2016 State Agricultural Mechanics Problem Solving

Directions: Place your name, chapter, and contestant number on the accompanying scantron form that you will receive from the test administrators. Read each of the following multiple-choice items and the possible answers carefully. Mark the letter of the correct answer on your answer sheet (scantron form) as instructed by the test administrators.

1. A 500 cc single cylinder engine has a combustion chamber with a volume of 50 cc. At bottom dead center of the stroke the cylinder volume is 550 cc. What is the compression ratio for the engine?
   a. 9:1
   b. 11:1
   c. 13:1
   d. 15:1

$\frac{550}{50} \cdot \frac{BDC}{TDC} = 11$ ratio 11:1

2. Larry is considering purchasing a new Dodge 1500 pickup truck and is trying to decide on a 3.6 L V6 engine that averages 21.5 miles per gallon or a 5.7L V8 engine that averages 18.5 miles per gallon. If he chooses the 3.6L V6 engine over the 5.7L V8, how much will he save in fuel cost for the 1st 100,000 miles if the average price of gasoline is $2.47? (Round to the nearest 10)
   a. $1862.88
   b. $4690.58
   c. $8511.28
   d. $11487.97

$\frac{100,000}{21.5} = 4651.2 \times 2.47 = 11,488.46$

$\frac{100000}{185} = 5405.4$
$\times 2.47$
13351.34

$13351.34 - 11488.46 = \$1862.88$

3. If a pipe has a friction loss of 75 gallons per hour, what is the loss in gallons per minute?
   a. 0.80 gallons
   b. 1.0 gallons
   c. 1.25 gallons
   d. 10.50 gallons

$\frac{75 \text{ gph}}{60 \text{ 60 min/hr}} = 1.25$ gal/min

4. A neighbor is covering a flat-toped roadside vegetable stand with 3' x 36' surface roll roofing material. If the building is 18' wide and 24' long how many rolls of the material will they need? **(Add 10% for waste and overlapping.)**
   a. 3
   b. 4
   c. 5
   d. 6

$18' \times 24' = 432 ft^2$

$3' \times 36' = 108 ft^2$

$\frac{432 ft^2}{108 ft^2} = 4 \times 1.1\% = 4.4$ rolls or 5

5. Jerry wants to replace the shingles on his hunting lodge that is an A frame building with that is 28' long and has a roof span of 24' and a rise of 6'. How many full squares of shingles will he need to purchase? **(1 square of shingles covers 100 sq. ft.)**
   a. 4 squares
   b. 8 squares
   c. 13 squares
   d. 17 squares

$c^2 = a^2 + b^2$

$c^2 = 6^2 + 12^2$

$c^2 = 36 + 144$

$c^2 = 180 ft^2$

$c = 13.4 ft$

$28 \times 13.4 = 375.2$
$\times$ 2 sides
750.4 sq ft

$\frac{750 ft^2}{100 ft^2/\text{square}} = 7.5$ square or 8

6. Mr. Blackmon is mixing concrete to pour a goldfish pond in his backyard landscape. Using the 1-2-3 rule, how many shovels of gravel will he need if he uses 15 shovels of Portland cement in his mix?
   a. 15
   b. 30
   c. 45
   d. 60

1 = cement
2 = SAND
3 = aggregate 3 x 15 = 45

7. A John Deere S660 combine will harvest grain at a speed of 6 mph. The combine head is 40 feet wide. How many acres can be harvested if the farmer begins at 11:00 am and works until 9:00 pm stopping a total of 3 hours for meals, service and to unload the harvested grain?
   (Acres/hour = width of machinery x speed in miles/hour)
   8.25

   complete

   a. 29 acres
   b. 58 acres
   c. 174 acres
   d. 203 acres

$\frac{40 \times 6}{8.25} = 29.1$

7hr of work

29.1 x 7 = 203.70

Fuel Comparison Chart					
Type of Fuel	**Octane Level**	**Cost per gallon**		**Miles per Gallon**	
Premium	92	$2.45	2800 ÷ 20	20 mpg	140 x 2.45 = 343
Super	90	$2.35	2800 ÷ 18.5	18.5 mpg	151.35 x 2.35 = 355.67
Regular	87	$2.21	2800 ÷ 17.75	17.75 mpg	157.75 x 2.21 = 348.63
E-85	105	$2.14	2800 ÷ 13.75	13.75 mpg	203.63 x 2.14 = 435.77

