UNITED STATES NUCLEAR REGULATORY COMMISSION
BOILING WATER REACTOR GENERIC FUNDAMENTALS EXAMINATION
JUNE 2003--FORM A

Please Print

Name: _____

Facility: _____

Docket No.: _____

Start Time: _____ Stop Time: _____

INSTRUCTIONS TO APPLICANT

Answer all the test items using the answer sheet provided. Each item has equal point value. A score of at least 80% is required to pass this portion of the written licensing examination. All examination papers will be collected 4.0 hours after the examination starts. This examination applies to a typical boiling water reactor (BWR) power plant.

SECTION	QUESTIONS	% OF TOTAL	SCORE
COMPONENTS	1 - 44		
REACTOR THEORY	45 - 72		
THERMODYNAMICS	73 - 100		
TOTALS	100		

All work done on this examination is my own. I have neither given nor received aid.

_____

Applicant's Signature

RULES AND GUIDELINES FOR THE GENERIC FUNDAMENTALS EXAMINATION

During the administration of this examination the following rules apply:

NOTE: The generic term "control rod" refers to the length of neutron absorber material that can be positioned by the operator to change core reactivity.

1. Print your name in the blank provided on the cover sheet of the examination.

2. Fill in the name of your facility.

3. Fill in your individual docket number.

4. Fill in your start and stop times at the appropriate time.

5. Two aids are provided for your use during the examination:

   (1) An equations and conversions sheet contained within the examination copy, and

   (2) Steam tables provided by your proctor.

6. Place your answers on the answer sheet provided. Credit will only be given for answers properly marked on this sheet. Follow the instructions for filling out the answer sheet.

7. Scrap paper will be provided for calculations.

8. Cheating on the examination will result in the automatic forfeiture of this examination. Cheating could also result in severe penalties.

9. Restroom trips are limited. Only **ONE** examinee may leave the room at a time. In order to avoid the appearance or possibility of cheating, avoid all contact with anyone outside of the examination room.

10. After you have completed the examination, sign the statement on the cover sheet indicating that the work is your own and you have neither given nor received any assistance in completing the examination.

11. Turn in your examination materials, answer sheet on top, followed by the examination booklet, then examination aids - steam table booklets, handouts, and scrap paper used during the examination.

12. After turning in your examination materials, leave the examination area, as defined by the proctor. If after leaving you are found in the examination area while the examination is in progress, your examination may be forfeited.

GENERIC FUNDAMENTALS EXAMINATION
EQUATIONS AND CONVERSIONS HANDOUT SHEET

EQUATIONS

$\dot{Q} = \dot{m}c_p\Delta T$

$\dot{Q} = \dot{m}\Delta h$

$\dot{Q} = UA\Delta T$

$\dot{Q} \propto \dot{m}^3_{Nat\ Circ}$

$\Delta T \propto \dot{m}^2_{Nat\ Circ}$

$K_{eff} = 1/(1 - \rho)$

$\rho = (K_{eff} - 1)/K_{eff}$

$SUR = 26.06/\tau$

$\tau = \dfrac{\overline{\beta} - \rho}{\lambda_{eff}\ \rho}$

$\rho = \dfrac{\ell^*}{\tau} + \dfrac{\overline{\beta}}{1 + \lambda_{eff}\tau}$

$\ell^* = 1 \times 10^{-4}$ sec

$\lambda_{eff} = 0.1\ sec^{-1}$ (for small positive ρ)

$DRW \propto \varphi^2_{tip}/\varphi^2_{avg}$

$P = P_o 10^{SUR(t)}$

$P = P_o e^{(t/\tau)}$

$A = A_o e^{-\lambda t}$

$CR_{S/D} = S/(1 - K_{eff})$

$CR_1(1 - K_{eff1}) = CR_2(1 - K_{eff2})$

$1/M = CR_1/CR_X$

$A = \pi r^2$

$F = PA$

$\dot{m} = \rho A\vec{v}$

$\dot{W}_{Pump} = \dot{m}\Delta P\upsilon$

$E = IR$

Eff. = Net Work Out/Energy In

$\upsilon(P_2 - P_1) + \dfrac{(\vec{v}_2^{\,2} - \vec{v}_1^{\,2})}{2g_c} + \dfrac{g(z_2 - z_1)}{g_c} = 0$

$g_c = 32.2$ lbm-ft/lbf-sec^2

CONVERSIONS

---

1 Mw	= 3.41×10^6 Btu/hr	1 Curie	= 3.7×10^{10} dps
1 hp	= 2.54×10^3 Btu/hr	1 kg	= 2.21 lbm
1 Btu	= 778 ft-lbf	1 gal_{water}	= 8.35 lbm
°C	= (5/9)(°F - 32)	1 ft^3_{water}	= 7.48 gal
°F	= (9/5)(°C) + 32		

QUESTION: 1

Refer to the drawing of two identical pressure vessels with identical relief protection (see figure below).

Both vessels have been pressurized to 50 psig and then isolated. Vessel A is completely filled with water at 150°F. Vessel B is in a saturated condition with one-half steam (100% quality) and one-half water (0% quality) by volume.

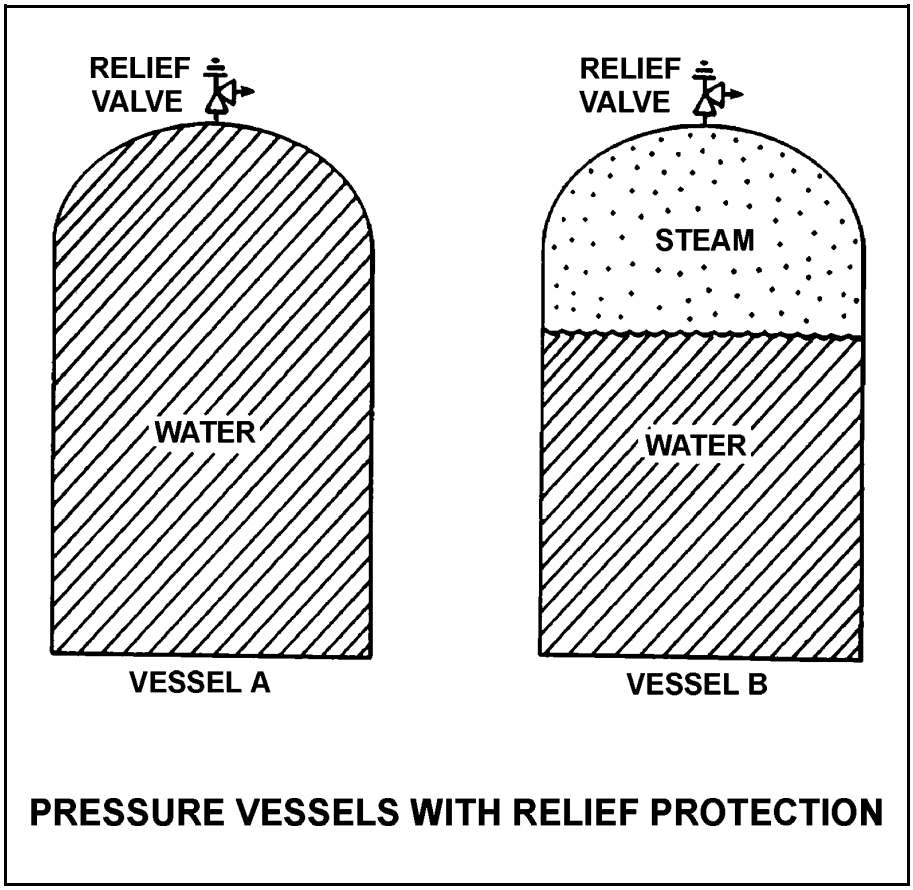
If both relief valves fully open simultaneously, the faster pressure reduction will occur in vessel _____; and if both relief valves close at 40 psig, the greater mass loss will have occurred in vessel _____.

A. A; A

B. A; B

C. B; A

D. B; B



PRESSURE VESSELS WITH RELIEF PROTECTION

QUESTION: 2

Refer to the drawing of a spring-loaded air-operated valve shown in a throttled position (see figure below).

