## 2015 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. PLEASE MAKE NO MARKS ON THIS TEST. You may use the paper provided to work out the problems. Round the final answer to the nearest 100th**

1. The motor on drill press is rated at 1,725 rpm and came with a 2" pulley. What size pulley should be installed on the drill press to run it at 530 rpm? **S x D = S' x D'** (S = speed of motor, D = diameter of motor pulley, S' = speed of machine, and D' = diameter of machine pulley)

   a. 5½"
   b. 6"
   c. **6½"**
   d. 7"

   $S \times D = S' \times D'$
   $1725(2) = 530\,D'$
   $\frac{3450}{530} = D'$
   $6.5 \text{ or } 6\frac{1}{2} = D'$

2. What is the speed of a saw with a 3" pulley if a motor drives it with a 4" pulley turning at 3640 rpm? **S x D = S' x D'** (S = speed of motor, D = diameter of motor pulley, S' = speed of machine, and D' = diameter of machine pulley).

   a. 2450
   b. 3693
   c. **4853**
   d. 5500

   $S \times D = S' \times D'$
   $3640(4) = S'(3)$
   $\frac{14560}{3} = S'$
   $4853 = S'$

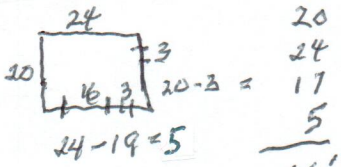
3. If Seth uses the 1-2-3 mix (cement – sand – rock) for a concrete project that requires 7 cubic foot bags of cement and 21 cubic feet of coarse aggregate, how many cubic feet of sand will he need?

   a. 0
   b. 7
   c. **14**
   d. 21

   $1 = 7$
   $2 = X$
   $3 = 21$
   $7(2) = X$
   $14 = X$

4. If the foundation wall for a 20' x 24' building is 36" high, how many 8" x 8" x 16" blocks are needed? Allow for a 16' overhead door opening and two 3' door openings. (Hint: Feet long x ¾ = blocks per course, Feet high x 3/2 = courses) **Allow 5% for waste and round the <u>final answer</u> to the nearest whole block.**

   a. 156
   b. **234**
   c. 287
   d. 312




20
24
17
5
66' length

$66' \times \frac{3}{4} = 49.5$ blocks per course
3' high $\times \frac{3}{2} = 4.5$ courses
$49.5(4.5) = 222.75$
$+5\%$ waste $= 233.88 = 234$

**Use the information from Table 2015.1 to answer questions 5 – 8.**

| Table 2015.1 Wire Sizes Needed to Carry Given Loads with 2% or Less Voltage Drop | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Copper up to 200 Amperes, 115 -120 Volts, Single Phase, Based on 2% Voltage Drop | | | | | | | | | | | | | |
| Minimum Allowable Size of Conductor | | | Length of Run in Feet | | | | | | | | | | |
| | | | Compare size shown below with size shown to the left of double line and use the larger size. (Smaller the number, the larger the size) | | | | | | | | | | |
| Load in Amps | Type R, T, and TW Cable | Bare and Covered Overhead in Air | 30 | 40 | 50 | 75 | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 500 |
| 15 | 12 | 10 | 12 | 12 | 10 | 10 | 8 | 6 | 4 | 4 | 4 | 3 | 2 | 1 |
| 20 | 12 | 10 | 12 | 10 | 10 | 8 | 6 | 4 | 4 | 3 | 2 | 2 | 1 | 0 |
| 30 | 10 | 10 | 10 | 8 | 8 | 6 | 4 | 4 | 2 | 1 | 1 | 0 | 00 | 000 |
| Aluminum up to 200 Amperes, 115 -120 Volts, Single Phase, Based on 2% Voltage Drop | | | | | | | | | | | | | | |
| 15 | 12 | 10 | 12 | 10 | 8 | 8 | 6 | 4 | 3 | 2 | 2 | 1 | 0 | 00 |
| 20 | 10 | 10 | 10 | 8 | 8 | 6 | 4 | 3 | 2 | 1 | 0 | 0 | 00 | 000 |
| 30 | 8 | 10 | 8 | 6 | 6 | 4 | 3 | 2 | 0 | 00 | 00 | 000 | 4/0 | 250 |

5. When using a load of 20 amps and Type R copper wire, at what length of run does the conductor size first change from 12 to 10?

