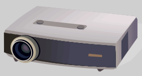
Module 4

Space, shape and orientation

read, interpret, make and use representations of the physical world appropriate to the workplace



Lecture slide
#1-3

After completing this module, students will be able to:

- Use and apply vocabulary of space, shape and orientation appropriately
- Perform space, shape and orientation calculations to solve problems in the workplace
- Read, interpret and use representations to solve problems in the workplace
- Make physical and diagrammatical representation to investigate and illustrate solutions in the workplace

1. Vocabulary of space, shape and orientation

Lecture slide #4

At the end of this outcome, students will know vocabulary regarding:

- **Space**: blocks, rectangular prism, pyramid, cone, cylinder, sphere, cube, base.
- **Shape**: rectangle, square, triangle, circle.
- **Attributes of shapes**: length, breadth, height, side, perimeter, diagonal, area, angle, centre, radius, diameter, circumference, volume, perpendicular, parallel, scale, column, row, co-ordinates/grid reference, weight (mass).
- **Time:** 24hour/12hour clocks and conventions – *refer to module 1 for this section.*

Introduction

- Revise the various geometric shaps including:
  - Triangle
  - Square
  - Parallelogram
  - Trapezium
  - Pentagon
  - Hexagon
  - Octagon
  - Rectangular Prism
  - Cylinder

Lecture slide #5

Assignment 1

Students should complete this assignment for homework.

2-D shapes. Look carefully at the road signs when you walk in town or drive on the road again.

Sketch six different road signs that display geometrical shapes. These signs are either placed next to the road or painted on the road. Identify the shapes.

3-D shapes. Sketch any two geometric objects that have volume/capacity, from your familiar living or working environment.

Lecture slide #6-9

Activity 1

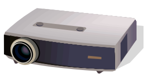
Students should be able to complete this activity in class relatively quickly since most of it constitutes revision of previous years' work.

1. Complete the following table with the knowledge that you already have, the vocabulary of space and shape was also explained in detail in level 2. If you do not know the answers, discuss it with your fellow students or do some research.

Shape or attribute	Explanation	Sketch
Rectangle		
Square		
Triangle		
Circle		
Rectangular prism, with its height and sides explained and indicated		
Cube and base of cube indicated		
Cylinder, and show its base		
Length, breadth and diagonal of a rectangle		
Perimeter of a shape		
Centre, radius, diameter and circumference of a circle		

2. Explain the meaning of the words, all of which you should already have encountered. Work in groups.

Word	Define or sketch to explain the word
Angle	
Volume	
Perpendicular line	
Parallel lines	
Scale	
Columns and rows	
Grid co-ordinate references	
Weight (mass)	



Lecture slide #10-20

2. Perform space, shape and orientation calculations

At the end of this outcome, students will be able to calculate:

- Area.
- Volume.
- Distance.

2.1 Dimensions

- *Describe the difference between two-dimensional and three dimensional shapes.*
- *Describe the common labels used for different dimensions e.g. lenth, breadth.*
- *Describe that two-dimensions are used to measure area and three-dimensions are used to measure volume.*

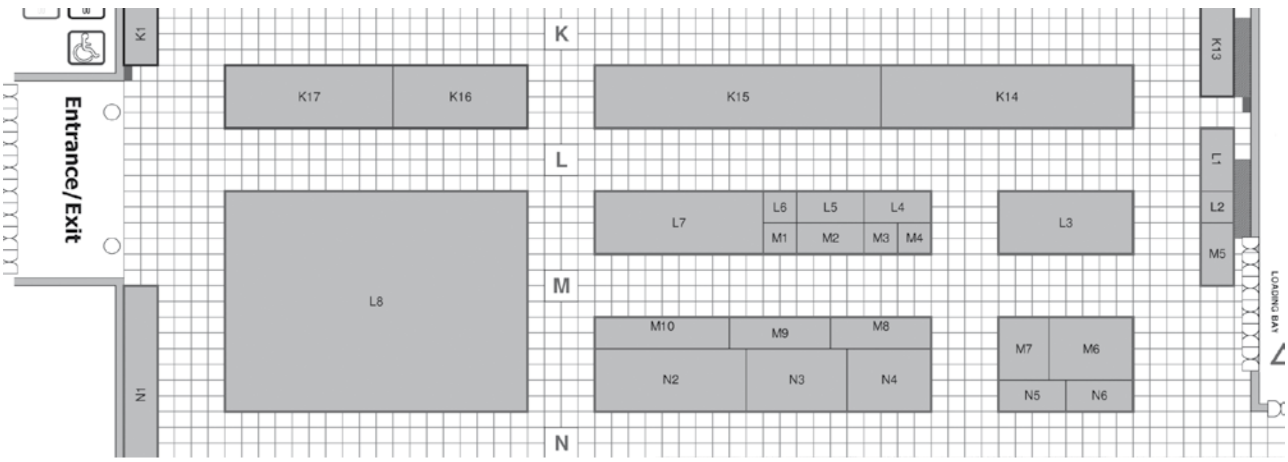
2.2 Perimeter calculations (i.e. distance/length)

- *Describe how to calculate perimeter.*
- *Give some examples where the perimeter would be a useful measurement e.g. packaging or construction.*

Cape Town Book Fair

The Cape Town Book fair is an annual event and a showcase for publishers from all over South Africa and abroad. Over 30 countries participated in the 2008 book fair and it was visited by over 50 000 people. Its popularity means that many publishers, bookshops, printers etc. want to exhibit at the book fair. These businesses have a choice of stand size and position. The cost of renting a stand is expensive and based on the size of the stand. A premium is paid for a corner stand, a stand close to the entrance and an island stand (open on both sides). Stands are classified in term of their width and depth (perimeter). Once a decision is made based on the various perimeters, the area is calculated and the cost per m² is determined. Overleaf is the floor plan of a section of the total exhibition from which publishers could chose.

Each small block represents an m².



Additional information:

Rate per ²	R2000
Island stand premium:	R2500
Corner stand:	R1500
Close to entrance:	R3000
Stand height:	2.5m

2.3 Area calculations

- *Describe, giving examples how to calculate the area of the following:*
  - *Rectangle*
  - *Triangle*
  - *Parallelogram (base x perpendicular height)*
  - *Trapezium (perpendicular height ÷ 2 x sum of the parallel sides)*
  - *Circle*

Lecture slide
#21-23

Activity 2
Book fair
Students should complete this activity in their own time as revision of previous years' work.
Refer back to the book fair example, use the information given and answer the following questions.

1. List 5 stand perimeter options (width and length) the organisers offered publishers to derive at the floor plan.
2. Calculate the sizes of the following stands:
   – K15
   – N2
   – N6
3. How much would the following companies have to pay for their respective stands?
   – L8
   – N6
   – M3
4. As part of their stand design a number of companies are using wallpaper with their logos and images on to decorate their stands. Calculate the surface the wall paper needs to cover for the following stands:
   – M6
   – N3
5. At a rate of R250/m^2 how much will the wall paper cost for M6 and N3?
6. What is the total cost for these two stands?

Lecture slide
#24-26

2.4 Volume calculations

- *Demonstrate, giving examples, how to calculate the volume of the following containers:*
  - *Rectangular prism*
  - *Cube*
  - *Triangular prism*
  - *Cylinder*

Lecture slide
#27-31

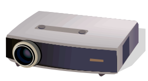
Activity 3
Perimeters and areas – approximate all answers to two decimal places
Students can complete this activity in class or for homework.

