

ANSWERS TO EXAMINATION Do Not Distribute

2010 Examination for the National Agricultural Mechanics

Career Development Event: INTEGRATED PEST MANAGEMENT

Mark all answers on the Scantron sheet using a pencil. Read each question carefully and identify the single correct answer. Use the blank sheet(s) of paper to do all scratch work. Students will need a calculator to complete this examination, but they are not allowed to share a calculator with another student.

SECTION 1: MACHINERY & EQUIPMENT SYSTEMS Question 1-20

1. Which one of the following must be present in the soil for seed germination?

- A. Water
- B. Nitrogen
- C. Potassium
- D. Phosphorous

Answer A (JD, FMO, Planting, p. 11)

2. When moving a tractor up a steep incline, which of the following techniques is recommended?

- A. Back up the incline
- B. Steer straight while driving up the incline
- C. Angle about 45 degree along the slope while driving up the incline
- D. Have someone stand on the front of the tractor while driving up the slope

Answer A Farm & Ranch Safety Management, 1994, page 282

3. What is the purpose of a press wheel on a planter?

- A. Opens the soil for seed planting
- B. Firms the soil after the seed is covered
- C. Presses the seed to the bottom of the groove
- D. Distributes the seed evenly throughout the groove

Answer B (JD, FMO, Planting, p. 41)

4. Which of the following variables directly influence power output of a tractor's power takeoff (PTO)?

- A. PTO torque and rotational speed
- B. Tractor travel speed and direction
- C. Tractor wheel diameter and travel speed
- D. PTO diameter and tractor engine oil pressure

Answer A Machinery Management - John Deere

5. How many splines are on the shaft of a 540 rpm PTO stub?

- a. 6 splines
- b. 10 splines
- c. 20 splines
- d. 21 splines

Answer A (JD, FMO, Planting, p. 73)

6. Which of the following factors directly influence the field capacity of agricultural equipment?

- A. Power takeoff (PTO) speed and temperature
- B. Machine weight and ground clearance
- C. Travel speed and operating efficiency
- D. Machine height and length

Answer C Machinery Management - John Deere

7. How does an underinflated ground driven planter drive tire affect the number of seeds planted per acre?

- a. No affect
- b. Over planting occurs
- c. Under planting occurs
- d. Correct amount of seed is planted per acre

Answer B (JD, FMO, Planting, p. 79)

8. When an engine is operated in an enclosed shed, what exhaust gas presents a hazard to people and animals?

- A. Hydrogen Peroxide
- B. Carbon Monoxide
- C. Hydrogen Sulfide

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D. Carbon Dioxide

Answer B <http://www.cdc.gov/nasd/docs/d000901-d001000/d000918/d000918.html>

9. When a tractor is equipped with a rollover protective structure (ROPS) and a seat belt, what is the purpose of the ROPS?

- A. Lower the tractor's center of gravity
- B. Prevent head injuries caused by falling objects
- C. Limit most rollovers to 90 degrees and when the seatbelt is worn, to protect the operator
- D. Limit most rollovers to 180 degrees and when the seatbelt is not worn, to protect the operator

Answer C [Safe Grain and Silage Handling](http://www.cdc.gov/niosh/contents.html), Karl Snyder and Thomas Bobick, NIOSH, 1995 page 1-2 <http://www.cdc.gov/niosh/contents.html>

10. Which of the following is an acceptable way to dispose of empty herbicide containers after use?

- A. Rinse once and burn on site
- B. Reuse the container to store nontoxic liquids
- C. Triple rinse and puncture
- D. Cut the top out and reuse for food storage

Answer C [2009 Missouri Pest Management Guide](#), 2009, University of Missouri Extension, p 9.

11. What is the term for a herbicide that is applied to kill a plant before it emerges from the surface of the soil?

- A. Post emergence
- B. Pre-emergence
- C. Incorporated
- D. Aerated

Answer B [2009 Missouri Pest Management Guide](#), 2009, University of Missouri Extension, p 22.

12. What type of pest management systems relies on the physical removal of pests such as hoeing weeds?

- A. Biological
- B. Chemical
- C. Incorporated
- D. Mechanical

Answer D [Midwest Home Fruit Production Guide](#), 2009, The Ohio State University Extension, p 84. http://ohioline.osu.edu/b940/pdf/b940_ch7.pdf

13. Applying insecticide often eliminates natural enemies of the pest insects; what term describes the process where a pest population recovers from a pesticide treatment?

- A. Resurgence
- B. Residual
- C. Reactant
- D. Mechanical

Answer A [Biointensive Integrated Pest Management](#), 2010. National Center for Appropriate Technology. <http://attra.ncat.org/attra-pub/ipm.html>

14. What is the term/practice for planting a different crop to prevent the buildup of pest organisms that feed on a particular type of plant?

- A. Multiple cropping
- B. Strip cropping
- C. Crop rotation
- D. Intercropping

Answer C [Biointensive Integrated Pest Management](#), 2010. National Center for Appropriate Technology. <http://attra.ncat.org/attra-pub/ipm.html>

15. Which of the following terms describes the inspection of a field to determine if there is a pest problem?

- A. Scouting
- B. Eradication
- C. Cultural control
- D. Resistance

Answer A [Biointensive Integrated Pest Management](#), 2010. National Center for Appropriate Technology. <http://attra.ncat.org/attra-pub/ipm.html>

16. Using living organisms to control pest populations is known as what type of control system?

- A. Biological
- B. Chemical
- C. Mechanical
- D. Physical

Answer A [Biointensive Integrated Pest Management](#), 2010. National Center for Appropriate Technology. <http://attra.ncat.org/attra-pub/ipm.html>

17. The use of botanical and synthetic pesticides is known as what type of control system?

- A. Biological
- B. Chemical

- C. Mechanical
- D. Physical

Answer B Biointensive Integrated Pest Management, 2010. National Center for Appropriate Technology. <http://attra.ncat.org/attra-pub/ipm.html>

18. A planter has a 20-foot effective swath width, travels at 5 miles per hour, and operates with a field efficiency of 80 percent. What is the approximate effective field capacity (EFC) of the planter in acres per hour?

Note: $EFC \text{ in acres per hour} = \frac{\text{width of implement in feet} \times \text{speed in miles per hour} \times \text{efficiency}}{8.25}$

- A. 7.3 acres per hour
- B. 8.0 acres per hour
- C. 9.7 acres per hour
- D. 11.0 acres per hour

Answer C: $9.696969 \text{ ac/hr} = [(20 \text{ ft}) \times (5 \text{ mph}) \times (0.80)] / 8.25$

19. What is the approximate speed, in miles per hour, of a planter that travels 200 feet in 25.6 seconds?

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

- A. 3.9 miles per hour
- B. 5.3 miles per hour
- C. 6.5 miles per hour
- D. 8.7 miles per hour

Answer B: $5.3267 \text{ mph} = (200 \text{ ft} / 25.6 \text{ sec}) \times (3600 \text{ sec} / 1 \text{ hr}) \times (1 \text{ mi} / 5,280 \text{ ft})$

20. If a farm cooperative charges \$17.00 per acre to apply pesticide, what is the total cost to treat six fields with the following acreages: 139 acres, 245 acres, 180 acres, 375 acres, 607 acres, and 495 acres?

- A. \$34,697.00
- B. \$45,831.00
- C. \$52,488.00
- D. \$61,625.00

Answer A: $\$34,697 = (139 \text{ ac.} + 245 \text{ ac.} + 180 \text{ ac.} + 375 \text{ ac.} + 607 \text{ ac.} + 495 \text{ ac.}) \times (\$17.00)$

SECTION 2: INDUSTRY AND MARKETING SYSTEMS Question 21-40

21. Which of the following would be considered a liability in farm accounting?

- A. The herbicide bill that you owe to the farm supply store
- B. Money in your checking account
- C. A debt owed to you by another farmer
- D. The cash value of your life insurance policy

Answer A: Farm and Ranch Business Management, 2004. John Deere, p 3-2 to 3-3

22. What is the name for the decrease in the value of a capital asset that occurs over time?

- A. Repair and maintenance
- B. Obsolescence
- C. Depreciation
- D. Capital accrual

Answer C: Farm and Ranch Business Management, 2004. John Deere, p A-3

23. In economics, applying any production input, such as herbicides, in excess of the required amount, leads to which of the following?

