



Candidate Handbook answers

Progress check 7.1, p. 341

1. What must the electrical system installed in premises be suitable for?
The purpose of the system; the building and environment
2. What is the role of an architect?
He or she is the designer for a whole construction project and sometimes represents the customer.
3. What are building specifications?
Information about the building itself, particularly the materials used and the finishes important to the electrical designer in terms of fixings and cable routes

Working practice 7.1, p. 342

1. Was this the correct position for the isolating switches?
There are no specific regulations that state the exact position of an isolator. Regulation 537.3.2.4 states that an isolator must be placed where it is convenient for use. Part P of the building regulations states that cooker isolators must not be placed where you have to lean over hot plates to operate them.
2. How could the electrician have handled the situation differently?
The electrician could have shown the customer regulation 537.3.2.4 and discussed it with them.
3. Was it right for the electrician to call the customer's view of the kitchen a 'fairy tale'?
No, this was rude and disrespectful. A customer may not have any electrical knowledge or understand the need for an isolator for their appliance. It is down to the electrician to explain calmly and politely why the job may not be possible in exactly the way the customer wants it.

Progress check 7.2, p. 344

1. What does BS 7671:2008 say generally about positioning electrical equipment?
Electrical equipment must not:
 - cause heat damage or fire to surrounding materials – Chapter 42
 - be inaccessible for maintenance and repair (including cable joints) – Chapter 51
 - have any adverse effects on other electrical and non-electrical services – Chapter 52
2. What effect does excess heat have on a cable?
Increases resistance and lowers current-carrying capacity
3. What are EMC regulations?
Electromagnetic Compatibility Regulations – intended to protect electronic, data and communication equipment from the kind of electromagnetic interference caused by mains electrical services.



Activity 7.1, p. 345

Calculate the actual positions of these items of electrical equipment in metres from the following drawing measurements.

1. A 13A socket outlet 45 mm from the edge of a doorframe – scale 1:100.

$$\frac{(45 \times 100)}{1000} = 4.5 \text{ m}$$

2. A row of fluorescent luminaires run parallel with a wall. The line of lights is 12.5 mm from the wall and the scale is 1:40.

$$\frac{(12.5 \times 40)}{1000} = 0.5 \text{ m}$$

3. Each light is shown as 3 mm apart – what will be the actual distance between the lights?

$$\frac{(3 \times 40)}{1000} = 0.12 \text{ m}$$

4. A cable run from a distribution board to a sub board is shown as 689 mm on a drawing. If the scale is 1:20, how much cable should be ordered? (Allow four metres for connection at either end.)

$$\frac{(689 \times 20)}{1000} = 13.78 \text{ m} + 4 \text{ m} = 17.78 \text{ m (realistically 20 m of cable)}$$

5. A row of six 13 A sockets is installed along the wall of an office. The wall is shown as 266.67 mm and the scale is 1:15. How long is the wall and how could the socket outlets be evenly spaced along the wall? The two end sockets must be 0.25 m from each end of the wall.

$$\text{Wall length } \frac{(266.67 \times 15)}{1000} = 4 \text{ m}$$

- a. Socket spacing for first and last socket – each 0.25 m from either end, so total spacing used by these two sockets is 0.5 m
- b. Remaining length 3.5 m or 3500 mm
- c. There are five spaces between the first and last socket.
- d. $\frac{3500}{5} = 700 \text{ mm or } 0.7 \text{ m}$

Activity 7.2, p. 345

Find the area of:

1. a playing field 126 m x 205 m

$$126 \times 205 = 25\,830 \text{ m}^2$$

2. a triangle with a height of 465 mm and base width of 23 cm

Convert cm to mm: $23 \times 10 = 230 \text{ mm}$

$$\frac{(465 \times 230)}{2} = 53.478 \text{ mm}^2$$

3. a helicopter circular landing pad with a diameter of 11 000 mm.