1. Calculate the perimeter of the rectangles with the following dimensions (Use the formula: perimeter of a rectangle = 2 lengths + 2 breadths):
   a. length = 24,6 cm; breadth = 8,95 cm.
      Perimeter = 49,2 + 17,9 = 67,1 cm
   b. length = 145 mm; breadth = 2,63 cm.
      Perimeter = 29 + 5,26 = 34,26cm.
   c. length = 25,25 m; breadth = 3 238 cm.
      Perimeter = 50,5 + 64,76 = 115,26m

2. Now calculate the area of the rectangles with the dimensions in the previous question. (Use the formula: area of a rectangle = length times breadth.).
   a. *Area = 220,17cm²*
   b. *Area = 38,14cm²*
   c. *Area = 817,60m²*

3. Calculate the circumference of circles with the following radii:
   a. Radius = 6,4 cm
      Circumference = 40,21cm
   b. Radius = 4,55 m
      Circumference = 28,59m
   c. Radius = 55,4 cm
      Circumference = 348,09cm
      (Circumference of a circle = $2 \pi r$)

4. Calculate the area of the above three circles using the formula : (Area of a circle = πr^2)
   a. Area = 128,68 cm²
   b. Area = 65,04m²
   c. Area = 9462,04cm²



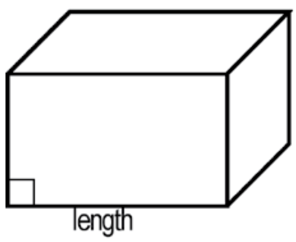
Lecture slide #32-35

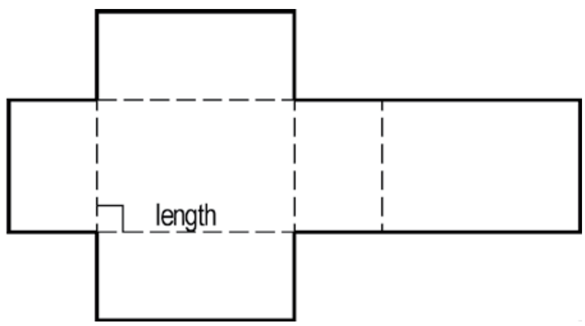
2.5 Total external surface area

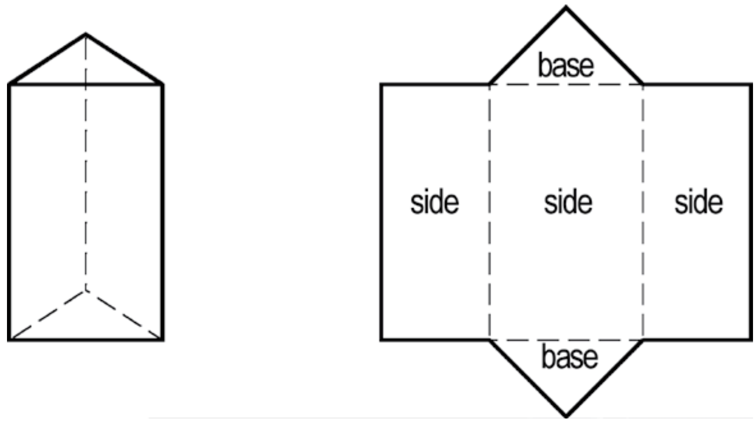
- *Explain to students what the net of a shape is (it may be worthwhile to bring a box into class to demonstrate).*
- *Explain how to calculate the total external surface area.*

Shape | **Net of the Shape**

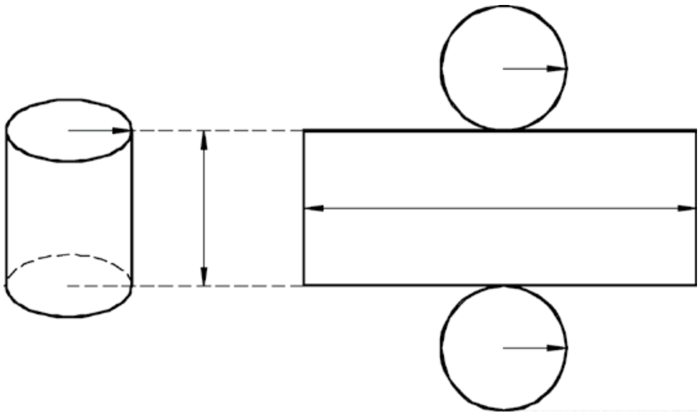
Rectangular prism





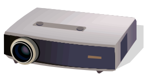


Cylinder



The surface areas of right prisms are calculated:

- **Surface area of the rectangular prism** = 2 times (length times breadth of base rectangle) + circumference of base, times height / altitude of prism.
- **Surface area of the triangular prism** = 2 times (base of triangle times its height, divided by two) + circumference of triangle times height / altitude of prism.
- **Surface area of the closed cylinder** = 2 times pi times square of radius + circumference of circle times height / altitude of cylinder.



Lecture slide
#36-37

Activity 4

Total external surface areas of right prisms

Students can complete this activity in class or for homework.

1. Calculate the area in square units of:
   - a rectangle with length 34,65 cm and breadth 12,74 cm
     Area of rectangle = 441,44cm²
   - a circle with radius 25 cm
     Area of circle = 1963,49cm²
   - a triangle with base length 35,5 cm and perpendicular height 28 cm
     Area of triangle = 497cm²

2. Calculate the total external surface areas of the following right prisms

Type of Prism	Dimensions of Prism
Rectangle as base	Base length = 26 cm; base breadth = 18 cm; prism altitude = 10 cm
Equilateral triangle as base	Triangle sides = 8 cm; triangle height = 9 cm; prism altitude = 22 cm
Cylinder (circle as base)	Radius of circular base = 20 mm; altitude of cylinder = 18 cm

Rectangular prism external area = 936 + 360 + 520 = 1816cm²
External area of prism if equilateral triangle forms base of prism = 594cm²
Area of cylinder = 12,57 (2) + 226,19 = 251,32cm²

Lecture slide
#38-40

Activity 5 - Project work

Students can complete this activity as homework or in class.

Decide on a suitably sized gift box which you can make to hold a small gift.

1. Sketch the net of your gift box on an A4 sheet of paper. Add the correct dimensions on the dimension lines.
2. Add small attachment flaps with which the sides can be glued to each other. Experiment to determine where these flaps should be. Cut the net out and make the small box.
3. Place the gift box in front of you on the table and sketch it in depth, i.e. as a holder with capacity or volume.

*You have now made a rectangular right prism and you have sketched it in three dimensions. This kind of sketch is also called **a perspective sketch.***

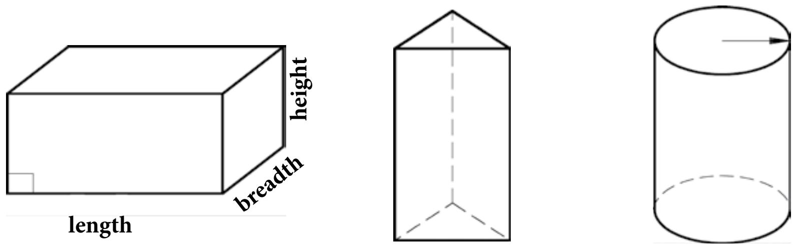
Lecture slide
#41-44

Activity 6

Surface area and volume

Students should complete this activity in class. Note that you will need to provide the ten containers mentioned in question 2.

1. Calculate the total external surface areas and the volumes of the right prisms in the sketches given below. Compare the answers that you get for the triangular prism and the cylinder to that obtained in the prior worked example – areas of bases remain unaltered, only altitude of the prisms differ.



Volume of rectangular prism = 9 360 cm

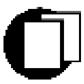
Total external surface area of rectangular prism = 2 696 cm
Volume of triangular right prism = 43,5 x 60 = 2 598 cm
Total external surface area of triangular right prism = 2 x 43,3 + 3 x 10 x 60 = 1886,6 cm
Volume of cylinder = 314,15 x 60 = 18 849 cm
Total external surface area of cylinder = 2 x 314,15 + 3769,911184 = 4398,21 cm

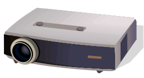
2. Estimate the contents of ten different containers (items from a grocery store), which will be shown to you in the class. Five of the estimates must be in millilitres and the other five in grams. Make a table and compare your estimate to the correct values.

3. Sketch the following right prisms with measurements marked on the correct sides. Work out the **volume** and the **total external surface area** of each prism.
   a. Rectangular prism with length of base = 50 cm; breadth of base = 20 cm, and altitude of prism = 300 mm.
      Volume = 30 000 cm ; Total external surface area = 6 200 cm
   b. Cylinder with radius of the circular base = 18 cm, and altitude of cylinder = 300mm.
      Volume = 30 536,28 cm ; Total external surface area = 5 428,93 cm

4. Calculate the volume of fruit juice in two pipes of 10 metres length:
   The first pipe has a diameter of 10 cm.
   The second pipe has a diameter of 5 cm.
   V = ≈r2h = ≈(10)2(1000) =314159.27cm3
   V = ≈r2h = ≈(5)2(1000) =78539.8cm3

5. A worker in a wine packing shed knows that there is still 8 000 litres of wine remaining in a tank. He has to requisition sufficient bottles of 750 ml capacity from the store to complete the bottling process. Calculate the number of bottles required.
   8000 ÷ 0,75 = 10656,67 ≈ 10666 bottles





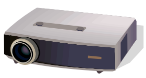
Lecture slide #45

Assignment 2

Students will need to conduct this activity in their own time and report back to the class.

