STUDENTS DO NOT OPEN THIS TEST OR BEGIN UNTIL INSTRUCTED TO START

2014 Examination for the

National Agricultural Technology and Mechanical Systems

ANSWER KEY

When a reference page (diagrams, pictures, tables) is needed to answer a question, the question will refer to the appropriate reference page.

Read each question carefully and determine the single correct answer. If a marked Scantron answer needs to be changed, completely erase the incorrect answer and clearly mark the appropriate answer.

*Each student needs a calculator to complete this examination, but calculators **may not** be shared between students.*

Students are **NOT allowed** to use any type of electronic communication device, including but not limited to cellular telephones, pagers, two way radios, or PDAs, during the CDE on Wednesday or Thursday. If a student uses, handles, or accesses any type of electronic communication device, she or he may be disqualified. If a personal emergency should arise, students should contact a CDE official immediately for assistance.

This exam begins on the back of this sheet.

You may write on this exam, but information written on this exam is not graded.
Mark all answers on the Scantron form.

2014 Written Examination for the National Agricultural Technology & Mechanical Systems Career Development Event

Mark all answers on the Scantron sheet using a pencil. *Read each question carefully and mark the single correct answer on the Scantron sheet. Each student needs a calculator to complete this examination, but calculators **may not** be shared between students. Information written on this exam will not be graded.*

You may write on this exam, but only the Scantron sheet is graded.

SECTION 1: MACHINERY & EQUIPMENT SYSTEMS Questions 1-5

1. A tractor's power takeoff produces 275 horsepower and turns at 1000 revolutions per minute. Approximately how much torque, in foot-pounds, can this PTO produce?

Torque in foot-pounds = $\frac{\text{PTO Horsepower x 5252}}{\text{Revolutions / Minute}}$

A. 1111 foot-pounds
B. 1222 foot-pounds
C. 1333 foot-pounds
D. 1444 foot-pounds

275 hp x 5252 ÷ 1000 rpms = 1444.3 ft-lbs

2. If a tractor travels at 28.5 kilometers per hour, what approximate length of time (in hours) is required to travel 29.5 miles? 1 mile = 1.6 kilometers 1 hour = 60 minutes

A. 1 hour and 2.1 minutes
B. 1 hour and 16.8 minutes
C. 1 hour and 39.4 minutes
D. 2 hours and 11.7 minutes

1 hr / 28.5 km x 1.6 km / 1 mi x 29.5 mi = 1.65614 hrs
→ 60 min/hr x 0.65614 hrs = 39.3684 minutes
1 hour and 39.4 minutes

3. There are 195 acres of corn with an average yield of 96.5 bushels per acre. Due to moisture content, a bushel has an average weight of 64.2 pounds. If the price is 14.2 cents per pound of harvested corn, what is the approximate income for the crop? 1 ton = 2000 pounds 1 bushel = 2.44 cubic feet

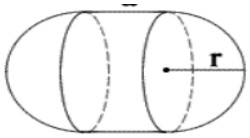
A. $ 120,808
B. $ 171,548
C. $ 1,208,084
D. $ 1,715,479

195 ac x 96.5 bu /ac x 64.2 lbs / bu x $ 0.142 / lb = $171,547.857

4. The center section of a fuel storage tank has a cylindrical shape (capsule) that is 6.5 feet long with an inside diameter of 3.5 feet. Each end of the tank has a half-sphere shape (two halves of a sphere), each with an internal radius of 21 inches. What is the approximate total storage capacity of the tank in gallons? 1 gallon = 231 cubic inches 1 foot = 12 inches π = 3.14 Diameter = 2 × (radius)
Volume of a Cylinder = $(\pi) \times (\text{radius})^2 \times (\text{length})$ Volume of Sphere = $4/3 \times (\pi) \times (\text{radius})^3$

A. 515 gallons
B. 575 gallons
C. 635 gallons
D. 695 gallons

Cylinder Volume = (3.14) x (3.5' x 12"/1' ÷ 2)² x (6.5' x 12"/1') = 108009.72 in³
Sphere Volume = 4/3 x (3.14) x (21")³ = 38,772.72 in³
→ → (108009.72 in³ + 38,772.72 in³) x (1 gal / 231 in³) = 635.4218182 gal



Picture of capsule

5. Each cylinder in a eight cylinder tractor engine has a bore (diameter) of 4.75 inches and a piston stroke of 5.9 inches. What is the approximate total displacement of this engine in liters?

