

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

2017 Examination for the National Agricultural Technology and Mechanical Systems Career Development Event

Name _____
Print Name Legibly

READ THE FOLLOWING INSTRUCTIONS:

Mark all answers on the scan-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 of paper are provided if additional calculation space or scratch paper is needed.*
- *If a diagram, picture, or table is needed to answer a question, the question will refer to the appropriate figure/page.*
- *Read each question carefully and determine the single correct answer.*
- *If a mark on the scan sheet needs to be changed, completely erase the incorrect answer and clearly mark the appropriate answer on the answer sheet.*
- *Each student needs a calculator to complete this examination, but calculators may not be shared between students.*
- *Formulas and conversion values are provided. Do not round off intermediate answers when using the calculator to solve these problems.*

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 during the CDE, students should contact a CDE official immediately for assistance.

Order, Point Assignment, and Competency Alignment* for Exam Questions (2 points each)

1. Machinery 1.16, 6.1, 6.4-7	6. Environmental 4.17, 4.18, 4.19, 6.1, 6.4-7	11. Structural 5.1, 5.2, 5.3, 5.22, 6.1, 6.4-7	16. Compact Equipment 3.1, 3.4, 3.15, 3.21, 6.1, 6.4-7	21. Electrical 2.4, 2.6, 2.7, 2.10, 6.1, 6.4-7
2. Electrical 2.4, 6.1, 6.4-7	7. Machinery 1.14, 1.16, 1.17, 6.1, 6.4-7	12. Environmental 4.2, 4.11, 6.1, 6.4-7	17. Structural 5.1, 5.2, 5.3, 5.4, 6.1, 6.4-7	22. Compact Equipment 3.1, 3.15, 3.21, 6.1, 6.4-7
3. Compact Equipment 3.1, 3.4, 6.1, 6.4-7	8. Electrical 2.4, 2.10, 6.1, 6.4-7	13. Machinery 1.16, 1.17, 6.1, 6.4-7	18. Environmental 4.15, 4.18, 6.1, 6.4-7	23. Structural 5.1, 5.3, 5.6, 6.1, 6.4-7
4. Structural 5.2, 5.22, 6.1, 6.4-7	9. Compact Equipment 6.1, 6.4-7	14. Electrical 2.4, 2.11, 6.1, 6.4-7	19. Machinery 1.17, 3.5, 6.1, 6.4-7	24. Environmental 1.16, 4.2, 4.4, 4.5, 4.14, 4.18, 6.1, 6.4-7
5. Environmental 4.2, 4.4, 4.14, 6.4-7	10. Structural 5.2, 6.1, 6.4-7	15. Compact Equipment 3.15, 6.1, 6.4-7	20. Electrical 2.1, 2.11, 6.1, 6.4-7	25. Machinery 1.15, 1.16, 1.17, 6.1, 6.4-7

*Competency numbers (1.2, 2.1, 3.1, 4.1, 6.1 etc.) accompanying each question coincide with numbered competencies listed on ATMS CDE web site.

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 scan sheet.*

2017 Written Examination for the National Agricultural Technology & Mechanical Systems Career Development Event

Mark all answers on the scan sheet using a pencil. Read each question carefully and mark the single correct answer on the scan 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.

1. **Machinery:** Approximately how many acres are in a rectangular field measuring 1940 meters by 0.75 miles?
- 1 acre = 43, 560 square feet 1 hectare = 2.47 acres 1 acre = 0.4045 Hectares
Area of Rectangle = length x width 1 mile = 5,280 feet 1 foot = 0.3048 meter

A. 491.6 acres
B. 578.6 acres
C. 613.5 acres
D. 683.5 acres

2. **Electrical:** A variety of incandescent lights are all operating on a single 120-volt electrical circuit in a livestock barn. The circuit includes four 100-watt lights, five 150-watt lights, and six 60-watt lights. What is the amperage of the circuit with all of these lights operating?

Total Wattage = Voltage x Amperage

A. 10.5 amps
B. 12.6 amps
C. 14.7 amps
D. 16.8 amps

3. **Compact Equipment:** A 25 horsepower single-cylinder engine is operating at 3,480 feet above sea level. What approximate horsepower can be produced by the engine if the engine's power is reduced 1.5 percent for each 1000 feet of elevation above sea level?

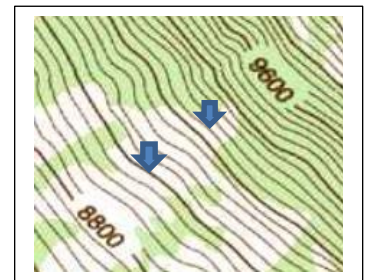
A. 23.1 horsepower
B. 23.7 horsepower
C. 24.3 horsepower
D. 24.9 horsepower

4. **Structural:** Steel angle iron is sold for \$1.46 per linear foot, steel rod is sold for 94 cents per linear foot, and steel pipe is sold for \$2.76 per linear foot. If 35.5 feet of angle iron, 12 feet of rod, and 100 inches of pipe are purchased, and 7% taxes are paid with the purchase, what is the approximate total price for the metal?