   a. 30
   b. **40**
   c. 50
   d. 75

Go to ROW 2 = Load in Amps for 20
Move to the Right until a 10 is located
Read column heading = 40

6. What is the minimum allowable size conductor for a 20-amp load using Type R aluminum?

   a. **10**
   b. 8
   c. 6
   d. 4

Find aluminum heading
Go to ROW 2 under that heading for 20 amp
Look for smallest conductor size in the ROW = 10

7. Which type wire has the same minimum allowable size for conductors regardless of load?

   a. **Overhead in air**
   b. Type R cable
   c. Type T cable
   d. Type TW cable

See chart for aluminum
3rd column - all conductors are the same

8. When using Type TW copper cable for a 100' run, the minimum size conductor allowed is:

   a. 3 if carrying a 30 amp load
   b. **4 if carrying a 30 amp load**
   c. 6 if carrying a 30 amp load
   d. 8 if carrying a 30 amp load

Compare answers to the chart for each. 4 is the answer

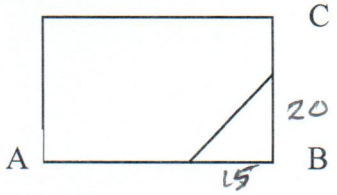
9. How many gallons of paint are needed to cover a 30' x 40' shop floor with two coats? (1 gallon covers 450 square feet) Round up to the nearest quart.

30 x 40 = 1200 sq ft
2 coats
2400/450 per gallon = 5.33 gallons = 5.5 gallons
.33 gallons is between ¼ and ½ = Round up

a. 5
b. 5¼
c. **5½**
d. 5¾

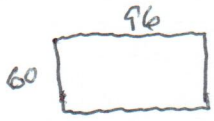
10. Matt uses the 3:4:5 rule to square the end wall on his shop-building project. He pulls a line between Stake A and Stake B and measures 15' from stake B toward Stake A and sets a temporary stake. He then pulls a line between Stake B and Stake C and measures 20' from stake B toward stake C and sets a temporary stake. What should be the distance between the temporary stakes when he has the end wall squared?

3=15 3x5
4=20 4x5
5=25 or 5X5




a. **25'**
b. 30'
c. 40'
d. 50'

11. Silas is preparing a bill of materials for a 60" wide x 96" long utility trailer. He will use 2" x 2" x 3/16" angle iron to make the frame. He needs 2 pieces for the side frame rails, 1 piece for the front frame rail, and 6 pieces for frame cross members. How much angle iron will he need to make the frame of the trailer?




2 x 96 = 192
1 x 60 = 60
6 x 60 = 360
612"/12" = 51'

a. 43'
b. 43'
c. 46'
d. **51'**

12. What is the resistance for an electric motor that operates on 220 volts with 1.8 amps of electrical flow? E = IR, E = volts, I = amperes, and R = Resistance

E = IR
220 = 1.8 R
220/1.8 = R
122.2 = R = 122

a. **122 ohms**
b. 396 watts
c. 396 ohms
d. 410 watts

13. How many watts of electricity will a 5 – ampere motor running on 120 volts of electricity consume during a 30-day period if it operates for 6 hours per day? W = VA

W = VA
600 = 120(5)
30 days x 6 hrs = 180 hrs
180 hrs x 600 watts = 108,000 watts

a. **108,000**
b. 144,000
c. 234,000
d. 324,000

The materials in the table 2015.2 below are needed to construct a small building. Use the information to answer questions 14 – 17.

| Table 2015.2 Typical Amperage for Carbon Steel | | | | |
|---|---|---|---|---|
| **Wire Feed Speed In./min (m/min)** | **Amperage Setting for each Wire Diameter** | | | |
| | **0.030in. (0.8mm)** | **0.035in. (0.9mm)** | **0.045 in. (1.2mm)** | **0.062 in. (1.6mm)** |
| 100 (2.5) | 40 | 65 | 120 | 190 |
| 200 (5.0) | 80 | 120 | 200 | 330 |
| 300 (7.6) | 130 | 170 | 260 | 425 |
| 400 (10.2) | 160 | 210 | 320 | 490 |

14. Seth runs the wire feed for 6 seconds to produce 30" of 0.030" feed wire for his MIG welder. Based on the length of feed wire, at what amperage should he set the welder?

    $\frac{60 \text{ sec/min}}{6 \text{ sec}} = 10 \times 30'' = 300''$ (column on left)

    Find column for .030 and read amperage.

