MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

UNIVERSITY OF MALTA, MSIDA

MATRICULATION CERTIFICATE EXAMINATION
ADVANCED LEVEL
SEPTEMBER 2012

SUBJECT:	**ENGINEERING DRAWING / GRAPHICAL COMMUNICATION**
PAPER NUMBER:	**I**
DATE:	**4th September 2012**
TIME:	**9.00 a.m. to 12.00 noon**

Directions to Candidates

Write your index number where indicated at the top of all drawing sheets.

Attempt **any FIVE** questions.

Programmable calculators **cannot** be used.

Unless otherwise stated:

a. drawings should conform to B.S. or equivalent (ISO) standards;
b. all dimensions are in millimetres;
c. all answers are to be accurately drawn with instruments;
d. unless otherwise stated, all construction lines must be left in each solution;
e. drawing aids may be used.

Dimensions not given should be estimated.

Careful layout and presentation are important.

Marks will be awarded for accuracy, clarity and appropriateness of constructions.

Mark allocations are shown in brackets.

Question 1

i) Figure 1.1 shows a natural occurrence of a 3D spiral.

Figure 1.1

a) A **part** of a convolution of an Archimedean spiral passes through point A. It coils clockwise about O and after going through an additional 210º, it reaches point B. Points O, A and B are located as in Figure 1.2. Construct the part of the convolution from A to B. **(6 marks)**

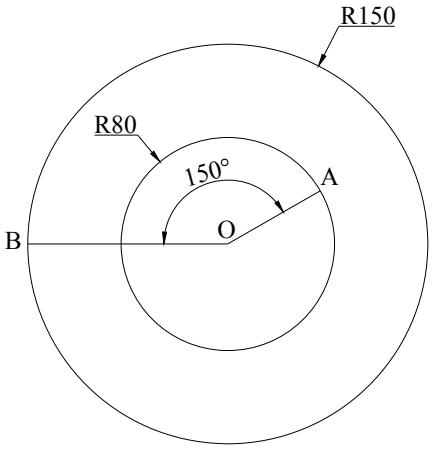


Figure 1.2

b) The polar equation for an Archimedean spiral is given by:

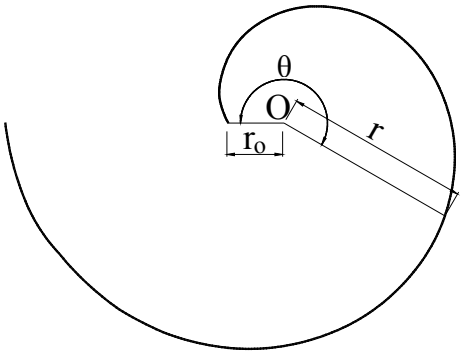
$$r = r_o + a\theta$$

where r = length of radius vector;

r_o = length of initial radius vector;

a = constant of the curve;

θ = angle of radius vector measured in radians from the position of the initial radius vector.



Use the relevant data for points A and B to determine the value of the constant a of the spiral. Record the value of a. **(4 marks)**

c) On the curve produced as the answer to part (a), construct the normal at the point which is 125 mm away from the pole O. **(3 marks)**

ii) The cardioid is a particular case of the epicycloid. It is produced when the rolling circle has the same size as the fixed base circle. Construct the cardioid traced by a point on the circumference of a rolling circle having a diameter of 80 mm.

The candidates are free to consider any point on the circumference. The generating circle may be assumed to roll either clockwise or anticlockwise. **(7 marks)**

(20 marks total)

Question 2

The given views represent the intersection between two right prisms. The solid pentagonal prism penetrates a hollow square duct from above, passes through and emerges again such that both prisms stand on the same horizontal plane. The square duct is manufactured from thin sheet metal.

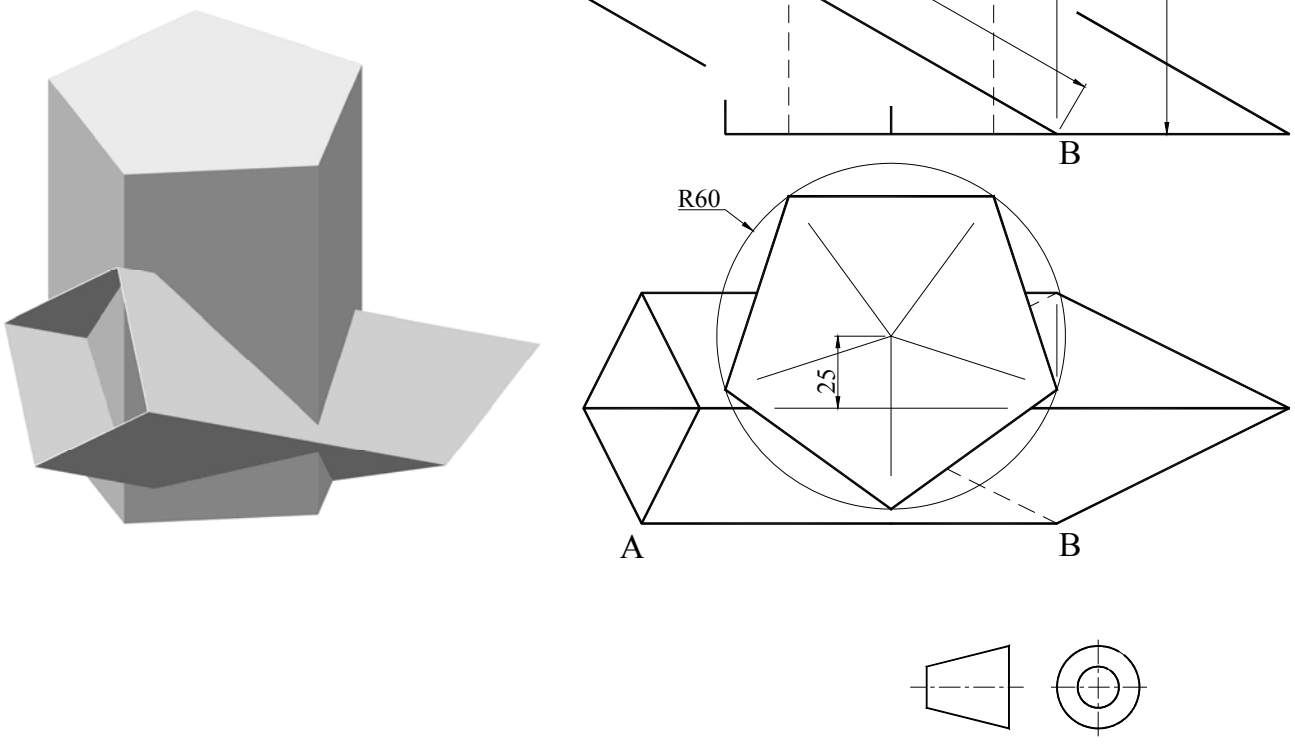
i) Copy the given orthographic views. **(3 marks)**

ii) Complete the front elevation. ***Hidden detail is required.*** **(9 marks)**

iii) Produce a full development of the hollow square prism, making edge AB as the joint line. **(8 marks)**

When copying the given views candidates are advised to set them close to the left vertical margin of the border printed on the sheets provided. This ensures sufficient paper space is left on the right to accommodate the required development.

(20 marks total)



(Please turn the page)

Question 3

A large block of stone is dressed into a window sill. Scaled views of the window sill are given below.

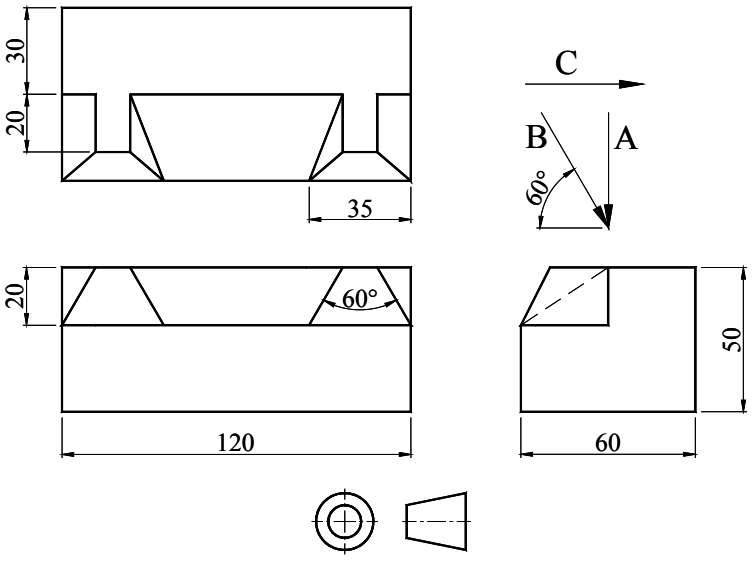
i) Copy the given orthographic views. **(3 marks)**