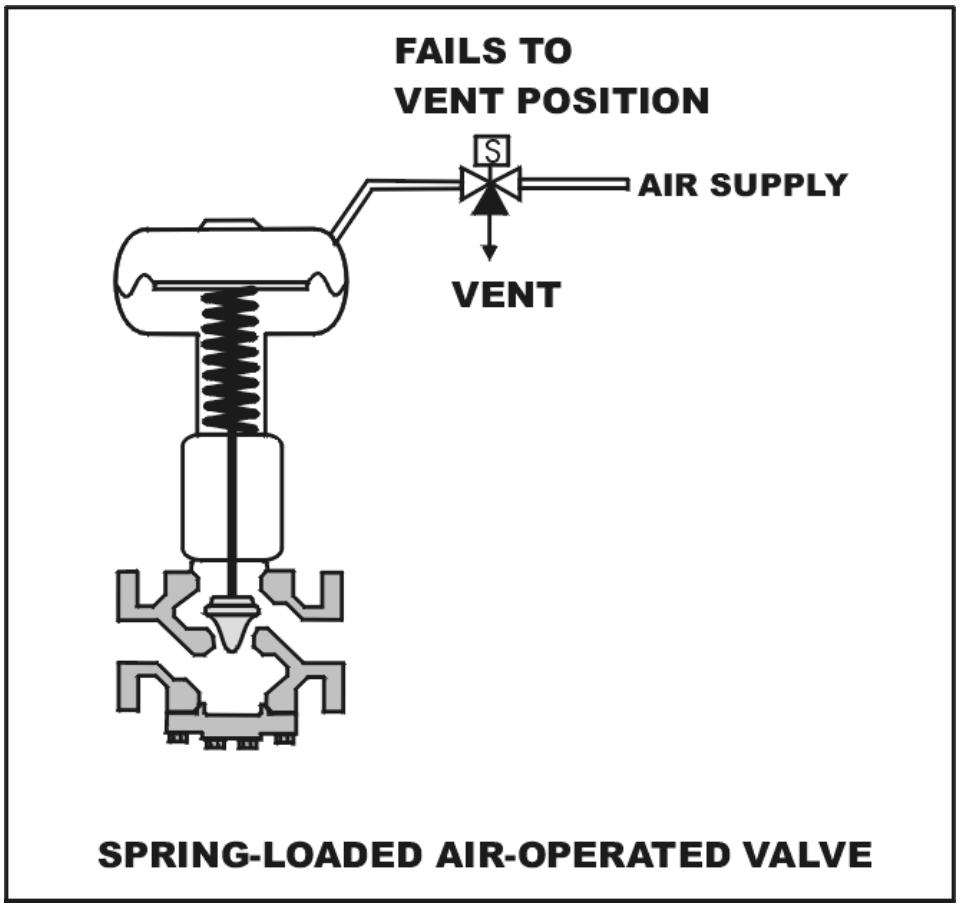
Which one of the following will be the valve position following a loss of electrical power to the solenoid? (The figure currently depicts normal air supply pressure and an energized solenoid.)

A. As is

B. More open

C. More closed

D. Varies with system flow



QUESTION: 3

To verify the position of a fully open manual valve in an operating system, the operator should operate the valve handwheel...

A. in the open direction until the valve is backseated one-half turn.

B. to fully close the valve, then open the valve to the fully open position.

C. in the closed direction, then open the valve to its previously open position.

D. to open the valve until it touches the backseat, then close the valve to the desired position.

QUESTION: 4

A motor-operated valve (MOV) has just been opened from the main control room, and the breaker for the MOV has been opened. A plant operator has been directed to close the MOV locally for a surveillance test.

If the operator attempts to turn the MOV handwheel in the clockwise direction without first operating the clutch lever, which one of the following will occur?

A. The handwheel will not turn, and the valve stem will not move.

B. The handwheel will turn, but the valve stem will not move.

C. The handwheel will turn, and the valve stem will move toward the closed position because the clutch is automatically engaged when the handwheel is turned.

D. The handwheel will turn, and the valve stem will move toward the closed position because the clutch is automatically engaged when the breaker is opened.

QUESTION: 5

In a comparison of butterfly valves with ball valves, _____ valves are generally more leak tight in high pressure applications; and _____ valves generally exhibit the lower system pressure drop when fully open.

A. ball; ball

B. ball; butterfly

C. butterfly; ball

D. butterfly; butterfly

QUESTION: 6

The following is the current calibration data for an orifice plate that is being used for water flow rate measurement:

Upstream Pressure:	135 psig
Downstream Pressure:	120 psig
Flow Rate:	100 gpm

During a surveillance the following pressures are observed across the orifice plate:

Upstream Pressure:	124 psig
Downstream Pressure:	117 psig

What is the approximate water flow rate through the orifice plate?

A. 47 gpm

B. 57 gpm

C. 68 gpm

D. 78 gpm

QUESTION: 7

The change in pressure across a main steam line flow element is...

A. directly proportional to the volumetric flow rate.

B. inversely proportional to the volumentric flow rate.

C. directly proportional to the mass flow rate.

D. inversely proportional to the mass flow rate.

QUESTION: 8

Refer to the drawing of a tank differential pressure (D/P) level detector (see figure below).

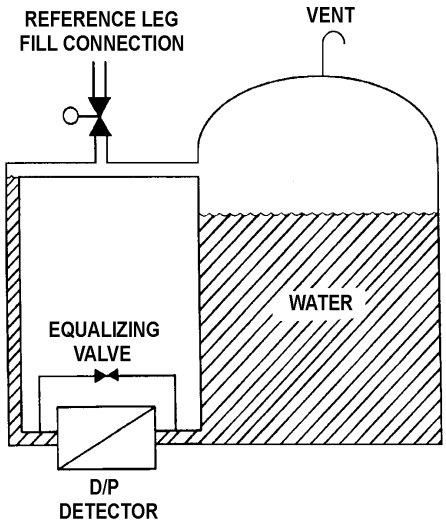
The D/P sensed by the detector varies in the _____ direction as the temperature of the water in the tank if the _____ of the tank water is constant. (Assume reference leg and tank water temperatures are initially the same.)

A. same; level

B. inverse; level

C. same; mass

D. inverse; mass



TANK DIFFERENTIAL PRESSURE LEVEL DETECTOR

QUESTION: 9

A centrifugal pump is taking suction from the bottom of a vented cylindrical storage tank that contains 100,000 gallons of water at 60°F. A pressure gauge at the inlet to the pump indicates 40 psig. Over the next several days storage tank temperature increases to 90°F with no change in tank water level and no change in head loss in the pump suction line.

Which one of the following is the current approximate pressure at the inlet to the pump?

A. 39.8 psig

B. 37.4 psig

C. 34.6 psig

D. 31.2 psig

QUESTION: 10

A properly calibrated 0 to 100 psia diaphragm pressure detector is connected to a pressurized system; the low pressure side of the detector is vented to the atmosphere. The detector is currently producing a system pressure indication of 75 psia.

If the detector diaphragm ruptures, indicated pressure will be approximately...

A. 0 psia.

B. 15 psia.

C. 60 psia.

D. 90 psia.

QUESTION: 11

What is the purpose of the reference junction panel that is provided with many thermocouple circuits?

A. Ensures that thermocouple output is amplified sufficiently for use by temperature indication devices.

B. Ensures that only temperature changes at the thermocouple measuring junction affect thermocouple temperature indication.

C. Ensures that electrical noise in the thermocouple extension wires does not affect thermocouple temperature indication.

D. Ensures that different lengths of thermocouple extension wires do not affect thermocouple temperature indication.

QUESTION: 12

Reed switches are being used to monitor the position of a control rod in a reactor. The reed switches are mounted in a column below the reactor vessel such that the control rod drive shaft passes by the reed switches as the control rod is withdrawn.

Which one of the following describes the action that causes the electrical output of the reed switches to change as the control rod is withdrawn?

A. An ac coil on the control rod drive shaft induces a voltage into the nearest reed switch.

B. The primary and secondary coils of each reed switch attain maximum magnetic coupling as the control rod drive shaft passes by.

C. A permanent magnet on the control rod drive shaft attracts the movable contact arm of the nearest reed switch.

D. A metal tab on the control rod drive shaft mechanically closes each reed switch as the shaft passes by.

QUESTION: 13

Fission chamber detectors are used to monitor reactor power/neutron level in a shutdown reactor as well as a reactor operating at full power (and all power levels in between). At what power levels and why is it necessary to compensate the output of the detectors for gamma interactions with the fission chambers?

A. At all power levels, because gamma interactions produce larger detector pulses than neutron interactions.

B. At all power levels, because gamma interactions produce smaller detector pulses than neutron interactions.

C. Only when shutdown or at low power levels, because gamma flux is <u>not</u> proportional to reactor power at low power levels.

D. Only when operating at high power levels, because gamma flux is <u>not</u> proportional to reactor power at high power levels.

QUESTION: 14

During reactor power operation, a reactor coolant sample is taken and analyzed. Which one of the following lists three radionuclides that are all indicative of a fuel cladding failure if detected in elevated concentrations in the reactor coolant sample?

A. Lithium-6, cobalt-60, and argon-41

B. Iodine-131, cesium-138, and strontium-89

C. Nitrogen-16, xenon-135, and manganese-56

D. Hydrogen-2 (deuterium), hydrogen-3 (tritium), and oxygen-18

QUESTION: 15

A flow controller has proportional, integral, and derivative control features. Which one of the following lists the effect on the control features when the controller is switched from the automatic mode to the manual mode?

A. Only the derivative feature will be lost.

B. Only the integral and derivative features will be lost.

C. All proportional, integral, and derivative features will be lost.

D. All control features will continue to influence the controller output.

QUESTION: 16

The level in a drain collection tank is being controlled by an automatic level controller and is initially at the controller set point. Flow rate into the tank increases, slowly at first, and then faster until a stable flow rate is attained.

As tank level increases, the controller slowly opens a tank drain valve. The level controller output signal increases both as the tank level increases and as the rate of tank level change quickens. After a few minutes, a new, steady-state tank level above the original level is established, with the drain flow rate equal to the supply flow rate.

The controller in this system uses _____ control.

A. proportional only

B. proportional plus derivative

C. proportional plus integral

D. proportional plus integral plus derivative

QUESTION: 17

Refer to the drawing of a pressure bistable in an alarm circuit (see figure below).

The orientation of the bistable symbol indicates the characteristics of the bistable, as is normal for a control circuit diagram. The bistable turns on to actuate an alarm at a system pressure of 100 psig. The bistable has a 5 psig dead band, or neutral zone.

