RED SEAL EXAM PREP

309A Construction Electrician

Free 50-Question Mock Exam

Practice for the Red Seal / Certificate of Qualification exam

Pass mark: 70% · Aligned to the published occupational standard topic weightings
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Mock Exam — answer all questions, then check the key

Q1. **Under CEC Section 2 (General Rules), all electrical installations must be made to avoid:**

A) Excessive use of aluminum conductors

B) Reverse polarity on any outlet

C) Use of more than 6 circuits per panel

D) Fire or shock danger to persons or property

Q2. **When pulling conductors through conduit, what is the maximum allowable conductor fill percentage for a conduit containing three or more conductors?**

A) 50% fill — half the conduit interior area may be used by conductors

B) 60% fill — commercial conduit systems allow higher fill than residential

C) 31% fill — applies to two conductors in the same conduit

D) 40% fill — the limit for three or more conductors in a conduit

Q3. **What is the purpose of a motor starter overload relay?**

A) To reverse the motor's direction of rotation

B) To protect the windings from sustained overcurrent

C) To control the motor's running speed

D) To start and stop the motor remotely

Q4. **A ground fault occurs on a 120V branch circuit protected by a 15A breaker. The fault current is only 3 amps — too low to trip the breaker. What safety device would protect against this fault?**

A) An arc fault breaker (AFCI) — it detects all ground faults below breaker trip thresholds

B) A fuse with the same rating as the breaker — fuses are faster than breakers for small faults

C) A GFCI — it detects ground faults as small as 4–6 mA and trips in milliseconds

D) A larger 20A breaker — higher rated breakers are more sensitive to small faults

Q5. **In a three-phase system, the relationship between line voltage (V_L) and phase voltage (V_Ph) in a WYE (star) connection is:**

A) $V_L = V_{Ph} \times \sqrt{3}$

B) $V_L = V_{Ph} \div \sqrt{3}$

C) $V_L = V_{Ph} \times 3$

D) $V_L = V_{Ph}$ (equal)

Q6. **A 240V single-phase circuit has a measured power factor of 0.72 lagging. The apparent power is 8 kVA. What is the true (real) power consumed by the load?**

A) 5.76 kW — real power = apparent power × power factor (8 kVA × 0.72 = 5.76 kW)

B) 8 kW — apparent power equals real power on all single-phase circuits

C) 11.1 kW — real power is always greater than apparent power

D) 5.76 kVAR — the reactive component, not real power

Q7. **What is the minimum approach distance for an unqualified worker near an energized overhead power line at 25kV in Canada?**

A) 10 metres

B) 3 metres

C) 5 metres

D) 1 metre

Q8. **A VFD (Variable Frequency Drive) controls motor speed by:**

A) Varying the supply voltage only, keeping frequency constant

B) Varying the motor's pole count electronically

C) Switching between star and delta windings

D) Varying both frequency and voltage proportionally

Q9. **A transformer has a primary voltage of 600V, a secondary voltage of 120V, and a primary current of 2A. What is the secondary current (ignoring losses)?**

A) 10A

B) 120A

C) 0.4A

D) 2A

Q10. **Under the CEC, GFCI protection is required in which of the following locations?**

A) Only in commercial kitchen installations

B) Only on circuits rated over 30 amperes

C) Bathrooms, garages, outdoors, and near sinks

D) Only in bedroom outlet locations

Q11. **Under the CEC, what colour is required for the grounding conductor in a fixed wiring system?**

A) Red or orange — grounding conductors must contrast with neutral conductors

B) Bare copper or green — distinguishing it from current-carrying conductors

C) White — white is used for grounding conductors in all Canadian installations

D) Any colour — grounding conductors have no colour requirement under the CEC

Q12. **Under the CEC, what is the maximum voltage drop allowed in a branch circuit for power and heating loads?**

A) Voltage drop is not regulated by the CEC — it is a design guideline only

B) 3% for the branch circuit and 5% total from service to point of utilization

C) 1% maximum — power loads are more sensitive to voltage drop than lighting

D) 5% maximum for all circuits — no distinction between feeder and branch circuit drop

Q13. **What is the purpose of a bonding conductor in an electrical installation?**

A) It ties all metal enclosures into a low-impedance fault path so devices trip quickly

B) Bonding prevents static electricity buildup — it is only required in flammable/explosive locations

C) Bonding is another term for the neutral conductor — they serve the same function

D) Bonding provides the return path for current during normal operation — it carries load current

Q14. **When installing a conduit run, the maximum permitted spacing between conduit supports for 1-inch EMT is:**

A) 2m (6.5 ft)

B) 4.5m (15 ft)

