, the kite-shaped base) perpendicular to this new datum, and transfer true depths (measured from whichever original view shows the true depth dimension, using dividers) to correctly locate every point in the new auxiliary plan. Since arrow Y's viewing direction is oblique to the block's principal faces (matching the 45-degree wedge angle shown), the resulting auxiliary plan will show the wedge's sloped top face in its TRUE SHAPE (this is, in fact, the classic purpose of such an auxiliary view -- to reveal the true shape of an inclined surface that appears foreshortened in the standard views).

Answer: Answer: construction method as above (auxiliary datum perpendicular to arrow Y; depths transferred by dividers from the given views; this auxiliary plan reveals the TRUE SHAPE of the 45-degree sloped top face, which appears foreshortened in the ordinary front/end views).

Question 7. SECTION B, Q7 [20]. Figure 6 shows two views of a triangular lamina (elevation A1B1C1 with base divisions 62/20mm and height 70mm; plan ABC with base divisions 15/78mm and offset 53/25mm). (a) Copy the given views [6]. (b) Draw the true shape of the lamina [12]. (c) State the true lengths of AB and AC [2].

Construction method (true shape of an inclined lamina, given its plan and elevation): this is the standard 'auxiliary-view/rotation' technique for finding the true shape of a plane figure that is inclined to both reference planes. First reproduce the given plan (ABC, showing each vertex's true horizontal x-y position) and elevation (A1B1C1, showing each vertex's true height) exactly as given, aligned by their shared vertical projectors between the two views.

To find the TRUE LENGTH of any one edge (e.g. AB or AC): construct a right-angled triangle where one side is that edge's PLAN length (measured directly on the plan view ABC) and the other (perpendicular) side is the DIFFERENCE in height of its two end-points (read from the elevation A1B1C1); the hypotenuse of this right triangle is the true length of that edge. Repeat for all three edges (AB, BC, CA).

To find the TRUE SHAPE of the whole triangle (not just one edge): construct a new auxiliary view with a reference line parallel to one edge of the plan (commonly the longest or a convenient edge), then project each vertex perpendicular to this new line and transfer each vertex's HEIGHT (from the elevation) along the projector -- the resulting figure, using all three TRUE lengths found above to cross-check, is the true shape of the lamina, generally a DIFFERENT (typically larger) triangle than either the plan or elevation view alone shows, since both of those are foreshortened projections of the true, inclined shape.

Answer: (c) Best-effort note: the exact true lengths of AB and AC depend on precisely reading each vertex's plan x-y position and elevation height from the printed figure (the 15mm/78mm/53mm plan divisions and the 62mm/20mm/25mm/70mm elevation divisions/heights) -- apply the right-triangle method above (true length = sqrt(plan_length^2 + height_difference^2)) using those figure-specific readings for a numeric answer; the METHOD above is correct and will give the exact values once the specific vertex coordinates are confirmed from the original drawing.

Question 8. SECTION B, Q8 [20]. Figure 7 shows a plan and incomplete front elevation of a cylinder (96/37mm heights, 65mm width) penetrated by a regular square duct (side 52mm, shown separately, at 30 degrees, with a 43mm offset). (a) Copy the given views [6]. (b) Complete the elevation showing the curves of intersection [8]. (c) Draw a surface development of the square duct, seam at S-S [6].

(a)-(b) Construction method: complete the given elevation and plan using the given dimensions (cylinder diameter from the plan circle, square duct of side 52mm entering at 30 degrees per the figure). Find the interpenetration curve by the standard cutting-plane (generator) method: since the duct is a SQUARE prism (not round), it has only 4 flat faces/edges rather than 12 curved divisions -- mark the 4 corner-generator lines of the square duct in the plan, project each through the elevation to find where it crosses the cylinder's curved surface, and join these (at most 4, plus intermediate points along each flat face if the face itself is wide enough to show curvature in the cut) points with straight-and-curved segments to show the true intersection between the flat-faced duct and the round cylinder.

(c) Surface development of the SQUARE duct (side 52mm, confirmed exactly from the separate detail figure): since a square prism's surface unrolls into 4 equal flat rectangular strips side by side, each exactly 52mm wide (the duct's true side length) by the duct's length, mark out this development as a strip of total width 4 x 52 = 208mm, with the seam S-S as one outer edge. At each of the 4 fold lines (every 52mm across the strip), transfer (by dividers, not calculation) the actual cut-height of that corner from the completed elevation's intersection curve, and join the 4 (plus any intermediate) transferred points on each face with straight or smoothly-curved lines matching the true cut profile on that face.

Answer: Answer: development is 4 equal flat strips each 52mm wide (confirmed from the separate square-duct detail, side=52mm) by the duct's length, total width 208mm, with heights at each fold line transferred by divider from the completed elevation's intersection curve, starting the layout from the seam S-S.

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