Remove the jack from a vehicle (first ask permission!!)

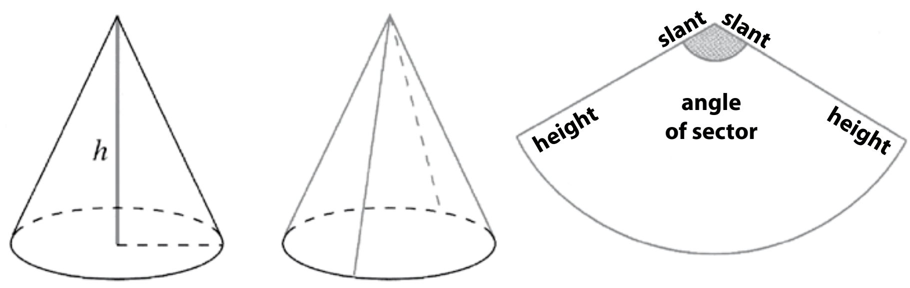
- Make simple scale drawings of it (top, front and side views on square-ruled paper) with accurate measurements. Decide on a scale according to the size of the particular jack.
- Establish how the jack functions – ask the driver or a mechanic to explain it to you and accurately report this information.
- Explain where this jack fits onto the car when in use and where it is stored when not in use.



Lecture slide
#46-50

2.6 Cones and spheres

- *Explain the following terms:*
    - *Cone*
    - *Right circular cone*
    - *Perpendicular height*
    - *Slant height*
    - *Curved surface of a right circular*
    - *Frustum*
    - *Sphere*
- *Explain how to calculate the volumes of spheres and cones*
- *Explain how to calculate the surface areas of spheres and cones.*

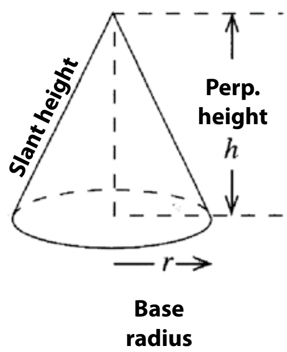


perpendicular height of a right circular cone

slant heights of a right circular cone

curved surface of a right circular cone opened out and laid flat to form a sector of a circle

Cone



Volume $= \frac{1}{3}$ x Area of base x Perpendicular height
$= \pi r^2 h \div 3$

Curved surface area
$= \pi \times$ radius of base $\times$ slant height

Slant height $= \sqrt{r^2 + h^2}$

Sphere

Volume = $4 \times \pi \times (\text{Radius})^3 + 3 = \pi \times (\text{Diameter})^3 \div 6$

Surface area = $4 \times \pi \times (\text{Radius})^2 = \pi \times (\text{Diameter})^2$

Lecture slide
#51-58

Activity 7

Calculate the following areas/volumes:

This activity should be completed in class, since it involves difficult questions that students will struggle with.

Areas:

1. Use the Cartesian co-ordinate system and work with trapezia:

   Area of a trapezium = $\frac{\text{height}}{2}$ times (sum of the two parallel sides)

   Find the area of a quadrilateral with vertices/corners at:

   a. (0;8), (7;11), (10;5), (5;2).

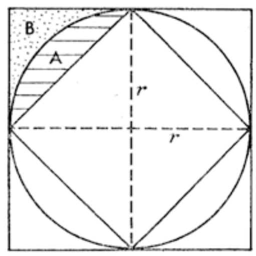
   b. (2;6), (8;7), (10; 3), (0;1).

2. Calculate the area of the triangle with vertices as follows:

   a. (3;0), (4; 10), (8;3)

   b. (2;2), (6;9), (10;4)

3. In the following sketch, obtain a formula for the calculation of the square which surrounds the circle, as well as the area of the square inside the circle.

   Side length of the big square = 2r

   Therefore area of the big square = 2r x 2r = $4r^2$

   In one of the four right-angled triangles inside the inner square:

   $(\text{Hypotenuse})^2 = r^2 + r^2 = 2r^2$

   Therefore, the hypotenuse = $\sqrt{(2r.r)}$

   Therefore, area of the inner sq uare = side times side = $2r^2$

4. A gun has a range of 10 000 m. If it can turn through an angle of 90 degrees what area can it cover? Answer in square metres.

   Area covered by the gun = ¼ (≈r²) = ¼ (≈X 10 ²) square km = 78,54 square km

5. A farmer has 600 m of fencing.

   Calculate the area he will enclose if the fencing forms:

   - an equilateral triangle;

     Height of this triangle by Pythagoras = 173,21 m

     Area of the triangle = 0,5 X 200 X 173,21 = 17 320,5m^2
   - a square;

     A square will have side lengths = 150 m

     Area of this square = 22 500 square metres
   - an equilateral hexagon (consider the radius of the circle that this hexagon will fit into as = 95 m) ;

     An equilateral hexagon will have 100 m to each side. Take radius as 100m.

     Divide hexagon into six congruent triangles by joining vertices of the hexagon. Height of each triangle = 86,60 m

     Therefore area of each triangle = 4 330,13 m^2

     Therefore area of hexagon = 25 980,76 m^2
   - an equilateral octagon (consider the radius of the circle that this octagon will fit into as = 95 m);

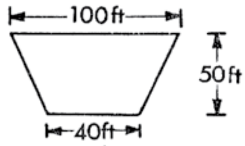
     An equilateral octagon will have side lengths of 75 m.

     Divide the octagon in eight congruent triangles by joining opposite vertices.

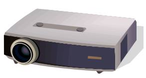
The height of each triangle is taken to be 90,53 m.
Area of one triangle = 3 394,9 m^2
Area of octagon = 27 159,18 m^2
- a circle.

A circle with circumference of 600 m; r = 95,49 m
Area of the circle = 28 646,11 m^2

6. A circular flower-bed with diameter 15 m has a one metre wide path around it. Find the area of the path to the nearest square metre. If the path must be 10 cm in depth, calculate the volume of concrete you will need to fill this path.
   Radius of outer circle = 8,5 m
   Area of outer circle = X $8{,}5^2$ *= 226,98* m^2
   Radius of inner circle = 7,5 m
   Area of inner circle = X $7{,}5^2$ *= 176,71* m^2
   Area of the path = 226,98 - 176,71 = 50,27 m^2
   Volume of concrete for the path = area X depth = 50,27 X 0,1 = 5,03 m^3



7. A railway cutting has an end view as in the accompanying figure. How many cubic metres of earth must be excavated if the cutting is 120 m long? (Conversion factor from feet to metres = 0,3048).
   1 ft = 0,3048 m
   Therefore: 50 ft = 15,24 m; 100 ft = 30,48 m; 40 ft = 12,19 m
   Area of the front view of the cutting = (30,48 + 12,19)
   = 7,62 x 42,67 = 325,1454 m^2
   Volume of earth removed = 325,1454 X 120 = 39 017,45 m^3



Lecture slide
#59-65

Case study

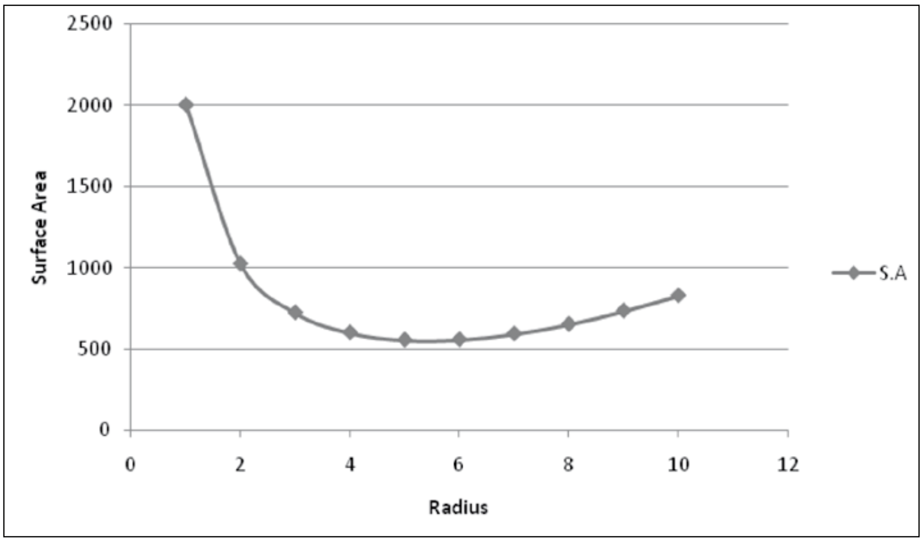
Students should complete this activity in groups of two either in class or for homework.