Information: Area of a cylinder bore = $(\pi) \times (\text{radius})^2$ π = 3.14 radius = (diameter ÷ 2)
Volumetric displacement of a single cylinder = (length of piston stroke) x (the area of the cylinder bore)
1 liter = 61 cubic inches 1 cubic inch = 0.0164 liter

A. 1.7 liters
B. 2.8 liters
C. 13.7 liters
D. 54.8 liters

8 cyl × 3.14 × (4.75 in / 2)² × 5.9 in × (1 L / 61 in³) = 13.70468 L

You may write on this exam, but only the Scantron sheet is graded.

SECTION 2: ELECTRICAL SYSTEMS Questions 6-10

6. What is the approximate annual power consumption (kilowatt-hours = kWh) of a 120 volt electrical installation with 24 incandescent lights, each light using 1.5 amps and operating 8 hours per day and 28 days per month? 1 year = 12 months Kilowatt = 1000 Watts Watts = Volts × Amps Volts = Amps × Resistance in Ohms Kilowatt-hours = Kilowatts × Hours

A. 11,612 kWh
B. 116,122 kWh
C. 1,161,216 kWh
D. 11,612,160 kWh

120 volts x 1.5 amps / load x 24 loads x 8 hrs/day x 28 days/ mth x 12 mths / yr x 1 kWh / 1000 Watts = 11,612.16 kWh

7. Use reference Page A, Table 1 to answer this question. A 115-volt electrical circuit is 95 feet in length and uses 25 amps to operate an electrical space heater. According to Table 1 on reference sheet A, what is the minimum size aluminum conductors needed to limit the voltage drop to 3% and safety power this electrical load? Watts = Volts × Amps Volts = Amps × Resistance in Ohms

A. # 6 AWG
B. # 4 AWG
C. # 2 AWG
D. # 0 AWG

At intersection of 100 feet and 30 amps on Table 1, Page A:find #4 AWG

8. Use reference Page A, Table 1 to answer this question. A 115-volt electrical circuit is 170 feet in length and uses 2070 Watts of power. According to Table 1 on reference sheet A, what is the minimum size aluminum conductors needed to limit the voltage drop to 3% and safety power this electrical load? Watts = Volts × Amps Volts = Amps × Resistance in Ohms

A. # 6 AWG
B. # 4 AWG
C. # 2 AWG
D. # 0 AWG

2070 Watts = 115 volts x ??? amps → 18 amps
At intersection of 175 feet and 20 amps on Table 1, Page A: find #4 AWG

9. Use reference Page A, Table 2 to answer this question. A 230-volt electrical circuit is 221 feet in length and powers a resistance heating load of 18.5 ohms. According to Table 2 on reference sheet A what is the minimum size aluminum conductors needed to limit the voltage drop to 3% and safety power this electrical load? Watts = Volts × Amps Volts = Amps × Resistance in Ohms

A. # 8 AWG
B. # 6 AWG
C. # 4 AWG
D. # 2 AWG

230 volts = ??? amps x 18.5 Ohms → 12.4324 amps
At intersection of 225 feet and 15 amps on Table 2, Page A: find # 6 AWG

10. Use reference Page A, Tables 1, 2, & 3 to answer this question. The larger the cross sectional area of an electrical conductor, the more expensive the conductor will be to install. A dual voltage electrical motor can be connected to operate at either: 115 volts & 24 amps or 230 volts & 12 amps. If the motor will be installed at the end of a 145-foot electrical circuit, what voltage and minimum size conductors are needed for the most economical installation that will limit the voltage drop to 3% and safety power this electrical load?

