

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

2013 Examination for the National Agricultural Technology and Mechanical Systems FFA Career Development Event

Name _____
Print Name Legibly

Read the following instructions:

Mark all answers on the Scantron sheet using a pencil.

You have one hour to complete this exam.

You may write on this exam, but information on this exam is not graded. Blank sheets are provided if additional space is needed.

If a reference sheet (diagram, picture, table) is needed to answer a question, the question will refer to the appropriate reference sheet.

Read each question carefully and calculate the single correct answer.

If a marked Scantron answer needs to be changed, completely erase the incorrect answer and clearly mark the appropriate answer.

Students need a calculator to complete this examination.

*Students are **not allowed** to share a calculator with another student.*

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.

**2013 Written Examination for the
National Agricultural Technology and Mechanical Systems
FFA 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. Students need a calculator to complete this examination, but they are not allowed to share a calculator with another student. Information written on this exam will not be graded.

SECTION 1: MACHINERY & EQUIPMENT SYSTEMS Questions 1-5

- 1. What is the approximate speed, in miles per hour, for a planter that travels 200 feet in 28.7 seconds?**

Information: 5,280 ft = 1 mile 3600 seconds = 1 hour

- A. 3.98 miles per hour
B. 4.75 miles per hour
C. 5.50 miles per hour
D. 6.37 miles per hour

$$4.75135 \text{ mph} = (200 \text{ ft} / 28.7 \text{ sec}) \times (3600 \text{ sec} / 1 \text{ hr}) \times (1 \text{ mi} / 5,280 \text{ ft})$$

- 2. A planter has a 18-foot effective swath width, it travels at 5.5 miles per hour, and it operates with a field efficiency of 87 percent. What is the approximate effective field capacity (EFC) of the planter in acres per hour?** Information: $\text{EFC} = \frac{\text{width of implement in feet} \times \text{speed in miles per hour} \times \text{efficiency}}{8.25}$

- A. 7.2 acres per hour
B. 8.6 acres per hour
C. 9.8 acres per hour
D. 10.4 acres per hour

$$10.44 \text{ ac/hr} = (18 \text{ ft} \times 5.5 \text{ mph} \times 0.87) / 8.25$$

- 4. A pesticide label indicates that it is to be applied at the rate of 4.5 ounces per acre. Approximately how many acres will one gallon of this pesticide formulation treat? Note: 1 gallon = 128 ounces**

- A. 28.4 acres per gallon
B. 29.7 acres per gallon
C. 31.6 acres per gallon
D. 32.5 acres per gallon

$$28.44444 \text{ ac/ gal} = (1 \text{ ac} / 4.5 \text{ oz}) \times (128 \text{ oz} / \text{gal})$$

- 4. Each cylinder in an four cylinder engine has a circumference of 10.6 inches and a piston stroke of 5.8 inches. What is the approximate total displacement of the engine in liters?**

Hints: 1 liter = 61 cubic inches Circumference of a circle = $2 \times \pi \times \text{radius}$
Area of a cylinder bore = $\pi \times \text{radius}^2$ $\pi = 3.14$ radius = diameter $\div$ 2
Displacement of a single cylinder = (length of piston stroke) $\times$ (the area of the cylinder bore)

- A. 0.85 liters
B. 3.40 liters
C. 33.55 liters
D. 134.18 liters

$$4 \text{ cyl} \times 3.14 \times [10.6" \div (2 \times 3.14)]^2 \times 5.8" \times 1 \text{ lit} / 61 \text{ in}^3 = 3.402359 \text{ liters}$$

- 5. A utility tractor is re-equipped with high profile tires (larger diameter than the factory equipped tires). If the original tires had a 39.8-inch outside diameter and the new larger tires have a 43.9-inch outside diameter, what is the actual speed of the tractor when the tractor's mechanical speedometer displays 20 miles per hour? Assume all tires are properly inflated, tires have no slippage, and the speedometer is still calibrated for the smaller diameter tires.**

Information: Circumference of a circle = $(2) \times (\pi) \times (\text{radius})$ $\pi = 3.14$ diameter of circle = $(2) \times (\text{radius})$

