# G12 ECZ DESIGN & TECH P1 2020 SPECIMEN

**Grade 12 ECZ Design & Technology Paper 1 (6045/1), 2020 Specimen**

Section A theory + Section B design/construction (Part I compulsory, Parts II-III: both options solved)

Candidate Name _____

| Centre Number | Candidate Number |
|---|---|
| | |

# EXAMINATIONS COUNCIL OF ZAMBIA

**Examination for School Certificate Ordinary Level**

# Design and Technology 6045/1

**Paper 1 (Theory & Design)**

## Specimen

**Additional Materials**
A3 Drawing Paper
Drawing instruments

**Time: 2 hours 30 minutes** **Marks: 110**

**Instructions to Candidates**

Write your **name**, **centre number** and **candidate number** in the spaces at the top of this page and on the separate **Answer Booklet provided**.
If working is needed for any question, it must be shown in the space provided in the question paper and answer Booklet.
There are **two** sections in this paper.

**Section A**
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

**Section B**
**Part I** is compulsory
**Part II** has **three** questions, answer **one** question.
**Part III:** has two questions, answer **one** question.
Write your answers in the Answer Booklet provided.
Where a freehand sketch is required, it must be drawn to half full size with good linework.
At the end of the examination:
1 fasten the Answer Booklet used securely to the question paper,
2 enter the numbers of the Section B questions you have answered in the grid under column, "For **candidate use**".

| For Candidate use | For Examiner's use |
|---|---|
| Section A | |
| Section B | |
| Part I | |
| Part II | |
| Part III | |
| | |
| Total | |

**Information for candidates**
The number of marks is given in brackets [ ] at the end of each question or part of question.
Use of colour is allowed.
All dimensions are in millimetres.
**Cell phones and calculators are not allowed in the examination room.**

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**Section A [30 marks]**

**Answer all the question in the spaces provided on the question paper.**
**If working is needed for any question, it must be shown in the space below tha question.**

**1** **(a)** **Figure 1** shows one of the driving tools used in the Design and Technology workshop.

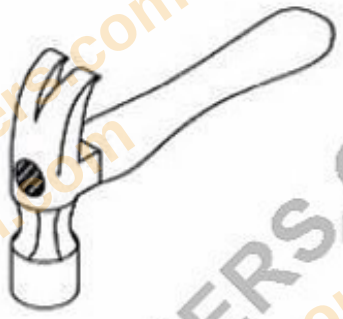

**Figure 1**

**(i)** Give the name of the tool in figure 1.

..... [1]

**(ii)** State **two** safety rules to be observed when using the tool in figure 1.

1 .....

.....

2 .....

..... [2]

**(iii)** Give **two** uses of the tool in figure 1 above.

1 .....

2 ..... [2]

**(b)** State **one** property of ash which makes it suitable for the mallet handle. [1]

**[Total: 6 marks]**

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2 **Figure 2** shows some components used in Design and Technology.

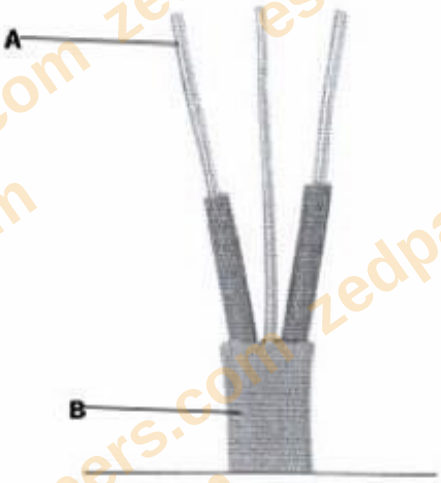


**Figure 2**

**(a)** **(i)** Identify the components for the parts labelled **A** and **B**.

**A** .....

**B** ..... [2]

**(b)** Pulleys and gears are both used in the transmission of motion.

**(i)** Give **one** advantage of gears over pulleys

.....

..... [2]

**(ii)** Mention **one** example where gears are used.

.....