- A. Diminishing returns
- B. Profit maximization
- C. Differentiated input function
- D. Liquidity

Answer A: Farm and Ranch Business Management, 2004. John Deere, p 5-4

24. Which of the following correctly describes the owner(s) of the cooperative?

- A. Stockholders
- B. Private investors
- C. Member-patrons of the cooperative
- D. A sole proprietor

Answer C: Farm and Ranch Business Management, 2004. John Deere, p 10-11

25. Which type of pesticide can only be purchased a certified pesticide applicator?

- A. General use pesticide
- B. Special use pesticide
- C. Reserve use pesticide

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D. Restricted use pesticide

Answer D : Farm and Ranch Business Management, 2004. John Deere, p 11-23

26. What type of insurance gives a farmer protection against financial loss if a chemical application drifts onto an adjacent farm and damages a neighbor's crop?

- A. Accident insurance
- B. Property insurance
- C. Liability insurance
- D. Crop insurance

Answer C: Farm and Ranch Business Management, 2004. John Deere, p 11-13

27. In economics, a product or service has this characteristic if it satisfies a consumer's need.

- A. Elasticity
- B. Leverage
- C. Parity
- D. Utility

Answer D: Farm and Ranch Business Management, 2004. John Deere, p 7-2

28. What type of business arrangement gives a farmer the right to use a self-propelled spray rig owned by a machinery dealership for a certain period of time in exchange for one or more payments?

- A. Barter
- B. Exchange
- C. Lease
- D. Sale

Answer C: Farm and Ranch Business Management, 2004. John Deere, p A-6

29. Which of the following is a variable cost associated with owning fertilizer application equipment?

- A. Depreciation
- B. Chemical expense
- C. Interest expense
- D. Annual taxes

Answer B:

30. Which type of fuel is most efficiently converted into work by a tractor's engine?

- A. Gasoline
- B. Diesel fuel
- C. LP-gas
- D. Ethanol

Answer B

31. Which of the following is an example of a variable cost for a grain elevator employing seasonal workers?

- A. Monthly telephone charge for local calls
- B. Property tax on elevator
- C. Depreciation on a grain auger
- D. Overtime wages paid to hired labor

Answer D at <http://uwadmnweb.uwyo.edu/SBDC/fod/258.html>

32. Which of the following is a variable cost associated with owning grain handling equipment?

- A. The operating costs not declared on income tax expenses
- B. Depreciation costs
- C. Fuel/energy costs
- D. Principal payment on a fixed loan

Answer C

33. Which of the following is an example of a variable cost for a pesticide company that is hiring certified applicators?

- A. Fuel cost
- B. School tax on the company's property
- C. Casualty insurance on transport trailers
- D. Depreciation on a new semi-truck with tanker

Answer A

34. In this accounting system, an expense is recognized as an expense before cash is paid.

- A. Cash accounting system
- B. Accrual accounting system
- C. Liability accounting system
- D. Expense accounting system

Answer A - <http://accountinginfo.com/study/accrual-101.htm>

35. Which of the following are all fixed costs associated with operating a farm?

- A. Soil conservation losses, lost crop repayments, death benefits, and federal incentive payments
- B. The opportunity and entertainment costs not declared on Schedule F of the IRS 1040 Form
- C. Shelter, interest, taxes, depreciation, and insurance
- D. Livestock depreciation and all operating costs

Answer C Fundamentals of Machine Operation, Wendell Bowers, Deere & Company, 1981

36. Which one of the following costs is generally considered to vary with individual operator use?

- A. Annual cost for repairs
- B. Annual cost for equipment shelter
- C. Annual cost for equipment taxes
- D. Annual cost for the interest on the loan for the equipment's purchase

Answer: A.

37. Which of the following 2WD tractor weighting schemes is most agreed upon for a heavy duty chisel plow?

- A. 50 percent on the front and 50 percent on the rear
- B. 40 percent on the front and 60 percent on the rear
- C. 35 percent on the front and 65 percent on the rear
- D. 25 percent on the front and 75 percent on the rear

Answer D <http://www.extension.iastate.edu/Publications/PM2089G.pdf>

38. If sales tax is 7.25 percent, what is the approximate total cost including the sales tax, for an item marked \$636.94?

- A. \$225.58
- B. \$319.63
- C. \$497.36
- D. \$683.12

Answer D: $\$683.1182 = (\$636.94) \times (1.0725)$

39. It costs \$5.45 per acre per year to have a crop service scout for insect pests. What will be the approximate yearly charge to scout a field measuring 2588 feet wide and 2409 feet long? Note: 1 acre = 43,560 square feet

- A. \$679 per year
- B. \$780 per year
- C. \$867 per year
- D. \$987 per year

Answer B: $\$780.0271 = (\$5.45/\text{ac}) \times [(2588 \text{ ft}) \times (2409 \text{ ft})] \times (1 \text{ ac}/43,560 \text{ ft}^2)$

40. A label specifies that pesticide formulation be applied at the rate of 6.5 ounces per acre. Approximately how many acres will one gallon of this pesticide formulation treat? Note: 1 gallon = 128 ounces

- A. 16.5 acres per gallon
- B. 19.7 acres per gallon
- C. 22.9 acres per gallon
- D. 25.3 acres per gallon

Answer B: $19.6923 \text{ ac/gal} = (1 \text{ ac} / 6.5 \text{ oz}) \times (128 \text{ oz} / \text{gal})$

SECTION 3: ENERGY SYSTEMS Question 41-60

41. What material provides great resistance to the flow of electricity?

- A. Insulator
- B. Conductor
- C. Filament
- D. Commutator

Answer A (Agricultural Mechanics: Fundamentals and Applications, 6th ed., p. 516)

42. What type of wire can be used for direct burial in soil?

- A. Type T
- B. Type TW
- C. Type UF
- D. Type THWN

Answer C (Agricultural Mechanics: Fundamentals and Applications, 6th ed., p. 526)

43. What type of variable resistor is used to control voltage?

- A. Voltmeter
- B. Ammeter
- C. Oscilloscope
- D. Potentiometer

Answer D (Agricultural Mechanics: Fundamentals and Applications, 6th ed., p. 547)

44. What device converts light energy into electrical energy?

- A. Photodiode
- B. Phototransistor
- C. Photovoltaic cell
- D. Photoconductive cell

Answer C (Agricultural Mechanics: Fundamentals and Applications, 6th ed., p. 553)

~~45. What type of semiconductor is used to electronically control switches?~~

- ~~A. Diode~~
- ~~B. Thyristor~~
- ~~C. Transistor~~
- ~~D. Integrated Circuit~~

~~Answer D (Agricultural Mechanics: Fundamentals and Applications, 6th ed., p. 552)~~

New Question in Test

Answer: A

46. When an electrical wiring system provides power to a 230-volt motor, why is the frame of the motor grounded?

- A. To complete the branch circuit
- B. To prevent the motor from turning in reverse
- C. To physically connect the motor to equipment frames
- D. To ground the motor and reduce the likelihood of electrical shock

Answer D Fundamentals of Electricity, ASAE, pg 216

47. The grounded conductor in an electrical wiring system serves what purpose?

- A. It is the neutral conductor for the electrical system
- B. It is a noncurrent carrying conductor for most appliances
- C. It is the unnecessary connection of an electrical conductor to earth
- D. It is the only possible electrical connection between the electrical system and the earth

Answer A Agricultural Electrification, Southwestern, pg 213

48. What type of switch is used to control water levels in livestock water tanks and other areas where liquid levels must be controlled?

- A. Timer switch
- B. Actuator switch
- C. Thermocouple
- D. Float switch

Answer D (Agricultural Mechanics: Fundamentals and Applications, 6th ed., p. 572)

49. If a wiring circuit has a path through which electricity can flow, it is said to have what property?

- A. Switched
- B. Parallel
- C. Power
- D. Continuity

Answer D Continuity <http://a248.e.akamai.net/pix.crutchfield.com/ca/learningcenter/car/pdfs/000multi2.pdf>

50. When measuring an unknown voltage with a multimeter that requires you to select a voltage, what is the recommended procedure?