A. 115 Volts and # 3 AWG
B. 115 Volts and # 8 AWG
C. 230 Volts and # 3 AWG
D. 230 Volts and # 8 AWG

From Table 3: 125% of 24 amps is 30 amps
125% of 12 amps is 15 amps
From Table 1: For 115 Volts, intersection of 150 feet and 30 amps find #3 AWG
From Table 2: For 230 Volts, intersection of 150 feet and 15 amps find #8 AWG

SECTION 3: ENERGY SYSTEMS Questions 11-15

11. A kilowatt-hour meter records 5.9 kilowatts of power being used by an eight horsepower electric motor during one hour when it is operating at 230 volts and using 28 amps. What is the approximate power factor for this motor? Voltage = Amperage × Resistance 1kilowatt = 1000 hours
Wattage = Voltage × Amperage × Power Factor

A. 0.92 power factor
B. 0.97 power factor
C. 1.09 power factor
D. 9.16 power factor

Pf = 5900 Watts ÷ (230 volts x 28 amps) = 0.916149

12. A 250 horsepower six cylinder engine is operating at 7150 feet above sea level. What approximate horsepower is produced by the engine if the engine's power is reduced 2.5 percent for each 1000 feet of elevation above sea level?

A. 45 horsepower
B. 138 horsepower
C. 196 horsepower
D. 205 horsepower

250 horsepower – [250 hp x 7150 ft x (0.025 / 1000 ft)] = 205.3125 hp

13. A hot waterline that is used only 10 hours per day has three different leaks and the amount of water lost at each leak is measured during a 30 minute time period. The three quantities of water from the leaks are (a) 119 ounces, (b) 46 ounces, and (c) 91 ounces. Approximately how many gallons will be lost from the waterline during 30 days of operation?
Information: 1 gallon = 128 ounces 24 hours = 1 day 60 minutes = 1 hour

A. 900 gallons
B. 1000 gallons
C. 1100 gallons
D. 1200 gallons

[(119 oz + 46 oz + 91 oz) ÷ 30 min] × (60 min/1 hr) × (10 hrs/day) × 30 days x (1 gal/128 oz)
= 1200 gals / 30 days

14. An available electronic thermometer is calibrated in degrees Celsius (ºC), but the requirements to sterilize agricultural testing equipment specify 100 degrees Fahrenheit (ºF) for 30 minutes. What is the approximate temperature equivalent in degrees Celsius?
ºF = (9/5 ºC) + 32 ºC = 5/9 (ºF - 32) Water freezes at 32 ºF Water boils at 212 ºF

A. 37.8 ºC
B. 45.6 ºC
C. 51.0 ºC
D. 73.0 ºC

ºC = 5/9 x (100 ºF - 32) = 37.777778 ºC

15. An inefficient electrical motor (identified as motor A) is to be replaced with a new high efficiency motor (identified as motor B). Motor A was operated 6 hours per day, 325 days each year, and its annual electrical bill averaged $12,553. The purchase price for motor B is $1,120 and the installation charge is $345. Motor B will be operated the same number of hours as motor A and will have an average cost of $6.07 per hour to operate. Approximately how many months will motor B operate to payback the purchase and installation cost of the new motor? 1 year = 12 months 1 day = 24 hours

$$\text{Payback} = \frac{\text{total cost for new high efficient equipment}}{\text{average saving in energy cost per month}}$$

A. 24.5 months
B. 96.2 months
C. 125.3 months
D. 294.4 months

$$\text{Payback} = \frac{(\$1{,}120 + \$345)}{(\$12{,}553/\text{yr} \times 1\text{yr}/12\text{ mths}) - (\$6.07/\text{hr} \times 6\text{ hrs/day} \times 325\text{ days/yr} \times 1\text{yr}/12\text{ mths})} = 24.5359\text{ mths}$$

You may write on this exam, but only the Scantron sheet is graded.