..... [2]

**[Total: 6 marks]**

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**3** **Figure 3** shows a cabinet to be used in the workshop for storing tools.

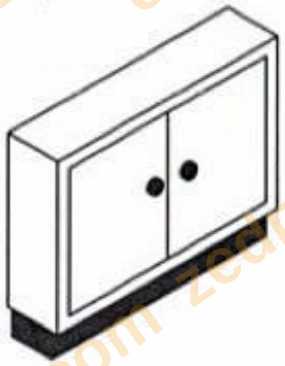

**Figure 3**

**(a)** Briefly describe the type of finish you would use for the cabinet.

.....

..... [1]

**(b)** Explain why safety rules should be observed when carrying out the following processes.

**(i)** Using a circular saw

..... [1]

**(ii)** Melting plastics

..... [1]

**(c)** **(i)** Define an entrepreneur

.....

..... [2]

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**(ii)** What does the abbreviation SWOT stand for in marketing?

..... [1]

**[Total: 6 marks]**



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4 **Figure 4** shows a simple electric circuit. Study the drawing and answer the questions that follow.


**Figure 4**

**(a)** How are the bulbs arranged in the diagram?

..... [1]

**(b)** When bulb **X** blows out, what happens to bulb **Y**?

..... [1]

**(c)** Using electronic symbols, redraw the circuit diagram in **figure 4.**

[4]

**[Total: 6 marks]**

5 **(a)** Explain the term static force.

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.....

..... [2]

**(b)** Give **two** examples of forces.

1 .....

2 ..... [2]



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**(c)** State any **two** reasons that lead to structural failure

1 .....

..... [1]

2 .....

..... [1]

**[Total: 6 marks]**

**Section B [80 marks]**

**There are three parts in this section. Part I, is compulsory. Part II and III, answer one question from each part.**

**Part I Compulsory**

**6** Study **Figure 5** and refer to it as you answer the questions that follow.

**Figure 5**

**(a)** **(i)** Write down the situation. [2]

**(ii)** Identify the problem from the situation in **figure 5**. [2]

**(b)** **(i)** Derive a design brief from the problem in **(a) (ii)** above. [2]

**(ii)** Using annotations, sketch one possible solution in pictorial view for the situation above. [12]

**(c)** List **three** specifications which could be considered when coming up with your design solution. [3]

**(d)** You are also expected to do research in order to gather information that will guide you in making decisions. Mention **four** possible areas of research. [4]

**[Total 25 marks]**



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**Part II Answer one question**

**7** **(a)** Jane specified the following materials for her Grade 12 artefact: aluminium, mukwa, acrylic

For each type of material;

**(i)** State **two** properties [6]

**(ii)** Give an example where each material can be used [3]

**(iii)** Identify the tools that can be used when cutting the materials stated [3]

**(iv)** The finish that can be applied to each of the materials [3]

**(b)** Most products we use have been fabricated (joining materials together) With the aid of annotated sketches, illustrate the stages of how to come up with any joint of your choice. [10]

**[Total: 25 marks]**

**8** **(a)** **Figure 6** shows some fittings and fixings that are used in artefact making.

**1** **2** **3** **4**

**Figure 6**

**(i)** Name the fittings [4]

**(ii)** Give an example where each of them can be used. [4]

**(iii)** Mention a tool that can be used when preparing to fix or fit each of them. [4]

**(b)** The drawing in **figure 7** shows a wooden box made by a Grade 7 learner which he wants to use for keeping coins.

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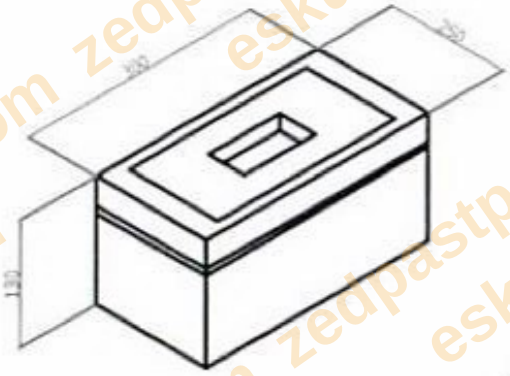

