Name: _____ Date: _____

Engine Performance Work Example 1

WorkKey Level: 3
NATEF Automotive Tasks: VIII.F

For every pound of pressure (psi), the boiling point rises 3 degrees Fahrenheit. What is the boiling point of a system with a 16-psi cap, assuming the boiling point of the current coolant mixture is 228 degrees Fahrenheit.

Solution

1 psi = 3 degrees
(16 pounds)(3 degrees) = 48°
48° + 228° = 276°

Engine Performance Work Example 2

WorkKey Level: 4
NATEF Automotive Tasks: VIII.F

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

Solution

(15 quarts)(60%) = (15)(0.60) = 9 quarts
Need 9 quarts of coolant

Engine Performance Work Example 3

WorkKey Level: 3
NATEF Automotive Tasks: VIII.F

According to the following chart, if I have a 14-quart capacity cooling system and I want to obtain protection against freezing down to –54 degrees Fahrenheit, how many quarts of antifreeze should the system contain?

Cooling system capacity in quarts	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
8	–7	–34	–69						
9	0	–21	–50	–70					

10	4	–12	–34	–62					
11	8	–6	–23	–47	–65				
12	10	0	–15	–34	–57				
13		3	–9	–25	–45	–64			
14		6	–5	–18	–34	–54	–68		
15		8	0	–12	–26	–43	–62		
16		10	2	–8	–19	–34	–52	–64	
17			5	–4	–14	–27	–42	–58	–69
18			7	0	–10	–21	–34	–50	–62
19			9	2	–7	–16	–28	–42	–56
20			10	4	–3	–12	–22	–34	–48

Solution

Reading from the chart:
Go down to 14 quarts and over to –54 degrees.
The answer is 8 quarts.

Engine Performance Work Example 4

WorkKey Level: 4
NATEF Automotive Tasks: VIII.F

According to the following chart, if you had a 25-quart system that contained 15 quarts of antifreeze and 10 quarts of water, what would the boiling point of the system be?

Freeze/Boil Protection Chart
***Using a 15-PSI Pressure Cap**

	Protects from	
% of cooling system capacity	**Freezing down to**	**Boiling up to ***
50	–34º F	265º F
60	–62º F	270º F
70	–84º F	276º F

Solution

15/25 = 3/5 = 0.60 = 60%
Reading from chart: 60% = 270º F

Engine Performance Work Example 5

WorkKey Level: 4
NATEF Automotive Tasks: VIII.B.3, VIII.B.4, VIII.B.6

The resistance of a coolant temperature sensor reads 1025 ohms. Looking at the chart below, what is the approximate temperature of the coolant in Fahrenheit?

Coolant Temperature Sensor Temperature-to-Resistance Values (Approximate)

ºF	ºC	Ohms
210	100	185
160	70	450
100	38	1,600
70	20	3,400
40	–4	7,500
20	–7	13,500
0	–18	25,000
–40	–40	100,700

Solution

Look at the chart. In the Ohms column, the value 1025 is exactly halfway between 450 and 1600. The readings in Fahrenheit are 160 and 100. Since it is halfway between the two values, the students should arrive at an answer of approximately 130°F.

$x = (160° + 100°)/2 = 260/2 = 130°F$

Engine Performance Work Example 6

WorkKey Level: 3
NATEF Automotive Tasks: VIII.A.8

The following are results from a cylinder power balance test. Fill in the chart and determine which cylinder is weakest.

Cylinder number	Idle speed	RPM it dropped to	Difference between idle speed and test speed
1	850 rpm	720 rpm	
2	850 rpm	700 rpm	
3	850 rpm	780 rpm	
4	850 rpm	695 rpm	

Solution

Students need to subtract to find the differences.
850 – 720 = 130 rpm
850 – 700 = 150 rpm
850 – 780 = 70 rpm
850 – 695 = 155 rpm

To determine which cylinder needs further inspection, you are looking for the cylinder with the least drop; therefore, cylinder 3 needs further inspection.