8. Mr. Bass has a Chevrolet truck with a 5.3L V8 flex-fuel engine. He is planning a cross country trip to Montana and estimates he will travel 2800 miles on the trip. Previously he has done some fuel comparison in his truck as evident in the chart above. Which fuel will be the most economical for him to use on his trip?
   a. Premium
   b. Super
   c. Regular
   d. E-85

9. An electric fan motor runs at a constant speed of 2600 rpm and has two pulleys mounted on its shaft a 3" pulley and a 4" pulley connected by belt to a fan blade with a 4" pulley. With the belt on the 4" pulleys the fan runs 2600 rpm. At what rpm would the fan run on the 3" pulley? **($S \times D = S_1 \times D_1$)**
   a. 1950 rpm
   b. 2400 rpm
   c. 2750 rpm
   d. 2900 rpm

$2600 \times 3 = S_1 4$

$7800 = S_1 4$

$1950 = S_1$

10. Mr. Davis wants to construct a garage that is 24' wide and 24' long with two 8' garage doors and one 3' door opening. He plans to build a foundation wall that is ~~30~~ 24". How many 8" x 8" x16" blocks will he need to purchase? **(Feet long x ¾ = blocks per course; feet high x 3/2 = courses)**
    a. ~~77~~ 152 blocks
    b. ~~154~~ 174 blocks
    c. 231 block
    d. 308 blocks

$24 \times 4 = 96' - 16' - 3 = 77$ $\quad$ $24'' = 2.0''$

$77 \times 3/4 = 57.75$ or 58 $\quad$ $2.0 \times 3/2 = 3$

$58 \times 3 = 174$

11. Cotton crops grown in eastern NC require 19 inches of water/acre per year. How many gallons of water are needed to produce a crop on a field that is 1500'x 1000'? **(1 acre inch of water = 27,154 gallons of water; 1 acre =43,560 sq .ft.)**
    a. 17,747,854 gallons
    b. 18,527,947 gallons
    c. 19,196,475 gallons
    d. 20,409,611 gallons

$1500' \times 1000' = 1{,}500{,}000\ ft^2$

$\frac{1{,}500{,}000\ ft^2}{43560\ ft^2/acre} = 34.4$ Acres

$34.4 \times 19 = 653.6$ acre inch water

$653.6 \times 27{,}154 = 17{,}747{,}854$ gal.

12. Each cylinder in an eight cylinder engine has a diameter of 3.15 inches and a piston stroke of 5.2 inches. What is the total displacement of the engine in liters?
(Volume displacement of a cylinder = π r² x stroke;1 liter =61 cubic inches)
    a. 4.7 liter
    b. 5.3 liter
    c. 6.2 liter
    d. 7.7 liter

$r = 3.15 \div 2 = 1.575''$

$VD = 3.14 \times 1.575''^2 \times 5.2'' =$

$VD = 3.14 \times 2.48 \times 5.2 = 40.5$

40.5×8 cylinder $= 324$

$\frac{324\ in^2}{61\ in^3/liter} = 5.3$ liter

13. A greenhouse is 30 feet wide and 75 feet long with an eave height of 7 feet and a ridge height of 12 foot. It has two circulation fans that pull air in through a 3 foot x 26 foot cool cell opening. If each fan moves 8,500 cubic feet of air per minute, how long would it take to exchange 100% of the air in the greenhouse if both fans were running.