Because 11 000 mm is such a large number to deal with, convert it to metres first.

$$\frac{11000}{1000} = 11 \text{ m} \quad \text{If using } \pi r^2, \text{ calculate the radius: } \frac{11}{2} = 5.5 \text{ m}$$

$$3.142 \times (5.5 \times 5.5) = 95.05 \text{ m}^2$$

Activity 7.3, p. 346

1. A room is 3 m wide, 4.5 m long and 4 m high. What is its volume?
 $3 \times 4.5 \times 4 = 54 \text{ m}^3$
2. What is the capacity of a fuel tank that is 3.2 m long and has a diameter of 2 500 mm?

Convert 2 500 mm to metres: $\frac{2500}{1000} = 2.5 \text{ m}$

Cross-sectional area of tank: $\frac{\pi d^2}{4} = \frac{(3.142 \times [2.5 \times 2.5])}{4} = 4.91 \text{ m}^2$

Volume = $4.91 \times 3.2 = 15.71 \text{ m}^3$

3. What is the volume of a container that is 9 275 mm x 3.2 m x 4 m?

Convert 9 275 mm to metres: $\frac{9275}{1000} = 9.275$

Volume: $9.275 \times 3.2 \times 4 = 119.04 \text{ m}^3$

Progress check 7.3, p. 347

1. What is scale when used on a layout drawing?
Scale is a way of reducing the real-life dimensions to manageable proportions.
2. How many mm^3 in 1 mm^3 ?
 10^9 or 1 000 000 000
3. What are British Standards?
Quality standards for technology, construction, manufacturer and management

Progress check 7.4, p. 349

1. What is a special location?
An electrical installation which is in a hazardous or extreme environment
2. What sort of earth system is used for a medical location?
IT
3. What are the hazards for the electrical installation in a visiting fairground?
Electric shock, fire, mechanical stress, moisture, adverse weather

Working practice 7.2, p. 350

1. Why couldn't the work be carried out during normal working hours?
The office area could not be cleared during normal working hours and the work was too drastic to be carried out around office staff.
2. Why were three contractors interviewed?
It is a legal requirement that work is put out to tender.
3. Why wasn't the cheapest tender accepted?
It was not the most suitable method for carrying out the work.



Progress check 7.5, p. 353

1. What is a quotation?
A statement of how much the work will cost
2. What does ISO9000 require with regards to design?
It should be reviewed with the customer and formally agreed. If the design changes then the revised design should go through the same process. Only the most up-to-date design should be used.
3. When would you need to go to a manufacturer for a price?
If you require a specially made item of equipment such as an electrical control panel

Progress check 7.6, p. 354

1. List three typical protective device ratings for a domestic electrical system.
Choose from 6 A, 16 A, 20 A, 32 A, 45 A.
2. What are labour costs?
The cost for the time actually spent carrying out the work
3. What are the two stages of an electrical installation in a new domestic property?
First and second fix

Working practice 7.3, p. 358

1. Why are single-core conductors used?
HV cables tend to be a single-core type. This is because the amount of insulation required is so heavy it would make multi-core cables too heavy for use. Also, the magnetic field around a high voltage conductor can cause electromagnetic induction in other conductors if they are too close.
2. What is built-in redundancy?
Two identical routes for a supply, so that if one fails the supply is maintained

Progress check 7.7, p. 358

1. What is the requirement for an isolator if it is situated remotely from the equipment it controls?
It needs to be labelled and include the facility for it to be locked off.
2. What is a TN-S system?
A separate earth conductor connects the installation earth system to the star point in the sub-station transformer.
3. What is the UK frequency?
50 Hz

Progress check 7.8, p. 365

1. What is a BMS outstation?
Outstations use the information they receive from the central processor to set necessary levels of control. The outstations are linked together so that information can be shared between them.



2. What is a maintained emergency lighting system?

One which is fed from the mains supply during normal conditions, then switched over to an integral battery pack in emergency conditions.