- A. 20.6 mph
B. 21.1 mph
C. 21.6 mph
D. 22.1 mph

Answer: Two step complicated method:

$$\text{rpm} = 20 \text{ mi} / \text{hr} \div [(3.14 \times 39.8" \times 1' / 12") / \text{rev} \times 1 \text{ mi} / 5280' \times 60 \text{ min} / \text{hr}] = 168.9978555 \text{ rpm}$$

$$\text{mph} = [(3.14 \times 43.9" \times 1' / 12") / \text{rev}] \times 1 \text{ mi} / 5280' \times 60 \text{ min} / \text{hr} \times 168.9978555 \text{ rpm} = 22.0603 \text{ mph}$$

$$\text{Simple method: } [43.9" \div 39.8"] \times 20 \text{ mph} = 22.0603 \text{ mph}$$

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SECTION 2: ELECTRICAL SYSTEMS Questions 6-10

6. Three incandescent light bulbs (100 Watts, 200 Watts, 300 Watts) are operating in a 120 volt circuit. If each bulb operates at 120 volts, which of the following statements is correct in regard to the operation of the bulbs? Information: Wattage = Voltage $\times$ Amperage Voltage = Amperage $\times$ Resistance

- A. All three bulbs operate at the same amperage.
B. All three bulbs have the same electrical resistance.

$$0.833 \text{ Amps} = 100 \text{ Watts} / 120 \text{ volts} \quad R = 120 \text{ volts} / 0.833 = 144 \text{ ohms}$$

- C. The 100-watt light bulb has more electrical resistance (ohms) than the 200- or 300-Watt light bulbs.
D. The 100-watt light bulb has less electrical resistance (ohms) than the 200- or 300-Watt light bulbs.

7. A 120-volt electrical circuit operates TWO 2400-watt resistance heaters and TEN 300-watt lights. If the circuit is operated 8 hours each day for 330 days, how many kilowatt-hours (kWh) will the electrical system use during that time period?

Information: Kilowatt hours = $\frac{\text{Total Watts} \times \text{Total hours}}{1000 \text{ Watts/Kilowatt}}$

- A. 14,256 kWh
B. 20,592 kWh
C. 27,083 kWh
D. 71,280 kWh

$$\text{kWh} = [(4800 \text{ Watts} + 3000 \text{ Watts}) \times 8 \text{ hours/day} \times 330 \text{ days}] / 1000 \text{ W/kW} = 20,592 \text{ kWh}$$

8. The monthly charge to operate an electric pump is 11.5 cents per kilowatt hour (kWh) for the first 1000 hours and 12.5 cents for each kWh greater than 1000 hours. If the pump uses 7.5 kilowatts per hour and it operates 20 days each month for 16 hours each day, what is the approximate monthly kWh charge to operate the pump? Information: 1 kilowatt = 1000 Watts 100 cents = \$1.00

- A. \$ 14.50
B. \$ 229.00
C. \$ 260.50
D. \$ 290.00

$$\begin{aligned} \text{kWh / month} &= 7.5 \text{ kW} \times 20 \text{ days / mth} \times 16 \text{ hrs / day} = 2400 \text{ kWh / mth} \\ \$ &= (1000 \text{ kWh/mth} \times \$0.115 / \text{kWh}) + [(2400 \text{ kWh/mth} - 1000 \text{ kWh/mth}) \times \$0.125 / \text{kWh}] = \$ 290 \end{aligned}$$

9. A Wattmeter indicates that 4691 Watts of power is used by an eight horsepower electric motor (induction load), when it is connected to 215 volts and operates at 24 amps. What is the approximate power factor for this motor? Information: Voltage = Amperage $\times$ Resistance

Wattage of Induction Load = Voltage $\times$ Amperage $\times$ Power Factor

- A. 0.74 power factor
B. 0.91 power factor
C. 1.09 power factor
D. 8.95 power factor

$$\text{Pf} = 4691 \text{ Watts} \div (215 \text{ volts} \times 24 \text{ amps}) = 0.9091$$

10. An old electrical motor has 'burned' out and must be replaced. The old motor operates an average of 12 hours each day, 340 days each year, and its average annual electrical bill was \$12,665. The replacement cost for a motor (identified as A) that is identical to the old motor sells for \$899 dollars and the installation charge is \$245. An energy efficient motor (identified as B) sells for \$1,290 and the installation charge is \$295. Motor B will have an average cost of \$3.05 per hour to operate. Approximately how many months must motor B operate to make up for (payback) the higher cost to purchase and install an energy efficient motor B? Information: 1 year = 12 months 1 day = 24 hours

