Name:_____ Date: _____

Brakes Work Example 1

WorkKey Level: 3
NATEF Automotive Tasks: V.C.7

A rotor is 0.975" thick; the discard thickness is 0.950", with a minimum machine measurement of 0.960".

a. What is the maximum amount of metal that can be removed from the rotor during machining?

b. Can 0.030" be removed from the rotor without exceeding machine-to specs?

c. How many cuts at 0.008" (0.004" from each side) can be taken without exceeding the limit? Justify your answer.

Solution

a. The maximum amount of metal that can be removed is:
0.975" – 0.96" = 0.015"

b. No

c. One cut
2(0.008") = 0.016"
0.016" > 0.015"

Brakes Work Example 2

WorkKey Level: 3
NATEF Automotive Tasks: V.C.7

A brake rotor is mounted on a hub. A dial indicator is put on the center of the wear surface of the rotor. While the rotor makes one complete revolution the needle sweeps from 60 to 54 on the gauge. How many thousandths of run-out is in this rotor?

Solution

0.060" – 0.054" = 0.006" run-out

Brakes Work Example 3

WorkKey Level: 4
NATEF Automotive Tasks: V.C.7

A dial indicator is placed on the wear surface of a rotor and the needle sweeps from –3 to +4. How much lateral run-out exists? Express your answer in thousandths of an inch.

Solution

The range from +0.004 to –0.003 is 0.007.
+0.004 – –0.003 = +0.004 + 0.003 = 0.007

The lateral run-out is 7 thousandths of an inch (0.007").

Brakes Work Example 4

WorkKey Level: 4
NATEF Automotive Tasks: V.C.7

A brake rotor has the readings below when checked at the 2, 4, 6, 8, 10, and 12 o'clock positions.

Position	Reading
2	0.986
4	0.986
6	0.987
8	0.988
10	0.986
12	0.986

a. What is the greatest variation of this rotor from parallel?

b. When compared to the spec of 0.0005, is this rotor within parallelism specs? If not, by how much?

Solution

a. The range from the highest (0.988) to the lowest (0.986) is 0.988 – 0.986 = 0.002.

b. The rotor is not within parallelism specs.
It is out of specs by (0.002 – 0.0005) = 0.0015.

Brakes Work Example 5

WorkKey Level: 4
NATEF Automotive Tasks: V.B.2, V.B.3

A brake drum has a maximum machine diameter of 9.060". The size of the brake drum measures 9.062". Can the drum be re-machined and remain within specification? Justify your answer.

Solution

No, it is already too large.
9.060" – 9.062" = –0.002"

Brakes Work Example 6

WorkKey Level: 4
NATEF Automotive Tasks: V.B.2, V.B.3

A brake drum is 9.000" and needs to be machined to a spec of 9.030" to resurface the drum. How many cuts at 0.010" can be made without exceeding the turn to spec?

Solution

3 cuts

9.030" – 9" = 0.030"

$$\frac{0.030"}{0.010"} = 3$$

Brakes Work Example 7

WorkKey Level: 4
NATEF Automotive Tasks: V.A.1

Specifications for a freestanding brake pedal are given as 3 to 4 inches. With your ruler, measure the distance below from point A to point B to determine the given pedal height.

A ——— B

Which of the following adjustments would give you a measurement in specifications?

a. Increasing the length by 1 inch

b. Increasing the length by 1.5 inches

c. Increasing the length by 1 3/4 inches

d. Increasing the length by 2 inches

Solution

Since the line segment measures approximately 2 inches in length, all of the above answers are acceptable.

Brakes Work Example 8

WorkKey Level: 4
NATEF Automotive Tasks: V.A.1

Brake pedal travel on a car is shown below along with the specifications.

>._____ .<

Vehicle	Spec	Tolerance
Car	2.5"	0.75"
Truck	1.75"	0.75"

Measure the line segment to determine whether this is in spec? Justify your answer.

Solution

No, this is not in spec.

It is over by approximately 3/4 inch.