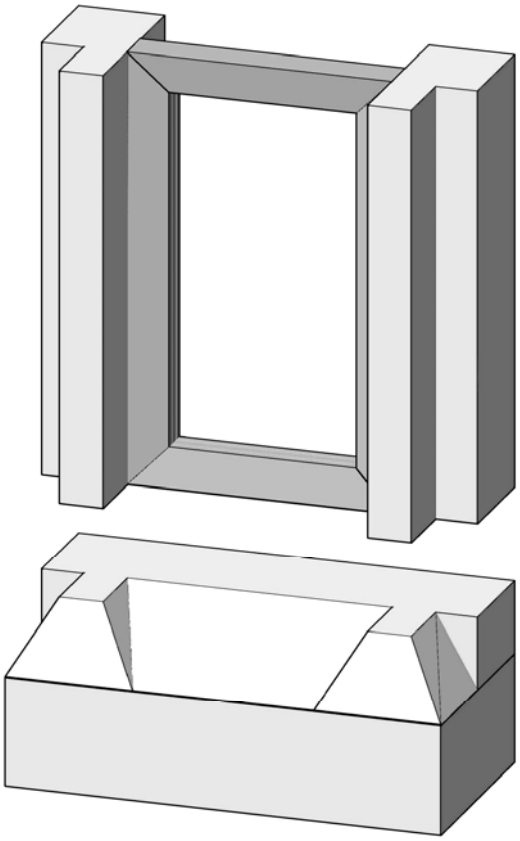
ii) Looking on the given end elevation in the direction of arrow A, shows the given plan. Derive a first auxiliary plan by looking on the end elevation in the direction of arrow B. ***Hidden detail is required.*** **(8 marks)**

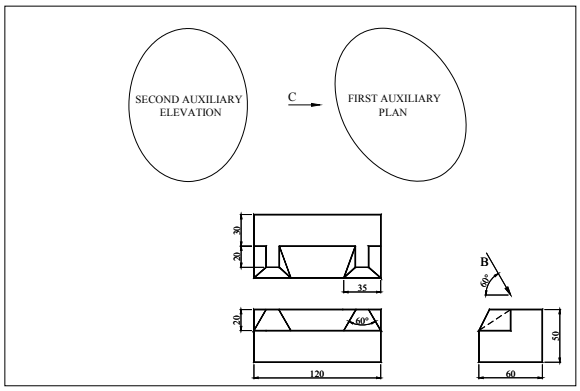
iii) Construct a second auxiliary elevation by looking on the plan obtained in (ii) in the direction of arrow C. ***Hidden detail is not required.*** **(9 marks)**

When copying the given views candidates are advised to set them close to the bottom right corner of the border printed on the sheets provided. This ensures sufficient paper space is left to accommodate the required auxiliary views. A scheme of the suggested layout is given below.

(20 marks total)







Layout scheme

Question 4

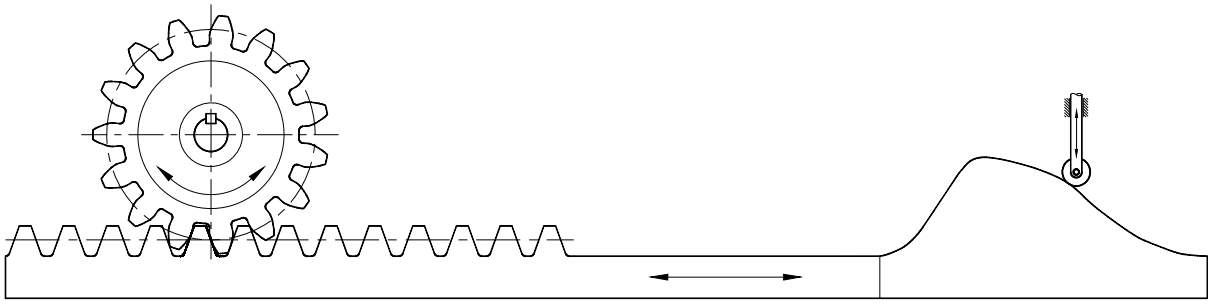
A wedge cam moves back and forth displacing a roller follower vertically. The cam is driven by a rack and pinion mechanism. The pinion performs an oscillatory rotary motion of **half a revolution in either direction** such that the rack imparts to the cam the necessary horizontal reciprocating motion. The pinion has 15 teeth and a module of 10 mm. The follower uses an R10 roller.

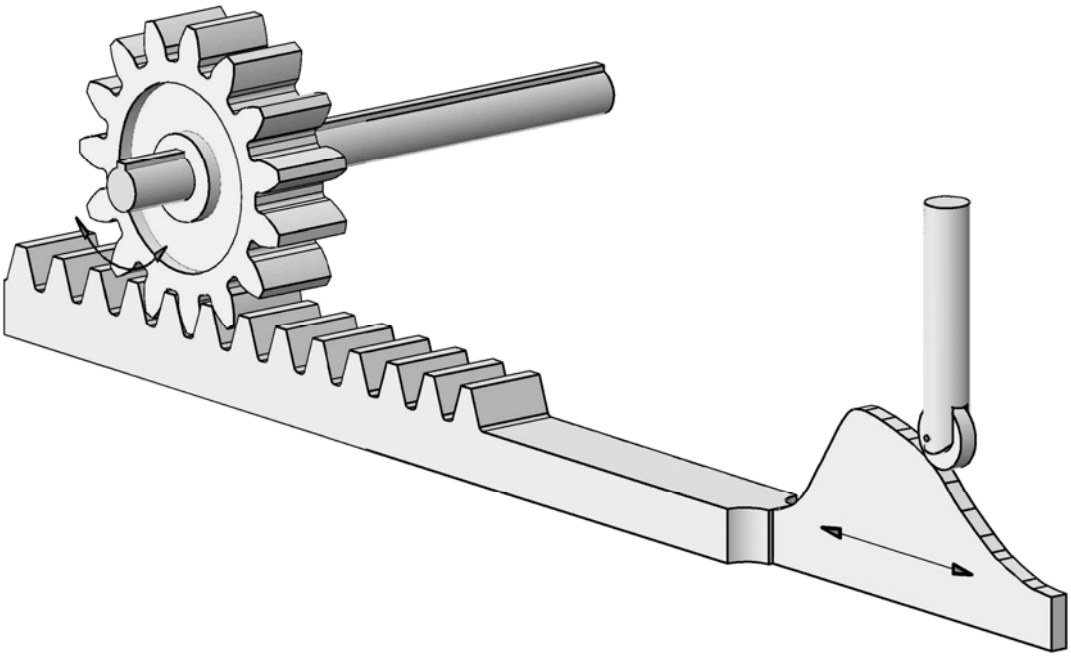
Derive the wedge cam profile that will displace the follower according to the following data:

i) first 3/10ths of forward stroke of cam: 30mm UA rise;
ii) next 1/10ths of forward stroke of cam: 20mm UV rise;
iii) next 3/10ths of forward stroke of cam: 20mm UR rise;
iv) remainder of forward stroke of cam: 70mm SHM fall.

For the setup given below, the forward stroke of the cam may be taken to be caused by the pinion performing its half revolution in the anticlockwise direction.

(20 marks total)





(Please turn the page)

Question 5

The views below describe a piece of thin sheet metal, bent along BC, to form two different triangular planes, BCD and BCA.

i) Copy the given orthographic views. **(2 marks)**

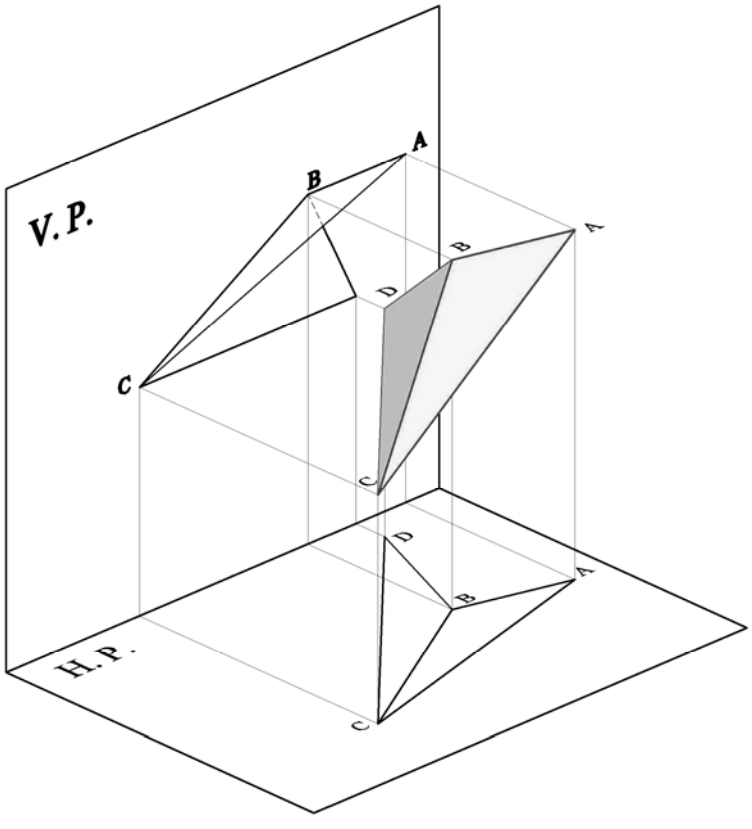
ii) By looking on the given elevation in a suitable direction, project a first auxiliary plan that includes the true length of BC. Record the true length of BC to the nearest mm and the true angle it makes with the reference vertical plane VP, measured to the nearest degree. **(5 marks)**

