EXERCISE 1-1
GD&T Skill Survey

1. C
2. A
3. E
4. B
5. C
6. A
7. C
8. C
9. D
10. A
11. A
12. A
13. C
14. T
15. F
16. F
17. F
18. T
19. C
20. E
21. A
22. A
23. A centerplane datum
24. A planar datum
25. An axis datum
26. An axis datum
27. E
28. C
29. Legal
30. Illegal
31. Legal
32. Legal
33. Illegal
34. Illegal
35. Legal
36. Illegal
37. Legal
38. Illegal
39. C
40. D
41. 8.4
42. 16

EXERCISE 1-2
Self-Assessment of GD&T Fundamentals

Rate your understanding of each topic. Place an X in the column that represents your assessment of your knowledge level. Connect your Xs with a line. Any topic assessment of knowledge level below 70% would be a weakness List your strengths and weaknesses below.

		Needs to be Reviewed									Fully Understand
Topic	Skill Survey Question #	10	20	30	40	50	60	70	80	90	100
Terminology	2,14,18,~~22~~								X		
Rules	1,~~5~~,6,~~10~~						X				
Modifiers	13,17,~~18~~							X			
Bonus	8,20,~~28~~							X			
Datum Shift	~~9~~,12,~~27~~			X							
Virtual Condition	10,~~11~~					X					
Planar Datums	24,39,40								X		
Feature of Size Datums	~~4~~,7,16,23,25,~~26~~					X					
Datum Targets	3,~~15~~,21					X					
Recognizing Improper GD&T	29-38						X				
Calculating Part Distances	41,~~42~~			X							

Weaknesses:
1. Datum Shift
2. Calculating part distances

Strengths:
1. Planar datums
2. Terminology
3. Modifiers

EXERCISE 2-1
The Importance of Design

1. T
2. F
3. F
4. T
5. T
6. F
7. T
8. T

EXERCISE 3-1
Tolerancing

1. T
2. T
3. T
4. F
5. T
6. F
7. F
8. T
9. T
10. F

EXERCISE 3-2
The Importance of Functional Dimensioning

1. T
2. T
3. T
4. F
5. A
6. C
7. B
8. D

EXERCISE 4-1
Interpretation of Feature

1. 4 X Ø8 ± 0.2 holes,
   12 ± 1 X 6 ± 0.2 elongated holes
2. None
3. Dimension E, surface C of part
4. Revolved surface, regular feature
5. C
6.

Dimension Label	Applied to Element Type
D	Circular
E	Lines
F	Lines
G	Points

7. C
8. C
9. F
10. F

EXERCISE 5-1
Interpretation of Feature of Size

1.

Surfaces	Fully Opposed	Partially Opposed	Not Opposed
A, B		X	
A, C			X
B, C		X	
C, D		X	
A, D		X	
E, F	X		

2. Ø5, Ø12.4, Ø2.9, Ø20, 8, 35.7-36.3,
   Ø24.1, 11-12, 36, Ø3.05, Ø54

3.

Feature of Size	Category			
	Complete	Partial	Interrupted	Bounded
Ø5	X			
Ø12.4	X			
Ø2.9			X	
Ø20	X			
8		X		
35.7-36.3		X		
Ø24.1	X			
11-12		X		
36	X			
Ø3.05	X			
Ø54			X	

