

C&G 2394/2395 Past Exam Paper

Section A - All questions carry equal marks. Answer all twenty questions.

- 1 State the **three** documents that must be completed and handed to the client on completion of an initial verification.
(3 marks)
- 2 State **three** relevant non-statutory guidance publications that an inspector may consult when carrying out a periodic inspection on an installation.
(3 marks)
- 3 State **three** factors that need to be considered when deciding on the recommended time to the first periodic inspection of an installation. (3 marks)
- 4 Explain why it is necessary to avoid, where possible, the dismantling of an installation when carrying out a periodic inspection.
(3 marks)
- 5 An existing electrical installation is to be inspected and tested before new tenants move into the property. State:
a) what must be agreed with the client prior to the inspection taking place
(2 marks)
b) on which document the agreement in a) above must be recorded. (1 mark)
- 6 List **three** checks to be made on test instruments prior to use, in addition to correct operation. (3 marks)
- 7 State, in the correct sequence, the **first three** tests to be carried out on completion of a newly installed lighting circuit. (3 marks)
- 8 A length of conductor has a resistance of 0.6Ω . State the expected value of resistance of a similar conductor of
 - a) the same length and twice the cross-sectional area (1 mark)
 - b) the same cross-sectional area and half the length (1 mark)
 - c) twice the length and half the cross-sectional area. (1 mark)
- 9 While verifying the continuity of a healthy ring final circuit as part of an initial verification the measured loop resistance of the line, neutral and circuit protective conductor were 0.9Ω , 0.91Ω and 1.5Ω respectively. All sockets are connected directly in the ring.
 - a) State the most likely reason for the cpc resistance being greater than the line and neutral resistance. (1 mark)
 - b) What is the expected test value at each socket between line and neutral when the line and neutral are correctly interconnected at the distribution board. (1 mark)
 - c) Determine the expected test value at each socket between line and cpc when the line and cpc are correctly interconnected at the distribution board. (1 mark)

- 10 The following results were recorded when carrying out a number of tests on a radial circuit which meets the requirements of BS 7671. State, for each test result, one possible test that would produce the value indicated. (Z_e was measured and recorded at 0.36Ω .
- a) 0.20Ω . (1 mark)
 - b) 0.54Ω . (1 mark)
 - c) $>100 M \Omega$. (1 mark)
- 11 A test for insulation resistance is conducted on a lighting circuit securely isolated from the supply. State:
- a) one item of current-using equipment that may need to be disconnected in order to carry out a line to neutral test (1 mark)
 - b) the action to be taken with regard to two-way switching (1 mark)
 - c) the recommended test method used if a dimmer is to be left in the circuit during the test, other than linking out or removing the switch. (1 mark)
- 12 List **three** special installations/locations identified in Part 7 of BS 7671 in addition to bathrooms, shower rooms, saunas and swimming pools.
- 13 State the **minimum** IP code for each of the following.
- a) The face plate of a surface mounted lighting switch. (2 marks)
 - b) The top surface of a motor starter (1 mark)
- 14 State the checks to be made when carrying out a test of polarity on a
- a) single pole switch (1 mark)
 - b) Edison screw lampholder (1 mark)
 - c) 13 A socket. (1 mark)
- 15 Describe the difference between a TN-C-S and a TN-S system. (3 marks)
- 16 State one
- a) important check to be made regarding main protective bonding before carrying out a loop impedance test on a circuit (1 mark)
 - b) action to be taken regarding the earthing conductor prior to conducting an external earth loop impedance test (1 mark)
 - c) precaution that should be taken before conducting the test in b). (1 mark)
- 17 When using an RCD in a 230 V circuit forming part of a TN system the following conditions must be fulfilled, $Z_s \times I_a \leq U_o$
- a) State what is represented by
 - i) Z_s (1 mark)
 - ii) I_a (1 mark)
 - b) Calculate the max permitted earth loop impedance for a circuit incorporating a 100 mA RCD in an office, using the condition stated above. (1 mark)
- 18 A 100mA general purpose RCD to BS EN 61008 is to be tested to ensure it operates within specification. State the
- a) value of the **two** test currents (2 marks)
 - b) **maximum** operating time when using the larger test current. (1 mark)

