Advanced Concepts of GD&T, 2009 - PD023000-CB02

Answer key

Exercise 1-1

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

Exercise 2-1

1. A
2. D
3. A
4. A
5. D
6. Yes, it may be applied to a geometric tolerance associated with an interrupted surface (See page 10).
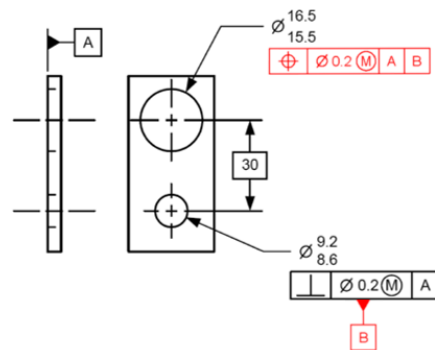
Exercise 3-1

1. Yes, to communicate part feature relationships required for fit, function, and inspection
2. Lower, by communicating the same requirement to both manufacturing and inspection, scrap rates are greatly reduced.
3. 1. To establish a functional relationship between part features
   2. To relate the measurement of a dimension to a datum reference frame
4. A very simple part like a pin or ball bearing may not need datums

Exercise 3-2

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

Exercise 3-2 continued

4.

5.   B

Exercise 3-3

1.   The datum target specifications A & B because they are not referenced in a feature control frame.
2.   The 152.5 and 22 MIN dimensions because they are not related to a datum reference frame.
3.   Datum feature C is too small to orient the part repeatably, therefore, it shouldn't be referenced as a primary datum feature.
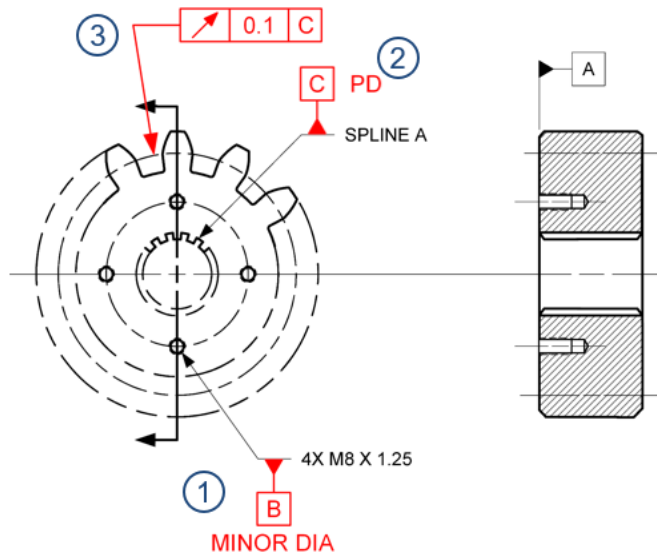
Exercise 4-1

1.   A-B-C; They are the mounting surfaces that orient the part.
2.   N/A; There is no secondary datum reference.
3.   C
4.   B

Exercise 4-2
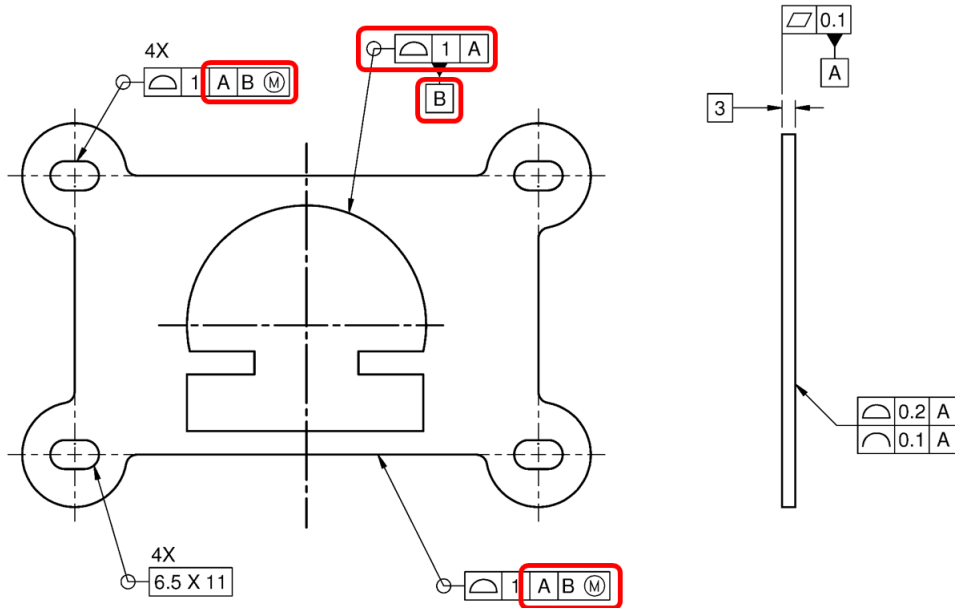
1.   B
2.   C
3.   D
4.   D
5.   D
6.   B