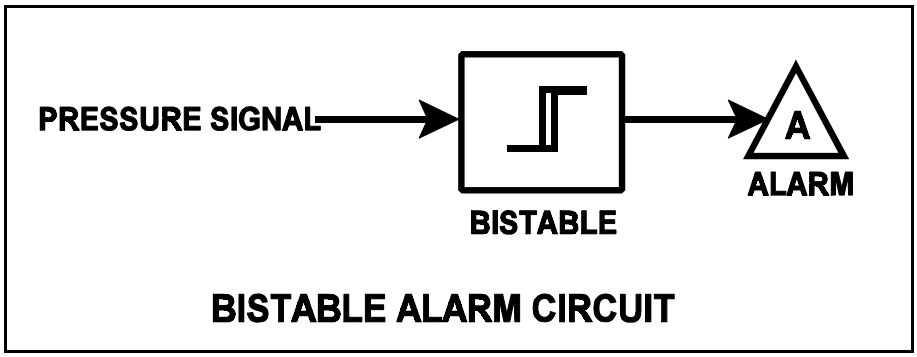
If current system pressure is 90 psig, which one of the following describes the alarm response as system pressure is slowly increased to 110 psig?

A. The alarm is currently actuated and will turn off at 95 psig.

B. The alarm will actuate at 100 psig and will not turn off.

C. The alarm is currently actuated and will turn off at 105 psig.

D. The alarm will actuate at 100 psig and will turn off at 105 psig.



QUESTION: 18

A centrifugal pump with no recirculation flow path must be stopped when discharge pressure reaches the pump shutoff head to prevent...

A. overheating of the pump.

B. overheating of the motor.

C. bursting of the pump casing.

D. water hammer in downstream lines.

QUESTION: 19

A motor-driven centrifugal pump is operating in an open system. If the pump discharge valve is fully opened from a throttled position, available net positive suction head (NPSH) will _____ and required NPSH will _____.

A. increase; increase

B. increase; remain the same

C. decrease; increase

D. decrease; remain the same

QUESTION: 20

Operating a motor-driven centrifugal pump under "pump runout" conditions causes...

A. pump overheating, cavitation, and ultimately pump failure.

B. excessive motor current to be drawn, damage to the motor windings, and ultimately motor failure.

C. excessive motor current to be drawn, overheating of pump and motor bearings, and ultimately pump failure.

D. no damage, because most pumps and motors are designed to operate without failure under pump runout conditions.

QUESTION: 21

Refer to the drawing of a centrifugal pump operating curve (see figure below).

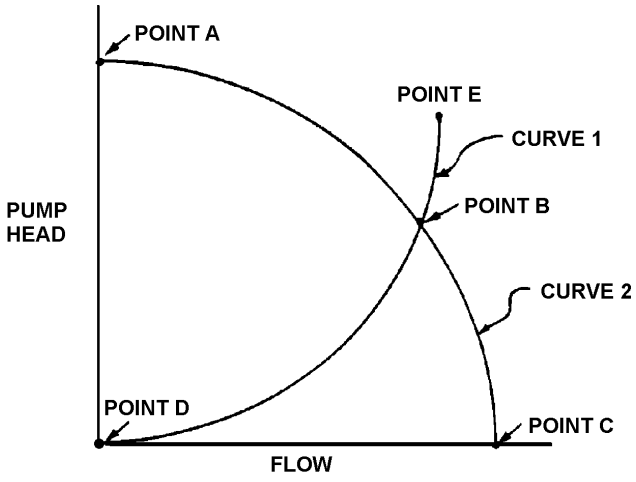
A centrifugal pump is currently operating at point B. If the pump speed is reduced by one-half, the new operating point will be located on curve _____, closer to point _____. (Assume that no other changes occur in the system.)

A. 1; D

B. 2; A

C. 1; E

D. 2; C



CENTRIFUGAL PUMP OPERATING CURVE

QUESTION: 22

A rotary positive displacement pump (PDP) is being used to supply water to a piping system. The PDP is driven by an ac induction motor. The initial parameters are:

System pressure:	500 psig
PDP flow rate:	50 gpm
PDP motor current:	40 amps

After several hours, the PDP motor speed is increased such that the new PDP flow rate is 100 gpm. If system pressure does not change, what is the approximate value of the PDP motor current at the 100 gpm flow rate?

A. 80 amps

B. 160 amps

C. 320 amps

D. 640 amps

QUESTION: 23

What is the purpose of the safety/relief valve located between the pump outlet and discharge isolation valve of most positive displacement pumps?

A. Protect the pump and suction piping from overpressure if the discharge valve is open during system startup.

B. Protect the pump and suction piping from overpressure if the suction valve is closed during pump operation.

C. Protect the pump and discharge piping from overpressure if the discharge valve is closed during pump operation.

D. Protect the pump and discharge piping from overpressure due to thermal expansion of pump contents when the pump is shutdown with its suction valve closed.

QUESTION: 24

A section of reactor coolant piping is being hydrostatically tested to 1400 psig using a positive displacement pump. The operating characteristics of the positive displacement pump are shown below, identifying ideal, expected, and actual pump performance.

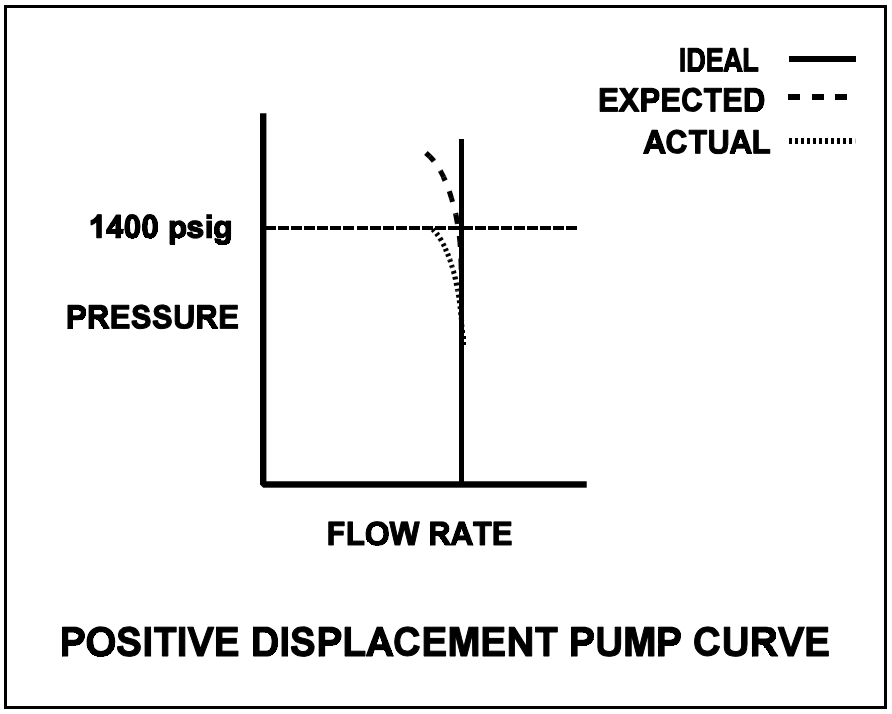
Which one of the following could cause the observed difference between the expected and the actual pump performance?

A. Pump internal leakage is greater than expected.

B. Reactor coolant piping boundary valve leakage is greater than expected.

C. Available NPSH has decreased more than expected, but remains slightly above required NPSH.

D. A relief valve on the pump discharge piping has opened prior to its setpoint of 1400 psig.



QUESTION: 25

A positive displacement pump should be started with its suction valve _____ and its discharge valve _____.

A. throttled; throttled

B. throttled; fully open

C. fully open; throttled

D. fully open; fully open

QUESTION: 26

A cooling water pump is being driven by an ac induction motor. Which one of the following describes how and why pump motor current will change if the pump shaft seizes?

A. Decreases due to decreased pump flow

B. Decreases due to increased counter electromotive force

C. Increases due to decreased pump flow

D. Increases due to decreased counter electromotive force

QUESTION: 27

If the voltage supplied by an ac generator to an isolated electrical system with a power factor of 1.0 is held constant while real load (kW) is increased, the current supplied by the generator will increase in direct proportion to the _____ of the change in real load. (Assume power factor remains constant at 1.0.)

A. square root

B. amount

C. square

D. cube

QUESTION: 28

What is the significance of a power factor of 0.8 when describing the output of a generator?

A. The relationship between generator output voltage and current can be described as purely resistive.

B. 80% of the energy input to the generator produces useful output.

C. 80% of the generator output will be converted to useful power.

D. This information characterizes the generator as a dc generator.

QUESTION: 29

A main generator that is connected to an infinite power grid has the following indications:

600 MWe
100 MVAR (VARs in)
13,800 amps
25,000 volts

If main generator excitation is decreased slightly, amps will _____ and MVAR will _____.

A. decrease; increase

B. increase; increase

C. decrease; decrease

D. increase; decrease

QUESTION: 30

A diesel generator (D/G) is supplying an electrical bus that is connected to an infinite power grid. Assuming D/G terminal voltage and bus frequency do not change, if the D/G governor setpoint is increased from 60 Hz to 60.1 Hz, then D/G kVAR will be _____ and D/G amps will be _____.

A. the same; higher

B. the same; the same

C. higher; higher

D. higher; the same

QUESTION: 31

Which one of the following describes the process for placing a steam (shell) and water (tube) heat exchanger into service?