- A. Select the highest voltage range and work your way down
- B. Select the lowest voltage range and work your way up
- C. Select the voltage range closest to the voltage you expect
- D. Select 120 volts

Answer A. <http://a248.e.akamai.net/pix.crutchfield.com/ca/learningcenter/car/pdfs/000multi2.pdf>

51. When measuring resistance with a multimeter what is the name of the units of the value measured?

- A. Voltage
- B. Amperage
- C. Ohms
- D. Continuity

Answer C Ohms <http://a248.e.akamai.net/pix.crutchfield.com/ca/learningcenter/car/pdfs/000multi2.pdf>

52. In an irrigation electrical wiring system, what is the result of broken and/or damaged electrical wires?

- A. A closed circuit.
- B. A complete circuit.
- C. An open circuit.
- D. A long circuit.

Answer C An open circuit. http://www.grounds-mag.com/mag/grounds_maintenance_test_irrigation_wiring/

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53. How do ohm meters work?

- A. By combining the amperage and the wattage measurement of the circuit
- B. By measuring the current of a component being tested
- C. By passing current through the component being tested
- D. By combining the voltage and the amperage measurement of the circuit

Answer C. <http://www.doctrionics.co.uk/meter.htm>

54. What is the purpose of the ground fault circuit interrupter (GFCI)?

- A. Provide protection from electrical shock
- B. Signal the probability of an earthquake
- C. Step up the output voltage of equipment
- D. Measure stray voltage

Answer A Fundamentals of Electricity, ASAE

55. What function do sprinkler control valves perform in a sprinkler system?

- A. Control the amount of water in the system
- B. Direct the flow of water
- C. Turn the flow of water on or off
- D. Allow the water in the system to drain during cold weather

Answer C. Turn the flow of water on or off <http://www.rainbird.com/documents/diy/ValveInstallTips.pdf>

56. What type of zone control valve should be used underground?

- A. Anti-siphon valve
- B. In-line valve
- C. A UL listed gate valve
- D. A UL listed solenoid actuated anti-siphon valve

Answer B. In-line valve <http://www.rainbird.com/documents/diy/ValveInstallTips.pdf>

57. Which of the following types of valves, when properly installed, is most effective at preventing back flow?

- A. Anti-siphon valve
- B. In-line valve
- C. A gate valve
- D. A pressure limiting safety valve

Answer A. Anti-siphon valve. <http://www.rainbird.com/documents/diy/ValveInstallTips.pdf>

58. The monthly charge to operate a pivot irrigation system is 8 cents per kilowatt hour (KWH) for the first 1000 hours and 7.75 cents for each hour greater than 1000 hours. If the irrigation system uses 1785 KWHs of electricity during a single month, what is the monthly cost, in dollars, to operate the irrigation system? (1 Kilowatt = 1000 Watts)

- A. \$113.84
- B. \$140.84
- C. \$162.84
- D. \$191.84

Answer B. $\$140.8375 = (1000 \text{ KWH} \times \$0.08/\text{KWH}) + [(1785-1000) \times \$0.0775]$ AAVIM Understanding Electricity. Pages 74-76

59. If a wattmeter measures 5800 watts of power being used by a five horsepower electric motor, operating at 230 volt, and 28 amps, what is the power factor for the motor?

Formula: Wattage = Voltage x Amperage x Power Factor

- A. 0.123 or 12% power factor
- B. 0.252 or 25% power factor
- C. 0.901 or 90% power factor
- D. 0.972 or 97% power factor

Answer C $\text{Pf} = 0.9006 = 5800 \text{ watts} / (230 \text{ volts} \times 28 \text{ amps})$

60. An 120-volt electrical circuit will operate a 2400-watt resistance heater and ten 300-watt incandescent light bulbs. If the circuit is operated 10 hours each day for 300 days, how many kilowatt hours will the electrical system use during the time period?

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

- A. 10,900 kilowatts hours
- B. 13,700 kilowatts hours
- C. 16,200 kilowatts hours
- D. 19,400 kilowatts hours

Answer C. $16,200 \text{ kilowatts} = [(2400 \text{ Watts} + 3000 \text{ Watts}) \times 10 \text{ hours/day} \times 300 \text{ days}] / 1000 \text{ Watts/kilowatt}$

SECTION 4: STRUCTURAL SYSTEMS Questions 61-80**61. What is another name for metallic inert gas welding (MIG)?**

- A. Stick welding
- B. Gas tungsten arc welding (GTAW)
- C. Shielded metal arc welding (SMAW)
- D. Gas metal arc welding (GMAW)

Answer D: Mechanical Technology in Agriculture Johnson, Harper, Lawver and Buriak, Interstate Publishers, 1998, p 533**62. What is the name of the tool used to cut internal threads?**

- A. Tap
- B. Die
- C. Drill
- D. Reamer

Answer A: Mechanical Technology in Agriculture Johnson, Harper, Lawver and Buriak, Interstate Publishers, 1998, p 526**63. What is the most common shielding gas used for TIG welding aluminum?**

- A. Carbon dioxide
- B. Argon
- C. Nitrogen
- D. Carbon dioxide/argon mix

Answer B: Mechanical Technology in Agriculture Johnson, Harper, Lawver and Buriak, Interstate Publishers, 1998, p 537**64. What is indicated by the two (sometimes three) digits immediately to the right of the E of shielded metal arc welding electrodes?**

- A. Weld position
- B. Tensile strength
- C. Compression strength
- D. Special electrode characteristic

Answer B: Mechanical Technology in Agriculture Johnson, Harper, Lawver and Buriak, Interstate Publishers, 1998, p 539**65. What is the maximum safe working pressure for acetylene?**

- A. 15 psi
- B. 20 psi
- C. 25 psi
- D. 30 psi

Answer A: Mechanical Technology in Agriculture Johnson, Harper, Lawver and Buriak, Interstate Publishers, 1998, p 541**66. What is the process by which base metals are fastened with a filler metal that melts at temperatures below 840° F?**

- A. Brazing
- B. Braze welding
- C. Soldering
- D. Welding

Answer C: Mechanical Technology in Agriculture Johnson, Harper, Lawver and Buriak, Interstate Publishers, 1998, p 546**67. What type welding uses an arc surrounded by a layer of flux and is established and maintained between a continuously fed wire and the work piece?**

- A. Flux cored arc welding (FCAW)
- B. Submerged arc welding (SAW)
- C. Plasma arc welding (PAW)
- D. Laser beam welding (LBW)

Answer B: Agriscience Mechanics, Phipps and Miller, Interstate Publishers, 1998, p 439**68. What is the typical arc length for a 1/8" diameter E6011 electrode used in SMAW for the flat position?**

- A. The electrode should touch and drag along the base metal
- B. 1/32"
- C. 1/8"
- D. 3/8"

Answer C: Agriscience Mechanics, Phipps and Miller, Interstate Publishers, 1998, p 434**69. What device can be installed on oxy-fuel equipment to prevent a flame from traveling back up the torch/hose, past the point of installation?**

- A. Regulator
- B. Cylinder valve
- C. Flashback arrester

D. Reverse flow check valve

Answer C (JD – Welding- FOS, p. 27)

70. What type of flame is formed when oxygen is added to a neutral flame?

- A. Neutral flame
- B. Oxidizing flame
- C. Carburizing flame
- D. Pure acetylene flame

Answer B (JD-FOS-Welding, p. 33)

71. Which of the following is the fuel gas that can be used for welding purposes?

- A. MAPP
- B. Propane
- C. Acetylene
- D. Propylene

Answer C (JD-FOS-Welding, p. 38)

72. What is the safe gas withdrawal rate for an acetylene cylinder?

- A. 1/7 of the cylinders capacity per hour
- B. 1/4 of the cylinders capacity per hour
- C. 1/2 of the cylinders capacity per hour
- D. 2/3 of the cylinders capacity per hour

Answer A (JD-FOS-Welding, p. 21)

73. What fuel gas has the highest flame temperature when burned with oxygen?

- A. Acetylene
- B. Natural Gas
- C. MAPP Gas
- D. Propylene

Answer A (JD-FOS-Welding, p. 18)

74. According the American Welding Society (AWS), what is the color code for pure tungsten electrodes (EWP) that are used with the Gas Tungsten Arc Welding process?

- A. Green
- B. Orange
- C. Black
- D. Yellow

Answer A (JD-FOS-Welding, p. 123)

75. According to the American Plywood Association, which of the following grades of veneer is the highest (best) quality?