A. \$ 78.14
B. \$ 86.11
C. \$ 92.14
D. \$ 100.11

5. **Environmental:** Refer to the enlarged view of contour lines (in feet) on the topographic map at the right of the page. What is the elevation change between the lines identified by the tips of the two arrows?

A. 120 feet
B. 240 feet
C. 360 feet
D. 480 feet



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6. **Environmental:** A 10 horsepower pump is required to produce the desired flow rate for water. The new piping/plumbing system that will be used will reduce the efficiency of a pump 12 percent. If the manufacturer of the pump being purchased recommends a 10 percent oversizing of horsepower to compensate for pump inefficiency, what approximate size water pump should be purchased for this situation? $1.00 = 100\%$
- A. 7.5 horsepower
B. 10.0 horsepower
C. 12.5 horsepower
D. 13.0 horsepower
7. **Machinery:** A portable irrigation pump has a 5.5-inch diameter pulley that must turn at approximately 400 revolutions per minute (rpm). The shaft of the tractor's PTO that powers the pump rotates at 540 rpm and rotates the pump using a belt and two-pulley system. What is the approximate diameter of the pulley needed on the PTO shaft to turn the pulley on the pump at 400 rpms? Pulley Size Formula: $(\text{Diameter of Pulley 1} \times \text{Speed of Pulley 1}) = (\text{Diameter of Pulley 2} \times \text{Speed of Pulley 2})$
- A. 3.0 inches
B. 3.5 inches
C. 4.0 inches
D. 4.5 inches
8. **Electrical:** A water pump for stock tanks has an electrical motor that operates at 120 volts and uses 13.8 amps of current. If it is a 1.5 horsepower motor and it operates with a power factor of 0.92, what is the approximate efficiency of the motor? $1 \text{ horsepower} = 746 \text{ Watts}$

$$\text{horsepower} = \frac{\text{voltage} \times \text{amperage} \times \text{power factor} \times \text{efficiency}}{746}$$
- A. 2.5 %
B. 64.3 %
C. 73.4 %
D. 81.5 %
9. **Compact Equipment:** Which of the following will have the greatest weight in pounds: 4.6 gallons of gasoline, 4.1 gallons of diesel, 3.8 gallons of 15W-40 engine oil, or 3.9 gallons of automatic transmission fluid?
- 1 gallon of gasoline = 6.3 pounds 1 gallon of diesel = 6.943 pounds
 1 gallon 15W-40 engine oil = 7.3 pounds 1 gallon automatic transmission fluid = 7.298 pounds
- A. 4.6 gallons of gasoline
B. 4.1 gallons of diesel
C. 3.8 gallons of 15W-40 engine oil
D. 3.9 gallons of automatic transmission fluid
10. **Structural:** Which of the following quantities of lumber has the least number of board-feet?
- 1 board-foot = 144 cubic inches 1 square foot = 144 square inches
- A. 10 boards measuring 1 inches by 10 inches by 10 feet
B. 10 boards measuring 1 inch by 8 inches by 12 feet
C. 7 boards measuring 2 inches by 6 inches by 12 feet
D. 5 boards measuring 2 inches by 10 inches by 10 feet

11. **Structural:** Four solid round steel rods are 12 feet long and each have a diameter of 2.5 inches. If the rods have a cross sectional tensile strength of 70,000 pounds per square inch, what is the combined maximum tensile strength (approximate value in pounds) for all four rods?

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

- A. 1,131,250 pounds
- B. 1,265,500 pounds
- C. 1,373,750 pounds
- D. 1,492,000 pounds

12. **Environmental:** The Universal Soil Loss Equation is composed of six factors to predict the long-term average annual soil loss and one of those values is slope of the land area expressed as a percentage. What is the approximate slope (percentage) of the land that changes elevation from 1875 feet to 1384 feet over a distance of 1.24 miles? $\text{Slope} = \text{Rise} \div \text{Run} \times (100\% / 1)$

- A. 4.5 %
- B. 5.5 %
- C. 6.5 %
- D. 7.5 %

13. **Machinery:** What is the approximate speed, in miles per hour, for a fertilizer spreader that travels 110 meters in 1 minute and 6.5 seconds?

$$5,280 \text{ ft} = 1 \text{ mile} \quad 60 \text{ seconds} = 1 \text{ minute} \quad 60 \text{ minutes} = 1 \text{ hour} \quad 1 \text{ foot} = 0.3048 \text{ meter}$$