- 19 State why it is necessary to carry out a test of prospective fault current at the main intake position of an installation. (3 marks)
- 20 In a small shop a ring final circuit forming part of a TN-S system has fault protection (indirect contact) using a 30 mA RCD. Determine the maximum permitted earth loop impedance value for this circuit. Show all calculations. (3 marks)

Section B - All questions carry equal marks. Answer all six questions.

Questions 21 to 26 all refer to the following scenario.

The three-phase 400/230 V electrical installation, within an eight-year-old small industrial unit producing wrought iron gates and fencing, forms part of a TN-C-S system that is to be inspected and tested during working hours.

The existing metal-clad TP & N distribution board contains BS EN 60898 type B and type C circuit breakers. The wiring system is thermoplastic (pvc) insulated single-core cables with copper conductors enclosed in steel conduit and trunking in the workshop and pvc conduit and trunking in the office.

The car park lighting circuit is wired using thermoplastic (pvc) steel wire armoured cable. Each circuit has a copper cpc the same size as the circuit line conductor.

Figure 1, attached, shows the installation circuit arrangements and details some test results recorded during inspection and testing.

Figure 2, below, shows categories of non-compliance.

- 21 State
- a) the documents that will need to be completed for this inspection (3 marks)
 - b) 1 statutory and 2 non-statutory documents relevant to the inspection (3 marks)
 - c) 3 items of documentation and/or information that should be available to the person carrying out the inspection (3 marks)
 - d) what must be agreed with the client with regard to carrying out testing with the supply off. (2 marks)
 - e) four areas for investigation, in addition to wear, tear and aging, that would need to be considered during the inspection. (4 marks)
- 22 List five items to be checked during inspection on the conduit and trunking system in the factory to ensure the containment system remains correctly erected and is suitable for the environment.
- 23 a) State
- i) the **minimum** acceptable value for an insulation resistance test when testing the complete installation (2 marks)
 - ii) the value of insulation resistance below which further investigation is recommended (2 marks)
 - iii) the test voltage to be used for this installation. (2 marks)
- b) Describe how an insulation resistance test would be carried out on the office lighting circuit 3 L3. (9 marks)

- 24 Describe, in detail, the process for carrying out an external earth loop impedance (Z_e) test by direct measurement. Your description should include
- safety considerations
 - the instrument to be used
 - instrument and lead checks
 - instrument test connections
 - final safety procedures.
- (15 marks)
- 25 a) Draw a fully labelled diagram of the earth loop impedance path for the workshop water heater circuit, 3 L2. Clearly indicate the path of the earth fault current. (8 marks)
- b) State
- why it is important for the earth fault loop impedance in a) to be low value. (1 mark)
 - two possible hazards that may result from the earth fault loop impedance being too high (2 marks)
- c) if the earth loop impedance test value was too high, state two practical actions that could be taken to ensure the circuit complies. (it is impractical to shorten the circuit length or de-rate the protective device). (4 marks)
- 26 a) From the test results shown in *Figure 1* attached, identify, giving reasons, any results that give cause for concern. (10 marks)
- b) Clearly indicate the category of non-compliance for each cause for concern from a) using the categories identified in *Figure 2* below. (5 marks)

| Category of non-compliance | Action required |
|----------------------------|-----------------------------------|
| 1 | Requires urgent attention |
| 2 | Requires improvement |
| 3 | Requires further investigation |
| 4 | Does not comply with BS 7671:2008 |