3. What is a CCTV multiplexer?

Multiplexers are used to process information from multiple cameras.

Activity 7.4, p. 367

Calculate the allowable diversity of:

1. a 45 A cooking appliance in a house – the isolator incorporates a 13 A socket

From table: 10 A + 30% of remaining current demand. Add on 5 A if there is a 13 A socket in the cooker isolator.

$$10 \text{ A} + (30\% \times 35 \text{ A}) + 5 \text{ A} = 10 + 10.5 + 5 = 25.5 \text{ A}$$

2. a guest house with three instantaneous water heaters: 3 kW, 2.5 kW and 1 kW

$$\text{Heater 1 current} = \frac{P}{U} = \frac{3000}{230} = 13.04 \text{ A}$$

$$\text{Heater 2 current} = 10.87 \text{ A}$$

$$\text{Heater 3 current} = 4.35 \text{ A}$$

From table: 100% of demand of largest appliance, plus 100% of second largest, plus 25% of remaining appliances.

$$13.04 + 10.87 + (0.25 \times 4.35) = 25 \text{ A approx}$$

3. a small shop with four electric heaters: 5 kW, 3 kW and two at 2.5 kW.

$$\text{Heater 1 current} = \frac{P}{U} = \frac{5000}{230} = 21.74 \text{ A}$$

$$\text{Heater 2 current} = 13.04 \text{ A}$$

$$\text{Heater 3 and 4 currents} = 10.86 \text{ A each}$$

From table: 100% of demand for largest appliance, plus 75% of current demand for all other appliances.

$$21.74 + (0.75 \times [13.04 + 21.72]) = 47.81 \text{ A}$$

Progress check 7.9, p. 368

1. What is meant by 'aesthetic considerations'?

The installation must be neat and discreet and fit in with the decor and ambience of the environment.

2. What is ladder racking?

Heavy duty form of cable tray

3. When would you use thermosetting insulation?

In hot conditions

Activity 7.5, p. 371

Using Appendix 4 of BS 7671:2008, carry out cable selection calculations for the two circuits described below. Remember to include the appropriate de-rating factors.

1. A single-phase 5 kW heater is to be fed by twin-and-earth cable (copper conductors). The cable passes through holes in the joists with four other cables. The length of run is 12 m.

$$I_b = \frac{5000}{230} = 21.74 \text{ A}$$

I_n will therefore be a 26 A circuit breaker.

$$I_z = \frac{I_n}{C_g} = \frac{26}{0.6} = 43.33 \text{ A}$$

Table 4D Reference Method C (column 2) is the closest and the nearest cable which will take I_z .

Try 6.0 mm² which will carry 46 A.

$$\text{Total volt drop} = \frac{12 \times 46 \times 7.3}{1000} = 4.03 \text{ V, which is acceptable.}$$

2. A circuit of four 500 W spotlights is fed using steel conduit and single cables. The maximum length of run is 22 m. There is another radial circuit in the conduit.

$$I_b = \frac{2000}{230} = 8.7 \text{ A}$$

I_n will be a 10 A circuit breaker.

$$I_z = \frac{I_n}{C_g} = \frac{10}{0.8} = 12.5 \text{ A}$$

Table 4D1A Reference Method B (column 4) is the closest and the nearest cable which will take 12.5 A.

Try 1.0 mm² which will carry 13.5 A.

$$\text{Total volt drop} = \frac{22 \times 13.5 \times 38}{1000} = 11.23 \text{ V, which is unacceptable.}$$

Try 2.5 mm²

$$\text{Total volt drop} = \frac{22 \times 24 \times 15}{1000} = 7.92 \text{ V, which is acceptable}$$

Activity 7.6, p. 376

Calculate the maximum time a cable can carry fault currents in the following circuits.

