Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination, 2017

Design & Communication Graphics

Higher Level
Sections B and C (180 marks)

Wednesday, 21 June
Afternoon, 2:00 - 5:00

This examination is divided into three sections:	
SECTION A	(Core - Short Questions)
SECTION B	(Core - Long Questions)
SECTION C	(Applied Graphics - Long Questions)

SECTION A
- Four questions are presented.
- Answer **any three** on the accompanying A3 examination paper.
- All questions in Section A carry **20 marks** each.

SECTION B
- Three questions are presented.
- Answer **any two** on drawing paper.
- All questions in Section B carry **45 marks** each.

SECTION C
- Five questions are presented.
- Answer **any two** (i.e. the options you have studied) on drawing paper.
- All questions in Section C carry **45 marks** each.

General Instructions:
- *Construction lines must be shown on all solutions.*
- *Write the question number distinctly on the answer paper in Sections B and C.*
- *Work on one side of the drawing paper only.*
- *All dimensions are given in metres or millimetres.*
- *Write your Examination number in the box provided on section A and on all other sheets used.*

SECTION B - Core

Answer **any two** questions from this section on drawing paper.

B-1. The image shows *'Cloud Gate'*, an iconic sculpture located in Chicago's Millennium Park. The drawing below shows a similar piece of sculpture.

The main body of the sculpture is generated by revolving the semi-ellipse **ABC**, which is shown in elevation, about the axis **AC**, through an angle of 360°, as indicated by the arrow in the end view.

A parabolic ***'extruded cut'***, **DEF**, is then removed to complete the sculpture. The vertex of the parabola **DEF** is located at **E** in elevation. A 3D graphic of the completed sculpture is also given on the right below. For the purpose of clarity this 3D graphic is viewed from underneath.

