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ABSTRACT

Utilizing word problems relevant to automotive mechanics, this workbook presents a concept-oriented approach to competency development in 13 areas of basic mathematics: (1) the expression of numbers as figures and words; (2) the addition, subtraction, multiplication, and division of whole numbers, fractions, and decimals; (3) scientific notation; (4) ratios and proportions; (5) percents; (6) measurement; (7) geometry; (8) the Pythagorean Theorem; (9) introductory trigonometry; (10) introductory algebra; (11) problem solving; (12) probability and statistics; and (13) graphs and charts. For each competency area, the workbook presents a series of word problems designed to reinforce student learning and to demonstrate the applicability of the concept to the automotive work environment. An answer key for the problems is appended. (JP)

PERSONAL ACHIEVEMENT

MATHEMATICS

Automotive

Produced by
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CURRICULUM MATERIALS DEVELOPED

UNDER THE AUSPICES OF

FUND TO IMPROVE POST SECONDARY EDUCATION

Prepared By

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1977

THE PROBLEMS FOUND IN THIS BOOKLET ARE NOT MEANT TO INSTRUCT YOU IN THE FIELD OF AUTOMOTIVE OCCUPATIONS. THEY ARE PRACTICES OF THE VARIOUS MATHEMATICAL CONCEPTS AND ARE CONTENT ORIENTED TO HELP SHOW THE PRACTICALITY OF EACH CONCEPT.

STUDY EACH MATHEMATICAL COMPETENCY IN THE GENERAL LEARNING PACKETS BEFORE ATTEMPTING THESE APPLIED PROBLEMS.

CONTENTS

INTEREST AREA: AUTOMOTIVE

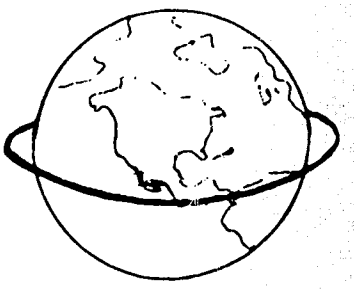
Numeration

1. In 1970, cars, trucks, and buses travelled a total of one trillion one hundred billion miles. Write that number using numerals.

2. In 1970, 90,000,000,000 gallons of petroleum products were used by cars, trucks, and buses. Write that number in words.

3. A million is the number of miles in 40 trips around the earth. Write the numeral for one million.

4. Every year about 7,000,000 old, worn out cars become rusty scrap metal. Write that number in words.



5. Manufacturer's recalls of motor vehicles for correction of safety defects reached a high of 12,081,803 in 1972. Write that number in words.

Addition & Subtraction

1. Last year on this date Sam's car odometer read 67,243 miles. It now reads 81,062 miles. How many miles has he driven in the past year?

2. One engine makes 3,500 r.p.m. while another makes 2,400 r.p.m. Find the difference of r.p.m. in these two engines.

3. Coil springs that are available for a station wagon have capacities of 475 lbs. and 300 lbs. Find the difference between the capacities of the two different springs.

4. Different areas of a 4 cylinder car have the following approximate capacities. What would be the total volume of the combined areas.

   Cooling system
   6 quarts
   Oil Capacity with filter
   4 quarts
   Fuel Tank
   40 quarts
   Manual Transmission
   2 quarts
   Rear axle
   2 quarts

5. Due to overheating, the resistance of an electric resistor changed from 195 ohms to 262 ohms. How much did the resistance change?

6. In the mid 1970's about 46,000 Americans were killed and 4,300,000 were injured in traffic accidents each year. What is the total deaths and injuries for any one year?

7. Find the total amperes being used at one time if the following are being used:

air conditioner	10 amps
ignition system	2 amps
low beam lights	8 amps
radio	1 amp
windshield wipers	2 amps

8. In 1941, 8,000 tons of synthetic rubber were produced and by 1973 the output in the United States exceeded 2,500,000 tons. How many tons increase does that represent?

Multiplication

1. In an engine, during one revolution a piston travels from its highest point to its lowest point and back to the highest again. If the length from the high point to the low point is 3" on a particular piston, how far will the piston travel in one minute if the engine makes 2400 revolutions per minute.

2. A four cylinder engine has a piston displacement of 71 cu. in. for each cylinder. Find the total piston displacement for the four cylinders.

3. The pressure inside the cylinder chamber is as high as 600 pounds per square inch. If the piston head has an area of 7 square inches what would be the total force?

4. A salesman changed the oil in his car 9 times last year, using 6 qts. each time. How many quarts were used?

5. A flywheel makes 2600 revolutions per minute. How many revolutions does it make in a 24 hour day?

Division

1. Suppose a little Honda sports car travels 418 miles on 11 gallons of gas. How many miles to the gallon is it getting?

2. The noise of an explosion travels 6192 meters through air in 18 seconds. What is the speed of sound in meters per second?

3. A 6 cylinder engine has a total piston displacement of 498 cubic inches. Find the displacement of each piston.

4. If the total force exerted on a piston with a head area of 8 square inches is 4,400 pounds, find the force per square inch.

5. A certain auto part costs $14. If the cost of a shipment of the parts to an auto supply dealer is $514, which includes a $10 shipping charge, how many parts were in the shipment?

6. If a total of approximately 100 studs are inserted into the 4 or 6 rows of holes molded into the tread surface of 2 types of tires, how many studs will be in each row of each type.