A. Water side is valved in before the steam side to ensure adequate venting.

B. Water side is valved in before the steam side to minimize thermal shock.

C. Steam side is valved in before the water side to minimize scale buildup on the heat exchanger tubes.

D. Steam side is valved in before the water side to ensure that the cooldown rate does not exceed 100°F/hr.

QUESTION: 32

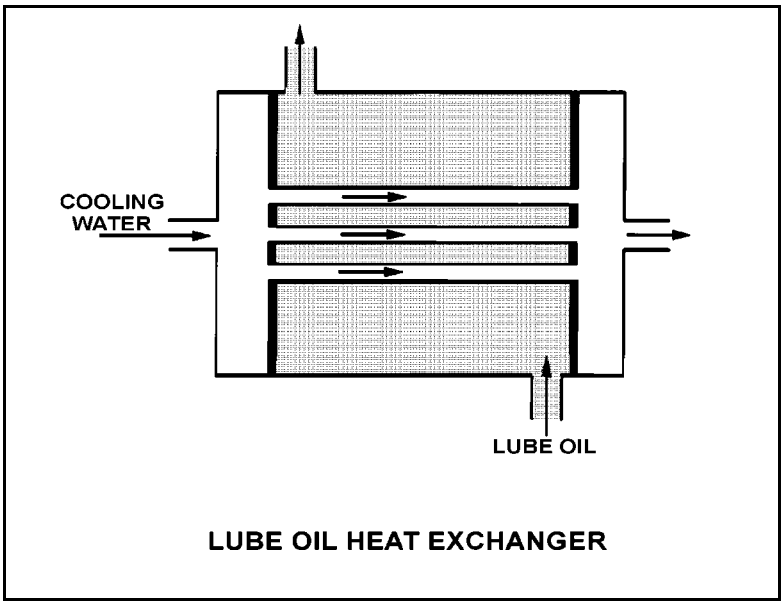
Refer to the drawing of a lube oil heat exchanger (see figure below).

The lube oil heat exchanger is in service with the following inlet temperatures:

Lube oil inlet temperature: 130°F
Cooling water inlet temperature: 70°F

Assume that cooling water mass flow rate is less than lube oil mass flow rate, and that both fluids have the same specific heat. Which one of the following pairs of heat exchanger outlet temperatures is not possible?

	Lube Oil Outlet Temp	Cooling Water Outlet Temp
A.	100°F	105°F
B.	105°F	105°F
C.	110°F	90°F
D.	115°F	90°F



QUESTION: 33

A condensate pump is taking suction on a main condenser hotwell, containing water at 100°F, and discharging the water at a volumetric flow rate of 100,000 gpm to the main feedwater system. The main feedwater system heats the water to 400°F before it enters the reactor vessel. Assume there is no leakage, and no bypass or recirculation flow paths are in use.

What is the approximate volumetric flow rate of the feedwater entering the reactor vessel?

A. 100,000 gpm

B. 105,000 gpm

C. 109,000 gpm

D. 116,000 gpm

QUESTION: 34

A pressure gauge on a main condenser reads 2 psiv. What is the approximate absolute pressure in the main condenser?

A. 2 psia

B. 13 psia

C. 15 psia

D. 17 psia

QUESTION: 35

What is the reason for ensuring that a piping system is completely filled and vented prior to initiating system flow?

A. To minimize the system head losses

B. To ensure all noncondensible gases are removed from the piping system to reduce system corrosion

C. To preclude a reduction in the overall system heat transfer coefficient

D. To minimize the potential for water hammer

QUESTION: 36

A nuclear power plant is operating at 100% power when air inleakage results in the buildup of noncondensible gases in the main condenser. Assume no operator or automatic actions occur that affect reactor power or turbine load.

Which one of the following will occur as a result of this air inleakage?

A. Decreased condensate temperature

B. Decreased pressure in the main condenser

C. Decreased suction pressure at the condensate pumps

D. Decreased condenser cooling water outlet temperature

QUESTION: 37

The purpose of a demineralizer is to...

A. raise the conductivity of water without affecting pH.

B. reduce the conductivity of water without affecting pH.

C. increase the pH of water by reducing the number of positively charged ions in it.

D. decrease the pH of water by increasing the number of negatively charged ions in it.

QUESTION: 38

A condensate demineralizer differential pressure (D/P) gauge indicates 4 psid at 50% flow. Over the next two days plant power changes have caused condensate flow to vary between 25% and 100%.

Which one of the following combinations of condensate flow and demineralizer D/P, observed during the power changes, indicates an increase in the accumulation of corrosion products in the demineralizer?

	CONDENSATE FLOW	DEMINERALIZER D/P (PSID)
A.	100%	15.0
B.	75%	9.0
C.	60%	5.0
D.	25%	2.0

QUESTION: 39

Refer to the drawing of a parallel demineralizer loop that is currently aligned for normal flow direction through the demineralizer (see figure below).

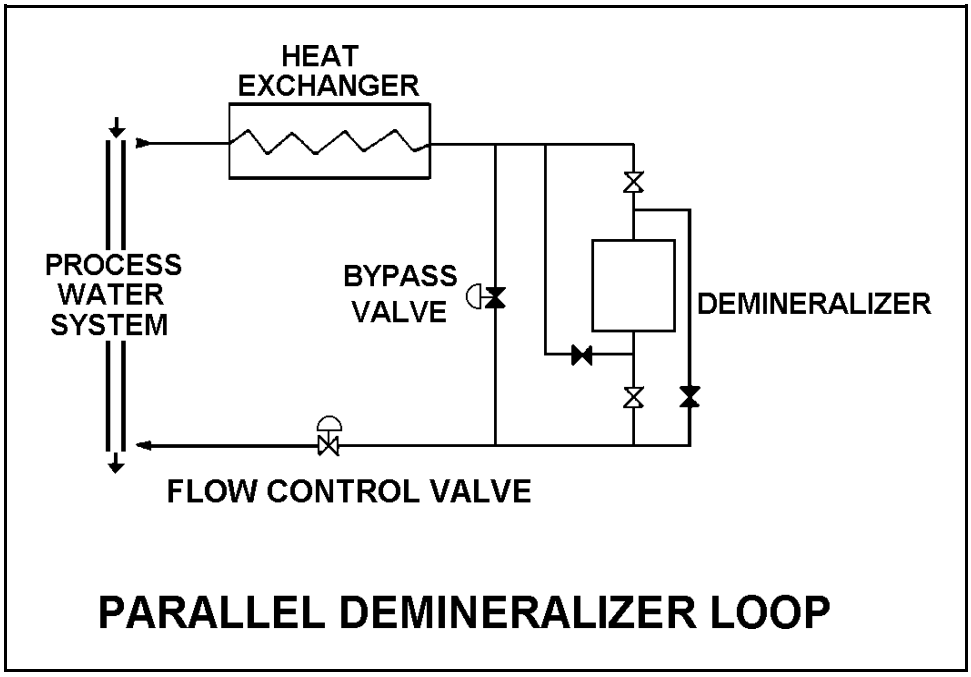
Which one of the following is most likely to cause a decrease in the demineralizer decontamination factor for ionic impurities?

A. Divert 50% of the demineralizer loop flow to bypass the demineralizer.

B. Decrease the process water system pressure from 125 psig to 115 psig.

C. Decrease the flow rate in the demineralizer loop from 105 gpm to 95 gpm.

D. Decrease the temperature in the demineralizer loop from 110°F to 100°F.



QUESTION: 40

Which one of the following describes the normal operation of a local breaker overcurrent trip flag indicator?

A. Actuates when an overcurrent lockout is reset; satisfies an electrical interlock to remotely close a breaker.

B. Actuates when a breaker overcurrent trip has occurred; may be manually reset when the overcurrent condition clears.

C. Actuates when a breaker has failed to trip on an overcurrent condition; may be manually reset when the overcurrent condition clears.

D. Actuates to cause a breaker trip when the overcurrent trip setpoint is reached; can be remotely reset when the overcurrent condition clears.

QUESTION: 41

A thermal overload device for a large motor protects the motor from...

A. sustained overcurrent by opening the motor breaker or motor line contacts.

B. sustained overcurrent by opening contacts in the motor windings.

C. instantaneous overcurrent by opening the motor breaker or motor line contacts.

D. instantaneous overcurrent by opening contacts in the motor windings.

QUESTION: 42

Refer to the drawing of a motor controller circuit (see figure below). (Note: Relay contacts follow the standard convention for control circuit drawings.)

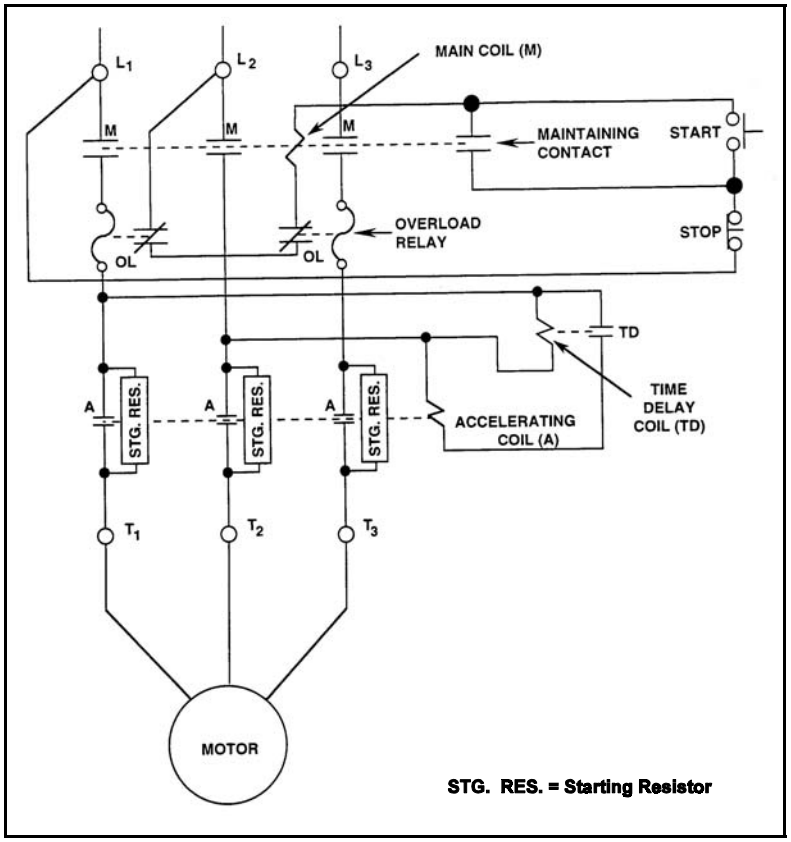
What is the purpose of the Time Delay Coil (TD) in the motor controller circuit?