Brakes Work Example 9

WorkKey Level: 3
NATEF Automotive Tasks: V.A

You are replacing a brake line that is 35 inches long. The brake lines you have on hand are of varying lengths: 24 inches, 12 inches, 6 inches, and 4 inches. Which of the following combination of lengths will provide you with a length greater than (>) or equal to (=) 35 inches in the *fewest number of pieces?*

a. 24" 12"

b. 12" 12"

c. 12" 12" 12"

d. 24" 6" 6"

Solution

Options A, C, and D all provide enough line since all total 36 inches, which is greater than 35 inches.

Since the question asks for the option with the *fewest number of pieces*, the correct answer is A, which uses only two pieces. Options C and D both use three pieces.

Brakes Work Example 10

WorkKey Level: 4
NATEF Automotive Tasks: V.A

A proportioning valve is suspected of being bad. You hook up a pressure gauge at the master cylinder and one at the wheel cylinder. The spec says there should be at least a 10% reduction in pressure at the rear. Pressure is applied and the following pressures are recorded.

Front	900 pounds
Rear	820 pounds

Is the valve doing its job? Please explain.

Solution

A 10% reduction in the rear would be calculated as follows:
(900)(10%) = (900)(0.10) = 90 pounds
900 – 90 = 810 pounds

No, the valve is not doing its job. Rear pressure needs to be at most 810 pounds.

Brakes Work Example 11

WorkKey Level: 4
NATEF Automotive Tasks: V.D.2

You are testing the vacuum supply to a power brake booster assembly. The spec, according to the manual, is 17 inches of vacuum at an engine idle speed of 850 RPM, with all accessories turned off. There is an allowable tolerance of ± 2 inches. Your gauge is reading 15.5 inches with all conditions met. Your gauge reading is:

a. Out of tolerance and needs further diagnosis.

b. Out of tolerance but it doesn't matter.

c. In tolerance and is acceptable.

d. In tolerance but needs to be further diagnosed.

Solution

An acceptable reading is 17 inches ± 2 inches.
17" – 2" = 15"
17" + 2" = 19"
The acceptable range is 15" ≤ x ≤19"

Option C is the correct answer, since your gauge is reading 15.5 inches, which falls within the acceptable range.

Brakes Work Example 12

ACT Work Keys Level: 7
NATEF Tasks: V.D.2; V.D.13; V.D.14

You have a customer who wants to be the only person driving around in a Ford truck just the right shade of blue. To ensure a completely unique paint job, you will need to adjust a more traditional paint formula. You use a certain company's specifications for a formula for a single batch of a deep azure blue:

2.6 gallons blue no. 4
3.2 gallons blue no. 6
1 3/4 gallons yellow no. 1
3 quarts purple no. 1

The color is unique, but to ensure that your customer never encounters another Ford quite the same color, you decide to adjust the formula by reducing all non-blue colors in the mixture by 10% and replacing the loss (same amount) with additional blue no. 4. Complicating the matter is the fact that this is a big truck and you will need a triple batch of paint.

What will the final formula for this unique paint be?

Solution

Yellow no. 1: (1 3/4 gallons)(10% reduction) = (1.75)(0.10) = 0.175 or 0.18 rounded
1.75 – 0.18 = 1.57 gallons of yellow no. 1

Purple no. 1: 3 quarts = 3/4 gallon

$$\frac{3}{\text{quarts}} \times \frac{1 \text{ gallon}}{4 \text{ quarts}}$$

(3/4 gallon)(10% reduction) = (0.75)(0.10) = 0.075 or 0.08 rounded
0.75 – 0.08 = 0.67 gallons of purple no.1

Now, add on the reduction to blue no. 4.
0.18 + 0.08 + 2.6 = 2.86 gallon blue no. 4

So, the single-batch formula is:
2.86 gallons blue no. 4
3.2 gallons blue no. 6
1.57 gallons yellow no. 1
0.67 gallons purple no. 1

Now, triple that formula:
(3)(2.86 gallons) = 8.58 gallons blue no. 4
(3)(3.2 gallons) = 9.6 gallons blue no. 6
(3)(1.57 gallons) = 4.71 or 4.7 (rounded) gallons yellow no. 1
(3)(0.67 gallons) = 2.01 or 2.0 (rounded) gallons purple no. 1

Brakes Work Example 13

ACT Work Keys Level: 4
NATEF Tasks: V.C.2

A technician is using a micrometer to determine whether a drum can be turned on a lathe. The drum measures 9.551" and at 90° it measures 9.563". The drum specifications are:

- Machining limit 9.572
- Maximum diameter of 9.590

The technician estimates that it will take a total 0.014 of an inch to make the drum true. Can the drum be machined?

