Name: _____ Date: _____

Engine Repair Work Example 1

WorkKey Level: 4
NATEF Automotive Tasks: I.A.8, VIII.A.8

When doing a cylinder balance test, you come up with the following results.

Cylinder	RPM drops from 650 to
1	575
2	560
3	630
4	570

Predict which cylinder is not producing power.

The manufacturer requires at least a 10% drop in RPM when a cylinder is killed. Complete the following chart.

Cylinder	Percentage of Drop
1	
2	
3	
4	

According to your calculations in the above chart, which cylinder is not producing power?

Solution

Student predictions: Answers may vary.

Cylinder	Percentage of Drop (rounded to nearest tenth of a %)
1	(650 – 575)/650 = 75/650 = 11.5%
2	(650 – 560)/650 = 90/650 = 13.8%
3	(650 – 630)/650 = 20/650 = 3.1%
4	(650 – 570)/650 = 80/650 = 12.3%

10% drop of original amount = (0.10)(650) = 65 rpm
Acceptable amount must be (650 – 65) = 585 rpm or less.

Cylinder 3 is not producing power.
3.1% ≤ 10%
630 rpm ≥585 rpm

Engine Repair Work Example 2

WorkKey Level: 4
NATEF Automotive Tasks: I.A.9

A good engine will have a fairly even compression from cylinder to cylinder. If the highest and lowest readings vary more than 25% of the highest reading, the engine should be repaired.

Compression readings for a 4-cylinder engine are shown below. Determine whether the engine compression range is within recommendations.

Cylinder 1	Cylinder 2	Cylinder 3	Cylinder 4
173	180	147	128

Which, if any, cylinder would you perform a cylinder leakage test on? Please explain.

Solution

The highest reading is 180.
25% of the highest reading = (0.25)(180) = 45
The cylinders should be between (180 – 45) = 135 and 180.

You need to perform a cylinder test on cylinder 4, since 128 is less than 135.

Engine Repair Work Example 3

WorkKey Level: 4
NATEF Automotive Tasks: I.B.3, I.B.8

You measured the free height of a set of valve springs and have come up with the following:

Spring	Height (inches)	Acceptable	Not Acceptable
1	1 7/8		
2	1 15/16		
3	1 3/4		
4	1 7/8		
5	1 13/16		
6	1 29/32		
7	1 31/32		

8	1 15/16		

The manufacturer's spec for free height is 1 7/8 inches + 1/16 inch. Check each spring in the table above and determine whether each is acceptable or not.

Solution

The range of acceptable springs is as follows:
1 7/8" + 1/16" = 1 14/16" + 1/16" = 1 15/16"
1 7/8" – 1/16" = 1 14/16" – 1/16" = 1 13/16"
(1 13/16" ≤ spring height ≤ 15/16")

Spring	Height (inches)	Acceptable	Not Acceptable
1	1 7/8	X	
2	1 15/16	X	
3	1 3/4		X
4	1 7/8	X	
5	1 13/16	X	
6	1 29/32	X	
7	1 31/32		X
8	1 15/16	X	

Engine Repair Work Example 4

WorkKey Level: 4
NATEF Automotive Tasks: I.B.6

If the inside diameter of the guide you have measured is 0.3458" and the outside diameter of the valve stem is 0.3413", what is the valve-stem-to-valve-guide clearance?

The maximum valve guide clearance is 0.0015". Is this exhaust-stem-to-valve-guide clearance within service specifications?

Solution

$0.3458 - 0.3413 = 0.0045$

$$\frac{0.0045}{2} = 0.00225"$$

This is not within specifications since 0.00225" > 0.0015".

Engine Repair Work Example 5

WorkKey Level: 4
NATEF Automotive Tasks: I.B.6, I.B.14, I.C.4, I.C.6, I.C.7, I.C.9

Find the difference between the major and minor diameter of the following components.