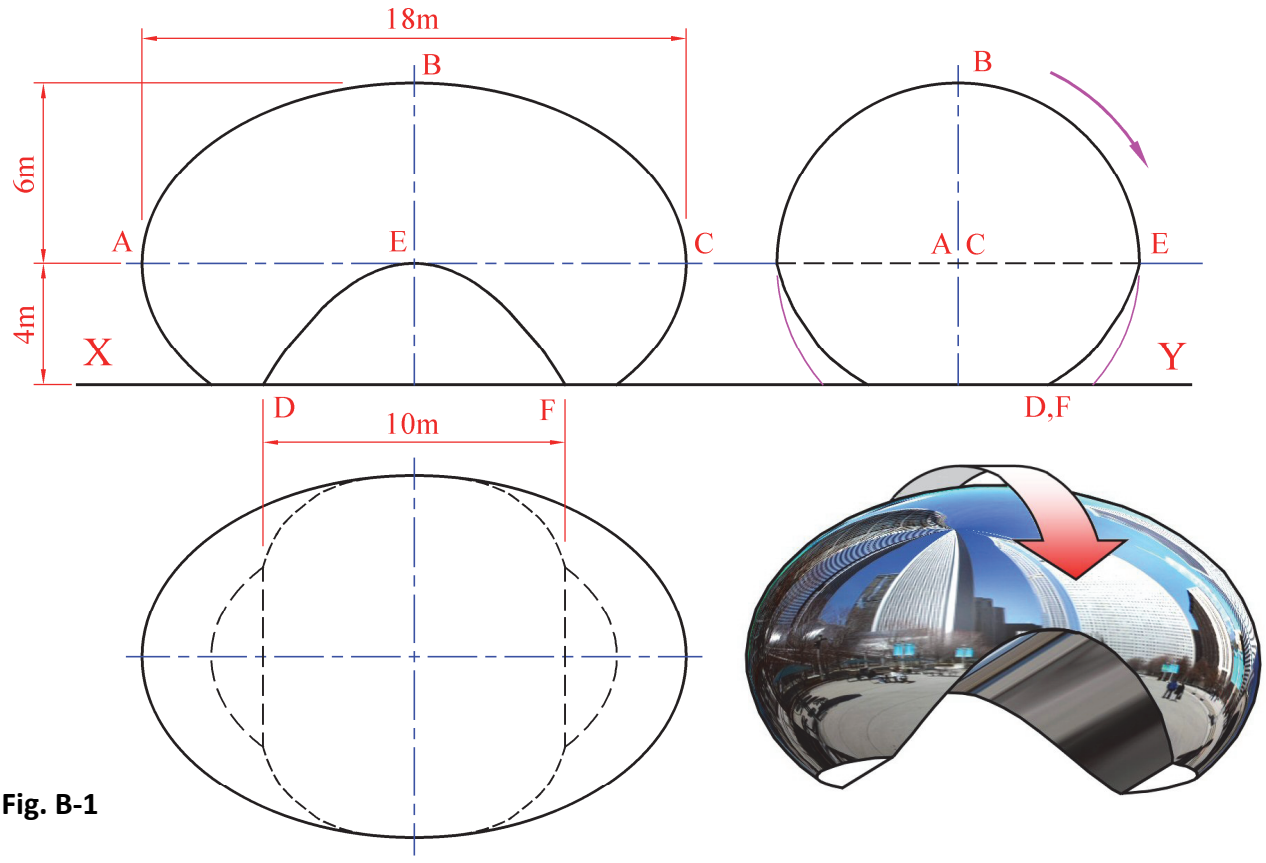


Fig. B-1

(a) Draw the given elevation, showing clearly the constructions for the ellipse and the parabola.

(b) Draw the elliptical outline of the sculpture in the plan as given.

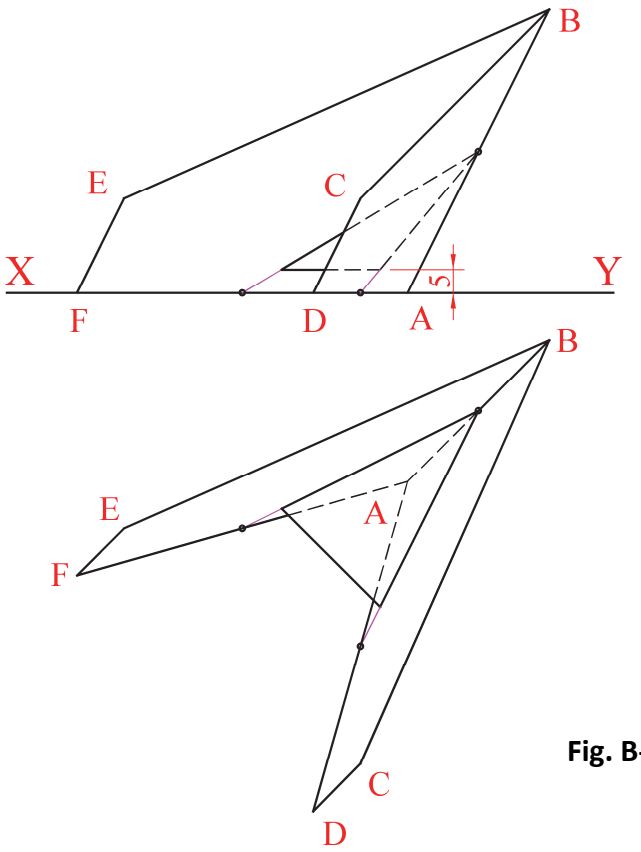
(c) Draw the outline end view.

(d) Use appropriately spaced vertical sections to complete the plan and end view as shown.

Scale 1:100

B-2. The image on the right shows a playground unit incorporating two planar surfaces which intersect as shown to represent the bow of a boat. The unit also includes a triangular seat and two circular portholes.

Fig. B-2 below shows the plan and elevation of a model of the unit. The horizontal and vertical coordinates of the two intersecting planes **ABCD** and **ABEF** are also given.



A: 205 --- 0 --- 40

B: 235 --- 60 --- 10

C: 195 --- 20 --- 100

D: 185 --- 0 --- 110

E: 145 --- 20 --- 50

F: 135 --- 0 --- 60

Fig. B-2

(a) Draw the plan and elevation of the two intersecting planes **ABCD** and **ABEF**.

(b) Determine the dihedral angle between the planes.

(c) Determine the true shape of the surface **ABCD**. On the true shape include a Ø20mm circle for the porthole, given that its centre is 30mm from the line **AB** and 50mm from point **D**.

(d) The midpoints of the lines **AB**, **AD** and **AF** define the oblique plane which contains the seat. Draw the elevation and plan of the seat.

Determine and indicate the horizontal and vertical traces of this oblique plane.

Scale 1:1

B-3 Fig. B-3 shows the plan and elevation of a display box, similar to the one shown in the image on the right.
The design is based on regular hexagonal prism which is truncated as shown.

A pictorial view of the box is also shown.