4. T
5. T
6. F
7. F
8. F
9. F
10. F

EXERCISE 6-1
Applicable Drawing Standards

1. T
2. T
3. T
4. T
5. T

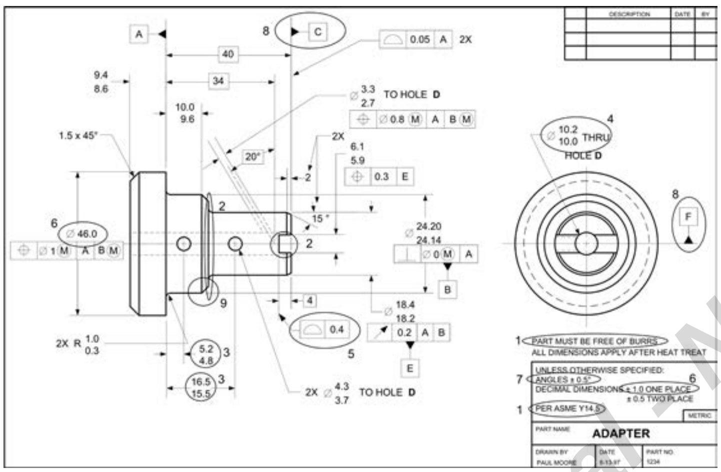
EXERCISE 7-1
Drawing Interpretation: Titleblock, Fundamental Rules, Notes

1. T
2. T
3. F
4. F
5. F
6. F
7. F

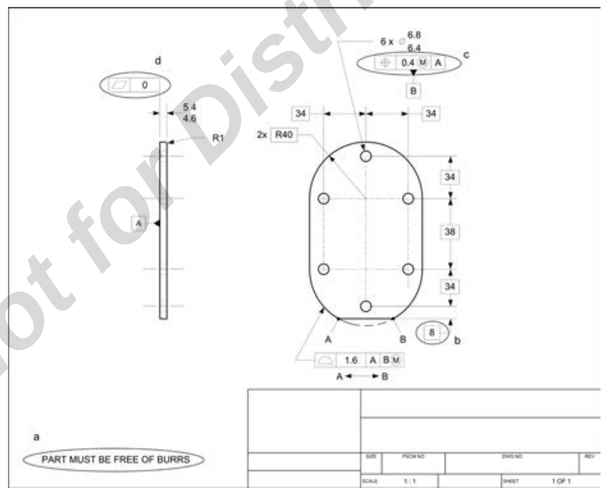
EXERCISE 7-2
Drawing Interpretation: Datums, Feature Definition, Coordinate Tolerances

1. T
2. T
3. T
4. F
5. T
6. F
7. F
8. T
9. T

EXERCISE 7-3
Drawing Interpretation: Guidelines, Vague Drawings



EXERCISE 8-1
Substandard Drawings



2. T
3. F
4. T
5. F
6. F
7. F

EXERCISE 9-1
Rigid/Non-Rigid Part Definitions

1. T
2. T
3. T
4. T
5. B
6. C
7. E
8. D
9. A
10. B

EXERCISE 10-1
Restraint Notes

1. A
2. A
3. C
4. Included - Amount of force, direction of force, number of places force applies, location of force
   Not included - Area of contact, sequence of applying the force
5. T
6. T
7. F
8. F
9. T
10. T
11. A, C, E, F, G

EXERCISE 11-1
Restrained Part Tolerances

1.

⊥ | ⌀0.2 Ⓜ Ⓕ | A	⌖ | ⌀0.5 Ⓜ Ⓕ | E | F Ⓜ
⌖ | ⌀1 Ⓜ Ⓕ | E | G Ⓜ	⌓ | 1.5 Ⓕ
⌖ | 0.2 Ⓜ Ⓕ | A | B Ⓜ	⊥ | 0.5 Ⓜ Ⓕ | E

2. Free state; the restraint note specifies that only geometric tolerances are to be measured in the restrained state.
3. X direction - 0.8; Y direction - 0.8
4. Free state - 1.5; restrained state - 0.2
5. The small holes are toleranced relative to the larger hole. The restraint condition would not significantly affect the relationship.
6. Free state - not specified; restrained state - 0.1
7. 4
8. No; it is non-rigid, so it will conform to touch all four targets

EXERCISE 12-1
Calculating Flatness Tolerance Values

1.