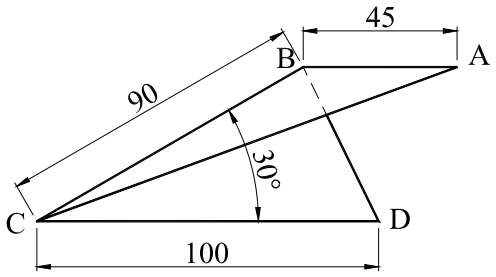
iii) Using the technique of auxiliary views, determine the dihedral angle, through which the thin sheet metal plate was bent to correspond with the given views. Record the angle to the nearest degree. **(5 marks)**

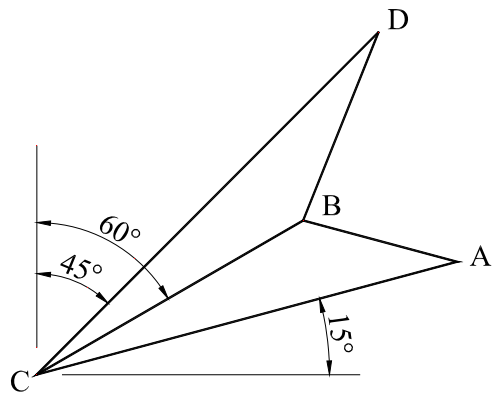
iv) Using the technique of auxiliary views, deduce the true shapes of triangles BCD and BCA. **(6 marks)**

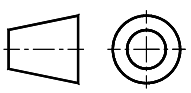
v) Combine the true shapes derived in (iii) to develop the original piece of thin sheet metal before it was bent. **(2 marks)**

(20 marks total)









Question 6

A **cone A**, having an apex angle of 60º, stands on the reference horizontal plane HP. A **sphere B** is brought to touch the cone in a plane parallel to the reference vertical plane VP. A larger **sphere C** is also brought to touch the cone A, but in a plane making 30º with the reference VP. A third **sphere D** is lodged in between cone A and sphere C such that it touches them both. A corresponding plan view is given in Figure 6.1.

i) Project a front elevation and a plan of the setup described above, showing clearly the projection of the centrelines and the points of contact.
Leave all constructional work showing. **(8 marks)**

Sphere B is now rotated through a clockwise angle θ, around cone A, until it comes to touch also the smallest sphere D. In this position sphere D is in mutual contact with all the other three solids. A corresponding plan view is given in Figure 6.2.

ii) Determine and record, to the nearest degree, the value of the angle θ. **(3 marks)**

iii) Update the front elevation and plan you produced in answer to part (i) to represent the final setup. Show clearly the projection of the centrelines and the points of contact.
Leave all constructional work showing. **(9 marks)**

(20 marks total)