Formula: $\frac{\text{Eave Height + Ridge Height}}{2}$ x W x L = Cubic Content

    a. 1 minute and 16 seconds
    b. 1 minute and 43 seconds
    c. 2 minutes and 31 seconds
    d. 2 minutes and 58 seconds

$\frac{7' + 12'}{2} \times 30' \times 75' =$

$9.5' \times 30' \times 75' = 21375\ ft^3$ volume

$8500 \times 2 = 1700$

$\frac{21375\ ft^3}{1700\ ft^3/min} = 1.26$

1 min - 1.6 second

60 sec x .26 = 15.6 or 16 second

14. A farm shop is equipped with the following electrical devices. What will be the electric bill for the s shop for 30 days if electricity cost $.1275 per KWH. **(Round to the nearest cent.)**

Item	Wattage	Voltage/appliance	Amperage/ appliance	Hertz	Hours used per day
3 Hp air compressor		208	16.6	60	4 13811.2
Miller DialArc Welder		208	36	60	2 14976
Table Saw		110	14	60	2 3080
Drill Press		110	8	60	2 1760
Four grinders		115	9	60	2 2070
Exhaust Fan		115	6.3	60	12 8694
Eight 4' – 4 bulb florescent light fixtures		120	2.5	60	16 4800
Metal band saw		208	6.25	60	3 3900

a. $6.77
b. $53.09
c. $127.34
d. 203.07

1592.7 x .1275 = 203.07

53091.2 x 30 = 1592736 / 1000 = 1592.7 KWH

14. How many gallons of paint are needed to paint the floor of a shop that is 60' x 75' with three coats? **(1 gallon of paint will cover 500 sq. ft.)**

a. 27
b. 30
c. 33
d. 36

60' x 75' = 4500 ft²
4500 ft² / 500 ft²/gal = 9 gal x 3 coats = 27 gal.

16. Mr. Overcash is building a commercial produce shed and his bill for the concrete floor and pillars is $40,590. The cost to pour the pad and pillars is $198.00 / cubic yard of concrete for preparation, delivery and finishing. If the pad is 60' wide and 9 inches thick, what is the length? **(A cubic yard of concrete = 27 cubic feet; Round up to the nearest cubic yard when calculating concrete material.)**

a. 102'
b. 123'
c. 141'
d. 158'

$40,590 / 198 = 205 yds

205 yd x 27 ft³/yd = 5535 ft³
5535 ft³ = 60 x .75 x L
5535 ft³ = 45 ft² L
123 ft = L

17. A farmer wishes to build a fence around a square field measuring a total distance of 84 chains. How many post will he use if he places them 14' apart? **(1 chain = 66 ft.)**

a. 6
b. 98
c. 210
d. 396

84 x 66 = 5544 ft / 14 ft/post = 396 posts

18. A swine producer is shipping weaned pigs from a sow farm in Fayetteville, NC to nurseries in Smithfield, Va. The average weight of the weaned pigs is 15 lbs each. The truck and trailer when empty weighs 30,000 lbs. and the maximum weight it can legally carry on NC and VA roads is 80,000 lbs. How many pigs can be transported in the truck to stay with-in legal limits?

a. 2,000

b. 3,333

c. 5,333

d. 7,333

$80{,}000 - 30{,}000 = 50{,}000\#$

$\frac{50{,}000}{15} = 3333$ pigs

19. Mr. McPherson purchases an older flatbed trailer that is 94" wide and 16' long. The wood flooring is rotten and needs to be replaced. How many 2" x 6" x 16' does he need to purchase to complete the job? **(Finished lumber reduces the width and thickness so the accurate dimensions are 1 ½" x 5 ½" x 16')**

a. 15

b. 17

c. 19

d. 21

$\frac{94''}{5.5''} = 17$

20. Mr. Bowden is planning to build blue picnic tables in his class and wants to calculate the cost for each table. Calculate the total cost for the tables from the bill of materials below:

Qty	Description	Unit Price	Total Price
2	Treated 2"'x 6''x 12' #1 lumber	$10.41	20.82
2	Treated 2" x 12" x 8' #1 lumber	$14.58	29.16
5	Treated 2' x 10" x 8' #1 lumber	$13.25	66.25
2	2" x 2" x ¼" x 10' Angle Iron	$11.74	23.48
44	5/16" x 3 ½" Carriage Bolts	$0.25 each	11.00
1 gallon	Thompson Weather Sealer	$14.25 /gallon	14.25
2	Paint Brushes	$3.56	7.12
		TOTAL	172.08
		Sales Tax (6.88%)	11.84
		Grand Total	183.92

a. $172.08
b. $183.92
c. $197.20
d. $207.56