Design Proposal Number	F Gasket Free Height	CR Gasket Compression Rating %	C_{max} Compressed Height	S_{min} Min. Gasket Squeeze	⏥ combined Hsg. * Flatness	⏥ combined Cover * Flatness
1	0.84 0.80	28 -30	0.605	0.02	0.08	0.08
2	0.60 0.56	24 - 28	0.456	0.02	0.04	0.04
3	0.50 0.46	20 - 24	0.4	0.02	0.02	0.02
4	0.46 0.42	30 - 34	0.322	0.02	0.02	0.05
5	0.50 0.46	16 - 20	0.420	0.02	Not Possible	0.04

EXERCISE 12-2
Cylindricity

1. 0.007
2. No; it would not control the straightness of the line elements
3. a. No
   b. Verify the validity of the design requirement and increase the tolerances. Select a more capable process to make one or both adjacent parts. Add another operation to increase the capability of one or both processes. Redesign the application.

EXERCISE 12-3
Straightness Tolerance Values

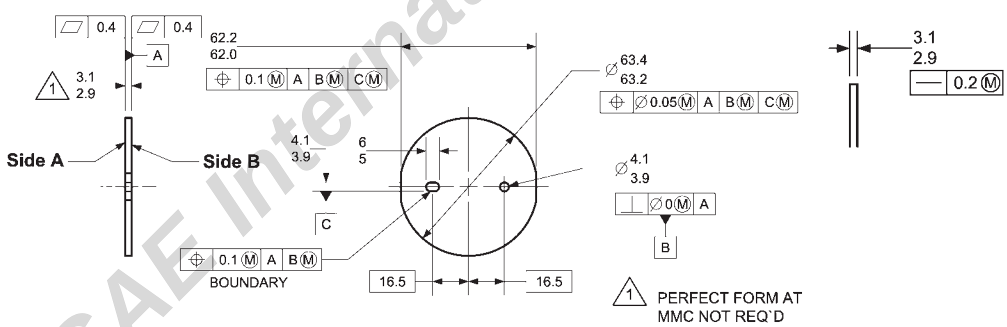
1.

Minimum Clearance for Assembly	Virtual Condition of Housing Dia.	MMC of Screw	Virtual Condition of Screw	Straightness Tolerance on Screw
0	7.15	6.0	7.15	1.15
0.1	7.15	6.0	7.05	1.05
0.2	7.15	6.0	6.95	0.95
0.5	7.15	6.0	6.65	0.65

2. No; in this case, the size tolerance is limited by the thread size.

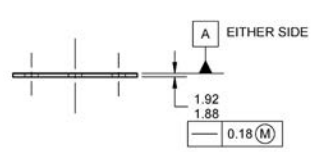
EXERCISE 12-4
Using Straightness on Thin Parts

1. 0.1
2. 0.2
3.



4. B
5. C
6. A 1.92mm as specified
   B. 0.04mm, 1.92-1.88=0.04mm

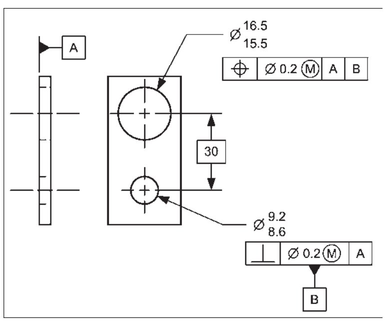
C.



EXERCISE 13-1
When to Use Datums

1. Yes; the sequence for holding the part on the inspection equipment needs to be specified.
2. To establish a functional relationship between part features
   To relate the measurement of a dimension to a datum reference frame
3. Lower; it communicates the same requirements to manufacturing and inspection
4. No; a very simple part like a pin or a ball bearing does not need datums

EXERCISE 13-2
Datums: Advantages, Misconceptions, Errors

1. I, F
2. H, K
3. A, C, G
4. 

5. B

EXERCISE 13-3
Planar & Coplanar Datum Features

1. Specifications Datum A and Datum B
2. The 152.5 and 22 MIN dimension has an implied datum sequence
3. Datum feature C is not large enough to be a repeatable primary datum feature

EXERCISE 14-1
Planar & Coplanar Datum Features

1. C
2. D
3. For the convenience of manufacturing
   For the convenience of inspection
4. Use datum targets
5. C
6. A

EXERCISE 14-2
Offset Planar Surfaces as a Datum Feature

1. A, B, C; They are referenced as co-primary
2. NA; There is no secondary datum reference in the feature control frame
3. C
4. B

