WELDING INSPECTION TECHNOLOGY Sample CWI Fundamentals Examination

FIFTH EDITION

Published By
American Welding Society
Education Services

American Welding Society

F1 Which of the following metals cannot be efficiently cut with OFC?

a. high-carbon steel
b. low-carbon steel
c. stainless steel
d. cast iron
e. tempered steel

F2 Electrical conductivity of a part is the primary requirement for which NDE method?

a. ET
b. UT
c. PT
d. RT
e. VT

F3 The melting point of carbon steel is approximately:

a. 2250°F
b. 2375°F
c. 2780°F
d. 3005°F
e. 3333°F

F4 Decibel is a term associated with which NDE method?

a. UT
b. RT
c. MT
d. PT
e. ET

F5 Which GMAW metal transfer mode results in the least amount of penetration?

a. globular
b. short circuiting
c. spray
d. pulsed spray
e. globular spray

F6 Which of the following gas(es) is commonly used as a shielding gas for GTAW?

a. argon
b. carbon dioxide
c. oxygen
d. argon/carbon dioxide
e. Tri-mix

F7 After a rejected weld has been repaired, reinspected and found to be acceptable, the welding inspector should:

a. change the original inspection report to indicate the part's acceptance
b. mark directly on the part
c. fill out a second inspection report
d. tell the foreman to have the part moved to its next operation
e. no further action is required

F8 When a metal is alloyed, how are the atoms of the alloy incorporated into the original metal lattice structure?

a. by inclusion or exclusion
b. substitutionally or interstitially
c. by diffusion
d. by becoming martensitic
e. by casting

F9 A wire IQI is used in which NDE method?

a. UT
b. ET
c. RT
d. MT
e. PT

F10 In general, which of the following is not commonly used as a semiautomatic process?

a. GMAW
b. FCAW
c. SMAW
d. SAW
e. MIG

F11 The performance of which of the following test methods is least affected by high part temperatures?

a. ET
b. RT
c. PT
d. UT
e. VT

F12 Crater cracks are most often the result of:

a. improper technique
b. improper filler metal
c. improper base metal
d. trapped slag
e. trapped hydrogen

F13 The tail of a welding symbol should not be used for:

a. denoting welding process requirements
b. denoting welding procedure requirements
c. denoting welding electrode requirements
d. denoting welding specification requirements
e. denoting groove angle

F14 During tempering, as the temperature increases, which of the following are correct?

a. hardness increases
b. hardness decreases
c. elongation decreases
d. strength increases
e. ductility decreases

F15 In GMAW, the distance from the end of the contact tube to the arc is:

a. arc length
b. electrode extension
c. stickout
d. stand off
e. work angle

F16 Of the following, which is not a type of metal transfer in GMAW?

a. spray
b. short circuiting
c. globular
d. pulsed arc
e. open circuiting

F17 Ultraviolet light may be used with which NDE methods?

a. VT and UT
b. PT and UT
c. MT and PT
d. RT and UT
e. ET and MT

F18 The technique which does not aid in reducing residual stress is:

a. peening
b. vibratory stress relief
c. thermal stress relief
d. external restraint
e. preheating

F19 Which of the following may not be detected with VT?

a. large surface crack
b. undercut
c. overlap
d. underfill
e. Lamellar tear

F20 Heat treatment conditions can be determined using which of the following?

a. MT
b. PT
c. ET
d. RT
e. LT

F21 Of the following tests, which can be used for the actual determination of a material's toughness?

a. Charpy test
b. MT
c. chemical analysis
d. tensile test
e. bend test

F22 Which of the following elements are commonly used as alloying elements with tungsten to produce GTAW electrodes?

a. cesium
b. thorium
c. columbium
d. vanadium
e. chromium

F23 For single bevel-groove weld symbols, the line of the AWS weld symbol running perpendicular to the reference line is always drawn on which side of the weld symbol?

a. on the right
b. on the left
c. on either side, depending on company policy
d. on the side in which the straight side actually appears in the joint
e. does not matter

F24 The portion of the groove face within the joint root is called:

a. weld interface
b. faying surface
c. groove weld edge
d. root face
e. groove angle

F25 Which of the following are common cases of undercut when using SMAW?

a. weld current too high
b. improper electrode manipulation
c. welding electrode too large
d. improper electrode angle
e. all of the above

F26 NDE technicians are usually qualified in accordance with the requirements of:

a. AWS D1.1
b. API 1104
c. ASNT SNT-TC-1A
d. ASME Section VIII
e. ASME Section IX

F27 Which of the factors listed below has the least amount of effect on the residual stress and distortion that results from welding?

a. heat input
b. phase changes
c. welding position
d. tensile strength
e. coefficient of thermal expansion

F28 Capillary action plays a role in which NDE method?

a. ET
b. UT
c. RT
d. PT
e. MT

F29 If a welder is continually turning out rejectable work, the welding inspector should:

a. inspect his work more critically
b. ask that the welder be fired
c. require that the welder be retested for qualification
d instruct the welder in the proper techniques
e. ask that the welder use another process

F30 Which of the following tests would be least effective for judging the soundness of a weld in the as-welded condition?

a. nick break
b. side bend
c. face bend
d. radiography
e. straight beam UT

F31 Arc blow can not be caused by:

a. magnetic field distortion
b. improper worklead (ground) location
c. welding at the end of a joint
d. welding in corners
e. welding on AC

F32 Which of the following shielding gases is used for GMAW spray transfer on steel?

a. carbon dioxide—100%
b. argon—100%
c. helium—100%
d. oxygen—2%, argon—98%
e. argon 75%, carbon dioxide—25%

F33 Developing is one of the steps in which NDE method?

a. UT and ET
b. RT and PT
c. PT and MT
d. MT and ET
e. VT and PT

F34 Which discontinuity below will provide the sharpest MT indication?

a. surface porosity
b. surface crack
c. subsurface porosity
d. subsurface crack
e. indications will be identical for all of the above

F35 In SMAW, an increase in arc length results in:

a. increased current; increased voltage
b. decreased current; increased voltage
c. increased heat input; decreased voltage
d. decreased current; decreased voltage
e. decreased current; increased heat input

F36 Weld inspection reports should always:

a. be completed in ink, or typewritten and signed
b. be done in pencil so mistakes can be easily corrected
c. be filled out only if the weld is rejected
d. retyped by a clerk so that everything is readable
e. include the welder's identification

F37 The ability to be cyclically loaded without failing is related to which of the following properties of a metal?

a. hardness
b. toughness
c. tensile strength
d. fatigue strength
e. ductility

F38 In GMAW, the type of metal transfer requiring a special power source is:

a. spray
b. globular
c. pulsed arc
d. short circuiting
e. open arc

F39 Which of the following is truly a volumetric test method?

a. RT
b. UT
c. VT
d. MT
e. PT

F40 Use of preheat will result in:

a. a faster cooling rate and wider heat-affected zone
b. a faster cooling rate and narrower heat-affected zone
c. a slower cooling rate and wider heat-affected zone
d. a slower cooling rate and narrower heat-affected zone
e. none of the above

F41 Which of the following methods is most likely to use a transducer to scan for flaws?

a. RT
b. MT
c. UT
d. PT
e. VT

F42 For plain carbon steels, how are hardness and tensile strength related?

a. increase hardness; decrease tensile strength
b. increase hardness; increase tensile strength
c. decrease hardness; increase tensile strength
d. hardness and tensile strength can both be increased by tempering
e. hardness and strength are not related