Burnout Payback = $\frac{(\text{total cost for high efficient equipment B}) - (\text{total cost for identical equipment A})}{(\text{average saving in energy cost per month})}$

- A. 23.9 months
B. 26.5 months
C. 29.8 months
D. 32.4 months

$$\text{Payback} = \frac{(\$1,290 + \$295) - (\$899 + \$245)}{(\$12,665/\text{yr} \times 1\text{yr} / 12 \text{ mths}) - (\$3.05/\text{hr} \times 12 \text{ hrs/day} \times 340 \text{ days/yr} \times 1\text{yr}/12 \text{ mths})} = 23.9457 \text{ mths}$$

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SECTION 3: ENERGY SYSTEMS Questions 11-15

11. An auger has a 4.5-inch diameter pulley on the drive shaft and must turn at 1000 revolutions per minute (rpm). The auger is powered by an electric motor that rotates at 1725 rpm. What is the approximate diameter of the pulley needed on the motor shaft to rotate the auger at the correct speed?

Information: 1 foot = 12 inches

Pulley Size Formula: (Diameter of Pulley 1 $\times$ Speed of Pulley 1) = (Diameter of Pulley 2 $\times$ Speed of Pulley 2)

A. 2.6 inches

B. 4.1 inches

C. 5.3 inches

D. 7.5 inches

$$(4.5 \text{ in} \times 1000 \text{ rpms}) = (?? \text{ in} \times 1725 \text{ rpms}) \rightarrow \rightarrow \text{diameter} = 2.6086''$$

12. A thermometer calibrated in degrees Celsius ($^{\circ}\text{C}$) is used to measure the temperature during a feed processing operation that requires heating to 200 degrees Fahrenheit ($^{\circ}\text{F}$). What temperature on the Celsius thermometer is approximately equal to 200 $^{\circ}\text{F}$?

Information: $^{\circ}\text{F} = (9/5 ^{\circ}\text{C}) + 32$

$^{\circ}\text{C} = 5/9 (^{\circ}\text{F} - 32)$

Water freezes at 32 $^{\circ}\text{F}$

A. 93.3 $^{\circ}\text{C}$

B. 168.0 $^{\circ}\text{C}$

C. 232.5 $^{\circ}\text{C}$

D. 392.0 $^{\circ}\text{C}$

$$^{\circ}\text{C} = 5/9 \times (200^{\circ}\text{F} - 32^{\circ}) \rightarrow \rightarrow 93.333$$

13. An electric water heaters uses 1190 kilowatt-hours (kWh) of power each day. If electric power cost 8.9 cents per kWh, approximately how much energy (in therms) does this water heater use during 30 days of operation? Information: 1 kWh = 3412.3 Btus of energy 1 therm of energy = 100,000 Btus of energy

A. 12.2 therms

B. 121.8 therms

C. 1218.2 therms

D. 121,819,110.0 therms

$$1190 \text{ kWh/day} \times 30 \text{ days} \times 3412.3 \text{ Btus / kWh} \times 1 \text{ therm / } 100,000 \text{ Btus} = 1218.19110 \text{ therms}$$

14. This question refers to the sample natural gas bill and accompanying information at the bottom of this page. Based on the values show on the sample bill, what is the approximate charge per therm for natural gas?

A. \$ 1.42 per therm

B. \$ 6.67 per therm

C. \$ 7.89 per therm

D. \$ 9.57 per therm

$$\$/\text{therm} = \$52.62 / (75 \text{ ft}^3 \times 0.088914) = \$7.890857 / \text{therm}$$

15. This question refers to the sample gas bill and accompanying information at the bottom of this page. Including the connection fee, taxes, and the gas charge, what is the total amount paid by the consumer for each cubic-foot of natural gas?