A. Ensures the motor cannot be started until the overload relays are reset.

B. Ensures the motor cannot be started until the accelerating coil is energized.

C. Allows the motor to come up to speed before bypassing the starting resistors.

D. Allows the motor to come up to speed before placing the starting resistors in the circuit.



QUESTION: 43

Loss of breaker control power will...

A. remove all local indication of breaker position.

B. prevent local tripping of the breaker.

C. remove the remote breaker tripping capability.

D. prevent the breaker from tripping on overcurrent.

QUESTION: 44

Refer to the simplified drawing of an electrical distribution system showing 7.2 KV switchgear, step-down transformers, and 480 V motor control centers (MCCs) (see figure below). The high voltage side of each step-down transformer has a remote-operated disconnect. The control circuit for each disconnect is position-interlocked with the associated MCC feeder breaker.

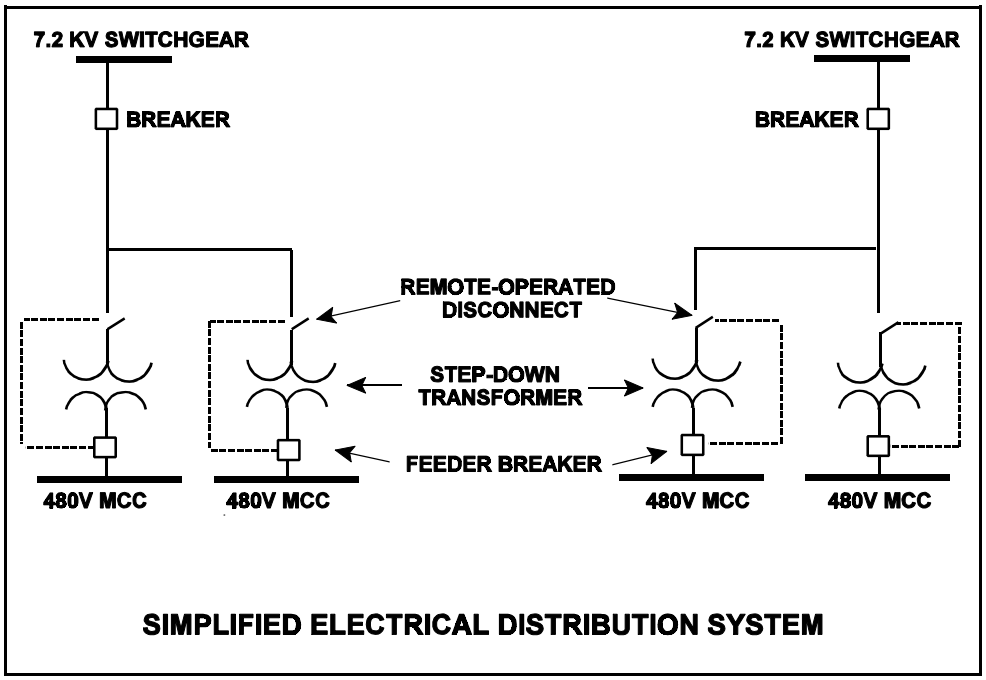
Which one of the following describes the interlock operating scheme that will provide the greatest protection for the disconnect?

A. Permits opening the feeder breaker only if the disconnect is closed.

B. Permits opening the feeder breaker only if the disconnect is open.

C. Permits opening the disconnect only if the feeder breaker is closed.

D. Permits opening the disconnect only if the feeder breaker is open.



SIMPLIFIED ELECTRICAL DISTRIBUTION SYSTEM

QUESTION: 45

Which one of the following is a characteristic of a prompt neutron?

A. Born with an average kinetic energy of 0.5 MeV.

B. Usually emitted by the excited nucleus of a fission product.

C. Accounts for more than 99% of fission neutrons.

D. Released an average of 13 seconds after the fission event.

QUESTION: 46

The best neutron moderator is _____ and is composed of _____ atoms.

A. dense; large

B. not dense; large

C. dense; small

D. not dense; small

QUESTION: 47

The fractional change in neutron population from one generation to the next is called...

A. beta.

B. K_{eff}.

C. lambda.

D. reactivity.

QUESTION: 48

A nuclear plant has just completed a refueling outage. Reactor engineers have predicted a control rod configuration at which the reactor will become critical during the initial reactor startup following the refueling outage based on the expected core loading. However, the burnable poisons scheduled to be loaded were inadvertently omitted.

Which one of the following describes the effect of the burnable poison omission on achieving reactor criticality during the initial reactor startup following the refueling outage?

A. The reactor will become critical before the predicted critical control rod configuration is achieved.

B. The reactor will become critical after the predicted critical control rod configuration is achieved.

C. The reactor will be unable to achieve criticality because the fuel assemblies contain insufficient positive reactivity to make the reactor critical.

D. The reactor will be unable to achieve criticality because the control rods contain insufficient positive reactivity to make the reactor critical.

QUESTION: 49

A step positive reactivity addition of 0.001 ΔK/K is made to a reactor with a stable neutron population and an initial core K_{eff} of 0.99. Consider the following two cases:

Case 1: The reactor is near the beginning of core life.
Case 2: The reactor is near the end of core life.

Assume the initial core neutron population is the same for each case.

Which one of the following correctly compares the prompt jump in core neutron population and the final stable core neutron population for the two cases?

A. The prompt jump will be greater for case 1, but the final stable neutron population will be the same for both cases.

B. The prompt jump will be greater for case 2, but the final stable neutron population will be the same for both cases.

C. The prompt jump will be the same for both cases, but the final stable neutron population will be greater for case 1.

D. The prompt jump will be the same for both cases, but the final stable neutron population will be greater for case 2.

QUESTION: 50

A reactor is operating at equilibrium 75% power with the following conditions:

Total power defect	= -0.0176 ΔK/K
Shutdown margin	= 0.0234 ΔK/K
Effective delayed neutron fraction	= 0.0067
Effective prompt neutron fraction	= 0.9933

How much positive reactivity must be added to make the reactor "prompt critical"?

A. 0.0067 ΔK/K

B. 0.0176 ΔK/K

C. 0.0234 ΔK/K

D. 0.9933 ΔK/K

QUESTION: 51

A reactor core is exactly critical well below the point of adding heat during a plant startup. A small amount of positive reactivity is then added to the core, and a stable positive reactor period is established.

With the stable positive reactor period, the following is observed:

Time	Power Level
0 sec	3.16×10^{-7}%
90 sec	1.0×10^{-5}%

Which one of the following will be the reactor power at time = 120 seconds?

A. 3.16×10^{-5}%

B. 5.0×10^{-5}%

C. 6.32×10^{-5}%

D. 1.0×10^{-4}%

QUESTION: 52

A reactor is shut down with the reactor vessel head removed for refueling. The core is covered by 23 feet of water with a temperature of 100°F.

Which one of the following can both increase and decrease Keff depending on core burnup?

A. A spent fuel assembly is removed from the core.

B. Refueling water temperature decreases to 95°F.

C. A fresh neutron source is installed in the core.

D. Movable incore source range instrumentation is repositioned to increase source range count rate.

QUESTION: 53

Refer to the drawing of a curve showing the neutron absorption characteristics of a typical U-238 nucleus at a resonance neutron energy (see figure below). The associated reactor is currently operating at steady-state 80% power.

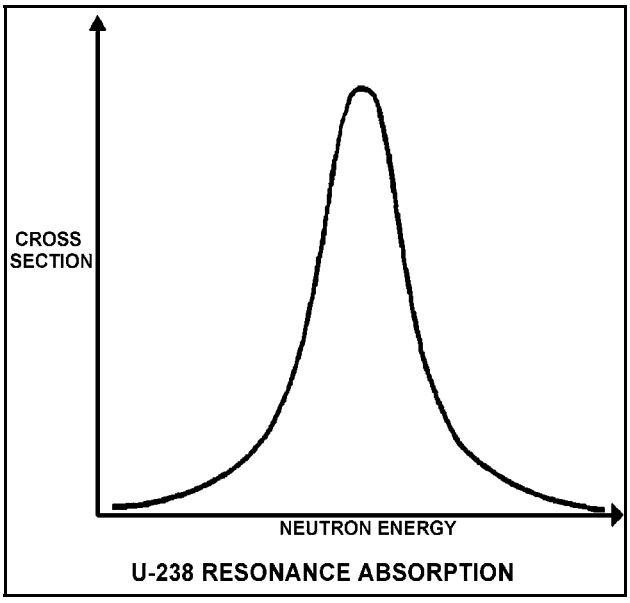
During a subsequent reactor power decrease to 70%, the curve will become _____; and the percentage of the core neutron population lost to resonance capture by U-238 will _____.