**Figure 7**

**(i)** Which of the four fixings in **(a)** above would the learner use on the artefact? [2]

**(ii)** With the help of sketches, suggest where the fixings you have mentioned in **(b)(i)** will be applied. [8]

**(iii)** Explain how the child will be removing the money. [3]

**[Total: 25 marks]**

**9** **Figure 8** shows a work piece being drilled. The part marked **'X'** is slot for a key hole.

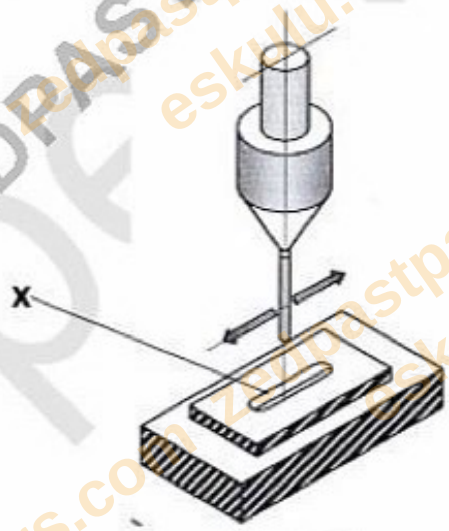


**Figure 8**

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**(a)** List **two** reasons why it is necessary to place scrap wood underneath the work piece when drilling. [2]

**(b)** **(i)** Illustrate, with the aid of sketches, how you would obtain the slot **'X'**.[12]

**(ii)** Give examples of **two** materials you can make a slot in. [2]

**(c)** **(i)** Classify **three** sources of energy. [3]



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**(ii)** Using sketches demonstrate the following motions:

1 Reciprocating [2]

2 Oscillating [2]

3 Rotary [2]

**[Total: 25 marks]**

**Part III Answer one question.**

**10** The roof truss of a small guard house is triangular in section as shown in **figure 9.** Within the triangle are two supports which form part of the irregular polygon ABCDE. The sides of this polygon are in the ratio AB:BC:CD:DE:EA as 2:3:3:3:3, and the perimeter of the polygon is 12m.

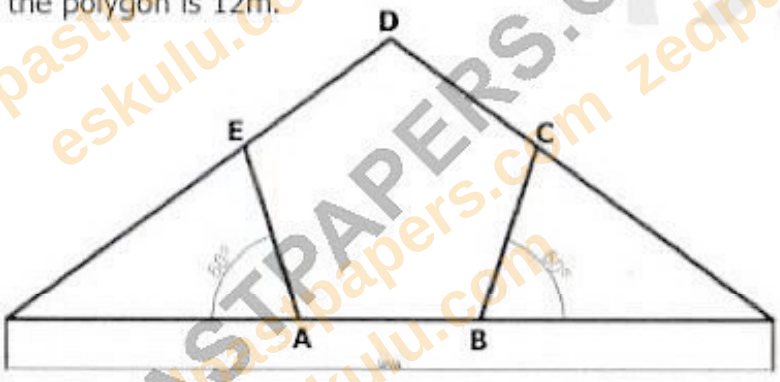


**Figure 9**

Find the actual span of the roof using the scale of 1:50.

**[Total: 30 marks]**

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**11** In order to help solve the litter problem at Tinenenji Technical Secondary School Tuckshop, learners have decided to design and make litter bins. The litter bins will be attached to the walls of the tuckshop. The chosen solution of the design of the bins is in the shape of a truncated cone as shown in **figure 10.**

