Candidate Handbook answers

Progress check 3.1, p. 113

1. Name three methods of producing electricity at a power station.

   Coal, gas, oil, nuclear energy

2. What is renewable energy?

   Energy produced by sources that do not use any resources

3. Describe the main principles of hydroelectric generation.

   Water is used to rotate a turbine, either by being released through a dam or storing it for release at peak times

Progress check 3.2, p. 115

1. What are the transmission and distribution networks?

   Transmission is the main network that transports electricity from the power station around the country

   Distribution networks are owned by supply companies and transfer electricity from the transmission grid to the supply company's customers

2. At what voltage is the distribution network fed from the transmission grid?

   33 kV or 11 kV

3. A local sub-station supplies electricity at what voltage?

   400 V three-phase, distributed to individual installations at either this voltage or 230 V single-phase

Progress check 3.3, p. 117

1. Describe how HV transformers are cooled.

   They are filled with inert oil. Core heat warms the oil and the resulting convection currents force the oil through a set of cooling fins attached to the outside of the transformer

2. What is a pylon insulator?

   It provides a barrier between the cable and the metal suspension arm of the pylon

3. Why are HV overhead transmission cables un-insulated?

   Because the amount of insulation needed would make the cable extremely heavy and would be extremely expensive.

Progress check 3.4, p. 120

1. What are the two ways a supply cable can be run to an installation?

   Overhead or underground

2. What is the line conductor of a circuit connected to in a consumer unit?

   Protective device

3. What is a:

   - fused switch

     Main switch that physically connects and disconnects a set of fuses from the circuit

   - meter

     Device for measuring how much electricity (in kW/h) has been used

   - MET?

     Main earth terminal (point at which all installation earths are connected to the supply earth)

Working practice 3.1, p. 122

1. How can both the ring final circuit and LAN cables be run through the same dado trunking?

   The trunking has two separate compartments

2. How are 13 A computer sockets distinguished from general purpose ones?

   The computer sockets are fitted with T-shaped earth slots

3. What is a functional earth?

   It is an earth system that carries a small amount of current during normal use

Progress check 3.5, p. 123

1. What are strappers?

   The conductors connected between two two-way switches

2. What type of circuit is wired using the loop-in method?

   Lighting circuits wired using twin-and-earth

3. What is the maximum number of 13 A sockets allowed in a ring final circuit covering 120 m^2?

   Ten

Activity 3.3, p. 128

[Star delta motor starter calculation]

To prove this point, calculate the following:

$$\frac{230\,V}{350\,\Omega} = ?A \qquad \frac{400\,V}{350\,\Omega} = ?A$$

Star [230 V] = 0.66 A

Delta [400 V] = 1.14 A

Progress check 3.6, p. 129

1. What is a coil used for in a relay and a contactor?

   The electromagnetic coil creates a strong magnetic field at start-up. This can be used to mechanically operate a set of switches

2. What is meant by a zone in a fire alarm system?

   Fire alarm systems are divided into sections or zones. The control panel is then able to show which part of the building the fire is in

3. What is a thermostat?

   It is a device that enables you to set the maximum temperature needed and which will automatically keep the temperature at that level

Progress check 3.7, p. 130

1. What are the hazards to be considered when carrying out an agricultural installation?

   Rodents; dampness; that farm animals are very susceptible to electric shock

2. What is a PLC?

   Programmable controller – the electronic 'brain' of modern control circuits

3. What is meant by twisted pair?

   Type of wiring in which two conductors (the forward and return conductors of a single circuit) are twisted together for the purposes of cancelling out electromagnetic interference

Working practice 3.2, p. 133

1. Why did they mark all the switch positions and lights on a drawing?

   To give them an idea where the underfloor conduit inspection boxes might be (this would mean that they would know which floorboards to pull up)

2. Why did they need to locate all the conduit boxes?

   The old cable could only be pulled out and the new cable drawn in using the conduit inspection boxes

3. How did they gain access to the conduit boxes under the original flooring?

   Cut traps into the old flooring using a drill and jigsaw

Working practice 3.3, p. 135

1. Why must you never blow away the excess dust when fitting a mineral-insulated cable?

   The magnesium oxide powder is highly moisture-absorbent

2. What is the outer sheath of the cable made of?

   Copper

3. Are the conductors insulated?

   Only by the powder; the conductors themselves are bare

Progress check 3.8, p. 135

1. What is a CPC?

   A circuit protective (earth) conductor

2. What is FP Gold cable used for?

   Fire alarm systems (because it is fireproof so will continue to operate emergency lighting etc. while the rest of the installation is failing)

3. What is meant by a cable's cross-sectional area?

   The area of the conductor face. The larger the cross-sectional area, the more current it can carry

Activity 3.5, p. 141

Select the conduit size for the following cable looms.