A. taller and more narrow; decrease

B. taller and more narrow; increase

C. shorter and broader; decrease

D. shorter and broader; increase



QUESTION: 54

Rod position indications indicate that a control rod is at position 16. When the control rod is moved to position 22, it is being...

A. inserted 18 inches.

B. withdrawn 18 inches.

C. inserted 36 inches.

D. withdrawn 36 inches.

QUESTION: 55

Which one of the following expresses the relationship between differential rod worth (DRW) and integral rod worth (IRW)?

A. IRW is the slope of the DRW curve.

B. IRW is the inverse of the DRW curve.

C. IRW is the sum of the DRWs between the initial and final control rod positions.

D. IRW is the sum of the DRWs of all control rods at any specific control rod position.

QUESTION: 56

As moderator temperature increases, the magnitude of differential rod worth will...

A. increase due to longer neutron migration length.

B. decrease due to reduced moderation of neutrons.

C. increase due to decreased resonance absorption of neutrons.

D. decrease due to decreased moderator absorption of neutrons.

QUESTION: 57

A reactor is operating at 50% power at the beginning of a fuel cycle. Assuming the reactor does not scram, which one of the following compares the effects of dropping a deep control rod to the effects of dropping the same control rod if it is shallow?

A. Dropping a deep control rod causes a greater change in shutdown margin.

B. Dropping a deep control rod causes a smaller change in shutdown margin.

C. Dropping a deep control rod causes a greater change in axial power distribution.

D. Dropping a deep control rod causes a greater change in radial power distribution.

QUESTION: 58

Fission fragments or daughters that have a substantial neutron absorption cross section and are not fissionable are called...

A. fissile materials.

B. fission product poisons.

C. fissionable nuclides.

D. burnable poisons.

QUESTION: 59

Xenon-135 is produced in the reactor by two methods. One is directly from fission, the other is from the decay of...

A. xenon-136.

B. iodine-135.

C. cesium-135.

D. barium-135.

QUESTION: 60

Reactors A and B are operating at steady-state 100% power with equilibrium core Xe-135. The reactors are identical except that reactor A is operating near the end of core life and reactor B is operating near the beginning of core life.

Which reactor is experiencing the most negative reactivity from equilibrium core Xe-135?

A. Reactor A due to a greater concentration of equilibrium core Xe-135

B. Reactor A due to lower competition from the fuel for thermal neutrons

C. Reactor B due to a greater thermal neutron flux in the core

D. Reactor B due to a smaller accumulation of stable fission product poisons

QUESTION: 61

A reactor is initially shut down with no xenon in the core. The reactor is brought critical and power level is increased to the point of adding heat. The shift supervisor has directed that power be maintained constant at this level for 12 hours for testing.

To accomplish this, control rods will have to be:

A. withdrawn periodically for the duration of the 12 hours.

B. inserted periodically for the duration of the 12 hours.

C. withdrawn periodically for 4 to 6 hours, then inserted periodically.

D. inserted periodically for 4 to 6 hours, then withdrawn periodically.

QUESTION: 62

A reactor has been operating at 100% power for two months when a reactor scram occurs. Four hours later, the reactor is critical and stable at 10% power.

Which one of the following operator actions is required to maintain reactor power at 10% over the next 24 hours?

A. Add positive reactivity during the entire period

B. Add negative reactivity during the entire period

C. Add positive reactivity, then negative reactivity

D. Add negative reactivity, then positive reactivity

QUESTION: 63

Which one of the following describes a reason for the direction of change in core xenon-135 reactivity immediately after a reactor shutdown from long-term power operation?

A. The production rate of Xe-135 from I-135 decay significantly decreases.

B. The production rate of Xe-135 from fission significantly decreases.

C. The removal rate of Xe-135 by decay to I-135 significantly decreases.

D. The removal rate of Xe-135 by neutron absorption significantly decreases.

QUESTION: 64

Refer to the drawing of K_{eff} versus core age for a reactor core following a refueling outage (see figure below).

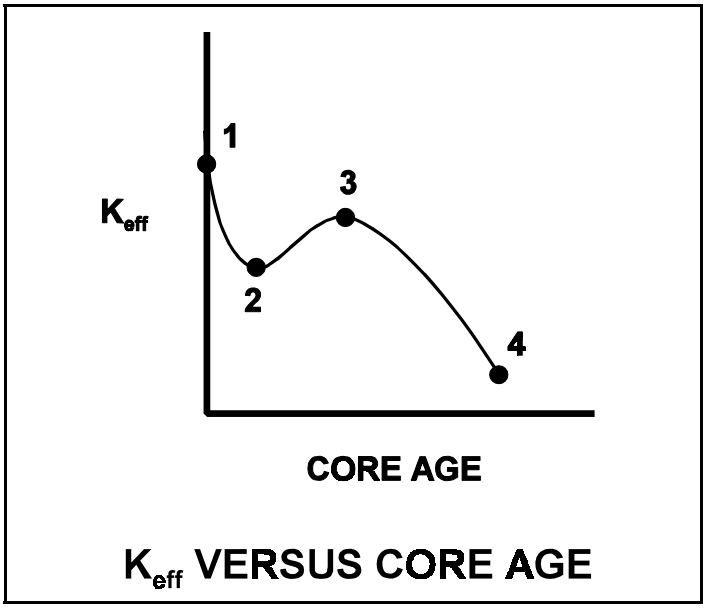
Which one of the following is responsible for the majority of the decrease in K_{eff} from point 1 to point 2?

A. Depletion of fuel

B. Burnout of burnable poisons

C. Initial heat-up of the reactor

D. Buildup of fission product poisons



QUESTION: 65

A nuclear plant was operating at steady-state 100% power near the end of a fuel cycle when a reactor scram occurred. Four hours after the scram, reactor pressure is being maintained at 600 psig in anticipation of commencing a reactor startup.

At this time, which one of the following will cause the fission rate in the reactor core to decrease?

A. Core void fraction is decreased by 2%.

B. Reactor coolant temperature is allowed to decrease by 3°F.

C. The operator fully withdraws the first group of control rods.

D. An additional two hours is allowed to pass with no other changes in plant parameters.

QUESTION: 66

After recording critical data during a cold reactor startup with main steam isolation valves open, the operator withdraws the control rods to continue the startup. Which one of the following pairs of parameters will provide the first indication of reaching the point of adding heat?

A. Reactor pressure and reactor water level

B. Reactor power and reactor period

C. Reactor pressure and turbine load

D. Reactor water level and core flow rate

QUESTION: 67

During a reactor heat-up, a center control rod is notched outward with no subsequent operator action. The heat-up rate will...

A. increase initially, then gradually decrease.

B. decrease initially, then gradually increase.

C. increase and stabilize at a new higher value.

D. decrease and stabilize at a new lower value.

QUESTION: 68

A reactor is critical at 5×10^{-2}% power during a cold reactor startup at the beginning of core life. Reactor period is stable at positive 87 seconds. Assuming no operator action, no reactor scram, and no steam release, what will be reactor power 10 minutes later?

A. Below the point of adding heat (POAH)

B. At the POAH

C. Above the POAH but less than 49%

D. Approximately 50%

QUESTION: 69

Neglecting the effects of changes in core Xe-135, which one of the following power changes requires the smallest amount of positive reactivity addition?

A. 3% power to 10% power

B. 10% power to 15% power

C. 15% power to 30% power

D. 30% power to 40% power

QUESTION: 70

Which one of the following is the purpose of a rod sequence exchange?

A. Ensures proper rod coupling

B. Prevents rod shadowing

C. Promotes even fuel burnout

D. Minimizes water hole peaking

QUESTION: 71

A reactor plant that has been operating at rated power for two months experiences a reactor scram. Five minutes after the scram, with all control rods still fully inserted, a count rate of 5,000 cps is indicated on the source range nuclear instruments with a reactor period of negative 80 seconds.
.
The majority of the source range detector output is currently being caused by the interaction of _____ with the detector.

A. intrinsic source neutrons

B. fission gammas from previous power operation

C. fission neutrons from subcritical multiplication

D. delayed fission neutrons from previous power operation

QUESTION: 72

A reactor is exactly critical in the source range when a fully withdrawn control rod fully inserts into the core.

If no operator or automatic actions occur, how will the source range count rate respond?

A. Decrease to zero.

B. Decrease to the value of the source neutron strength.

C. Decrease to a value above the source neutron strength.

D. Decrease initially and then slowly increase and stabilize at the initial value.

QUESTION: 73

Refer to the drawing of four differential pressure level detectors (see figure below).

The tanks are identical and are being maintained at 30 psia with a water level of 20 feet. They are surrounded by standard atmospheric pressure. The water temperatures in the tanks and reference legs are the same.

