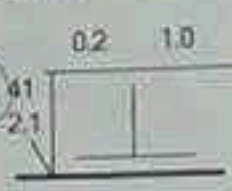
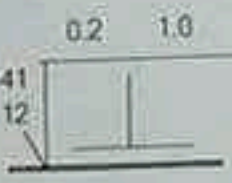
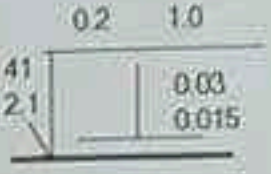
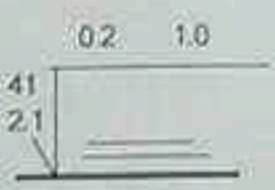
A surface roughness reading was made using a skid stylus devise. The average roughness was 12 µm, the maximum roughness was 41 µm and minimum roughness 2.1 µm. there is no demand to measure the roughness width for this surface. The skid was used and measured a maximum wave height of 0.2 mm and maximum wave width or 1.0 mm. considering a perpendicular lay direction, choose the best surface roughness drawing

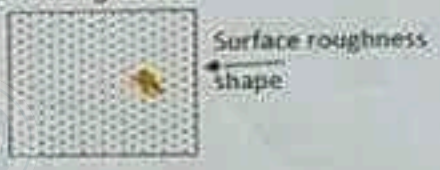
a. 

b. 

c. 

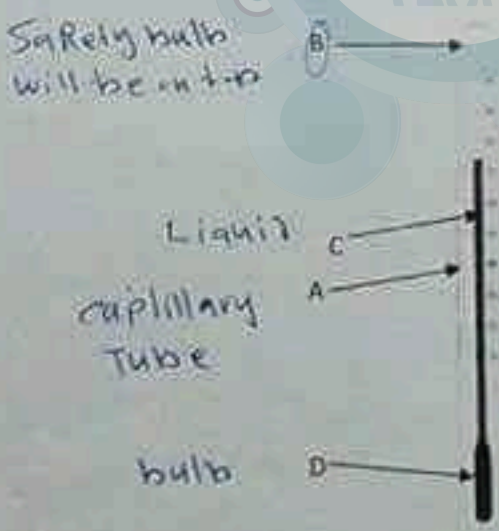
d. 

Choose the correct layout symbol for the following surface roughness:



a. $\sqrt{X}$ b. $\sqrt{C}$ c. $\sqrt{M}$ d. $\sqrt{=}$

Which part of the liquid thermometer shown is needed when the temperature exceeds the temperature range of the thermometer?



emperature can be gauged by one of the following effects:

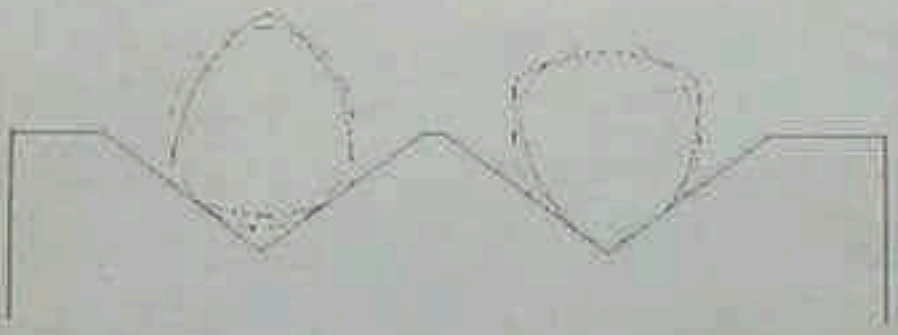
a. Temperature of atmosphere
b. Fluid motion
c. Radiation energy
d. Temperature of human body

quid in glass thermometer is considered which type temperature sensing techniques?

a. Change in physical dimension
b. Change in liquid color due to temperature
c. Change in electrical signal from liquid particles
d. Change in chemical phase (from liquid to vapor)

30
for the following non-cylindrical shape, how do you expect the readings to be if we measure roundness using the Vee block method?

a. The roundness measurement will give a a good roundness reading
b. The roundness measurement will give a smaller out of roundness reading than the actual roundness value
c. The roundness measurement will give a higher out of roundness value than the actual roundness value
d. The roundness measurement will give smaller out of roundness reading for the left measurement shown below, and higher for the right measurement shown below



Metrology and Instrumentation, Final exam, Fall 2017, Dr. Belal Gharaibeh/Eng. Usmaan Al-Dorghom,

Name: 4/1/2018

number: section: seat #:

Q4(3 points) If a thermocouple circuit at T1 and reference temperature of T2=22 C is designed in a room then the second thermocouple measuring from T1 to a junction outside the room at T1= 14 C. The output emf from the first thermocouple circuit was E =0.118 mV, and the second thermocouple circuit was 0.041 What is T1? Use the following thermocouple table if needed