1. Two radial 4 mm^2 circuits in 5 m of conduit with one 90° bend.

   25 mm

2. Two one-way lighting circuits in 4.5 m of conduit with three bends.

   20 mm

3. Three radial circuits: 2.5 mm^2, 4 mm^2 and 1.5 mm^2 in 9 m of conduit with two bends.

   32 mm

Progress check 3.9, p. 141

1. What are stocks and dies used for?

   Cutting a thread onto metal conduit

2. What are the main purposes of a conduit box?

   Drawing points for cables and to provide angles, tee-off points and intersections

3. When would you use flexible conduit?

   To connect equipment such as electric motors to their supply

Activity 3.6, p. 142

Calculate the minimum acceptable trunking sizes for the following (the cables all have BS6004 insulation).

1. Six ring final circuits (solid conductors), five 2.5 mm^2 radial circuits (solid conductors) and six 4 mm^2 radial circuits (stranded conductors).

   50 mm × 38 mm

2. Eight 6 mm^2 radial circuits and four 10 mm^2 radial circuits.

   50 mm × 50 mm or 100 mm × 25 mm

3. Seven 16 mm^2 sub-main supplies.

   50 mm × 50 mm

Working practice 3.4, p. 144

- How could this mistake have been avoided?

  The electrician should have 'walked' the route before starting the actual work. The trunking and then the mains position should have been checked against the drawing

Progress check 3.10, p. 145

1. What is dado trunking?

   Trunking designed to be installed on a wall in an office

2. What type of trunking is used for running both mains voltage and data cables?

   Multi-compartment trunking

3. Where would you use mini-trunking?

   When running cables around a house when wiring an extra socket etc. and it is not possible to conceal the wiring

Activity 3.7, p. 145

What wiring systems would you use for the following types of installation?

1. Extra 13 A sockets in a house that has been decorated – the owner does not want the décor disturbed as far as possible.

   Mini-trunking fixed to the surface, as discreetly as possible (e.g. where possible, run in the corner of the room or along the top of skirting)

2. A feed out across a garden to feed a three-way distribution board in the garage.

   Steel wire armoured cable run underground

3. A large grid of fluorescent fittings to light a large motor vehicle workshop.

   Lighting trunking suspended from the steel girders and fed using steel conduit and singles cables

Progress check 3.11, p. 149

1. What does HRC stand for?

   High rupture capacity

2. Where would you expect to find a BS1362 fuse?

   In a plug top

3. What type of circuit would be protected by a type C circuit breaker?

   Electric motors, power supplies and general lighting circuits

Activity 3.8, p. 150

Find the following, using the tables in Appendix 4 of BS 7671:2008.

1. What is the current-carrying capacity for 16 mm^2 copper single-core, single-phase, non-armoured cable with thermoplastic insulation? The cable is installed in conduit in a thermally insulated wall.

   61 A Table 4D1A

2. What is the current-carrying capacity of 4 mm^2 multi-core armoured copper cable with 70°C thermoplastic insulation? The cable feeds a three-phase circuit and is installed on a cable tray.

   35 A Table 4D4A

Activity 3.9, p. 152

1. What is the millivolt drop/amp/metre for a 16 mm^2 single-core, non-armoured copper cable feeding a single-phase circuit? The cable is clipped to a tray, touching other cables, as per Reference Method C. The insulation and sheath is 70°C thermoplastic.

   2.8 mV/A/m Table 4D1B

2. What is the millivolt drop/amp/metre for a 2.5 mm^2 multi-core, non-armoured copper cable feeding a three-phase circuit? The insulation and sheath is 70°C thermoplastic.

   15mV/A/m Table 4D2B

Activity 3.10, p. 152

Find the minimum-sized cables for the following circuits. The insulation in each case (except Question 4) is 70°C thermoplastic and the conductors are all copper.