Engine Performance Work Example 7

WorkKey Level: 3
NATEF Automotive Tasks: VIII.B.3, VIII.B.4, VIII.B.6

An engine is operating at 70ºC and the coolant temperature sensor has a resistance of 3,400 ohms. Is this a logical temperature resistance temperature relationship?

Coolant Temperature Sensor Temperature-to-Resistance Values (Approximate)

ºF	ºC	Ohms
210	100	185
160	70	450
100	38	1,600
70	20	3,400
40	–4	7,500
20	–7	13,500
0	–18	25,000
–40	–40	100,700

Solution

No. Reading from the chart, for 70°C, the number of ohms should be approximately 450.

Engine Performance Work Example 8

WorkKey Level: 3
NATEF Automotive Tasks: VIII.E.3.1, VIII.E.3.4

You are testing a catalytic converter using the temperature variation method. The converter temperature variation specification should read at least 600 degrees Fahrenheit. The inlet of the catalytic converter reads 700 degrees. The outlet reads 1200 degrees. Is the catalytic converter working properly? Please explain.

Solution

You need to see a change of at least 600°F to determine whether a catalytic converter is working properly.

Outlet – Inlet = 1200 – 700 = 500

Since 500 < 600, the catalytic converter is bad.

Engine Performance Work Example 9

WorkKey Level: 3
NATEF Automotive Tasks: VIII.E.3.1, VIII.E.3.4

You are testing a catalytic converter using the temperature variation method. The converter temperature variation specification should read at least 600 degrees Fahrenheit. The inlet of the catalytic converter reads 500 degrees. The outlet also reads 500 degrees. Is the catalytic converter working properly? Please explain.

Solution

You need to see a change of at least 600°F to determine whether a catalytic converter is working properly.

Outlet – Inlet = 500 – 500 = 0

Since 0 < 600, the catalytic converter is bad.

Engine Performance Work Example 10

WorkKey Level: 3
NATEF Automotive Tasks: VIII.E.3.1, VIII.E.3.4

You are testing a catalytic converter using the temperature variation method. The converter temperature variation specification should read at least 600 degrees Fahrenheit. The inlet of the

catalytic converter reads 400 degrees. The outlet reads 1800 degrees. Is the catalytic converter working properly? Please explain.

Solution

You need to see a change of at least 600°F to determine whether a catalytic converter is working properly.

Outlet – Inlet = 1800 – 400 = 1400 degrees

Since 1400°F ≥ 600°F, the catalytic converter is working properly.

Engine Performance Work Example 11

WorkKey Level: 5
NATEF Automotive Tasks: VIII.D.4

Excessive alcohol (over 10%) will cause drivability problems. You have a beaker with one milliliter of tap water and ten milliliters of fuel from a car's gas tank. After thoroughly mixing the two liquids and letting them settle, you find that the water level is 0.5 milliliters higher than it originally was. What is the percentage of alcohol in the fuel? Allowing up to 10% alcohol on gasoline, is this acceptable? Note: Water will extract alcohol from fuel.

Solution

1.5 ml water-alcohol mixture
–1.0 ml water
0.5 ml alcohol fuel

$$\frac{\text{Alcohol taken out}}{\text{Original amount of fuel}} = 0.5 \text{ ml}/10 \text{ ml} = 0.05 = 5\%$$

Since 5% ≤ 10%, yes, this is an acceptable amount.

**** Automotive teacher can do a demonstration for further clarification, if needed.***

Engine Performance Work Example 12

WorkKey Level: 5
NATEF Automotive Tasks: VIII.D.4

Excessive alcohol (over 10%) will cause drivability problems. You have a beaker with one milliliter of tap water and ten milliliters of fuel from a car's gas tank. After thoroughly mixing the two liquids and letting them settle, you find that the water level is 0.75 milliliters higher than it originally was. What is the percentage of alcohol in the fuel? Allowing up to 10% alcohol on gasoline, is this acceptable? Note: Water will extract alcohol from fuel.