Type T Thermocouple (Blue & Red) Reference Junction 0 °C										
°C	0	1	2	3	4	5	6	7	8	9
0	0.000	0.039	0.078	0.117	0.156	0.195	0.234	0.273	0.312	0.352
10	0.391	0.431	0.470	0.510	0.549	0.589	0.629	0.669	0.709	0.749
20	0.790	0.830	0.870	0.911	0.951	0.992	1.033	1.074	1.114	1.155
30	1.196	1.238	1.279	1.320	1.362	1.403	1.445	1.486	1.528	1.570
40	1.612	1.654	1.696	1.738	1.780	1.823	1.865	1.909	1.950	1.993

Q5(3 points) Using the thermocouples tables above solve the following problem: a surface temperature needs to be measured using thermocouples. It was found that the surface temperature is expected to be 8 C however, the error in the data collecting device is 0.2 mV and you are asked to have at least 3 times the accuracy of the device to avoid error problems. How would you solve this issue knowing that the room temperature is 15 C?

Metrology and Instrumentation class (441)

Fall 2015/2 [illegible]5, 15/12/2015, class work # 4, Dr Belal Sharaibeh

Name: [redacted] student #: [redacted] seat #:

1. You are asked to measure the minor diameter of a 35 mm nominal diameter thread using a bench micrometer, to do so, you choose a calibrated cylinder available in the metrology labs as your setting cylinder with a diameter of 35.004 mm, then you start the measurement of cylinder diameter using the bench micrometer which r[illegible] 35.916 mm) and then, using same procedure, a thread micrometer reading of (35.018 mm) what would you include in your report as the most accurate minor diameter measurement?

$R_t = 35.916 - 35.018 = 0.898$

$R_c = 35.916 - 35.004 = 0.912$

$D_m = D_c + (R_t - R_c)$

$D_m = 35 + (0.898 - 0.912) = 34.986$

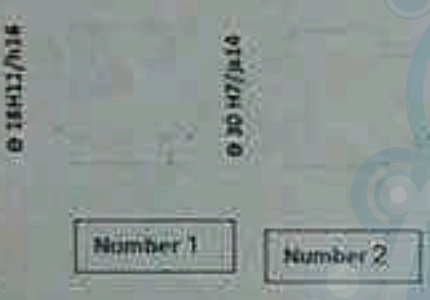
2. The following image describes what type of thread measurement and write the steps of measuring procedure

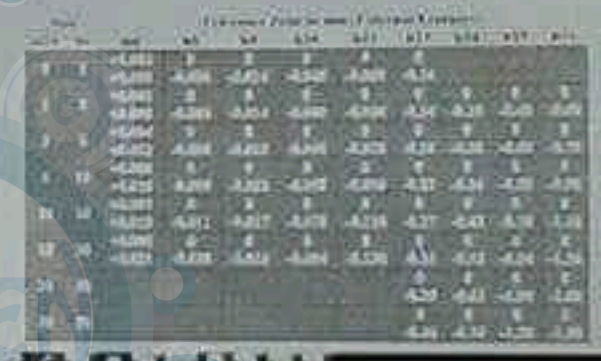
Step minor

[illegible] the name of this error?

25

Use the table below to determine the type of fit for the shaft hole arrangement (number 1)





a. Clearance

b. Interference

c. No relation

d. Transitional

$= 18 - 1.10 = 16.9$ ✓

$= 18 + 0 = 18$ ✓

$18 - 110 = 17.89$

$18 + 0 = 18$

Clearance

$H_{min} > S_{max}$

X

$17.2 < 18$

Interference

$S_{min} > H_{max}$

X

$16.9 < 18$

nstrumentation, Final exam, Fall 2017, Dr. Belal Gharaibeh/Eng. Lamees Al-Durgham, 4/1/2018

number: section: seat #:

ermocouple circuit at T1 and reference temperature of T2=22 C is designed in a room ermocouple measuring from T_2 to a junction outside the room at T_3= 14 C The output hermocouple circuit was E =0.718 mV, and the second thermocouple circuit was 0.641. he following thermocouple table if needed

ouple (Blue & Red) Reference Junction 0 °C

1	2	3	4	5	6	7	8	9
0.039	0.078	0.117	0.156	0.195	0.234	0.273	0.312	0.352
0.431	0.470	0.510	0.549	0.589	0.629	0.669	0.709	0.749
0.830	0.870	0.911	0.951	0.992	1.033	1.074	1.114	1.155
1.238	1.279	1.320	1.362	1.403	1.445	1.486	1.528	1.570
1.654	1.696	1.738	1.780	1.823	1.865	1.908	1.950	1.993