EXERCISE 14-3
Cylinder as a Datum Feature

1. C
2. A
3. B, C, F
4. C

EXERCISE 14-4
Coaxial Cylinders as Datum Features

1. B
2. A
3. B, C, F
4. C

EXERCISE 14-5
Offset Surfaces, Pattern of Holes as Datum Feature

1. A-B; These surfaces orient the part in the assembly
2. C; The pattern of holes locate the part in the assembly
3. No; That is not the way holes function
4. No; It is difficult (some say impossible) and very expensive to simulate a pattern of holes as RFS in a datum simulator
5. No; The outside edges are clearance and have no bearing on the function

EXERCISE 14-6
Coplanar Surfaces, Pattern of Holes and Widths as Datum Features

1. A 10.0 gage width that is perpendicular to datum plane A
2. A basic implied zero
3. No; Datum feature B locates the part
4. The orientation of a secondary datum relative to the primary datum should be specified
5. The holes should be located from surface C; that is the way the part function is described in the problem description
6. C primary, D M secondary, and B M tertiary

EXERCISE 14-7
Coplanar Widths as Datum Features

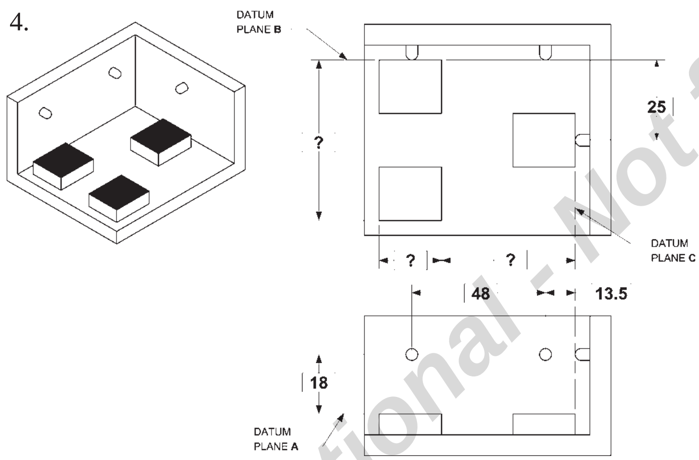
1. B
2. C
3. B, C, F
4. B

EXERCISE 14-8
Pattern of Slots as a Datum Feature

1. No difference in this case; co-secondary & tertiary produce the same results
2. B
3. B
4. B
5. No; It depends on the geometric tolerances. Some geometric tolerances only require 3 degrees of freedom to be constrained.

EXERCISE 15-1
Datum Target - Requirements/Applications

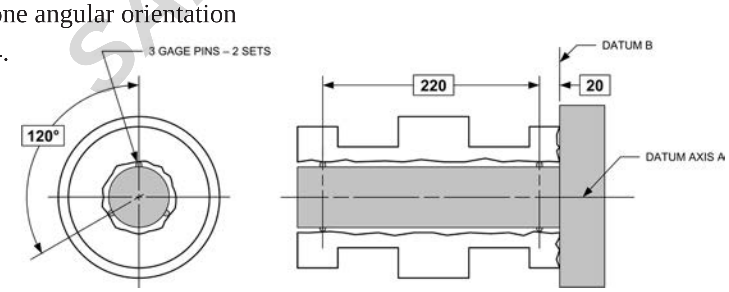
1. A, E
2. B, E
3. A, B, E
4.



5. Rest on 3 gage pads for A first, touch B seocnd, and touch C third. Part to gage relationship is repeatable.
6. Rest on 3 gage pads for A. No - part to gage rela tionship is not repeatable.
7. Touch 2 points for B, then rest on 3 gage pads for A, then touch one point for C. Part to gage relationship is not repeatable.
8. Two ways:
   1. Use “A” as the primary datum reference.
   2. Add “B” and “C” as secondary and tertiary datum references.
9. Basic dimensions not used to define target sizes.