Solution

1.75 ml water-alcohol mixture
–1.00 ml water
0.75 ml alcohol fuel

$$\frac{\text{Alcohol taken out}}{\text{Original amount of fuel}} = 0.75 \text{ ml}/10 \text{ ml} = 0.075 = 7.5\%$$

Since 7.5% ≤ 10%, yes this is an acceptable amount.

**** Automotive teacher can do a demonstration for further clarification, if needed.***

Engine Performance Work Example 13

WorkKey Level: 5
NATEF Automotive Tasks: VIII.D.5, VIII.D.8

You are testing the injectors on a 4-cylinder engine; the base pressure is 36 psi in the fuel rail. When each injector is energized, the fuel rail pressure drops down to the following readings.

Fuel injector	Reading
1	25
2	27
3	35
4	25

According to the specs, these readings should not vary by more than 10% of the highest reading. Do these end-of-test readings after tests fall within specs? Please explain your answer. Predict which injectors are bad.

Solution

10% of highest reading = (0.10)(35) = 3.5
35 psi – 3.5 psi = 31.5 psi
Readings need to be greater than or equal to 31.5, or $r \geq 31.5$.
No, not all of the readings are acceptable and they do not fall within the 10% range.

Engine Performance Work Example 14

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

The following are compression test results from an engine. Specs state that the results should be within 10% of the highest reading. Are the results acceptable? Show why.

120 psi 115 psi 119 psi 109 psi 117 psi 115 psi

Solution

10% of highest reading = (0.10)(120) = 12 psi
120 psi – 12 psi = 108 psi
Readings need to be greater than or equal to 108, or $r \geq 108$.
Yes, all of the readings are acceptable and fall within the 10% range.

Engine Performance Work Example 15

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 enough 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 Performance Work Example 16

WorkKey Level: 6
NATEF Automotive Tasks: I.A.8, VIII.A.8

A vehicle is getting 20 miles per gallon (mpg) with the engine operating at approximately 180°F. For each 10° increase in engine operating temperature above 160° the fuel economy will increase 2.5%. If the 180° thermostat is removed and replaced with a 200° thermostat, what will be the new mpg?

Solution

Replacing the 180° thermostat with a 200° thermostat equals a 20° increase in operation temperature.

Therefore, 20 mpg × 2.5% (0.025) = 0.5 mpg, and
20 mpg + 0.5 mpg = 20.5 mpg

Engine Performance Work Example 17

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

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 Performance Work Example 18

WorkKey Level: 6
NATEF Automotive Tasks: Background

You just recently accepted a position at one of the Big 3 automakers setting up auto repair training programs at dealerships throughout the state. As part of your benefit package, you have the choice to 1) use a company car for business, 2) lease a car, or 3) get reimbursement for using your car for business travel. The specifics of each are as follows:

1. Company car: You may use a company car on business only. The company car must stay at your work location whenever not in use. You must use your own transportation to and from work. The company pays all costs (gas, maintenance, insurance, and repair) of the car. Your personal car gets 26 miles per gallon and the maintenance and repair costs average out to 28 cents per mile.

2. Lease a car: You may lease a car for your business and personal use. (You will not need another car.) The lease costs $350 per month of which the company pays 70%. (Your company assumes you will use the car 70% of the time on company business and the other 30% of the time will be used for personal business). The company will also pay 70% of the cost of gas, insurance, maintenance, and repair of the car. The leased car averages 31 miles per gallon and the maintenance and repair costs average out to 28 cents per mile.

3. Reimbursement: The company reimbursement rate for using a personal car on company business is 37 cents per mile.

Determine the best deal for you assuming you average 1900 miles per month while on business and 1500 miles per month personal (includes commuting to and from work). Also, assume an average cost of gasoline of $1.50 per gallon and a 20-day work month.

Solution

Determine your transportation costs for all three options.