C) 1.5m (5 ft)

D) 6m (20 ft)

Q15. **The impedance (Z) of a series RL circuit with resistance 3Ω and inductive reactance 4Ω is:**

A) 7Ω

B) 5Ω

C) 12Ω

D) 1Ω

Q16. **Under the CEC, what clearance must be maintained between an overhead service entrance conductor and the finished grade of a residential property?**

A) 3.5 m over pedestrian areas, 4 m over residential driveways, 5.5 m over roads

B) Clearance is only specified for power lines over 600V — residential service has no CEC height requirement

C) 3 metres above grade at all points

D) 6 metres above all outdoor areas regardless of vehicle access

Q17. **What test is used to measure the insulation resistance of a motor winding, and what is a generally acceptable minimum reading?**

A) Standard voltmeter test — measure voltage between windings and frame to confirm insulation

B) Hi-pot (high potential) test at 1,000V DC — used for routine motor insulation testing

C) Continuity test with a standard ohmmeter — reading should be infinite (OL) for good insulation

D) Megohmmeter (megger) test — minimum generally 1 MΩ per kV of rated motor voltage

Q18. **In the CEC, what defines a "wet location" and what wiring method requirements apply?**

A) Wet locations require only a 15-degree drip shield above enclosures

B) A wet location is defined only as underground wiring locations

C) Any location where water may drip on the electrical installation — same wiring methods as dry locations

D) A location subject to saturation — requires weatherproof fixtures and wet-rated wiring methods

Q19. **A 200A service entrance requires conductors sized at 125% of the continuous load plus 100% of the non-continuous load. The continuous load is 160A and non-continuous load is 20A. What minimum ampacity conductor is required?**

A) 160A — only the continuous load determines conductor size

B) 240A — service entrance conductors must be 120% of total load for safety margin

C) 200A — the service entrance conductor must match the service size

D) 220A — calculated as (160A × 1.25) + (20A × 1.0) = 200A + 20A = 220A minimum conductor ampacity

Q20. **A transformer has 240V primary and 120V secondary with a 2:1 turns ratio. If the secondary is loaded at 20 amperes, what is the primary current (assuming 100% efficiency)?**

A) 40A — primary current doubles in a step-down transformer

B) 5A — primary current is divided by the turns ratio squared

C) 20A — current is the same on both sides of an ideal transformer

D) 10A — current ratio is the inverse of the voltage ratio

Q21. **A technician is installing Type AC (armoured cable) and needs to connect it to a metal box. What is required at the connection point?**

A) The armour must be soldered to the box for a continuous ground path

B) The armoured cable can be connected directly to the box knockout — no fittings required

C) An AC-approved connector plus an anti-short (red) bushing over the cut armour

D) A grounding lug must be attached externally to the armour before entering the box

Q22. **A three-phase induction motor is running but makes a loud hum and vibrates excessively. One phase has been lost (single-phasing). What happens to the motor?**

A) It keeps running but overheats from high current and reduced torque

B) The motor reverses direction when single-phasing occurs

C) The motor immediately stops when one phase is lost

D) The motor runs normally at slightly reduced speed and efficiency

Q23. **A three-phase motor draws high current on all three phases but runs at reduced speed under load. The MOST likely cause is:**

A) Low supply voltage on all three phases

B) Motor is too large for the application

C) Overload relay set too high

D) Single-phasing (one phase lost)

Q24. **Under the CEC and CSA Z462, what constitutes an "Electrically Safe Work Condition" before performing maintenance on a distribution panel?**

A) Wearing appropriate arc flash PPE before opening the panel

B) Turning the main breaker to the off position before opening the panel

C) Having a second electrician present as a safety observer while working on energized equipment

D) De-energizing, locking out, releasing stored energy, and verifying absence of voltage

Q25. **Under CEC Rule 14-104(2) and Table 13, what is the maximum overcurrent protection permitted for a 10 AWG copper conductor (rated 30A) in a general branch circuit?**

A) 15A — CEC requires conductors to be protected at 50% of their ampacity

B) 30A — the conductor is rated 30A so 30A overcurrent protection is permitted

C) 30A is permitted if the conductor's ampacity equals or exceeds the OCPD rating. However, CEC Rule 14-104 limits the standard ratings — the next standard fuse/breaker size below 30A (if 30A is not a standard size for that circuit type) applies

D) 40A — overcurrent protection may be the next size up if the exact ampacity rating is not a standard size

Q26. **A 480V three-phase motor is connected to a circuit that measures 480V L-L. The motor runs but is unusually hot. An ammeter shows one phase drawing 22A and the other two phases drawing 18A each. What does this indicate?**