Exercise 4-3

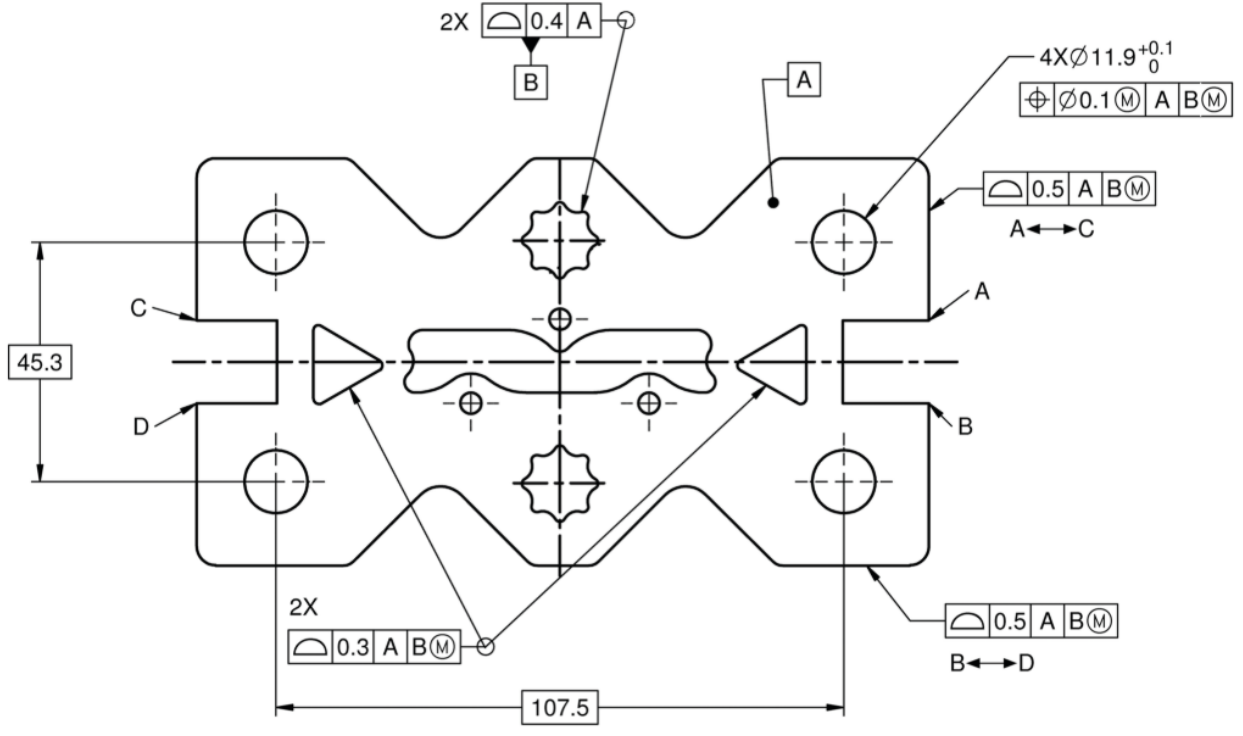

1-3.

4. C
5. C

Exercise 4-4

1. B
2. B

Exercise 5-1

1.
2. Five
3. A
4. Radiator hose

5.