- A. Grade A
- B. Grade B
- C. Grade 1
- D. Grade 2

Answer A (Agricultural Mechanics: Fundamentals and Applications, 6th ed., p. 664- 668)

76. What is the name of a single board that supports a section of a roof on truss type building construction?

- A. Girder
- B. Column
- C. Subfloor
- D. Rafter

Answer D (Agricultural Mechanics: Fundamentals and Applications, 6th ed., p. 664)

77. What is the concrete base that provides a solid, level foundation for brick, stone, or block walls?

- A. Form
- B. Footer
- C. Control joint
- D. Moisture barrier

Answer B (Agricultural Mechanics: Fundamentals and Applications, 6th ed., p. 644)

78. If 180 feet of steel rod is used to construct a hay feeding rack and the rod weighs 0.385 pounds per foot of length, what is the approximate weight of the hay feeding rack?

- A. 69 pounds
- B. 91 pounds
- C. 155 pounds

D. 260 pounds

Answer A: $69.3 \text{ lbs} = (180 \text{ ft}) \times (0.385 \text{ lbs/ft})$

79. Steel angle iron is sold for \$2.45 per linear foot, steel rod is sold for \$1.93 per linear foot, and steel pipe is sold for \$2.79 per linear foot. If 18 feet of angle iron, 25 feet of rod, and 28 feet of pipe are purchased, what is the total price for the metal before taxes?

- A. \$ 83.75
- B. \$110.23
- C. \$138.61
- D. \$170.47

Answer D: $\$170.47 = [(18 \text{ ft}) \times (2.45 / \text{ft})] + [(25 \text{ ft}) \times (\$1.93 / \text{ft})] + [(28 \text{ ft}) \times (\$2.79 / \text{ft})]$

80. What is the volume, in cubic inches, of a cylinder with a diameter of 10 inches and a length of 3 feet?

Note: Volume of Cylinder = $\pi \times (\text{radius})^2 \times (\text{length})$ $\pi = 3.14$ (dia./2) = radius 1 foot = 12 inches

- A. 1,384 cubic inches
- B. 1,826 cubic inches
- C. 2,044 cubic inches
- D. 2,826 cubic inches

Answer D: $2826 \text{ in}^3 = \text{Vol of Cyl.} = (\pi) \times (10''/2)^2 \times (3' \times 12''/1')$

SECTION 5: ENVIRONMENTAL AND NATURAL RESOURCE SYSTEMS Question 81-100

81. What is the primary purpose of the spinner located below the feed chute on a granular fertilizer spreader?

- A. Force air through the hopper and aid the gravity feed process
- B. To improve the uniform distribution of the granular fertilizer
- C. Vary the distance that fertilizer is thrown during turns and stops
- D. Mix fertilizer and water together prior to injection in the soil

Answer: B ASABE Standard: and Calibrating Granular Broadcast Spreaders

82. Which of the following statements describes effective swath width for a broadcast granular fertilizer spreader?

- A. The maximum distance that fertilizer is thrown directly below the hopper of a spreader
- B. The maximum distance that fertilizer is thrown behind a granular fertilizer spreader
- C. The width of the application that achieves uniform deposition rates with appropriate overlap between adjacent passes
- D. The width of the application that achieves maximum deposition rates without having to overlap between adjacent passes

Answer: C ASABE Standard: Calibrating Granular Broadcast Spreaders

83. Which of the following describes the benefit of conducting a spread pattern test for a granular fertilizer spreader?

- A. It evaluates the uniformity of the fertilizer distributed over the effective swath width by the spreader
- B. It determines the volume of the fertilizer that is distributed directly in front of the power unit towing the fertilizer spreader
- C. It measures the width of a fertilizer application that also achieves the maximum soil deposition rates
- D. It accounts for the number of pounds of fertilizer that are distributed beyond the spreader's effective swath width

Answer: A ASABE Standard: Calibrating Granular Broadcast Spreaders

84. Which of the following statements is correct with regard to how the spinner's rotating speed effects granular fertilizer distribution?

- A. Increasing spinner speed (revolutions per minute) decreases the distance that granular fertilizer is thrown
- B. Increasing spinner speed (revolutions per minute) increases the distance that granular fertilizer is thrown
- C. Decreasing spinner speed (revolutions per minute) increases the flow rate of the fertilizer from the hopper
- D. Decreasing spinner speed (revolutions per minute) decreases the flow rate of the fertilizer from the hopper

Answer: B ASABE Standard: Calibrating Granular Broadcast Spreaders

85. How will a 6 mile per hour wind, blowing perpendicular to the direction of travel, effect the distribution of a liquid heicide being applied by a spray boom positioned 30 inches above the ground?

- A. Increases off target fertilizer movement
- B. Decreases off target fertilizer movement
- C. Increases the uniform effectiveness of fertilizer application
- D. Decreases the amount of fertilizer required for a application

Answer: A ASABE Standard: Calibrating Granular Broadcast Spreaders

86. Which of the following is the best option to reduce the off target movement of a liquid fertilizer being applied by a boom sprayer?

- A. Reduce the height of the spray boom above the ground

- B. Use fertilizer spray nozzles that produce smaller spray droplets
- C. Increase the spray pressure (pounds per square inch) being used to deliver the fertilizer
- D. Increase the travel speed (miles per hour) of the fertilizer application

Answer: A ASABE Standard: Calibrating Granular Broadcast Spreaders

87. What values are used to calculate the application rate of granular applications in pounds per acre?

- A. Use travel speed in miles per hour, effective swath width in feet, and delivery rate in pounds to calculate application rate
- B. Use effective swath width in feet, delivery rate in pounds, and granular size in inches to calculate application rate
- C. Use delivery rate in pounds, granular size in inches, and travel speed in miles per hour to calculate application rate
- D. Use granular size in inches, travel speed in miles per hour, and hopper volume to calculate application rate

Answer: A ASABE Standard: Calibrating Granular Broadcast Spreaders

88. Which of the follow correctly describes the relationship between application rate (pounds per acre) and the overlap between multiple passes of a granular fertilizer spreader?

- A. Less overlap between passes will increase the travel speed requirements for the application
- B. Less overlap between passes will decrease the travel speed requirements for the application
- C. Greater overlap between passes will increase the overall application rate
- D. Greater overlap between passes will decrease the overall application rate

Answer C: ASABE Standard: Calibrating Granular Broadcast Spreaders

89. When liquid pesticide is applied with a traditional boom sprayer, if all other variables remain constant, which of the following will result in a decreased chemical application rate?

- A. Reduce the travel speed of the sprayer
- B. Increase the travel speed of the sprayer
- C. Replace the existing nozzles with nozzles having a larger tip size
- D. Increase the spray pressure at the nozzle

Answer B: Applying Pesticides Correctly – Private Applicator Supplement, United States Environmental Protection Agency Bulletin E-2474, p. 4-19.

90. Which of the following pesticide spray equipment components can directly control and vary the pressure developed at the sprayer nozzle and the quantity of spray delivered to the nozzles?

- A. Strainer
- B. Screen
- C. Nozzle body
- D. Pressure regulator

Answer D Applying Pesticides Correctly – Private Applicator Supplement, United States Environmental Protection Agency Bulletin E-2474, p. 3-9.

91. Which of the following is a true statement with respect to groundwater and liquid chemical contamination?

- A. Groundwater is easily cleaned after it becomes contaminated
- B. Chemicals are not transported into groundwater by leaching
- C. Shallow groundwater is more susceptible to contamination than deeper groundwater
- D. Contamination is more likely with clay soils than with sandy soils

Answer C Applying Pesticides Correctly – Private Applicator Supplement, United States Environmental Protection Agency Bulletin E-2474

92. If other variables remain constant, which of the following adjustments to spray equipment will result in the greatest increase in application rate?

- A. Increase the travel speed 20 percent
- B. Decrease the travel speed 20 percent
- C. Increase the spray pressure 10 percent
- D. Decrease the spray pressure 10 percent

Answer B: Applying Pesticides Correctly – Private Applicator Supplement, United States Environmental Protection Agency Bulletin E-2474

93. If other variables remain constant, which of the following adjustments to spray application equipment will have the described effect?