EXERCISE 15-2
Variable and Fixed Datum Targets

1. Spherical-tipped
2. Variable; The gage pins need to expand to touch the part surface
3. No; Need a tertiary datum to ensure the part fits on the gage in only one angular orientation
4.



5. No; needs a tertiary datum to ensure the part fits on the gage in only one angular orientation

EXERCISE 15-3
Cylindrical Datum Target Area, Coaxial Diameters

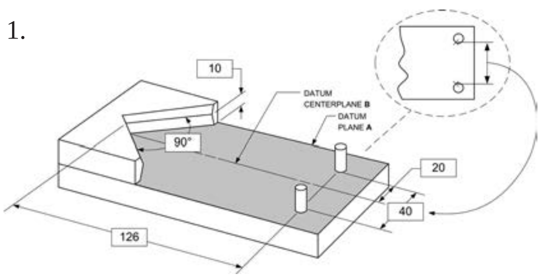
1. A portion of the 11.0-11.6 diameter
2. Partial length; By the datum targets specification
3. Variable; No basic diameter shown
4. Full length; No datum target shown
5. Yes; To obtain part to gage repeatability
6. To locate the hole relative to the 6.0-6.4 diameter axis

EXERCISE 15-4
Datum Target Points and Areas on Cylindrical Datum Features

1. Variable; No basic diameter is give.
2. The part will be held on datum features A and B simultaneously.
3. No; When inspecting the position control, there is no secondary datum referenced. Therefore, there is no way to locate the part (axially) relative to the gage.
4. Two additional items need to be addressed: 1. Add a secondary datum reference. 2. Change targets for “B” to a cylindrical line or area.

EXERCISE 15-5
Datum Targets for V-Block

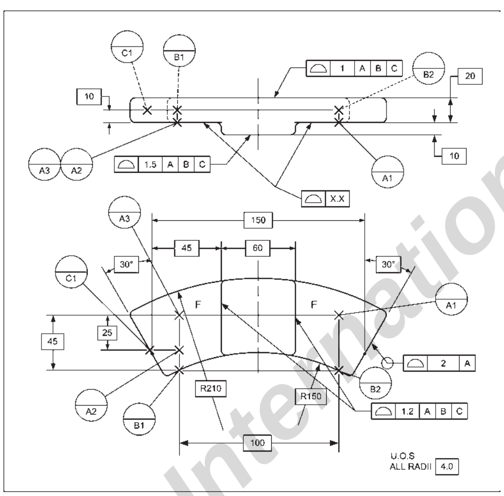
1.



2. Fixed; Defined with basic dimensions in each direction
3. Rest on datum feature A, fit between gage elements for datum feature B
4. Loosely - when the part is not at its maximum size, it can move around in the gage
5. Remove the 126 basic dimension to allow the gage to center the part better.

EXERCISE 15-6
Irregular Part Features as Datums

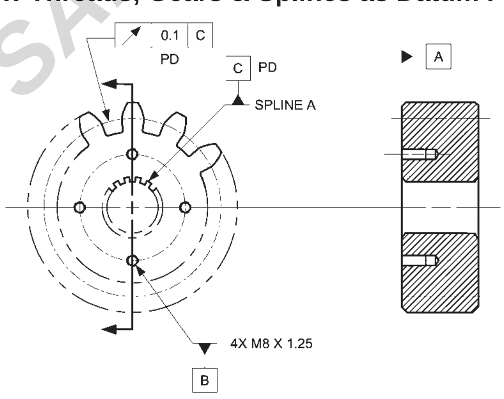
1.



Symbol	Part to Gage Repeatability Yes	Part to Gage Repeatability No	Reason
⌓ 1 A B C	X		
⌓ 1.5 A B C	X		
⌓ 1.2 A B C	X		
⌓ 2 A		X	Cannot reference target as a primary datum reference without a secondary and tertiary datum reference

EXERCISE 16-1
Screw Threads, Gears & Splines as Datum Features

1-3.