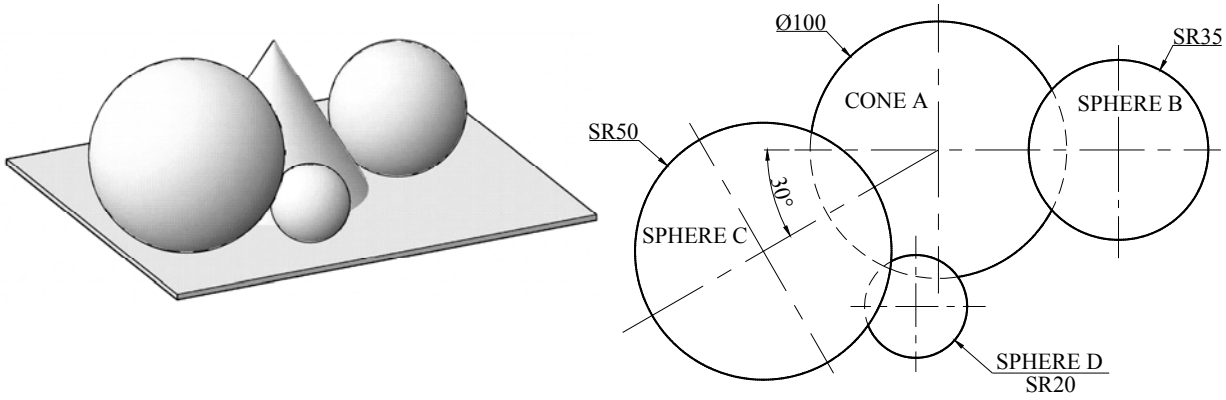


Figure 6.1

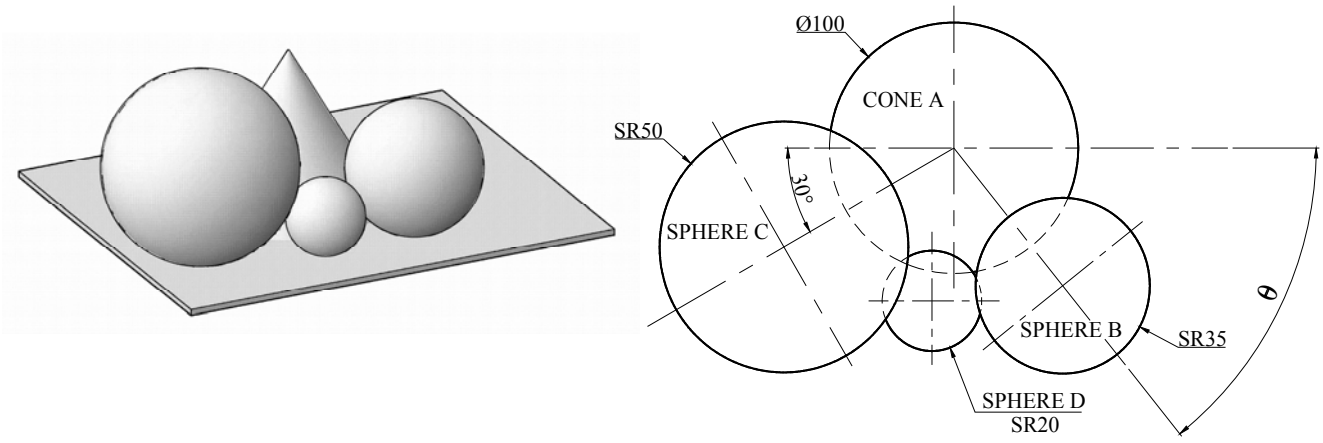


Figure 6.2

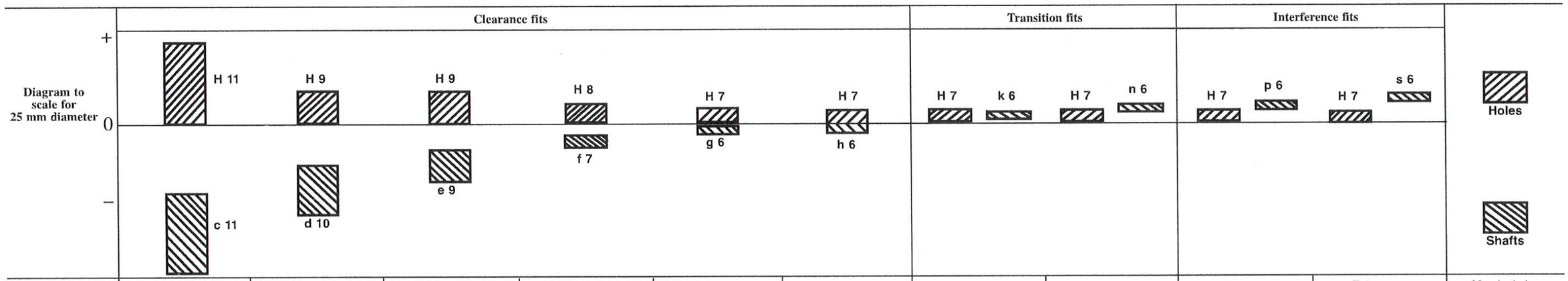
End of examination paper

Extracted
from
BS 4500 : 1969

BRITISH STANDARD

SELECTED ISO FITS—HOLE BASIS

Data Sheet
4500A
Issue 1. February 1970
confirmed August 1985



Nominal sizes		Tolerance		Tolerance		Tolerance		Tolerance		Tolerance		Tolerance		Tolerance		Tolerance		Tolerance		Tolerance		Nominal sizes	
Over	To	H11	c11	H9	d10	H9	e9	H8	f7	H7	g6	H7	h6	H7	k6	H7	n6	H7	p6	H7	s6	Over	To
mm	mm	0.001 mm	0.001 mm	0.001 mm	0.001 mm	0.001 mm	0.001 mm	0.001 mm	0.001 mm	0.001 mm	0.001 mm	0.001 mm	0.001 mm	0.001 mm	0.001 mm	0.001 mm	0.001 mm	0.001 mm	0.001 mm	0.001 mm	0.001 mm	mm	mm
—	3	+ 60 0	– 60 – 120	+ 25 0	– 20 – 60	+ 25 0	– 14 – 39	+ 14 0	– 6 – 16	+ 10 0	– 2 – 8	+ 10 0	– 6 0	+ 10 0	+ 6 + 0	+ 10 0	+ 10 + 4	+ 10 0	+ 12 + 6	+ 10 0	+ 20 + 14	—	3
3	6	+ 75 0	– 70 – 145	+ 30 0	– 30 – 78	+ 30 0	– 20 – 50	+ 18 0	– 10 – 28	+ 12 0	– 4 – 12	+ 12 0	– 8 0	+ 12 0	+ 9 + 1	+ 12 0	+ 16 + 8	+ 12 0	+ 20 + 12	+ 12 0	+ 27 + 19	3	6
6	10	+ 90 0	– 80 – 170	+ 36 0	– 40 – 98	+ 36 0	– 25 – 61	+ 22 0	– 13 – 28	+ 15 0	– 5 – 14	+ 15 0	– 9 0	+ 15 0	+ 10 + 1	+ 15 0	+ 19 + 10	+ 15 0	+ 24 + 15	+ 15 0	+ 32 + 23	6	10
10	18	+ 110 0	– 95 – 205	+ 43 0	– 50 – 120	+ 43 0	– 32 – 75	+ 27 0	– 16 – 34	+ 18 0	– 6 – 17	+ 18 0	– 11 0	+ 18 0	+ 12 + 1	+ 18 0	+ 23 + 12	+ 18 0	+ 29 + 18	+ 18 0	+ 39 + 28	10	18
18	30	+ 130 0	– 110 – 240	+ 52 0	– 65 – 149	+ 52 0	– 40 – 92	+ 33 0	– 20 – 41	+ 21 0	– 7 – 20	+ 21 0	– 13 0	+ 21 0	+ 15 + 2	+ 21 0	+ 28 + 15	+ 21 0	+ 35 + 22	+ 21 0	+ 48 + 35	18	30
30	40	+ 160 0	– 120 – 280	+ 62	– 80	+ 62	– 50	+ 39	– 25	+ 25	– 9	+ 25	– 16	+ 25	+ 18	+ 25	+ 33	+ 25	+ 42	+ 25	+ 59	30	40
40	50	+ 160 0	– 130 – 290	0	– 180	0	– 112	0	– 50	0	– 25	0	0	0	+ 2	0	+ 17	0	+ 26	0	+ 43	40	50
50	65	+ 190 0	– 140 – 330	+ 74	– 100	– 74	– 60	+ 46	– 30	+ 30	– 10	+ 30	– 19	+ 30	+ 21	+ 30	+ 39	+ 30	+ 51	+ 30 0	+ 72 + 53	50	65
65	80	+ 190 0	– 150 – 340	0	– 220	0	– 134	0	– 60	0	– 29	0	0	0	+ 2	0	+ 20	0	+ 32	+ 30 0	+ 78 + 59	65	80
80	100	+ 220 0	– 170 – 390	+ 87	– 120	– 87	– 72	+ 54	– 36	+ 35	– 12	+ 35	– 22	+ 35	+ 25	+ 35	+ 45	+ 35	+ 59	+ 35 0	+ 93 + 71	80	100
100	120	+ 220 0	– 180 – 400	+ 0	– 260	– 0	– 159	0	– 71	0	– 34	0	0	0	+ 3	0	+ 23	0	+ 37	+ 35 + 0	+ 101 + 79	100	120
120	140	+ 250 0	– 200 – 450																	+ 40 0	+ 117 + 92	120	140
140	160	+ 250 0	– 210 – 460	+ 100 0	145 305	+ 100 0	– 84 – 185	+ 63 0	– 43 – 83	– 40 0	– 14 – 39	+ 40 0	– 25 0	+ 40 0	+ 28 + 3	+ 40 0	+ 52 + 27	– 40 0	+ 68 + 43	+ 40 0	+ 125 + 100	140	160
160	180	+ 250 0	– 230 – 480																	+ 40 0	+ 133 + 108	160	180
180	200	+ 290 0	– 240 530																	+ 46 0	+ 151 + 122	180	200
200	225	+ 290 0	260 550	+ 115 0	– 170 – 355	+ 115 0	– 100 – 215	+ 72 0	– 50 – 96	+ 46 0	– 15 – 44	+ 46 0	– 29 0	+ 46 0	+ 33 + 4	+ 46 0	+ 60 + 31	+ 46 0	+ 79 + 50	+ 46 0	+ 159 + 130	200	225
225	250	+ 290 0	280 570																	+ 46 0	+ 169 + 140	225	250
250	280	+ 320 0	300 620	+ 130	– 190	+ 130	– 110	+ 81	– 56	+ 52	– 17	+ 52	+ 32	+ 52	– 36	+ 52	+ 66	+ 52	+ 88	+ 52 0	+ 190 + 158	250	280
280	315	+ 320 0	330 650	0	– 400	0	– 240	0	– 108	0	– 49	0	0	0	+ 4	0	+ 34	0	+ 56	+ 52 0	+ 202 + 170	280	315
315	355	+ 360 0	360 – 720	+ 140	– 210	+ 140	– 125	+ 89	– 62	+ 57	– 18	+ 57	– 36	+ 57	+ 40	+ 57	+ 73	+ 57	+ 98	+ 57 0	+ 226 + 190	315	355
355	400	+ 360 0	400 760	0	– 440	0	– 265	0	– 119	0	– 54	0	0	0	+ 4	0	+ 37	0	+ 62	+57 0	+ 244 + 208	355	400
400	450	+ 400 0	440 840	+ 155	– 230	+ 155	– 135	+ 97	– 68	+ 63	– 20	+ 63	– 40	+ 63	+ 45	+ 63	+ 80	+ 63	+ 108	+ 63 0	+ 272 + 232	400	450
450	500	+ 400 0	480 880	0	– 480	0	– 290	0	– 131	0	– 60	0	0	0	+ 5	0	+ 40	0	+ 68	+ 63 0	+ 292 + 252	450	500

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MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

UNIVERSITY OF MALTA, MSIDA

MATRICULATION CERTIFICATE EXAMINATION
ADVANCED LEVEL
SEPTEMBER 2012

SUBJECT:	**ENGINEERING DRAWING**
PAPER NUMBER:	**II**
DATE:	**5th September 2012**
TIME:	**9.00 a.m. to 12.00 noon.**

Directions to Candidates

Write your index number where indicated at the top of all drawing sheets.

Attempt **question 1** and any other **TWO** questions.

Programmable calculators **cannot** be used.

Unless otherwise stated:

a. drawings should conform to BS or equivalent ISO standards;
b. all dimensions are in millimetres;
c. all answers are to be accurately drawn with instruments;
d. all construction lines must be left on each solution;
e. drawing aids may be used.

Dimensions not given should be estimated.

Careful layout and presentation are important.

Marks will be awarded for accuracy, clarity and appropriateness of constructions.

Mark allocations are shown in brackets.

Question 1 carries 60 marks. Questions 2, 3 and 4 carry 20 marks each.

Data sheet 4500A is supplied for use with question 3.

Question 1

Figure 1.1 shows a flanged Globe Valve. Such a fitting is used to control the flow of a fluid in a pipework system.