- A. Doubling the travel speed will double the spray application rate
- B. Doubling the spray pressure will double the spray application rate
- C. Doubling the travel speed will reduce the application rate by one-half
- D. Doubling the spray pressure will reduce the application rate by one-half

Answer C: Applying Pesticides Correctly – Private Applicator Supplement, United States Environmental Protection Agency Bulletin E-2474

94. Which of the following conditions are most likely to reduce the likelihood of off target movement by liquid chemical?

- A. High spray pressure, high temperature, no wind, and high humidity
- B. Low spray pressure, low temperature, low wind speed, and high humidity
- C. High spray pressure, low temperature, high wind speed, and low humidity
- D. Low spray pressure, high temperature, high wind speed, and low humidity

Answer B: Applying Pesticides Correctly – Private Applicator Supplement, United States Environmental Protection Agency Bulletin E-2474

95. Which of the following is typically the reason why inexperienced operators apply granular fertilizer incorrectly with a pull-behind/towed spreader?

- A. Improper fertilizer is applied for the crop being treated
- B. Improper loading of the spreader resulting in poor operation of the hopper delivery system
- C. Improper overlap distance between passes resulting in under or over application
- D. Improper and/or inconsistent travel speed when operating wheel driven spreaders

Answer C

96. Which of the following statements is true with regard to granular fertilizer spreaders?

- A. Two fertilizers with different densities will have the same rate of flow and distance of throw
- B. Operating spreaders with low quantities of fertilizer does not influence application rate
- C. Two fertilizers with different particle sizes have the same rate of flow and distance of throw
- D. When a spreader with spinners is operated over sloped terrain, the fertilizer is not uniformly applied

Answer D

97. Which of the following results in feed problems from the hopper to the spinner of a fertilizer spreader?

- A. Normal motion and agitation of the spreader during operation
- B. Uniform granule size and density
- C. Wet or damp fertilizer granules
- D. Fine rather than course granular fertilizer is used

Answer C

98. Approximately how many acres are in a rectangular field measuring 1200 yards by 2360 feet?

Note: 1 acre = 43,560 square feet 1 yard = 3 feet

- A. 141 acre
- B. 195 acres
- C. 256 acres
- D. 320 acres

Answer B: $195.041 \text{ acres} = (1200 \text{ yd} \times 3 \text{ ft} / 1 \text{ yd} \times 2360 \text{ ft}) \times (1 \text{ acre} / 43,560 \text{ ft})$

99. What is the approximate speed, in miles per hour, of a granular pesticide spreader that travels 275 feet in 0.75 minutes? Note: 5,280 ft = 1 mile 60 minutes = 1 hour

- A. 4.2 miles per hour
- B. 5.0 miles per hour
- C. 6.4 miles per hour
- D. 8.6 miles per hour

Answer A: $4.1666 \text{ mph} = (275 \text{ ft} / 0.75 \text{ min}) \times (60 \text{ min} / 1 \text{ hr}) \times (1 \text{ mi} / 5,280 \text{ ft})$

100. A pesticide label specifies that 1.5 pints of pesticide concentration, mixed with 20 gallons of water, are to be applied per acre. Approximately how many gallons of pesticide concentration are required to treat a 320-acre field?

Note: 128 ounces = 1 gal 16 ounces = 1 pint

- A. 20 gallons
- B. 45 gallons
- C. 60 gallons
- D. 85 gallons

Answer C: $60 \text{ gal} = [(1.5 \text{ pts} / \text{ac}) \times (16 \text{ oz} / \text{pt}) \times (1 \text{ gal} / 128 \text{ oz}) \times (320 \text{ acres})]$

End of Examination

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

**2012 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 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 (diagrams, pictures, tables) 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,
but they 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.

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

**2012 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. 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. A diesel tank has the capacity to hold 95.2 liters of fuel. What is the approximate capacity of the tank in gallons?** Information: 1 liter = 0.26 gallon 1 gallon = 3.79 liters

- A. 15 gallons
B. 25 gallons
C. 85 gallons
D. 365 gallons

$$\text{Gallons} = 95.2 \text{ liters} \times 0.26 \text{ gal / liter} = \underline{24.752 \text{ gallons}}$$

- 2. The torque requirement for a bolt is listed as 4 foot-pounds. If the only torque wrench available is calibrated in inch-pounds, how many inch-pounds are required to equal 4 foot-pounds?**

Information: 1 foot = 12 inches 1 pound = 16 ounces

- A. 0.33 inch-pounds
B. 12 inch-pounds
C. 48 inch-pounds
D. 96 inch-pounds

$$\text{Inch-pounds} = 4 \text{ ft-lbs} \times 12 \text{ in / ft} = \underline{48 \text{ in-lbs}}$$

- 3. If the average weight of wheat is 60 pounds per bushel, approximately how many bushels of wheat can be transported in a rail car with a maximum carrying capacity of 94.2 tons?**

Information: 1 ton = 2000 pounds 1 bushel 2.44 cubic feet

- A. 1,287 bushels
B. 2,162 bushels
C. 3,140 bushels
D. 4,225 bushels

$$\text{bu} = 1 \text{ bu} / 60 \text{ lb} \times 94.2 \text{ T} \times 2000 \text{ lb} / 1 \text{ T} = \underline{3,140 \text{ bu}}$$

- 4. A hydraulic cylinder that operates the arm of a skid steer loader has a bore diameter of 3 inches and a stroke of 36 inches. The tractor's hydraulic system produces a maximum pressure of 2,900 pounds per square inch. Approximately, what is the maximum force the cylinder can exert on the lift arm?**

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

- A. 20,490 pounds
B. 40,640 pounds
C. 60,810 pounds
D. 81,950 pounds

$$\text{Force} = \text{Pressure} \times \text{Area} = 2,900 \text{ lb/in}^2 \times 3.14 \times (3 \text{ in} / 2)^2 = \underline{20,488 \text{ lbs}}$$

- 5. Each cylinder in a six cylinder tractor engine has a bore diameter of 4.1 inches and a piston stroke of 6.4 inches. What is the approximate total displacement of this engine in liters?**

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

- A. 1.4 liters
B. 8.3 liters
C. 33.2 liters
D. 506.7 liters

$$\text{Displacement} = 6 \text{ cyl} \times 3.14 \times (4.1 \text{ in} / 2)^2 \times 6.4 \text{ in} \times (1 \text{ L} / 61 \text{ in}^3) = \underline{8.31 \text{ L}}$$

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

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

SECTION 2: ELECTRICAL SYSTEMS Questions 6-10

6. If each outlet on an electrical circuit theoretically uses 1.5 amperes, approximately how many outlets may safely be installed on a circuit sized to carry a maximum of 20 amperes?

- A. 10 outlets
B. 13 outlets
C. 18 outlets
D. 20 outlets

$$\text{outlets} = 20 \text{ amps} \div 1.5 \text{ amps / outlet} = 13.33 \text{ outlets}$$

7. What is the approximate power consumption (Wattage) of a 120 volt electrical circuit (wired in parallel) with 6 incandescent (resistance) lighting loads, each load using 1.75 amps?

Information: Wattage = Voltage \times Amperage

Voltage = Amperage \times Resistance

- A. 210 Watts
B. 728 Watts
C. 1260 Watts
D. 6448 Watts

$$\text{Watts} = 120 \text{ volts} \times 6 \text{ loads} \times 1.75 \text{ amps / load} = 1260 \text{ Watts}$$

8. The monthly charge to operate an electric pump is 9.5 cents per kilowatt hour (kWh) for the first 1000 hours and 8.25 cents for each kWh greater than 1000 hours. If this pump uses 2669 kWh of electricity during a single month, what is the approximate monthly cost to operate the pump?

Information: 1 kilowatt = 1000 Watts

100 cents = \$1.00

1 hour = 60 minutes

- A. \$ 138
B. \$ 159
C. \$ 233
D. \$ 253

$$\text{\$} = (1000 \text{ hrs} \times \$0.095 / \text{kWh}) + [(2669 \text{ kWh} - 1000 \text{ kWh}) \times \$0.0825 / \text{kWh}] = \$ 232.6925$$

9. The Occupational Safety and Health Administration (OSHA) lists the daily permissible noise level exposure during an eight-hour work day as 90 decibels (dB) followed by at least ten hours of recovery time where the noise level must be at 70 dB or lower. If the noise level is elevated to 95 dB, the daily permissible noise level exposure is limited to 4 hours. The OSHA guidelines indicate that for every 5 dB above the permissible level it reduces the permissible exposure time by 50 percent. Approximately how much time can a person be safely exposed to 92.5 dB?