4. C
5. D

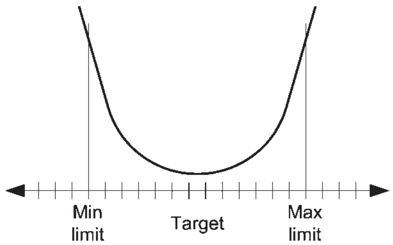
EXERCISE 16-2
Temporary Datum Features

1.C
2. A
3. F
4. F
5.1) To analyze machine clean-up stock
2)To define minimum wall thickness
6. B

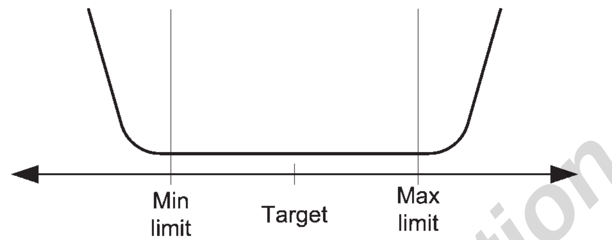
EXERCISE 17-1
Definitions, Top Usage and Modifiers

1. A, I, J or K
2. B
3. F
4. H
5. A

6.



7.

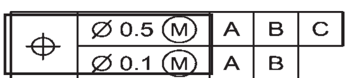


EXERCISE 18-1
Simultaneous Requirement

1. 3: by looking for identical datum references
2. 2, 3, 4; less; There is no datum shift between the features.
3. Add a “SEP REQT” note beneath each feature control frame.
4. The lower section of composite position callouts

EXERCISE 19-1
Composite Position Tolerancing

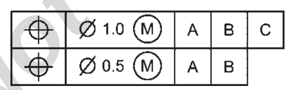
1.



2. A, C
3. 1) When the orientation (and spacing) of a pattern of features of size is more important than the location of the pattern
   2) Where coaxial holes need to be in-line within a tight tolerance value but could vary in location a larger amount
4. A. Legal
   B. Illegal - FRTZF (lower) tol. zone can’t be larger than PLTZF (upper)
   C. Illegal - Datum references of the lower segment must be re peats & in the same order as the upper segment datum references
   D. Illegal - Only two segments should be used as “PLTZF” and a “FRTZF”
5. Location - 1.0; Squareness - 0.2; Spacing - 0.2; Parallelism to B - 0.2; Parallelism to C - 1.0

EXERCISE 20-1
Multiple Single-Segment Position Tolerancing

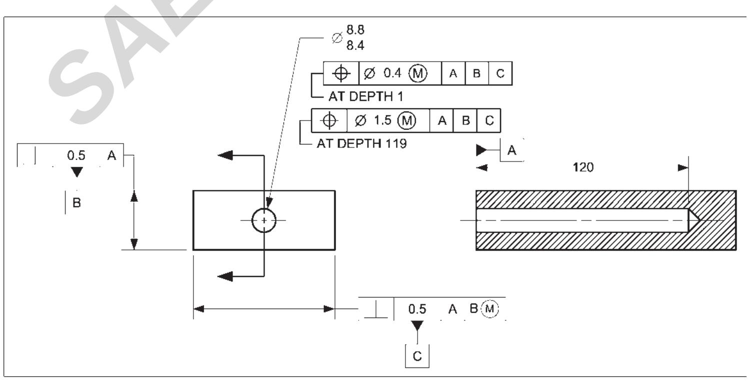
1.



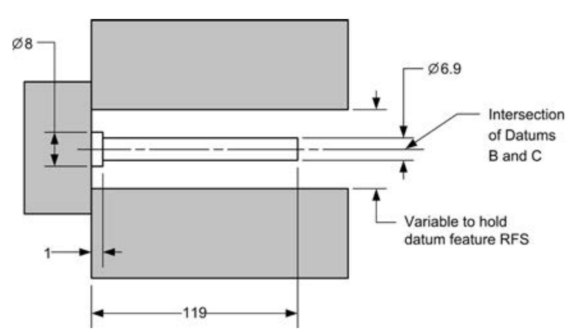
2. C
3. 1) When it is desired to control the location of a pattern of features of size relative to more than one datum reference frame
4. A. Legal
   B. Legal
   C. Legal
   D. Illegal - Conflicting requirements
5. Location to A,B, C - 1; Location to B - 0.5; Spacing - 0.2; Squareness - 0.2

EXERCISE 21-1
Conical Tolerance Zones

1.