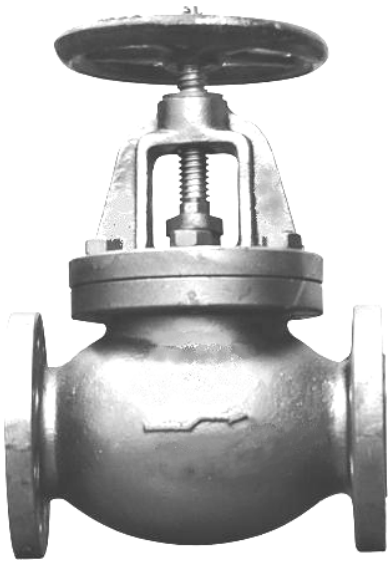


Figure 1.1

Figure 1.2 and Figure 1.3 (on separate A3 sheets) describe the details of the seven main parts making up a similar device.

The valve plug (Part 7) is lifted from its seat in the main body (Part 1) by a rising spindle (Part 6) which threads in the upper cylindrical part of the bonnet (Part 2). The spindle is rotated by a handwheel (Part 4). The R23 valve plug is bored and tapped internally. Its bore fits over the R14 disc at the end of the spindle and is secured in position by a threaded collar (Part 5). The collar threads into the valve plug and thrusts against the disc at the end of the spindle, forming the plug-spindle assembly. The handwheel fits on the square cross-section machined towards the top end of the spindle. It is fastened to the spindle using a plain washer (not shown) and an M14 standard nut (not shown).

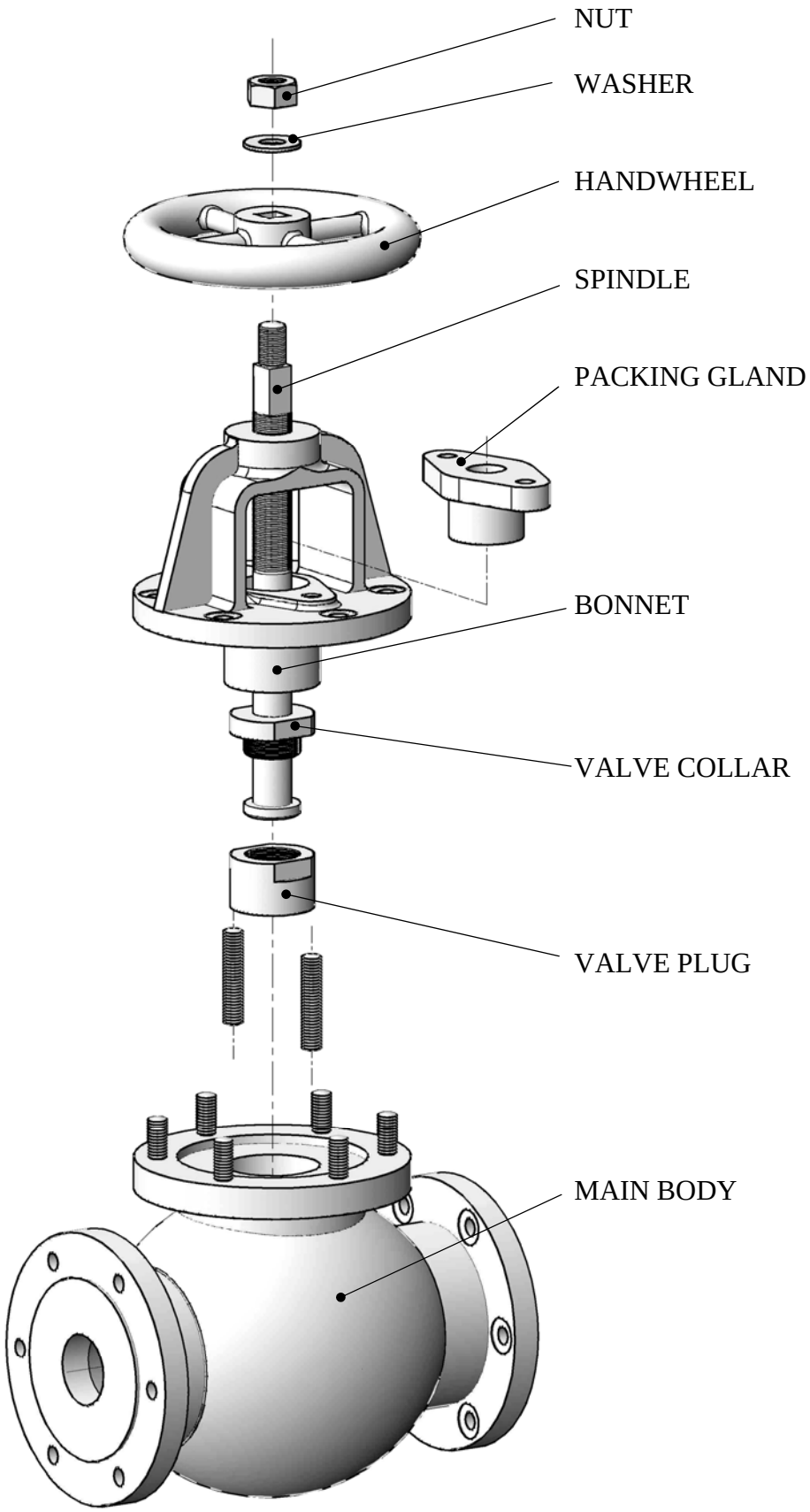
The spindle passes through the stuffing box provided at the lower section of the bonnet. Packing is employed to prevent the leakage of fluid between the spindle and the clearance Ø20 hole of the stuffing box. To affect a satisfactory seal, the packing is compressed by a gland (Part 3) drawn down by two bolts (not shown) which engage into matching M10 female threads provided in the bonnet. With the packing compressed, the vertical distance between the underside A of the gland and the boss B of the bonnet measures 10 mm.

Consider the parts of the globe valve assembled together. Draw full size, a sectional front elevation of the complete setup, on the vertical plane A-A.

Notes:

a) It is assumed that no gasket material is used between the bonnet and the main body.
b) The packing may be represented by double hatching at 45º.
c) The handwheel is to be arranged such that two spokes lie in the cutting plane A-A.
d) Show the M14 hexagonal nut in the 'across corners' position.

(60 marks total)



(Please turn the page)

Question 2

i) Geometrical tolerances are divided into four types. List the four types. **(2 marks)**

ii) Figure 2 on the opposite page shows four tolerance frames applied to a spindle of a globe stop valve. One frame is incomplete.

Copy each of the three complete tolerance frames and for each case:

a) state the geometrical characteristic to which the tolerance applies;
b) the type of tolerance to which the characteristic belongs;
c) explain in words, the tolerance requirements implied by the frame;
d) support your written interpretation in (c) by a sketch that explains the tolerance zone.

(14 marks)

iii) The incomplete tolerance frame has its leader lines connected, but its two compartments are left empty. The frame is to be used to control the straightness of the axis of the **whole length** of the spindle. The axis must lie within a cylindrical tolerance zone of 0.1 dmm. Copy the given empty frame and add to it the necessary details to make it represent this geometrical requirement. **(4 marks)**

(20 marks total)