1. A 5 kW three-phase electric motor is fed using non-armoured, non-sheathed single cables. The cables are run in a conduit, which is fixed to the surface of a wall. The length of run is 12 m.

   a. $\frac{I}{V} = P \quad I = \frac{5000}{400} \quad I = 12.5\,A$

   b. Table 4D1A

   First cable which will carry this load = 1.5 mm^2

   c. Table 4D1B

   Vd/A/m for this cable is 25 mV

   d. Total volt drop = $\frac{2m \times 12.5 \times 25}{1000} = 3.75\,V$ **which is acceptable**

2. A single-phase, 7 kW oven is fed using a multi-core, non-armoured cable. The cable is run through conduit which is buried in a thermally insulated wall. The length of run is 7.5 m.

a. $I = \frac{P}{V}$ $I = \frac{7000}{230}$ $I = 30\,A$ **approx**

b. **Table 4D2A**

First cable which will carry this load = 6.0 mm²

c. **Table 4D2B**

Vd/A/m for this cable is 7.3 mV

d. **Total volt drop =** $\frac{7.5\,m \times 30 \times 7.3}{1000} = 1.6\,V$ **which is acceptable**

3. A three-phase 275 kW high impedance supply is run using single-core armoured cables which are clipped to a horizontal cable tray according to Reference Method F. The cables are all touching. The length of run is 13 m.

a. $I = \frac{P}{V}$ $I = \frac{275000}{400}$ $I = 687.5\,A$

b. **Table 4D3A**

First cable which will carry this load = 400 mm²

c. **Table 4D3 – mVd/A/m**

There are three volt drop values for this cable:

r – resistive load

x – reactive load

z – high impedance load

d. **Because the load fed by our supply has high impedance, we will use the z value, which is 0.22 mV**

e. **Total volt drop =** $\frac{13 \times 687.5\,A \times 0.22}{1000} = 1.97\,V$ **which is acceptable**

4. A three-phase transformer is fed by a multi-core armoured cable with aluminium. The total distribution board load is 46 kW. The armoured cable has 90°C thermosetting sheath and 70°C insulation. The load is reactive. What is the minimum-sized cable that can be used if the cable run is 11 m and it is enclosed in duct which is buried in a wall according to Reference Method A?

a. $I = \frac{P}{V}$ $I = \frac{46000}{400}$ $I = 115\,A$

b. **Table 4J2A**

First cable which will carry this load = 70 mm²

c. **Table 4J2B**

Vd/A/m for this cable is 0.135 mV

d. **Total volt drop =** $\frac{11m \times 115 \times 0.135}{1000} = 0.17\,V$ **which is acceptable**

Progress check 3.12, p. 153

1. What is mV/A/m a measurement of?

   Millivolts per amp per metre, in other words how many millivolts a cable will drop for every amp that flows along one metre of that cable

2. What is a reference method?

   A code which represents the way in which a cable is installed

3. What is *It*?

   Tabulated current, the current shown for a particular cable by the cable current-carrying capacity charts in Appendix 4 of BS 7671:2008

Progress check 3.13, p. 157

1. What is connected to the MET?

   All the earth conductors in an installation and the supply earth conductor

2. Where would a TT earthing system normally be used?

   In rural situations

3. What is the Zs of a supply if R_1 = 3.7 Ω, R_2 = 5.18 Ω and Ze = 4.2 Ω

   Zs = Ze + (R_1 + R_2)

   Zs = 4.2 + (3.7 + 5.18)

   Zs = 13.08 Ω

Progress check 3.14, p. 159

1. What is micro-renewable energy?

   Renewable energy systems, such as solar power and heating, and heat pumps intended for domestic and small business premises

2. What are the three heat sources for a heat pump?

   Ground, air, water

3. What is grey water and what can it be used for?

   Water re-use from washing

   Permitted uses: washing a car; flushing toilets; watering the garden – but not any produce that is eaten raw (e.g. home-grown fruit and salad)

Knowledge check, p. 160

1. At what voltage is electricity usually generated at a power station?

c **25 kV**

2. Which part of the electricity supply system belongs to the supply companies?

a **Distribution grid**

3. At what point does the supply enter an installation?

d **The main fuse**

4. Which of the following is a domestic installation?

c **Flat**

5. A fire alarm system is divided into:

a **zones**

6. The cable used to connect an item of electrical equipment to its supply is:

b **flex**

7. The cable used as a television aerial is:

a **coaxial**

8. Metal containment systems such as conduit and trunking must be:

c **earth-tight**

9. Shock protection is provided by a:

b **residual circuit breaker**

10. In which earthing system is the earth conductor connected to the neutral on the supply company side of the intake position?

c **TN-C-S**