A) The motor is under-loaded — different phase currents indicate the load is not balanced across all phases

B) Phase imbalance — from voltage imbalance, a developing fault, or a failing winding

C) The circuit breaker on the high phase is faulty — replace the 22A phase breaker

D) Normal operation — three-phase motors commonly have some phase imbalance

Q27. **The reactance of a capacitor (X_C) in an AC circuit:**

A) Decreases as frequency increases

B) Is equal to the capacitance value in farads

C) Increases as frequency increases

D) Is not affected by frequency

Q28. **A motor nameplate shows "SF 1.15" (Service Factor). What does this mean?**

A) SF 1.15 indicates the motor starting torque is 15% above standard motors

B) The motor can operate at 115% of its rated horsepower continuously without damage

C) Service Factor 1.15 means the motor efficiency is 15% higher than a standard motor

D) The motor can run at 115% of rated horsepower briefly under nameplate conditions

Q29. **Under the CEC, what is the maximum number of single-conductor wires permitted in a standard trade-size ½-inch EMT conduit based on Table 6 wire fill?**

A) 4 conductors (regardless of size — conduit fill is not size-dependent)

B) It depends on conductor size — per Table 6, typically 9 conductors for 12 AWG T90

C) 2 conductors maximum — NEC and CEC both limit conduit to 2 conductors

D) Fill is unlimited as long as conductors can be pulled without damage

Q30. **What does EMT stand for in electrical conduit systems?**

A) Enclosed Metal Trough

B) Exterior Metal Tube

C) Electrical Metal Tubing

D) Electrical Mechanical Threading

Q31. **The colour coding for conductors in a 3-phase 4-wire system in Canada (per CEC) typically uses:**

A) Brown, Orange, Yellow for phases

B) Red, Black, Blue; White neutral; Green ground

C) Black, White, Red, Green

D) All black conductors with coloured tape at each end only

Q32. **What is the purpose of the overload relay in a motor starter?**

A) To protect the motor against short circuit faults

B) To protect the circuit conductor from overcurrent conditions

C) To protect the motor windings from sustained overload current

D) To prevent the motor from starting in reverse direction

Q33. **What does LOTO stand for and when must it be applied?**

A) Line Output Test Operation — during electrical testing

B) Lockout/Tagout — before maintenance or service on equipment

C) Lock Out, Tag Out — only for high voltage above 600V

D) Load Only, Turn Off — when changing light bulbs

Q34. **A VFD (Variable Frequency Drive) is installed on a pump motor and the operator reports the motor makes a high-pitched whine but operates correctly otherwise. What is the most likely explanation?**

A) The VFD's PWM carrier frequency is in the audible range — a normal characteristic

B) The pump impeller is cavitating due to low suction pressure

C) The motor bearings are failing — high-pitched whine is early bearing failure

D) The VFD is malfunctioning — high-pitched noise indicates an output fault

Q35. **What is the purpose of the contacts on a holding coil in a motor starter (latching contact/seal-in contact)?**

A) To provide overload protection

B) To hold the coil in after START is released

C) To reduce inrush current during startup

D) To prevent reverse rotation of the motor

Q36. **An AC circuit has R = 8 Ω and XL = 6 Ω in series. What is the total impedance?**

A) 4.8 Ω (8 × 6 ÷ 10)

B) 10 Ω ($\sqrt{(8^2 + 6^2)}$)

C) 2 Ω (8 − 6)

D) 14 Ω (8 + 6)

Q37. **A Type NMD90 cable is being installed in a residential building. According to the CEC, in which locations is NMD90 cable installation NOT permitted?**

A) NMD90 is not permitted in exterior walls only — all interior walls are acceptable

B) NMD90 may not be used in finished basements — only conduit is acceptable below grade

C) In commercial/industrial buildings, wet or damp locations, concrete, or exposed to damage

D) NMD90 may be installed anywhere in a residential building without restriction

Q38. **In an AC circuit with both resistance and inductive reactance, what does the term "power factor" represent?**

A) The ratio of true power to apparent power

B) The total current in the circuit

C) The frequency of the AC supply

D) The resistance of the conductor

Q39. **Before drilling through a wall to run conduit in an existing building, a technician MUST:**

A) Notify the building manager and wait 24 hours

B) Verify the location of hidden wiring, plumbing, and gas lines

C) Drill a test hole first to check for studs

D) Assume the wall is clear if no outlets are visible on the surface

Q40. **A three-phase motor runs in the wrong direction. What is the SIMPLEST correction?**

A) Add a starting capacitor to the circuit

B) Replace the motor starter contactor

C) Swap any two of the supply phase conductors

D) Rewind the motor stator windings

Q41. **A technician is working alone in an electrical room. According to safety regulations, lone-worker requirements typically include:**