(a) Draw the given plan and make a perspective drawing of the box, given the following:

- The spectator point, **S**, is 1m from the surface **B** as shown
- The picture plane, **PP**, contains the vertical surface **B** as shown
- The horizon line is 1.2m above the ground line
- The sloping lines on the surfaces **B** and **C** are inclined at an angle of 15° to the horizontal plane.

*Use an auxiliary vanishing point to determine the sloping line on surface **C** in the perspective drawing.*

(b) On a separate diagram, draw a one-piece surface development of surfaces **A**, **B** and **C**. Include the lines on surfaces **A**, **B** and **C** on the development.

Scale 1:10

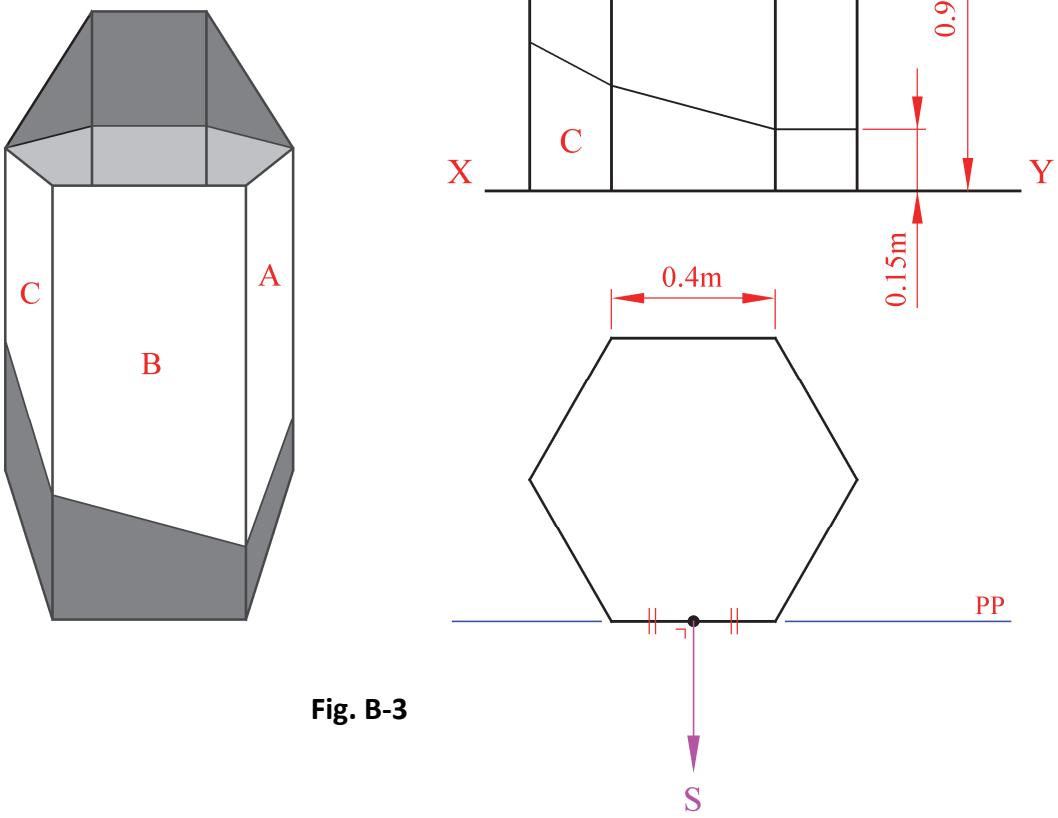


Fig. B-3

SECTION C - Applied Graphics

Answer **any two** questions (i.e. the options you have studied) from this section on drawing paper.

Geologic Geometry

C-1 **(a)** The accompanying map, located on the back page of Section A, shows ground contours at five metre vertical intervals on a proposed ski run.

On the map, **ABCD** is the centreline of the ski run. The ski run has the following specifications:

- the portion of the ski run between **A** and **B** is level at an altitude of 65m
- the portion of the ski run from **B** to **C** is falling uniformly to a level of 50m at **C**
- the portion of the ski run from **C** to **D** is level at an altitude of 50m and is widened on its northern side as shown.

Using side slopes of 1 in 1.5 for the cuttings and 1 in 2 for the embankments, complete the earthworks necessary for the ski run between **A** and **D** on the northern side.
(*You may ignore the southern side.*)

(b) In the space provided at the top of the map, draw the vertical section (profile) through the ski run on the line **EF**.