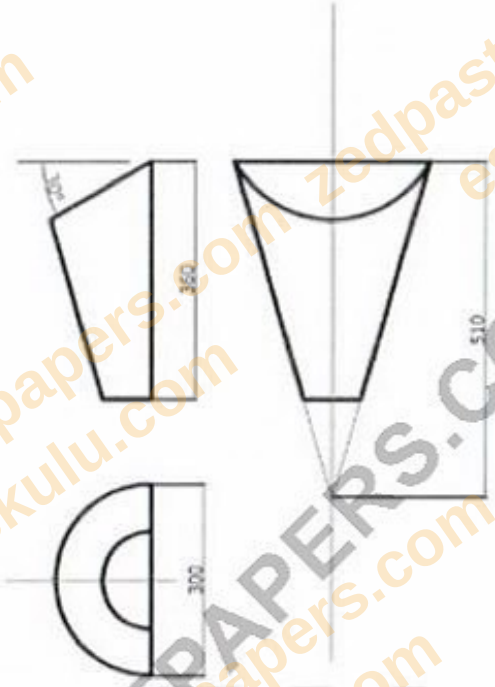


**Figure 10**

Draw the surface development of the design using a scale of 1:5.

**[Total: 30 marks]**

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## Question 1. SECTION A, Q1 [6 marks]: the claw hammer (Figure 1).

**Answer: (a)(i) The tool is a CLAW HAMMER.**

**Answer: (a)(ii) Two safety rules: (1) ENSURE THE HEAD IS SECURELY FITTED to the handle before use, so it cannot fly off; (2) KEEP FINGERS CLEAR of the striking area and do not use it near other people.**

**Answer: (a)(iii) Two uses: (1) DRIVING NAILS into wood; (2) using the claw end to WITHDRAW (PULL OUT) NAILS.**

**Answer: (b) Ash is suitable for the mallet/hammer handle because it is TOUGH AND SHOCK-ABSORBENT (resilient) -- it can withstand repeated striking without splitting or transmitting excessive vibration to the hand.**

## Question 2. SECTION A, Q2 [6 marks]: components and motion transmission (Figure 2).

**Answer: (a)(i) Component A is the (stranded) WIRE / CONDUCTOR bundle; component B is the FERRULE (the crimped metal sleeve/terminal that binds and terminates the wire strands). If your own Figure 2 shows a different fitting, name the parts as drawn -- this is the standard reading of a crimped wire-and-ferrule assembly.**

**Answer: (b)(i) One advantage of gears over pulleys: gears give a POSITIVE (NON-SLIP) DRIVE -- because the teeth interlock, gears cannot slip the way a belt can on a pulley, so they transmit motion more precisely and can carry heavier loads.**

**Answer: (b)(ii) Example where gears are used: the GEARBOX OF A BICYCLE or car (or a hand drill / clock mechanism), where precise, non-slip transmission of motion between shafts is required.**

## Question 3. SECTION A, Q3 [6 marks]: the tool cabinet (Figure 3).

**Answer: (a) A suitable finish for the cabinet is VARNISH (a clear polyurethane varnish) or PAINT -- either protects the wood from moisture and wear while giving an attractive appearance.**

**Answer: (b)(i) Safety rules must be observed when using a circular saw because THE FAST-SPINNING BLADE CAN CAUSE SEVERE CUTS OR AMPUTATION if fingers or clothing come into contact with it, and thrown-back material (kickback) can injure the user.**

**Answer: (b)(ii) Safety rules must be observed when melting plastics because THE HOT, MOLTEN PLASTIC AND ITS FUMES CAN CAUSE BURNS AND ARE TOXIC IF INHALED, so the process must be done with protection and ventilation.**

**Answer: (c)(i) An entrepreneur is A PERSON WHO IDENTIFIES A BUSINESS OPPORTUNITY, ORGANISES RESOURCES (capital, labour, materials) AND TAKES ON THE RISK of starting and running a business in order to make a profit.**

**Answer: (c)(ii) SWOT stands for STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS -- a framework used to analyse a business or product idea before marketing it.**

## Question 4. SECTION A, Q4 [6 marks]: the electric circuit (Figure 4).

**Answer: (a) The bulbs are arranged IN PARALLEL (each bulb is on its own loop between the same two points of the circuit).**

**Answer: (b) When bulb X blows out, bulb Y CONTINUES TO LIGHT (stays on) normally, because in a parallel circuit each branch has its own independent path for current, so a break in one branch does not affect the other.**