A) A check-in system, buddy system, or remote monitoring

B) Working alone requires only notifying a supervisor before starting

C) Lone work is prohibited for any electrical task

D) No special requirements — electrical work can always be done alone

Q42. **A 20-amp branch circuit must use conductors rated for at least:**

A) 30 amps — one size up for safety

B) 15 amps — one size down is permitted

C) 25 amps — to allow for load growth

D) 20 amps — must match the protection rating

Q43. **According to CEC Table 53, what is the minimum depth of burial for a direct-buried armoured cable (such as TECK90) rated 750V or less in an area not subject to vehicular traffic?**

A) 450 mm (18 inches), reducible by 150 mm where mechanical protection is added

B) 900 mm (36 inches) for all direct-buried cables regardless of type or location

C) 150 mm (6 inches) — the armour alone provides sufficient protection for a shallow burial

D) No minimum — armoured cables may be laid at any convenient depth

Q44. **A circuit has a power factor of 0.75 and draws 20A at 240V (single phase). What is the real power (watts) consumed?**

A) 2,400W

B) 3,600W

C) 6,400W

D) 4,800W

Q45. **When running EMT conduit through a fire-rated wall assembly, what is required at the penetration?**

A) A junction box on each side

B) An approved firestop system at the penetration

C) A locknut on each side of the wall

D) Nothing — EMT is metal and inherently fire resistant

Q46. **An EMT (Electrical Metallic Tubing) conduit system must be properly bonded and grounded. What is the purpose of a bonding jumper at a service entrance where EMT is connected to the service equipment enclosure?**

A) The bonding jumper improves the aesthetic appearance of the conduit connection

B) The bonding jumper increases the ampacity of the grounding system by providing a parallel path

C) Bonding jumpers are required only on aluminum conduit — steel EMT provides its own inherent bonding

D) It ensures a low-impedance fault current path so the breaker trips reliably

Q47. **What is the minimum arc flash PPE category (under NFPA 70E or CSA Z462) required when working on a 600V distribution panel with the panel cover removed and circuits energized?**

A) Arc flash PPE is only required for voltages above 1,000V

B) No PPE required — all commercial panels are covered with non-conductive material

C) Minimum Arc Flash PPE Category 2, confirmed by an arc flash hazard analysis

D) Standard safety glasses are adequate — arc flash only occurs during fault conditions

Q48. **Under the CEC, what is the purpose of an Equipment Ground Fault Protection (EGFP) device on a 1000A service?**

A) To balance the load between phases

B) To provide GFCI (shock) protection for personnel

C) To protect against lightning strikes on the service entrance

D) To detect ground faults before arcing destroys the switchgear

Q49. **Under the CEC, what GFCI protection is required for a receptacle outlet installed in a bathroom of a dwelling unit?**

A) Bathroom receptacles require AFCI protection — GFCI is never required in bathrooms

B) Class A GFCI protection for receptacles within 1.5 m of a sink, bathtub, or shower

C) GFCI protection is required only for exterior receptacles — bathroom receptacles need only be tamper-resistant

D) No special requirements for bathroom receptacles in dwelling units — standard grounded receptacles are acceptable

Q50. **A contactor coil is rated 120VAC. When measured with a multimeter, the coil reads 0Ω (zero resistance). What does this indicate?**

A) The coil is open — it will not energize

B) Normal — coil resistance is always near zero

C) The coil is functioning correctly

D) The coil is shorted — it will draw excess current

Answer Key & Explanations

Q1. Answer: D

CEC general intent: safety for persons and property. CEC Section 2 (General Rules) establishes that all electrical work must not create shock or fire hazards, and must be suitable for the environment (wet location, hazardous area, outdoor, etc.). All specific CEC rules flow from this foundational safety requirement.

Q2. Answer: D

CEC: maximum 40% fill for 3 or more conductors in a single conduit. Fill limits allow conductors to be pulled in without excessive damage, and allow air circulation for heat dissipation. Two conductors: maximum 31% fill. One conductor: maximum 53% fill. These limits are based on the conduit's inside diameter cross-sectional area vs. the total cross-sectional area of all conductors including insulation. Check CEC Appendix C for specific conductor combination tables.

Q3. Answer: B

Overload relay = motor thermal protection. It monitors motor current and trips if current exceeds the full-load amp (FLA) rating for too long. Unlike a fuse (instant trip), overloads respond to sustained overcurrent — protecting against overloaded mechanical conditions. The goal is to protect the motor winding insulation from thermal damage.