7. If it is recommended that the stop light switch on a car be checked every 8000 mi. how many times would this electrical connection have been checked if a car has been driven 56,000 miles.

8. If the shipping weight of a 54 gallon drum of brake fluid is approximately 496 lbs., how many pounds is that per gallon including the container?

9. An auto repair shop has 312 spark plugs in its stock. If the spark plugs are to be used in sets of 8, how many sets would this represent?

Introduction To Fractions

1. The radiator of a car holds 15 quarts. If it now contains 6 quarts of anti-freeze and the rest water, what part of the solution is anti-freeze?

2. In 1970, approximately 9 million new cars were sold in the United States. If there were only 2 million sold in 1920, what fractional part is that of the 1970 number?

3. In 1901, the Olds Company built 425 cars. The next year, using mass production methods, the company built 2,500 cars. Write a fraction to compare the production of the first year to the second year.

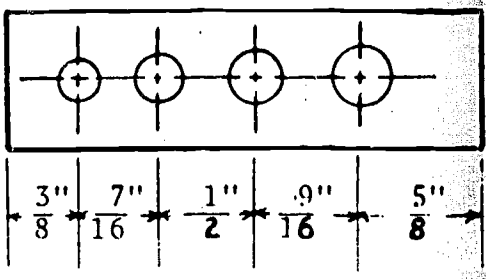
Fractions, + −

1. If one mechanic can assemble a motor in 6½ hours, while another can do the same job in 7 5/6 hours, how much less time does the first mechanic take?

2. A certain machine part consists of 3 joined pieces. If the three pieces measure 2 9/16, 1 27/32, and 7/8 inches respectively, how long is the whole assembled part?

3. What is the size of a piece that is 1/16 inch larger than 2 3/8 inches?

4. What is the length of the piece of metal shown?



5. A mechanic checking the alignment of a car frame finds the 2 diagonals to be 73 11/16 inches and 73 3/8 inches. How much difference is there between the 2 measurements?

6. What is the total thickness of a metal frame and cross member if they are 7/32 inches and 1/8 inch respectively?

7. Three electrical resistors are 3 1/18 ohms, 2 5/24 ohms, and 1 7/15 ohms. What is the sum of the three resistances?

8. A metal plate is 3/16 inch thick and has a film coating 1/64 inch thick applied to both sides. What is the resulting thickness of the plate?

9. Two splice plates must be cut from a piece of sheet metal that has an overall length of 15 3/4 inches. The plates are to be 6 7/8 inches and 7 5/16 inches long. How much metal is left if 1/16 inch is allowed for a saw cut?

10. With journal lengths of 1 3/4 inches, 1 29/32 inches, and 1 57/64 inches, what is the total length of the main bearing journals?

11. A garageman uses a 7 1/2 horsepower motor to run his air pump. If the air pump requires 4 3/4 horsepower, how much power is left to be used for other purposes?

12. A truck box is 8 3/4 feet long. If a crate 3 7/8 feet long is placed in the box, how much room is left?

13. A piece of stock 6 inches long has a hole drilled with its center 2 5/15 inches from one end. How far is it from the center of this circle to the other end of this stock?

14. A gasoline tank contains 16 gallons of gas. 7 3/4 gallons are removed to clean parts. How many gallons are left in the tank?

15. A radiator contained 12 quarts of water. How much would remain if 3/4 quarts were taken out?

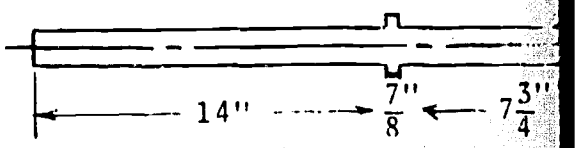
16. During one 8 hour day, a repairman took 45 minutes for lunch and 2 coffee breaks, 1/4 hour each. What was the total time he worked?

17. A depth of tire tread on a new tire is 9/32 inches. After two month's use, 1/16" has been worn off. What would be the tread depth then?

18. A strip of copper 3/32" thick is unwound from around a shaft 1/2" in diameter. What is the new diameter?

19. What is the outside diameter of a pipe with a 5/64" wall and a 1 3/4" inside diameter?

20. What is the total length of the shaft shown at the right?



21. Double Hex Drive Sockets for Torque wrenchs come in the following sizes:

5/8", 11/16", 3/4", 13/16", 7/8", 15/16",

How much difference is there between the smallest and the largest size?

Multiplying Fractions

1. Find the weight of 19 pieces of metal rod, each 2 1/2 feet long, if the rods weigh 1 7/8 lbs. per foot.

2. What is the total voltage of 50 small batteries, each of which is 1 1/2 volts?

3. A particular rectangular metal part is 11/16 inches by 15/32 inches. What fraction would represent its area? (Area = length times width)

4. 2/5 of a piece of scrap metal 11 1/4 feet long is used in reinforcing a metal angle iron. What is the length of the remaining scrap?

5. If a metal bar is cut into 6 equal pieces 3 3/8 inches long and each cut wastes 1/16 inches, how long was the original bar?