Vertical towers constructed at points **E** and **F** support a steel cable for a ski lift. The cable is 15m and 20m above the ground at points **E** and **F** respectively.

Determine the maximum vertical distance between the cable and the ground.
(*Assume that the cable is a straight line.*)

(c) On the map, **P** and **Q** are two points on the surface of the earth. Vertical boreholes at these points reveal the top surface of a stratum of ore at altitudes of 50m and 35m respectively.

A skew borehole at **Q** is drilled in an easterly direction and has an inclination of 55° to the horizontal plane. It reveals the top surface of the stratum at an altitude of 30m.

In the space provided at the top of the map, draw the elevation of this triangular portion of the top surface of the stratum. Draw the plan of the triangle and determine the strike and dip of the stratum.

Scale 1:1000

Structural Forms

C-2 The image on the right shows a sun canopy over an umpire's chair at a tennis tournament. The canopy is based on a hyperbolic paraboloid.

The projections of the canopy are shown in Fig. C-2 below. A pictorial view is also given. The surface of the hyperbolic paraboloid is generated by translating the parabola **ABC**, in a vertical position, along the parabola **DBE**.
B is the vertex of both parabolas.

(a) Draw the given plan of the canopy, showing all points of tangency.

(b) Draw the end view of the generating parabola **ABC** as shown.

(c) Project the front elevation of the canopy.

(d) It has been decided to extend the surface of the canopy to provide more shade for the umpire. This will be achieved by extending the generating parabola **ABC** upwards and outwards, as indicated by the arrows in the end view, to a width of 900mm.

On a separate diagram, draw a new end view of the extended parabola.