Q4. Answer: C

GFCI: detects ground faults as small as 4–6 mA. A 15A breaker won't trip until current reaches ~20–25A. But 100 mA through the human body can be fatal. GFCI compares current in the hot conductor to current in the neutral. A difference of 4–6 mA (flowing through a ground path = through a person) causes the GFCI to trip in milliseconds. Required by CEC in bathrooms, kitchens, garages, outdoor, and other wet locations.

Q5. Answer: A

Wye: V_Line = V_Phase × √3. In a wye connection, each phase connects between one line and neutral. Line voltage (between two lines) = phase voltage × 1.732. Example: 208V wye system has phase voltage = 208/1.732 = 120V. Delta connections: V_Line = V_Phase (equal).

Q6. Answer: A

Real power (W) = Apparent power (VA) × Power Factor. 8000 × 0.72 = 5,760 W = 5.76 kW. Power factor of 0.72 lagging indicates a largely inductive load. The reactive component (kVAR) = $\sqrt{(kVA^2 - kW^2)}$ = $\sqrt{(64 - 33.18)}$ = $\sqrt{30.82}$ ≈ 5.55 kVAR. Power factor correction capacitors can be added to bring PF closer to unity, reducing reactive current draw and improving efficiency.

Q7. Answer: B

25kV = 3 metre minimum approach distance. Provincial regulations set minimum approach distances based on voltage. At distribution voltages (up to 46kV), unqualified persons must stay at least 3 metres away. Qualified electricians have different limits based on training and PPE.

Q8. Answer: D

VFD: varies frequency and voltage proportionally (V/Hz ratio). Motor speed depends on supply frequency. A VFD converts AC to DC then back to variable-frequency AC. Voltage is reduced proportionally with frequency to maintain the same magnetic flux (torque) at all speeds. This allows smooth, efficient speed control from 0–60Hz+.

Q9. Answer: A

Transformer: V1/V2 = I2/I1. 600/120 = I2/2. I2 = 2 × (600/120) = 2 × 5 = **10A**. Voltage steps down by ratio 5:1, current steps up by same ratio 5:1. Power in = Power out (ideal): 600×2 = 1200VA = 120×10 = 1200VA.

Q10. Answer: C

GFCI required in wet/damp locations. CEC requires GFCI (Ground Fault Circuit Interrupter) in bathrooms, garages, outdoor outlets, within 1.5m of sinks, swimming pool areas, and other specified wet locations. GFCI detects current leakage as small as 4–6mA and trips in <1/40 second — preventing electrocution. These are locations where contact with water or ground is likely.

Q11. Answer: B

CEC: grounding conductors must be bare copper OR green (with or without yellow stripe). Green is exclusively reserved for grounding conductors — a green wire must NEVER be used as a current-carrying conductor. Bare copper can also be used as a grounding conductor. White is reserved for neutral conductors. These colour codes are critical for safety — improper colour coding can lead to energized ground conductors, which are life-threatening.

Q12. Answer: B

CEC Rule 8-102: maximum 3% voltage drop in a feeder or branch circuit, and 5% total from the supply side of the consumer's service to the point of utilization. Unlike the US NEC, where voltage drop is only a recommendation, Rule 8-102 is a mandatory ("shall") requirement in the CEC. Excessive voltage drop causes: motor overheating (motor draws more current to maintain torque), inefficient operation, and premature equipment failure.

Q13. Answer: A

Bonding creates a low-impedance fault current path to ensure rapid OCPD operation during a ground fault. Without bonding, a fault from a live conductor to a metal enclosure would result in the enclosure becoming energized at line voltage — dangerous touch voltage. With proper bonding, fault current flows freely back to the source through the bonding/grounding system, causing the fuse or breaker to operate within milliseconds and clearing the fault.

Q14. Answer: A

1-inch EMT: 2 m maximum between supports. Contrary to a common misconception, the CEC DOES specify EMT support intervals — Rule 12-1010 requires 1.5 m for trade sizes 16–21 (½"–¾"), 2 m for 27–35 (1"–1¼"), and 3 m for 41 and larger. EMT must also be supported within 1 m of each junction box, fitting, or termination. Insufficient support allows conduit to sag, stresses fittings, and can damage conductors. (3 m / 10 ft is the US NEC figure.)

Q15. Answer: B

$Z = \sqrt{(R^2 + X_L^2)} = \sqrt{(9 + 16)} = \sqrt{25} = 5\Omega$. Impedance cannot simply be added — resistance and reactance are 90° apart (phasors). Pythagoras applies: $Z = \sqrt{(R^2 + X^2)}$. This is the effective opposition to AC current flow considering both resistance and inductive reactance.