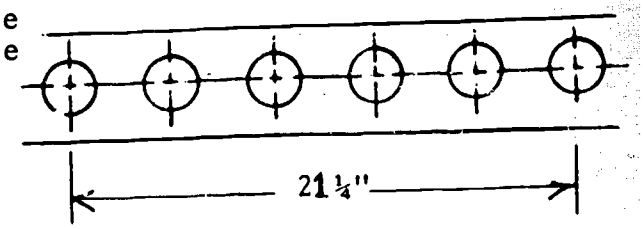
6. A new automobile contains approximately 15,000 parts. If 2/3 of all the parts are to be altered to some extent for a new model, how many parts will need to be redesigned?

Dividing Fractions

1. If a car was driven 63 miles in 1 3/4 hours, what was its average speed per hour?

2. If the outside diameter of an air brake hose is 5/8" and the inside diameter is 1/4", what is the wall thickness of the hose?

3. What is the distance center-to-center between the holes in the exhaust manifold(shown at the right) if they are equally spaced and the total distance between the left and right end holes is 21 1/4"?



4. If the pitch circle of a gear has a circumference of 33" and the distance between teeth is 1 3/8", how many teeth are there on the gear?

5. A metal plate has an area of 2 3/16 inches. If its length is 1 7/8", what is its width?

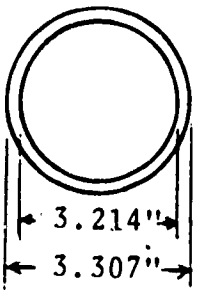
6. If a gas tank hold approximately 7 1/2 gallons per cu. ft., what would the volume be in cubic feet, if a truck tank holds 90 gallons of gas?

Decimals +, −

1. A customized Phaeton Limousine is 264.9 inches in length which is 3 feet longer than a Lincoln Continental standard model. How many inches in length is a standard model?

2. A machine part is 5 7/16 inches wide and the other end is 4.982 inches wide. How much wider is the first end?

3. The diameter of a piston is 3.214" and the cylinder's diameter is 3.307". What is the clearance between the piston and the cylinder?



4. If the diameter of a piston is 9.7 cm and is to have a clearance of .005 cm, what size is the cylinder bore? (Note: there will be clearance all around the piston.)

5. If the bore of a cylinder is 2.875" and is to be increased to 2.890" what is the amount of the increase?

6. Three electrical resistors have resistances of 13.2 ohms, 6.9 ohms, and 8.4 ohms, respectively. What is the sum of the three?

Multiplying Decimals

1. Find the price of 12.5 gallons of gas if the price is 51.9 cents per gallon.

2. In the formula for finding the area of a circle, (Area = πr^2) find the area when the radius (r) is 2.5" and the value of π is 3.14.
   Area = (3.14)(2.5)(2.5)

3. A rectangular metal part is 5.273 inches long and 3.026 inches wide. What is the area to the nearest hundredth of a sq. inch? (Area = length times width)

4. The approximate length in feet of a certain large pulley belt is found by making the following calculation:

   2(4.27) + 3.14 (0.83 + 1.42)

   Find the length of the belt to the nearest hundredth of a foot.

5. A car travels at an average speed of 51 miles each hour. How far will the car travel in 4.25 hours?

6. If a one foot length of steel angle will increase in length by 0.0000067 feet for each 1°F increase in temperature, what will the increase in length of a 6 ft. 3 in. piece be when the temperature is increased 45°F?

7. What is the cost of a piece of sheet metal 8.25 feet by 4.88 feet, if the cost is $4.28 per square foot?

8. Gasoline weighs about 5.66 lbs per gallon, and Tom puts 17.6 gallons in his car. How much weight is he adding to the tank?

9. Metal expands when heated and contracts when cooled. If a metal rod is 100 cm long and is then cooled by 20°C, find its length if it contracts 0.1 cm for each 1°C when cooled.

Dividing Decimals

1. A car travels 1371.7 miles on 63.8 gallons of gas. Find the miles per gallon average rate for such a trip.

2. John wants to buy a new car and finds that his present one is now worth $2348. He had paid $3275 for it 3 years ago. What was the average yearly depreciation?

3. If oil can be bought for $.45 per quart in individual cans or $6.80 for 5 gallons in bulk, how much do you save per quart if you buy 5 gallons of oil in bulk?

4. A stack of sheet metal has a total thickness of 2.85 inches. If there are 20 sheets in the stack how thick is each sheet?

5. To calculate the number of revolutions per minute that a certain pulley will make, the calculations needed would be:

$$\frac{(4.36)(1530)}{9.12}$$

How many revolutions per minute would it be?

6. If a case of twelve 1-quart cans of heavy brake fluid has a shipping weight of 29.9 lbs. per case, what is the wei... nearest tenth for each quart can?

7. PART 1
If a force of 100 lbs. is applied through the use of a hammer head of (1¼" diameter) 1.2284 sq. in. , how many pounds is applied per square inch?

PART 2
If the same 100 lbs. is applied through a very small hammer of only 1/16" in diameter (0.0031 square inch) how much is the resulting force per square inch?

8. Six containers hold a total of 137.68 gallons. Approximately what amount does each container hold?

9. The difference in diameters of 2 circular cylinders is 0.086". If one is placed in the center of the other, how much clearance will there be between the two?

Scientific Notation

A number is used in each of the following statements. Write the number in either scientific notation or in ordinary notation (the opposite of its existing form). Tell in each case the number of significant figures.