Type	Major diameter	Minor diameter	Difference
Valve stem	0.375"	0.368"	
Cylinder bore	3.692"	3.686"	
Crank shaft journal	2.499"	2.4965"	
Cam lobe	25.67 mm	20.86 mm	
Cylinder bore	93.77 mm	93.624 mm	

Solution

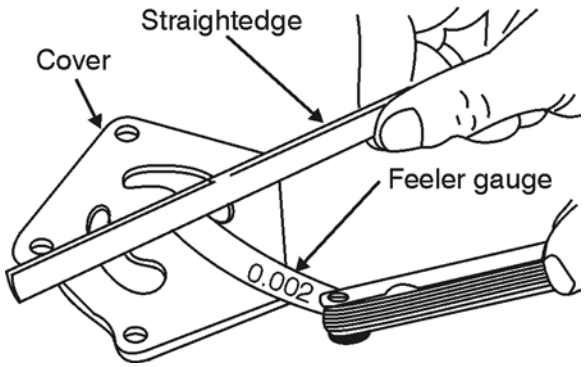
Difference is major diameter minus minor diameter.

Valve stem: 0.375 – 0.368 = 0.007"
Cylinder bore: 3.692 – 3.686 = 0.006"
Crank shaft journal: 2.499 – 2.4965 = 0.0025"
Cam lobe: 25.67 – 20.86 = 4.81 mm
Cylinder bore: 93.77 – 93.624 = 0.146 mm

Engine Repair Work Example 6

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

The feeler gauge below is marked 0.002" with a light drag. The manual specifies that the space must be less than 0.0015". Is this an acceptable measure? By how much?



Solution

No, it is not an acceptable measure.
0.002" > 0.0015"
It is out by (0.002" – 0.0015") = 0.0005".

Engine Repair Work Example 7

WorkKey Level: 4
NATEF Automotive Tasks: I.B.8

You measured the installed height of a set of valve springs and have come up with the following:

Spring	Height (inches)	Acceptable	Shim thickness
1	1.85		
2	1.71		
3	1.75		
4	1.82		
5	1.78		
6	1.69		
7	1.72		
8	1.79		

The manufacturer's spec for installed height is 1.75 inches ± 0.030 inch. Complete the table above to determine whether each spring is acceptable. Then select the most appropriate shims to do the job from the list below.

0.005" 0.010" 0.015" 0.030"

Solution

The range of acceptable springs is as follows:
1.75" + 0.030" = 1.78"
1.75" – 0.030" = 1.72"
(1.72" ≤ spring height ≤ 1.78")

Spring	Height (inches)	Acceptable	Not acceptable	Shim thickness
1	1.85		X	
2	1.71		X	0.015
3	1.75	X		
4	1.82		X	
5	1.78	X		