Scale 1:5

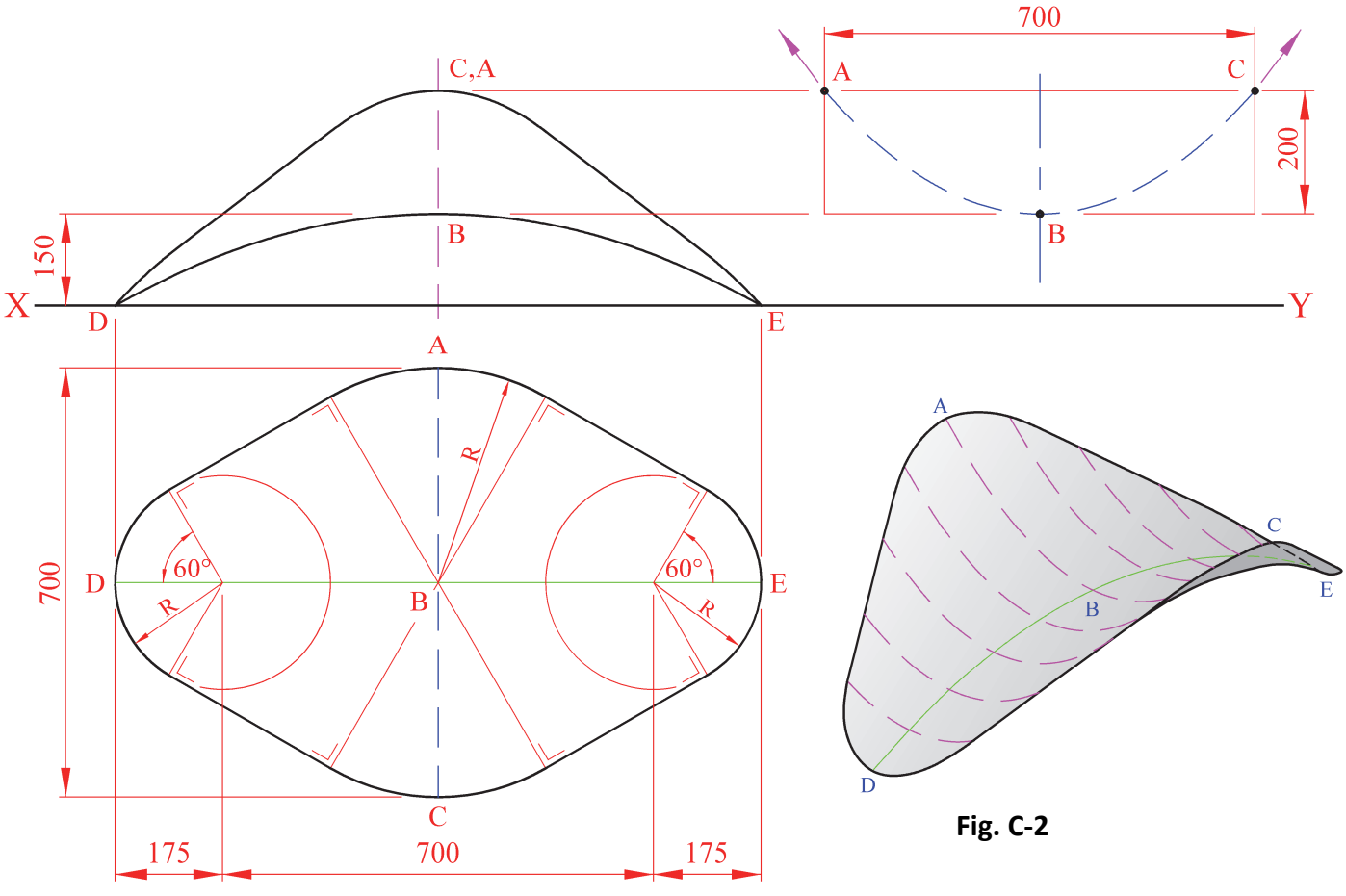


Fig. C-2

Surface Geometry

C-3 The image on the right shows a recycling bin in a shopping centre. The sloping top of the metal bin is a transition piece made up of two trapeziums and three rectangles as shown.

Fig. C-3(a) shows the plan and elevation of the transition piece. (*The two openings are not included.*) A one-piece surface development of the transition piece is also given in Fig. C-3(b).

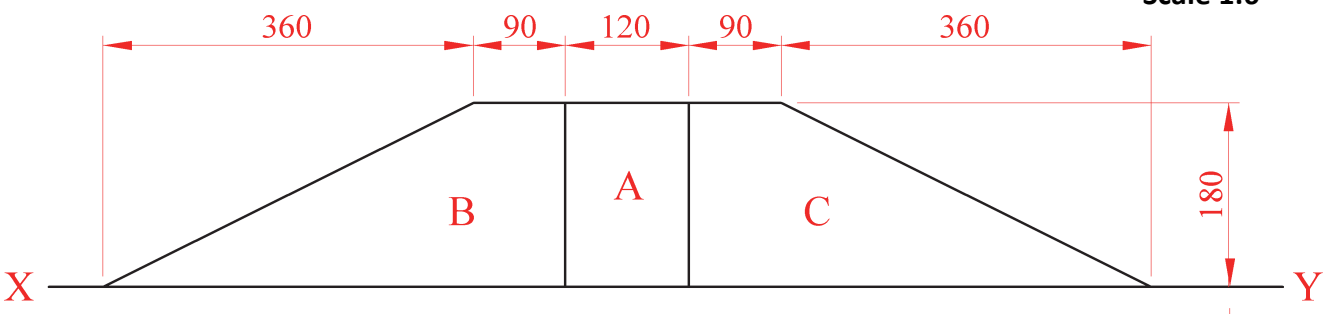
(a) Draw the given plan and elevation of the five surfaces of the transition piece.

(b) Determine the dihedral angle between surfaces **A** and **B**.

(c) Determine the true length of the shortest diagonal on surface **C**. Hence using triangulation, or otherwise, draw the given one-piece surface development of the transition piece as shown in Fig. C-3(b).

(d) The openings in surfaces **B** and **C** are offset 60mm from the outside edges of the surfaces. Draw both openings in the plan **and** in the elevation.