1. The area of the oceans of the earth is about 360,000,000 km^2.

2. The mass of an electron is .000,000,000,000,000,000,000,000,000,91 g.

3. The sun weighs about 4×10^{30} lbs.

4. The wavelength of a red light is about 0.000065 cm.

5. It takes about 5×10^4 lb. of water to grow one bushel of corn.

6. The transmitting frequency of one television channel is approximately 88,000,000 hertz.

7. A typical capacitor has a capacitance of 0.00005 farad.

8. Special boring machines can produce finishes to about 10^{-6} inches.

9. Some gamma rays have wavelengths of 5×10^{-11} cm.

10. Oil film on water is about 0.0000002" thick.

Ratio and Proportion

1. If 12 drills cost $8.00, how much will 9 drills cost?

2. A flywheel on an engine makes 220 revolutions in 2 seconds. How many revolutions does it make in 8 seconds?

3. A motorist travels 204 miles in 6 hours. Write a proportion and find the time it will take him to travel 523 miles.

4. If three gallons of paint covers a surface containing 825 square feet, how many gallons at the same rate will be needed to paint a surface containing 1,925 square feet?

5. Find the ratio of a gear 5" in diameter to a gear 10" in diameter.

6. If 125' of wire weighs 13 lbs., how much will 375' of the same wire weigh?

7. For comparing the speed of two gears when the teeth ratio and speed of one gear are known use the following proportion:

$$\frac{\text{Gear A \# teeth}}{\text{Gear B \# teeth}} = \frac{\text{Speed Gear B}}{\text{Speed Gear A}}$$

Find the speed of the Driven Gear B when it has 40 teeth and is in mesh with a Drive Gear with ten teeth which is turning at 200 RPM.

8. A good mixture for burning in an engine about 15 poinds of air to 1 pound of gasoline. If a gallon of gasoline weighs about 6 lbs., how many pounds of air would be used in burning a gallon of gas with the above mentioned mixture?

9. In the chart below, the braking force and the air pressure in the brake chamber are shown. Is the relationship in each case the same ratio?

air pressure lbs.	5	10	20	30	40	60	80	100
developed force lbs.	120	240	480	720	960	1440	1920	2400

10. If 20 out of every 300 new cars have engine problems, how many cars have to be tested to find 50 with engine problems?

11. A mixture of 1 part regular gas and 1 part supreme gas, has a total volume of 5 gallons. If you add to that, 5 gallons of regular gas, what would be the ratio of regular to supreme?

Percent

1. A man who earns $7.30 per hour in wages is to be given a cost of living increase of 17%. What would his new hourly rate be?

2. The efficiency of a motor is usually expressed in percent. What is the efficiency of an electric motor whose horsepower input is 850 watts and whose power output is 561 watts?

3. If 2 months is about 6% of the guaranteed life of an automobile battery, what is the guaranteed life of the battery to the nearest year?

4. At a temperature of 80° F a fully charged battery of a car will have 100% efficiency. At 32° F the efficiency will be reduced to 65%. If a 40 ampere-hour rated battery is only operating at 50% at 80°, what will be its approximate ampere-hour rate at 32° F?

5. A driver who accelerates rapidly away from a stop can easily use 15% more fuel than a driver who accelerates moderately. If Driver A is of the first type mentioned, and Driver B is more moderate, while Driver B uses 20 gallons, about how much will Driver A use?

6. In 1970, 6 million barrels of crude oil a day were used in the United States for cars, trucks, and buses. If this represents 40% of all petroleum products used in the United States, how many barrels of crude oil are used each day for the other purposes?

7. In an auto body shop a Grey Chromated Oil Primer with 10% thinner is to be applied. If one pint of thinner is added, how much paint was being used?

8. If 15.3 lbs. of air pressure per square inch is 73% of the maximum air pressure that a tire can take, what would the maximum pressure be?

9. A supply house indicates that it is only able to fill 34% of your order, and is only sending you 102 oil filters. How many filters did you order altogether?

10. A loaded truck weighs 20,000 lbs. If 80% of this represents the load, how much does the truck weigh?

11. A brass bar weighing 75 lbs. is made of 45% zinc and the balance is copper. How many lbs. of copper does it contain?

12. One man in a crew receives a bonus of $5.25, which is 17.5% of the total bonus allowed for the job. What is the total bonus in dollars and cents?

13. A discount of 5% is given on a bill of $300. How much does the discount save?

14. A repair shop made a profit of 25% on a bill for $500. How much was the cost of the job?

15. A certain electric motor is 78% efficient. What is the output if the input is 1,400 watts?

16. The capacity of a cooling system is 22 quarts. What part of that amount should be alcohol to have a 35% alcohol solution?

Measurement

1. How many quarts of oil are in a drum containing 55 gallons?

2. If a car wheel goes 9'2" in one revolution, how many times does it revolve in 1 mile?

3. If the diameter of a piston is 3", how many 1/8 inch divisions would this be equal to?

4. How many 1/16" units are there in a 5/8" shackle bolt?

5. Measure the following lengths - to the nearest indicated unit of measure.

1/4" = 1' 0"

1/8" = 1' 0"

1/16" = 50 miles

6. In a sports car race one car had four successive laps of 3 minutes 42 seconds, 3 minutes 25 seconds, 3 minutes 32 seconds, and 3 minutes 24 seconds. What was the total time required for the four laps?