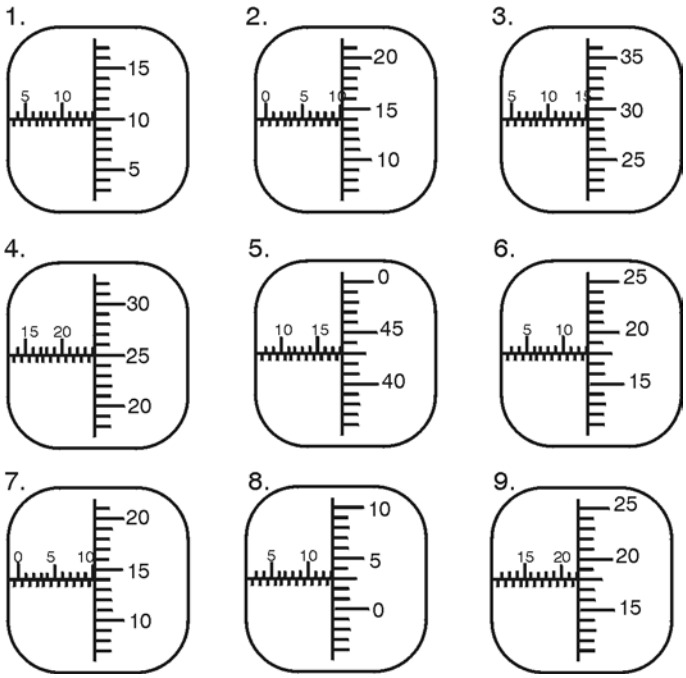
6	1.69		X	0.030
7	1.72	X		
8	1.79		X	

Engine Repair Work Example 8

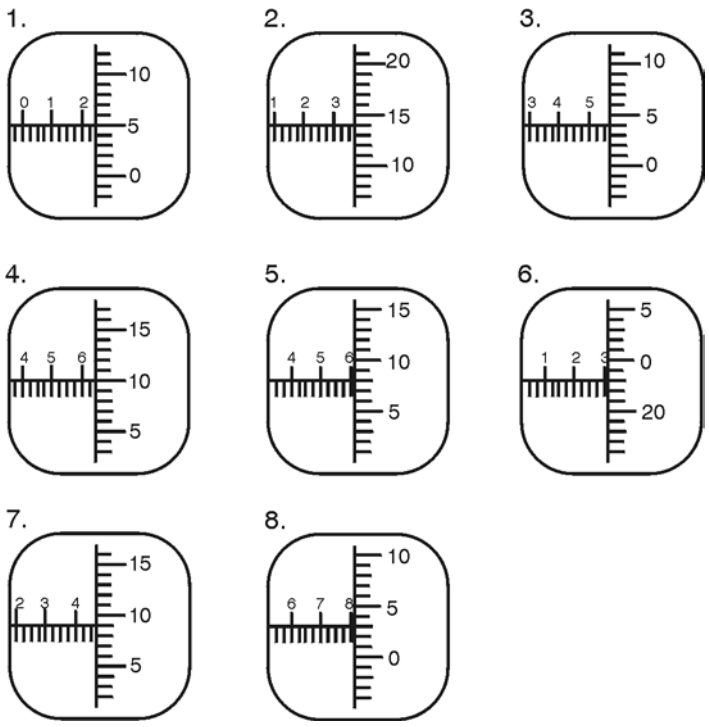
WorkKey Level: 3
NATEF Automotive Tasks: I.B.6, I.B.12, I.B.14, I.B.15, I.C.6, I.C.7, I.C.8, I.C.10, I.C.12

Read the following 17 micrometer measures. Label your answers with the appropriate units.

Metric Micrometer Readings



American Standard Micrometer Readings



Solution

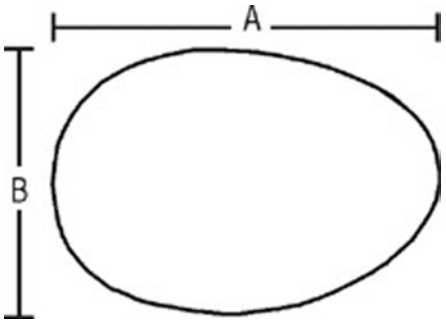
Metric	American
1. 14.10 mm	1. 0.230 in
2. 10.14 mm	2. 0.364 in
3. 15.29 mm	3. 0.554 in
4. 24.25 mm	4. 0.635 in
5. 18.43 mm	5. 0.608 in
6. 13.18 mm	6. 0.323 in
7. 10.14 mm	7. 0.459 in
8. 13.03 mm	8. 0.803 in
9. 22.18 mm	

Engine Repair Work Example 9

WorkKey Level: 4
NATEF Automotive Tasks: I.B.14

The amount of wear that has taken place on a camshaft may be determined by taking two measurements of a cam lobe. One measurement, dimension A, is across the cam lobe and the

other, dimension B, is across the base circle (see figure below). The lobe lift is determined by subtracting the B measurement from the A measurement.



The cam lobe dimension A is 35.90 mm and dimension B is 29.25 mm. What is the lobe lift?

Solution

The lobe lift is the difference between the cam lobe dimension A and dimension B.

35.90 mm – 29.25 mm = 6.65 mm

Engine Repair Work Example 10

WorkKey Level: 4
NATEF Automotive Tasks: I.B.15

The outside diameter of a camshaft bearing journal is 1.125" and the inside diameter of the installed bearing measures 1.1273". How much clearance is there?

Solution

The amount of clearance is one-half the difference between the inside and the outside diameters.