thermocouples tables above solve the following problem: a surface temperature using thermocouples. It was found that the surface temperature is expected to be in the data collecting device is 0.2 mV and you are asked to have at least 3 times vice to avoid error problems. How would you solve this issue knowing that the room

$$P_{1a} - P_{2a} = \frac{(\rho_m - \rho_f)hg}{g_c}, \quad \rho_f = 0$$

$$P_{1a} - P_{2a} = \rho L sin(\theta) g / g_c$$

a. angle should make the manometer length six times longer than the vertical manometer
b. angle should be less than 5 degrees in all cases
c. angle is equal to 9.59 degrees
d. angle depends on manometer fluid density therefore, the density should be 6 times thicker in inclined manometer than the vertical manometer

17.
It is desired to measure water flow rate across a 20 cm pipe by using a venturi obstruction meter. The pressure difference was found by using a u-tube with value of (ΔP= 7.5 kPa). The throat diameter for the venture is 10 cm. water density at 21^{0}C is: ρ= 997.9 kg/m^3 , μ = 9x10^{-4}Pa.s, g=9.81 m/s^2
Determine the flow rate for a venturi meter (laminar incompressible flow), with average value for the discharge coefficient.

$$Re_D = \frac{\rho D V}{\mu}$$

$$E = \frac{1}{\sqrt{1-\beta^4}}, \quad \beta = \frac{d}{D}$$

$$K = CE$$

Laminar-incompressible flow rate:

$$Q_{actual} = KA_2\sqrt{\frac{2g_c(P_1 - P_2)}{\rho}}$$

Turbulent-compressible mass flow rate:

$$W = KA_2 Y\sqrt{2g_c\rho_1(P_1 - P_2)}$$

Venturi characteristics:

$$0.95 < C < 0.98$$

Flow-Nozzle characteristics:

Name: number: section: seat #:

6. A thread dimension is being measured using a bench micrometer, which of the following can be measured using this instrument
a. major and pitch
b crest and root smoothness
c. effective diameter and pitch
d. minor and major diameters

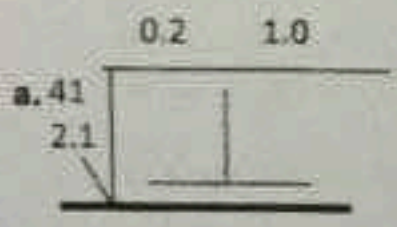
7.You are asked to design a liquid glass thermometer. To do so you need to choose between two types of liquids. Liquid (1) has a good coefficient of expansion and it will expand in the glass by 1 mm for each 1°C increase temperature. Liquid (2) has a better coefficient of expansion but it will expand in the glass by 2 mm for each 1°C for the first 10°C and then it will expand by 2.5 mm for each 1°C after that. Which liquid should you choose to include in the glass thermometer.

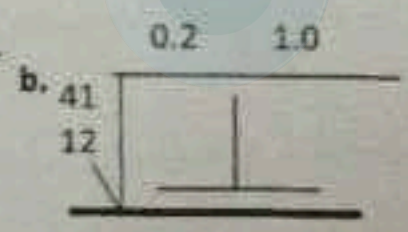
a. Liquid (1)
b. Liquid (2)
c. Same effect
d. Use both liquids together

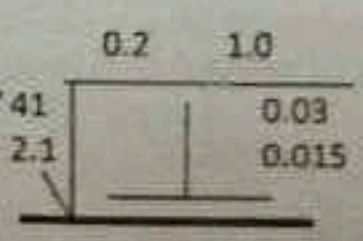
8. Which of the following temperature measuring methods has an inverse response to temperature?
a. thermistors
b. RTD
c. Liquid thermometer
d. Thermocouples

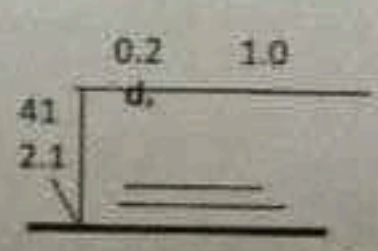
9. five (5) thermocouples are connected in series and installed in a furnace to measure the temperature during furnace operation. The output of the 5 thermocouples was 1500 °C, what is the actual temperature of the furnace?
a. 7500°C
b. 1500°C
c. 300°C
d. none of the above

10. A surface roughness reading was made using a skid stylus devise. The average roughness was 12 µm, the maximum roughness was 41 µm and minimum roughness 2.1 µm. there is no demand to measure the roughness width for this surface. The skid was used and measured a maximum wave height of 0.2 mm and maximum wave width or 1.0 mm. considering a perpendicular lay direction, choose the best surface roughness drawing

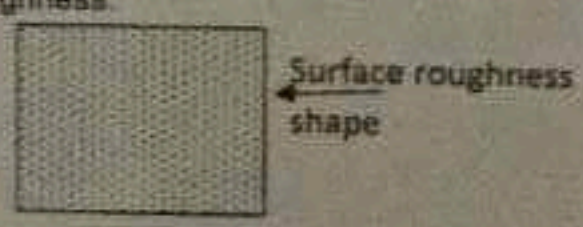
a. 

b. 

c. 

d. 