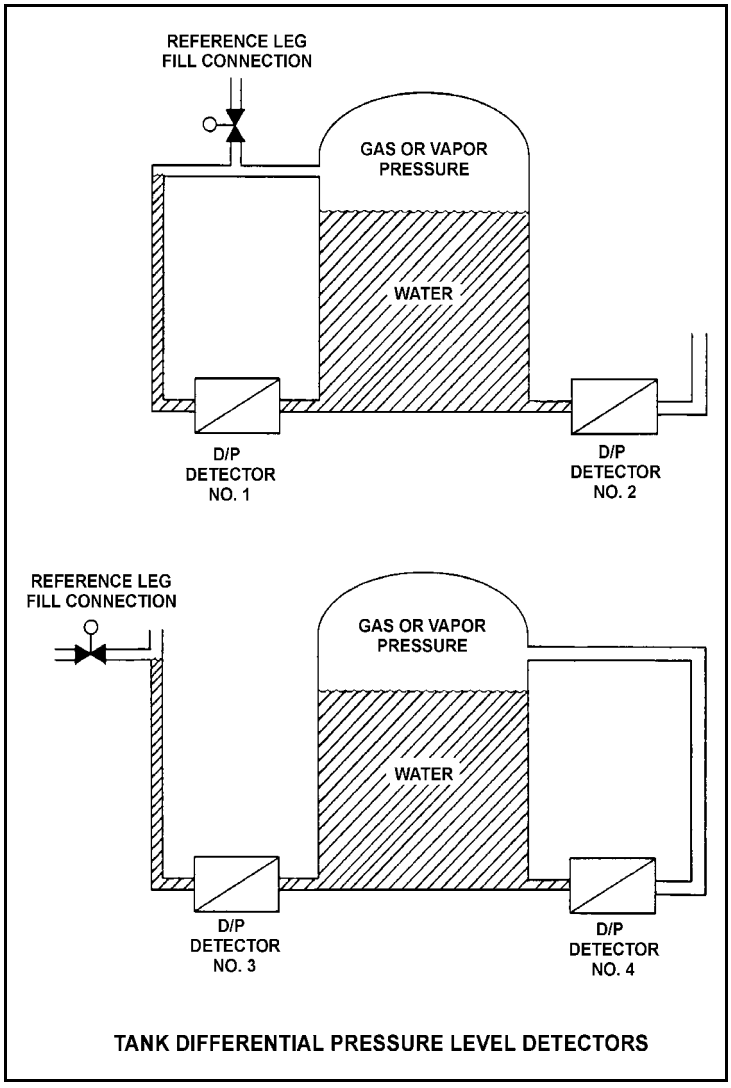
If each detector experiences a ruptured diaphragm, which detector(s) will cause indicated tank level to decrease? (Assume actual tank water level remains constant.)

A. No. 1 only

B. No. 2 only

C. No. 1, 2, and 3

D. No. 2, 3, and 4



TANK DIFFERENTIAL PRESSURE LEVEL DETECTORS

QUESTION: 74

A 100 ft^3 vessel contains a saturated water-steam mixture at 1,000 psia. The water portion occupies 30 ft^3 and the steam portion occupies the remaining 70 ft^3. What is the approximate total mass of the mixture in the vessel?

A. 1,547 lbm

B. 2,612 lbm

C. 3,310 lbm

D. 4,245 lbm

QUESTION: 75

An ideal main turbine generator (MTG) is producing 1000 MW of electrical power while being supplied with 100% quality steam at 920 psig. Steam supply pressure is then gradually increased to 980 psig at the same quality. Assume turbine control valve position and condenser vacuum remain the same.

Which one of the following describes why the MTG output increases as steam pressure increases?

A. Each lbm of steam entering the turbine has a higher specific heat.

B. Each lbm of steam entering the turbine has a higher specific enthalpy.

C. Each lbm of steam passing through the turbine expands to fill a greater volume.

D. Each lbm of steam passing through the turbine performs increased work in the turbine.

QUESTION: 76

A plant is operating at 80% power with 5°F of condensate depression in the main condenser. If the condensate depression increases to 10°F, plant efficiency will _____ and the probability of condensate pump cavitation will _____.

A. increase; increase

B. increase; decrease

C. decrease; increase

D. decrease; decrease

QUESTION: 77

A nuclear power plant is operating near rated power with the following initial conditions:

Main steam pressure: 900 psia
Main steam quality: 100%, saturated vapor
Main condenser pressure: 1.0 psia

Air leakage into the main condenser results in the main condenser pressure increasing and stabilizing at 2.0 psia. Assume that all main steam parameters (e.g., pressure, quality, and mass flow rate) remain the same and that the main turbine efficiency remains at 100%.

Which one of the following is the approximate percent by which the main generator output will decrease as a result of the main condenser pressure increase?

A. 5.0%

B. 6.3%

C. 7.5%

D. 8.8%

QUESTION: 78

Given the following:

- A saturated steam-water mixture with an inlet quality of 40% is flowing through a moisture separator.
- The moisture separator is 100% efficient for removing water.

How much water will be removed by the moisture separator from 50 lbm of the steam-water mixture?

A. 10 lbm

B. 20 lbm

C. 30 lbm

D. 40 lbm

QUESTION: 79

Refer to the drawing of a centrifugal pump operating curve (see figure below).

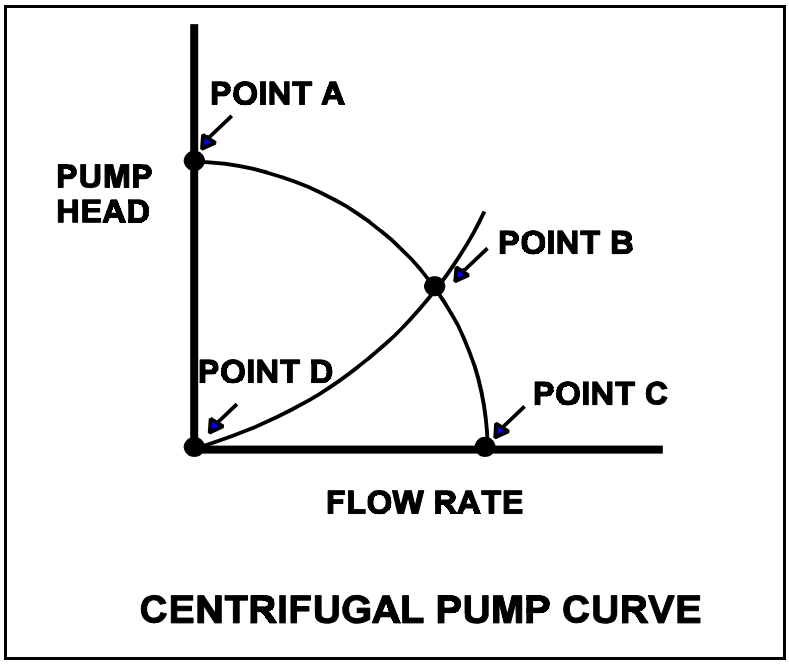
Which one of the following determines the general shape of the curve from point D to point B?

A. Pump flow losses due to the decrease in available net positive suction head as the system flow rate increases

B. Pump flow losses due to back leakage through the clearances between the pump impeller and casing as the D/P across the pump increases

C. The frictional and throttling losses in the piping system as the system flow rate increases

D. The frictional losses between the pump impeller and its casing as the differential pressure (D/P) across the pump increases



QUESTION: 80

Which one of the following components of a centrifugal pump has the specific primary function of converting the kinetic energy of a fluid into pressure?

A. Volute

B. Impeller

C. Pump shaft

D. Discharge nozzle

QUESTION: 81

Refer to the drawing of four sets of centrifugal pump operating curves (see figure below). Each set of curves shows the results of a change in pump/system operating conditions.

Two identical constant-speed centrifugal pumps are operating in parallel in an open system when one pump trips.

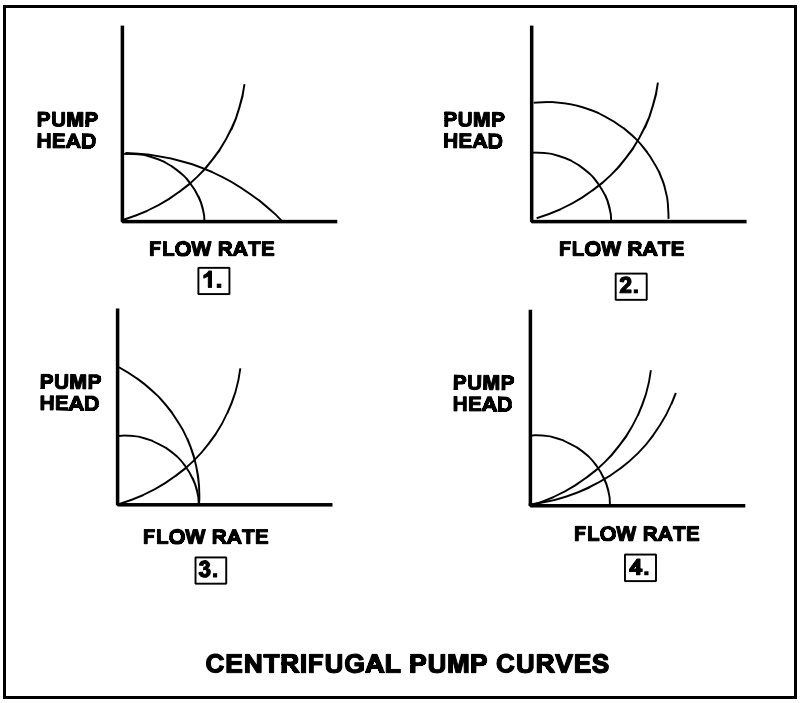
Which set of operating curves depicts the "before" and "after" conditions described above?

A. 1.

B. 2.

C. 3.

D. 4.



QUESTION: 82

The order of reactor coolant heat transfer mechanisms, from the least efficient to the most efficient, is...

A. transition boiling, stable film boiling, nucleate boiling.

B. transition boiling, nucleate boiling, stable film boiling.

C. stable film boiling, nucleate boiling, transition boiling.

D. stable film boiling, transition boiling, nucleate boiling.

QUESTION: 83

A reactor is operating at power. The feedwater flow rate to the reactor vessel is 7.0×10^6 lbm/hr at a temperature of 440°F. The steam exiting the reactor vessel is at 1000 psia with 100% steam quality.