1. Company car:
   No cost for the company car; however, you still need a car for personal use.
   1500 miles ÷ 26 miles/gal = 57.7 gal × $1.50 gal = $86.54
   1500 miles × $0.28/mile = $420
   Your personal cost: $86.54 + $420 = $506.542.

2. Leased car:
   You can use this car for business and personal use.
   $350 × 0.30 = $105
   3400 miles ÷ 31 miles/gal = 109.7 gal × $1.50/gal = $164.52 × 0.30 = $49.35
   3400 miles × $0.28/mile = $952 × 0.30 = $285.60
   Your personal cost: $105 + $49.35 + $285.60 = $439.95

3. Reimbursement for business use for your personal car.

   Cost:
   3400 miles ÷ 26 miles/gal = 130.77 gal × $1.50/gal = $196.15
   3400 miles × $0.28/mile = $952

   Reimbursement:
   1900 miles × $0.37/mile = $703.00
   Your personal cost: $196.15 + $952 – $703 = $445.15

   Thus, option #2 ($439.95) is the best option for you.

Engine Performance Work Example 19

WorkKey Level: 4
NATEF Automotive Tasks:

A technician has installed a stock cam in an engine with a lobe lift of 0.375 in. He wants to get more performance from it so he decides to replace his stock 1.5 ratio rockers with 1.6 ratio rockers. How much more valve lift will he get from this modification?

Solution

Valve lift = (cam lobe lift)(rocker ratio)
With a stock rocker he would obtain a valve lift of 0.5625" (0.375 × 1.5). If he puts in 1.6 ratio rockers he would obtain a valve lift of 0.6000" (0.375 × 1.6). If we subtract the two numbers we get 0.0375" increase of valve lift.

Engine Performance Work Example 20

WorkKey Level: 3
NATEF Automotive Tasks: VIII.F.4

For every pound of pressure (psi), the boiling point rises 3 degrees Fahrenheit. What is the boiling point of a system with a 16-psi cap, assuming the boiling point of the coolant is 228 degrees Fahrenheit?

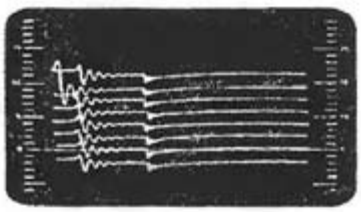
Solution

1 psi = 3 degrees
(16 pounds)(3 degrees) = 48°
48° + 228° = 276°

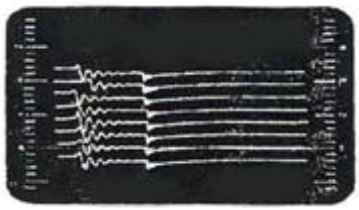
Engine Performance Work Example 21

WorkKey Level: 4
NATEF Automotive Tasks:

Using the attached pictures, answer the following questions.



A.



B.

1. How many cylinders would you assume this engine that is being analyzed on the oscilloscope has?
   a. one
   b. two
   c. four
   d. eight
   e. twelve

2. On pattern A, which trace looks more unlike any other?
   (Traces are numbered from bottom to top.)
   a. one
   b. five
   c. six
   d. seven
   e. eight

3. On pattern B, which trace looks more unlike any other?
   (Traces are numbered from bottom to top.)
   a. one
   b. five
   c. six
   d. seven
   e. eight

Solution

1. D; since there are 8 lines, there are 8 cylinders.
2. D; #7 from the bottom is missing the spark line.
3. D; #7 from the bottom has a longer spark line.

Engine Performance Work Example 22

WorkKey Level: 4
NATEF Automotive Tasks: Background

Joe is keeping a log of mileage in his new car. Complete the following chart.