    130 amps

    a. 40
    b. 80
    c. **130**
    d. 160

15. Caroline has the amperage set at 120 on her MIG welder and she is using 0.045" wire. Approximately how much wire should run for her 6-second test period to have the correct wire feed speed?

    100" = wire feed for 120 amps on .045 wire

    6 sec = 1/10 of 60 sec or a minute

    100/10 = 10"

    a. 5"
    b. **10"**
    c. 15"
    d. 20"

16. Scott switches from using 0.030" feed wire set at 100 in/min feed speed to 0.045" feed wire set at 200 in/min feed speed. What change does he make to the amperage setting?

    .030 wire @ 100 in/min requires 40 amps

    .045 wire @ 200 in/min requires 200 amps

    200 − 40 = 160 increase

    a. Decrease the amperage by 10
    b. Double the amperage he was using
    c. **Increase the amperage by 160**
    d. Increase the amperage by 3 times

17. Hannah has done a test run for 6 seconds and has 15" of 0.062" feed wire. Calculate the best amperage setting for her welder?

    6 sec is 1/10 of 60 sec or 1 min

    10 × 15" for 6 sec = 150" wire/min

    100" wire speed = 190 amps

    200" wire speed = 330 amps

    Since 150" wire speed is mid point

    subtract $\begin{array}{r} 330 \\ -190 \\ \hline 140 \end{array}$ / 2 = 70

    And divide by 2

    Add 70 to 190 OR subtract 70 from 330 → 260 amps

    a. 190
    b. **260**
    c. 330
    d. 400

18. If the bill for concrete is $5,715.00 and one cubic yard cost $127.00, what will be the length of the poured slab if it is 40' wide and 6 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.)**

Divide 5715 (total cost) by
127 cost/yard = 5715/127 = 45 cubic yards

45 x 27 cu ft = 1215 cu ft

1215 = (.5' thick x 40 x L)

1215 = 20 L

$\frac{1215}{20} = L$

60.75' = L

.75 x 12" = 9"

60'9"

a. 60'3"
b. **60'9"**
c. 61'
d. 61'6"

19. A farm shop is equipped with the following electrical devices. What will be the electrical bill for the shop for 60 days if electricity costs $.10219 per Kwh? **(Round the cost to the nearest cent.)**

| ITEM | WATTAGE | VOLTAGE/ appliance | AMPERAGE/ appliance | HOURS USED PER DAY |
|---|---|---|---|---|
| 1 - 1 HP Air Compressor | - | 220 | 6.8 | 1.5 |
| 1 - Lincoln 225 AC Welder | 9000 | - | - | 4.0 |
| 1 - 3/8 inch portable electric drill | | 110 | 4.0 | 1.0 |
| 2 - Seven inch Rigid Angle Grinders | | 110 | 13.0 | 2.0 |
| 4 - Eight foot 4-bulb florescent fixtures | | 110 | 2.9 | 8.0 |

W = VA

Compressor
220 x 6.8 x 1.5 x 60 = 134,640

Welder
9000 x 4 x 60 = 2,160,000

Drill
110 x 4 x 1 x 60 = 26,400

2 Grinders
2 x 110 x 13 x 2 x 60 = 343,200

4 Lights
4 x 110 x 2.9 x 8 x 60 = 612,480

955,680

2,321,000 + 955,680 = 3,276,720 divided by 1000 watts/Kwh =

= 3,276.72 kwh (.10219) =

334.84801 ≈ $334.85

a. $267.37
b. $279.30
c. $303.55
d. **$334.85**

20. A farm shop has eight four-bulb florescent light fixtures on a 120-volt circuit. Each fixture is equipped with 40-watt bulbs and the current rate for electricity is $.10219 per Kwh. However, the rate will go up to $.10706 on July 1st. How much more will it cost to run the lights during the month of July than in the month of June, if they are run for eight hours per day and 20 days per month? **(Round the cost to the nearest cent.)**

W = VA

8 fixtures
4 bulb/fixture
32 bulbs
40 watts
1280 watts
x 8 hrs/day
10,240 watts
20 days
204,800 watts

204,800 watts / 1000 watts per kwH =

204.8 Kwh

Current bill
204.8 kwH (.10219) = 20.92815 = 20.93

July bill
204.8 kwH (.10716) = 21.92588 = 21.93

21.93 - 20.93 = $1.00

a. **$1.00**
b. $1.28
c. $1.74
d. $2.21