1.1273" – 1.125" = 0.0023"

$$\frac{0.0023"}{2} = 0.00115"$$

Engine Repair Work Example 11

WorkKey Level: 4
NATEF Automotive Tasks: I.C.2, I.C.3

Find the proper tap drill size for a 3/4" by 10 tpi national (coarse) grade-5 bolt.

American National Screw Thread Pitches

Bolt or tap size	Threads per inch	Outside diameter at screw	Drill sizes	Decimal equivalent of drill
1	64	0.073	53	0.0595
2	56	0.086	50	0.0700
3	48	0.099	47	0.0785
4	40	0.112	43	0.0890
5	40	0.125	38	0.1015
6	32	0.138	36	0.1065
8	32	0.164	29	0.1360
10	24	0.190	25	0.1495
12	24	0.216	16	0.1770
1/4	20	0.250	7	0.2010
5/16	18	0.3125	F	0.2570
3/8	16	0.375	5/16	0.3125
7/16	14	0.4375	U	0.3680
1/2	13	0.500	27/64	0.4219
9/16	12	0.5625	31/64	0.4843
5/8	11	0.625	17/32	0.5312
3/4	10	0.750	21/32	0.6562
7/8	9	0.875	49/64	0.7656
1	8	1.000	7/8	0.8750
1 1/8	7	1.125	63/64	0.9843
1 1/4	7	1.250	1 7/64	1.1093

Solution

Reading off of the chart in the drill size column, the proper size needed is 21/32.

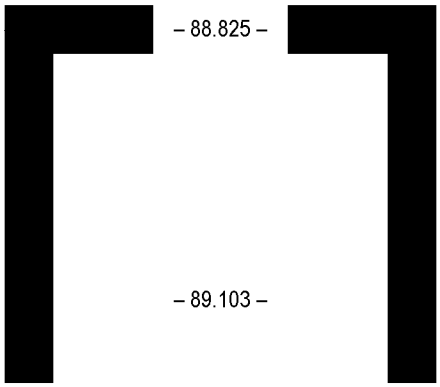
Engine Repair Work Example 12

WorkKey Level: 5
NATEF Automotive Tasks: I.C.5, I.C.6

You are doing an engine repair that requires the removal of a piston. Before you remove the piston, you must first measure the ring ridge. If the ring ridge is greater than 0.1 millimeter, it must be removed before the piston is removed. The top measurement in the unworn part of the cylinder is 88.925 mm. The measurement in the worn part of the cylinder is 89.103 mm.

1. What is the difference in the measurements you made?

2. Should the ring ridge be removed before the piston is removed? Explain your answer.



Solution

1. Ring ridge = 89.103 mm – 88.925 mm
   Ring ridge = 0.178 mm
2. Yes. Since 0.178 mm > 0.1 mm, the ring ridge must be removed before the piston is removed.

Engine Repair Work Example 13

WorkKey Level: 7
NATEF Automotive Tasks: I.C.10

A 4-cylinder Honda has a bore of 8 cm and a stroke of 9.1 cm. Find the piston displacement in cubic centimeters. Use the formula $V_d = 0.785 \times d^2 \times s \times n$

where: d is the bore or diameter of the piston
V is the volume of the cylinders
s is the stroke or piston travel length
n is the number of pistons

Solution

$V_d = 0.785 \times d^2 \times s \times n$
$V_d = (0.785)(8^2)(9.1)(4)$
$V_d = (0.785)(64)(9.1)(4)$
$V_d = 1828.736$
$V_d = 1829$ cubic centimeters

Engine Repair Work Example 14

WorkKey Level: 7
NATEF Automotive Tasks: I.C.10

What is the total piston displacement on an 8-cylinder engine with a 3 1/2 inch diameter and a 4 3/8 inch stroke? Round your answer to the nearest whole number. Use the formula $V_d = 0.785 \times d^2 \times s \times n$

where: d is the bore or diameter of the piston
V is the volume of the cylinders
s is the stroke or piston travel length
n is the number of pistons

Solution

$V_d = 0.785 \times d^2 \times \text{s} \times n$
$V_d = (0.785)(3.5^2)(4.375)(8)$
$V_d = (0.785)(12.25)(4.375)(8)$
$V_d = 336.56875$
$V_d = 337$ cubic centimeters

Engine Repair Work Example 15

WorkKey Level: 7
NATEF Automotive Tasks: Background

An engine leaks 1/10 ounce drop of oil every 4 seconds at the rear seal. How many hours will the engine run before you have to add 1 qt of oil?