SECTION 4: STRUCTURAL SYSTEMS Questions 16-20

16. Steel angle iron is sold for $1.83 per linear foot, steel rod is sold for $1.61 per linear foot, and steel pipe is sold for $2.94 per linear foot. If 19.5 feet of angle iron, 15.5 feet of rod, and 12 feet of pipe are purchased, what is the approximate total price for the metal before taxes?

A. $ 9.59
B. $ 95.92
C. $ 959.92
D. $ 9599.20

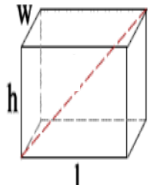
19.5' x $ 1.83 / ft = $ 35.685
15.5' x $ 1.61 / ft = $ 24.955
12' x $ 2.94 / ft = $35.28 Total = $ 95.92

17. Which of the following quantities of lumber has the smallest number of board-feet?
Information: 1 board-foot = 144 cubic inches 1 square foot = 144 square inches

A. 24 boards measuring 1 inches by 8 inches by 14 feet
B. 27 boards measuring 2 inch by 4 inches by 12 feet
C. 22 boards measuring 2 inches by 6 inches by 10 feet
D. 20 boards measuring 1 inch by 8 inches by 16 feet

24 × 1" × 8" × 14' × 12"/1 ft × 1bd-ft/144in^3 = 224 bd-ft
27 × 2" × 4" × 12' × 12"/1 ft × 1bd-ft/144in^3 = 216 bd-ft
22 × 2" × 6" × 10' × 12"/1 ft × 1bd-ft/144in^3 = 220 bd-ft
20 × 1" × 8"× 16' × 12"/1 ft × 1bd-ft/144in^3 = **213.4 bd-ft**

18. An rectangular shaped metal tank (rectangular prism) weighs 798 pounds empty. When filled with water the tank and water weighs 3604 pounds. If the internal height of the tank is 7.5 feet and the internal width of the tank is 3.75 feet, what is the internal length of the tank?
1 gallon = 231 cubic inches 1 gallon water = 8.34 pounds
1 cubic-foot = 1728 cubic-inches
Volume of rectangular prism = Length × Width × Height



Picture of rectangular prism

A. 0.9 feet
B. 1.6 feet
C. 13.3 feet
D. 19.1 feet

(3604 lbs - 798 lbs) x 1 gal / 8.34 lbs x 231 in^3 / gal x 1 ft3 / 1728 in^3 = 44.97693512 ft^3
→ 44.97693512 ft^3 = 7.5' x 3.75' x length in feet →→ **L = 1.599179915'**

19. A 21-foot length of unthreaded black pipe is to be cut into 13 pieces of equal length. Both ends of the 21-foot pipe are already cut square (90 degrees) and the 13 pieces will also have square cut ends. The metal saw being used cuts a kerf (material removed by saw blade) that is 5/32 inch wide. Other than the material lost by the saw kerf, none of the pipe is wasted or unused in cutting the 13 pieces of equal length. What is the approximate length (in feet, inches and fraction of an inch) of each piece of the pipe. Information: 1 foot = 12 inches 5/32 inch = 0.15625 inch

A. 1 foot, 6 and 7/16 inches
B. 1 foot, 6 and 15/32 inches
C. 1 foot, 7 and 1/4 inches
D. 1 foot, 7 and 3/8 inches

[(21 feet × 12"/ft) - (12 cuts × 5/32" /cut)] ÷ 13 pieces = 19.24038462"
→ 1 foot 7 inches + 0.24038462 inch → 1/4" = 0.25"
→ 1' 7 ~ 1/4"

20. A round concrete column is fabricated using 5.8 cubic yard of concrete. If the concrete column is 40 inches in diameter, what is the approximate height of the column?
Information: 1 cubic yard = 27 cubic feet 1 cubic foot = 1728 cubic inches 1 foot = 12 inches
Volume of cylinder = π × (cylinder radius)^2 × cylinder height π = 3.14 diameter = (2 × radius)

A. 17.95 feet
B. 18.45 feet
C. 18.95 feet
D. 19.45 feet

5.8 yd^3 = 3.14 × (40" ÷ 2 x 1' / 12")^2 × height ft × (1 yd^3 / 27 ft^3)
height = 5.8 yd^3 ÷ [(3.14 x (1.666667)^2 × (1 yd^3 /27 ft^3)] = 17.95414013'

You may write on this exam, but only the Scantron sheet is graded.