7. If one meter = 39.37", how many meters are there in 8 feet? (answer in hundredths)

8. If the speedometer of a European car is calibrated in km/hr and reads 60, how fast in miles per hour is the car going? (Round to whole units)

9. One horsepower is defined as 550 ft lbs./sec. Express this in $kg\text{-}cm^2/sec^3$. (Round to even units.)

10. A particular auto part thickness is given as 0.145 inches. What is this measurement in mm with the same degree of accuracy?

11. The density of gasoline is 5.6 lbs./gal. What is its density in kilograms/liter?

12. A machinist milled a machine part to a thickness of 0.285 in. thick (tolerance = I .002). What two values (the least and the greatest possible) should this thickness be?

13. Two horse assemblies with non-detachable fittings have an overall length of (#215021) 1 ft. 8 3/8" and(#215023) 2 ft. 6 1/8 in. How much difference is there in the two lengths?

Introduction To Geometry

1. Find the area of the head of a piston if the bore (diameter) of the piston is 3½".

2. If a piston makes a stroke of 4 inches in a circular cylinder of a radius of 3", what would be the volume displacement of each piston?

3. An oil storage drum is 28" in diameter and 3' high. How many gallons of oil will it hold if 1 gallon = 231 cu. in.? (1 cu. ft. holds 7 ½ gallons)

4. If a car travels at 40 m.p.h., how many revolutions per minute will its wheels turn? The diameter of the wheel is 24".

5. How many gallons of oil does a tank car hold if it is 10' in diameter and 42' long? (1 cu. ft. = 7½ gallons)

6. What is the weight of a round steel rod 8' long and 3/4" diameter? (1 cu. ft. of steel = 490 lbs.)

7. What is the area of metal on one side of a washer if its diameter is 3/4" and the diameter of the hole is ¼"?

8. If the diameter of the pitch circle of a gear is 5¼", what is the circumference?

9. If holes are drilled around a circular metal plate at 45 degree intervals, how many holes will there be?

10. If a 1/6 turn of the adjusting nut below the fuel bowl will raise or lower the float assembly at the fuel level sight plug opening 3/64", how much will a turn of 40° change the level?

11. If chalk marks are placed around the crankshaft damper 120° apart, into how many parts is the circumference divided?

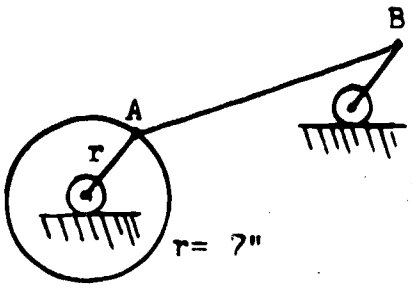
12. A container for any liquid will hold 7.48 gallon per cu. ft. Calculate the number of gallons in a truck gas tank that is 1.0 ft. by 2.0 ft. by 6 ft.

13. The area within a racetrack is a rectangle with semicircles at each end. The radius of the circular parts is 75.0 yds. and the perimeter of the track is 1760 yds. How long are the straight sections of the track?

14. The cam shown at the right is to be coated with a special metal strip to resist wear. The strip costs 75¢ per inch. How much will it cost to put the strip on the cam?

15. What would be the length of a belt connecting 2 pulleys 12" diameter if the pulleys are 40" apart (center to center)?

16. In the figure at the right a crank-lever mechanism is shown. From the figure determine the scale and then determine the length of AB.



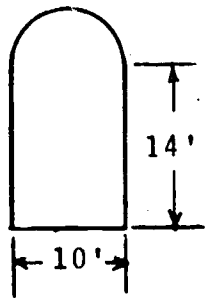
17. How much does a wire 0.250" diameter weigh if it is 1 mile long? Assume the weight of the wire is 550 lbs./ft^3.

18. How many cubic inches of metal are there in a length of pipe 15.5 ft. long when the outside diameter is 8 inches and the metal is ¼" thick?

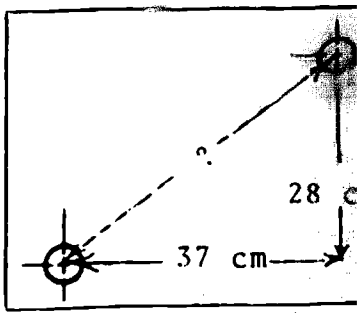
Pythagorean Theorem

1. The diagonal measurement of the frame of a car is 165" and its width is 40". What would be the length of the frame to the nearest inch?

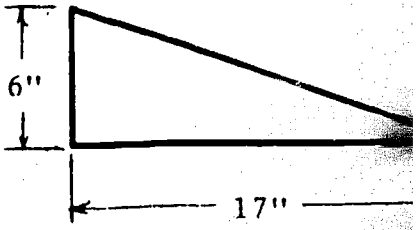
2. A one-way tunnel entrance is a rectangle 10' wide by 14' high surmounted by a semi-circular arch. How high a truck (7' wide) can enter?



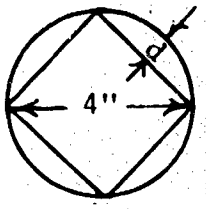
3. The metal plate shown at the right has 2 small holes bored in it. What is the center to center distance between the holes?