A manufacturer wants to sell fruit juice in cylindrical one-litre cans using the least possible amount of metal. For the litre can, he has to find the radius and height which give the metal smallest surface area.
Use the formulae:
Volume of a cylinder = πr^2
Total external **surface area of cylinder** = $2\pi r^2 + 2\pi rh$.

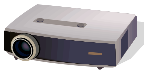
a. Complete the table by calculating the total external surface area of the cans:

Radius (cm)	1	2	3	4	5	6	7	8	9	10
Height of can (cm)	318	79,6	35,4	19,9	12,7	8,8	6,5	5,0	4,0	3,2
Tot. ext. surf. area of cylinder (cm^2)	2004	1025	725	601	556	558	594	653	735	829

b. Plot the radius against the total external surface area of the cylinder on graph paper.



c. Study the table and the plotted graph to decide on dimensions for the cylinder which will use the least metal.
   Least area of metal for a radius of 5cm or 6 cm.
d. Sketch the net of this cylinder – decide on an appropriate scale and write it down in the corner of the sketch.
   Students own sketch as on page 97 of student guide with the appropriate dimensions.
e. Would a rectangular prism of one litre capacity use less area of material than the cylinder? Investigate.
   Would a rectangular prism of one litre capacity use less area of material than the cylinder?
   If the rectangular prism has side lengths all equal to 10 cm then the total external surface area = 600cm . More practical dimensions would be 8cm x 5cm x 25cm in height. These measurements would give a total external surface area of 730cm^2. The cylinder uses less material.
f. Design a piece of flat cardboard for a fruit juice packaging company with the nets of 250 ml fruit juice containers marked out on the cardboard.



Lecture slide
#66-73

3. Read, interpret and use representations

At the end of this outcome, students will be able to:

- Use maps.
- Use plans. (see Activity above)
- Use diagrams.
- Sequence activities.

3.1 Maps

Scale

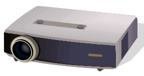
- *Explain what scale diagrams are and why they are important.*
- *Explain how the grid coordinate system is used on a road map, and how the scale system is used on maps.*
- *Explain how a compass works and what bearings are*

Activity 8

Enrichment activity – do in groups and help your neighbour

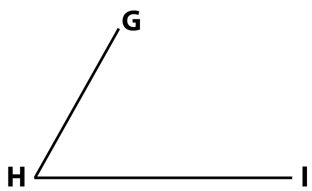
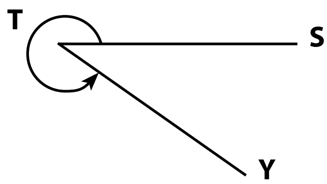
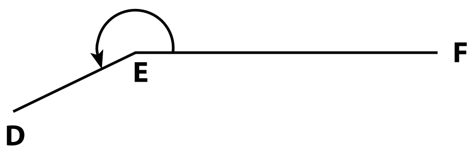
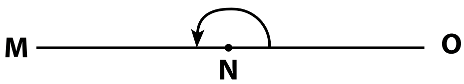
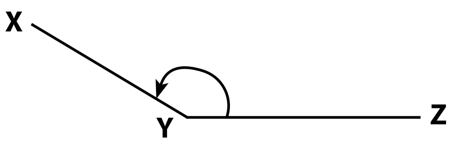
Students should complete this activity in class, in groups.

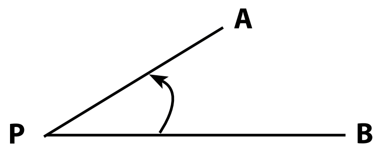
A graduated arc is necessary for this activity.



Lecture slide
#74-78

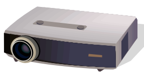
1. Measure the following angles with a graduated arc:

Angle	Degrees
	62°
	224°
	205°
	180°
	150°

	33°

2. An aircraft flies in the direction 080° for 600 km. It then changes course and flies in the direction (on a bearing of) 145° for 400 km. Let 10 mm on your page represent 100 km of real distance.
   a. Sketch this and fill in the angles and the distances.
   b. Work out the scale factor for this sketch.

3. On the sketch of a radar screen of a boat below, the dots represent objects seen by the navigator on board. Directions are given every 10°. The distances between the concentric circles represent 1 km. The boat is at the centre of the four circles. Object A is three kilometres in the direction 050°, written (3; 050). In the same manner, give the positions of the other objects on the screen.
   B (2,5; 230°); Q (2; 180°); R (3,5; 330°); P (4; 080°)

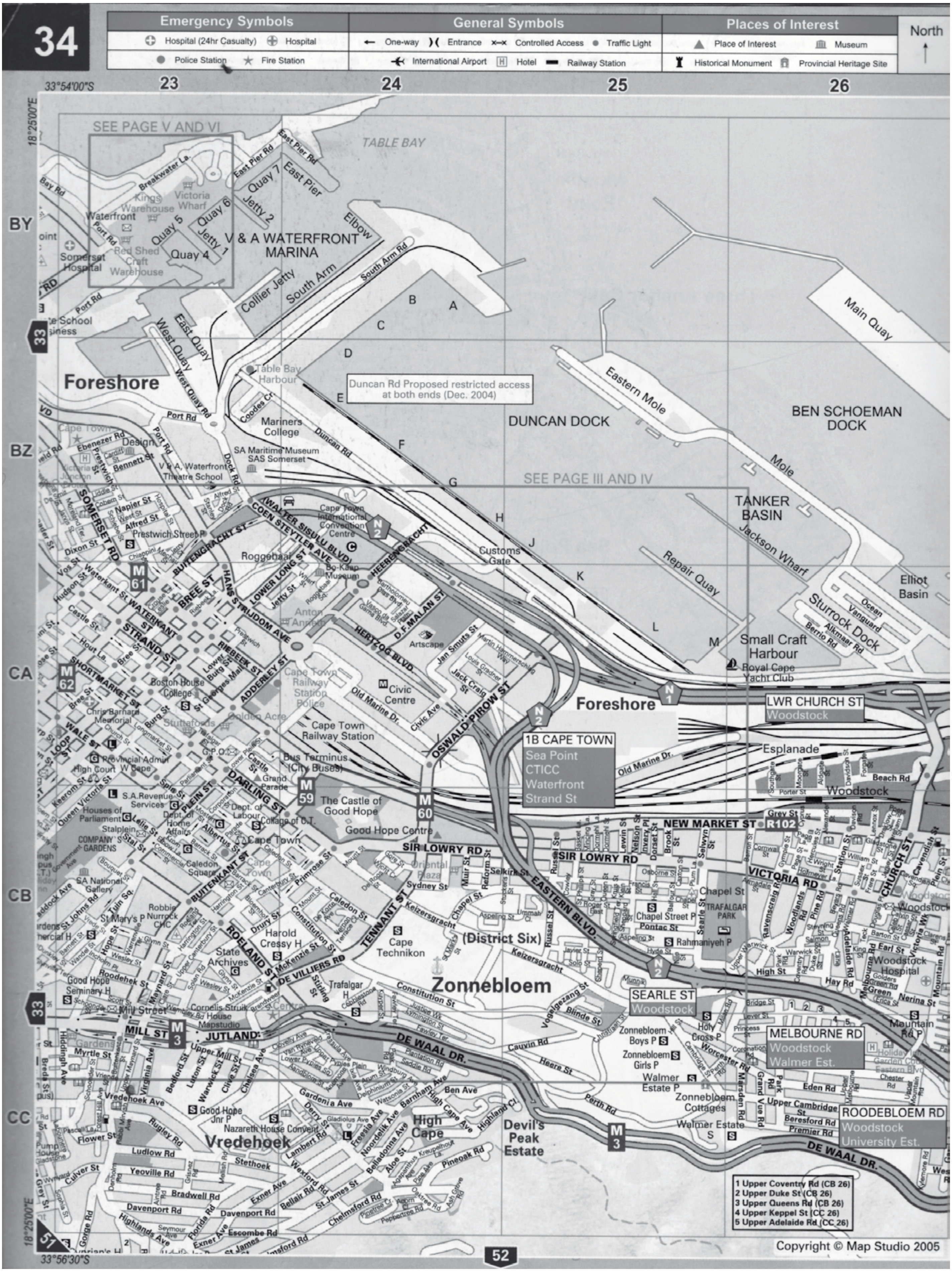


Lecture slide
#79-86

Activity 9

Students can complete this activity in class or for homework.