Mileage	Miles traveled	Gallons purchased	Miles per gallon
720	_____	_____	_____
1080		18	
1424		17	
1803		16	

1. Is his mileage getting better or worse?
   a. Better
   b. Worse
   c. About the same
2. What is his average miles per gallon?
   a. About 17 mpg
   b. About 19 mpg
   c. About 21 mpg
   d. About 23 mpg

Solution

Mileage	Miles traveled	Gallons purchased	Miles per gallon
720	_____	_____	_____

1080	**360**	18	**20**
1424	**344**	17	**20.2**
1803	**379**	16	**23.7**

1. **a.** Better

2. $\text{Mpg} = \dfrac{\text{miles traveled}}{\text{gallons purchased}}$

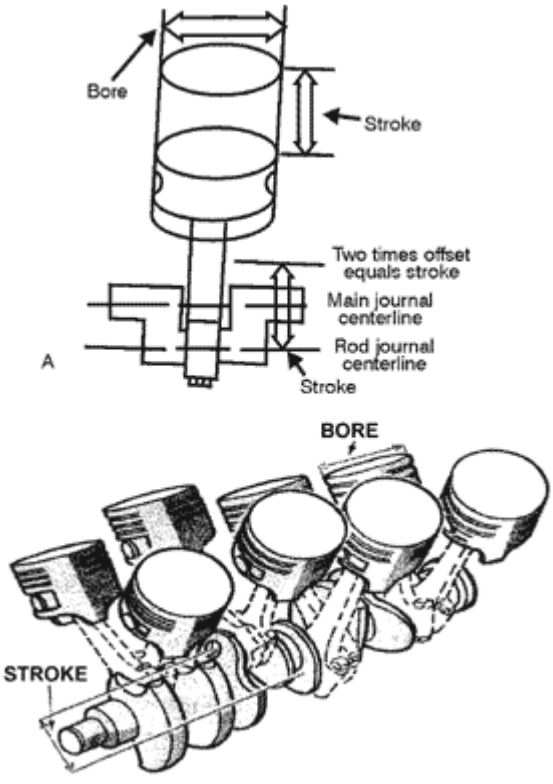
   $\text{Avg} = \dfrac{20 + 20.2 + 23.7}{3} = 63.9/3 = 21.3$

   c. About 21 mpg

Engine Performance Work Example 23

Work Key Level: 5
NATEF Automotive Tasks:

You are building a racing engine for a customer and he wants more cubic inches. You have an eight-cylinder engine with a bore of 4.00 inches and a stroke of 3.50 inches. You are given the formula for engine displacement of (Bore/2) squared times π times stroke times number of cylinders.



Facts:
Radius = Diameter of bore divided in half
$\pi = 3.14159....$(Use 3.14)
Volume of a cylinder = $\pi r^2 L$ (L is the stroke length.)

A. What is the cubic inches of the stock motor? _____

B. What is the cubic inches if the bore is increased by 0.120 inches? _____

C. What is the cubic inches if a crankshaft with a stroke of 3.750 inches is used? _____

D. It costs $160 to bore a motor and buy pistons or $399 to buy a longer stroke crank. What would you tell the customer who wants more cubic inches but wants it cheap?
_____

Solution

A. 351.68 in^3

B. 373.97 in^3

C. 376.8 in^3

D. Go with the bore unless you want an extra 3.8 in^3 for an extra $240.

Engine Performance Work Example 24

WorkKey Level: 5
NATEF Automotive Tasks: VIII.A.6

A technician is doing a cylinder balance test on a 6-cylinder engine. Before performing the test the technician notes an engine RPM of 750. The RPM readings for each cylinder during the test are:

1) 680 RPM
2) 650 RPM
3) 660 RPM
4) 638 RPM
5) 733 RPM
6) 668 RPM

a. Did the engine pass the test? Show your work and explain your answer.

b. Which cylinder is doing the least amount of work? Explain your answer.

Solution

a. Calculate the percentage difference between the highest and the lowest cylinder RPM reading.

638/733 = 87%
100 – 87 = 13%

Since the percentage difference between the two cylinders' RPM readings is greater than 10%, the engine fails the test.

b. Since the RPM reading dropped the least with cylinder 5 disengaged, cylinder 5 is doing the least amount of work.