**Answer: (c) Redrawing with electronic symbols: draw the battery using the standard symbol (a long and a short parallel line, long = positive), the switch as a break in the line with a diagonal contact arm, and each bulb as a circle with a cross inside (X). Draw the battery and switch in the main loop, then two parallel branches leading off it, each containing one bulb-in-a-circle symbol, joined back to the main loop -- exactly reproducing the parallel arrangement of Figure 4 in standard symbols.**

## Question 5. SECTION A, Q5 [6 marks]: forces and structures.

**Answer: (a) A static force is A FORCE THAT ACTS ON AN OBJECT WITHOUT CAUSING MOVEMENT -- it holds the object in a fixed position by being balanced by an equal and opposite force (e.g. the weight of a stationary structure balanced by the ground's reaction force).**

**Answer: (b) Two examples of forces: (1) TENSION (a pulling/stretching force, e.g. in a rope); (2) COMPRESSION (a pushing/squeezing force, e.g. in a column) -- gravity and friction are also accepted.**

**Answer: (c) Two reasons for structural failure: (1) OVERLOADING -- the structure is subjected to a load greater than it was designed to carry; (2) USE OF POOR-QUALITY OR UNSUITABLE MATERIALS (or faulty joints/poor workmanship), which cannot withstand the forces acting on the structure.**

## Question 6. SECTION B, PART I (compulsory) -- Q6 [25 marks]: design brief from a situation (Figure 5).

**(a)(i) The situation**

Figure 5 shows a person walking while carrying several separate items -- tools/a bag in one hand and further items balanced under an arm -- awkwardly, with no single, purpose-made way of carrying them all together and safely.

**(a)(ii) The problem**

THE PERSON HAS NO CONVENIENT, SAFE MEANS OF CARRYING SEVERAL TOOLS/ITEMS AT ONCE -- carrying them loose in the hands and under the arm is tiring, risks dropping items, and leaves the hands not fully free.

**(b)(i) Design brief**

'To design and make a portable carrier (a tool bag/box or carrying case) that allows the user to carry several small tools and items together, safely, comfortably and with hands as free as possible.'

**(b)(ii) Sketch (SKETCH REQUIRED, not reproduced here) [12]**

On your answer booklet, freehand-sketch ONE possible solution in pictorial (3D) view, fully annotated. A strong answer for this brief is a hand-held TOOL CARRIER/CADDY: a rectangular open box or bag

with a central carrying handle, an internal compartment or two divided by a partition, and possibly an outer pocket. Annotate the sketch with labels such as: 'carrying handle', 'compartment for tools', 'pocket for small items', and the intended material (e.g. plywood or canvas).

**(c) Three specifications**

**Answer: 1. The carrier MUST BE LIGHT ENOUGH to carry comfortably when loaded with the intended items.**

**Answer: 2. It MUST BE STRONG/DURABLE ENOUGH to hold the weight of the tools/items without breaking.**

**Answer: 3. It MUST HAVE A COMFORTABLE HANDLE/GRIP for carrying over a reasonable distance without hurting the hand.**

**Answer: (A fourth acceptable specification: it should be a size that fits the items to be carried and be low-cost to produce.)**

**(d) Four areas of research**

**Answer: 1. EXISTING SIMILAR PRODUCTS on the market (tool bags, tool boxes, caddies) and how they are constructed.**

**Answer: 2. SUITABLE MATERIALS available (their strength, weight and cost).**

**Answer: 3. THE SIZE AND WEIGHT OF THE ITEMS to be carried, so the carrier is made to the right dimensions.**

**Answer: 4. USER NEEDS/PREFERENCES -- asking intended users what features (handle type, compartments, size) they would want.**

## Question 7. SECTION B, PART II, Q7 [25 marks, if chosen]: materials, tools and joints.

**(a) Materials: aluminium, mukwa, acrylic**

ALUMINIUM -- (i) properties: LIGHTWEIGHT and RESISTANT TO CORROSION (does not rust); (ii) example use: making COOKING POTS/window frames; (iii) cutting tools: HACKSAW or TIN SNIPS; (iv) finish: POLISHING or PAINTING.