Solution

1 quart = 32 oz
1/10 = 0.1
You lose 0.1 oz every 4 seconds.

So, $\frac{0.1}{4} = \frac{32}{x}$, $\frac{0.1 \times 10}{4 \times 10} = \frac{32}{x}$, or $\frac{1}{40} = \frac{32}{x}$

and $x = 40.32$ or $x = 1280$ seconds
$1280 \div 60 = 21.3$ minutes

Engine Repair Work Example 16

WorkKey Level: 7
Engine Repair: I.C.10

What is the engine displacement in cubic inches on an 8-cylinder, 4.6-liter engine with a cylinder bore diameter of 3 1/2 inches and a piston stroke length of 4 3/8 inches?

Solution

Calculate the volume of one cylinder.
$V = \pi r^2 l$
$V = (\pi)\left(\frac{3.5}{2}\right)^2 (4.375)$
$V = (\pi)(1.75^2)(4.375)$
$V = (\pi)(3.0625)(4.375)$
$V = 42.09243282$
The volume displacement for one cylinder is approximately 42.09 in^3.

Calculate the total volume of all eight cylinders.
(42.09)(8) = 336.72
The total engine displacement is 336.72 in^3.

Engine Repair Work Example 17

WorkKey Level: 4
NATEF Tasks: I.D.3, I.D.7

1. When filling a 15-quart system with a solution that is 40% water and 60% coolant, how many quarts of coolant would be required?

2. The chart below shows the relationship between the boiling point and freezing point of ethylene glycol coolant and the percent antifreeze coolant content of the coolant. According to the following chart, if you had a 15-quart system that contained 9 quarts of antifreeze and 6 quarts water, what would the boiling point of the antifreeze in the system be?

Antifreeze Boiling and Freeze Protection Chart

Percent Antifreeze	Freezing Point (°C)	Boiling Point (°C)
40 %	–24	126
50%	–37	129
60%	–52	132
70%	–64	136

Conditions: 100 kilopascals (15 psig) radiator cap in good condition

Solution

1. 40% of 15 = (0.40)(15) = 6
   6 qts water
   15 – 6 = 9 qts of coolant
2. 132°C @ 60% from chart

Engine Repair Work Example 18

WorkKey Level: 6
NATEF Tasks: I.C.5

A technician is rewiring a parallel circuit in an auto with a 12-volt system. The circuit has four branches each with one load with the following resistance values:

Load 1—6 ohms
Load 2—3 ohms
Load 3—2 ohms
Load 4—1 ohm

What is the circuit total amperage? (Hint: Don't forget Ohms law, $E = I * R$)

Solution

Load 1	12 = I * 6	I = 12/6	I = 2
Load 2	12 = I * 3	I = 12/3	I = 4
Load 3	12 = I * 2	I = 12/2	I = 6
Load 4	12 = I * 1	I = 12/1	I = 12

Parallel circuit amperage is the "sum" of all the branches.

2 + 4 + 6 + 12 = 24 amps

Engine Repair Work Example 19

WorkKey Level: 4
NATEF Tasks: Background

Joe's Auto Repair shop ordered parts totaling $418.90. The supplier requires 25% down and 5% for shipping with each order. If Joe plans to send $125.00, will that amount be sufficient?

Solution

$A = (25\%)(418.90) + (5\%)(418.90)$
$A = (30\%)(418.90)$
$A = (0.3)(418.90)$
$A = 125.67$

No, $125 will not be sufficient. Joe needs to send $125.67.

Engine Repair Work Example 20

ACT Work Keys Level: 3
NATEF Tasks: I.B.20

If a panel is 0.031 inch (0.79 mm) thick and you grind off 0.024 inch (0.61 mm) of metal, how thick is the remaining panel?