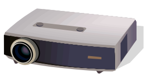
1. On the supplied road map of Cape Town city, the side of one map grid box represents more or less 850 m on the ground.
   a. Work out the scale of this map.
      Side of one grid box = 44mm which represents 850m
      4,4cm : 85000cm
      1 : 19320
   b. Calculate the distance in kilometers by road from the House of Parliament to the V & A Waterfront.
      On Map 2 the Houses of Parliament are in CB 23 upper left hand corner and the V & A Waterfront is in BY 23. Measured up to the Victoria Wharf with a piece of string the distance = 215mm which represents 4153800mm = 4153,8m = 4,154km
   c. Approximately how long would it take you to walk this distance?
      At an average speed of 10 minutes per km it would take roughly 40 minutes.
   d. Also calculate the direct distance (as the crow flies) between the above-mentioned two points.
      As the crow flies the distance is 130mm which represents 2511600mm = 2511,6m = 2,51km.


34
Emergency Symbols
Hospital (24hr Casualty)
Hospital
Police Station
Fire Station
General Symbols
One-way
Entrance
Controlled Access
Traffic Light
International Airport
Hotel
Railway Station
Places of Interest
Place of Interest
Museum
Historical Monument
Provincial Heritage Site
North
23
24
25
26
BY
BZ
CA
CB
CC
SEE PAGE V AND VI
TABLE BAY
V & A WATERFRONT MARINA
Foreshore
Duncan Rd Proposed restricted access at both ends (Dec. 2004)
DUNCAN DOCK
BEN SCHOEMAN DOCK
SEE PAGE III AND IV
TANKER BASIN
Eastern Mole
Main Quay
Small Craft Harbour
Royal Cape Yacht Club
Elliot Basin
Sturrock Dock
LWR CHURCH ST
Woodstock
1B CAPE TOWN
Sea Point
CTICC
Waterfront
Strand St
Esplanade
NEW MARKET ST
SIR LOWRY RD
VICTORIA RD
EASTERN BLVD.
(District Six)
Zonnebloem
SEARLE ST
Woodstock
MELBOURNE RD
Woodstock
Walmer Est.
ROODEBLOEM RD
Woodstock
University Est.
DE WAAL DR.
Vredehoek
High Cape
Devil's Peak Estate
Cape Town Railway Station
The Castle of Good Hope
Civic Centre
1 Upper Coventry Rd (CB 26)
2 Upper Duke St (CB 26)
3 Upper Queens Rd (CB 26)
4 Upper Keppel St (CC 26)
5 Upper Adelaide Rd (CC 26)
Copyright © Map Studio 2005
52
33°54'00"S
33°56'30"S
18°25'00"E

2. Answer the questions on the same map of Cape Town.
   a. Describe a fast route by road from the Garden Court Holiday Inn (follow Eastern Boulevard), to the V & A Waterfront Theatre School.
   b. Now choose a route between the two points which would be more interesting for a tourist. Take them up the road to Signal Hill for the view. Use both maps for this exercise. (For the second road map a side length of one grid box once again represents 850 m.
   c. Calculate the scale for this map.
   d. Calculate the distances for both routes and decide for the tourist whether it would practical for him to walk the distances.

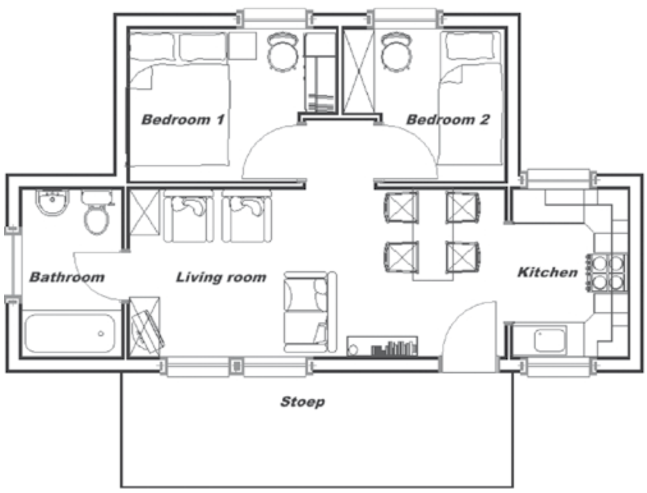
3. Find and give the horizontal and vertical co-ordinate values; **also give the main wind of compass directions within the grid block:**
   a. State Archives in Roeland Street.
   b. Sea Point pavilion.
   c. Noon Gun.
   d. Civic Centre.
   e. Sturrock dock in the harbor area.
   f. Devil's Peak estate.
   g. Breakwater Lodge in the Foreshore area.

3.2 Use plans



Lecture slide
#87-89

Case study 2
Use the plan sketch of Ashley's house in Module 1 pg. 22 as below.



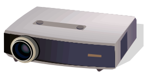
Questions
1. Identify and measure the dimensions of the pieces of furniture in each room and list the information.

Furniture item	Length (mm); (m)	Width (mm); (m)	Area (m^2)
Double bed	*24; 2,88m*	*18; 2,16m*	*6,22*
Single bed	*24; 2,88m*	*10; 1,2m*	*3,46*
Seats	*9 ; 1,08m*	*8 ; 0,96m*	*1,04*

Couch	*14; 1,68m*	*9; 1,08m*	*1,81*
Table	*16; 1,92m*	*7 ; 0,84m*	*1,61*
Chairs at table	*6 ; 0,72m*	*5 ; 0,60m*	*0,43*
Book case	*9 ; 1,08m*	*2,5; 0,3m*	*0,32*
Coffee table	*8 ; 0,96m*	*5 ; 0,6m*	*0,58*

2. Work out the square area covered by the furniture in the two bedrooms and the living room/dining room.
3. Decide whether the furniture can be placed in any other way in the three mentioned rooms.
4. Design a pavement area around the backdoor of the kitchen.
5. How big is this area of pavement?
6. Which side of this house would you like to face north? Give a reason.

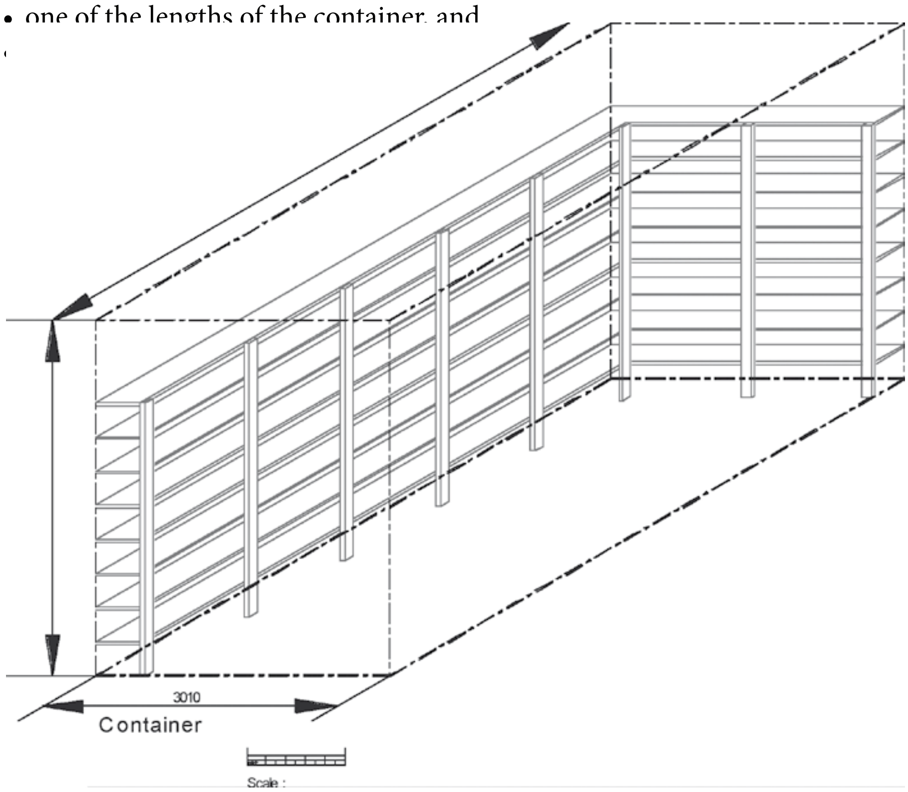
3.3 Use diagrams



Lecture slide
#90-94

Case study 3
Thumeka's *Little Shop*
Students should complete this activity in groups in class or at home. It will probably take one lesson to complete.
The tuck shop of Noluthando's daughter, Thumeka, is in a shipping container. The length of the container is placed next to the fence of Noluthando's property and has been converted to have a serving hatch that can lock down at night. The length of the container is 6,1 m and the breadth is 3,01 m. Thumeka asks Mandla, a carpenter, to build her packing/storage space in the form of shelves along:

- one of the lengths of the container, and



Questions – Mandla's job

1. Measure with your ruler the length and width of the planks and convert the measurements to actual size with the scale given beneath the diagram. List the total length of planks to be ordered.
   Scale 13mm = 1m. 1:76.92
   (74mm x 76.92) + (39mm x 76,92) x (8) = 70 metres (rounded up)

2. The local hardware store informs you that planks are available in lengths of 2000 mm and 3000 mm.
   a. Decide which length would be practical for Mandla.
      3000mm
   b. Calculate the order that Mandla should present to the hardware store – you need to give the **length, width and thickness** of the **planks** and of the **struts.** Mandla needs to order:
      - Planking to have the shelves built.
      - Strutting to support the shelves.