11. Choose the correct layout symbol for the following surface roughness



a. $\sqrt{X}$ b. $\sqrt{P}$ c. $\sqrt{C}$ d. $\sqrt{=}$

19.

If the maximum stress for an orifice was 100 Pa, what would be the dimensional ratio (diameter/thickness) to design an orifice for a pipe of 20 cm diameter and using an orifice of 10 cm diameter. The pressure difference was found by using a u-tube with value of (ΔP= 7.5 kPa) water density at 21°C is, ρ= 997.9 kg/m^3, μ = 9x10^{-4}Pa.s, g=9.81 m/s^2.
the same pressure difference and same venture diameter ratio

β	0.2	0.3	0.4	0.5	0.6	0.7	0.8
F	0.18	0.17	0.15	0.12	0.09	0.06	0.04

Orifice characteristics:
Max stress

$$\sigma_{max} = \frac{FD^2\Delta P}{t^2}$$

20.

what determines if the fluid flow rate laminar or turbulent?
a. density of the fluid
b. speed of the flow
c. pipe diameter
d. Reynolds number

a. angle should make the manometer length six times longer than the vertical manometer
b. angle should be less than 5 degrees in all cases
c. angle is equal to 9.59 degrees
d. angle depends on manometer fluid density therefore, the density should be 6 times thicker in inclined manometer than the vertical manometer

37.
It is desired to measure water flow rate across a 20 cm pipe by using a venturi obstruction meter. The pressure difference was found by using a u-tube with value of (ΔP= 7.5 kPa). The throat diameter for the venture is 10 cm, water density at 21°C is ρ= 997.9 kg/m^3, $\mu = 9\times10^{-4}$ Pa.s, g=9.81 m/s^2
Determine the flow rate for a venturi meter (laminar incompressible flow), with average value for the discharge coefficient.

$$Re_D = \frac{\rho D V}{\mu}$$

$$E = \frac{1}{\sqrt{1-\beta^4}}, \quad \beta = \frac{d}{D}$$

$$K = CE$$

Laminar-incompressible flow rate:

$$Q_{actual} = KA_2\sqrt{\frac{2g_c(P_1 - P_2)}{\rho}}$$

Turbulent-compressible mass flow rate:

$$W = KA_2Y\sqrt{2g_c\rho_1(P_1 - P_2)}$$

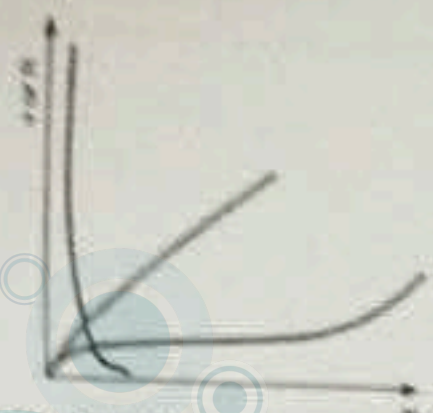
Venturi characteristics:

$$0.95 < C < 0.98$$

Flow-Nozzle characteristics:

Name: Number: Section: Seat #:

16. Indicate on the figure below the response shape for the three temperature measurements types discussed in class



17. Liquid in glass thermometer is considered which type temperature sensing technologies?

a. Change in physical dimension
b. Change in liquid color due to temperature
c. Change in electrical signal from liquid particles
d. Change in chemical phase (from liquid to vapor)

18. one of the following cases is better measured using intrinsic roundness measurement tools:
a. odd lobbed shaped cylinder small in shape around 800 mm diameter
b. a shaft with warped shape knowing that the shaft can be fixed to a lathe machine
c. small cylindrical part in the range of 60 mm diameter
d. large shaft (2 m diameter) and also attached to a big motor

19. In the picture below, what do you expect the operator is trying to measure:

a. the dimension under the wire
b. the simple effective diameter
c. thread pitch
d. the dimension over the wire