- A. 3.7 miles per hour
- B. 4.2 miles per hour
- C. 4.7 miles per hour
- D. 5.2 miles per hour

14. **Electrical:** A 240-volt air conditioning unit uses 63 kilowatt hours of power during 24 hours of operation. What is the approximate size of this air conditioning unit in tons of refrigeration (disregard efficiency)? One ton of air conditioning removes heat at the rate equivalent to melting one ton of ice during a period of 24 hours.

$$\text{Information: } \text{British Thermal Unit (BTU): } 3412.14 \text{ BTUs} = 1 \text{ kilowatt hour} \\ 1 \text{ Ton of Refrigeration} = 12,000 \text{ BTUs / hour (the rate of heat removal)}$$

- A. Three-Quarter Ton
- B. One Ton
- C. One and One-Half Tons
- D. Two Tons

15. **Compact Equipment:** An engine manual requires each head bolt to be torqued to 13 Newton meters (Nm) during reassembly. The torques wrench available is calibrated in foot pounds (ft. lbs.). What approximate torque in ft. lbs. is equivalent to 13 Nm?

$$4.44822 \text{ Newtons} = 1 \text{ pound force} \quad 0.22481 \text{ pound force} = 1 \text{ Newton} \\ 1 \text{ meter} = 3.28084 \text{ feet} \quad 1 \text{ foot} = 0.3048 \text{ meters}$$

- A. 6.3 ft. lbs.
- B. 7.4 ft. lbs.
- C. 8.5 ft. lbs.
- D. 9.6 ft. lbs.

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16. **Compact Equipment:** A gasoline mower's power takeoff (PTO) produces 18 horsepower and turns at 540 revolutions per minute. Approximately how much torque, in foot-pounds, can this PTO produce?

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

- A. 142.4 foot-pounds
- B. 153.3 foot-pounds
- C. 164.2 foot-pounds
- D. 175.1 foot-pounds

17. **Structural:** Concrete is poured inside a vertical pipe to provide rigidity to the pipe. If 0.75 cubic yards of concrete are needed to fill the pipe that is 10 feet 9 inches tall, what is the approximate inside diameter of the pipe in inches?

$$1 \text{ cubic yard} = 27 \text{ cubic feet}$$

$$1 \text{ cubic foot} = 1728 \text{ cubic inches}$$

$$1 \text{ foot} = 12 \text{ inches}$$

$$\text{Volume of cylinder} = \pi \times (\text{cylinder radius})^2 \times \text{cylinder height}$$

$$\pi = 3.14 \quad \text{diameter} = (2 \times \text{radius})$$

- A. 18.6 inches
- B. 19.9 inches
- C. 20.2 inches
- D. 21.5 inches

18. **Environmental:** Water flows through 97.5 feet of horizontal pipeline that includes three 90 degree elbows. The water flow rate is 5.5 gallons per minute (GPM) where the water exits the 97.5-foot pipeline. The pressure loss through the pipeline is equivalent to 6.6 vertical feet of head (pressure) loss per 100 feet of horizontal run. The head loss through each elbow is equivalent to that of 4.9 feet of additional horizontal length and there are no water leaks. Approximately, what is the water flow rate at the source and what is the equivalent vertical head (pressure) loss for this horizontal pipeline?

- A. 6.5 GPM and 4.2 feet of head loss
- B. 6.5 GPM and 6.3 feet of head loss
- C. 5.5 GPM and 7.4 feet of head loss
- D. 5.5 GPM and 8.5 feet of head loss

19. **Machinery:** Each of two hydraulic cylinders raise and lower the arms that operate the bucket on a skid steer loader. Each cylinder has a bore diameter of 2.75 inches and a stroke of 34.5 inches. The tractor's hydraulic system produces a maximum pressure of 3,200 pounds per square inch. Approximately, what is the maximum combined force that these two cylinders can exert on the lift arms?

$$\text{Area of a cylinder bore} = (\pi) \times (\text{radius})^2$$

$$\pi = 3.14$$

$$\text{Force} = \text{Pressure} \times \text{Area}$$

$$\text{radius} = (\text{diameter} \div 2)$$

- A. 19,334 pounds
- B. 25,884 pounds
- C. 31,664 pounds
- D. 37,994 pounds

20. **Electrical:** A farm building that is poorly insulated is located in a zone of the U.S. that typically requires 50 BTUs per square-foot of floor area to adequately heat the interior. If the interior dimension of the rectangular building is 26.75 feet by 13 yards and the model of furnace being purchased is 87% efficient, what approximate size furnace is required?

$$1 \text{ yard} = 3 \text{ feet}$$

$$\text{Furnace Size in BTUs} = \frac{\text{Number of square feet} \times \text{Number of BTUs per square foot}}{\text{Furnace Efficiency}}$$

- A. 60,000 BTUs
- B. 70,000 BTUs
- C. 80,000 BTUs
- D. 90,000 BTUs

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21. **Electrical:** Refer to the nameplate shown at the right of the page for an electric motor. Which of the following describes the characteristics of: (1) this motor when it is correctly operating at full load amperage (FLA) on 230 volts and (2) the maximum safe amperage when the 230-volt motor is slightly overloaded and must operate at an amperage higher than full load amperage?

