

# 2013 State Agricultural Technology & Mechanical Systems Problem Solving

**Directions:** Place your name, chapter and contestant number on the accompanying scantron form that you 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. You may use this paper to work out the problems.

## Area: Energy Systems

**Ohm's Law: Watts = Volts x Amps**

1. Mr. Blair has a 24' x 40' workshop. He uses 8 ceiling fans rated at 50 watts and 8 four-bulb florescent lights. If each fixture is equipped with 60-watt bulbs, how many watts of electricity will the fans and lights use during a 30-day period if they operate for 8 hours per day?

- a. 55,056
- b. 96,000
- c. 460,800
- d. 556,800

$$\begin{aligned}
 &8 \text{ fans} \times 50 \text{ watts} = 400 \text{ watts} \\
 &\quad \quad \quad 8 \text{ hr} \\
 &\quad \quad \quad \underline{3200 \text{ watts/day}} \\
 &\quad \quad \quad \quad \quad 30 \text{ day} \\
 &\quad \quad \quad \underline{96000 \text{ watts/mth}} \\
 &\quad \quad \quad 460,800 \\
 &\quad \quad \quad \boxed{556,800 \text{ watts}}
 \end{aligned}$$

$$\begin{aligned}
 &\text{Bulbs } 8 \times 4 = 32 \text{ bulbs} \\
 &\quad \quad \quad 60 \text{ watts} \\
 &\quad \quad \quad \underline{1920 \text{ watts}} \\
 &\quad \quad \quad \quad \quad 8 \text{ hr} \\
 &\quad \quad \quad \underline{15360} \\
 &\quad \quad \quad \quad \quad 30 \text{ days} \\
 &\quad \quad \quad \underline{460,800 \text{ watts/mth}}
 \end{aligned}$$

2. Mr. Cole's shop has the same lights and fans as Mr. Blair's shop in problem one. However, he will also be using the electrical devices in the table below. What will be the electrical bill for the shop for 30 days if electricity costs \$.10619 per Kwh? (Round the cost to the nearest cent.)

ITEM	WATTAGE	VOLTAGE/ appliance	AMPERAGE/ appliance	HOURS USED PER DAY
1 HP Air Compressor	-	220	6.8	1.5
Three Lincoln 225 AC Welders	9000	-	-	4.0
Three 3/8 inch portable electric drills		110	4.0	1.0
Two 7 inch Rigid Angle Grinders		110	13.0	2.0

- a. \$367.97
- b. \$432.76
- c. \$508.45
- d. \$521.41

$$\begin{aligned}
 &3 \text{ drills } 110 \text{ V} \\
 &\quad \quad \quad 4 \text{ A} \\
 &\quad \quad \quad \underline{440 \text{ W}} \\
 &\quad \quad \quad \quad \quad 30 \\
 &\quad \quad \quad \underline{13,200 \text{ W/mth}} \\
 &\quad \quad \quad 3 \text{ drills} \\
 &\quad \quad \quad \underline{39,600 \text{ watts} *}
 \end{aligned}$$

$$\begin{aligned}
 &\text{Lights/fan } 556,800 \div 1000 = 556.8 \\
 &\text{Air comp } 67,300 \div 1000 = 67.3 \\
 &\text{Welders } 3,240,000 \div 1000 = 3240.0 \\
 &\text{Drills } 39,600 \div 1000 = 39.6 \\
 &\text{Grinders } 171,600 \div 1000 = 171.6
 \end{aligned}$$

Air Compressor

$$\begin{aligned}
 &220 \text{ V} \\
 &\quad \quad 6.8 \text{ A} \\
 &\quad \quad \underline{1496 \text{ watts}} \\
 &\quad \quad \quad 1.5 \text{ hrs}
 \end{aligned}$$

$$\begin{aligned}
 &\underline{2244 \text{ W/d}} \\
 &\quad \quad 30 \text{ days}
 \end{aligned}$$

$$\underline{67,320 \text{ watts} *}$$

$$\begin{aligned}
 &\text{Welders} \\
 &3 \times 9000 = 27,000 \\
 &\quad \quad \quad 4 \text{ hr}
 \end{aligned}$$

$$\begin{aligned}
 &\underline{108,000 \text{ W}} \\
 &\quad \quad 30 \text{ days} \\
 &\underline{3,240,000 \text{ watts} *}
 \end{aligned}$$