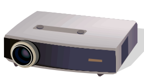
      Answers may vary from student to student. Answers should be reasonable.
   c. Play the role of the clerk at the hardware store and write out the order as an invoice – refer to module 2 on Finance to see an example of an invoice form.
   d. At the closest hardware store the prices are as follows:
      - The shelving planks: R50,67 per metre for the 3 m long planks and R60 per metre for the 2 m long planks.
      - The struts: R28 for the 3 m long strut of dimensions 22 × 44 × 3 000
        R35 for the 3m long struts of dimensions 22 × 69 × 3 000

      Calculate the total price of the wood ordered.

3. Mandla charges R85 per hour for labour and works for 16 hours to complete the shelving job for Thumeka. VAT at 14% still has to be added. Compile the invoice for wood plus labour that he sends to Thumeka.

3.4 Sequence activities

(Refer to Case study 3 and section on flow diagrams)

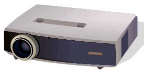


Lecture slide
#95

Activity 10

Help Mandla to plan the job.
Students should complete this activity in groups in class.

- List the sequence of activities for the shelving job of Mandla.
- Present the sequence in the form of a flow diagram. If one of the activities consists of a few different steps, bring these steps in from the side of the flow chart.



Lecture slide
#96

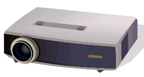
4. Make physical and diagrammatical representations

At the end of this outcome, students will be able to make:
- 2-D and 3-D models of 3-D objects – packing problems.
- 3-D scale models of objects from 2-D plans.
- Rough sketches and final plans/sketches.
- Route maps.
- Flow diagrams.

4.1 2-D and 3-D models of 3-D objects – packing problems

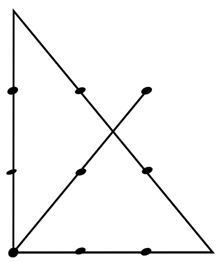
Introduction

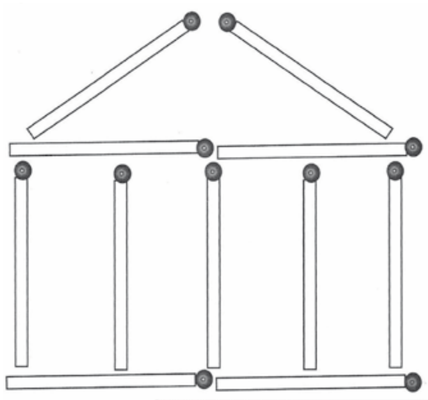
Example:
3-D Imagination or Geometric imagination can also sometimes be called "being practical".
From Charles Seiter's book *Everyday Maths for Dummies:*
The electronics of a huge spot-welding machine in a factory broke down about twice a year. When this happened, the standard procedure was to get two forklifts working together to back this huge block of equipment away from a wall so that the back access panel could be reached. An employee who saw this dramatic industrial operation for the first time, immediately walked to a door next to the spot welder to see what was in the room behind the wall. There was nothing. In fact, the wall was just a dry-wall built to support a few electric plugs. The obvious maintenance step was to cut a removable panel in the wall for access to the back of the machine. This had not occurred to anyone in the 12 years since the welder had been put into place.



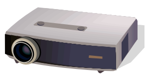
Lecture slide
#97-99

Activity 11
Game time! – go outside the boundaries to find a geometric solution
Students should either bring matches to class or you should provide them with matches.
1. You are each given six matches.
   Find a way to make four triangles using all six matches at once.
   Answer – One triangle lies flat on the table. The other three triangles are at an angle to the horizontal culminating in one vertex where all three touch, i.e. almost like the roof of a house or like a hat but in triangular shape.
2. Sketch nine dots in a square i.e. three rows of three dots each.
   Connect the dots with only four lines without taking your pencil off the page.





3. Look at the matches arranged as a classical-style building front.
   a. Move only two matches in this pattern and make 11 squares.
   b. Move 4 matches and get 15 squares.
   Answer: Move the top two "roof" matches down to lie horizontally halfway down the length of the vertical "pillar" matches. Count 11 squares.
   Move the top "roof" matches to the right half of the "pillar" section to lie horizontally and to divide that square in thirds horizontally.



Lecture slide #100-105

4.2 3-D scale models of objects from 2-D plans

4.3 Rough sketches and final plans/sketches

Introduction

In this section, students will cover orthographic sketches, perspective sketches and isometric drawings.

Explain to students how to use each sketch when appropriate.

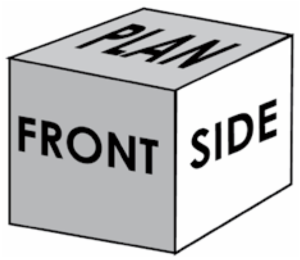
Explain how orthographic sketches will generally be used by professionals like architects, while perspective sketches don't show scale, and are often more artistic in design.

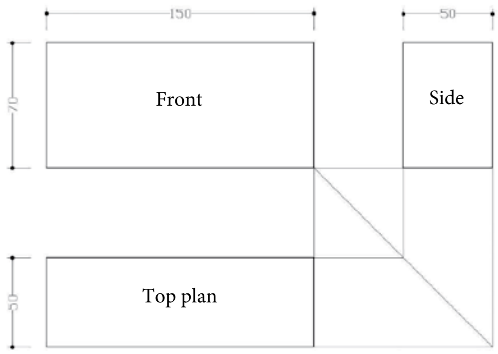
For more information on sketches visit: http://en.wikipedia.org/wiki/User:Mdd/Architectural_drawing

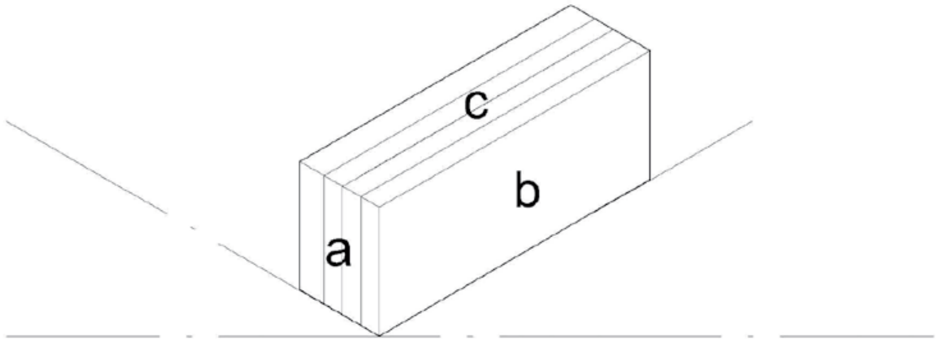
Orthographic sketch

Before commencing any explanation of how to make the drawings**, a few terms** have to be explained.
There are six possible views of any object but three are usually enough to show all of the features.
These three views are normally represented on any engineering drawing and are called the **front**, the **side** and the **plan**. The plan view is the view from the top.

A front view: This is a view of the object or building, **looking at it from the front**.
A side view : This is a view of the object or building, **looking at it from the side**.
A plan or top view: This is view of the plan or object, **looking at it from above**.