Figure 1

| Circuit designation | | | Protective device 6kA | | Conductor c _{sa} (mm ²) | | BS 7671 maximum tabulated Z _s (Ω) | Test results | | | | Functional Testing | |
|---------------------|-------|--------------------------|--------------------------|-----------------------|--|-----|---|-------------------|----------------------------------|----------------|--|-----------------------|--|
| | | | | | | | | Continuity (Ω) | Insulation resistance (MΩ) | | Earth loop impedance Z _s (Ω) | | |
| Way | Phase | Description | Type | Rating I _n | Live | Cpc | R ₁ + R ₂ | Live/live | Live/ earth | Z _s | RCD time | Other | |
| 1 | L1 | Workshop lights | B | 10 | 1.5 | 1.5 | 0.49 | 140 | 184 | 0.58 | - | ✓ | |
| | L2 | Workshop Ring | B | 32 | 2.5 | 2.5 | 0.09 | 120 | >200 | 0.20 | - | ✓ | |
| | L3 | 16A radial socket | C | 16 | 2.5 | 2.5 | 0.29 | >200 | >200 | 0.41 | - | ✓ | |
| 2 | L1 | Forge fan | - | - | - | - | - | - | - | - | - | - | |
| | L2 | Forge fan | C | 6 | 1.5 | 1.5 | 0.34 | 0.32 | >200 | 0.42 | - | ✓ | |
| | L3 | Forge fan | - | - | - | - | - | - | - | - | - | - | |
| 3 | L1 | Bench drill | C | 10 | 1.5 | 1.5 | 0.49 | >200 | >200 | 0.60 | - | ✓ | |
| | L2 | Workshop water Heater | B | 20 | 2.5 | 2.5 | 0.16 | 0.32 | >200 | 2.3 | - | ✓ | |
| | L3 | Office 1 lights | C | 10 | 1.5 | 1.5 | 0.75 | 140 | >200 | 0.85 | - | ✓ | |
| 4 | L1 | Office 2 lights | C | 6 | 1.5 | 1.5 | 0.87 | 190 | >200 | 0.99 | - | ✓ | |
| | L2 | Office Ring | B | 32 | 2.5 | 2.5 | 0.19 | >200 | 162 | 0.31 | - | ✓ | |
| | L3 | Car park lights | C | 10 | 2.5 | 2.5 | 0.30 | 170 | 0.4 | 1.04 | - | ✓ | |

Z₀ = 0.1Ω PFC = 4.7kA

Figure 2

Answers:

Section A

1. Electrical installation Certificate, Schedule of Test Results, Schedule of Inspections. (p85).
2. BS 7671, Guidance Notes 3, The On Site Guide.
3. Type of installation, its use and operation, frequency and quality of maintenance, external influences. (p62).
4. Dismantling and disconnection of cables or components introduces a risk of unsatisfactory reassembly. You could do more harm than good. (p60).
5. a. Extent and limitations, exactly what is and what is not covered by the report. (p99).
b. In the Extent and limitations box provided on the Periodic Inspection Report form.
6. Do they conform to an appropriate British Standard?
Are test leads and probes in good order?
Do test leads and probes comply to GS38? (p13).
7. Continuity of protective conductors.
Insulation resistance
Polarity. (p33).
8. a. 0.3Ω
b. 0.3Ω
c. 2.4Ω
9. a. A reduced csa has been used as with 2.5/1.5 cable. Resistance is indirectly proportional to csa. $0.9 \times 1.67 = 1.5$
b. $(0.9 + 0.91) / 4 = 0.45$
c. $(0.9 + 1.5) / 4 = 0.6$
10. a. $R1 + R2$
b. Zs
c. Insulation Resistance.
11. a. Lamps.
b. The test must be carried out with all combinations of switching in order to bring strappers and switch lines into the test.
c. Only test between Live conductors and earth, not between L and N. (p74,b).
12. Construction sites, agricultural sites, caravan parks. (Part 7 of BS7671).
13. a. IP2X (BS7671 reg 416.2.1)
b. IP4X (BS7671 reg 416.2.2)

