SUMMER– 19 EXAMINATION

Subject Name – Engineering Metrology **Model Answer** Subject Code: 22342

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q N.	Answer	Marking Scheme
1	a	**Accuracy: -** The closeness to the measured value with true value is called accuracy. **Precision: -** Repeatability of measuring process is called precision.	**01 marks for each definition**
	b	1) **Line Standard** 2) **End Standard 3) Wave length standard**	**01 mark each any two**
	c	**Advantages of Interchangeability:-** i) Assembly time is reduced, as the operator is not required to waste his/her skill in fitting the mating components by trial and error. ii) There is an increased output with reduced production cost. iii) Improve quality and reduce the time for operation. iv) The replacement and worn-out or defective parts and repairs becomes very easy. v) The cost of maintenance and shutdown period is also reduced to minimum.	**01 mark each any two**
	d	**Run out error:** It is the total range of the readings of a fixed indicator with contact point applied to a surface rotated, without axial movement about a fixed axis. Run out error is related to concentricity of gear outer diameter with mounting hole.	**02 marks for definition**
	e	**Uses of combination set:-** 1)used to check squareness of the work pieces, 2)use to measure an angle of 45 degree.	**01 mark each any two use**

3)used to find centres of cylindrical objects.

4)square head with steel rule to measure the height of the work pieces

f

Causes of surface roughness:-

Vibrations, material of the work piece, type of machining, rigidity of the system consisting of machine tool, fixtures, cutting tool and work, type form material and sharpness of the cutting tool, cutting conditions (speed, feed and depth of cut), type of coolant used

Any four causes ½ mark each

g

RMS value in surface finish:- R.M.S. value is defined as the square root of the arithmetic means of the values of the squares of the ordinates of the surface measured from a mean line.

$$RMS = \sqrt{\frac{h1^2+h2^2+h3^2+\cdots+hn^2}{n}}$$

Note:- formula not essential if written give advantage

02 marks for definition

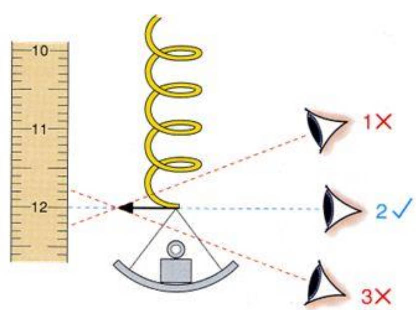
2

a

Parallax error:-

This occurs when the pointer in a scale is not observed along a line normal to the scale.

Now this can understand with help of this diagram, we have the scale here, and we have pointer here, and the observer is observing the pointer from 3 different positions. This is position number 1, position number 2 and we have position number 3. When the observer observes the scale and pointer from the location 2 is observing the scale normally, then we get the correct real. When we observes from the location 1 now you may get the reading at this place which is incorrect real. Similarly when the observer observes from location 3 again there will be an error. So this parallax error can be eliminated by reducing the distance between the scale and pointer.



02 marks for explanatio n, 02 marks for figure

b

Mechanical Comparator	Pneumatic Comparator
1) Mechanical comparators are robust and compact in design	Pneumatic Comparators are not portable and compact in design
2) Usually the Mechanical comparators have linear scale.	The scale is generally not linear
3) Due to more moving parts the friction is more	It has few number of moving parts

01 mark each any four points

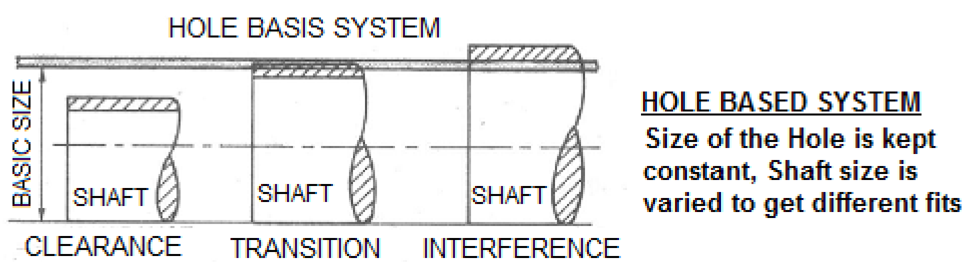
which reduces the accuracy	and in some cases none. Thus the accuracy obtained is more due to absence of friction and inertia.
4) Less degree of magnification as compare to pneumatic comparators.	It is possible to obtain high degree of magnification
5) Less costlier as compared to other comparators	Cost is high as compared to mechanical comparators

c

Hole Basis system

In hole basis system the hole is kept as the constant and the shaft upper and lower deviation values determine the type of fit. In hole basis system the Lower deviation of the hole will be Zero.