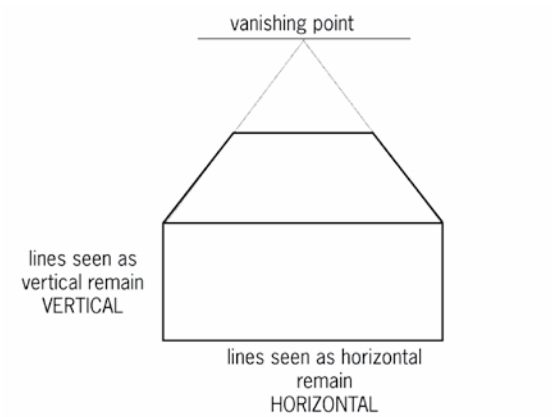


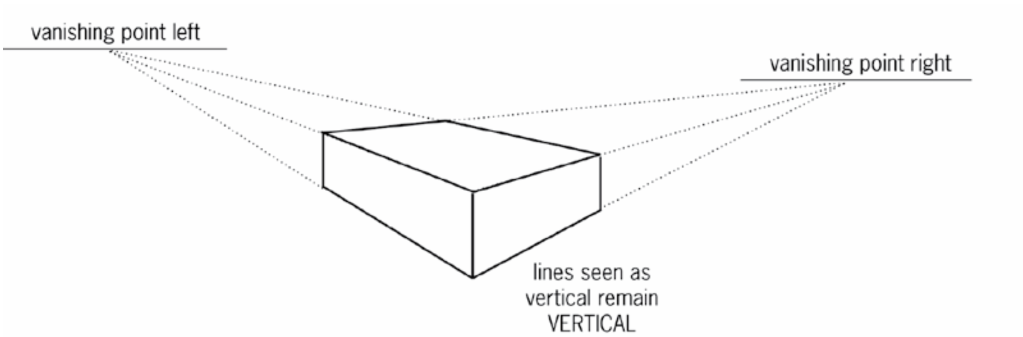


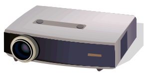


Perspectives
On perspective drawings all features of the object cannot be shown or measured as in orthographic projections. Perspective drawings distort the view.
Take note that **you cannot read scale from a perspective drawing.**

A one point perspective drawing is the simplest perspective and is used to show head-on views such as that of a cuboid shape cupboard right from the front.
A two-point perspective drawing has two vanishing points, such as when a building is sketched with one of the corners closest to the viewer, and the two walls of the building or cupboard stretching away to two vanishing points to the left and to the right of the sketch.







Lecture slide
#106-109

Activity 12

Students can complete this activity in class or for homework.

1. **Orthographic sketch of a cigarette box (front, side and plan views).** .
   - Borrow an empty cigarette box. Measure the length, width and height, as well as any other dimensions (aspects) that will be needed.
   - Note these measurements on a piece of paper.
   - Decide which side is to be the front, which side is to be the side and which the top or plan view.
   - Decide on an appropriate scale factor.
   - Roughly work out the position of the views on the page. The views need to be evenly spaced.
   - Make a rough layout before starting the final sketch.

   Normally, different parts of the drawing are done in different lines.
   The main lines are:
   Construction lines - these are faint continuous lines used to plot out the basic shape, as well as for projection and dimension lines. Use a *4H pencil.*
   Outlines – these are firm continuous lines used to show the outline of the object. Outlines are often drawn over construction lines. Use a *2H pencil.*

   Measure basic dimensions (height and length) for the front view. Using a 4H pencil, draw construction lines right across the page and down too.
   Measure and draw construction lines for the width of the side view and the height of the plan view.
   Go over the outlines with a 2H pencil. Press quite hard so that the outlines stand out clearly.
   Draw the dimension lines with a 2H pencil.
   Dimension lines have the dimension written on them and have an arrowhead at each end, and the point of the arrow should touch the projection line.
   Projection lines are used to position the dimension lines outside the outline. They start about 3 mm outside the outline and extend just beyond the dimension line. You can often draw them on top of the construction lines.
   Write dimensions in the centre of the dimension lines. The digits/letters should be 3 – 5 mm high.

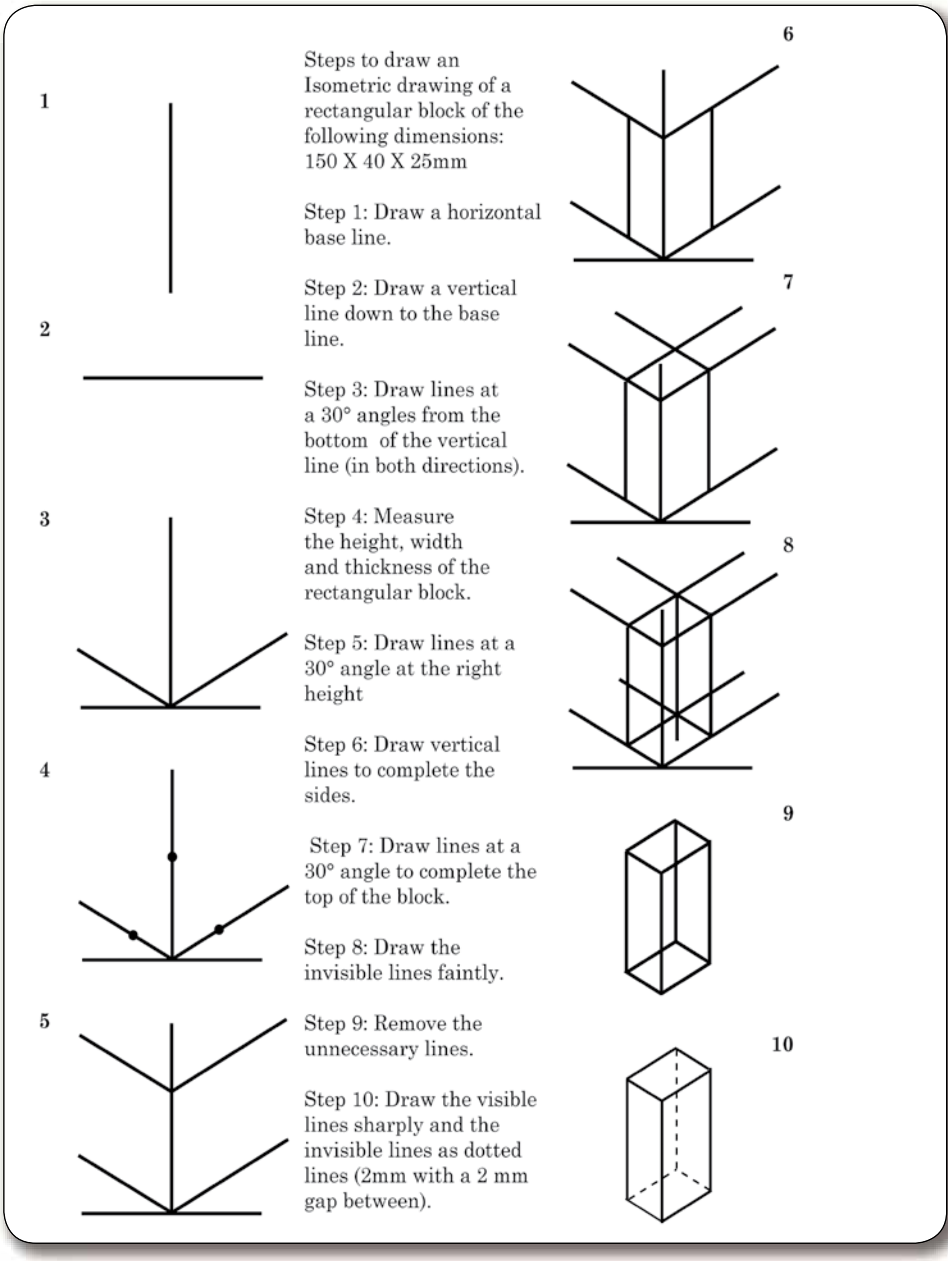
2. Make a first angle orthographic projection of the jack that you sketched in Assignment 2. If you could not get hold of a car jack then make a first angle orthographic projection of the same object that you sketched in that assignment.

Isometric drawings:
From an orthographic projection, it can be difficult to imagine what the object really looks like. To help visualise things engineers and architects use **a style of three-dimensional drawing called an isometric projection**.

The advantage of an isometric projection is that all the sides of an object are drawn at the true length (according to the scale factor). Thus **measurements can be taken from the finished drawing.**

- Isometric projections are useful because they are quick and easy to draw. It is done on isometric paper.
- In this kind of sketch, lines that are parallel on the real object must also be parallel on the sketch of the object.
- Isometric sketches are therefore also called parallel projections.
- Isometric drawings are **not in perspective**, so they can look slightly distorted.