SECTION 5: ENVIRONMENTAL & NATURAL RESOURCE SYSTEMS Questions 21-25

21. Approximately how many acres are in a rectangular field measuring 1109 meters by 928 yards?
Information: 1 acre = 43, 560 square feet 1 hectare = 2.47 acres 1 acre = 0.41 Hectares
Area of Rectangle = length × width 1 yard = 3 feet 1 foot = 0.3048 meter

A. 2.4 acres
B. 23.6 acres
C. 232.5 acres
D. 2325.4 acres

1109 m x 1 ft / 0.3048 m x 928 yds x 3 ft / 1 yd x 1 ac / 43,560 ft^2 = 232.5401474

22. Use reference <u>Page B</u> to answer this question. Refer to the dimensions of the proposed concrete slab for the new structure and the square footage lost by stacking the blocks on top of the slab to make the walls for the eight manure storage bays. After the blocks are set on top of the concrete slab, what is the remaining surface area for storing manure? Area of rectangle = Length × Width

A. 954 square-feet
B. 994 square-feet
C. 1024 square-feet
D. 1054 square-feet

34' x 42' - (16' x 2' x 10 walls) - (42' x 2' x 1 center wall)
1428 ft^2 - 320 ft^2 - 84 ft^2 = 1024 ft^2

23. Use reference <u>Page B</u> to answer this question. Refer to the dimensions of the concrete blocks that will be used with the proposed storage facility. The push wall is stacked three blocks high and the side walls of each bay are stacked two blocks high. Approximately how many of the blocks will be needed for the proposed facility? Area of rectangle = Length × Width

A. 112 concrete blocks
B. 120 concrete blocks
C. 128 concrete blocks
D. 136 concrete blocks

42' of center wall x 3 blocks tall = 126' length of blocks for push wall
16' / side wall x 10 walls x 2 blocks tall = 320' length of blocks for side walls
446' Total length of blocks ÷ 4' / block = 111.5 blocks

24. Use reference <u>Page B</u> to answer this question. Each of the storage bays shown on Page B Figure 4 will hold manure as shown in Figure 5. Refer to the length and width dimensions of each bay and the height of the blocks that make up the three walls. What is the maximum holding capacity (volume) of each bay when one is filled with compost? This answer must be estimated.
1 cubic yard = 27 cubic-feet Volume of rectangular prism = Length × Width × Height

A. 11 to 13 cubic yards
B. 19 to 21 cubic yards
C. 27 to 29 cubic yards
D. 33 to 35 cubic yards

Volume inside walls 8' x 16' x 4' x 1 yd^3 / 27 ft^3 = 18.96 yd^3

25. A large quantity of manure initially had 28 percent solids and 72 percent moisture by weight. The manure was stockpiled in a covered structure for several months and during that time 30 percent of the manure's original moisture content evaporated and/or drained away. What approximate percentages of solids remain? 1.00 = 100%

A. 33.7 % solids
B. 35.7 % solids
C. 37.7 % solids
D. 39.5 % solids

Easiest Way: Let Q be unknown quantity of manure. 0.28 Q + 0.72 Q = 1.00 Q
(Q x 0.28 solids) + [(0.72 liquids x Q) - (0.72 x Q x 0.30)]
0.28 Q + 0.72 x Q - 0.216 x Q
0.28 Q + 0.504 Q = 0.784 Q → 0.28 Q / 0.784 Q → 0.3571428571 Solids
or
0.28 ÷ {0.28 + [(0.72 - (0.72 x 0.30)]} = 0.3571428571 or 35.7 %

You may write on this exam, but only the Scantron sheet is graded.