Q16. Answer: A

CEC Rule 6-112(3) overhead conductor clearances: 3.5 m over pedestrian-only areas, 4 m over residential driveways, 5 m over commercial driveways, 5.5 m over roads and lanes. Overhead service entrance conductors must maintain minimum vertical clearances above finished grade to prevent accidental contact. A residential driveway requires 4 m; areas where trucks and commercial vehicles pass (commercial driveways, roads, lanes) require 5 m and 5.5 m respectively. Check CEC Rule 6-112 for complete clearance requirements by installation type.

Q17. Answer: D

Megohmmeter (megger): measures insulation resistance in megohms. Minimum: 1 MΩ per kV motor voltage. Standard ohmmeters don't apply enough voltage to stress insulation properly. A megohmmeter applies typically 500V or 1,000V DC to drive a very small current through the insulation. Insulation resistance measured in MΩ or GΩ. Rule of thumb: 1 MΩ per kV of rated voltage + 1 MΩ = minimum acceptable (IEEE 43). For a 600V motor: minimum ~1.6 MΩ, but values above 100 MΩ are preferred.

Q18. Answer: D

Wet location: saturation exposure — requires weather-rated equipment and wiring. CEC defines wet, damp, and dry locations. Wet locations (direct water exposure): require wet-rated cable (like TECK, armoured, or direct-burial), weatherproof fixtures and enclosures, and sealable conduit entries. Damp locations: less severe but still require appropriate materials. Examples include car washes, spray areas, and exterior locations.

Q19. Answer: D

CEC conductor sizing: 125% of continuous load + 100% of non-continuous load. Continuous load (operates for 3+ hours): 160A × 1.25 = 200A. Non-continuous load: 20A × 1.0 = 20A. Minimum conductor ampacity = 200 + 20 = 220A. The 125% factor accounts for the heat generated by continuous current flow in the conductor — conductors must not be loaded to 100% continuously. The service entrance conductor ampacity must equal or exceed this calculated value.

Q20. Answer: D

Transformer: current ratio is inverse of voltage ratio. $V_1/V_2 = N_1/N_2 = I_2/I_1$. If voltage steps down 2:1, current steps up 2:1 on the secondary (20A secondary). Primary current = secondary current × (1/turns ratio) = 20 × (1/2) = 10A. Power in = Power out: 240V × 10A = 2,400VA; 120V × 20A = 2,400VA. ✓

Q21. Answer: C

AC cable connection: approved connector + anti-short bushing required. When cutting armoured cable, the spiral steel armour leaves sharp edges that can cut conductor insulation. The anti-short bushing (red plastic bushing) is inserted between the cut armour edge and the conductors. An approved AC connector clamps the cable to the box. The armour and internal ground wire (if present) provide the grounding path.

Q22. Answer: A

Single-phasing: motor runs but draws dangerously high current and overheats. A running 3-phase motor loses 1/3 of its magnetic field when a phase is lost. It continues to rotate (it has momentum and the magnetic coupling of two phases still produces rotation) but the remaining two phases carry the full current demand. This is typically 1.5–2× normal full-load current — causing rapid overheating unless the overload relay trips.

Q23. Answer: A

Low voltage + slow speed + high current = under-voltage condition. When supply voltage drops, motors slip more to develop the same torque, drawing higher current. Check supply voltage at the motor terminals under load. Also check for high resistance connections causing voltage drop.

Q24. Answer: D

Electrically Safe Work Condition (ESWC): full LOTO + absence of voltage verification. CSA Z462 defines ESWC as: 1) Disconnect all energy sources. 2) Operate disconnect under load if possible to confirm it works. 3) Lock and tag each energy source. 4) Release or restrain stored energy (capacitors, springs). 5) Verify absence of voltage with a properly rated tester (test the tester before and after). Only after ALL steps are complete is the work considered safe. An ESWC must be established for all electrical maintenance.

Q25. Answer: B

CEC Rule 14-104(2)/Table 13: maximum OCPD for a 10 AWG copper conductor = 30A. 10 AWG copper = 30A ampacity (at 60°C or 75°C depending on insulation). Therefore, maximum OCPD = 30A. Rule 14-104 allows the next larger standard size only when the conductor ampacity does not correspond to a standard OCPD rating — but 30A is a standard rating. So the answer is 30A maximum. Using larger OCPD on a 30A conductor = code violation and fire hazard.

Q26. Answer: B

Phase current imbalance (22A vs 18A) = phase voltage imbalance or motor winding fault. In a balanced three-phase system, all three phase currents should be equal (within ~1–2% for perfectly balanced loads). A 4A imbalance on a motor rated for ~18A represents ~22% current imbalance — this is significant. Even small voltage imbalances cause large current imbalances in motors (NEMA guideline: voltage imbalance should be <1% for motors). Excessive current in one winding → overheating → insulation failure.