20. Temperature can be gauged by one of the following effects:

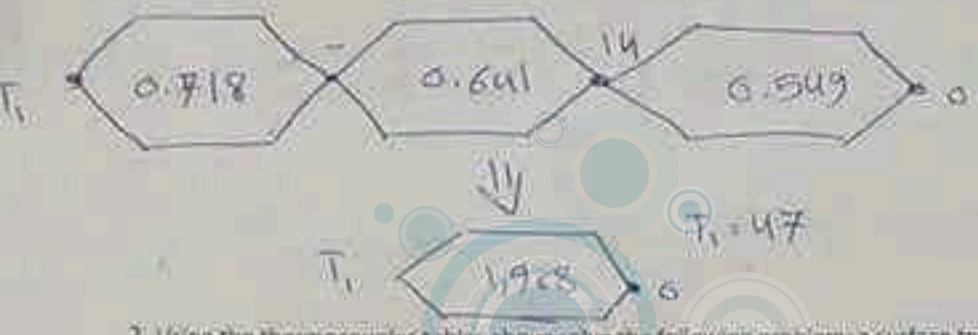
a. Temperature of atmosphere
b. Fluid motion
c. Radiation energy
d. Temperature of human body

Name: ID#: Seat #:

Quiz #5: temperature measurement, wed. 4.5.2016 section#2. Dr. Belal Gharaibeh Metrology

1.If a thermocouple circuit at T1 and reference temperature of 12=22 C is designed in a room then the second thermocouple measuring from T_2 to a junction outside the room at T_3= 14 C. The output emf from the first thermocouple circuit was E =0.718 mV, and the second thermocouple circuit was 0.641. What is T1? Use the following thermocouple table if needed

Type T Thermocouple (Blue & Red) Reference Junction 0 °C										
°C	0	1	2	3	4	5	6	7	8	9
0	0.000	0.039	0.078	0.117	0.156	0.195	0.234	0.273	0.312	0.352
10	0.391	0.431	0.470	0.510	0.549	0.589	0.629	0.669	0.709	0.749
20	0.790	0.830	0.870	0.911	0.951	0.992	1.033	1.074	1.114	1.155
30	1.196	1.238	1.279	1.320	1.362	1.403	1.445	1.486	1.528	1.570
40	1.612	1.654	1.696	1.738	1.780	1.823	1.865	1.908	1.950	1.993



2. Using the thermocouples tables above solve the following problem: a surface temperature needs to be measured using thermocouples. It was found that the surface temperature is expected to be 6 C however, the error in the data collecting device is 0.2 mV and you are asked to have at least 3 times the accuracy of the devic to avoid error problems. How would you solve this issue knowing that the room temperature is 15 C?

3. What should be the diameter of a capillary tube needed for a glass thermometer if the fluid chose has thermal expansion coefficient of 0.05 mm³/°C and you are asked to have a scale deviation of 0.75 mm on the tube?

$0.05 = A(6.75)$

$A = \frac{\pi}{4} D^2 = 0.0667$

$D^2 = 0.0848$

Error = 0.355

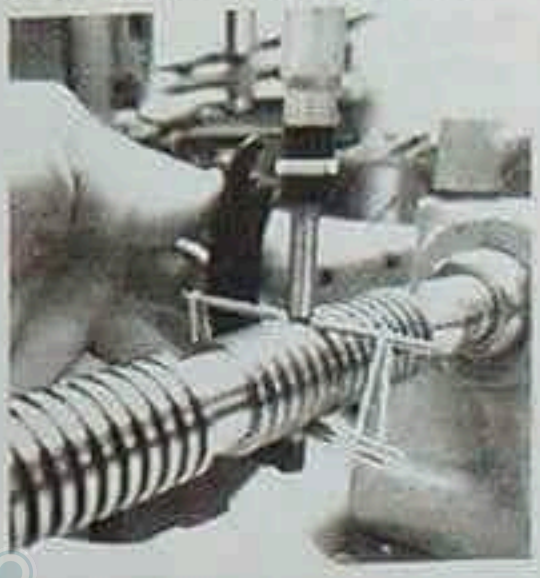
Emf exp

D = 6.2913 mm

5

In the picture below, what do you expect the operator is trying to measure:

a. the dimension under the wire
b. the simple effective diameter
c. thread pitch
d. the dimension over the wire



6

Saddle fault and incorrect lead screw are reason for the following type of error:

a. periodic error
b. progressive error
c. design error
d. drunken pitch error

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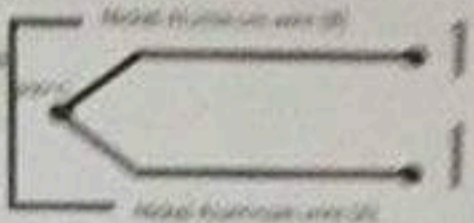
Name: number: section: page #