MUKWA (a hardwood) -- (i) properties: STRONG/DURABLE and has an ATTRACTIVE GRAIN; (ii) example use: making FURNITURE; (iii) cutting tools: TENON SAW or CROSS-CUT SAW; (iv) finish: VARNISHING or FRENCH POLISHING.

ACRYLIC (a thermoplastic) -- (i) properties: TRANSPARENT (can be clear or coloured) and LIGHTWEIGHT; (ii) example use: making SIGNS/DISPLAY CASES/light fittings; (iii) cutting tools: a FRETSAW or a HOT-WIRE (STRIP) CUTTER; (iv) finish: BUFFING/POLISHING (it is not painted, since its finish comes from the material itself).

**(b) Stages of forming a joint, with annotated sketches (SKETCH REQUIRED) [10]**

Choosing the HOUSING (DADO) JOINT as an example, sketch and annotate these stages: (1) MARK OUT the width and depth of the housing on the receiving piece using a marking gauge and try square; (2) SAW down the two sides of the housing to the marked depth with a tenon saw; (3) CHISEL OUT the waste wood between the saw cuts, working from both edges to the middle, to leave a flat-bottomed housing; (4) TEST-FIT the second piece into the housing, checking it sits square and snug; (5) GLUE AND CRAMP the joint, wiping off excess glue, and leave to set. Label each sketch with the tool used

at that stage.

## Question 8. SECTION B, PART II, Q8 [25 marks, if chosen]: fittings and fixings (Figures 6-7).

**(a)(i) Naming the fittings in Figure 6 [4]**

**Answer: 1. A COACH BOLT (carriage bolt) with a domed head.**

**Answer: 2. A COACH SCREW (or self-tapping/wood screw with hex head).**

**Answer: 3. A HINGE.**

**Answer: 4. A MORTISE LOCK (box lock).**

**(a)(ii) Example use of each [4]**

**Answer: 1. Coach bolt: JOINING TWO THICK PIECES OF WOOD/a wooden frame together, where the bolt passes through both and is secured with a nut.**

**Answer: 2. Coach screw: FIXING A WOODEN SHELF BRACKET or heavy timber joint securely.**

**Answer: 3. Hinge: FITTING A DOOR OR LID so it can open and close (e.g. the tool cabinet door in Figure 3).**

**Answer: 4. Mortise lock: LOCKING A DOOR to secure it (e.g. the tool cabinet).**

**(a)(iii) A tool used to prepare/fix each [4]**

**Answer: 1. Coach bolt: a SPANNER (with a drill for the pilot hole).**

**Answer: 2. Coach screw: a SPANNER or SCREWDRIVER (with a drill/bradawl for the pilot hole).**

**Answer: 3. Hinge: a SCREWDRIVER (with a chisel to cut the hinge recess).**

**Answer: 4. Mortise lock: a CHISEL AND MORTISE GAUGE (to cut the lock housing) and a SCREWDRIVER (to fit the lock plate).**

**(b)(i) Which fixing the Grade 7 learner would use on the coin box (Figure 7) [2]**

The HINGE (item 3) -- to fit a lid to the box so it can be opened to remove the coins.

**(b)(ii) Sketches suggesting where the fixings would be applied (SKETCH REQUIRED) [8]**

Sketch the box with a hinge fitted along the back edge of the lid, joining the lid to the box body so it swings open on that edge. If a lock or catch is also used, show it on the front edge opposite the hinge, so the lid can be secured shut.

**(b)(iii) How the child will remove the money [3]**

THE CHILD LIFTS/OPENS THE HINGED LID (swinging it up and back on the hinge) TO ACCESS THE INSIDE OF THE BOX AND TAKE OUT THE COINS, then closes the lid again afterwards.