4. Find the area of the sheet metal plate shown at the right.



5. How deep must the cut "d" be made to mill the square nut shown (in the figure at the right) from a bar of four-inch round stock?



Intro. To Trigonometry

1. What is the distance between 2 points on a wheel 38° apart on the circumference if the diameter of the wheel is 28"?

2. Eight bolt holes, equally spaced, are drilled on the circumference of a circular metal plate with diameter of 16.6". What is the dimension (center to center) between the holes?

3. A certain machine part is a regular hexagon (6 sides) 0.844" on a side. What is the distance across from one side to the opposite side?

4. At an airport, cars drive down a ramp 96 feet long to reach the lower level baggage-claim area which is 13 feet below the main level. What angle does the ramp make with the ground at the lower level?

Introduction To Algebra

PART 1 Solve the following:

1. One engine has 2 hp more than a second engine and 3 hp less than a third engine. All three together have 16 hp. What is the power of each?

2. Oil tank A has a capacity of 100 gallons more than tank B. Tank C has a capacity twice that of B. The 3 tanks together have a capacity of 3100 gallons. What is the capacity of each tank?

3. Two cars, 598 miles apart start toward each other. One travels at the average rate of 50 mi/hr. and the other at 42 mi/hr. How many hours will it be before they meet?

4. How many quarts of pure alcohol must be added to 10 quarts of a solution which is 50% alcohol in order to make a solution which would be 70% alcohol?

5. An automobile has a 12 quart cooling system. If it is filled with a 25% alcohol solution, how many quarts must be drained off and replaced by pure alcohol to make the solution 60% alcohol?

6. Two large shipments of auto parts weigh 1800 lbs. The lighter shipment weighs 1/2 as much as the heavier. What is the weight of the heavier of the two shipments?

PART 2 Write a formula for each of the following.

1. Write a formula for the efficiency E of an engine if it is defined as the difference of the heat input I and the heat output P (I-P) divided by the heat input.

2. Write a formula for the volume of a rectangular gas tank if it is equal to the length (l) times its width (w) times its height (h).

3. The volume of a circular oil drum is calculated by multiplying the height (h) by half its diameter (d) twice and multiplying that product by 3.14. Write a formula as stated here or in a simpler form if possible.

4. Write a formula for the increase (L) in the length of a wire if it is equal to the difference in temperature [(t) before heating and (T) after heating] divided by 1000.

5. The current (I) in a circuit with a resistor (R) and a battery with voltage (E) and internal resistance (r) equals E divided by the sum of r and R.

6. To find the horsepower (H) of an electric motor multiply the number of volts (V) by the number of amperes (a) and divide by 746.

7. The amperage (A) of an electric circuit is equal to the wattage (W) divided by the voltage (V).

8. Profit (P) equals the margin (M) minus the overhead (O).

9. The speed (R) of a revolving wheel is proportioned to the number of revolutions (N) it makes in a given time (T).

PART 3 Each of the following formulas is used in technical areas. Solve each for the indicated letter.

1. $P = \frac{N + 2}{D}$ Mechanics: gears
Solve for N

2. $L = 3.14 (r_1 + r_2) + sd$ Mechanics: pulleys
Solve for r_2

3. $P = \frac{V_1 (V_2 - V_1)}{gJ}$ Jet engine power
Solve for J

4. $Q_1 = P(Q_2 - Q_1)$ Refrigeration
Solve for Q_2

5. $P-Pa = dg\ (Y_2 - Y_1)$ Pressure guages
Solve for Y_2

6. $I = \frac{E}{r+R}$ Current
Solve for R

Problem Solving

1. If a driver's reaction time before applying his brakes is one second, how many feet will the car go in that one second at 55 miles per hour?

2. Scott Foresman can buy an auto for $4400 cash or $400 down and $180 a month for 24 months. How much can he save by paying cash?

3. A piece of metal 9' 7 1/4" long must be cut into 5 equal parts. Allowing 1/4" for waste, how long will each piece be?

4. In 1770 a 3 wheeled steam tractor for hauling cannons was used. It travelled about 3 miles per hour and had to stop at a rate of every 15 minutes (for about 10 minutes) to build up steam. How long would it take it to travel the 21 miles from Cedar Rapids to Iowa City?

Probability & Statistics

1. A student measured a 2" metal block 5 times using a precision instrument and made the following readings: 1.9962, 2.0012, 2.0008, 1.9993, and 2.0015. What is the average of these measurements?

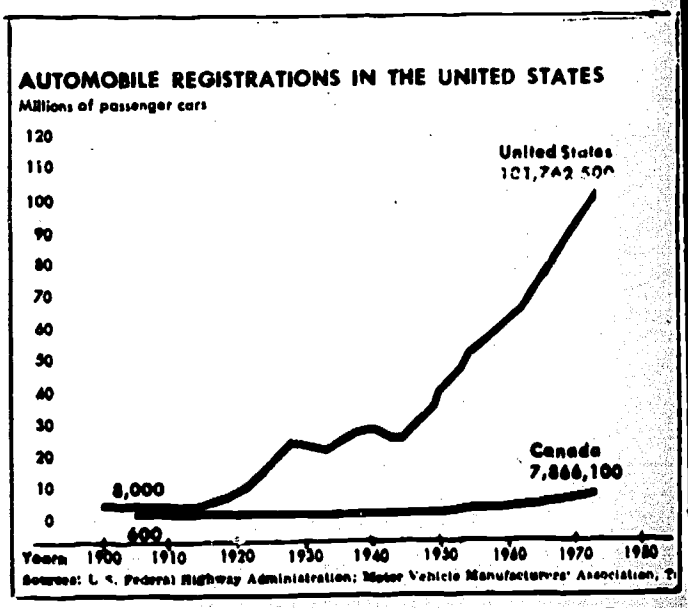
2. Mr. Brown kept a record of his miles and gas purchases on a recent trip. With the data below, calculate the average mileage per gallon for the total trip.