Solution

$$\begin{array}{r} 9.551 \\ +0.014 \\ \hline 9.565 \end{array}$$

The answer is yes. Since 9.565 is smaller than 9.572, the drum can be turned.

Brakes Work Example 14

ACT Work Keys Level: 7
NATEF Tasks: Background

In a given brake system the pressure is 1200 psi from the master cylinder. The surface area of the piston is 10 in^2, in this floating caliper system.

(Pascal's law: Force = Pressure × Area)

a. What is the force capability applied at the caliper piston?

b. What is the force being applied to the rotor?

Solution

1. Pressure = 1200 psi
   Area = 10 in^2
   1200 psi × 10 in^2 = 12000 pounds of force

2. In a floating caliper system the pressure is equal on both sides of the rotor. This doubles the pressure on the rotor.
   2 × 12000 pounds of force = 24000 pounds of force on the rotor

Brakes Work Example 15

ACT Work Keys Level: 7
NATEF Tasks: V.B.1

1. Describe the output force of a brake pedal lever if the driver is exerting 50 # on a brake pedal that is 10" from pedal to pivot and 1.25" from the pivot to the master cylinder plunger rod. (Show your work and circle the answer.)

2. Describe the output force of a system if an input force of 400 # is exerted on a 1-inch-diameter input piston and the output piston has a 3.25-inch diameter. (Show your work and circle the answer.)

3. Describe the output force of a brake pedal lever if the driver is exerting 30 # on a brake pedal that is 8" from pedal to pivot and 0.5" from the pivot to the master cylinder plunger rod. (Show your work and circle the answer.)

Solution

1. $$\frac{10}{1.25} = \frac{x}{50}$$
$$(10)(50) = 1.25x$$
$$500 = 1.25x$$
$$\frac{500}{1.25} = x$$
$$400 = x$$

2. $[400 \times (1" \times 0.5)^2 \times 3.14] \bullet (3.25 \times 0.5)^2 \bullet (3.14)$
   $(400 \bullet 0.25 \bullet 3.14)(2.66)(3.14)$
   $(314)(2.66)(3.14)$
   2622.65

3. $$\frac{8}{0.5} = \frac{x}{30}$$
$$(0.5)x = (8)(30)$$
$$0.5x = 240$$
$$x = \frac{240}{0.5}$$
$$x = 480$$

Brakes Work Example 16

ACT Work Keys Level: 4
NATEF Tasks: V.C.2

A technician is using a micrometer to measure a brake drum with a dial-type drum mike. He has the bar set at 8 7/8 inches with 0.044 on the dial. What is the total reading?

Solution

(8 7/8 + 0.044) = (8.875 + 0.044) = 8.919"

Brake Work Example 17

ACT Work Keys Level: 4
NATEF Tasks: V.F.8

To neutralize an area on a 1998 Chevy Lumina's body damaged by acid rain, a technician will need 1 gallon of solution. If specifications call for one tablespoon of baking soda to one quart of water, how many tablespoons of baking soda will be needed for this?

Solution

4 quarts = 1 gallon

Therefore:

$$\frac{1 \text{ T baking soda}}{1 \text{ qt water}} \times \frac{4 \text{ quarts}}{1 \text{ gallon}} = \frac{4 \text{ T baking soda}}{1 \text{ gallon}}$$

The technician will need 4 tablespoons of baking soda to neutralize the area on the Chevy Lumina.

Brake Work Example 18

ACT Work Keys Level: 6
NATEF Tasks: V.C.8

A brake rotor has a minimum machine to thickness of 0.980" and a discard thickness of 0.965". The brake rotor measures 25.2 mm.