A. \$ 0.70 per ft^3

B. \$ 0.91 per ft^3

C. \$ 20.32 per ft^3

D. \$ 26.38 per ft^3

$$\$ / \text{ft}^3 = \$68.33 / 75 \text{ ft}^3 = 0.91106666 \$ / \text{ft}^3$$

Sample Natural Gas Monthly Bill: September 29, 2013 to October 28, 2013 (29 days)			
NATURAL GAS CONSUMPTION		SERVICE FEES	Cost
Current Meter Reading (cubic-feet)	1708	Gas Consumption Charge	\$ 52.62
Previous Meter Reading (cubic-feet)	1633	Monthly Connection Fee	\$ 11.00
Meter Difference (cubic-feet)	75	Subtotal	\$ 63.62
Average Consumption (cubic-feet / day)	2.59	City/State/Energy Taxes (7.4%)	\$ 4.71
Volume Multiplier	0.088914	Current Total Due	\$ 68.33

1 kWh = 3412.3 Btus

1 therm = 100,000 Btus (approximate, varies seasonally)

Therm: Unit of measurement used by gas companies to convert the volume of gas---to its heat equivalent (actual energy use).

Volume Multiplier: Converts gas volume (cubic-feet read on meter) to therms of gas consumed (value varies seasonally).

A British thermal unit (Btu) is the heat required to raise the temperature of one pound of water one degree Fahrenheit.

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SECTION 4: STRUCTURAL SYSTEMS Questions 16-20

16. Which of the following will have the greatest weight: 0.0039 acre-feet of water, 170 cubic-feet of water, 1275 gallons of water, or 4850 liters of water?

Information: 1 cubic foot of water = 62.43 pounds
1 liter of water = 2.20 pounds

1 gallon of water = 8.35 pounds
1 acre-foot water = 43,560 cubic feet of water

- A. 4.1 acre feet of water
B. 170 cubic-feet of water
C. 1275 gallons of water
D. 4850 liters of water

Answer: $0.0039 \text{ ac-ft} \times 43560 \text{ ft}^3 / \text{ac-ft} \times 62.43 \text{ lbs/ft}^3 = 10,605.9 \text{ lbs}$
 $170 \text{ ft}^3 \times 62.43 \text{ lbs/ft}^3 = 10,613.1 \text{ lbs}$
 $1275 \text{ gal} \times 8.35 \text{ lbs/gal} = 10,646.25 \text{ lbs}$
 $4850 \text{ lit} \times 2.2 \text{ lbs/lit} = 10,670 \text{ lbs}$

17. A concrete slab is needed to store equipment. The rectangular wooden forms to pour the concrete slab have inside dimensions of 24 feet by 36 feet and provide for a slab thickness of 6 inches. An additional five percent of the total volume of concrete must be ordered to allow for ground irregularities. What volume of concrete (in cubic yards) must be ordered to pour this slab? Special note: The local concrete company's minimum charge is for two cubic-yards of concrete and for amounts larger than two cubic-yards, concrete is sold/delivered only in quarter yard units (2.0, 2.25, 2.5, 2.75, 3.0, 3.25, 3.5, etc). Information: 1 cubic yard = 27 cubic feet 1 foot = 12 inches

- A. 15 cubic yards
B. 16 cubic yards
C. 17 cubic yards
D. 18 cubic yards

Answer: $105\% = 1.05$
 $1.05 \times 24' \times 36' \times 6'' \times 1' / 12'' \times 1 \text{ yd}^3 / 27 \text{ ft}^3 = 16.8 \text{ yd}^3 \rightarrow \rightarrow 17 \text{ yd}^3$

18. Use Reference Sheet A to answer this question. Examine the roof diagram 2_A. Which of the following statements correctly identifies the slope values for both angled portions of the roof.

Information: See Reference Sheet A for all information.

- A. The steepest slope is 12" to 12" (left side of 2_A) and the flatter slope is 4" to 12" (right side of 2_A).
 B. The steepest slope is 8" to 12" (left side of 2_A) and the flatter slope is 6" to 12" (right side of 2_A).
 C. The steepest slope is 6" to 12" (right side of 2_A) and the flatter slope is 8" to 12" (left side of 2_A).
 D. The steepest slope is 4" to 12" (right side of 2_A) and the flatter slope is 12" to 12" (left side of 2_A).

19. Use Reference Sheet A to answer this question. Approximately how many square feet is there on this building's roof? Note: The roof does not extend beyond the walls of the building.

Information: See Reference Sheet A for all information.