F43 In GMAW, the welding variable controlled by the wire feed speed is:

a. arc length
b. voltage
c. current
d. stickout
e. travel speed

F44 The welding variables used to calculate heat input are:

a. voltage and current
b. current and travel speed
c. voltage, current and travel speed
d. travel speed, preheat temperature and voltage
e. voltage, current and preheat temperature

F45 As the temperature of the base metal is increased:

a. impact strength decreases
b. tensile strength decreases
c. ductility decreases
d. hardness increases
e. tensile strength increases

F46 During RT, which of the following provides the best protection from radiation for a given thickness?

a. lead shielding
b. steel shielding
c. concrete shielding
d. copper shielding
e. wood shielding

F47 A weld inspection plan should be developed:

a. before welding begins
b. during welding
c. after welding is completed
d. before shipping the work
e. only when there is a problem

F48 If the weld symbol straddles the reference line, it means:

a. weld both sides
b. weld arrow side first
c. weld other side first
d. weld has no side significance
e. the symbol was drawn incorrectly

F49 Which of the following represents the proper eye protection for SAW?

a. a welding helmet with filter lens of the appropriate shade
b. clear safety glasses
c. no eye protection is required because there is no visible arc
d. tinted safety glasses
e. a full face shield with a shade #5 minimum

F50 An E7018 SMAW electrode exhibits which of the following characteristics?

a. low hydrogen; use on AC only; iron powder
b. low hydrogen; use on AC and DCEN
c. low hydrogen; AC and DCEP; iron powder
d. rutile; DCEP
e. rutile; DCEP; iron powder

F51 Piezoelectricity is a material property used by which NDE method?

a. UT
b. ET
c. RT
d. MT
e. PT

F52 A thermal treatment that follows quenching and restores some of the metal's ductility is referred to as:

a. stress relief
b. tempering
c. hardening
d. normalizing
e. postheat

F53 Which of these methods is most often used to eliminate the high residual stress created by welding?

a. prebending
b. shot blasting
c. quenching rapidly after welding
d. postweld heat treating
e. preheating

F54 The physical principle that permits the migration of liquid penetrant into very fine surface discontinuities is:

a. magnetic permeability
b. optical fluorescence
c. capillary action
d. emulsification
e. solubility

F55 The process whereby a large gap is filled with braze material without the help of capillary action is:

a. torch brazing
b. arc brazing
c. braze welding
d. dip brazing
e. flow brazing

F56 Which of the following contains ferrous base metal specifications?

a. AWS D1.2
b. ASME Section II, Part C
c. AWS A5.1
d. ASME Section V
e. ASME Section II, Part A

F57 Which of the following is considered to be the most portable method of magnetization when conducting a magnetic particle test?

a. AC coil
b. AC yoke
c. DC coil
d. DC prod
e. Head Shot

F58 Advantages of MT include:

a. the detection of surface flaws
b. both AC and DC methods
c. the detection of surface flaws tightly closed by carbon, slag or contaminants
d. the fact that it is faster than PT
e. all of the above

F59 In general, an increase in the carbon equivalent of a carbon steel will result in an increase in its:

a. ductility
b. hardness
c. defects
d. toughness
e. all of the above

F60 A welding process commonly used to join light gage stainless steel tubing for critical applications is:

a. SMAW
b. GMAW
c. GTAW
d. OFW
e. FCAW

F61 Hydrogen in the molten weld metal can cause:

a. undercut and overlap
b. cracking and porosity
c. incomplete penetration and incomplete fusion
d. porosity and slag inclusions
e. hydrogen will diffuse during welding and will not cause problems

F62 Which of the following results from improper termination of the SMAW electrode and shrinking of the molten weld pool during welding?

a. porosity
b. slag inclusions
c. delayed cracking
d. crater cracking
e incomplete fusion

F63 Entrapped slag can result when using all of the following except:

a. SMAW
b. SAW
c. FCAW
d. ESW
e. GMAW

F64 The material property that best describes its ability to withstand a static load is:

a. hardness
b toughness
c. tensile strength
d fatigue strength
e. torsional strength

F65 The presence of paint on the surface of a part will most greatly affect the results of which NDE method?

a. PT and MT
b. RT and UT
c. MT and ET
d. UT and ET
e. ET and VT

F66 If no information appears to the left of a groove weld symbol, this means:

a. no weld is required on that side
b. the weld is to be complete joint penetration
c. the weld is to be continuous for the entire length of the joint
d. bevelling is not required
e. weld size is to be determined by the welder

F67 Which of the following is not easily detected using RT that is perpendicular to the weld center line?

a. throat crack
b. porosity
c. side wall incomplete fusion at a bevel angle of 35°
d. a crack with its depth parallel to radiation beam
e. incomplete joint penetration

F68 Dwell time is a term associated with which NDE method?

a. MT
b. PT
c. RT
d. ET
e. UT

F69 The material property expressed in terms of an endurance limit is:

a. fatigue strength
b. toughness
c. tensile strength
d. ductility
e. hardness

F70 Fracture toughness results will often be expressed in terms of:

a. breaking energy
b. tensile strength
c. percent elongation
d. endurance limit
e. reduction of area

F71 Shielding of the molten pool in OFW is accomplished by:

a. a granular flux
b. a chemical reaction
c. an inert gas
d. a vacuum chamber
e. a flux paste

F72 The welding inspector is usually not responsible for which of the following?

a. checking for proper electrode storage
b. verification of a welder's qualification
c. witnessing all repairs
d. reinspecting repairs
e. checking fit up

F73 The last digit of an SMAW electrode designation is an indication of:

a. tensile strength of the weld deposit
b. position the welder is qualified to weld in
c. Operating characteristics
d. impact strength of the weld deposit
e. position suitable for electrode use

F74 ET can be used to detect which of the following?

a. a material's conductivity
b. a material's hardness
c. a thin material's thickness
d. a material's heat treatment
e. all of the above

F75 For an SMAW electrode designation **E60X3** the "X" refers to:

a. the tensile strength of the weld deposit
b. the position in which the electrode can be used
c. the type of coating
d. the recommended type of current
e. flux chemistry

F76 The property of a material that best relates to its resistance to impact loading is:

a. endurance limit
b. fatigue strength
c. fracture toughness
d. tensile strength
e. ductility

F77 Of the following discontinuities, which is most likely to be a flaw caused during the manufacture of steel?

a. porosity
b. lamination
c. undercut
d. crack
e. inclusion slag

F78 Which of the following is considered to be an advantage of VT?

a. discontinuities can be located and noted when they occur
b. it is capable of detecting subsurface discontinuities
c. welders can accept their own work
d. equipment can be expensive
e. it can determine material strength

F79 Which of the following is considered to be part of the welding inspector's responsibility to the public?

a. undertaking only those assignments for which the inspector is qualified
b. making public statements as to the quality of a weldment
c. signing for all inspections on the job
d. reporting all discontinuities
e. verify conformance based on past experience

F80 Which of the following processes is performed primarily in the flat and horizontal positions?

a. SAW
b. OAW
c. GTAW
d. GMAW-S
e. SW

F81 A groove weld symbol with no information appearing to the right means:

a. the weld is to be complete joint penetration
b. no weld is required on that side
c. the weld is to be continuous for the entire joint length
d. no weld joint preparation is required
e. weld length can be determined by the welder

F82 The welding process that requires a tubular electrode is:

a. SMAW
b. GMAW
c. FCAW
d. SAW
e. ESW

F83 The property relating to a metal's resistance to indentation is:

a. tensile strength
b. ductility
c. hardness
d. toughness
e. fatigue strength

F84 LT is the abbreviation for:

a. leak testing
b. liquid penetrant testing
c. liquid test inspection
d. lithium testing
e. lender test method

