higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NON-NATIONAL CERTIFICATE

INSTALLATION RULES
(Second paper)

(11040432)

27 November 2023 (X-paper)
09:00–12:00

Drawing instruments and nonprogrammable calculators may be used.

This question paper consists of 6 pages and 2 addenda.

108Q1E2327

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NON-NATIONAL CERTIFICATE
INSTALLATION RULES
(Second paper)
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Number the answers according to the numbering system used in this question paper.
2. Start each question on a new page.
3. The answers need not be word perfect in all aspects according to the relevant publication/s but they must show that candidates fully understand the context of the relevant question.
4. Candidates must pass both Paper 1 and Paper 2 with 50% to be able to obtain a pass.
5. For accreditation purposes, all candidates must meet the requirements prescribed by the Department of Labour.
6. No condonations will be considered.
7. The necessary tables are supplied.

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QUESTION 1: SANS 1973-3: SAFETY OF ASSEMBLIES WITH A RATED PROSPECTIVE SHORT-CIRCUIT CURRENT OF UP TO AND INCLUDING 10 kA

Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (1.1–1.10) in the ANSWER BOOK.

1.1 An assembly shall be controlled by a switch disconnector or a circuit-breaker that complies with the isolating requirements specified for a disconnector.

1.2 Pollution degree 4 is when pollution generates persistent conductivity caused, for example, by conductive dust or by rain or snow.

1.3 In the absence of the minimum clearance distance being specified in the relevant product standard for a component, the minimum clearance distance between phase and between each phase and earth shall be 16 mm.

1.4 The size and design of a busbar system shall be rated for the prospective short-circuit current that could occur at the consumers' terminals of the assembly.

1.5 If colour is used for control wire coding, any colour may be used, except green/yellow, green or black.

1.6 The dimensions of the busbar joining plates shall be similar to those of the busbar and the overlap on each side shall be at least equal to the width of the busbar.

1.7 Conductors installed within a fault-free zone shall be sufficiently insulated where they could touch the conducting parts.

1.8 A warning label may be fitted to every assembly where series-connected (cascaded) systems are used.

1.9 Where flammable material is used for construction of the enclosure, the switchgear and control gear mounted in the enclosure shall be shrouded by non-flammable material.

1.10 Assemblies that have a rated current above 125 A shall be certified by a person who is competent to express an opinion on the safety of the assembly.

(10 × 1) **[10]**

QUESTION 2: SANS 10142-1: INSTALLATION REQUIREMENTS: CURRENT-CARRYING CAPACITY OF CONDUCTORS AND CABLES

2.1 Give all correction factors associated with grouping of cables in different types of installations. (4)

2.2 Briefly explain your understanding of the construction and the uses of single-phase concentric cables for aerial service connections. (6)

[10]

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QUESTION 3: SANS 10142-1: INSTALLATION REQUIREMENTS: PROTECTION

3.1 State the conditions that allow for the conductors that forms part of an installation to be protected by the supplier's overcurrent protective devices. (4)

3.2 When shall one install an overload protective device? (3)

3.3 Which equipment in an installation requires earth leakage protection? (3)

[10]

QUESTION 4: SANS 10142-1: INSTALLATION REQUIREMENTS: EARTHING

4.1 What are the main purposes for the provision of earthing? (3)

4.2 Name all parts of an electrical installation that need to be earthed. (7)

[10]

QUESTION 5: SANS 10142-1: INSTALLATION REQUIREMENTS: SOCKET OUTLETS

5.1 What are the requirements for single-phase socket outlets for general use? (4)

5.2 What are the installation requirements regarding floor mounted socket outlets? (2)

5.3 When is one allowed to install a socket outlet within 2 meters of a water tap? (2)

5.4 What types of dedicated socket outlets may be used for new electrical installations? (2)

[10]

QUESTION 6: SANS 10142-1: VERIFICATION AND CERTIFICATION

6.1 When issuing a certificate of compliance certain critical inspections need to be confirmed. Briefly describe those inspections. (4)

6.2 How would one confirm that earth continuity test/s are correct or not? (2)

6.3 From where and to which points of an installation would one test when performing continuity of bonding tests. (2)

6.4 What is the purpose of bonding? (2)

[10]

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QUESTION 7: SANS 10142-1: VERIFICATION AND CERTIFICATION

You have performed electrical tests on an installation of 230 V/60 A and want to confirm whether the test results are correct or not. The result for each test performed are given below.

State whether the test passes or fails and give a reason for your answer.