Scale 1:6



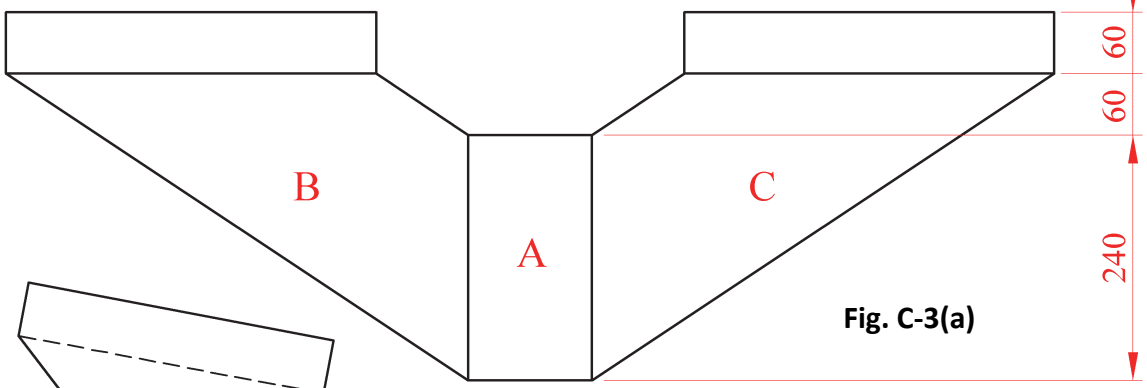


Fig. C-3(a)

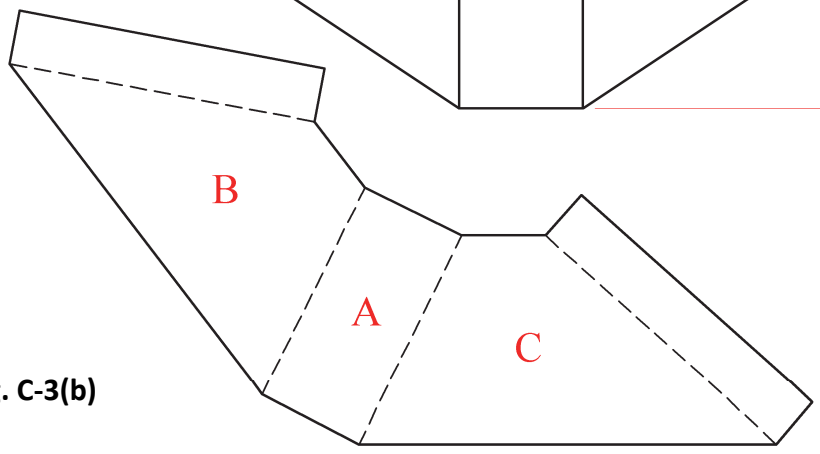
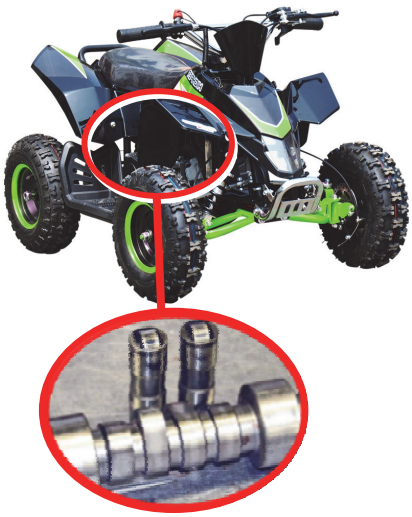


Fig. C-3(b)

Dynamic Mechanisms

C-4. **(a)** Cams are used in the engines of quad bikes.
Draw the displacement diagram and profile of a radial plate cam, which rotates in an anti-clockwise direction and imparts the following motion to an in-line **roller** follower of diameter 18mm:



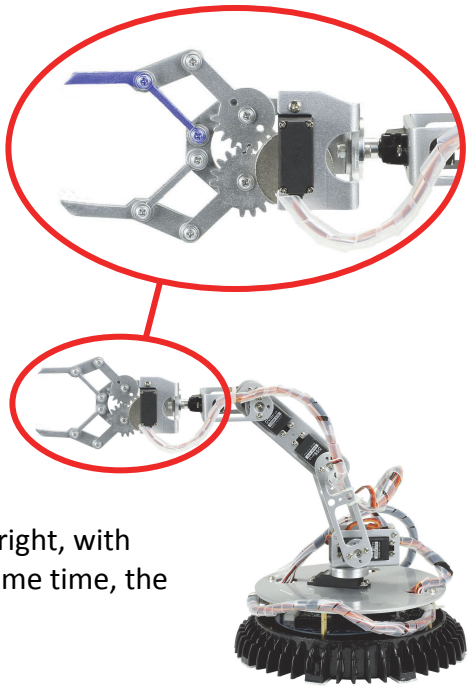
- 0° to 120° rise 36mm with uniform acceleration and retardation
- 120° to 180° rise 24mm with uniform velocity
- 180° to 360° fall 60mm with simple harmonic motion.

The nearest approach of the roller centre to the camshaft centre is 40mm. The camshaft diameter is 20mm.

Use a distance of 12mm for each 30° interval on your displacement diagram.