F85 Filler metal specifications are found in which of the following documents?

a. AWS A5.1 through A5.30
b. ASME Section II, Part A
c. AWS A3.0
d. AWS A2.4
e. AWS D1.1 Section 2

F86 The flux covering on an SMAW electrode provides which of the following?

a. gas shielding for the molten pool
b. arc stabilization
c. alloying
d. deoxidation
e. all of the above

F87 When a weld joint preparation is found to be defective, the inspector should:

a. allow welding to proceed if he feels that the welder can produce a satisfactory weld
b. instruct the welder in how to overcome the problem
c. report the deficiency to the proper supervisory personnel
d. require that the parts be disassembled and properly assembled
e. none of the above

F88 The orientation of the probing energy source with respect to that of a flaw is considered to be a significant variable for which NDE method?

a. RT
b. UT
c. ET
d. MT
e. all of the above

F89 Information that appears to the left of the weld symbol refers to:

a. the weld length
b. the weld size
c. the electrode size
d. the number of passes required
e. none of the above

F90 Which process uses a granular flux that can be manually added to the weld pool?

a. SMAW
b. GTAW
c. ESW
d. SW
e. FCAW

F91 Of those microstructural constituents listed below, the hardest is:

a. martensite
b. ferrite
c. bainite
d. austenite
e. pearlite

F92 In radiography, the image on the film of a completely through-cracked weld will:

a. appear as a well-defined, low density, lightly shaded, sharp line
b. appear as a well-defined, high density, darkly shaded, sharp line
c. appear as a row of low density light spots or dots
d. appear as a row of high density dark spots or dots
e. appear as a white line

F93 A material's ductility is commonly expressed in terms of:

a. percent elongation and reduction of area
b. width and thickness
c. tensile strength and yield strength
d. toughness
e. fatigue

F94 Who is responsible for verifying welding procedures have been properly qualified?

a. independent test lab
b. contractor
c. welding inspector
d. architect
e. engineer

F95 What MT technique could be used for the discovery of longitudinal flaws?

a. coil shot
b. circular magnetization
c. longitudinal magnetization
d. parallel magnetism
e. using a central conductor

F96 Which code gives prequalified status to certain weld joint configurations?

a. API 1104
b. AWS D1.1
c. AWS D17.1
d. ANSI B31.1
e. AWS B2.1

F97 Information that appears to the right of the weld symbol refers to the:
- a. process to be used
- b. type of electrode to be used
- c. length of weld required
- d. size of weld required
- e. required joint configuration

F98 When a clerical mistake is made while completing an inspection report, the inspector should:
- a. erase the error and fill in the correct information
- b. cross out the error and supply the proper information
- c. line out the error with a single line, supply the proper information, and initial and date the occurrence in ink
- d. attach a note to the report explaining the reason for the change
- e. erase the error or use white out, initial, and date the occurrence in black ink

F99 The rapid quenching of a high carbon steel from the austenitizing range will result in the formation of:
- a. pearlite
- b. martensite
- c. cementite
- d. ferrite
- e. austenite

F100 When an austenitized carbon steel is cooled to room temperature, an increase in the cooling rate will result in:
- a. an increase in hardness and a decrease in ductility
- b. an increase in tensile strength and a decrease in hardness
- c. a decrease in tensile strength and an increase in hardness
- d. an increase in ductility and a decrease in hardness
- e. a decrease in hardness and an increase in ductility

F101 Which of the following is least affected by the surface finish of the specimen?
- a. tensile strength
- b. fatigue strength
- c. impact strength
- d. nick break test
- e. macroetch

F102 The heat treatment in which a carbon steel's temperature is raised to the austenitizing range, held for a prescribed time and then allowed to cool to room temperature while remaining in the furnace is referred to as:
- a. stress relief
- b. annealing
- c. normalizing
- d. tempering
- e. austenitizing

F103 In which direction does a rolled plate of carbon steel usually exhibit its least amount of ductility?
- a. parallel to the rolling direction
- b. transverse to the rolling direction
- c. in the through thickness direction
- d. in the direction of welding
- e. rolling direction has no significance regarding ductility

F104 When a weld has been rejected by a qualified NDE technician, the welding inspector should:
- a. review the test results and maintain the test record
- b. reinspect to verify the defect
- c. accept the weld if its visual appearance is in compliance with the applicable code or specification
- d. require another inspection by a third party
- e. accept the weld since it is in a low stress region

F105 If equal thicknesses of steel, cast iron, aluminum, lead, and copper are radiographed using the same exposure conditions, which material will result in the darkest radiograph?
- a. lead
- b. steel
- c. aluminum
- d. copper
- e. cast iron

F106 The welding process that uses a nonconsumable electrode is:
- a. GMAW
- b. SAW
- c. GTAW
- d. FCAW
- e. SMAW

F107 The heat treatment in which the metal's temperature is raised to the austenitizing range, held for a prescribed time and then allowed to cool to room temperature in still air is referred to as:
- a. austenitizing
- b. normalizing
- c. annealing
- d. quenching
- e. tempering

F108 In a guided bend test, the bend radius is:
- a. always 5 in.
- b. as specified in the appropriate code or specification
- c. 0.5 in.
- d. 0.65 in.
- e. as stated on the MTR

F109 An E71T-1 electrode designation is for which welding process?
a. PAW
b. FCAW
c. SMAW
d. GMAW
e. SAW

F110 The AWS Certified Welding Inspector is responsible for:
a. welding
b. performing PT
c. positively identifying base materials
d. supervising welding
e. determining the disposition of a radiographed part

F111 A break in the arrow line of a welding symbol has what significance?
a. Welding must first be done on the arrow side
b. Welding must first be done on the other side
c. Welding must be done alternately on both the arrow and the other sides
d. The broken arrow line segment points to that member which receives preparation
e. an intermittent weld is required

F112 It is discovered that a GMAW mild steel weld was produced with a shielding gas containing excess moisture. To determine the extent of the surface and subsurface porosity that resulted, which NDE method would be most effective?
a. MT
b. RT
c. VT
d. PT
e. ET

F113 Which welding process utilizes a vertical joint orientation with welding occurring in the flat position?
a. ESW
b. SAW
c. SMAW
d. FCAW
e. OFW

F114 The heat treatment for carbon steels in which the metal's temperature is raised to just below the lower transformation temperature and held for a prescribed time before allowing it to cool at a controlled rate is referred to as:
a. tempering
b. austenitizing
c. stress relieving
d. normalizing
e. preheating

F115 The position on a metal's stress-strain curve referring to its change in behavior from elastic to plastic is the:

a. yield point
b. modulus of elasticity
c. endurance limit
d. transformation temperature
e. Young's Modulus

F116 Low-hydrogen electrodes can be properly identified by which digit of a classification number?

a. first digit
b. second digit
c. first and second together
d. second to last digit
e. last digit

F117 All welding symbol information referring to the arrow side of the joint is found:

a. in the tail
b. above the reference line
c. below the reference line
d. in a note
e. to the left of the weld symbol

F118 The marking of a rejectable weld should:

a. be clear and understandable to all involved
b. be made with a steel impression stamp
c. note the proper repair procedure
d. always be in red
e. always include the welder's identification

F119 MT can be used effectively to inspect which of the following metals?

a. welds on A36 steel
b. steel welds on stainless steel plate
c. welds on aluminum
d. Welds on all alloy materials
e. materials properly qualified for use with E308 electrodes