ELECTRIC MOTOR NAMEPLATE						
MODEL 500		SPLIT PHASE		TOTALLY ENCLOSED		
FRAME		TYPE	INS. CLASS	IDENTIFICATION NO.		
145		KC	J	2538094990298309		
HP	RPM	VOLTS		AMPS	CYC	S.F.
1 1/2	1725	115/230		15/7.5	60	1.25
DESIGN CODE: B				PHASE	EFF	p.f.
DRIVE END BEARING BBD 116				1	62%	75%
OPP. END BEARING B0B 117				DUTY: CONTINUOUS		
AMB. 40 C			NO THERMAL PROTECTION			

- A. 15 FLA and cannot be safely operated over 15 amps
 B. 7.5 FLA and cannot be safely operated over 7.5 amps
 C. 15 FLA and safely up to 18.75 amps when overloaded
 D. 7.5 FLA and safely up to 9.375 amps when overloaded

22. **Compact Equipment:** Each cylinder in a four-cylinder tractor engine has a bore (diameter) of 2.85 inches and a piston stroke of 4.25 inches. What is the approximate total displacement of this engine in liters?

$$\text{Area of a cylinder bore} = (\pi) \times (\text{radius})^2 \quad \pi = 3.14 \quad \text{radius} = (\text{diameter} \div 2)$$

$$\text{Volumetric displacement of a single cylinder} = (\text{length of piston stroke}) \times (\text{the area of the cylinder bore})$$

- A. 1.2 liters
 B. 1.8 liters
 C. 2.5 liters
 D. 2.9 liters

$$1 \text{ liter} = 61 \text{ cubic inches}$$

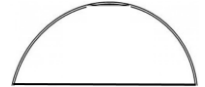
$$1 \text{ cubic inch} = 0.0164 \text{ liter}$$

23. **Structural:** Intake and/or exhaust fans should have the capacity in cubic feet per minute to adequately exchange the air in a greenhouse every three minutes. The rectangular floor of a greenhouse measures 40 feet by 80 feet and the walls and roof are made of plastic sheeting stretched over plastic pipe hoops positioned as half circles. The hoops give the greenhouse a perfect half cylinder shape with each hoop having a diameter of 40 feet. In cubic feet per minute, what is the approximate size fan needed to ventilate the greenhouse?

$$\text{Volume of a cylinder} = (\pi) \times (\text{radius})^2 \times \text{length}$$

$$\pi = 3.14 \quad \text{diameter} = (2 \times \text{radius})$$

- A. 16,750 cubic feet per minute
 B. 17,250 cubic feet per minute
 C. 17,750 cubic feet per minute
 D. 18,250 cubic feet per minute



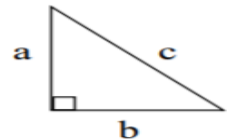
End view of greenhouse.

24. **Environmental:** A field has a legal land area of 100 acres with horizontal measurements being 800 feet by 5,445 feet. The 800-foot dimension is flat (horizontal), but the longer dimension has a gradual elevation change from 2006 feet to 2998 feet. Although the legal land area is 100 acres, the sloped surface area must be used when calculation fertilizer, pesticide, and seeding applications. What is the approximate area, in acres, for the sloped surface of the field?

Calculating length of side for right triangle uses the Pythagorean Theorem: $a^2 + b^2 = c^2$

Area of rectangle = Length x Width 1 acre = 43,560 square feet

- A. 100.54 acres
 B. 101.65 acres
 C. 102.76 acres
 D. 103.87 acres



25. **Machinery:** A utility tractor is re-equipped with high profile tires (larger diameter than the factory equipped tires). If the original tires had a 38.5-inch outside diameter and the new larger tires have a 44.8-inch outside diameter, what is the approximate speed of the tractor (miles per hour, with larger diameter tires) when the tractor's mechanical speedometer displays 15 miles per hour? Assume all tires are properly inflated, tires have no slippage, and the speedometer is still calibrated for the smaller diameter tires.

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

- A. 16.0 mph
 B. 16.5 mph
 C. 17.0 mph
 D. 17.5 mph

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