Q27. Answer: A

Capacitive reactance decreases with increasing frequency. $X_C = 1/(2\pi fC)$. As frequency rises, the capacitor charges and discharges more rapidly, offering less opposition to current flow. At DC (0Hz), X_C approaches infinity (blocks DC). At very high frequencies, X_C approaches zero (passes easily).

Q28. Answer: B

Service Factor 1.15: the motor may be loaded to 115% of rated HP continuously under standard conditions (per NEMA MG-1). A 10 HP motor with SF 1.15 can carry 11.5 HP continuously — the service factor is a permissible continuous overload, not just a momentary buffer. It runs hotter at SF load, so continuous operation there does shorten insulation life, and high ambient or altitude reduce the allowable SF. The CEC allows overload relay sizing at 125% of FLA for motors with SF ≥ 1.15.

Q29. Answer: B

Conduit fill: depends on conductor size and conduit type (CEC Table 6). CEC limits conduit fill to 40% for 3 or more conductors to allow heat dissipation and pulling clearance. For ½-inch EMT with 12 AWG T90 Nylon (or RW90): approximately 9 conductors. Larger conductor = fewer fit. Always calculate from CEC Table 6 for the actual conductor type and conduit size being used.

Q30. Answer: C

EMT = Electrical Metal Tubing (thin-wall conduit). EMT is lightweight, non-threaded, and uses set-screw or compression fittings. It is suitable for exposed indoor/outdoor use but NOT direct burial or in concrete. Provides mechanical protection for conductors and serves as the equipment ground when properly bonded.

Q31. Answer: B

CEC standard 3-phase colours: Red, Black, Blue (phases), White (neutral), Green/bare (ground). 120/208V wye system: Red, Black, Blue phases + White neutral + Green ground. 347/600V: Red, Black, Blue still common. Always verify — some regions may vary, and re-identification with tape is permitted under specific conditions.

Q32. Answer: C

Overload relay: protects motor from sustained overload current and thermal damage. The branch circuit breaker/fuse protects against short circuits. The overload relay (heater elements or electronic sensing) monitors current and disconnects the motor if overload current persists. The time delay allows brief overloads during starting (high starting current is normal) but trips on sustained excess current that would damage motor insulation. Overload relays are thermal devices — they can be manually reset after cooling.

Q33. Answer: B

LOTO = Lockout/Tagout. Required any time a worker could be injured by unexpected startup or release of stored energy (electrical, hydraulic, pneumatic, gravity). LOTO applies to ALL voltage levels — even 120V can kill.

Q34. Answer: A

VFD motor whine: PWM carrier frequency in audible range. VFDs convert AC to DC then back to AC using PWM switching. The carrier frequency (how fast the transistors switch) determines the motor magnetic noise frequency. Default carrier: 2–4 kHz (audible). Increasing to 8–16 kHz moves the noise above human hearing but increases heat in the VFD output transistors. A compromise is typical.

Q35. Answer: B

Holding contact (seal-in contact) keeps the contactor latched after the start button is released. When you press START, the coil energizes, the contactor closes, and one auxiliary contact seals in around the START button. The motor keeps running without holding the button. Pressing STOP breaks the seal-in contact.

Q36. Answer: B

Impedance in series AC circuit: $Z = \sqrt{(R^2 + X^2)}$. Resistance and reactance are 90° out of phase, so they add as vectors, not arithmetic. $Z = \sqrt{(8^2 + 6^2)} = \sqrt{(64 + 36)} = \sqrt{100} = 10\ \Omega$. This is the Pythagorean theorem applied to phasors. Power factor = R/Z = 8/10 = 0.8 (lagging for inductive circuit).

Q37. Answer: C

NMD90 (Romex/AC): prohibited in wet/damp areas, exposed damage locations, concrete, industrial/commercial. NMD90 (Non-Metallic Dry, 90°C) cable is designed for dry, protected residential installations. It must not be used where it could be damaged (exposed in garages without protection), in wet locations (bathrooms, crawlspaces with moisture issues), in concrete or masonry, or in most commercial/industrial buildings. When NMD90 passes through studs or rafters with a clearance of less than 32mm, it must be protected by a nail plate. NMD90 is also not permitted embedded in plaster or in air-handling spaces.

Q38. Answer: A

Power Factor = True Power (W) ÷ Apparent Power (VA). A PF of 1.0 = purely resistive (ideal). Inductive loads (motors, transformers) cause current to lag voltage, reducing PF below 1.0. Low PF wastes energy and requires larger conductors.