1. Can the rotor be machined?
2. If so, how much metal can be removed and stay with spec.?

Solution

1. Convert 25.2 mm to standard: 0.992 in.
   Thus, yes the rotor can be machined.
2. 0.992" – 0.980" = 0.012"

Brakes Work Example 19

ACT Work Keys Level: 7
NATEF Tasks: V.B.1

A driver puts a force of 360 Newtons on a brake pedal. The brake pedal ratio is 8:1, and the master cylinder diameter is 3 cm. The diameter of the front wheel cylinder caliper piston is 3.2 cm. What is the force that the front wheel caliper piston develops?

Solution

A. Force on master cylinder = Force on brake pedal × Brake pedal lever ratio
   $1/8 = 360/c$
   $c = (360)(8) = 2880$ Newtons

B. Area of master cylinder piston = diameter^2 × 0.7857.065 cm^2 = 32 × 0.785c.

C. Pressure developed within the master cylinder = Force/Area
   407.64 N/cm^2 = (2880)/(7.085)

D. Area of front wheel caliper piston = diameter^2 × 0.785
   8.04 cm^2 $(3.2)^2 \times 0.785$

E. Force resulting from the pressure within the master cylinder = Pressure × Area

$$3277.4 \text{ Newtons} = \frac{407.65 \ \frac{\text{N}}{\text{cm}^2}}{8.04 \text{ cm}^2}$$

The force that the front wheel caliper piston develops is 3277.4 Newtons.

Brakes Work Example 20

ACT Work Keys Level: 3
NATEF Tasks: V.C.10

The wheel lug torque specification for a Mercedes Benz E430 is 105 Newton meters. All data lists that this specification can be ±5 Newton meters from the listed specification.

A. What is the range of acceptable torque for this vehicle?

B. The technician set the torque on the Mercedes Benz E430 to 115 Newton meters. Is this acceptable? Why? Why not?

Solution

A. 105 Newton meters + 5 = 110 Newton meters
105 Newton meters – 5 = 100 Newton meters
The acceptable range is $100 \le x \le 110$.

B. No, this is not acceptable because it exceeds the acceptable range of 100–110 Newton meters.

Brakes Work Example 21

ACT Work Keys Level: 4
NATEF Tasks: V.B.1

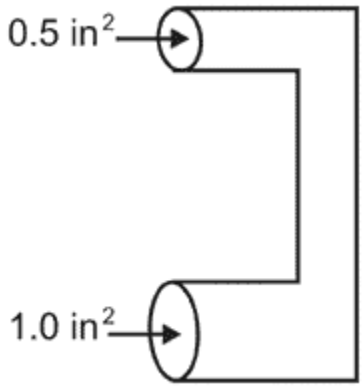
Formulas
D_o = Distance output
D_i = Distance input
F_o = Force output
F_i = Force input
Distance or force transformance = $F_i(D_i) = D_o(F_o)$
B = Bore = D = Diameter
$r = D(½)$ or Bore(½)
$r^2 = r \cdot r$
$\pi = 3.14159$
Square inches = $r^2(\pi)$
= pounds per square inch (psi)

1. Describe the output force of a system if an input force of 75 lbs is exerted on a 1-sq.-inch input piston and the output piston is 0.5 sq. inch. (Show your work.)

2. What is the system pressure in the above example?

3. Describe the output force of a system if an input force of 125 lbs is exerted on a 1-sq.-inch input piston and the output piston is 7 sq. inches. (Show your work.)

4. What is the system pressure in the above example?
5. Describe the output force of a system if an input force of 125 lbs is exerted on a 1-sq.-inch input piston and the output piston is 0.75 sq. inch. (Show your work.)
6. What is the system pressure in the above example?



Solution

1. = 75 psi = 75 psi (0.5") = 37.5 lbs of force
2. 75 psi
3. = 125 psi = 125 psi (7") = 875 lbs of force
4. 125 psi
5. = 125 psi = 93.75 lbs of force
6. 125 psi