2 Grinders

$$\begin{aligned}
 &110 \text{ V} \\
 &\quad \quad 13 \text{ A} \\
 &\quad \quad \underline{1430 \text{ W}}
 \end{aligned}$$

$$\begin{aligned}
 &1430 \text{ W} \\
 &\quad \quad 2 \text{ hrs/day}
 \end{aligned}$$

$$\begin{aligned}
 &\underline{2860 \text{ W/day}} \\
 &\quad \quad 30 \text{ day}
 \end{aligned}$$

$$\begin{aligned}
 &\underline{85,200 \text{ W/mth}} \\
 &\quad \quad 2 \text{ grinders}
 \end{aligned}$$

$$\underline{171,600 \text{ W}}$$

$$(\text{Kwh}) \rightarrow 4075.3$$

$$\begin{aligned}
 &4075.3 \text{ Kwh} \\
 &(\$ .10619) \\
 &\underline{\$ 432.76}
 \end{aligned}$$

3. The current rate for electricity is \$.10619. However, the rate will go up to \$.10706 on July 1<sup>st</sup>. Mr. Bowden has the same lights and equipment as Mr. Blair and Mr. Cole. How much more than Mr. Cole will it cost for him to run his lights and equipment during the month of July than in the month of June, if they are run for the same time period that Mr. Blair and Mr. Cole run theirs? (Round the cost to the nearest cent.)

- a. \$2.69  
b. \$3.54  
c. \$3.77  
d. \$4.05

$$\begin{array}{r} 4075.3 \text{ kWh} \\ (\$ .10706) \\ \hline \$ 436.30 \end{array}$$

$$\begin{array}{r} 436.30 \\ - 432.76 \\ \hline \$ 3.54 \end{array}$$

4. Ms. Taylor has a 12" Delta Table Saw wired on a 220-volt circuit. The saw motor requires 4600 watts to start, but once started will run on 2000 watts. How many more amperes of electricity are required to start the saw than to keep it running? (Round the answer to the nearest hundredth.)

- a. 9.96  
b. 10.14  
c. 11.82  
d. 12.17

$$\begin{array}{l} W = VA \\ 4600 = 220 A \\ \hline 20.91 = A \end{array}$$

$$\begin{array}{l} 2000 = 220 A \\ \hline 9.09 = A \end{array}$$

$$\begin{array}{r} 20.91 \\ 9.09 \\ \hline 11.82 \end{array}$$

### Area: Environmental – Natural Resource Systems

5. Mr. McPherson produces corn on 600 acres. The diesel fuel required for 250 acres of corn planted using conventional tillage is 6 gallons per acre at a cost of \$3.87 per gallon. On 350 acres he uses no till and saves 46% of the fuel cost per acre. How much more will Mr. McPherson spend on the 250 acres of corn planted by conventional tillage than he does on the 350 acres of corn planted no till? (Round to the nearest cent.)

- a. \$1,324.00  
b. \$1,416.00  
c. \$1,556.00  
d. \$1,637.00

$$\begin{array}{l} 250 \text{ ac} \\ 6 \text{ gallons} \\ \hline 1500 \\ 3.87 (\text{cost/gal}) \\ \hline \$ 5805.00 \div 250 \text{ ac} = 23.22 \text{ /acre} \\ \$ 5805.00 - 4389 = \$ 1416.00 \end{array}$$

$$23.22 - 46\% = 12.5388 = 12.54$$

$$\begin{array}{r} \$ 12.54 \\ 350 \\ \hline \$ 4389.00 \end{array}$$

6. Mr. Everett is determining field loss for a farmer's corn harvest. He found an average seed count of 3 kernels per square foot left in the field. If there are 80,120 kernels of corn in one bushel and corn is selling for \$7.00 per bushel, how much money is lost for the 300 acres the farmer planted? 1 acre = 43,560 square feet (Round the answer to the nearest hundredth.)

- a. \$3,189.21  
b. \$3,247.23  
c. \$3,425.24  
d. \$3,533.19

$$\begin{array}{l} 43560 \\ 3 \text{ Kernels} \\ \hline 130,680 \text{ K/acre} \\ 300 \text{ ac} \\ \hline 39,204,000 \div 80,120 / \text{bu} = 489.3160 \end{array}$$

$$\begin{array}{r} \$ 489.32 \\ 7 \\ \hline \end{array}$$

$$\begin{array}{r} \$ 3425.24 \end{array}$$

7. Mr. Gordon's "Clean Cut Lawn Care" mows grass an average of 50 hours per week for 18 weeks during the months of June, July, August, and September. His company mows an average of 30 hours per week for 8 weeks during May and October. Dull lawn mower blades increase fuel cost by 21%. A mower with sharp blades uses 1 gallon of fuel per hour. If gasoline cost \$3.33 per gallon, how much will his company save in one season by keeping the blades sharp?

- a. \$797.20  
b. \$805.20  
c. \$813.20  
d. \$819.20

$$\begin{array}{r} 50 \times 18 = 900 \\ 30 \times 8 = 240 \\ \hline 1140 \text{ hr/season} \\ 1140 \times \$3.33 = 3796.20 + 21\% = 4593.40 \\ \hline - 3796.20 \\ \hline \$ 797.20 \end{array}$$

8. Mr. Bennett's flex-fuel pickup averages 18 miles per gallon for regular unleaded gasoline. However, when he uses E85, the fuel mileage drops to 14 miles per gallon. What percentage drop is that?