Q39. Answer: B

Always locate hidden utilities before drilling. Drilling into existing wiring can cause electrocution, fires, or arc flash. Drilling into a gas line creates explosion risk. Use stud finders, electronic pipe/cable locators, or thermal cameras to identify hidden utilities. Never assume a wall is clear.

Q40. Answer: C

Reverse any two phases = reverse rotation. Three-phase motor direction is determined by phase sequence. Swapping any two of the three power conductors at the motor terminals (or disconnect) reverses the rotating magnetic field and thus the motor direction.

Q41. Answer: A

Lone worker policies require a check-in/monitoring system. Working alone in an electrical room creates risk — if injured, there is no immediate help. Regulations (CSA Z1009 and employer policies) require: documented check-in intervals, a designated monitor who alerts emergency services if check-in is missed, or a buddy system for high-risk tasks.

Q42. Answer: D

CEC Rule 14-100: conductor ampacity must match overcurrent protection. A 20A circuit requires 12 AWG copper (20A rated) minimum. Using 14 AWG (15A rated) on a 20A breaker means the wire can overheat and fail before the breaker trips — a fire hazard. The conductor must always be the limiting factor.

Q43. Answer: A

CEC Table 53: direct-buried armoured cable (750V or less) = 450 mm minimum cover in non-vehicular areas, 600 mm where subject to vehicular traffic. The CEC specifies burial depths that vary based on cable type, voltage, and location. Rule 12-012 permits the Table 53 depth to be reduced by 150 mm where mechanical protection (such as treated planking or a concrete slab) is installed over the cable — so a protected armoured cable may be as shallow as 300 mm. Depth is measured from finished grade to the top of the cable.

Q44. Answer: B

Real power P = V × I × PF = 240 × 20 × 0.75 = 3,600W. Apparent power (VA) = V × I = 240 × 20 = 4,800 VA. Real power (W) = apparent power × power factor. With PF < 1 (inductive or capacitive loads), real power is less than apparent power. The difference is reactive power (VAR).

Q45. Answer: B

Firestop required at all fire-rated penetrations. EMT itself does not restore the fire rating of a wall. An approved firestop system (intumescent material that expands with heat) must seal the opening. This is required by building code and the CEC. Approved systems include intumescent sealants and firestop collars.

Q46. Answer: D

Bonding jumper: ensures low-impedance path for fault current to clear overcurrent devices. For a ground fault to clear a breaker or fuse, sufficient fault current must flow back to the source. If the conduit system has high impedance (poor connections, loose fittings, corrosion), fault current may be too low to trip the breaker — the enclosure remains energized and hazardous. A bonding jumper bypasses any high-impedance conduit connections, ensuring a reliable low-impedance path from the enclosure to the service neutral/ground.

Q47. Answer: C

Energized work on 600V distribution: minimum arc flash PPE Category 2 (8 cal/cm^2) required. Arc flash energy releases extremely hot ionized plasma that can cause severe burns from even momentary exposure. CSA Z462 (Canadian standard, aligns with NFPA 70E) requires an arc flash hazard analysis to determine incident energy at the work location. Category 2 minimum for typical 600V distribution panels: arc-rated face shield over safety glasses, arc-rated balaclava, arc flash suit or jacket (8 cal/cm^2 rating), leather gloves over rubber insulating gloves.

Q48. Answer: D

EGFP: protects equipment from ground fault arcing at high current levels. At 1000A+, a line-to-ground fault creates an arc with enormous energy that can destroy switchgear in milliseconds. EGFP detects small ground fault currents (10–1200A) and trips the main breaker before damage occurs. NOT the same as GFCI (personnel protection) — different trip level.

Q49. Answer: B

CEC Rules 26-700(11)/26-704: receptacles within 1.5 m of a sink, bathtub, or shower must have Class A GFCI protection. Class A ground fault circuit interrupters trip at 4–6mA of ground fault current — protecting against electrocution from water contact. The CEC requirement is distance-based (within 1.5 m of the sink, tub, or shower) rather than the blanket room-based rule used in the US NEC. GFCI protection can be provided by a GFCI receptacle, GFCI breaker, or GFCI receptacle protecting downstream outlets. The GFCI must be located so its reset is accessible, and receptacles must not be installed within a bathtub or shower enclosure.

Q50. Answer: D

Zero resistance on a coil = shorted windings. A coil is made of many turns of fine wire — it should have measurable resistance (typically 20–500Ω depending on size). Zero ohms means the insulation between turns has broken down (short). The coil will draw excessive current, blow fuses, and produce heat until it burns open.