higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

INSTALLATION RULES
(Second Paper)

(11040432)

21 November 2019 (X-Paper)
09:00–12:00

This question paper consists of 6 pages and tables of 3 pages.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
INSTALLATION RULES
(Second Paper)
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.

2. Read ALL the questions carefully.

3. Number the answers according to the numbering system used in this question paper.

4. Even though not explicitly stated in a question, ALL answers must comply with the relevant codes and/or requirements of the SANS publications (latest edition) and the Occupational Health and Safety Act and regulations.

5. The answers need not be word-perfect in all aspects according to the publications but they must show that the candidate fully understands the context of the relevant question.

6. The necessary tables are attached.

7. The candidates must pass PAPER 1 and PAPER 2 with 50% each. Both examination papers may be written during the same examination period. However, candidates need not pass both examinations during the same trimester, but the second examination must be passed within 12 months of the first, otherwise both examinations must be rewritten. If a candidate obtains 75 of 100 marks in any one of the examinations, he/she will be permanently exempted from rewriting that examination. An appropriate statement will be issued. For accreditation ALL candidates must meet the requirements prescribed by the Department of Labour.

8. NO condonations will be considered.

9. Start each question on a NEW page.

10. Write neatly and legibly.

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QUESTION 1: SANS 1973-3 OF 2008: SAFETY OF ASSEMBLIES WITH A RATED PROSPECTIVE SHORT-CIRCUIT CURRENT OF UP TO 10 kA

Give a full description of the following:

1.1 Assembly (distribution board) (3)

1.2 Fault-free zone (4)

1.3 Pollution degree (3)

[10]

QUESTION 2: SANS 10142-1 OF 2017: ANNEX E: CALCULATIONS OF VOLTAGE DROP

A single-phase 230 V AC distribution board supplies the following circuits in conduit and is directly mounted against the wall.

A – 4 kW water heater, 15 metres from the distribution board (DB)
B – 30 A stove 4 metres from the DB
C – 1,5 kW pool pump with a 6 kW heating system, 12 metres from the DB

2.1 Calculate suitable supply cables for each load and give a reason why that cable is suitable for the load in question. (6)

2.2 Calculate the total voltage drop that is expected in the distribution board at full load. State whether it is acceptable or not and give a reason for your answer. (2)

2.3 What is the total load for this installation in kilowatts? (2)

[10]

QUESTION 3: SANS 10142-1 of 2017: CURRENT-CARRYING CAPACITY OF CONDUCTORS AND CABLES

3.1 The sustained current-carrying of conductors capacity I (amps) of a cable buried directly in the ground can be calculated by the following equation:
I = Is × F1 × F2 × F3 × F4 (amps)

Explain each factor used in the equation. (5)

3.2 Give TWO factors that can lead to neutral currents. (2)

3.3 Given:

Is = 80 A; F1 = 0,96, F4 = 0,81, soil temperature is 30 °C and resistivity is 1,5 K.m/W.

Calculate the conductor sustained current-carrying capacity. (3)

[10]

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QUESTION 4: SANS 10142-1 OF 2017: WIREWAYS

4.1 Give FOUR general requirements when conduit is used as a wireway. (4)

4.2 Give TWO requirements regarding the fixing of:

4.2.1 A rigid metallic wireway

4.2.2 A rigid nonmetallic wireway

(2 × 2) (4)

4.3 Give TWO instances or conditions in which a rigid nonmetallic wireway shall not be used. (2)

[10]

QUESTION 5: SANS 10142-1 OF 2017: EARTHING

Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'True' or 'False' next to the question number (5.1–5.10) in the ANSWER BOOK.

5.1 An earth-continuity conductor shall, if it forms part of a cable other than a flexible cable, comply with the relevant requirements of the standard for the cable.

5.2 An earth-continuity conductor shall, if it forms part of a flexible cable, be of the same material as, and have a nominal cross-sectional area at least equal to, that of the largest phase conductor.

5.3 An earth-continuity conductor shall be able to carry a minimum load without excessive heating of the conductor, within the disconnecting time.

5.4 Earth-continuity conductors shall be so arranged that they cannot be tampered with.

5.5 A metallic wireway may be used as an earth-continuity conductor.

5.6 Connections of earth-continuity conductors shall not rely only on twisting of the conductor or strands of the conductor.

5.7 Where electrical monitoring of earthing is used, the operating coils shall be inserted in protective conducts.

5.8 An earth-continuity conductor shall not be used to carry any current, including fault currents.

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5.9 An earth electrode might be required for purposes such as antennas and surge-voltage protection.