1. A 9 A circuit protected by a Type C BS EN 60898 circuit breaker. Cables are 1.5 mm² with 90°C thermosetting insulation.

$$\text{Fault current } I = \frac{U}{Z} = \frac{230}{2.3} = 100 \text{ A}$$

$$t^2 = \frac{k^2 S^2}{I^2} = \frac{143^2 \times 1.5^2}{100^2} = \frac{20449 \times 2.25}{1000} = 4.6 \text{ seconds}$$

2. A 28 A circuit protected by a BS 3036 fuse (0.4-second disconnection time), using a mineral-insulated cable with a 70°C thermoplastic sheath. Conductor size = 1.5 mm².

$$\text{Fault current } I = \frac{U}{Z} = \frac{230}{1.09} = 211 \text{ A}$$

$$t^2 = \frac{k^2 S^2}{I^2} = \frac{115^2 \times 1.5^2}{211^2} = \frac{13225 \times 2.25}{44521} = 0.67 \text{ sec onds}$$

3. A 58 A circuit protected by a 63 A BS88-2 type system E (bolted) fuse (5-second disconnection time). Cable size = 16.0 mm² with aluminium conductors and 70°C thermoplastic sheath.

$$\text{Fault current } I = \frac{U}{Z} = \frac{230}{0.82} = 280.49 \text{ A}$$

$$t^2 = \frac{k^2 S^2}{I^2} = \frac{76^2 \times 16^2}{280.49^2} = \frac{5776 \times 256}{78674.64} = 18.79 \text{ sec onds}$$

Progress check 7.10, p. 376

1. What is discrimination?

Ensuring that the protective device nearest to the fault is the one that operates

2. What is the disconnection time for a TN circuit feeding an a.c. circuit of less than 32 A?

0.2 seconds

3. What is meant by thermal constraint?

The protective device must operate before the heat caused by the fault current damages the conductor.

Working practice 7.4, p. 377

1. What is the principle of storage heating?

Elements heat bricks using the night-time cheap rate. The bricks slowly discharge their heat during the following day.

2. What is the advantage of a three-phase heater?

The load is spread over the three phases which reduces current use.

Progress check 7.11, p. 385

1. What is the difference between a Form 1 and a Form 2 control panel?

Form 1 panels – there is no segregation (physical separation) between the bus-bars in the panel and the rest of the equipment in the panel.

Form 2 panels – bus-bars are segregated from the rest of the panel by being run in a separate compartment.

2. What is a catenary wire?

Wire that supports the weight of an overhead cable; can be separate or integral

3. What causes electrolytic action at cable terminations?

A corrosive reaction between two differing metals in which one becomes an anode, the other a cathode



Progress check 7.12, p. 391

1. How do plasterers interact with electricians?
Waiting until first fix is complete before plastering walls and ceilings; plastering over chased-in cables and flush back boxes
2. What is the difference between a Gantt and PERT chart?
Gantt charts are more like a graph with the tasks in the left-hand column and timescales in the form of bars shown in the main body of the chart. The PERT chart shows the project as a set of circles linked by timelines.
3. What is snagging?
Correcting small faults at the end of a job

Knowledge check, p. 392

1. The de-rating factor for a cable grouped with other cables is:
c C_g
2. Design current is represented as:
a I_b
3. The disconnection time for a 230 V, single-phase TT-protected circuit feeding a 16 A load is:
c 0.4 seconds
4. The maximum earth fault loop impedance (Z_s) for a Type C, 25 A circuit breaker to BS 60898 is:
b 0.92 Ω
5. Where conductors carrying different voltages are run together:
d all insulation must be rated to the highest voltage
6. The regulations intended to protect electronic and data equipment from electromagnetic interference are:
c Electromagnetic Compatibility
7. Farms, construction sites and fairgrounds are:
c special locations
8. The transformer feeding SELV equipment in a bathroom should be located outside:
b Zone 2
9. A quotation is:
a a price entered by a contractor when tendering for work
10. A series of interdependent tasks running through a project are a:
c critical path