F120 Of the welding processes listed below, the one most commonly having the highest deposition rate is:

a. OAW
b. FCAW
c. SAW
d. SMAW
e. GMAW

F121 The use of preheat on a medium carbon steel weld test plate will perform all of the following except:

a. reduce distortion
b. reduce the possibility of hydrogen cracking
c. result in the formation of martensite
d. produce a wide heat-affected zone
e. diffuse hydrogen

F122 The tensile test can be used to provide values for which of the following?

a. yield point
b. ultimate tensile strength
c. modulus of elasticity
d. elastic limit
e. all of the above

F123 Which of the following is not an acceptable method for control of raw materials?

a. color coding
b. alpha-numeric coding
c. first in, first out
d. location segregation
e. bar coding

F124 In what document are the duties and responsibilities of a CWI described?:

a. AWS D1.1
b. AWS A3.0
c ANSI Z49.1
d. AWS QC-1
e. AWS QC-7

F125 All welding symbols require which of the following basic elements in their construction?

a. reference line, arrow, and tail
b. reference line and arrow
c reference line, arrow, and weld symbol
d. reference line, arrow, weld symbol, dimensions, and supplementary data
e. reference line only

F126 The size of the weld represented in Figure 1:

a. is not important
b. cannot be determined directly from the symbol
c. can be determined from the symbol
d. is not specified therefore may be determined by the welder
e. must be found in the WPS

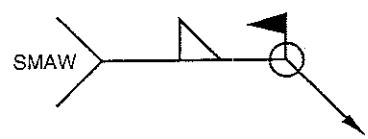


Figure 1

F127 Welding symbol information provided in Figure 1 requires:
- a. field welding
- b. weld-all-around
- c. a fillet weld
- d. the use of shielded metal arc welding
- e. all of the above

F128 A SMAW weld was produced in which the welder failed to properly clean between passes in a multipass weld. Which nondestructive test would best reveal the flaws that may be present in the completed weld?
- a. RT
- b. VT
- c. MT
- d. PT
- e. ET

F129 SMAW is typically used in which type of application?
- a. semiautomatic
- b. machine
- c. manual
- d. automatic
- e. mechanical

F130 What position is depicted in Figure 2?
- a. 6G
- b. 5G
- c. 6F
- d. 6GR
- e. 5GR

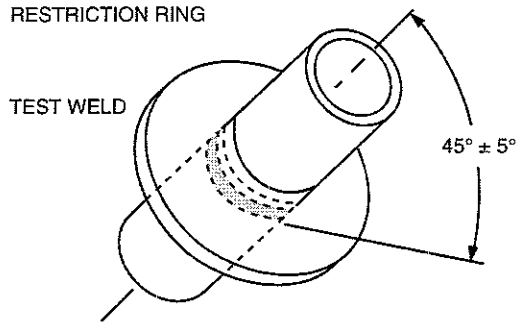


Figure 2

F131 Using the appropriate conversion factor provided in the chart on page 41, determine the approximate diameter in inches for an electrode that measures 1.2 mm.
- a. 0.047 in.
- b. 4.7 in.
- c. 0.0047 in.
- d. 0.47 in.
- e. 47.2 in.

F132 Underbead cracking is primarily caused by:
- a. a source of hydrogen
- b. restraint
- c. excessive preheat
- d. fatigue
- e. excessive loading

F133 Which of the following is a correct statement about brazing?

a. the base metal is not melted
b. the filler metal melts at a temperature below 800°F
c. it must be done in an inert gas atmosphere
d. in order to achieve capillary action large root opening is required
e. inert gases may be substituted for oxygen

F134 Which of the following welding processes commonly use a constant current power source?

a. GMAW and FCAW
b. SMAW and GTAW
c. GTAW and GMAW
d. FCAW and SMAW
e. SAW and SMAW

F135 The first operation required by the symbol in Figure 3 is:

a. ultrasonic inspection of the base metal
b. visual inspection of joint preparation
c. welding a V-groove from the other-side of the joint
d. welding a backing weld from the arrow-side of the joint
e. backgouging and back welding from the arrow-side of the joint

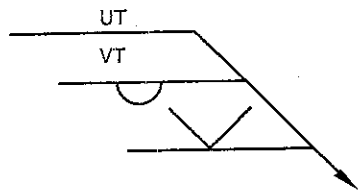


Figure 3

F136 For Figure 3, ultrasonic inspection is to be performed:

a. on the back weld only
b. on the entire length of the other side weld
c. on 10% of the weld length
d. from the arrow side
e. on the single V groove, from the arrow side

F137 Which of the following discontinuities are associated with shrinkage stresses in the through thickness direction of thick plate?

a. crater cracks
b. lamellar tears
c. toe cracks
d. root cracks
e. none of the above

F138 Which of the welding techniques below describes a welding process in which the filler metal feeding is machine operated while the joint travel speed and guidance are the responsibility of the welder?

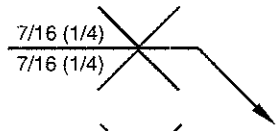
a. semiautomatic
b. manual
c. machine
d. automatic
e. mechanized

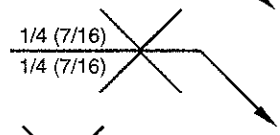
F139 The welding symbol shown in Figure 4 depicts:

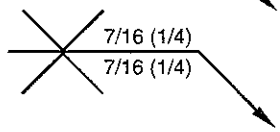
a. a backing weld other-side followed by a V-groove weld arrow-side
b. a V-groove weld arrow-side followed by a back weld other-side
c. a V-groove weld arrow-side with melt-through
d. a bevel groove weld made one-half the way around the diameter of a pipe
e. a V-groove weld arrow-side with the root finished to a convex contour

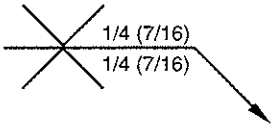
Figure 4

F140 Which of the following symbols correctly describes the joint configuration shown in Figure 5?

a.


b.


c.


d.


e. none of the above

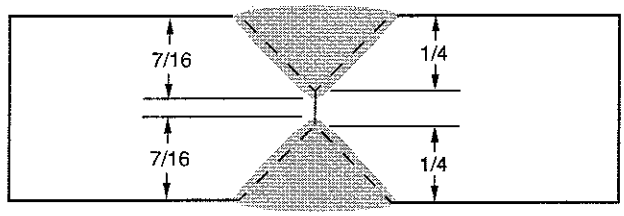


Figure 5

F141 The width of the cut produced during a cutting process is referred to as:

a. root opening
b. kerf
c. bevel
d. bevel angle
e. chamfer

F142 For the 2G position in pipe welding:

a. the axis of the pipe is vertical and the plane of the weld is horizontal
b. the axis of the pipe is horizontal and the plane of the weld is vertical
c. the pipe is not fixed
d. the axis of the pipe and the plane of the weld are at 45° angles with the vertical plane
e. the axis of the pipe is horizontal and the pipe is rotated

F143 During operation, the heat for electroslag welding is provided by:
- a. the arc
- b. the electrical resistance heating of the molten slag
- c. the consumable guide tube melting
- d. current passing through the base metal
- e. current passing through the filler wire

F144 Using the appropriate conversion factor provided in the chart on page 41, determine the approximate cubic feet per hour (cfh) for a flow rate of 22 liters per minute.
- a. 466 cfh
- b. 46.6 cfh
- c. 10.38 cfh
- d. 103.8 cfh
- e. 4.66 cfh

F145 It is suspected that a GMAW weld was produced in an area where there was an excessive draft. Which nondestructive test would best reveal the internal discontinuities which may have resulted?
- a. PT
- b. MT
- c. RT
- d. UT
- e. none of the above

F146 The size of the arrow side weld in Figure 6 is:
- a. 1/4 in.
- b. 5/16 in.
- c. 1 in.
- d. 2 in.
- e. 1 in. deposited every 6 in.