2.

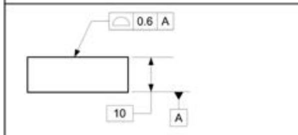
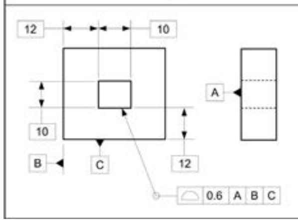


3. In applications where the depth of the hole would be subject to drill deflection

EXERCISE 22-1
When to Use Profile

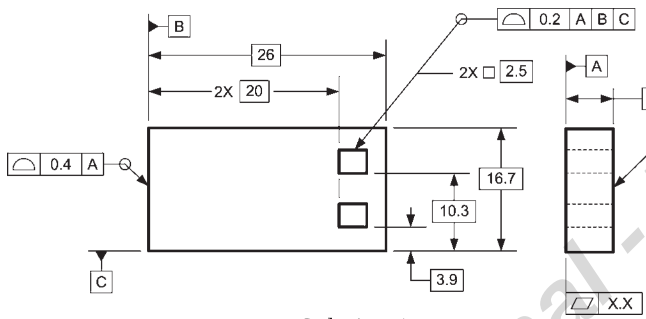
1. B, D, E
2. T, T, T

3.

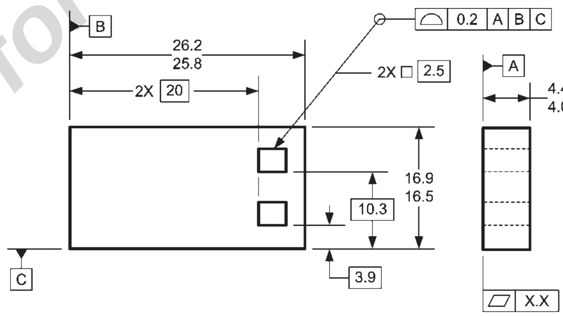
Drawing	Geometric Characteristics Affected			
	Size	Location	Orientation	Form
	No	Yes	Yes	Yes
	Yes	Yes	Yes	Yes

EXERCISE 22-2
Profile & Coordinate Tolerances

1.



Solution 1



Solution 2

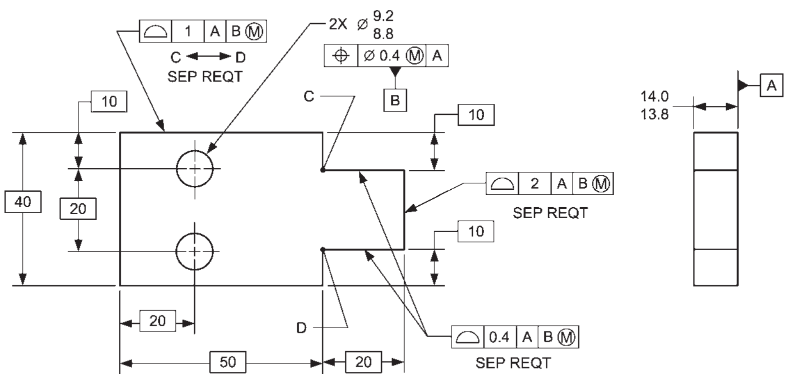
2. No; Assumptions were used on the drawing with coordinate tolerances.