- a. 12.22  
b. 14.33  
c. 17.77  
d. 22.22

$$\begin{array}{r} 18 \\ - 14 \\ \hline 4 \end{array} \div 18 = 22.22\%$$

### Area: Industry and Marketing Systems

9. Mr. Cole's students at Triton High School use a Plasma cam and Torch mate to make the FFA emblems in the picture below. If his students can make 20 emblems from one 4 x 8 sheet of 16 gauge metal and the sheet cost \$64.00, how much money will the FFA Chapter make if they sell each emblem for \$40.00? Consider scrap portions of the sheet will be used to make other ornaments valued at \$128.00 when sold.

- a. \$ 682  
b. \$ 740  
c. \$ 800  
d. \$ 864

$$\begin{array}{r} 20 \times 40 = 800 \\ + 128 \\ \hline 928 \\ - 64 \\ \hline 864 \end{array}$$



10. If a can of paint will cover 4 emblems with one coat, how much cost will be added for the 20 emblems in the above problem, if Mr. Cole's class applies three coats to each emblem? The paint cost \$1.49 per can. Add 6.75% sales tax to the cost of the paint. (Round the final answer to the nearest cent.)

- a. \$ 21.36  
b. \$ 23.86  
c. \$ 24.96  
d. \$ 25.16

$$\begin{array}{r} 4 \overline{) 20} \\ 16 \\ \hline 4 \end{array} \begin{array}{l} \text{5 cans for 20 emblems} \\ \times 3 \text{ coats} \\ \hline 15 \text{ cans} \end{array}$$

$$15 \times \$1.49 = 22.35 + 6.75\% = 23.8586 \approx \$23.86$$

11. If Mr. McPherson is building a trailer that requires he purchase an additional 6 pieces of 1/4" x 1 1/2" x 1 1/2" x 10' angle iron at a cost of \$ 1.81 per foot and 12 pieces of 2" x 8" x 10' at \$ 1.20 per board foot, how much additional money will he need? Add 6.75% for sales tax.

(BF = pieces X T" x W" x L')

12

- a. \$272.69  
b. \$298.19  
c. \$320.89  
d. \$328.29

$$\begin{array}{r} 6 \times 10' = 60' \times \$1.81 = 108.60 \\ 12 \text{ pc} \times 2 \times 8 \times 10 = 160 \text{ bd ft} \\ \hline \times 1.20 \\ \hline 192.00 \end{array}$$

$$\begin{array}{r} 108.60 \\ 192.00 \\ \hline 300.60 + 6.75\% = \\ \hline \$ 320.8905 \end{array}$$

12. Mr. Blair's agricultural shop needs 50 lbs. of 1/8 inch E- 6011 electrodes. Machine Welding Supply has a special promotion on Lincoln Fleetwood 180 electrodes for \$10.95 for a five lb. box. Regular price is \$121.50 for a 50 lb. box. How much money will he save by buying enough five lb. boxes to equal one 50 lb. box?

- a. \$11.00  
b. \$12.00  
c. \$13.00  
d. \$14.00

$$\begin{array}{r} \cancel{\$} 10.95 / \text{box} \\ 10 \text{ boxes} \\ \hline 109.50 \end{array} \quad \begin{array}{r} 121.50 \\ - 109.50 \\ \hline \cancel{\$} 12.00 \end{array}$$

### Area: Machinery and Equipment Systems

13. If an electric motor has a rated speed of 1750 rpm, which size pulley should be installed on the motor to drive a drill press with a four-inch pulley at 875 rpm? **Formula:  $S \times D = S' \times D'$ , S = Speed of motor, D = Diameter of motor pulley, S' = Speed of equipment and D' = Diameter of equipment pulley.**

- a. 2  
b. 3  
c. 4  
d. 5

$$\begin{aligned} 1750 M &= 875(4) \\ 1750 M &= 3500 \\ M &= \frac{3500}{1750} \\ M &= 2 \end{aligned}$$

14. How many acres can Mr. Everett harvest if his combine speed is 4.6 miles per hour and he has a grain head that is 28 feet wide? Mr. Everett begins harvesting at 10 a.m. and works until 9 p.m., stopping 30 minutes to eat and an additional two hours to unload the harvested grain. **Formula: acres per hour = width of machinery in feet x speed in miles per hour divided by 10.**

- a. 104.78  
b. 109.48  
c. 115.42  
d. 119.88

$$\begin{aligned} \frac{28 \times 4.6}{10} &= \frac{12.88 \text{ ac/hr}}{8.5} \\ &= 1.515 \text{ ac/hr} \\ 11 \text{ hr} \\ - 2 \\ \hline 9 \\ - \frac{1}{2} \\ \hline 8.5 \text{ hrs} \end{aligned}$$

15. If during a calibration time of 1 minute and 30 seconds Ms. Taylor's feed auger delivers 119.5 pounds of feed to a container weighing 9.5 pounds, how many pounds of feed does the auger deliver per minute of operation?