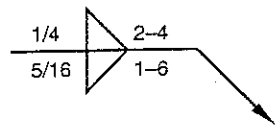


Figure 6

F147 The length of the other side weld in Figure 6 is:
- a. 1 in.
- b. 6 in.s
- c. 2 in.
- d. 4 in.
- e. continuous down the length of the joint

F148 The pitch of the other side weld in Figure 6 is:
- a. 1/4 in.
- b. 4 in.
- c. 5/16 in.
- d. 1 in.
- e. 6 in.

F149 If a contour symbol is used but the finishing method is not specified on the welding symbol:
- a. it is the inspector's choice
- b. it is the fabricator's choice
- c. the desired contour must be as-welded
- d. it should be found in the code specified
- e. it is the welder's choice

F150 In order to learn the exact location of a subsurface flaw in three directions, the best NDE method would be:
- a. RT
- b. MT
- c. PT
- d. UT
- e. VT

F151 The surface of a member included in the groove of a weldment best describes:
- a. root opening
- b. groove angle
- c. weld interface
- d. groove face
- e. none of the above

F152 Crater cracks can be the result of:
- a. poor welding technique
- b. abrupt termination of welding
- c. shrinkage of the molten pool
- d. underfill of the crater
- e. all of the above

F153 Figure 7 depicts which welding process?
- a. SAW
- b. SMAW
- c. PAW
- d. GMAW
- e. FCAW

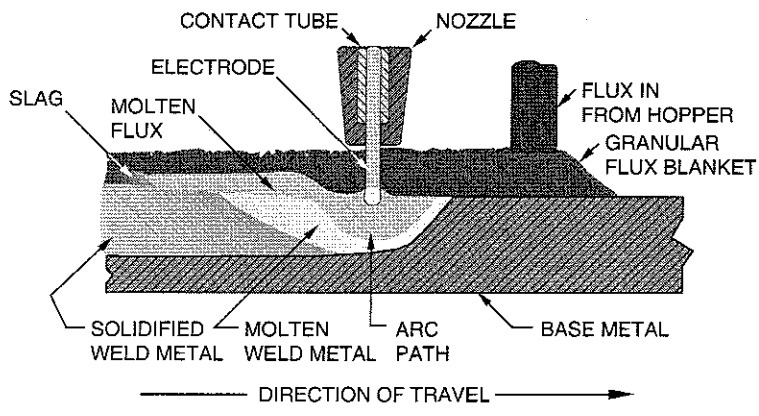


Figure 7

F154 The boundaries indicated by "A" in Figure 8 are:
- a. fusion line
- b. depth of fusion
- c. weld interface
- d. fusion face
- e. none of the above

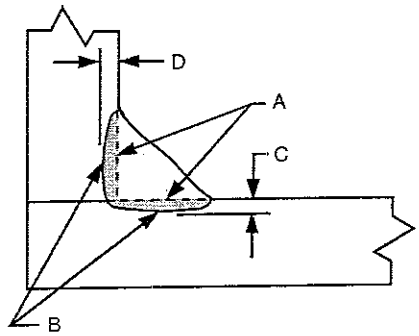


Figure 8

F155 The dimension "D" in Figure 8 is referred to as:
- a. fusion face
- b. fusion zone
- c. depth of fusion
- d. weld interface
- e. fusion line

F156 The weld interface in Figure 8 is indicated by:
- a. "A"
- b. "B"
- c. "C"
- d. "D"
- e. none of the above

F157 Using the appropriate conversion factor provided in the chart on page 41, determine the approximate degrees Celsius for a preheat temperature of 225°F.
- a. 225°C
- b. 107°C
- c. 437°C
- d. 10.7°C
- e. 1.07°C

F158 Which of the following welds is not considered applicable for a butt joint?
- a. V-groove
- b. plug
- c. edge-flange
- d. U-groove
- e. J-groove

F159 The dimension "A" in Figure 9 refers to:
- a. root penetration
- b. weld penetration
- c. depth of fusion
- d. joint penetration
- e. side wall penetration

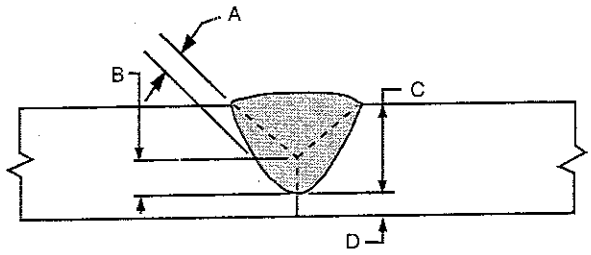


Figure 9

F160 The dimension "C" in Figure 9 identifies:
- a. joint penetration and weld size
- b. weld size and root penetration
- c. depth of fusion
- d. complete joint penetration
- e. incomplete joint penetration

F161 If the groove weld in Figure 9 has been properly welded, the dimension "D" is referred to as:
- a. underfill because the weld is left unfilled
- b. lack of penetration because weld size is inadequate
- c. partial joint penetration because weld size is indicated
- d. complete joint penetration because the joint is filled
- e. incomplete joint penetration because the joint should have been filled

F162 Which of the following is not a type of weld joint?
- a. lap
- b. T-
- c. fillet
- d. butt
- e. edge

F163 When using SMAW, wet electrodes will most likely cause:
- a. undercut
- b. overlap
- c. underfill
- d. porosity
- e. all of the above

F164 Which of the following is considered to be an acceptable way to provide backing for a V- groove weld in a carbon steel butt joint?
- a. copper backing bar
- b. ceramic backing
- c. flux backing
- d. backing weld
- e. all of the above

F165 A welder deposits an average of 12 pounds of weld metal per hour. Using the appropriate conversion factor provided in the chart on page 41, determine the approximate kilograms of weld metal that will be deposited in 6 hours of continuous welding.
- a. 5 kg
- b. 33 kg
- c. 6 kg
- d. 26 kg
- e. 37 kg

F166 A single-wire, submerged arc welding machine is operating at 32 volts, 600 amps, and is traveling at 8 inches per minute. Using the formula provided on pages 40 and 41, what is the heat input for this situation?

$$\text{Heat input} = \text{J/in.} \qquad \text{J/in.} = \frac{V \times A \times 60}{\text{Travel Speed} - (\text{ipm})}$$

a. 2,400 J/in.
b. 1,152,000 J/in.
c. 1.44×10^5 J/in.
d. 110,000 J/in.
e. 14,400 J/in.