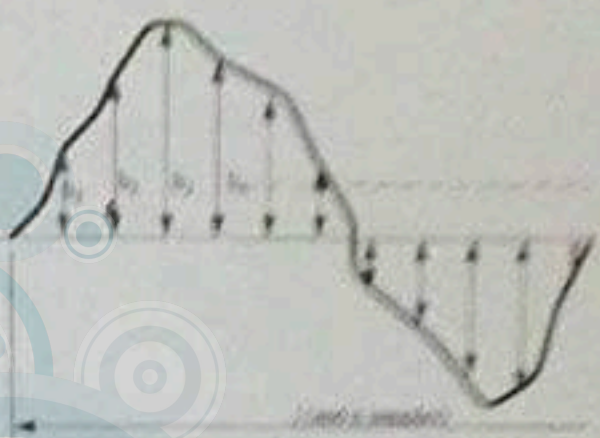
12 For the drawing shown What is the temperature measurement?

a. emf value for 300°C minus the reference junction temperature
b. emf value for temperature of 300°C
c. zero emf reading regardless of the temperature value
d. none of the above



13. The CLA for the following surface roughness is

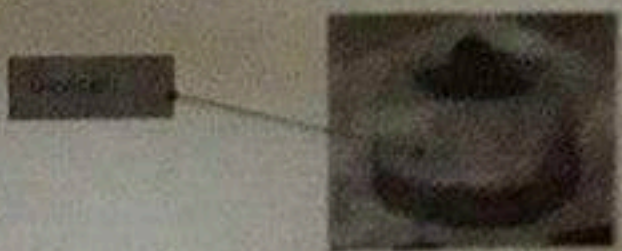
Position of stylus	Absolute elevation from A-A, μm
h1	4
h2	7
h3	11
h4	8
h5	7
h6	4
h7	2
h8	9
h9	7
h10	9
h11	0 9



14. Which part of the liquid thermometer shown is needed when the temperature exceeds the temperature range of the thermometer and the liquid is still expanding?
Indicate your answer by circling the right answer on the drawing

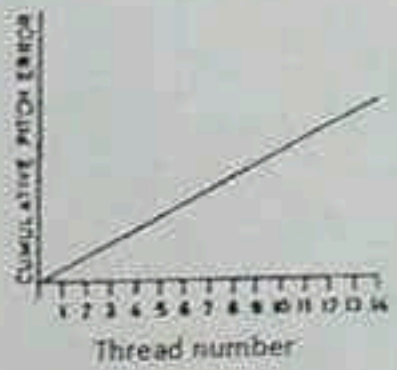
15. You are working at the cheese cake factory! You are asked to measure the temperature of the cheese cake while it is cooling down. Because the cake is made of cheese, it is required to cool it down in a very fast way and nonlinearly which requires a sensitive with fast response temperature measurement device. Which of the following temperature measurement devices you should use?

a. thermocouple b. liquid-glass thermometer c. Thermistors d. RTD



The following figure shows a type of pitch error, what is the name of this error?

a. thread drunkenness
b. cumulative pitch error
c. progressive pitch error
d. linear pitch error



2.
When a shaft and hole have a complete interference, it means that:
a. maximum metal size of hole – minimum metal size of shaft = negative value
b. minimum metal of hole-minimum metal of shaft= negative value
c. no relation to metal size
d. maximum metal of hole-maximum metal of shaft= negative value

3.
For the following drawing, determine the choice that describes the condition of t
mating parts:

Part A

Part B

a. Part A is a shaft and Part B is a hole
b. Part A is a hole and Part B is a shaft
c. None of the above, d. Part A is a tooth and Part B is a gear

4.
A thread dimension is being measured using a bench micrometer, which of the f
can be measured using this instrument
a. major and simple effective diameter
b. minor and major diameters
c. effective diameter and pitch
d. crest and root smoothness

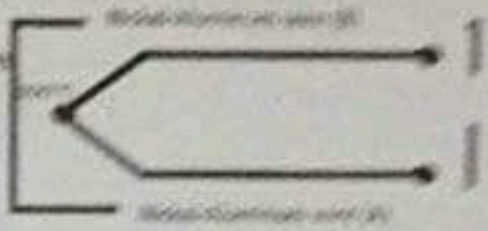
Metrology and Instrumentation, Final exam, Fall 2017, Dr. Belal Gharaibeh, Eng. Ameen Al-Zoghoul

4/1/2018

Name: number: section: seat #

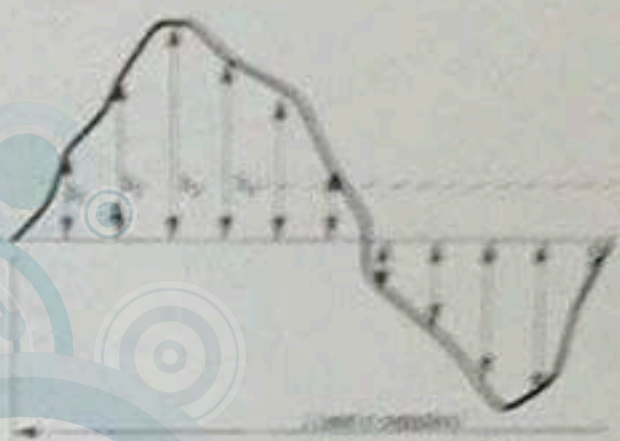
12 For the drawing shown What is the temperature measurement?