- A. 864.0 square feet
B. 915.5 square feet
C. 988.5 square feet
D. 1026.0 square feet

$\text{Sq Ft} = \{ 36' \times [(6 \text{ ft})^2 + (18 \text{ ft})^2]^{1/2} \} + \{ 36' \times [(6 \text{ ft})^2 + (6 \text{ ft})^2]^{1/2} \} = 988.5221 \text{ sq ft}$

20. Use Reference Sheet A to answer this question. What is the volume of this building's interior, including the space within the walls, and above the walls, under the roof?

Information: See Reference Sheet A for all information.

- A. 10,584 cubic feet
B. 11,232 cubic feet
C. 12,460 cubic feet
D. 14,324 cubic feet

$\text{ft}^3 = (10' \times 24' \times 36') + 1/2 (24' \times 6' \times 36') = 11,232 \text{ ft}^3$

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

21. Approximately how many hectares are in a rectangular field measuring 818 feet by 946 feet?

Information: 1 acre = 43,560 square feet 1 hectare = 2.47 acres 1 acre = 0.41 Hectares

Area of Rectangle = length $\times$ width

- A. 4.4 hectares
 B. 7.2 hectares
 C. 11.6 hectares
 D. 17.8 hectares

$$\text{hectares} = (1 \text{ ha} / 2.47 \text{ acres}) \times (1 \text{ ac} / 43,560 \text{ ft}^2) \times 818' \times 946' = \underline{7.192164 \text{ ha}}$$

22. If a center pivot irrigation system is 0.25 mile long (has a 0.25 mile radius), approximately how many acres can be irrigated under the pivot's boom during 360 degrees of travel?

Information: Area of a circle = $(\pi) \times (\text{radius})^2$ $\pi = 3.14$ diameter = $2 \times$ radius

1 acre = 43,560 square feet

1 mile = 5,280 feet

- A. 62.8 acres
 B. 96.8 acres
 C. 125.6 acres
 D. 2009.6 acres

$$\text{Acres} = 3.14 \times (0.25 \text{ mi} \times 5280 \text{ ft} / \text{mi})^2 \times 1 \text{ ac} / 43,560 \text{ ft}^2 = \underline{125.6 \text{ ac}}$$

23. Use
- Reference Sheet B
- to answer this question. What is the approximate acreage of the irregularly shaped piece of farm land that is shown with dimension in Diagram 1 on Reference Sheet B?

Information: See Reference Sheet B for all information.

- A. 107.28 acres
 B. 127.63 acres
 C. 147.95 acres
 D. 167.56 acres

$$\begin{aligned} \text{Acreage} = & [(0.5 \text{ mi} \times 5280 \text{ ft} / \text{mi}) \times (1090 \text{ yd} \times 3 \text{ ft} / \text{yd})] - (1320 \text{ ft} \times 1365 \text{ ft}) \\ & - 1/2 [(1090 \text{ yd} \times 3 \text{ ft} / \text{yd}) - (1320 \text{ ft} + 1365 \text{ ft})] \times 1320 \text{ ft} \} \times \\ & (1 \text{ ac} / 43,560 \text{ ft}^2) = \underline{147.9545455 \text{ ac}} \end{aligned}$$

24. Use
- Reference Sheet B
- to answer this question. Compare Diagrams 2
- _B
- and 3
- _B
- on Reference Sheet B. Select the follow sentence that correctly describes the operational characteristics of the two different pivot locations? Information: See Reference Sheet B for all information.

- A. The center pivot in Diagram 2_B will irrigate the same acreage as the center pivot in Diagram 3_B.
 B. The center pivot in Diagram 3_B will irrigate less acreage than the center pivot in Diagram 2_B.
 C. The center pivot in Diagram 2_B will irrigate more acreage than the center pivot in Diagram 3_B.
 D. The center pivot in Diagram 3_B will irrigate more acreage than the center pivot in Diagram 2_B.

25. Use
- Reference Sheet B
- to answer this question. Approximate how many acres can be irrigated under the pivot's boom when the center of the pivot is located as show in Diagram 4
- _B
- on Reference Sheet B?

Information: See Reference Sheet B for all information.

- A. 90.4 acres
 B. 92.6 acres
 C. 94.2 acres
 D. 96.8 acres

$$3.14 \times (1320 \text{ ft})^2 \times 0.75 \times 1 \text{ ac} / 43,560 \text{ ft}^2 = \underline{94.2 \text{ ac}}$$

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