Solution

Customary: 0.031 – 0.024 = 0.007 inch
Metric: 0.79 – 0.61 = 0.18 mm

Engine Repair Work Example 21

WorkKey Level: 5
NATEF Tasks: I.A.12

As a technician you are frequently asked to repair older model vehicles. A customer has brought into your shop an older car, valued at $2250, needing repairs to its suspension system resulting from an accident. After diagnosing the problem, you calculate that the parts needed for the repairs will be $1250. In addition, you calculate that it will take you 29 hours (at $35.00/hour) to complete the repairs. What is your advice to the customer? Go ahead with the repairs or "total" the car?

Solution

$1250 + ($35/hour × 29 hours) = ?
$1250 + ($1015) = $2265

The customer should "scrap" the car; the cost of the repairs ($2265) exceeds the value of the car ($2250).

Engine Repair Work Example 22

ACT Work Keys Level: 5
NATEF Tasks: I.C.11

What is the engine displacement in cubic inches on an 8-cylinder, 4.6-liter engine with a cylinder bore diameter of 3 1/2 inches and a piston stroke length of 4 3/8 inches?

Solution

Calculate the volume of one cylinder.
$V = \pi r^2 l$
$V = (\pi)\left(\frac{3.5}{2}\right)^2 (4.375)$
$V = (\pi)(1.75^2)(4.375)$
$V = (\pi)(3.0625)(4.375)$
$V = 42.09243282$
The volume displacement for one cylinder is approximately 42.09 in^3.

Calculate the total volume of all eight cylinders.
(42.09)(8) = 336.72
The total engine displacement is 336.72 in^3.

Engine Repair Work Example 23

WorkKey Level: 4
NATEF Tasks: Background

An auto parts distributor drives 129 miles on Monday, 135 miles on Tuesday, and 219 miles on Wednesday.

What was his average mileage for those 3 days?

Solution

$\frac{(129 + 135 + 219)}{3} = 161$ miles

Engine Repair Work Example 24

ACT Work Keys Level: 6
NATEF Tasks: I.B.20; III.B.13; III.B.14

As an auto body repairperson, you are asked to make repairs on a car that has been involved in a serious accident. Damage was sustained to the left front fender, as well as the right headlight, turn light, right fender, and right quarter panel. After consulting parts books and according to your calculations, these are the labor and parts costs:

Labor (nontaxable)
14 hours for repairs and repainting—$27.50/hour
2 hours of washing and waxing—$9.50/hour

Parts
Paint—$105
Headlight—$85
Turn light—$55
New fender—$265
New quarter panel—$625
Washing/waxing materials—$11.50

Discount on parts only (if paid in cash)
8.75%

Sales tax (on taxable items only)
6%

If the customer pays cash, how much will the repairs total?

Solution

Labor
(14 hours)($27.50 per hour) = $385
(2 hours)($9.50 per hour) = $19
$385 + $19 = $404

Parts
Paint—$105
Headlight—$85
Turn light—$55
New fender—$265
New quarter panel—$625
Washing/waxing materials—$11.50
$105 + $85 + $55 + $265 + $625 + $11.50 = $1146.50

($1146.50)(8.75%) = (1146.50)(0.0875) = 100.31875
Cash discount = $100.32

$1146.50 – $100.32 = $1046.18 for parts reflecting cash discount
($1046.18)(6%) = (1046.18)(0.06) = 62.7708
Sales tax = $62.77

$404 + $1046.18 + $62.77 = $1512.95 Total

Engine Repair Work Example 25

WorkKeys Level: 6
NATEF Tasks: I.C.5

A technician is overhauling a 6-cylinder engine with a bore of 3.800 inches and a stroke of 3.4 inches. Due to wear the engine block must be bored out 0.030. What will the new cubic inch displacement of the engine be when finished?

(Hint: Cylinder cubic inch = $\left(\frac{\text{Bore}}{2} * \pi\right)^2$ * stroke * cylinder)

Solution

$\frac{156.6}{4}$ * 6 = Cubic inch displacement

39.15 * 6 = Cubic inch displacement

234.9 = Cubic inch displacement