F167 If an MT indication is noted at the toe of a fillet weld that exhibits an excessively convex profile, what is the appropriate action?

a. ignore it, since it is a nonrelevant indication
b. reject the weld
c. correct the excess convexity and retest
d. accept the weld
e. none of the above

F168 The pipe welding test position in which the axis of the pipe is horizontal and the pipe is rotated so that welding takes place at or near the top is designated as:

a. 2G
b. 2F
c. 1G
d. 3G
e. 6GR

F169 The most efficient NDE method for discovery of undercut on the face of a weld is:

a. VT
b. RT
c. UT
d. MT
e. PT

F170 The design strength of a fillet weld is always based on the throat dimension because:

a. it has a columnar microstructure, which is more prone to cracking
b. it is the shortest failure path through the weld
c. it is the location of most defects
d. the design calculations cannot be checked
e. it is a theory of failure that cannot be supported by actual laboratory testing

F171 Arc strikes are discontinuities most commonly associated with:
- a. ESW
- b. SAW
- c. SMAW
- d. OAW
- e. GMAW

F172 Double-groove welds in butt joints always require:
- a. backgouging
- b. special welding processes
- c. high deposition rate processes
- d. weld to be deposited from both sides of the joint
- e. a spacer to hold critical root openings

F173 What welding process is depicted in Figure 10?
- a. FCAW
- b. GMAW
- c. SMAW
- d. SAW
- e. ESW

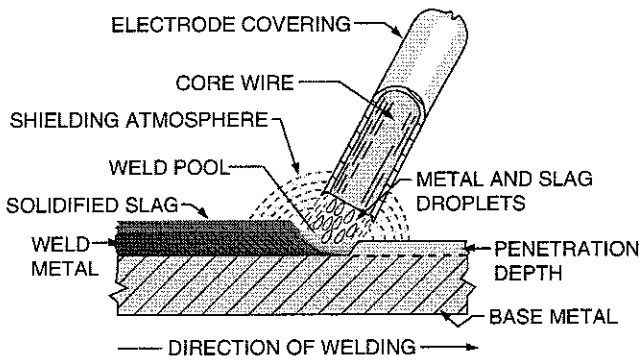


Figure 10

F174 Light-colored areas within the weld zone in a radiograph could represent:
- a. porosity and trapped slag
- b. tungsten inclusions and melt-through
- c. melt-through and trapped slag
- d. porosity and tungsten inclusions
- e. underfill and excessive reinforcement

F175 A single V-groove weld always requires:
- a. special welding processes
- b. backgouging
- c. a backing bar
- d. no root opening
- e. CPJ unless otherwise specified

F176 The substance used in UT to aid in the transmission of sound from the search unit to the work-piece and back is called:
- a. solvent
- b. attenuation
- c. couplant
- d. cable
- e. transducer

F177 Using the appropriate conversion factor from the chart on page 41, determine the approximate kilogram weight of a 30 pound roll of welding wire.

a. 1.36 kg
b. 66 kg
c. 136 kg
d. 66.15 kg
e. 13.6 kg

F178 The junction of the weld face with the exterior surface of the base metal is referred to as the:

a. face
b. root
c. leg
d. toe
e. edge

F179 Internal plate laminations are best revealed using:

a. UT
b. RT
c. MT
d. PT
e. ET

F180 Porosity in GMAW can be caused by:

a. drafts
b. contamination
c. too little shielding gas flow
d. too much shielding gas flow
e. all of the above

F181 The overhead fillet position is designated as:

a. 5F
b. 4F
c. 3F
d. 2F
e. 1F

F182 The radiograph in Figure 11 shows:

a. crack
b. incomplete fusion
c. incomplete joint penetration
d. slag inclusions
e. none of the above

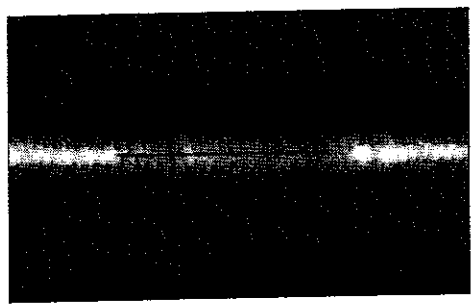


Figure 11

F183 The welding process depicted in Figure 12 is:

a. GMAW
b. SAW
c. SMAW
d. GTAW
e. PAW

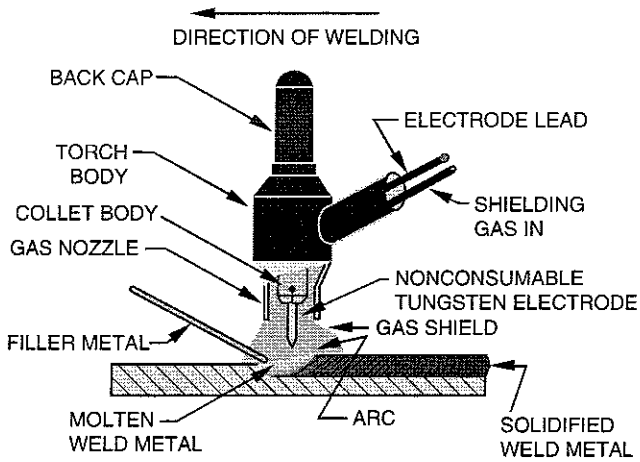


Figure 12

F184 The radiograph in Figure 13 shows:

a. slag inclusions due to improper fitup
b. tungsten inclusions due to poor tungsten grinding
c. porosity due to inadequate shielding
d. longitudinal crack due to stress
e. lack of penetration due to poor starts and stops

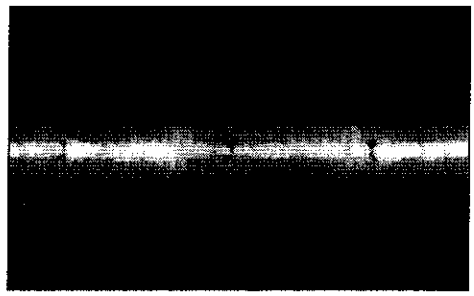


Figure 13

F185 Which of the following is an example of an electrode classification number for GTAW?

a. EWTH-2
b. A5.1
c. A5.9
d. E7018
e. ER70S-2

F186 In a groove-weld cross section, the 'line' separating weld metal from base metal is called:

a. the fusion face
b. the depth of fusion
c. the depth of penetration
d. the weld interface
e. none of the above

F187 In the radiograph in Figure 14, the arrows point to:
- a. transverse cracks
- b. crater cracks
- c. longitudinal cracks
- d. underbead cracks
- e. toe cracks

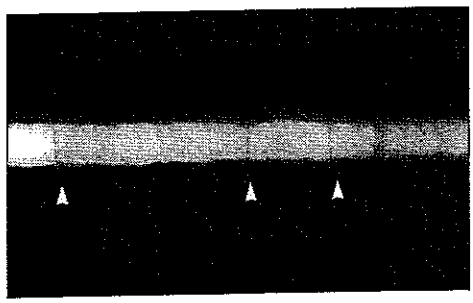


Figure 14

F188 Incomplete fusion can be caused by:
- a. not preheating
- b. not filling the joint completely
- c. improper gas shielding
- d. poor fitup
- e. excessive amperage

F189 In pipe groove welding, the 45° fixed position is designated as:
- a. 1G
- b. 2G
- c. 2F
- d. 5G
- e. 6G

F190 Using the appropriate conversion factor provided in the chart on page 41 determine the approximate feed speed in inches per minute for a wire fed at a speed of 120 mm/s.
- a. 28.3 ipm
- b. 283 ipm
- c. 2,834 ipm
- d. 5.076 ipm
- e. 50.76 ipm

F191 The defect noted in the radiograph in Figure 15 is:
- a. incomplete penetration
- b. a crack
- c. incomplete fusion
- d. porosity
- e. slag inclusions

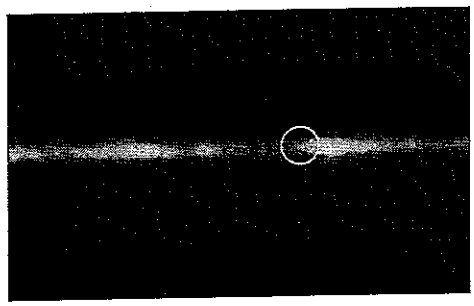


Figure 15

F192 The "A" dimension in Figure 16 is referred to as:

a. actual weld throat
b. weld size
c. weld leg
d. theoretical weld throat
e. effective weld throat