How to do an isometric drawing

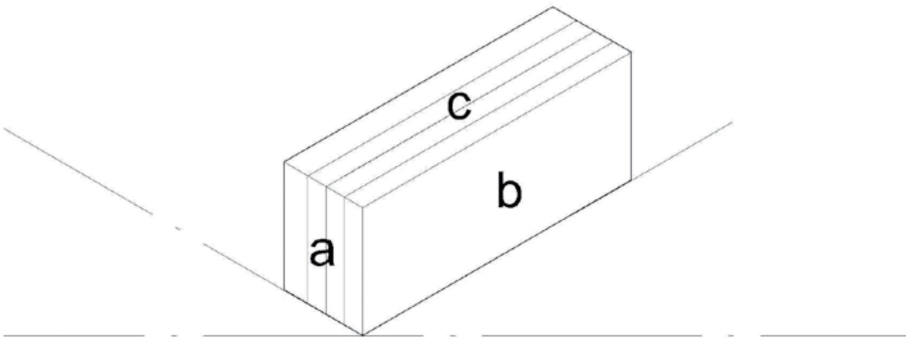


Lecture slide
#112-113

Activity 13
An isometric drawing – use isometric grid paper (paper which is printed with vertical and 30°/60° lines).
Learners will need isometric paper for this activity. This can be downloaded and printed from the following site: http://tinyurl.com/dflmuj

Get any box-shaped object such as a video recorder.
Note down the object's measurements.
Use isometric paper to accurately portray the object.

Your sketch should look something like this:

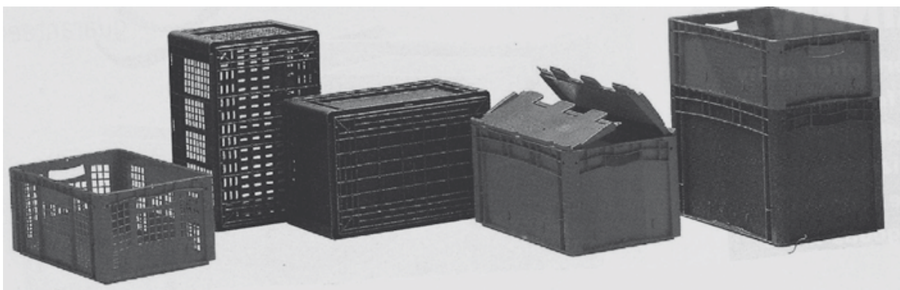


Lecture slide
#106-109

Assignment 3
Students can complete this activity in class or for homework.
- Make a first angle orthographic sketch of Thumeka's container shop, i.e. sketches of the plan, the length side and the breadth side.
- Make a scale model of this container showing the door at the one breadth side and the serving hatch at the opposite side.

Lecture slide
#115-117

Case study 4
Packing problem for Thumeka's *Little Shop*



Thumeka can choose between different bins to store her goods. The bin dimensions are given in the table overleaf:

Choose which bins she can use to fill the shelf space on the long side of the container. Thumeka has decided that she will use the shorter side for files with records and administrative work for both her *Little Shop* and her mother's *Little Laundry*.

The cost of the bins is also supplied.

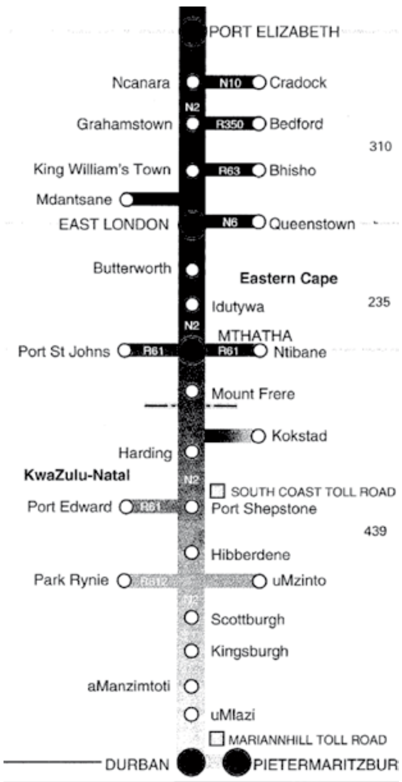
External dimensions L × W × H	600 × 400 × 120	600 × 400 × 170	600 × 400 × 220	600 × 400 × 270	600 × 400 × 420
Volume (l)	23,8	34	44,3	54,5	85,3
Load capacity (kg)	15	15	15	15	20
Stacking load (kg)	300	300	300	300	300
Product code	XL 64121	XL 64171	XL 64221	XL 64271	XL 64421
Unit price	R168	R180	R199	R219	R320

Questions

1. Thumeka has R1 480 which she wants to invest in bins. Decide which bins would be the best to buy. Motivate your choices.
2. Calculate the total cost of the bins.
3. Thumeka wants to invite her mother to also shelve her monthly washing powder and fabric softener for the Little Laundry in the container shop. How much money is left for this?

4.4 Route maps

Route maps give information on a particular route. It is also called a strip route. An example of a route map is the one which indicates distances and major towns between Port Elizabeth and Durban. It shows no information on compass direction or the lay of the land.



Source: South Africa – Road Atlas by Map Studio

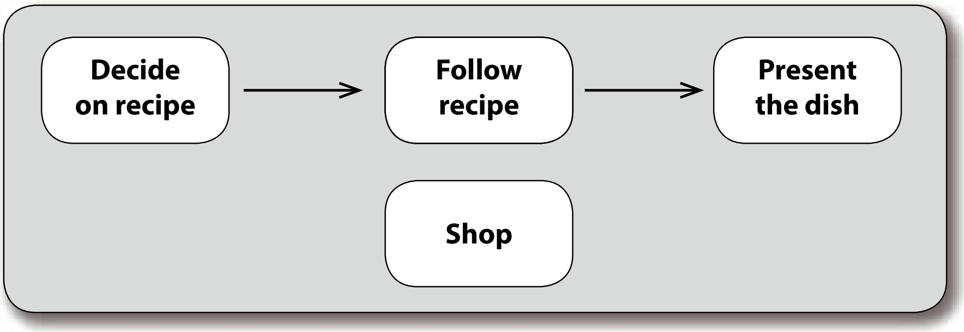
Lecture slide
#119

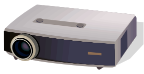
Assignment 4
Students should complete this activity for homework.
Get a road atlas and draw a route map as in the example above of the main road between two major towns/cities in your region.

4.5 Flow diagrams

Flow diagrams are an integral part of project management. Fields as diverse as analysts, engineers, managers or computer programmers use flowcharts. Proper flow charts will use different shapes to indicate different things e.g. a decision is represented by a diamond, however this is beyond the scope of this course.

Example of a flow diagram





Lecture slide
#121-123

Case study 5 – flow diagram

Ashley works at the KWV bottling plant. He is in charge of the **sequence of activities**, i.e. **the flow of work**, and has to explain it to the employees that are under his charge.

Organise the following steps in the correct order and sketch the flow diagram.

Where there is more than one action to any step, bring **the second tier activities in from the side** of the flow diagram.

- Boxes erected from nets of boxes;
- Labels have to be glued onto the bottles;
- The bottles have to be filled, corked;
- Palletted boxes are stretch-wrapped;
- Delivery of product;
- Bottles rinsed and dried;
- Boxes are coded;
- Corks are sealed with wax;
- Codes and time of packing printed on bottle;
- Boxes are sealed and weighed;
- Counting of stock produced, i.e. confirmation of correct amount produced;
- Tanks and pipe lines have to be washed and the product/wine has to be filtered;
- Bottles packed in the boxes;
- Separation cardboard inserted between bottles;
- Labels are stuck onto the boxes;
- Order supplies which consist of corks, bottles and the product;
- Boxes are loaded on pallets;
- Bottles have to be taken off the pallet (called depalletisation), rinsed and sterilized.
- *Order supplies which consist of corks, bottles and the product;*
- *Tanks and pipe lines have to be washed and the product/wine has to be filtered;*
- *Bottles have to be taken off the pallet (called depalletisation), rinsed, and sterilized;*
- *Bottles rinsed and dried;*
- *The bottles have to be filled, corked;*
- *Corks are sealed with wax;*
- *Counting of stock produced, i.e. confirmation of correct amount produced;*
- *Codes and time of packing printed on bottle;*
- *Labels have to be glued onto the bottles;*
- *Boxes erected from nets of boxes*
- *Bottles packed in the boxes;*
- *Separation cardboard inserted between bottles;*
- *Labels are stuck onto the boxes;*
- *Boxes are sealed and weighed;*
- *Boxes are coded;*
- *Boxes are loaded on pallets*
- *Palletted boxes are stretch-wrapped;*
- *Delivery of product.*