Exercise 6-1

1. F
2. F
3. D
4. B & C
5. The origin used to construct the model and origin of the datum reference frame.
6. The DOF constrained by each datum feature is indicated within the FCF by placing lowercase letters in brackets following each datum feature reference.
7. To override a DOF already constrained by a higher-ranking datum feature and assign it to a lower ranking datum feature.
8. C
9. DOFs
10. override

Exercise 7-1

1. A & D
2. B & D
3. A, B & D

Exercise 7-2

1. Variable: Datum features A & B are regular FOS referenced at RMB to establish the A-B datum axis. Therefore, the datum feature simulator must move normal to the surface.
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. 1. Add a secondary datum reference
   2. Change targets for "B" to a cylindrical line or area
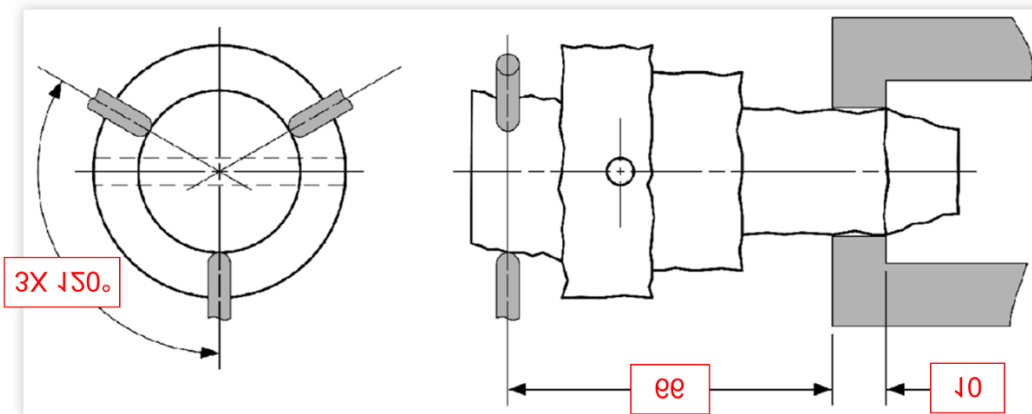
5.

Exercise 7-3
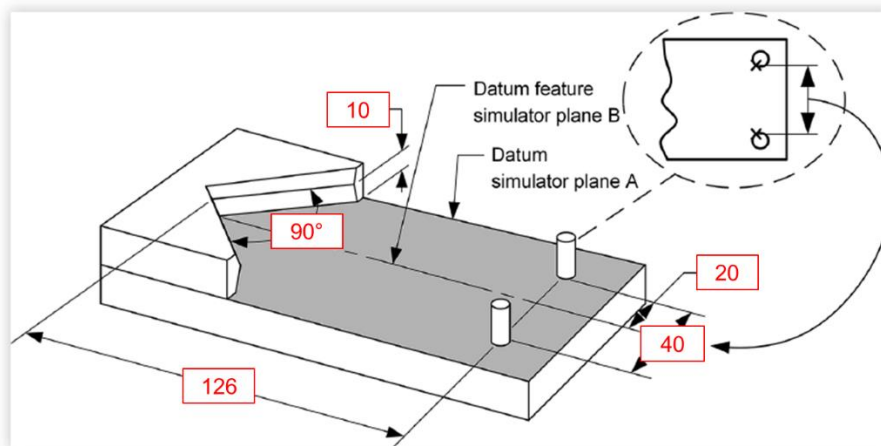
1. Fixed: They are defined by basic dimensions in each direction.
2. It is placed on datum feature simulator A first, then is located by datum target simulators B1, B2, B3, and B4.
3. The part is centered by the B1 and B2 v-block targets and the B3, B4 target gage pins that establish a datum center plane.
4. Add movable datum target symbol to B3 and B4 and identify the direction of movement horizontally towards the v-block. This ensures the part will always contact the v-block and not rotate to establish a repeatable origin and datum center plane.

Exercise 8-1

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

Exercise 9-1

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

	Included	Not Included
Amount of force	X	
Direction of force	X	
Number of places force applies	X	
Location of force	X	
Area of contact		X
Sequence of applying the force		X

5.
6. A, B-G
7. 1. In restrained state per general note that applies to most GD&T while some features are inspected in free state where the free state symbol is specified.