Information: 50 % = 0.5

8 hours exposure - (8 hours \times 50% reduction) = 4 hours exposure

- A. 6.0 hours
B. 6.5 hours
C. 7.0 hours
D. 7.5 hours

$$\rightarrow (0.5 \text{ reduction} \times 8 \text{ hrs}) / (95 \text{ dB} - 90 \text{ dB}) = ?? \text{ hrs reduction} / (95 \text{ dB} - 92.5 \text{ dB}) \rightarrow 2 \text{ hrs reduction}$$

$$8 \text{ hours exposure} - 2 \text{ hours reduction} = 6 \text{ hours}$$

10. A work environment exposes employees to *Sound 1* for approximately 5 hours and 24 minutes and *Sound 2* for approximately 3 hours and 9 minutes. The safe exposure time for *Sound 1* is 6 hours and *Sound 2* is 7 hours. When the daily noise exposure is composed of two or more periods of noise exposure, the combined effect determines safe exposure levels. What is the approximate Combined Exposure Value for these two sounds? Information: 1 hour = 60 minutes

Sound Exposure Is Safe When: (Exposure Time \div Allowed Exposure Time) = Value that is less than or equal to 1

Sound Exposure Is Unsafe When: (Exposure Time \div Allowed Exposure Time) = Value that is greater than 1

Combined Exposure Value = $(E_1 / T_1) + (E_2 / T_2)$

E_1 = 1st Exposure Time E_2 = 2nd Exposure Time T_1 = 1st Safe Exposure Time T_2 = 2nd Safe Exposure Time

- A. 1.11 CEV
B. 1.26 CEV
C. 1.35 CEV
D. 1.48 CEV

$$\text{CEV} = (5.4 \text{ hrs} / 6 \text{ hrs}) + (3.15 \text{ hrs} / 7 \text{ hrs}) = 1.35 \text{ CEV}$$

www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=9735

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

SECTION 3: ENERGY SYSTEMS Questions 11-15

11. A wattmeter measures 6477 Watts of power being used by a eight horsepower electric motor (induction load), when it is operating at 220 volts and using 32 amps. What is the approximate power factor for this motor? Information: Voltage = Amperage × Resistance
 Wattage of Induction Load = Voltage × Amperage × Power Factor

- A. 0.92 power factor
- B. 0.94 power factor
- C. 0.96 power factor
- D. 0.98 power factor

$$Pf = 6477 \text{ Watts} \div (220 \text{ volts} \times 32 \text{ amps}) = 0.9200$$

12. A portable auger has a 6 inch diameter pulley on the drive shaft and the auger needs to turn at 880 revolutions per minute. The auger will be powered by an electric motor that rotates at 1725 revolutions per minute. 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 × Speed of Pulley 1) = (Diameter of Pulley 2 × Speed of Pulley 2)

- A. 3 inches
- B. 4 inches
- C. 5 inches
- D. 6 inches

$$\text{Diameter} \rightarrow (6 \text{ in} \times 880 \text{ rpms}) = (?? \text{ in} \times 1725 \text{ rpms}) \rightarrow \rightarrow \text{diameter} = 3.0609''$$

13. A waterline that is used 24 hours each 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) 78 ounces, (b) 29 ounces, and (c) 112 ounces. Approximately how many gallons will be lost from the waterline during each day of operation?

Information: 1 gallon = 128 ounces 24 hours = 1 day 60 minutes = 1 hour

- A. 41 gallons per day
- B. 82 gallons per day
- C. 164 gallons per day
- D. 1970 gallons per day

$$[(78 \text{ oz}/30 \text{ min}) + (29 \text{ oz}/30 \text{ min}) + (112 \text{ oz}/30 \text{ min})] \times (60 \text{ min}/1 \text{ hr}) \times (24 \text{ hrs}/\text{day}) \times (1 \text{ gal}/128 \text{ oz}) = 82 \text{ gals}/\text{day}$$

14. The available electronic thermometer is calibrated in degrees Fahrenheit (°F), but the requirements to anneal (soften) a machined part lists the temperature as a range from 32 to 38 degrees Celsius (°C). What is the approximate temperature range for annealing in degrees Fahrenheit?

Information: °F = (9/5 °C) + 32 °C = 5/9 (°F - 32) Water freezes at 32 °F

- A. 0 to 3 °F
- B. 0 to 10 °F
- C. 64 to 70 °F
- D. 90 to 100 °F

$$^{\circ}\text{F range} = (9/5 \text{ } 32^{\circ}\text{C}) + 32 \text{ to } (9/5 \text{ } 38^{\circ}\text{C}) + 32 \rightarrow \rightarrow 89.6 \text{ to } 100.4^{\circ}\text{F}$$

15. An old electrical motor burned out and must be replaced. The old motor operated an average of 8 hours each day, 312 days each year, and its average annual electrical bill was \$14,985. The replacement cost for a motor (identified as A) that is identical to the old motor sells for \$990 dollars and the installation charge is \$285. An energy efficient motor (identified as B) sells for \$1,490 and the installation charge is \$325. Motor B will have an average cost of \$5.87 per hour to operate. Approximately how many months must motor B operate to make up for (payback) the higher cost to purchase and install the energy efficient motor B? Information: 1 year = 12 months 1 day = 24 hours
 Burnout Payback = $\frac{(\text{total cost for high efficient equipment}) - (\text{total cost for identical equipment})}{(\text{average saving in energy cost per month})}$

- A. 1.6 months
- B. 6.5 months
- C. 18.0 months
- D. 19.4 months

$$\text{Payback} = \frac{(\$1,490 + \$325) - (\$990 + \$285)}{(\$14,985/\text{yr} \times 1\text{yr} / 12 \text{ mths}) - (\$5.87/\text{hr} \times 8 \text{ hrs}/\text{day} \times 312 \text{ days}/\text{yr} \times 1\text{yr}/12 \text{ mths})} = 19.4314 \text{ mths}$$

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

SECTION 4: STRUCTURAL SYSTEMS Questions 16-20

16. Which of the following quantities of lumber has the greatest number of board-feet?

Information: 1 board-foot = 144 cubic inches

1 square foot = 144 square inches

- A. 12 boards measuring 2 inches by 4 inches by 10 feet
 B. 10 boards measuring 1 inch by 8 inches by 12 feet
 C. 6 boards measuring 2 inches by 6 inches by 10 feet
 D. 8 boards measuring 1 inch by 12 inches by 12 feet

$$12 \times 2'' \times 4'' \times 10' \times 12''/1 \text{ ft} \times 1 \text{ bd-ft}/144 \text{ in}^3 = 80 \text{ bd-ft}$$

$$10 \times 1'' \times 8 \times 12' \times 12''/1 \text{ ft} \times 1 \text{ bd-ft}/144 \text{ in}^3 = 80 \text{ bd-ft}$$

$$6 \times 2'' \times 6'' \times 10' \times 12''/1 \text{ ft} \times 1 \text{ bd-ft}/144 \text{ in}^3 = 60 \text{ bd-ft}$$

$$8 \times 1'' \times 12'' \times 12' \times 12''/1 \text{ ft} \times 1 \text{ bd-ft}/144 \text{ in}^3 = \underline{96 \text{ bd-ft}}$$

17. Approximately how many sheets of standard sized plywood, three-quarters inch thick, are needed to completely cover a floor measuring 36 feet by 24 feet? Information: Plywood measures 4 feet by 8 feet

- A. 12 sheets of plywood
 B. 17 sheets of plywood
 C. 22 sheets of plywood
 D. 27 sheets of plywood

$$4' \times 8' \text{ sheets} = [(36' \times 24') \div (4' \times 8')] = \underline{27 \text{ sheets}}$$

18. An irregularly shaped metal tank weighs 47 pounds empty. When it is filled with water, the tank and water weighs 440 pounds. Approximately how many gallons of water are required to fill this tank? Information: 1 gallon water = 8.34 pounds 1 gallon = 231 cubic inches

- A. 6 gallons
 B. 47 gallons
 C. 53 gallons
 D. 392 gallons

$$\text{gallons} = (440 \text{ lbs} - 47 \text{ lbs}) \times 1 \text{ gal} / 8.34 \text{ lbs} = \underline{47.122 \text{ gals}}$$