a. emf value for 300°C minus the reference junction temperature
b. emf value for temperature of 300°C
c. zero emf reading regardless of the temperature value
d. none of the above

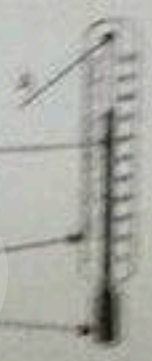


13. The CLA for the following surface roughness is:

Position of stylus	Absolute elevation from A-A, μm
h1	4
h2	7
h3	11
h4	8
h5	7
h6	4
h7	2
h8	9
h9	7
h10	8
h11	0.9



14. Which part of the liquid thermometer shown is needed when the temperature exceeds the temperature range of the thermometer and the liquid is still expanding?
Indicate your answer by circling the right answer on the drawing



15. You are working at the cheese cake factory! You are asked to measure the temperature of the cheese cake while it is cooling down. Because the cake is made of cheese, it is required to cool it down in a very fast way and nonlinearly which requires a sensitive with fast response temperature measurement device. Which of the following temperature measurement devices you should use?

a. thermocouple b. liquid-glass thermometer c. Thermistors d. RTD

12.

You are asked to measure the minor diameter of a 30 mm nominal diameter thread using a bench micrometer, to do so, you choose a calibrated cylinder available in the metrology labs as your setting cylinder with a diameter of 30.004 mm, then you start the measurement of cylinder diameter using the bench micrometer which reads (29.908 mm) and then, using same procedure, a thread minor diameter reading of (30.019 mm) what would you include in your report as the most accurate minor diameter measurement?

Nominal Diameter = 30 mm

Cylinder Diameter = 30.004 mm D_c

Micrometer reading cylinder = 29.908 R_c

Thread diameter = 30.019 mm R_L

$D_m = D_c + (R_L - R_c)$

$= 30.004 + (30.019 - 29.908)$

$= 30.115$

13.

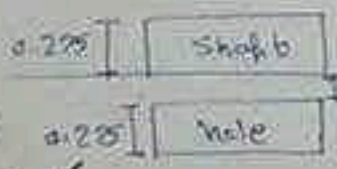
A medium force fit on a 75 mm shaft requires a hole and shaft tolerance equal to 0.225 mm and an interference of 0.0375 mm. determine the dimensions of the hole and shaft using the shaft based system.

max shaft = 75 + 0.225 = 75.225 mm

min shaft = 75 mm

max hole = 75 − 0.0375 = 74.9625 mm

min hole = 75 − 0.0375 − 0.225 = 74.7375 mm



14.

Determine the angle of inclination for the inclined manometer if the sensitivity is six times higher for the inclined manometer than a regular manometer

$$P_{1a} - P_{2a} = \frac{(\rho_m - \rho_f)hg}{g_c}, \quad \rho_f = 0$$

$$\gamma = \frac{\rho_x}{\rho_{H2O}}$$

as per question

$$P_{1a} - P_{2a} = \rho L \sin(\theta) g / g_c$$

$$\theta = \sin^{-1}\left(\frac{6 \cdot \rho_{H2O} * h}{\rho L}\right) \text{ or}$$

$$\sin^{-1}\left(\frac{8 \cdot \rho_{H2O} * h}{\rho L}\right)$$

$M = 1 \times 10^{-4}$

$\rho = 995$

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Answer the following questions and show full calculations

Q2(3 points) Determine the flow rate for a nozzle of 15 cm diameter for a pipe of 20 cm diameter knowing that the pressure difference was found by using a u-tube manometer with value of (ΔP= 7.5 kPa). Consider laminar incompressible flow and start by estimating the velocity for ideal flow rate.