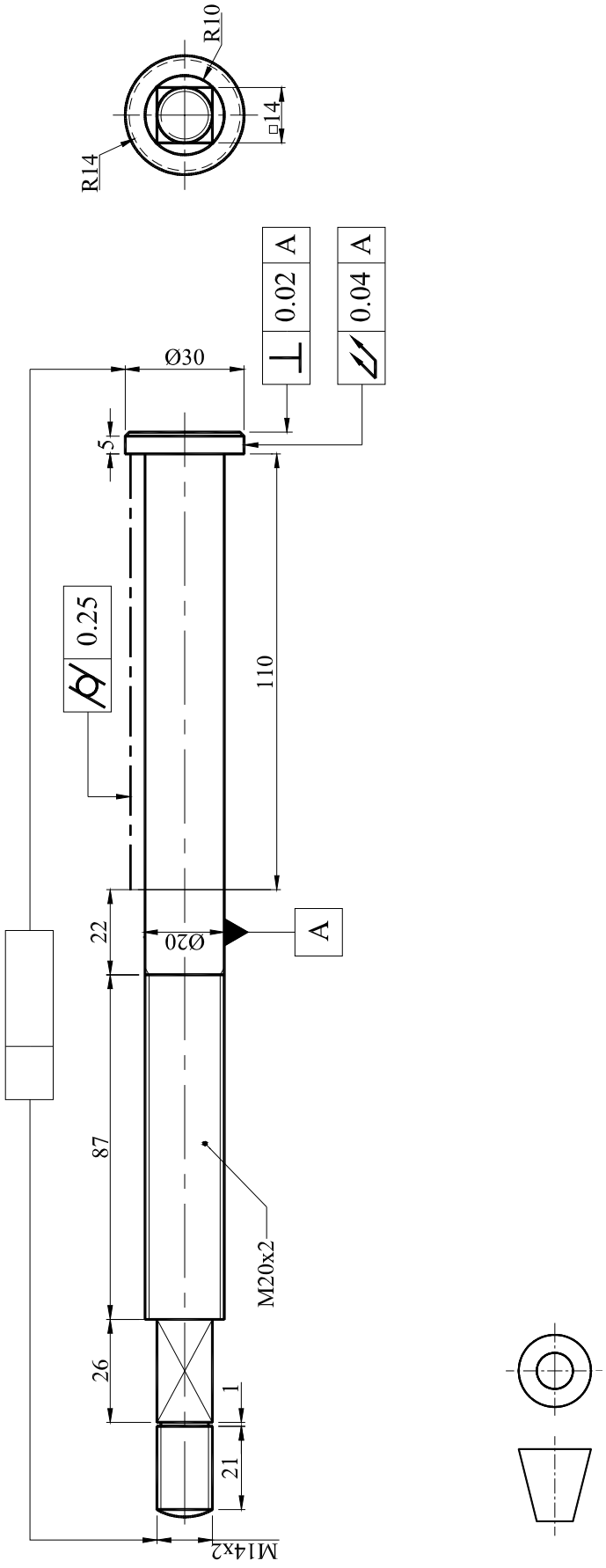


Figure 2

(Please turn the page)

Question 3

i) Figure 3.1 represents a new design of a plug for a globe stop valve. It is to be produced by machining a suitable piece of bar stock. The surface texture required is specified using five machining symbols. Copy the machining symbols and explain in words (and sketches if desired) what **each** symbol means. You are to identify the surface to which the symbol applies and account for **all** the characteristics making up each symbol.

(10 marks)

ii) Laboratory pressure tests performed on the globe valve revealed that the sealing properties of its plug may be improved by refining the surface texture of its R23 sealing face. The new finish has to meet the quality represented by the Ra value of 0.4 µm. This quality finish is to be achieved using a grinding operation. Produce a surface texture symbol to represent this new surface finish requirement. **(2 marks)**

iii) Figure 3.2 shows orthographic views of a valve plug, a part of a valve spindle and a valve plug collar. The pictorial view indicates the way these parts fit together. The threaded bore of the plug fits over the disc at the end of the spindle and the shouldered collar slides over the Ø20 shank of the spindle and screws into the M30 threaded bore of the plug.

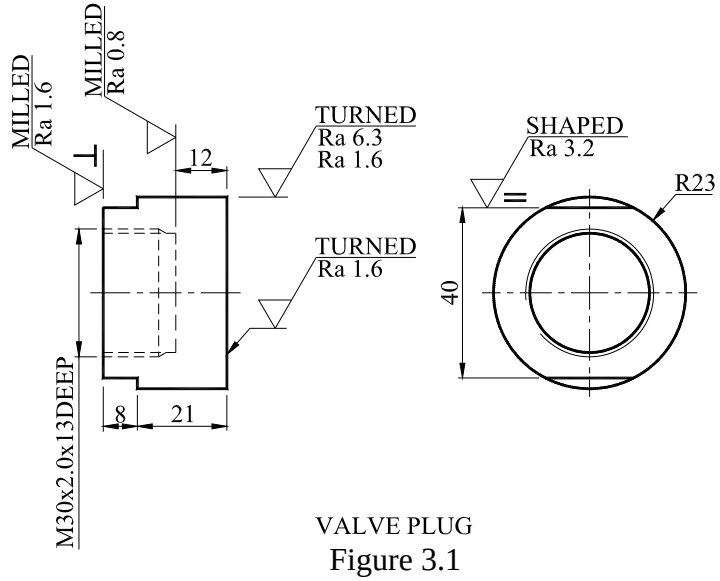
The fit between the bore of the collar and the spindle is designated as H11/c11. Determine the maximum and minimum limits of size for the collar and the spindle and the minimum clearance between the two parts. **(3 marks)**

Support your calculations by a sketch showing the tolerance zones, appropriately arranged relative to the basic size, labelled also by the limits of size. **(3 marks)**

iv) The valve plug and valve collar use corresponding matching threads. Both threads use a major diameter of 30 mm and a pitch of 2 mm. The fit employed is classed as ‘medium’. The ‘hole’ and the ‘shaft’ both use a tolerance grade of 6 (or more properly IT6). The ‘hole’ uses a zero fundamental deviation whereas the ‘shaft’ uses a ‘g’ fundamental deviation. Express all of this thread information as a single specification. **(2 marks)**

(20 marks total)

Candidates are expected to use the Data Sheet 4500A provided to answer this question.



VALVE PLUG

Figure 3.1

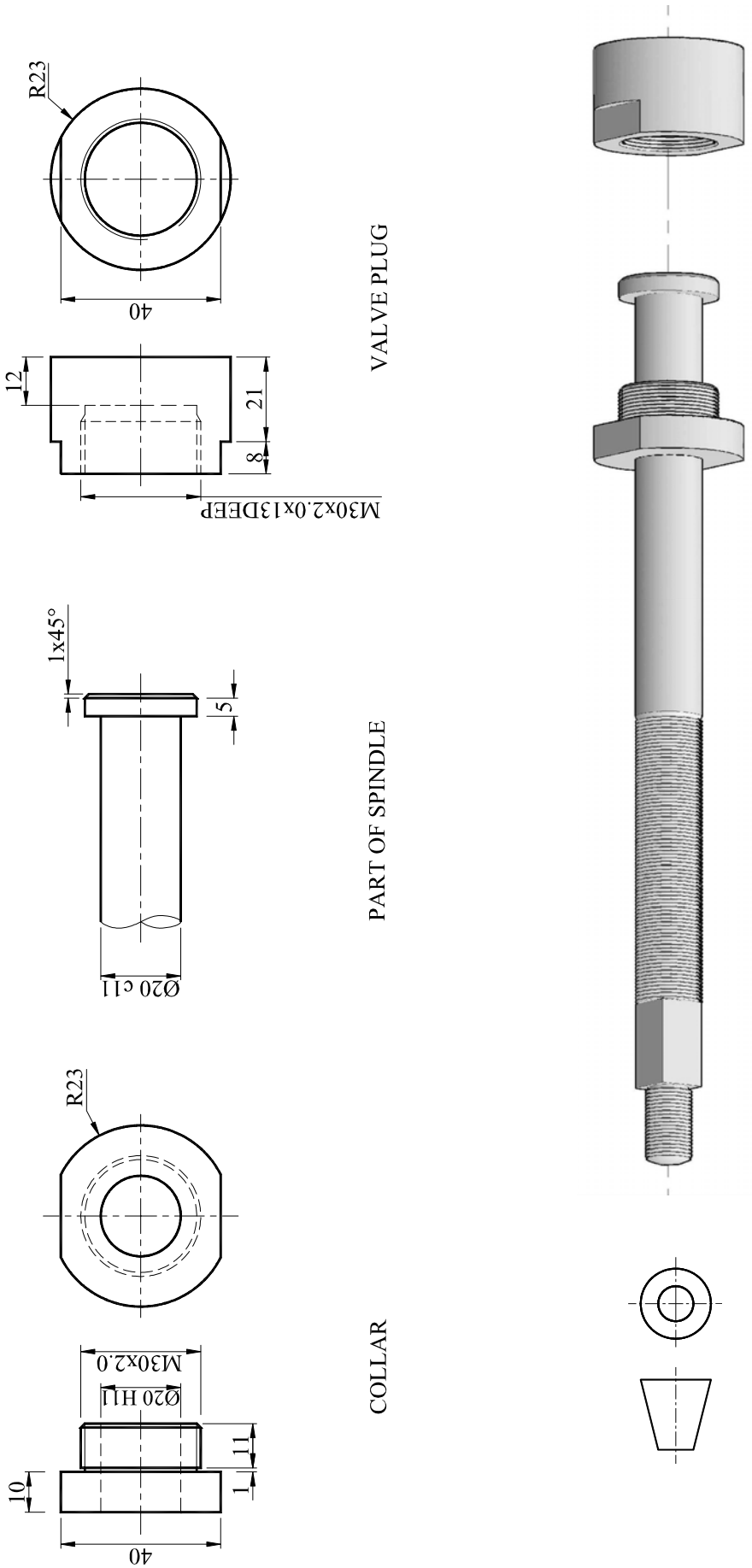


Figure 3.2

(Please turn the page)

Question 4

i) Explain the function of a locking device. **(2 marks)**

ii) Produce **pictorial** proportionate sketches to distinguish between:

a) a locknut and a Simmond's locknut (also called a self-locking nut);
b) a flat washer, a single-coil spring washer, a double-coil spring washer and a star washer;
c) a tab washer/nut assembly and a castle nut/split pin assembly.