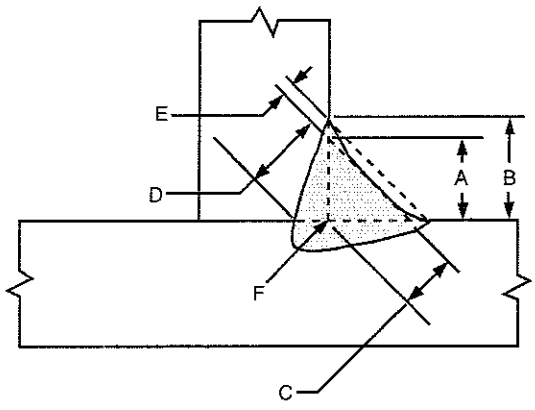


Figure 16

F193 "F" in Figure 16 points to:

a. the root penetration
b. the weld penetration
c. the weld root
d. the joint root
e. none of the above

F194 The dimension "C" in Figure 16 shows:

a. the theoretical throat
b. the actual throat
c. the effective throat
d. weld leg
e. convexity

F195 The dimension "D" in Figure 16 is called:

a. the theoretical throat and the effective throat
b. the effective throat and the actual throat
c. the actual throat and the theoretical throat
d. weld size
e. convexity

F196 The dimension "E" in Figure 16 refers to:

a. the actual throat
b. the effective throat
c. convexity
d. leg and weld size
e. concavity

F197 One common cause of centerline weld cracks is:

a. the use of preheat
b. a highly restrained weld joint
c. using the wrong polarity
d. stress relief heat treatment
e. the presence of incomplete sidewall fusion

F198 Using the appropriate conversion factor from the chart on page 41, determine the approximate pounds per square in. (psi) for a yield strength of 198 MPa.

a. 2.871×10^3 psi
b. 2.871×10^4 psi
c. 4,136 psi
d. 41.36 psi
e. 2,871 psi

F199 Which NDE method will best reveal subsurface porosity?

a. RT
b. PT
c. MT
d. UT
e. none of the above

F200 Liquid penetrant testing is not recommended when inspecting which of the following materials?

a. Aluminum plate that has been chemically cleaned
b. Steel weld test plates brushed clean
c. Stainless steel pipe as welded by GTAW
d. a casting that has been sand blasted
e. a weld test plate with defects removed by machining

F201 Using the conversion factors provided in the chart on page 41, determine the approximate MPa for a tensile strength of 65,000 psi.

a. 448,000
b. 4.48×10^8
c. 448
d. 9,425,000
e. 9.425×10^6

F202 An MT indication of a subsurface discontinuity 1 in. below the surface will appear how as compared to a surface discontinuity?

a. intermittent
b. sharper
c. less distinct
d. MT cannot detect a subsurface flaw 1 in. below the surface
e. only the central conductor method can be used to detect flaws in 1 in material

F203 Which of the following conditions can cause slag inclusions in a weld?

a. insufficient groove angle in an SMAW single V-groove weld
b. careful interpass cleaning of subsequent layer and beads of FCAW
c. insufficient preheat of test plate
d. insufficient shielding gas flow in GTAW
e. improper fitup of GMAW test plates

F204 What is meant by the term essential variable?
- a. Data on a WPS that if changed during production will render a WPS disqualified.
- b. Data on an inspection report that if changed render the report disqualified.
- c. Data on an MTR that is essential to the chemistry of the material.
- d. the recommended amperage and voltage for welding as published by the manufacturer.
- e. describes what should be included in a WPS.

F205 The dimension "B" in Figure 17 is:
- a. the weld throat
- b. the weld size
- c. point of tangency
- d. groove weld size
- e. fillet weld profile

F206 The dimension "A" in Figure 17 is the:
- a. convexity
- b. concavity
- c. face reinforcement
- d. weld size
- e. overlap

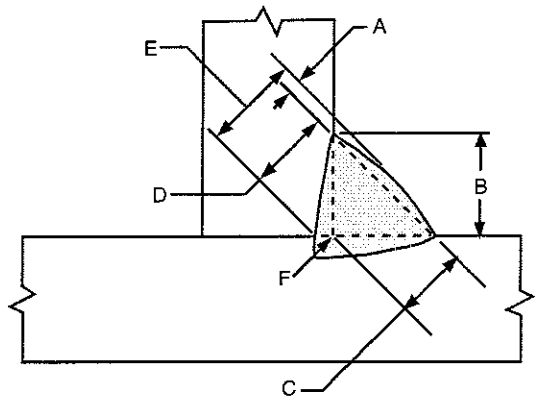


Figure 17

F207 The dimension "E" in Figure 17 is:
- a. the actual throat
- b. the effective throat
- c. the theoretical throat
- d. weld size
- e. convexity

F208 The dimension "D" in Figure 17 is:
- a. the actual throat
- b. the effective throat
- c. the theoretical throat
- d. weld size
- e. weld leg

F209 Where should the preheat temperature be measured?
- a. in the weld groove
- b. 12 in. from the weld groove
- c. where the arc will be initiated
- d. 2–3 in. from the weld groove
- e. preheat temperature need not be measured

F210 A discontinuity is:
- a. always rejectable
- b. never rejectable, but its condition should be noted in the inspection report
- c. always a defect
- d. an indication that renders a part unusable
- e. an interruption in the uniformity of a weldment

F211 What weld discontinuity is shown in the radiograph in Figure 18?
- a. crack
- b. incomplete joint penetration
- c. porosity
- d. burn through
- e. tungsten inclusions

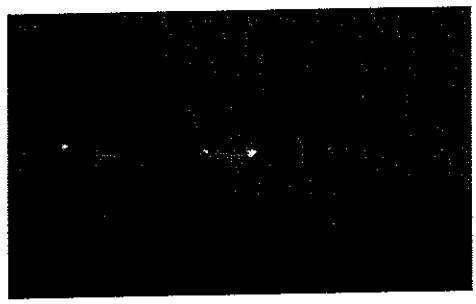


Figure 18

F212 An oxygen regulator is set for 40 psi. Using the appropriate conversion factor from the chart on page 41, determine the pressure in kPa.
- a. 2,758
- b. 27,580
- c. 2.758
- d. 27.58
- e. 275.8

F213 Which of the following discontinuities can be caused by poor welding technique?
- a. incomplete fusion
- b. porosity
- c. undercut
- d. overlap
- e. all of the above

F214 If a welder is continually turning out rejectable work, the welding inspector should:
- a. inspect his work more critically
- b. ask that the welder be terminated
- c. require requalification
- d. instruct the welder in proper techniques
- e. ask that the welder use another process

F215 How does a welder become certified?
- a. certification can only be obtained by taking a weld test given by a CWI
- b. by graduating from a welding school
- c. by having documented proof of 5 years in welding industry
- d. by documenting successful completion of a weld test according to the requirements of an applicable standard
- e. certification can only be obtained by taking a weld test at an approved test center

F216 Which discontinuity occurs in the heat-affected zone and can result from excess moisture in the weld zone?

a. throat crack
b. crater crack
c. underbead crack
d. porosity
e. centerline crack

F217 Which of the following measurements are taken from a tensile specimen to determine area?

a. mass and volume
b. length and thickness
c. width and length
d. width and thickness
e. load and pressure

F218 When establishing a PQR?

a. the type and number of tests required is determined by the applicable standard
b. a face and root bend will qualify all plates
c. testing requirements are determined by the contractor and approved by the inspector
d. destructive testing is required only if a problem is suspected
e. a weld test plate does not have to be mechanically tested to establish a PQR