19. A 20-foot length of square tubing is to be cut into 14 pieces of equal length. Both ends of the 20-foot tubing are already cut square (90 degrees) and the 14 pieces will also have square cut (90 degrees) ends. The metal saw being used cuts a kerf (material removed by saw blade) that is 3/16 inch wide. Other than the material lost by the saw kerf, none of the tubing is wasted or unused in cutting the 14 pieces of equal length. What is the approximate length (in feet, inches ~ fraction of an inch) of each piece of the square tubing. Information: 1 foot = 12 inches 3/16 inch = 0.1875 inch

- A. 1 foot, 4~29/32 inches
 B. 1 foot, 4~15/16 inches
 C. 1 foot, 4~31/32 inches
 D. 1 foot, 5~1/32 inches

$$[(20 \text{ feet} \times 12''/\text{ft}) - (13 \text{ cuts} \times 3/16''/\text{cut})] \div 14 \text{ pieces} = 16.96875'' \rightarrow \underline{1 \text{ foot } 4 \sim 31/32 \text{ inches}}$$

$$\rightarrow 1' + 4'' + .96875'' \quad 31/32'' = 0.96875''$$

20. A round concrete column is fabricated using one cubic yard of concrete. If the concrete column is 15 feet in length, what is the approximate diameter of the column?

Information: 1 cubic yard = 27 cubic feet

1 cubic foot = 1728 cubic inches

1 foot = 12 inches

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

$\pi = 3.14$

diameter = (2 × radius)

- A. 0.8 inch diameter
 B. 1.5-inch diameter
 C. 15.7-inch diameter
 D. 18.2-inch diameter

$$1 \text{ yd}^3 = \pi \times [(\text{diameter in inches} \times 1 \text{ ft} / 12 \text{ in}) \div 2]^2 \times 15 \text{ ft} \times (1 \text{ yd}^3 / 27 \text{ ft}^3) \rightarrow \rightarrow$$

$$\text{dia}'' = [1 \text{ yd}^3 \div \pi \div 15 \text{ ft} \times (27 \text{ ft}^3 / 1 \text{ yd}^3)]^{1/2} \times 2 \times 12 \text{ in} / 1 \text{ ft} = \underline{18.1712''}$$

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 hectares are in a rectangular field measuring 1210 feet by 336 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. 3.8 hectares
B. 5.4 hectares
C. 7.6 hectares
D. 9.6 hectares

$$\text{hectares} = (1 \text{ ha} / 2.47 \text{ acres}) \times (1 \text{ ac} / 43,560 \text{ ft}^2) \times 1210' \times 336' = \underline{3.77868 \text{ ha}}$$

22. Use reference sheet A to answer this question. The diagram on reference sheet A shows the perimeter and dimensions of an irregularly shaped pasture. What is the area of the triangular shaped portion of land in the lower right-hand corner that is not part of the irregularly shaped pasture? Information: Area of Triangle = $\frac{1}{2}$ (Base Length \times Height)

1 acre = 43,560 square feet 1 mile = 5,280 feet

- A. 57.9 acres
B. 65.7 acres
C. 73.6 acres
D. 115.8 acres

$$\text{Area of triangle} = 1/2 \times (1700 \text{ ft} \times 2967.5 \text{ feet}) \times (1 \text{ ac} / 43,560 \text{ ft}^2) = \underline{57.90576 \text{ ac}}$$

23. Use reference sheet A to answer this question. The diagram on reference sheet A shows the perimeter and dimensions of an irregularly shaped pasture. What is the area of the rectangular portion of land in the lower left-hand corner that is not part of the irregularly shaped pasture?

Information: Area of Rectangle = length \times width 1 acre = 43,560 square feet 1 mile = 5,280 feet

- A. 98.6 acres
B. 107.7 acres
C. 117.1 acres
D. 129.6 acres

$$\text{Area of rectangle} = 2679.5 \text{ ft} \times 1904 \text{ ft} \times (1 \text{ ac} / 43,560 \text{ ft}^2) = \underline{117.12048 \text{ ac}}$$

24. Use reference sheet A to answer this question. The diagram on reference sheet A shows the perimeter and dimensions of an irregularly shaped pasture. What is the approximate area of the irregularly shaped pasture in sections, given the measurements and other information provided on the diagram? Information: 1 section of land = 640 acres 1 mile = 5,280 feet

Area of Rectangle = length \times width 1 yard = 3 feet 1 acre = 43,560 square feet

- A. 1.1 section
B. 2.2 sections
C. 3.3 sections
D. 4.4 sections

$$[1.8 \text{ mi} \times (5,280 \text{ ft} / \text{mi}) \times (6838.5 \text{ ft} + 2967.5 \text{ ft})] - 57.90576 \text{ ac} - 129.7089 \text{ ac} = 93,196,036.39 \text{ ac}$$

$$93,196,036.39 \text{ ac} \times (1 \text{ ac} / 43,560 \text{ ft}^2) \times (1 \text{ sect.} / 640 \text{ ac}) = \underline{3.342947 \text{ sections}}$$

25. Water flows through 86 feet of pipeline that includes three 90 degree elbows. The water flow rate is 6.5 gallons per minute where the water exits the 86-foot pipeline. The pressure loss through the pipeline is equivalent to 6.2 vertical feet of head (pressure) loss per 100 feet of horizontal run. The head loss through each elbow is equivalent to that of 4.75 feet of additional horizontal length. Approximately, what is the vertical head (pressure) loss for this horizontal pipeline?

- A. 5.3 feet of head loss
B. 6.2 feet of head loss
C. 100.3 feet of head loss
D. 533.2 feet of head loss

$$\text{head loss} = 86 \text{ ft} + (3 \text{ elbows} \times 4.75 \text{ ft} / \text{elbow}) \times (6.2 \text{ ft loss} / 100 \text{ ft}) = \underline{6.2155 \text{ ft}}$$

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**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.

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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.

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Students need a calculator to complete this examination.

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**2013 Written Examination for the
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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: $EFC = \frac{\text{width of implement in feet} \times \text{speed in miles per hour} \times \text{efficiency}}{8.25}$

- 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) x (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:

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

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

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

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Mark all answers on the Scantron form.

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

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

- 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 × Speed of Pulley 1) = (Diameter of Pulley 2 × 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 (°C) is used to measure the temperature during a feed processing operation that requires heating to 200 degrees Fahrenheit (°F). What temperature on the Celsius thermometer is approximately equal to 200 °F?

Information: °F = (9/5 °C) + 32 °C = 5/9 (°F - 32) Water freezes at 32 °F

- A. 93.3 °C
- B. 168.0 °C
- C. 232.5 °C
- D. 392.0 °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 ft³
- B. \$ 0.91 per ft³
- C. \$ 20.32 per ft³
- D. \$ 26.38 per ft³

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

Sample Natural Gas Monthly Bill: September 29, 2013 to October 28, 2013 (29 days)			
NATURAL GAS CONSUMPTION		SERVICE FEES	
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 gallon of water = 8.35 pounds
 1 liter of water = 2.20 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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**2014 Examination for the
National Agricultural Technology and
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ANSWER KEY

Do Not Distribute

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**2014 Written Examination for the
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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?

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

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

$$275 \text{ hp} \times 5252 \div 1000 \text{ rpms} = 1444.3 \text{ ft-lbs}$$

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

$$\begin{aligned} 1 \text{ hr} / 28.5 \text{ km} \times 1.6 \text{ km} / 1 \text{ mi} \times 29.5 \text{ mi} &= 1.65614 \text{ hrs} \\ \rightarrow 60 \text{ min/hr} \times 0.65614 \text{ hrs} &= 39.3684 \text{ minutes} \\ 1 \text{ hour and } 39.4 \text{ minutes} \end{aligned}$$

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

$$195 \text{ ac} \times 96.5 \text{ bu/ac} \times 64.2 \text{ lbs/bu} \times \$0.142 / \text{lb} = \$171,547.857$$

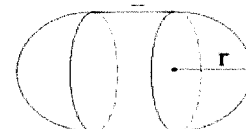
4. The center section of a fuel storage tank has a cylindrical shape (capsule) that is 6.5 feet long with an inside diameter of 3.5 feet. Each end of the tank has a half-sphere shape (two halves of a sphere), each with an internal radius of 21 inches. What is the approximate total storage capacity of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

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

$$\text{Volume of Sphere} = 4/3 \times (\pi) \times (\text{radius})^3$$

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

$$\begin{aligned} \text{Cylinder Volume} &= (3.14) \times (3.5' \times 12''/1' + 2)'^2 \times (6.5' \times 12''/1') = 108009.72 \text{ in}^3 \\ \text{Sphere Volume} &= 4/3 \times (3.14) \times (21'')^3 = 38,772.72 \text{ in}^3 \\ \rightarrow \rightarrow (108009.72 \text{ in}^3 + 38,772.72 \text{ in}^3) \times (1 \text{ gal} / 231 \text{ in}^3) &= 635.4218182 \text{ gal} \end{aligned}$$



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?