- In this system lower deviation of the hole is Zero i.e the lower limit of hole is the same as basic size.
- The higher limit of hole and the two limits of size for the shaft are then varied to give the desired type of fit.
- - The system is denoted by symbol 'H'.



Hole basis system is preferred over the shaft basis system because holes are machined by standard drills or reamers having fixed dimensions, while the shafts can be turned or ground to any given dimension. Hence it is convenient to produce various sizes of shafts than holes of various sizes

02 mark for explanation , 02 marks for sketch

d

-Work piece is mounted on a glass plate placed on the table.
-Light from lamp at the extreme right is collimated in the tube connecting the lamp to the center of instrument and is reflected as a parallel beam by the prism at the end of the tube.
- On its way up, this beam collects the image of the object to be inspected and this enters the microscope.
-Before the rays reach the eyepiece, it is turned by another prism. This is shown in Figure .
- For the most effective manipulation, the magnified image of the work is viewed through the eyepiece (or is projected).
-superimposed on a prepared background engraved on glass disk in the eyepiece.

02 marks for explanation, 02 marks for sketch

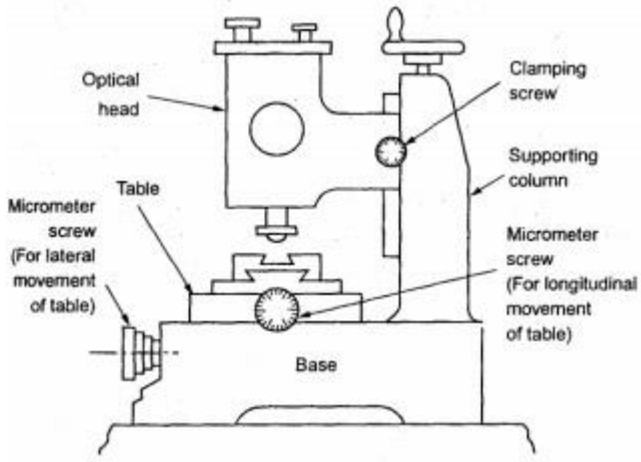
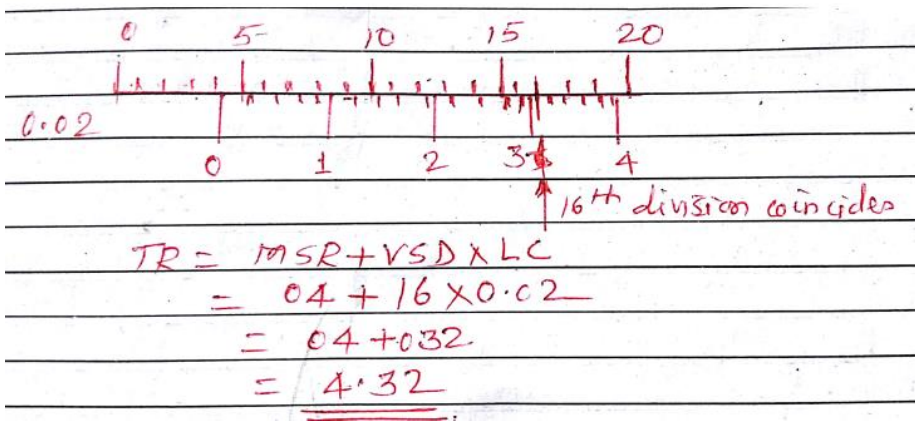