F219 Which of the following discontinuities is not associated with GTAW?

a. lack of fusion
b. slag inclusions
c. tungsten inclusions
d. porosity
e. undercut

F220 Using the appropriate conversion factor from the chart on page 41, convert a travel speed of 21 ipm to mm/s.

a. 88.9
b. 8.9
c. 0.88
d. 0.088
e. 49.61

F221 Using the appropriate conversion factor from the chart on page 41, calculate the ultimate tensile strength in MPa of a tensile specimen having a cross-sectional area of 0.300 sq. in. and broke at a tensile load of 24,600 lbs.

$$\frac{\text{Load (lbs.)}}{\text{Area of specimen (sq. in.)}} = \text{Tensile strength (psi)}$$

a. 565 Pa
b. 565 MPa
c. 5.65 Pa
d. 565 kPa
e. 5,650 kPa

F222 Which of the following discontinuities are not found with GMAW?

a. incomplete fusion
b. porosity
c. tungsten inclusions
d. incomplete penetration
e. cracks

F223 The CAWI:

a. is solely responsible for determination of a weldment's conformance to acceptable standards
b. inspects weldments only under the direction of a CWI or SCWI
c. cannot inspect critical weldments
d. performs all inspections the same as a CWI
e. all of the above

F224 NDE technicians are certified in accordance with:

a. AWS D1.1
b. API 1104
c. ASNT SNT-TC-1A
d. ASME Section VI
e. ASME Section IX

WIT—Useful Formulae

Area of Square or Rectangle

$$\text{Area} = \text{length} \times \text{width} \quad \text{or:} \quad \text{Area} = \text{width} \times \text{thickness}$$

Area or Circle

$$\text{Area} = \pi \times \text{radius}^2 \quad \text{or:} \quad \text{Area} = \pi \times \frac{\text{diameter}^2}{4} \quad \text{or:} \quad \text{Area} = 0.7854 \times \text{diameter}^2$$

Percent Elongation

$$\% \text{ Elongation} = \frac{\text{Final Gage Length} - \text{Original Gage Length}}{\text{Original Gage Length}} \times 100$$

Percent Reduction of Area

$$\% \text{ Reduction of Area} = \frac{\text{Original Area} - \text{Final Area}}{\text{Original Area}} \times 100$$

Tensile Strength

General

$$\text{UTS} = \frac{\text{P max}}{\text{Area}}$$

where: P max = load to break specimen
Area = specimen's original cross-sectional area

Pipe

$$\text{UTS for full section pipe} = \frac{\text{P max}}{0.7854\ (\text{OD}^2 - \text{ID}^2)}$$

Yield Strength

$$\text{YS} = \frac{\text{Load at specified offset}}{\text{Original cross-sectional area}}$$

Welding Heat Input

$$\text{J/in.} = \frac{\text{V} \times \text{A} \times 60}{\text{Travel Speed (ipm)}}$$

where: J = Joules (energy)
V = welding voltage
A = welding amperage
ipm = inches per minute

Carbon Equivalent

$$\text{CE} = \%\text{C} + \frac{\%\text{Mn}}{6} + \frac{\%\text{Ni}}{15} + \frac{\%\text{Cu}}{13} + \frac{\%\text{Mo}}{14}$$

Welding Usage Conversion Chart—U.S. Customary and SI

Property*	To Convert From:	To:	Multiply By:
area dimensions	$in.^2$	mm^2	6.452×10^2
	mm^2	$in.^2$	1.550×10^{-3}
current density	$A/in.^2$	A/mm^2	1.550×10^{-3}
	A/mm^2	$A/in.^2$	6.452×10^2
deposition rate	lb/hr	kg/hr	0.454
	kg/hr	lb/hr	2.205
flow rate	ft^3/h	l/min	4.719×10^{-1}
	l/min	ft^3/h	2.119
heat input	J/in.	J/m	39.37
	J/m	J/in.	2.54×10^{-2}
linear measure	in.	mm	25.4
	mm	in.	3.937×10^{-2}
	ft	mm	3.048×10^2
	mm	ft	3.281×10^{-3}
mass	lb	kg	0.454
	kg	lb	2.205
pressure	psi	kPa	6.895
	psi	MPa	6.895×10^{-3}
	kPa	psi	0.145
	MPa	psi	1.450×10^2
	bar	psi	14.50
	psi	bar	6.9×10^{-2}
temperature	°F	°C	(°F – 32)/1.8
	°C	°F	(°C × 1.8) + 32
tensile strength	psi	MPa	6.895×10^{-3}
	MPa	psi	1.450×10^2
travel speed	in./min	mm/s	4.233×10^{-1}
	mm/s	in./min	2.362
vacuum	Pa	torr	7.501×10^{-3}
wire feed speed	in./min	mm/s	0.423
	mm/s	in./min	2.362

ANSWER KEY

F1	c	F47	a	F93	a	F139	c	F185	a
F2	a	F48	d	F94	c	F140	b	F186	d
F3	c	F49	d	F95	b	F141	b	F187	a
F4	a	F50	c	F96	b	F142	a	F188	d
F5	b	F51	a	F97	c	F143	b	F189	e
F6	a	F52	b	F98	c	F144	b	F190	b
F7	c	F53	d	F99	b	F145	c	F191	d
F8	b	F54	c	F100	a	F146	b	F192	b
F9	c	F55	c	F101	d	F147	c	F193	d
F10	c	F56	e	F102	b	F148	b	F194	a
F11	a	F57	b	F103	c	F149	c	F195	b
F12	a	F58	e	F104	a	F150	d	F196	e
F13	e	F59	b	F105	c	F151	d	F197	b
F14	b	F60	c	F106	c	F152	e	F198	b
F15	b	F61	b	F107	b	F153	a	F199	a
F16	e	F62	d	F108	b	F154	d	F200	d
F17	c	F63	e	F109	b	F155	c	F201	c
F18	d	F64	c	F110	c	F156	b	F202	d
F19	e	F65	a	F111	d	F157	b	F203	a
F20	c	F66	b	F112	b	F158	b	F204	a
F21	a	F67	c	F113	a	F159	c	F205	b
F22	b	F68	b	F114	c	F160	a	F206	a
F23	b	F69	a	F115	a	F161	c	F207	a
F24	d	F70	a	F116	e	F162	c	F208	b
F25	e	F71	b	F117	c	F163	d	F209	d
F26	c	F72	c	F118	a	F164	e	F210	e
F27	c	F73	c	F119	a	F165	b	F211	e
F28	d	F74	e	F120	c	F166	c	F212	e
F29	c	F75	b	F121	c	F167	c	F213	e
F30	e	F76	c	F122	e	F168	c	F214	c
F31	e	F77	b	F123	c	F169	a	F215	d
F32	d	F78	a	F124	d	F170	b	F216	c
F33	b	F79	a	F125	b	F171	c	F217	d
F34	b	F80	a	F126	b	F172	d	F218	a
F35	b	F81	c	F127	e	F173	c	F219	b
F36	a	F82	c	F128	a	F174	b	F220	b
F37	d	F83	c	F129	c	F175	e	F221	b
F38	c	F84	a	F130	d	F176	c	F222	c
F39	b	F85	a	F131	a	F177	e	F223	b
F40	c	F86	e	F132	a	F178	d	F224	c
F41	c	F87	c	F133	a	F179	a		
F42	b	F88	e	F134	b	F180	e		
F43	c	F89	b	F135	c	F181	b		
F44	c	F90	c	F136	b	F182	c		
F45	b	F91	a	F137	b	F183	d		
F46	a	F92	b	F138	a	F184	e		