Miles travelled	Gas consumed
210.5	12.2
176.3	10.6
123.2	8.7

3. Unknown to the manager of a store which sells automobile tires, four of the fifty tires on display are defective. What is the probability that the first person who buys two tires will select two defective tires?

Graphs

1. From the line graph at the right, estimate the number of automobile registrations in the United States for the years 1930 and 1960.



2. In the graph at the right the number of automobile registrations for the United States is given. Estimate the number of registrations for West Germany.

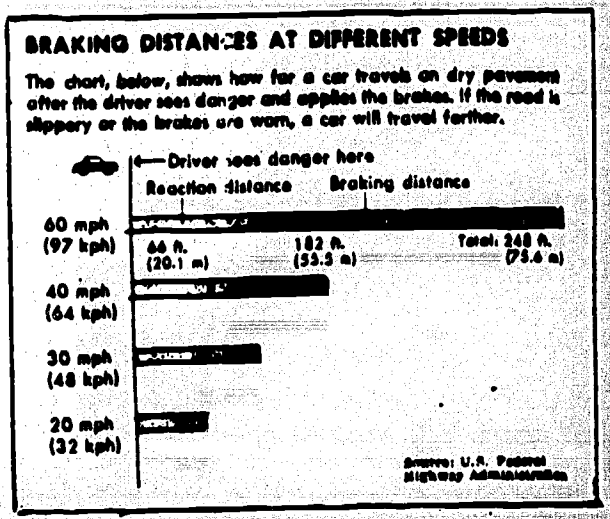
LEADING COUNTRIES IN AUTOMOBILE REGISTRATIONS

Passenger cars registered in 1973

	Number of Cars
United States	101,762,000
Germany (West)	
France	
Italy	
Great Britain	
Japan	
Canada	
Australia	
Spain	
Netherlands	

Sources: U.S. Federal Highway Administration; World Automotive Market, 1974, Johnston International Publishing Corp.; Motor Vehicle Manufacturers' Association, Toronto, Canada.

3. The bar graph at the right gives the breaking distance for 60 miles per hour as 248'. Estimate the breaking distance for 40 mph, 30 mph, and 20 mph.



Numeration

1. 1,100,000,000,000 mi.
2. ninety billion gallons
3. 1,000,000 mi.
4. seven million
5. twelve million eighty one thousand eight hundred three

Addition & Subtraction

1. 13,819 mi.
2. 1,100 r.p.m.
3. 175 lbs.
4. 54 qts.
5. 67 ohms
6. 4,346,000 people
7. 23 amps
8. 2,492,000 tons

Multiplication

1. 14,400 in.
2. 284 cu. in.
3. 4200 lbs.
4. $13\frac{1}{2}$ gals.
5. 3,744,000 revolutions

Division

1. $38\frac{2}{11}$ m.p.g.
2. $344\ \frac{8}{18}$ meters/sec.
3. 83 cu. in.
4. 550 lbs./sq. in.
5. 36 parts
6. 25 or 17 students
7. 6 times
8. $9\frac{10}{54}$ lbs./gal.
9. 39 sets.

Introduction to Fractions

1. $15\frac{6}{15}$ anti-freeze
2. 2/9
3. 17/100

Fractions

1. 1 1/3 hours
2. 5 9/32 inches
3. $2\frac{7}{16}$ in.
4. $2\frac{1}{2}$ in.
5. $\frac{5}{16}$ in.
6. $\frac{11}{32}$ in.
7. $6\frac{263}{360}$ ohms.
8. $\frac{7}{32}$ in.
9. $1\frac{7}{16}$ in.
10. $5\frac{35}{64}$ in.
11. $2\frac{3}{4}$ horsepower
12. $4\frac{7}{8}$ ft.
13. $3\frac{2}{3}$ gals.
14. $8\frac{1}{4}$ gal.
15. $11\frac{1}{4}$ qts.
16. $6\frac{3}{4}$ hrs.
17. $\frac{7}{32}$ in.
18. $\frac{5}{16}$ in.
19. $1\frac{29}{32}$ in.
20. $22\frac{5}{8}$ in.
21. $\frac{5}{16}$ in.

Multiplying Fractions

1. $89\frac{1}{16}$ lbs.
2. 75 volts
3. $\frac{165}{512}$ sq. in.
4. $6\frac{3}{4}$ ft.
5. $20\frac{9}{16}$ in.
6. 10,000 parts

Dividing Fractions

1. 36 m.p.h.
2. $\frac{3}{16}$ in.
3. $4\frac{1}{4}$ in.
4. 24 teeth
5. $1\frac{1}{6}$ in.
6. 12 cu. ft.