Fig Tool Maker's Microscope

3	a	**Explain i) Environmental error ii) Calibration error** **Environmental errors:** The measuring instruments are assembled and calibrated in certain environmental conditions and are designed to be used in within certain restricted conditions, but when they are used in different conditions, there are errors in measurement, which are considered to be the environmental errors. Most of the instruments are designed to be used within certain limits of temperature, pressure, humidity, altitude etc and when the limits are extended there are errors in the measuring instruments. Here are some precautions to be taken to reduce the environmental errors in the instruments: • Use in the instruments within the specified limits of temperature, pressure and humidity for which the instrument has been designed. These limits are mentioned in the instruments instructions manual. • If you have to use the instrument beyond the specified limits of environmental conditions, then apply suitable corrections to the recorded measurement. • One can also calibrate the instrument newly in the new conditions. • There are some devices that enable applying the compensation automatically. **Calibration error:** The difference between values indicated by an instrument and those that are actual. Normally, a corr ection card is placed next to the instrument indicating the instrument error. Also called calibration error. Calibration in measurement technology and metrology is the comparison of measurement values delivered by a device under test with those of a calibration standard of known accuracy. Such a standard could be another measurement device of known accuracy, a device generating the quantity to be measured such as a voltage, sound tone, or a meter ruler. Any deviation from standard, engraving scales, is considered as calibration error.	**02 marks for each explanatio n**

b **Draw the diagram indicates 4.32 mm on vernier scale.** **04 marks**

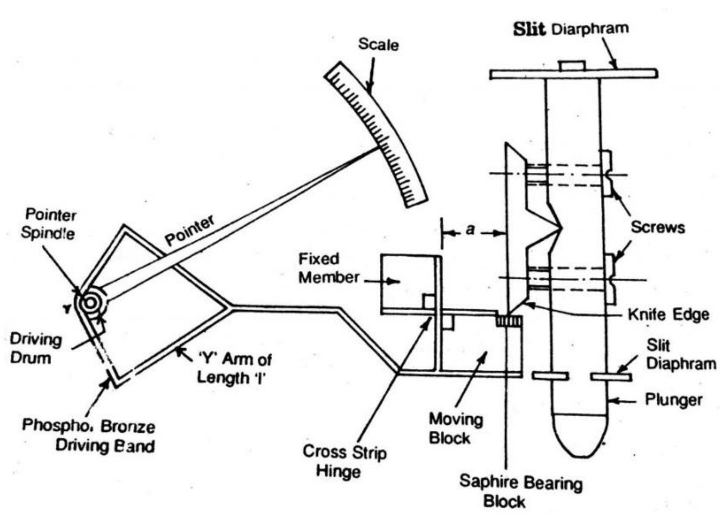
vernier scale reading



c **Explain in brief construction and working of sigma comparator.** **02 marks for explanation, 02 marks for sketch**

Construction and working of Sigma comparator:

- The Plunger will hold the contact with the work piece, and it is positioned in place with the help of slit diaphragms.
- the plunger will have a notch at its centre as shown in the figure.
- A knife Edge is attached to the plunger to magnify the linear movement of the plunger. which is connected to the Cross strip with the help of moving the block.
- The Y-shaped metallic arm is connected to the cross strip to Driving drum. This arm rotated and makes the drum to rotate and hence the pointer will move on the scale.
- The first step of magnification take place at the knife edge and cross strip and the second step of magnification is done at the drum diameter and the pointer length.



Sigma comparator

	d	**Differentiate between hole basis system and shaft basis system.**	**01 mark each any four points**

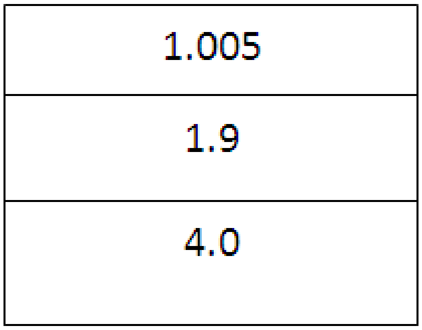
Hole basis system	Shaft basis system
• Size of hole whose lower deviation is zero is assumed as the basis size.	• Size of the shaft whose upper deviation is zero, is assumed as the basis size.
• Limits on the hole kept constant and those of shaft desired type at fit.	• Limits on the shaft kept constant and those on the hot varied to have necessary fit.
• The Hole basis system is referred to in mass production because it is convenient and less costing to make a hole of correct size due to availability by stand grills.	• This system is not suitable for mass production because it is inconvenient and time-consuming and costly to have a shaft of the correct size.
• It is more easily to vary a shaft size according to the fit required.	• It is some difficult to find the hole size according to the fit required.
• It requires less amount of capital and storage space.	• It required large capital, storage space. for a large number of tools required to produce holes of different size.
• Gauging of the shaft can be easily and conveniently done.	• Being internal measurement gauging of the hole cannot be easily conveniently done.