Appropriate labels should be printed underneath the respective sketches. **(15 marks)**

iii) A company performs custom modifications on **heavy plant equipment**. A client returns to the company complaining that most of standard nuts used on his modified **digger/excavator** are working loose after relatively short durations of equipment service. Which of the following locking device solutions would you recommend?

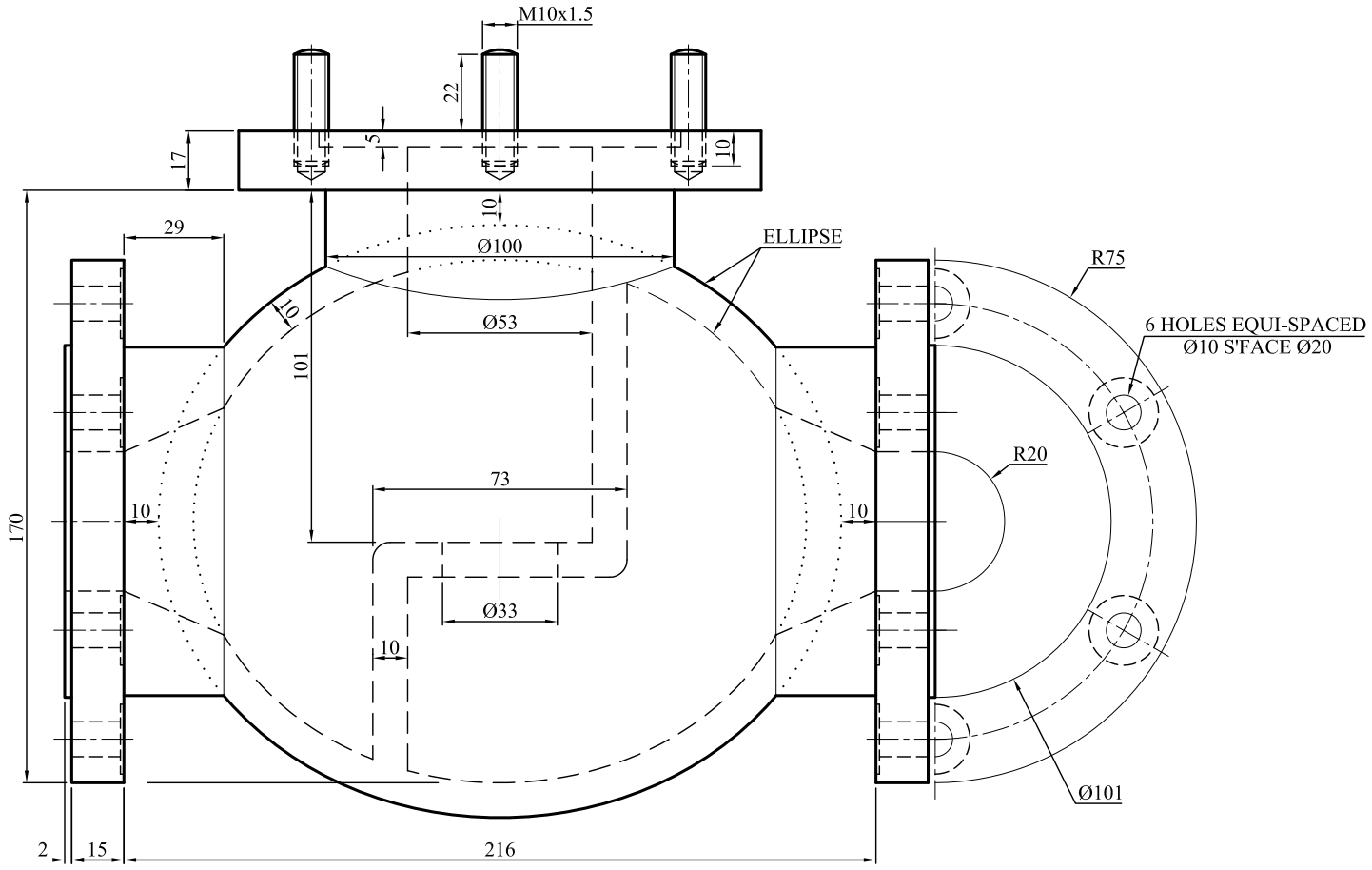
a) locknuts;
b) Simmond's locknuts;
c) castle nut/split pin assemblies.

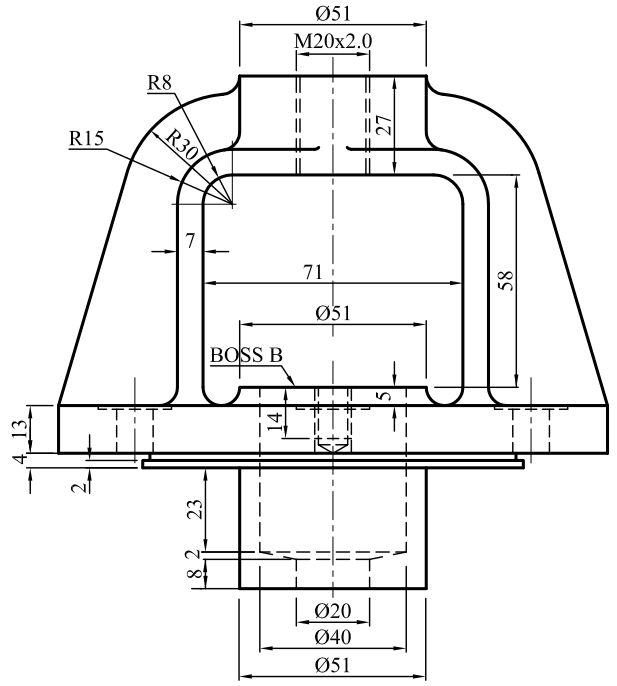
Explain your answer. **(3 marks)**

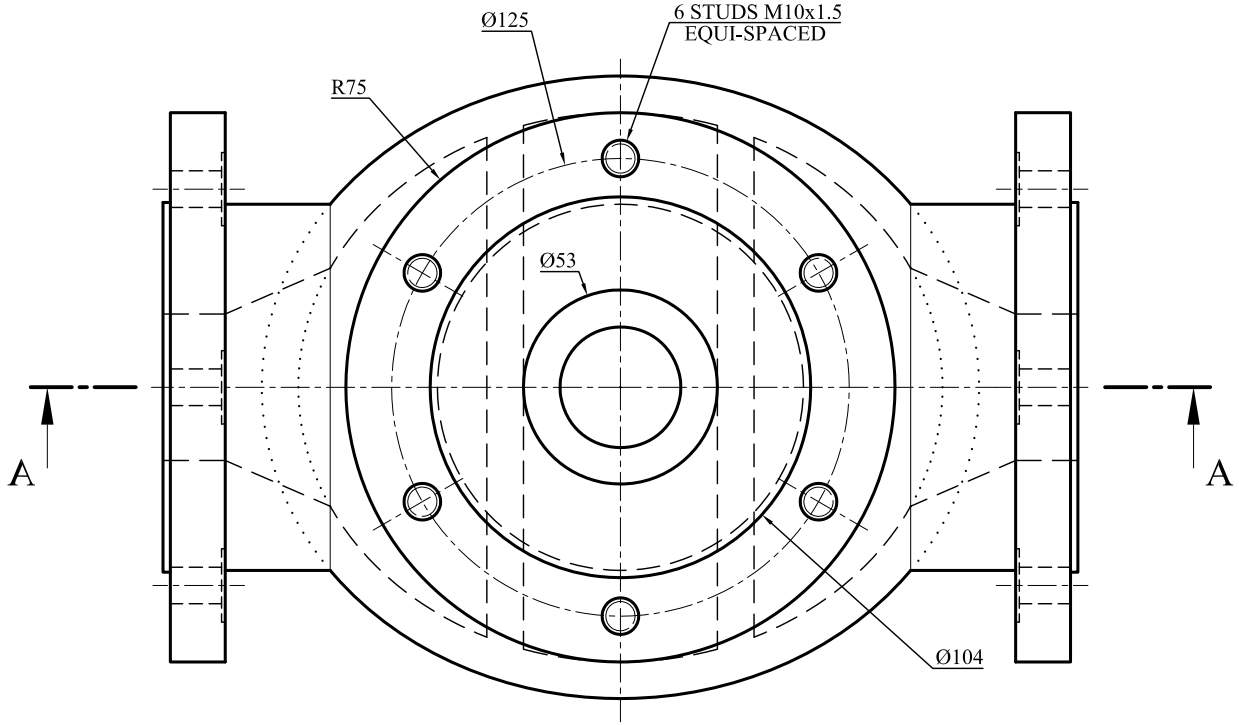
(20 marks total)