## Question 9. SECTION B, PART III, Q10 [30 marks, if chosen]: roof-truss span (Figure 9).

**Step 1: find AB from the given ratio and perimeter**

**Answer: The polygon ABCDE has AB:BC:CD:DE:EA = 2:3:3:3:3, so the ratio parts total 2+3+3+3+3 = 14 parts.**

**Answer: Perimeter = 12 m, so 1 part = 12 m / 14 = 6/7 m = 0.857 m (to 3 d.p.).**

**Answer: AB (2 parts) = 2 x 6/7 = 12/7 m = 1.71 m (to 2 d.p.) -- this is the actual distance between the feet of the two internal support struts (A and B).**

**Answer: (Each of BC, CD, DE and EA, being 3 parts, is 3 x 6/7 = 18/7 m = 2.57 m, to 2 d.p.)**

### Step 2: find the actual span from the scale drawing

The overall SPAN of the roof is the full width of the base of the truss (from the left eave to the right eave), which is wider than AB alone since A and B are only the two inner strut feet, not the ends of the base. Figure 9 is drawn to a stated scale of 1:50, meaning every 1 mm measured on the printed drawing represents 50 mm (0.05 m) of actual size.

**Answer: METHOD: (1) using a ruler, measure the full base line of the triangle in Figure 9 on YOUR OWN printed copy, in millimetres; (2) multiply that measured length by 50 to get the actual length in millimetres; (3) divide by 1000 to convert to metres. For example, if your measured base line is 100 mm on the page, the actual span = 100 x 50 = 5000 mm = 5 m.**

The exact printed base-line dimension is not reliably legible on this scanned copy, so the numeric example above illustrates the method -- substitute the measurement from your own paper into the same working (measured mm x 50, then divide by 1000 for metres) to reach the final actual span in metres.

## Question 10. SECTION B, PART III, Q11 [30 marks, if chosen]: surface development of a truncated cone litter bin (Figure 10).

### Readings from Figure 10

Front elevation: overall height to the (extended, imaginary) apex O = 510 mm; height of the visible frustum (bin) itself = 360 mm. Plan view: diameter shown = 300 mm (this is one of the two rim diameters -- confirm from your own copy whether it labels the TOP or BOTTOM rim; the smaller, narrower rim of a truncated cone is typically the base). All dimensions are drawn at a scale of 1:5, so 1 mm on the drawing = 5 mm actual size.

### Method: radial-line development of a cone frustum

**Answer: 1. DRAW THE FRONT ELEVATION of the truncated cone to scale 1:5, using the given heights and diameters (half the diameter each side of the centre line).**

**Answer: 2. EXTEND THE TWO SLOPING SIDES of the frustum UPWARDS/OUTWARDS until they meet at a single point -- this is the APEX (O) of the complete (imaginary) cone that the frustum was cut from.**

**Answer: 3. MEASURE (or calculate by similar triangles) the TRUE SLANT LENGTHS from the apex O to the top rim (call this R1, the longer radius) and from O to the bottom rim (R2, the shorter radius).**

**Answer: 4. WITH CENTRE O, draw an ARC OF RADIUS R1 (for the top/larger rim) and, with the same centre O, a CONCENTRIC ARC OF RADIUS R2 (for the bottom/smaller rim).**

**Answer: 5. CALCULATE THE SECTOR (DEVELOPMENT) ANGLE using: angle = (circumference of the larger rim / R1) x 360 degrees, i.e. angle = (2 x pi x r-large / R1) x 360, where r-large is the larger rim's radius.**

**Answer: 6. MARK THIS ANGLE OFF at O between the two arcs, using a protractor (or by stepping off the rim's actual circumference with dividers along the R1 arc), to give the true, flat (developed) shape of the cone's curved surface -- a portion of an annulus (ring) bounded by the two arcs and the two straight radial lines.**

**Answer: 7. ADD JOINT ALLOWANCE (a small extra tab along one straight edge) if the bin will be made from sheet material and folded/riveted into shape, and add the TOP AND BOTTOM RIM DETAILS (e.g. a rolled edge) as required by the design.**

This gives the complete, correctly-proportioned surface development (net) of the truncated-cone litter bin, ready to be cut out flat and rolled up into the 3-D shape shown in Figure 10.

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