   2. In restrained state per general restraint note that applies to all GD&T because no free state symbol is specified.

   3. In restrained state per local restraint note that applies to only one or a few GD&T.

Exercise 10-1

All feature control frames with the free state symbol

$\oplus$ | Ø1 Ⓜ Ⓕ | E | G Ⓜ

⊥ | Ø0.2 Ⓜ Ⓕ | A

$\oplus$ | Ø0.5 Ⓜ Ⓕ | E | F Ⓜ

$\oplus$ | Ø0.2 Ⓜ Ⓕ | A | B Ⓜ

⌒ | 1.5 Ⓕ

⊥ | 0.5 Ⓜ Ⓕ | E

1.

2. Four
3. No, because the part will be restrained against the datum targets.
4. a. 1.5 / b. 0.2
5. a. There is no free state requirement specified / b. 0.1
6. Free state; the restraint note only specifies that geometric tolerances apply when restrained in DRF.
7. a. 0.8 / b. 0.8
8. The holes are related to datum features E and F and this relationship is not affected by the restraint condition related to A, B and C.

Exercise 11-1

1. Three; by looking for identical datum references.
2. 2, 3, and 4 / Less / There is no datum shift between the features.
3. It requires that all affected controls must be within their tolerance zones at the same time, which may result in more restrictive requirements (i.e., datum feature shift between the patterns would not be available.
4. Add a "SEP REQT" note beneath each feature control frame.
5. The lower segment of composite position callouts.

Exercise 12-1

⊕	Ø1 Ⓜ	A	B	C
⊕	Ø0.5 Ⓜ	A	B	
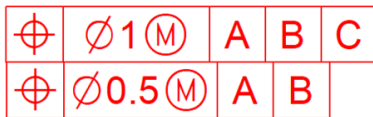
1.
2. C
3. When it's desired to control the location of a pattern of features of size to more than one DRF.
4. A. Legal / B. Legal / C. Legal / D. Illegal – datum references must be unique
5. A. 1 / B. 0.5 / C. 0.2 / D. 0.2

Exercise 13-1

	Ø1 Ⓜ	A	B	C
⊕	Ø0.6 Ⓜ	A	B	
	Ø0.3 Ⓜ	A		
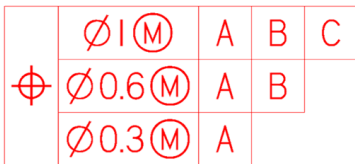
1.
2. A & C
3. 1. To control the location of a pattern of features of size to a larger tolerance than the orientation and spacing between the features.

   2. To control the coaxiality between two or more diameters to a smaller tolerance than their location and orientation to the datum features.

4. A. Illegal – material condition modifiers must be same in all segments

   B. Illegal – DRF in second segment must be same or subset of upper

   C. Illegal – datum modifier must be the same in all segments

   D. Illegal – datum reference in lower segments must be subset of segment above (i.e., unique)

5. A. 1.8 / B. 0.6 / C. 0.3 / D. 0.9 / D. 0.9

Exercise 14-1

1. B, D & E
2. T / T / T
3.

Drawing	Geometric Characteristics Affected			
	Size	Location	Orientation	Form
⌒ 0.6 A / 10 A	✗	✓	✓	✓
12 / 10 / 10 / B C 12 / A / ⌒ 0.6 A B C	✓	✓	✓	✓

Exercise 14-2

1. 0.6 tolerance zone boundary equally disposed about true profile and relative to datum features A, B & C
2. 1 mm wide zone centered about the true profile related to DRF A, B, C, except the zone at B & C have multiple interpretations because they are toleranced and referenced
3. 51.0 (50+0.5/side) or 50.5 or undefined
4. Remove datum references to datums B & C in feature control frame
5. No; No restraint note stated, so 'free state' applies.
6. 51

Exercise 14-3

1.