14. a. Connected in the Line conductor only.
 b. Centre pin connected to Line conductor.
 c. All accessories must be correctly connected. (p46).
15. TN-S, there is a separate earth connection provide by the supplier which connects the installation to the earthed star point of the transformer.
- TN-C-S, the suppliers Neutral conductor is also used as the earth (P.E.N). This is separated at the suppliers cut out. Therefore the N and E are combined on the suppliers side but separated at the customers side.
16. a. There connection must be verified and they must not be disconnected. (p50)
 b. Disconnected to remove parallel paths. (p50)
 c. The installation must be isolated before disconnecting the earthing conductor.
17. a. i) Total earth loop impedance path.
 ii) The level of fault current causing automatic disconnection of the protective device.
- b. $50 / 0.1 = 500\Omega$ Ω (GN3 p76), (Reg 411.4.9 Tab 41.5 BS 7671)
- 50v being the max level of touch voltage
18. a. 50mA and 100mA
 b. 300mS
19. A value of Pfc needs to be determined at all relevant places. This means where a protective device is situated. The test is made to check that the Pfc does not exceed the breaking capacity of the device. (p52)
20. $Z_s = V / I_a$
- $= 50 / .03 = 1666\Omega$ (p76), (Reg 411.4.9 Tab 41.5 BS 7671)
- 50v being the max level of touch voltage.

Section B

21. a. Periodic Inspection Report, Schedule of Inspections, Schedule of Test Results.
b. Health & Safety at Work Act 1974, BS 7671, Guidance Notes 3.
c. Diagrams, charts, design criteria, any previous test results. (p61).
d. Extent & limitation (p99, 5).
e. Safety, Corrosion, Damage, External influences. (p65,66).

22. Any relevant 5 from the check list on page 30.

23. a. i) 1 M ohm. (p75)
ii) 2 M ohm.
iii) 500 v dc.

b. Perform safe isolation for this circuit.

If possible remove all electrical loads (lamps etc) from the circuit. (p74)

Any equipment vulnerable to the test should be removed from circuit and the circuit remade for the duration of the test.

Ensure all covers of enclosures are in place.

With a test voltage of 500 v dc, test between live conductors and between live conductors and earth. Readings must be no less than 1M ohm.

If it is not possible to remove loads or vulnerable equipment then it is acceptable to only test between live conductors and earth (this would need to be agreed with the client and recorded as a limitation).

24. Isolate the supply.

Remove the earthing conductor from the earthing terminal, this removes parallel paths.

Select an earth loop impedance tester.

Ensure the instrument has a valid calibration label. Are the leads and probes GS 38 compliant? Check for visible signs of damage.

Connect the test leads to live side of the isolator (Line and Neutral) and the earthing conductor.

Press the button and record the value of Ze.

Reconnect the earthing conductor before switching the isolator back on.

25. a) Earth loop impedance path showing Line 2 of the 3 phase TN-C-S. Water heater connected as the load. Identify all component parts of the path.

b) i) Automatic Disconnection of Supply (ADS) is dependant on the Z_s value not exceeding the max tabulated values. If Z_s is too high there will not be enough fault current to disconnect quick enough.

ii) Shock under fault conditions where ADS is not achieved.

Overheating of the conductors, fire.

| | | | |
|-----|-------------------------|--|------------------|
| 26. | Circuit 1L3 radial skt | No rcd protection | Code 4 |
| | Circuit 4L2 office ring | No rcd protection | Code 4 |
| | Circuit 2L2 Forge Fan | I.R test Live to Live <1M | Code 2 |
| | Circuit 3L2 W.Heater | I.R test Live to Live <1M Measured $Z_s > 2.3 \times 0.8$ | Code 2 Code 2 |
| | Circuit 4L3 Car park | I.R test Live to Earth <1M | Code 2 |