End of examination paper

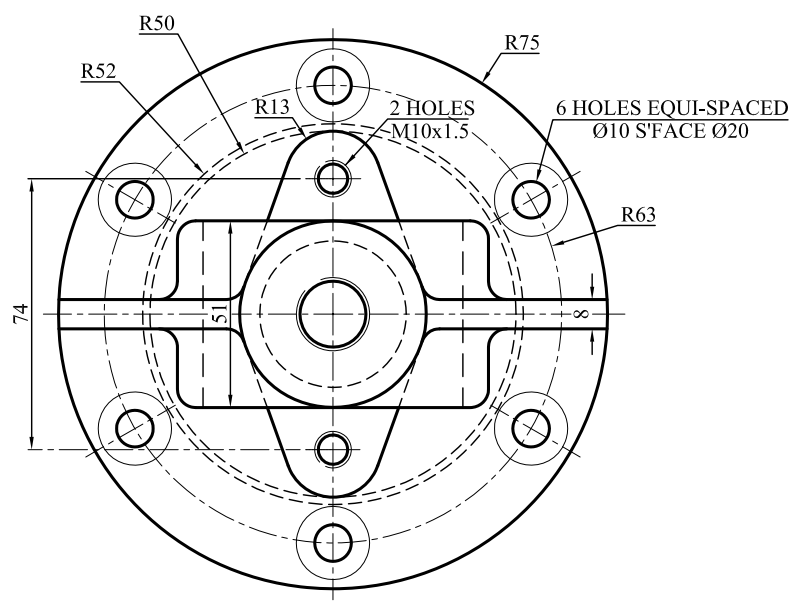
ALL FILLET RADII 5mm
UNLESS OTHERWISE STATED







MAIN BODY
PART 1



BONNET
PART 2

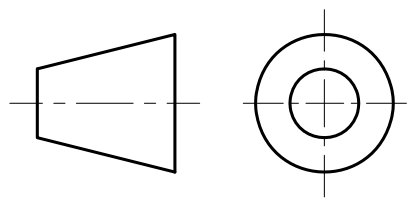
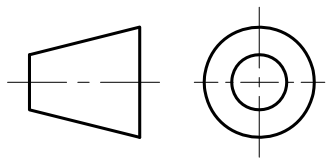
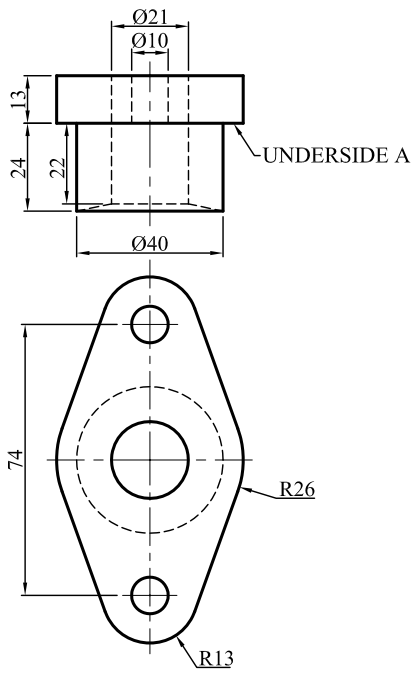


FIGURE 1.2

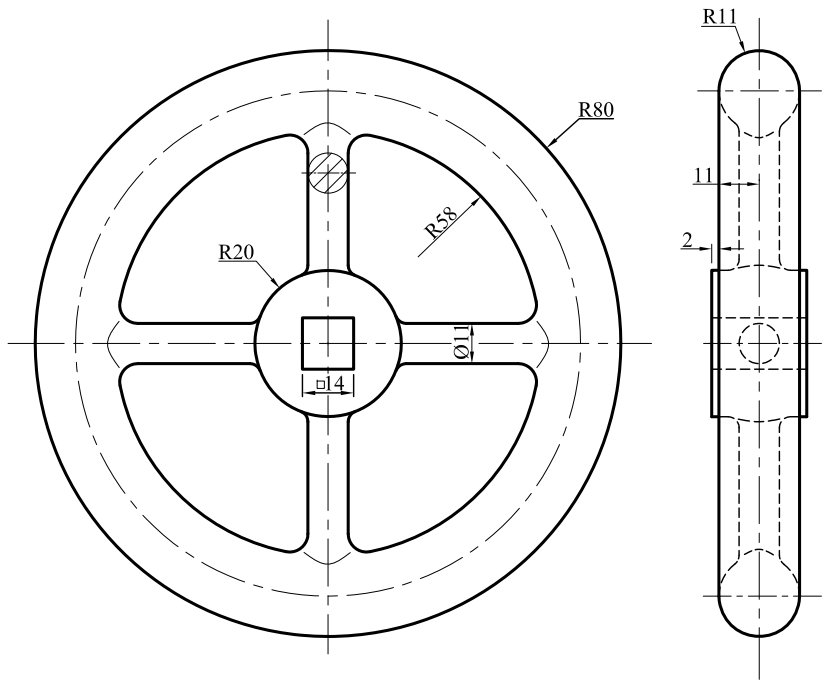
UNIVERSITY OF MALTA MATRICULATION CERTIFICATE EXAMINATION	AM 09 ENGINEERING DRAWING	PAPER II QUESTION 1 SEPT 2012



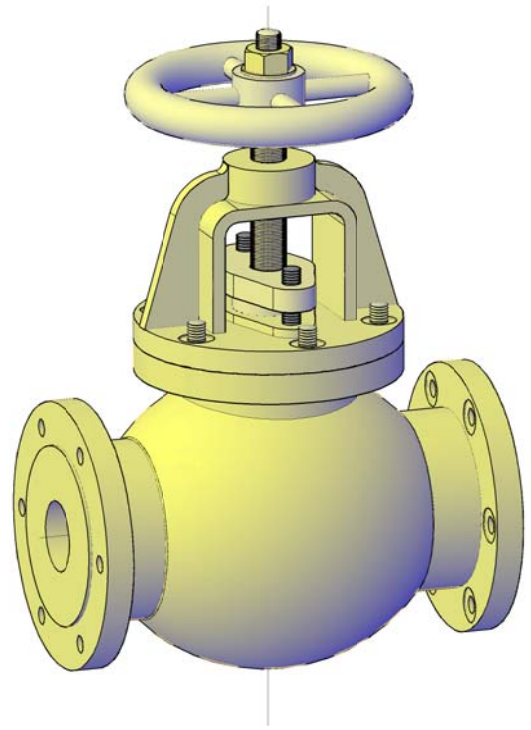
ALL FILLET RADII 5mm
UNLESS OTHERWISE STATED

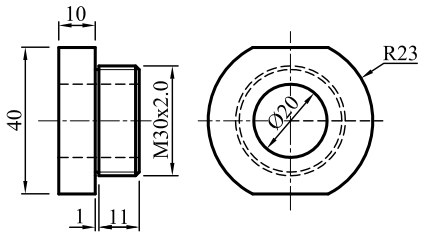


PACKING GLAND
PART 3

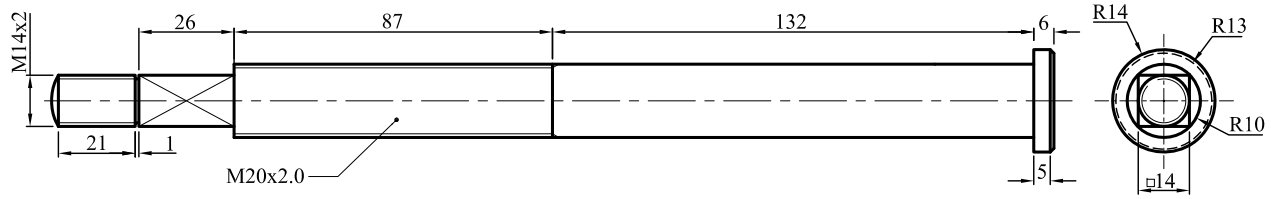


HANDWHEEL
PART 4

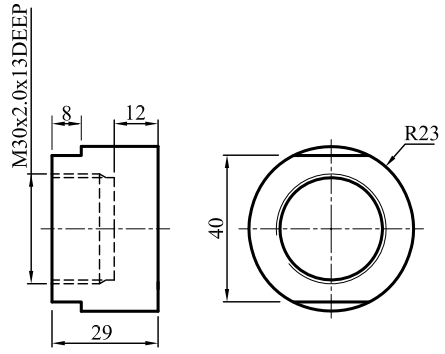




THREADED COLLAR
PART 5



SPINDLE
PART 6



VALVE PLUG
PART 7

FIGURE 1.3

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