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

2. a. 0.7 (0.4 + 0.3) / b. 0.8
3. B

Exercise 14-4

1.   The profile tolerance
2.   The profile tolerance
3.   The position tolerance
4.   Yes; It is an Irregular Type B. The actual mating envelope shape is not a sphere, circle, cylinder, parallel planes, or parallel lines.
5.   3.2 (31.6-28.4)

Exercise 15-1

1.   1, 2, 4, and 5
2.   Datum feature shift tolerance is not allowed between features that must be verified simultaneously.
3.   LMC 26.0 – MMB 25.6 = 0.4 Datum feature shift
4.   SEP REQT should be added beneath the profile of 2 and profile of 0.4
5.   LMC 9.2 – MMB 8.4 = 0.8

Exercise 15-2
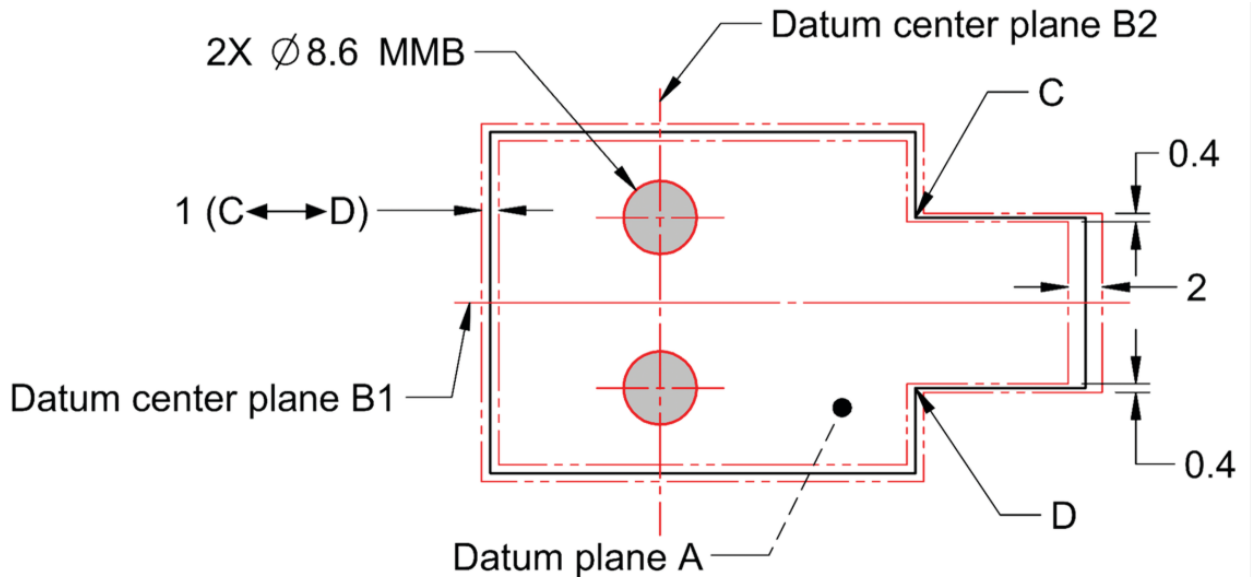
1.
2.   Maximum X = 71.5 (70 + 0.5 + 1) / Minimum X = 68.5 (70 - 0.5 - 1)
3.   Maximum Y = 41 (40 + 1) / Minimum Y = 39 (40 - 1)
4.   LMC 9.2 - MMB 8.6 = 0.6

5.   X = Yes, separate requirements applies to features at each end
     Y = No, simultaneous requirements still applies to features between C & D

Exercise 16-1

1. C & D
2. F / T / T / T
3. A. Illegal – The bottom segment does not specify a unique datum reference

   B. Legal

   C. Illegal – The top segment tolerance value must be a refinement of the bottom because its datum reference is a subset of the bottom segment

   D. Legal – Because a different DRF is specified the tolerance values are unrelated

   E. Illegal - The bottom segment tolerance value must be a refinement of the top

   F. Illegal – The bottom segment tolerance value must be a refinement of the top

Exercise 17-1

1. A & D
2. B
3. B
4. A & B

Relationship	Maximum Allowable Deviation
Orientation to datum A	0.8
Orientation to datum B	1.2
Orientation to datum C	1.8
Size (distance between opposed elements)	0.8*
Form of surface elements	0.4

5.

*0.4 x 2 = 0.8 (0.4 applies to each side)

6. X = Top (1.8)

   Y = Bottom (0.4)
7. C