7.1 Earth loop impedance = 1,90 Ω

7.2 Elevated voltage on the supply neutral = 50 mV

7.3 Operation of earth leakage unit = 30 mA

7.4 Earth resistance = 12,2 Ω

7.5 Voltage at distribution board – on load = 216,22 V

(5 × 2) **[10]**

QUESTION 8: SANS 10142-1: VERIFICATION AND CERTIFICATION

A transformer of 100 kVa 11000/400 V feeds a three-phase distribution board with a 70 mm² × 4 core armoured copper cable that is 65 meters long. The transformer impedance is 0,048 Ω

8.1 Calculate the PSCC at the point of control. (6)

8.2 May one install circuit breakers that have a higher kA rating than the main circuit breaker that feeds them? Give a reason for your answer. (2)

8.3 What is main reason for calculating PSCC of an installation? (2)

[10]

QUESTION 9: SANS 10142-1: ANNEX D: CALCULATION OF VOLTAGE DROP

A single-phase distribution board supplies three circuits all using armoured copper cables – the first circuit is a 3 kW pump, 22 meters from the DB using a 4 mm² × 3 core; the second circuit is a 3 kW geyser, 15 meters from the DB using a 2,5 mm² × 2 core plus a separate earth wire and the last circuit is TWO 4 kW heaters that are 15 meters from the DB using the same 6 mm² × 3 core cable.

9.1 Calculate the total voltage drop of the circuit. (7)

9.2 Is the voltage drop obtained in QUESTION 9.1 correct or not? Substantiate your answer. (1)

9.3 Briefly explain your understanding of the relationship between the load and the length of the cable with regard to the voltage drop. (2)

[10]

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QUESTION 10: SANS 10142-1: ANNEX K: EARTHING ARRANGEMENTS AND EQUIPOTENTIAL BONDING OF I.T.

10.1 Which conductors may be connected to the earthing busbar? (6)

10.2 Give THREE factors that affect the effectiveness of equipotential bonding. (3)

10.3 What must be considered when an earthing conductor is selected? (1)

[10]

TOTAL: 100

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TABLE 6.4 (b) – Multicore PVC-insulated armoured cables (SANS 1507)
Voltage (per ampere per metre) on copper conductors

Conductor operating temperature: 70 °C

1	2	3			4		
Conductor cross-sectional area	**Two-core cable D.C.** [a]	**Two-core cable, single-phase A.C.** [a]			**Three-core or four-core cable, three-phase A.C.**		
mm^2	**mV/A/m**	**mV/A/m**			**mV/A/m**		
1,5	29	29			25		
2,5	18	18			15		
4	11	11			9,5		
6	7,3	7,3			6,4		
10	4,4	4,4			3,8		
16	2,8	2,8			2,4		
		r	x	z	r	x	z
25	1,75	1,75	0,170	1,75	1,50	0,145	1,50
35	1,25	1,25	0,165	1,25	1,10	0,145	1,10
50	0,93	0,93	0,165	0,94	0,80	0,140	0,81
70	0,63	0,63	0,160	0,65	0,55	0,140	0,57
95	0,46	0,47	0,155	0,50	0,41	0,135	0,43
120	0,36	0,38	0,155	0,41	0,33	0,135	0,35
150	0,29	0,30	0,155	0,34	0,26	0,130	0,29
185	0,23	0,25	0,150	0,29	0,21	0,130	0,25
240	0,180	0,190	0,150	0,24	0,165	0,130	0,21
300	0,105	0,155	0,145	0,21	0,135	0,130	0,185
400	0,145	0,115	0,145	0,185	0,100	0,125	0,160

[a] In the case of single-phase circuits, the return path has been accounted for in the values given.

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TABLE D.1 – Impedance of 600/1 000 V conductors that comply with SANS 1507

Ambient temperature: 30 °C
Conductor operating temperature: 70 °C

1	2	3	4	5	6	7
Nominal cross-sectional area of conductor mm²	**Conductor resistance R for A.C. circuits Ω/km**		**Conductor reactance X for A.C. circuits Ω/km**		**Conductor resistance R for D.C. circuits Ω/km**	
	Material of conductor					
	Copper Cu	**Aluminium Al**	**Copper Cu**	**Aluminium Al**	**Copper Cu**	**Aluminium Al**
1	21,9	36,0	0,107	0,107	21,9	36,0
1,5	14,6	24,0	0,100	0,100	14,6	24,0
2,5	8,7	14,4	0,095	0,095	8,7	14,4
4	5,5	9,0	0,093	0,093	5,5	9,0
6	3,6	6,0	0,090	0,090	3,6	6,0
10	2,2	3,6	0,084	0,084	2,2	3,6
16	1,4	2,3	0,080	0,080	1,4	2,2
25	0,88	1,44	0,079	0,079	0,87	1,44
35	0,63	1,03	0,076	0,076	0,62	1,03
50	0,44	0,72	0,076	0,076	0,44	0,72
70	0,31	0,52	0,074	0,074	0,31	0,51
95	0,23	0,38	0,073	0,073	0,23	0,38
120	0,18	0,30	0,072	0,072	0,18	0,30
150	0,15	0,24	0,072	0,072	0,15	0,24
185	0,12	0,20	0,072	0,072	0,12	0,19
240	0,095	0,156	0,072	0,072	0,091	0,150
300	0,077	0,127	0,071	0,071	0,073	0,120
400	0,060	0,099	0,071	0,071	0,055	0,090
500	0,050	0,083	0,070	0,070	0,044	0,072
630	0,043	0,071	0,069	0,069	0,035	0,057
800	0,037	0,061	0,058	0,058	0,027	0,045
1 000	0,033	0,054	0,049	0,049	0,022	0,036

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