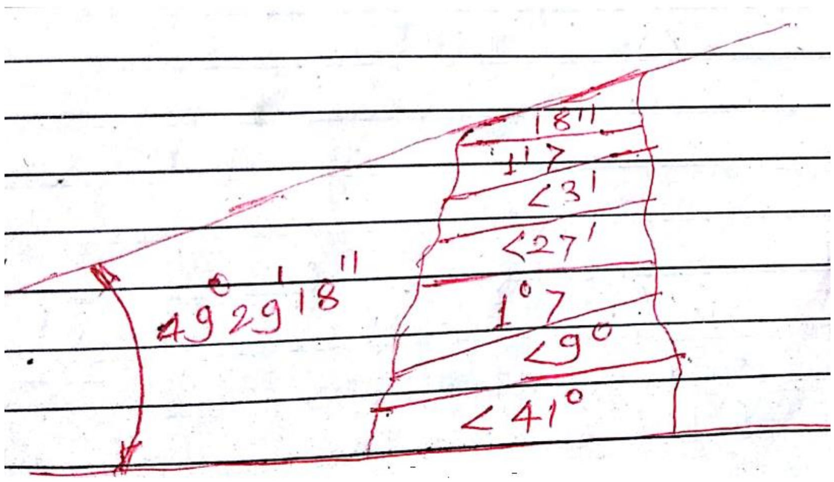
4	a	**Measure a distance of 6.905 mm with the help of slip gauge using 112 set. Show the arrangement with sketch.**	**03 marks for no. of gauges, 01 mark for arrangement**

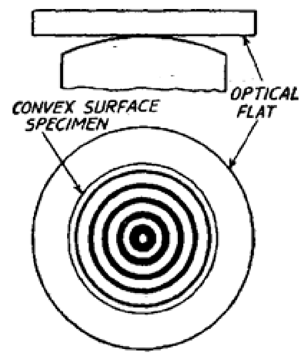
M122/1

step	range	quantity
--	1.0005	01
0.001	1.001-1.009	09
0.01	1.01-1.49	49
0.1	1.6-1.9	04
0.5	0.5-24.5	49
10	30-100	08
--	25. 75	02
	Total	122

Gauges required to build 6.905 mm are- 4.0 + 1.9 + 1.005 = 6.905

		 Slip gauge arrangement By using M112 table we use 1.005, 1.9 and 4.	
	b	**A shaft of 25 +- 0.004mm is to be checked by means of GO and NOGO gauge. Design the dimension of gauge required.** Maximum size = 25+0.004 = 25.004 Minimum size = 25-0.004 = 24.996 GO gauge allows max. shaft dia. Of 25.004 NOGO gauge designed to min. size of 24.996	**04 marks (02 mark for each dimension)**
	c	**Write the examples of use of following types of fits.** **i) Push fit** Requires a moderate pressure. e.g. gear slip bushing, PVC pipe push fit with solvent **ii) Press fit** Interference required to maintain this fit e.g. bushing, bearing pins, gears, pulleys, shaft collar **iii) Running fit** Permits free rotation or movement e.g. nut bolt assembly, running shaft in bearing. **iv) Wringing fit** Provides either zero interference or clearance e.g. gears of machine tools	**01 mark each**