Scale 1:1

(b) The graphics on the right show an enlarged view of the *gripper mechanism* on a robotic arm.



The details of part of the upper jaw of a similar gripper are shown in line diagram format in Fig C-4(b) below.

Jaw **AB** is pin jointed at **B** to link **BC**. **AB** always remains **horizontal**.

(i) Draw the horizontal axis **C-C$_2$**, the link **BC** and the horizontal jaw **AB**, as shown.

(ii) The entire mechanism, **ABC**, moves to the right, as indicated by arrow **X**, until point **C** reaches point **C$_1$**. At the same time, the link **BC** rotates clockwise about point **C**, through 60° to a vertical position. Plot the locus of point **A** for the combined movement.

(iii) The entire mechanism, **ABC**, then moves further to the right, with point **C** now moving from point **C$_1$** to point **C$_2$**. At the same time, the link **BC** rotates 60° anti-clockwise, about point **C**. On the same drawing, plot the locus of point **A** for this second combined movement.

Scale 1:1

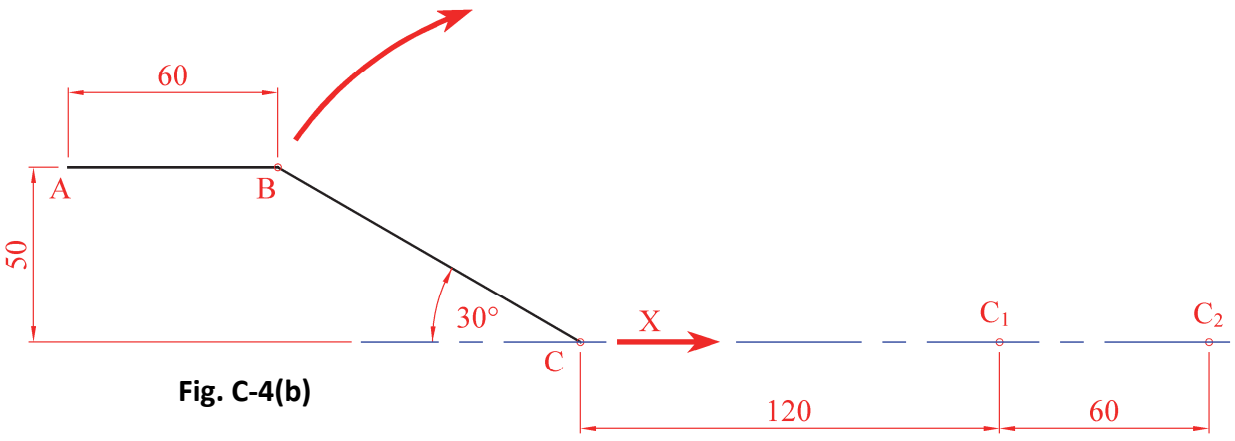


Fig. C-4(b)