Ignoring all other heat gain and loss mechanisms, what is the core thermal power?

A. 1335 MWt

B. 1359 MWt

C. 1589 MWt

D. 1612 MWt

QUESTION: 84

The power range nuclear instruments have been adjusted to 100% based on a heat balance calculation. Which one of the following will result in indicated reactor power being higher than actual reactor power?

A. The feedwater temperature used in the heat balance calculation was 20°F higher than actual feedwater temperature.

B. The reactor recirculation pump heat input term was omitted from the heat balance calculation.

C. The steam and feedwater flow rates used in the heat balance calculation were 10% lower than actual flow rates.

D. The ambient heat loss term was omitted from the heat balance calculation.

QUESTION: 85

Subcooled water is flowing into a fuel assembly in an operating reactor core. As the water flows upward through the fuel assembly, the water begins to boil and exits the fuel assembly as a saturated fluid.

If fuel assembly power is unchanged and system pressure is increased such that all of the water remains subcooled, the average fuel temperature in the fuel assembly would be _____ because boiling is a _____ efficient method of heat transfer.

A. higher; more

B. higher; less

C. lower; more

D. lower; less

QUESTION: 86

A reactor is shutdown at normal operating temperature and pressure. Which one of the following will decrease the critical heat flux for the reactor fuel? (Assume the reactor remains shutdown.)

A. Fully withdrawing one control rod

B. Increasing reactor vessel water level by 12 inches

C. Increasing reactor recirculation flow rate by 100 gpm

D. Increasing RCS pressure by 10 psig

QUESTION: 87

If the fission rate in a reactor core steadily increases, the mode of heat transfer that occurs immediately after the critical heat flux is reached is called...

A. transition boiling.

B. subcooled nucleate boiling.

C. saturated nucleate boiling.

D. stable film boiling.

QUESTION: 88

A reactor is operating at 70% power. Recirculation flow rate is increased by 5%.

Which one of the following statements describes the initial response of the boiling boundary within the core?

A. It physically moves upward, because fewer Btus per pound mass of water are now being transferred.

B. It physically moves upward, because more Btus per pound mass of water are now being transferred.

C. It physically moves downward, because more Btus per pound mass of water are now being transferred.

D. It physically moves downward, because fewer Btus per pound mass of water are now being transferred.

QUESTION: 89

Which one of the following describes the relationship between the feedwater mass flow rate entering the reactor vessel and the core mass flow rate at steady-state 100% reactor power?

A. The mass flow rates are about the same as long as the reactor vessel downcomer level is constant.

B. The mass flow rates are about the same as long as the reactor recirculation mass flow rate is constant.

C. The feedwater mass flow rate is much smaller than the core mass flow rate because most of the core mass flow is returned to the reactor vessel downcomer by the steam separators.

D. The feedwater mass flow rate is much larger than the core mass flow rate because the feedwater pump differential pressure is much larger than the core differential pressure.

QUESTION: 90

Two reactors, A and B, are operating at the same rated power with neutron flux radially peaked in the center of each core. Reactors A and B are identical except that reactor A has core orificing and reactor B does not. Both reactors have the same control rod pattern and density.

Compared to the center fuel bundle in reactor A, the center fuel bundle in reactor B will have the _____ critical power and the _____ coolant flow rate.

A. lowest; lowest

B. lowest; highest

C. highest; lowest

D. highest; highest

QUESTION: 91

A reactor is shut down with all reactor recirculating pumps stopped. Which one of the following explains why it is important to monitor reactor vessel skin temperatures?

A. Significant differential temperature between the top and bottom reactor vessel heads will result in excessive thermal stresses in the reactor vessel wall.

B. Significant differential temperature between the upper and lower elevation reactor vessel skin indicates that thermal stratification is occurring.

C. These temperatures provide a backup indication of reactor water level because the skin temperatures detected above vessel water level will be lower than those below vessel water level.

D. These temperatures provide the best indication of the accuracy of the shutdown reactor water level instruments due to the temperature variance from instrument calibration conditions.

QUESTION: 92

The ratio of the highest pin heat flux in a node to the average pin heat flux in the same node is called the _____ peaking factor.

A. local

B. radial

C. axial

D. total

QUESTION: 93

A BWR core consists of 30,000 fuel rods; each fuel rod has an active length of 12 feet. The core is producing 1,800 MW of thermal power. If the total peaking factor for a node is 1.6, what is the maximum local linear power density being produced in the node?

A. 4.0 kW/ft

B. 6.0 kW/ft

C. 8.0 kW/ft

D. 10.0 kW/ft

QUESTION: 94

A reactor has experienced a loss of coolant accident. Inadequate core cooling has resulted in the following core temperatures one hour into the accident:

90% of the fuel clad has remained below 1800°F
10% of the fuel clad has exceeded 1800°F
5% of the fuel clad has exceeded 2000°F
0.5% of the fuel clad has reached 2200°F
0.0% of the fuel clad has exceeded 2200°F
Peak centerline fuel temperature is 4650°F

Which one of the following is an adverse consequence that will occur if the above fuel and clad temperatures remain constant for 24 additional hours followed by the injection of emergency cooling water directly to the top of the core?

A. Explosive hydrogen concentration inside the reactor vessel

B. Explosive hydrogen concentration inside the reactor containment building

C. Release of radioactive fission products due to melting of the fuel pellets and fuel clad

D. Release of radioactive fission products due to rupture of the fuel clad

QUESTION: 95

Bundle critical power ratio must be maintained _____ 1.0 to prevent fuel damage caused by a rapid increase in the temperature of the _____.

A. greater than; fuel pellets

B. less than; fuel pellets

C. greater than; fuel clad

D. less than; fuel clad

QUESTION: 96

The fuel thermal time constant specifies the amount of time required for...

A. a fuel bundle to achieve equilibrium temperature following a power change.

B. a fuel pellet to achieve equilibrium temperature following a power change.

C. the fuel centerline temperature to undergo most of its total change following a power change.

D. the fuel cladding temperature to undergo most of its total change following a power change.

QUESTION: 97

Which one of the following is most likely to result in fuel failure due to pellet-clad interaction?

A. Increasing reactor power from 20% to 50% near the beginning of a fuel cycle

B. Increasing reactor power from 20% to 50% near the end of a fuel cycle

C. Increasing reactor power from 70% to 100% near the beginning of a fuel cycle

D. Increasing reactor power from 70% to 100% near the end of a fuel cycle

QUESTION: 98

The most limiting thermal limit for a loss of feedwater heating transient is...

A. average planar linear heat generation rate.

B. linear heat generation rate.

C. critical power ratio.

D. core thermal power.

QUESTION: 99

Which one of the following comparisons will result in a higher probability of brittle fracture failure of the reactor vessel?

A. A feedwater pH of 8.5 rather than 9.0

B. A high feedwater oxygen content rather than a low oxygen content

C. A 50°F/hr reactor cooldown rather than a 100°F/hr heatup

D. A high gamma flux rather than a high neutron flux

QUESTION: 100

Two identical reactors are currently shut down for refueling. Reactor A has achieved an average lifetime power capacity of 60% while operating for 15 years. Reactor B has achieved an average lifetime power capacity of 60% while operating for 12 years.

Which reactor, if any, will have the lowest reactor vessel nil ductility transition temperature?

A. Reactor A because it has produced the greater number of fissions.

B. Reactor B because it has produced the fewer number of fissions.

C. Both reactors will have approximately the same nil ductility transition temperature because they have equal average lifetime power capacities.

D. Both reactors will have approximately the same nil ductility transition temperature because the fission rate in a shut down core is not significant.

***** FINAL ANSWER KEY *****

JUNE 2003 NRC GENERIC FUNDAMENTALS EXAMINATION
BOILING WATER REACTOR - ANSWER KEY

FORM A	FORM B	ANS	FORM A	FORM B	ANS	FORM A	FORM B	ANS	FORM A	FORM B	ANS
1	29	B	26	54	D	51	79	A	76	4	D
2	30	B	27	55	B	52	80	B	77	5	C
3	31	C	28	56	C	53	81	A	78	6	C
4	32	B	29	57	B	54	82	B	79	7	C
5	33	A	30	58	A	55	83	C	80	8	A
6	34	C	31	59	B	56	84	A	81	9	A
7	35	A	32	60	C	57	85	D	82	10	D
8	36	A	33	61	D	58	86	B	83	11	C
9	37	A	34	62	B	59	87	B	84	12	B
10	38	B	35	63	D	60	88	B	85	13	A
11	39	B	36	64	D	61	89	A	86	14	D
12	40	C	37	65	B	62	90	C	87	15	A
13	41	C	38	66	D	63	91	D	88	16	A
14	42	B	39	67	D	64	92	D	89	17	C
15	43	C	40	68	B	65	93	D	90	18	A
16	44	B	41	69	A	66	94	B	91	19	B
17	45	B	42	70	C	67	95	A	92	20	A
18	46	A	43	71	C/D	68	96	B	93	21	C
19	47	C	44	72	D	69	97	B	94	22	D
20	48	B	45	73	C	70	98	C	95	23	C
21	49	A	46	74	C	71	99	D	96	24	D
22	50	A	47	75	D	72	100	C	97	25	D
23	51	C	48	76	A	73	1	D	98	26	C
24	52	A	49	77	B	74	2	A	99	27	C
25	53	D	50	78	A	75	3	D	100	28	B