EXERCISE 22-3
Profile Datum Rule

1. Two boundaries located 0.3 on each side of the true profile or a 0.6 wide bilateral tolerance zone
2. 1 mm bilateral tolerance zone all around except datum feature references B and C which have multiple interpretations due to being toleranced and referenced by the profile control
3. 50+⌓1 = 51 or 50 + 1/2 ⌓ = 50.5 or 50 + ??? = Undefined
4. Remove the datum feature references “B” and “C” from the profile callout.
5. Unless otherwise specified, all geometric tolerances apply in the free state.
6. $\boxed{50}$ + ⌓ | 1 | A = 51

EXERCISE 23-1
Profile - Simultaneous Requirement

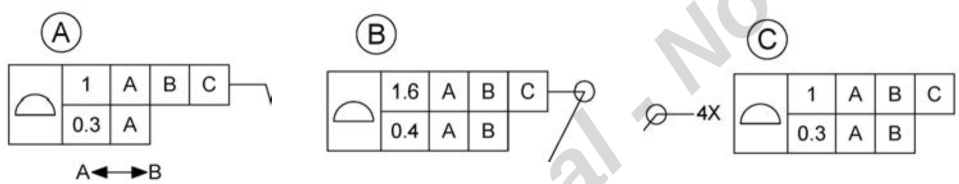
1. 1, 2, 4, 5
2. Because datum shifts is lost, and all affected surfaces must be verified simultaneously
3. LMC 26.0 - VC 25.6 = 0.4
4.



5. LMC Ø9.2 - VC Ø8.4 = 0.8

EXERCISE 24-1
Composite Profile Tolerancing

1.



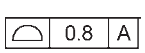
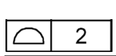
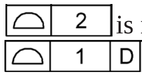
2. A, D
3. A
4. B

5.

Relationship	Maximum Error Permissible
Squareness relative to datum A	0.4
Orientation relative to datum B	0.4
Orientation relative to datum C	1.6
Size of opening	0.8
Form tolerance on surfaces of opening	0.4

6. Upper segment
7. Lower segment
8. C

EXERCISE 25-1
Multiple Single-Segment Profile Tolerancing

1. C, D
2. F, F, T, T, T
3. A Illegal - middle segment is redundant
   B. Legal
   C. Illegal -  is meaningless
   D. Legal
   E. Illegal -  is meaningless
   F. Illegal -  is redundant (does not specify a unique relationship)

EXERCISE 26-1
Coplanar Surfaces

1. 11
2.

Surface	Flatness Limited to
B	0.3
C	0.3
D	0.8
E	0.8

3. 0.4, 0.8

EXERCISE 26-2
Conical Surfaces & "All

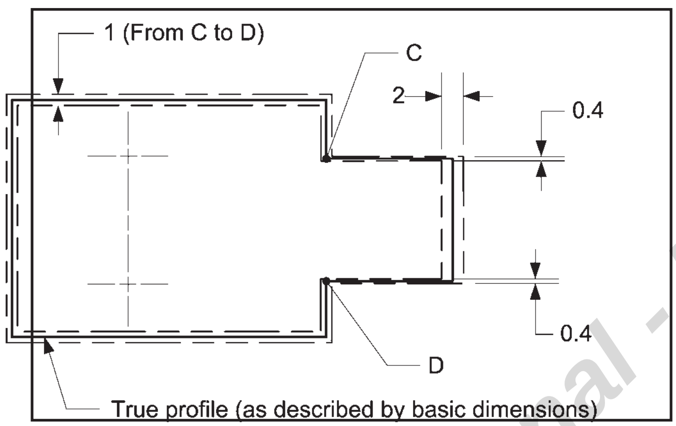
1. D
2. B
3. A
4. C
5. C

EXERCISE 26-3
Profile and Position Combined

1. The profile control
2. Both the position & profile control
3. The position control
4. No; There is no size dimension; perfect form at LMC is required in this case and not where Rule #1 applies
5. 1.6
6. The specification becomes illegal

EXERCISE 26-4
Profile With Datum Shift

1.



2. 71.5, 68.5
3. 41, 39
4. LMC Ø9.2 - VC Ø8.6 = 0.6
5. No; The characteristic of size is not related to datums

EXERCISE 26-5
Profile Specifications

1.