	d	**An angle of 49 degrees 29' 18" is to be developed by using std. angle gauge set of 13 pieces. Calculate the gauges required and sketch the arrangement.** Angle gauge set of 13 pieces **[1^0 3^0 9^0 27^0 41^0] [1' 3' 9' 27'][3" 6" 18" 30"]** **$49^0 = 41^0 + 9^0 - 1^0$;** **29' = 27' + 3' - 1' ;** **18" = 18" total 7 pieces required to build the given dimension.**  **Arrangement of angle gauges**	**03 marks for no of angle gauges, 01 mark for arrangement**
	e	**Explain procedure to determine whether the given surface is concave or convex by using optical flat.** **Concave surface:** If the optical flat is placed on some spherically concave surface. And the contact is made at the central high point and in centre a bright circle will be visible. Around it, there will be concentric dark and bright circular fringes. As the distance from the centre increases, the separation between optical flat and surface keeps on increasing and the fringes become narrow and more closely spaced as shown in fig.	**02 marks each (01 mark for explanation 01 mark for sketch)**

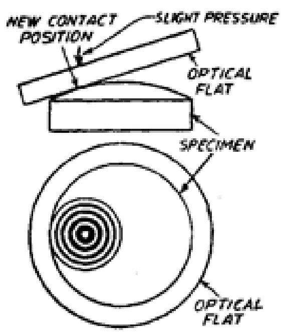


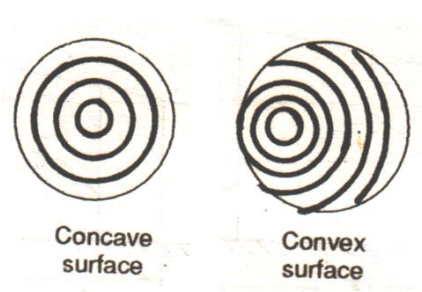
Fringe pattern as observed through optical flat.

Convex surface:

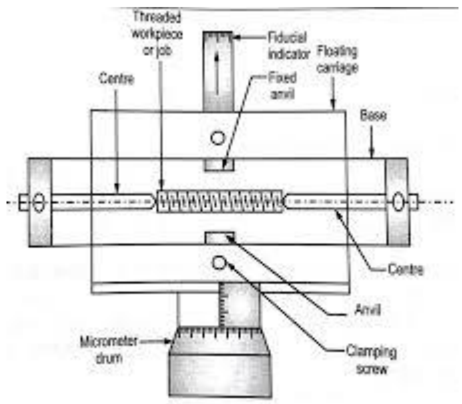
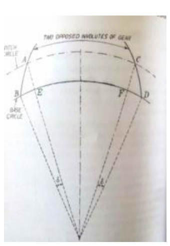
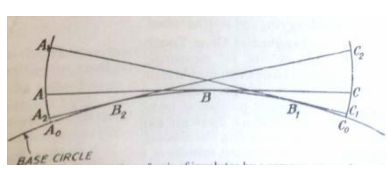
To distinguish between the two conditions of convex and concave surfaces one edge of the optical flat is lightly pressed. In case of convex surface, by light pressure the optical flat will rock on a new high spot and the centre of the fringe pattern will move as shown in Fig. Also the outer fringes will move closer together. In case of spherically concave surface, the flat is resting on a line passing around the surface and on lightly pressing the edge of the optical flat, the edge line does not move as the pressure is varied. Rather, light pressure at the centre will cause the optical flat to be deflected and will become more nearly parallel to the concave surface, thus reducing the number of fringes observed.

Thus if by light pressure, the centre of fringes is displaced and the fringes are brought
closer, it is convex surface and the level at that place must be lowered down to form a flat surface. If by light pressure the number of fringes is reduced and the fringes move apart, it is concave surface.





Test for convex surface.

5	a	**Floating Carriage Micrometer:** -The floating carriage micrometer consists of a three units a) A casting base carries a pair of centers, on which the treaded work piece is mounted. b) Another carriage mounted at exactly 900 to the above, which is capable to move parallel to thread axis. c) Another carriage mounted on the above, which is capable to move at 900 to the thread axis. - on one end of the upper carriage, there is a fixed anvil and a fiducial indicator which ensures that all the measurements are made at same pressure. Floating Carriage Micrometer is supplied with the set of master cylinders and wires, which are used to measure effective diameter of threads. Limitation of floating carriage micrometer is , it can be used for measurement of external threads only. Least count of this instrument is 0.002 mm  Floating carriage diameter measuring machine	**Principle and working - 04, Sketch – 02**
	b	**Base tangent method** In this method, the span of a convenient number of teeth is measured with the help of the tangent comparator. Consider a straight edge ABC being rolled back and forth along a base circle as shown in fig. Its ends thus sweep out opposed involutes A_2AA_1 and C_2CC_1 respectively. Thus the measurements made across these opposite involutes by span gauging will be constant Length of arc BD = distance between two opposite involutes $= Nm \cos\phi[\tan\phi - \phi - \pi/2N + \pi S/N]$   	**Base tangent method - 03, Sketch – 03**