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

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

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

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

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

$$8 \text{ cyl} \times 3.14 \times (4.75 \text{ in} / 2)^2 \times 5.9 \text{ in} \times (1 \text{ L} / 61 \text{ in}^3) = 13.70468 \text{ L}$$

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

$$120 \text{ volts} \times 1.5 \text{ amps/load} \times 24 \text{ loads} \times 8 \text{ hrs/day} \times 28 \text{ days/mth} \times 12 \text{ mths/yr} \times 1 \text{ kWh} / 1000 \text{ Watts} \\ = 11.612,16 \text{ kWh}$$

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 × ??? 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 × 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

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

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 \times Resistance 1kilowatt = 1000 hours
Wattage = Voltage \times Amperage \times Power Factor

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

$$Pf = 5900 \text{ Watts} \div (230 \text{ volts} \times 28 \text{ amps}) = 0.916149$$

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

$$250 \text{ horsepower} - |250 \text{ hp} \times 7150 \text{ ft} \times (0.025 / 1000 \text{ ft})| = 205.3125 \text{ hp}$$

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

$$[(119 \text{ oz} + 46 \text{ oz} + 91 \text{ oz}) \div 30 \text{ min}] \times (60 \text{ min}/1 \text{ hr}) \times (10 \text{ hrs}/\text{day}) \times 30 \text{ days} \times (1 \text{ gal}/128 \text{ oz}) = 1200 \text{ gals} / 30 \text{ days}$$

14. An available electronic thermometer is calibrated in degrees Celsius ($^{\circ}\text{C}$), but the requirements to sterilize agricultural testing equipment specify 100 degrees Fahrenheit ($^{\circ}\text{F}$) for 30 minutes. What is the approximate temperature equivalent in degrees Celsius?

$^{\circ}\text{F} = (9/5 ^{\circ}\text{C}) + 32$ $^{\circ}\text{C} = 5/9 (^{\circ}\text{F} - 32)$ Water freezes at 32°F Water boils at 212°F

- A. 37.8 $^{\circ}\text{C}$
B. 45.6 $^{\circ}\text{C}$
C. 51.0 $^{\circ}\text{C}$
D. 73.0 $^{\circ}\text{C}$

$$^{\circ}\text{C} = 5/9 \times (100^{\circ}\text{F} - 32) = 37.777778^{\circ}\text{C}$$

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

1 year = 365 days 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

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

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

$$\begin{aligned} 19.5' \times \$1.83 / \text{ft} &= \$35.685 \\ 15.5' \times \$1.61 / \text{ft} &= \$24.955 \\ 12' \times \$2.94 / \text{ft} &= \$35.28 \\ \text{Total} &= \$95.92 \end{aligned}$$

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

$$\begin{aligned} 24 \times 1'' \times 8'' \times 14' \times 12''/1 \text{ ft} \times 1 \text{ bd-ft}/144 \text{ in}^3 &= 224 \text{ bd-ft} \\ 27 \times 2'' \times 4'' \times 12' \times 12''/1 \text{ ft} \times 1 \text{ bd-ft}/144 \text{ in}^3 &= 216 \text{ bd-ft} \\ 22 \times 2'' \times 6'' \times 10' \times 12''/1 \text{ ft} \times 1 \text{ bd-ft}/144 \text{ in}^3 &= 220 \text{ bd-ft} \\ 20 \times 1'' \times 8'' \times 16' \times 12''/1 \text{ ft} \times 1 \text{ bd-ft}/144 \text{ in}^3 &= \underline{213.4 \text{ bd-ft}} \end{aligned}$$

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?

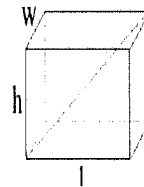
1 gallon = 231 cubic inches

1 gallon water = 8.34 pounds

1 cubic-foot = 1728 cubic-inches

Volume of rectangular prism = Length \times Width \times Height

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



Picture of rectangular prism

$$\begin{aligned} (3604 \text{ lbs} - 798 \text{ lbs}) \times 1 \text{ gal} / 8.34 \text{ lbs} \times 231 \text{ in}^3 / \text{gal} \times 1 \text{ ft}^3 / 1728 \text{ in}^3 &= 44.97693512 \text{ ft}^3 \\ \rightarrow 44.97693512 \text{ ft}^3 &= 7.5' \times 3.75' \times \text{length in feet} \rightarrow \text{L} = 1.599179915' \end{aligned}$$

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

$$\begin{aligned} [(21 \text{ feet} \times 12''/\text{ft}) - (12 \text{ cuts} \times 5/32'' / \text{cut})] \div 13 \text{ pieces} &= 19.24038462'' \\ \rightarrow 1 \text{ foot } 7 \text{ inches} + 0.24038462 \text{ inch} &\rightarrow 1/4'' = 0.25'' \\ \rightarrow 1' 7 \sim 1/4'' & \end{aligned}$$

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

$\pi = 3.14$

diameter = (2 \times radius)

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

$$\begin{aligned} 5.8 \text{ yd}^3 &= 3.14 \times (40'' \div 2 \times 1' / 12'')^2 \times \text{height ft} \times (1 \text{ yd}^3 / 27 \text{ ft}^3) \\ \text{height} &= 5.8 \text{ yd}^3 \div [3.14 \times (1.666667)^2 \times (1 \text{ yd}^3 / 27 \text{ ft}^3)] = \underline{17.95414013'} \end{aligned}$$

You may write on this exam, but information written on this exam is not graded.

Mark all answers on the Scantron form.

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 \times 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

$$1109 \text{ m} \times 1 \text{ ft} / 0.3048 \text{ m} \times 928 \text{ yds} \times 3 \text{ ft} / 1 \text{ yd} \times 1 \text{ ac} / 43,560 \text{ ft}^2 = 232.5401474$$

22. Use reference **Page B** 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 \times Width

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

$$34' \times 42' - (16' \times 2' \times 10 \text{ walls}) - (42' \times 2' \times 1 \text{ center wall}) \\ 1428 \text{ ft}^2 - 320 \text{ ft}^2 - 84 \text{ ft}^2 = 1024 \text{ ft}^2$$

23. Use reference **Page B** 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 \times Width

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

$$42' \text{ of center wall} \times 3 \text{ blocks tall} = 126' \text{ length of blocks for push wall} \\ 16' / \text{side wall} \times 10 \text{ walls} \times 2 \text{ blocks tall} = 320' \text{ length of blocks for side walls} \\ 446' \text{ Total length of blocks} \div 4' / \text{block} = 111.5 \text{ blocks}$$

24. Use reference **Page B** 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 \times Width \times 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

$$\text{Volume inside walls } 8' \times 16' \times 4' \times 1 \text{ yd}^3 / 27 \text{ ft}^3 = 18.96 \text{ yd}^3$$

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

$$\text{Easiest Way: Let } Q \text{ be unknown quantity of manure. } 0.28 Q + 0.72 Q = 1.00 Q \\ (Q \times 0.28 \text{ solids}) + [(0.72 \text{ liquids} \times Q) - (0.72 \times Q \times 0.30)] \\ 0.28 Q + 0.72 \times Q - 0.216 \times Q \\ 0.28 Q + 0.504 Q = 0.784 Q \rightarrow 0.28 Q / 0.784 Q \rightarrow 0.3571428571 \text{ Solids} \\ \text{OR} \\ 0.28 \div \{0.28 + [(0.72 - (0.72 \times 0.30))]\} = 0.3571428571 \text{ or } 35.7 \%$$

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