Q3(3 points) If the maximum stress for an orifice was 100 Pa. what would be the dimensional ratio (diameter/thickness) to design an orifice for the same pressure difference in question 2

$g_c = 1$

$$Re_D = \frac{\rho D V}{\mu}$$

$$E = \frac{1}{\sqrt{1-\beta^4}}, \quad \beta = \frac{d}{D}$$

Laminar-incompressible flow rate:

$$K = CE$$

Turbulent-compressible mass flow rate:

$$Q_{actual} = KA_2\sqrt{\frac{2g_c(P_1 - P_2)}{\rho}}$$

$$W = KA_2Y\sqrt{2g_c\rho_1(P_1 - P_2)}$$

Venturi characteristics:

$$0.95 < C < 0.98$$

Flow-Nozzle characteristics:

$$C = 0.99622 + 0.00059D - \frac{(6.36 + 0.13D - 0.24\beta^4)}{Re_D}$$

Orifice characteristics:

Max stress

$$\sigma_{max} = \frac{FD^2\Delta P}{t^2}$$

β	0.2	0.3	0.4	0.5	0.6	0.7	0.8
F	0.18	0.17	0.15	0.12	0.09	0.06	0.04

10.
An engineer is asked to measure the roundness of a small regular odd lobed shaped cylinder, which roundness intrinsic method should he/she use?

a. Diametric intrinsic method
b. between centers method
c. eccentricity method
d. vee support intrinsic method

B

Even lobed shape

11
what would be the eccentricity for the results of two spheres shown in the graph, if the device has 1000 magnification?

$$Eccentricity = \frac{Y - X}{2} \times \frac{1}{magnification}$$

a. 0.002
b. 0.0025
c. 0.0015
d. 0.003

$$\frac{6-1}{2} * \frac{1}{1000}$$

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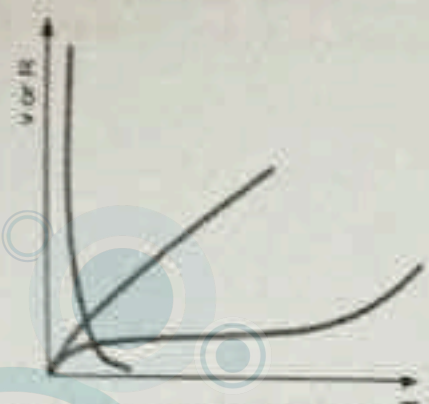
18. Indicate on the figure below the response shape for the three temperature measurements types discussed in class



17. Liquid in glass thermometer is considered which type temperature sensing techniques?

a. Change in physical dimension
b. Change in liquid color due to temperature
c. Change in electrical signal from liquid particles
d. Change in chemical phase (from liquid to vapor)

18. one of the following cases is better measured using intrinsic roundness measurement tools:
a. odd lobbed shaped cylinder small in shape around 500 mm diameter
b. a shaft with warped shape knowing that the shaft can be fixed to a lathe machine
c. small cylindrical part in the range of 60 mm diameter
d. large shaft (2 m diameter) and also attached to a big motor

19. In the picture below, what do you expect the operator is trying to measure:

a. the dimension under the wire
b. the simple effective diameter
c. thread pitch
d. the dimension over the wire

20. Temperature can be gauged by one of the following effects:

a. Temperature of atmosphere
b. Fluid motion
c. Radiation energy
d. Temperature of human body

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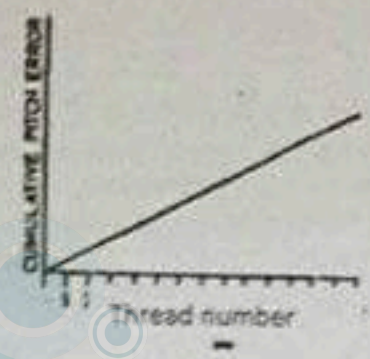
Choose the correct answer or final answer for the following questions (1 point each)

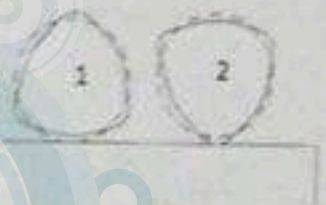
1. The following figure shows a type of pitch error, what is the name of this error?

a. thread drunkenness
b. cumulative pitch error
c. linear pitch error
d. progressive pitch error



2. In the following roundness measurement case, what do you expect the measurement results for reading 1 and reading 2?

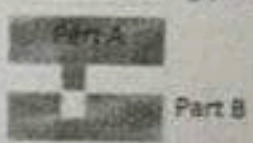
a. Reading 1 > reading 2
b. Reading 1 < reading 2
c. Reading 1 = reading 2
d. No relation



3. for the following surface roughness features (1 & 2), how do you expect the CLA (R_a) value would be:

a. Ra1=Ra2 b. Ra1 > Ra2 c. Ra1<Ra-2 d. no relation between Ra1 and Ra2

4. For the following drawing, determine the choice that describes the condition of the mating parts:



a. Part A is an external thread and Part B is an internal thread
b. Part A is a hole and Part B is a shaft
c. Part A is a shaft and Part B is a hole
d. None of the above

5. Interchangeable manufacturing is related to which of the following:
a. changing cutting tools and dies in a fast and reliable fashion
b. changing thermocouples to measure temperature more accurately
c. limits of dimensions of mating parts during assembly including tolerances and fits
d. accuracy in measuring thread dimensions