c

h1	45	$(h_1)^2$=2025
h2	42	$(h_2)^2$=1764
h3	40	$(h_3)^2$=1600
h4	30	$(h_4)^2$=900
h5	35	$(h_5)^2$=1225
h6	30	$(h_6)^2$=900
h7	25	$(h_7)^2$=625
h8	25	$(h_8)^2$=625
h9	24	$(h_9)^2$=576
h10	18	$(h_{10})^2$=324
	CLA=31.4	1056.4
		RMS= 32.50231

1) CLA = $|h_1+h_2+h_3+........+h_n| / n$

$= 314/10$

$= 31.4$

2) RMS=$\sqrt{(h_1)^2+(h_2)^2+(h_3)^2+...(h_{10})^2/10}$

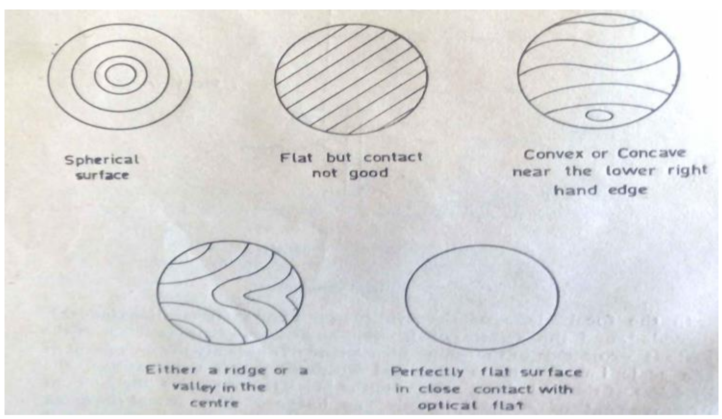
=32.50

CLA -03, RMS – 03

6

a

Sketches of fringe patterns and their meanings



any four interference patterns with meaning 1.5 each

b

Taper angle of plug gauge

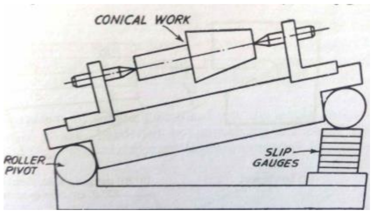
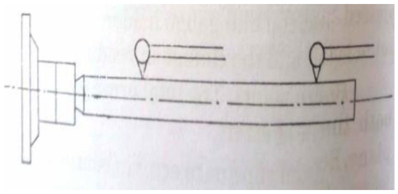
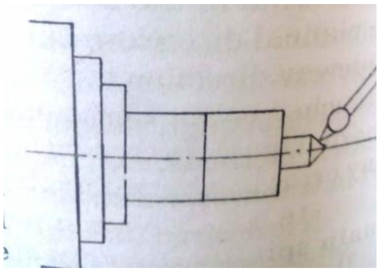
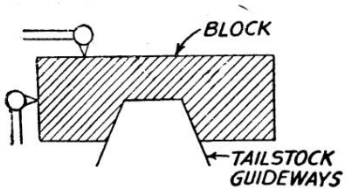
Taper Plug gauge is mounted between sine centers. One roller of sine bar is rested on surface plate, while slip gauges are added below other roller till the tapered edge of gauge becomes parallel to the surface plate. This can be checked using dial indicator and height gauge. Then using sine principle the taper angle can be find out

$\sin\theta = h / L$,

Where θ = taper angle, h= Height of slip gauges, L = center distance between the two rollers of sine bar.

Procedure -03,

Sketch – 03

			
	c	**Alignment test on lathe** (i) Run out of spindle  (ii) Parallelism of tail stock 	**any of these fig - 03 marks**