Assemblies

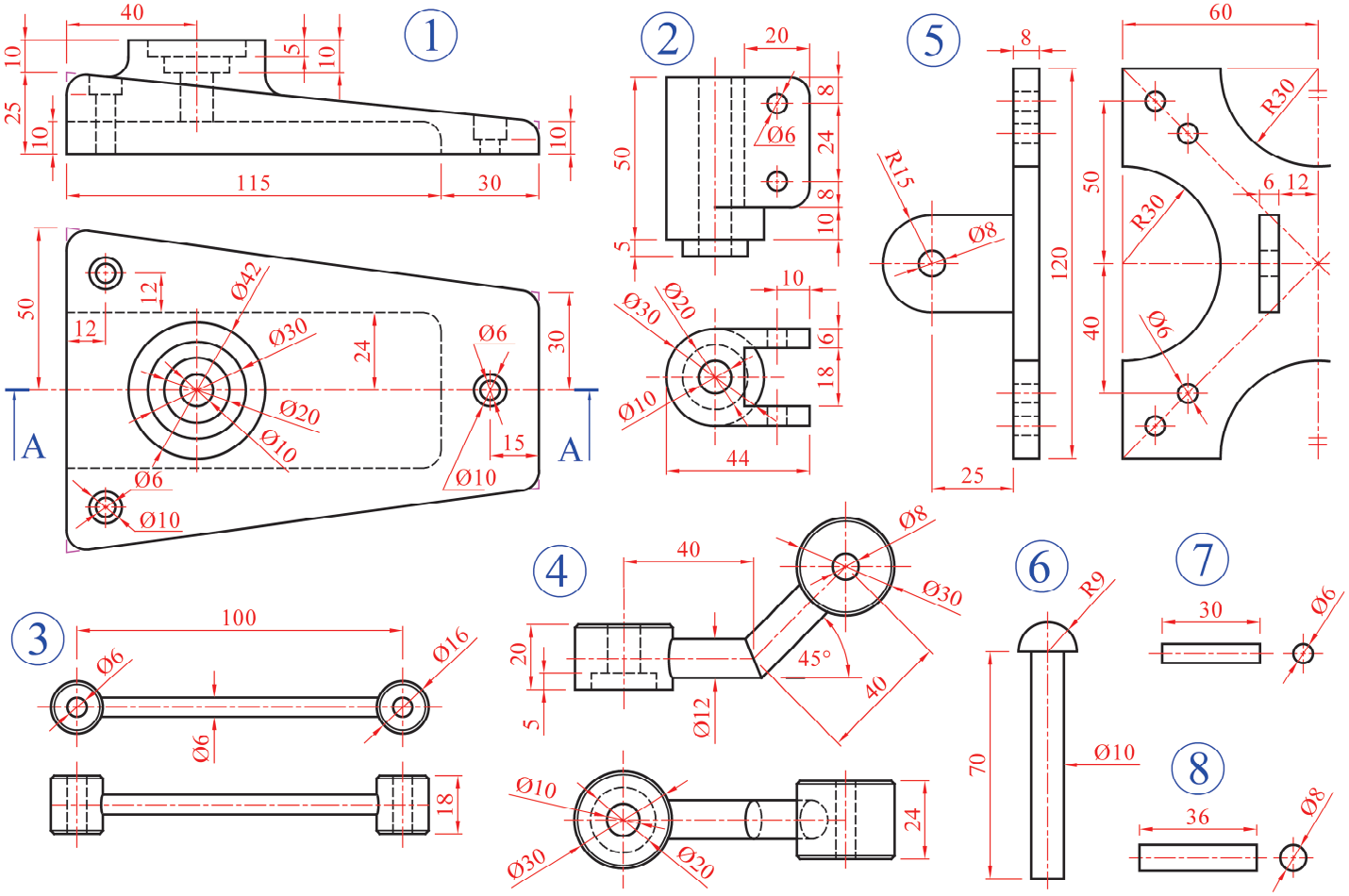
C-5. Details of a ***Desk Monitor Stand*** are shown in Fig. C-5. The parts list is given below together with a partially exploded 3D graphic of the stand and its constituent parts.

(a) Draw a full-size sectional elevation on **A-A**, showing the parts fully assembled, with the *Parallel Arms* horizontal and the *LCD Mount Bracket* vertical.

(*Unless otherwise stated, fillets are 6mm and chamfers 1×1mm. Some dimensions have been removed for clarity and any omitted dimensions may be estimated.*)

Note: *All assembly fits are loose, push or friction fit as required. Springs, which are required for the device to operate, have been omitted for clarity.*

(b) On your drawing determine the maximum rotation angle of the *Parallel Arms* as they rotate upwards about the left hand *Parallel Arm Pins.*
Assuming that the monitor remains vertical, indicate also the **horizontal** distance through which the *LCD Mount Bracket* moves during this rotation.



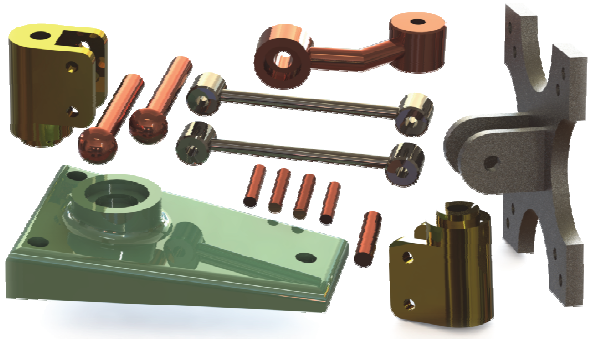


Fig. C-5

Part	Name	Qty.
1	Base	1
2	Vertical Hinge Post	2
3	Parallel Arms	2
4	Top Cranked Arm	1
5	LCD Mount Bracket	1
6	Vertical Hinge Pin	2
7	Parallel Arm Pin	4
8	LCD Mount Pin	1

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