Decimals +,-

1. 228.9 in.
2. 0.4555 in.
3. 0.093 in.
4. 9.71 cm
5. 0.015 in.
6. 28.5 ohms.

Multiplying Decimals

1. $6.49
2. 19.625 sq. in.
3. 15.96 sq. in.
4. 15.605 ft.
5. 216.75 in.
6. 0.00188 ft.
7. $172.31
8. 99.616 lbs.
9. 98 cm.

Dividing Decimals

1. 21.5 m.p.g.
2. $309/year
3. $.11/qt.
4. 0.1425 in.
5. 731.45 revolutions/min.
6. 2.5 lbs.
7. 81.4 psi
   32,258 psi
8. 22.95 gals.
9. 0.043 in.

Scientific Notation

1. 3.6×10^{8} km^2 S.D. = 2
2. 9.1×10^{-28} g S.D. = 29
3. 4,000,000,000,000,000,000,000,000,000,000 lbs. S.D. = 1
4. 6.5×10^{-5} cm S.D. = 6
5. 50,000 lbs. S.D. = 1
6. 8.8×10^{7} hertz S.D. = 2
7. 5×10^{-5} farad S.D. = 5
8. 0.000001 in. S.D. = 6
9. 0.00000000005 cm S.D. = 11
10. 2×10^{-7} in. S.D. = 7

Ratio & Proportion

1. $\frac{12}{8} = \frac{9}{4}$ 4 = $6.00
2. $\frac{220}{2} = \frac{x}{8}$ x = 880 revolutions
3. $\frac{204}{6} = \frac{523}{h}$ h ≈ 15.38 hrs.
4. $\frac{3}{825} = \frac{g}{1925}$ g = 7 gals.
5. $\frac{5}{10} = \frac{1}{2}$
6. $\frac{125}{13} = \frac{375}{p}$ p = 39 lbs.
7. $\frac{10}{40} = \frac{B}{200}$ B = 50 r.p.m.
8. $\frac{15}{1} = \frac{x}{6}$ x = 90 lbs.
9. yes
10. $\frac{20}{300} = \frac{50}{c}$ c = 750 cars
11. 3:1

Percent

1. $8.54
2. 66⅔%
3. 3 years
4. 13 ampere hours
5. 23 gals.
6. 9 million barrels
7. 9 pts.
8. 20.9 lbs.
9. 300 oil filters
10. 4,000 lbs.
11. 108 lbs.
12. $30
13. $15
14. $375
15. 1092 watts
16. 7.7 qts.

Measurement

1. 220 qts.
2. 576 revolutions/min.
3. 24 divisions
4. 10 units
5. $2\frac{3}{4}$" = 11'; $2\frac{1}{2}$" = 20'; $3\frac{3}{16}$" = 2550
6. 14 min. 3 secs.
7. 2.44 m
8. 37 m.p.h.
9. 7.457 (10^6) kg cm^2/sec.^{3}
10. 3.683 mm
11. 0.67 kg/liter
12. 0.283 in. to 0.287 in.
13. $9\frac{3}{4}$ in.

Introduction to Geometry

1. 9.61625 sq. in.
2. 113.04 cu. in.
3. ≈ 96 gals.
4. 33630.57 rev/min.
5. 24,727.5 gals.
6. 12.02 lbs.
7. 0.3925 sq. in.
8. $16\frac{1}{2}$ in.
9. 8 holes
10. $\frac{1}{32}$ in.
11. 3 parts
12. 89.76 gals.
13. 644.4 yds.
14. $21.21
15. 117.7 in.
16. $\frac{1}{16}$ in = 1 i
    AB = 24 in.
17. 989.93 lbs.
18. 2190 cu. in

Pythagorean Theorem

1. 160 in.
2. 17.57 ft.
3. 46.4 cm
4. 51 sq. in.
5. 0.586 in.

Intro to Algebra

Part I

1. 5 h.p., 3 h.p., 8 h.p.
2. A = 850 gals.; B = 750 gals; C = 1500 gals.
3. $6\frac{1}{2}$ hrs.
4. $6\frac{2}{3}$ ats.
5. 5.6 qts.
6. 1200 lbs.

Part II

1. $E = \frac{I-P}{I}$

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2. $U = l \cdot w \cdot h$

3. $3.14 \left(\frac{d}{2}\right)^2 h$

4. $L = \frac{t - T}{100}$

5. $I = \frac{E}{r + R}$

6. $H = \frac{a\ v}{746}$

7. $A = \frac{w}{v}$

8. $P = M - O$

9. $R = \frac{N}{T}$

Part III

1. $N = PD - 2$

2. $r_1 + r_2 = \frac{L - sd}{3.14}$

3. $J = \frac{V_1 (V_2 - V_1)}{gp}$

4. $Q_2 = \frac{Q_1}{P + Q_1}$

5. $Y_2 = \frac{P - P_a}{dg} + Y_1$

6. $R = \frac{E}{I} - r$

Problem Solving

1. 80.7 ft.
2. $320
3. 1 ft. 11 in.
4. 11 hrs. 20 min.

Probability & Statistics

1. 1.9998 in.
2. 16.19 m.p.g.
3. $\frac{6}{1225}$

Graphs

1. 1930 - 22 million
   1960 - 62 million
2. 16,960,333
3. 40 mph - 114 ft.
   30 mph - 74 ft.
   20 mph - 40 ft.