- a. 68.2  
b. 73.2  
c. 77.2  
d. 81.2

$$\begin{aligned} \frac{119.5}{- 9.5} \\ \hline 120.0 \text{ lb} / 90 \text{ sec} &= 1.222 \text{ lb/sec} \\ 1.22 / \text{sec} \\ 60 \text{ sec/minute} \\ \hline 73.2 \text{ lbs of feed} \end{aligned}$$

16. What size motor pulley will Mr. Bowden need to use on a Dayton 3NLF fan with a motor speed of 1750 rpm if the fan pulley is 6" and the fan speed is 875 rpm? **Formula:  $S \times D = S' \times D'$ , S = Speed of motor, D = Diameter of motor pulley, S' = Speed of fan, and D' = Diameter of fan pulley**

- a. 3  
b. 4  
c. 5  
d. 6

$$\begin{aligned} 1750 D &= 875(6) \\ D &= \frac{5250}{1750} \\ D &= 3 \end{aligned}$$

## Area: Structural Systems

17. Mr. Britt is pouring a 36' x 58' concrete pad for a metal building. If concrete cost \$123.00 per cubic yard, what will be the cost of concrete to pour the pad 8 inches thick? **A cubic yard of concrete = 27 cubic feet and Cu. Ft. = T' x W' x L'.** (Hint: Round up to the nearest cubic yard when calculating concrete needed.)

- a. \$5,047.00
- b. \$6,396.00
- c. \$6,564.00
- d. \$7,329.00

$$36 \times 58 \times .67 \approx 1398.96 / 27 = 51.8133$$

$$(8/12 = .666 = .67)$$

$$\begin{array}{r} 52 \\ \times 123 \\ \hline \$6,396.00 \end{array}$$

18. Mr. Warren is building the foundation for his shop with 8 inch concrete block. If the blocks cost \$1.54 each and the foundation is 2' high x 20' long x 12' wide, how much will the blocks cost to build the foundation? Allow for a 6' door opening in one of the 20' sides. (Round up to the next whole block.)

(Hint: To determine blocks needed per wall: Height x 3/2 = courses and length of wall x 3/4 = blocks per course.)

- a. \$176.43
- b. \$200.97
- c. \$215.35
- d. \$222.71

$$\text{Courses} = 2 \times \frac{3}{2} = 3 \text{ courses}$$

$$\text{Blocks per course} = 58 \times \frac{3}{4} = 43.5 \text{ blocks/course}$$

$$20 + 14 + 12 + 12 = 58'$$

$$201.74 + 6.75\% = 215.35$$

$$\begin{array}{r} 3 \times 43.5 = \\ 130.5 = \\ 131 \text{ blocks} \\ \times \$1.54 \\ \hline 201.74 \end{array}$$

19. Ms. Smith is building a 20' long x 12' wide x 8' high utility barn for her garden equipment. She has 32 pieces of 16' siding left over from a former project. How many additional pieces of 16' siding will she need to complete her project if the siding is 8" wide and she allows 1 inch to lap over? Do not allow for windows and doors. (Round calculations to the nearest hundredth and the answer to the nearest whole piece.)

- a. 13
- b. 18
- c. 23
- d. 28

$$2 \times 20 \times 8 = 320$$

$$2 \times 12 \times 8 = 192$$

$$\frac{192}{512}$$

$$16' \times \frac{1}{2} (.58) \times 32 = 296.96 \text{ sq ft}$$

$$512 - 296.96 = 215.04 \text{ sq ft}$$

$$16 \times .58 = 9.28 \text{ sq ft/board}$$

$$215.04 \div 9.28 \text{ sq ft} = 23.1724$$

$$\text{(23)}$$

20. What will it cost to paint Ms. Smith's building in the previous problem if she applies two coats of paint at a cost of \$28.00 per gallon? Add 6.75% sales tax to get the total bill for paint. (Assume 1 gallon of paint will cover approximately 400 square feet.) (Round up to the next whole gallon.)

- a. \$89.67
- b. \$91.35
- c. \$93.52
- d. \$95.48

$$\begin{array}{r} 512 \\ 2 \\ \hline 1024 \\ \hline 400 \end{array} = 2.56 \text{ gal} \div 3$$

$$3 \times 28 = 84.00 + 6.75\% =$$

$$\$89.67$$