5.10 A bonding conductor shall have a nominal cross-sectional area of at least 6 mm² copper or equivalent.

(10 × 1) **[10]**

QUESTION 6: SANS10142-1 OF 2017: LIGHTING

Complete the following sentences by filling in the missing words or phrases. Write only the answer next to the question number (6.1–6.6) in the ANSWER BOOK.

6.1 A single-phase circuit that supplies luminaires can only … (1)

6.2 Each identified group of single-phase luminaires supplied from a multiphase supply that also feeds other luminaires, shall be … (1)

6.3 The disconnecting device should disconnect all live conductors that feed the group of luminaires, including the neutral in order that … (1)

6.4 A circuit that has two phase conductors and that supplies only luminaires that are connected between the phase conductors, may supply any number of points if … (2)

6.5 In a lighting circuit, a luminaire can be in a fuse ceiling or in a roof space 4 m above the floor where there is no ceiling, or in a floor cavity, or in a wall socket outlet which may be unswitched and not protected by earth-leakage protection, provided that the socket outlet … (4)

6.6 A lighting circuit that incorporates 6 A socket outlets or 13 A socket outlets in accordance with 6.14.1, shall be … (1)

[10]

QUESTION 7: SANS 10142-1 OF 2017: FIXED APPLIANCES

7.1 In addition to the requirements of 6.7 (protection), the circuit that supplies a motor shall have overcurrent protection, except if five conditions are met.

State the FIVE conditions. (5)

7.2 Give FIVE requirements regarding the overcurrent protection for motor circuits in 7.1. (5)

[10]

QUESTION 8: SANS 10142-1 OF 2017: PROSPECTIVE SHORT-CIRCUIT CURRENT, DC

The following information is given:

A 120 cell battery unit supplies a 6 kW DC load using a 16 mm² × 2 core copper cable and the battery has a total internal resistance of 0,3 ohms and the combined resistance of the battery terminals is 0,8 ohms.

8.1 Calculate the PSCC of the battery and show ALL the calculations. (7)

8.2 Explain the following items that are used to calculate the PSCC mentioned in QUESTION 8.1.

8.2.1 Eb (1)

8.2.2 Rbbr (2)

[10]

QUESTION 9: SANS 10142-1 OF 2017: VERIFICATION AND CERTIFICATION; SANS 10142-1 OF 2008: TEST REPORT: INSPECTIONS

State TEN items which shall be ensured/checked during inspection of an installation to ensure that the installation complies with this part of SANS10142. **[10]**

QUESTION 10: SANS 10142-1 OF 2017: ANNEX I: INSTALLATION OF SURGE PROTECTION DEVICES (SPDs) IN VOLTAGE SYSTEMS

10.1 State TWO requirements regarding the installation of SPDs with regard to protection against overcurrent and consequences of an SPD failure. (2 × 2) (4)

10.2 What is the requirement when power and telecommunication lines enter a building or structure? (1)

10.3 What are the THREE compositions of an external structural lighting protection system (LPS)? (3)

10.4 State TWO risk criteria that are used as guidelines for installation of SPDs in fixed installations. (2)

[10]

TOTAL: 100

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Table 6.3(b) — Multicore PVC insulated cables, unarmoured, with or without protective conductor (SANS 150 Voltage drop (per ampere per metre) copper conductors

Conductor operating temperature: 70 °C

1	2	3			4		
Conductor cross-sectional area mm²	**Two-core cable d.c.**[a] mV/A/m	**Two-core cable, single-phase a.c.**[a] mV/A/m			**Three-core or four-core cable, three-phase a.c.** mV/A/m		
1	44	44			38		
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	0,145	0,155	0,145	0,21	0,135	0,130	0,185
400	0,105	0,155	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.

Table 6.11 — Correction factors for soil temperature

Maximum conductor temperature: 70 °C

1	2
Soil temperature °C	**Correction factors for cables buried directly or buried in pipes in the ground**
10	1,15
15	1,11
20	1,05
25	1,00
30	0,94
35	0,88
40	0,82

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Table 6.12 — Correction factors for thermal resistivity of soil

1	2	3
Thermal resistivity of soil K·m/W	**Correction factors**	
	Cables buried directly in the ground	**Cables installed in pipes buried in the ground**
0,7	1,17	1,07
0,8	1,13	1,05
0,9	1,09	1,04
1,0	1,06	1,02
1,2	1,00	1,00
1,5	0,93	0,96
2,0	0,83	0,91
2,5	0,76	0,87
3,0	0,71	0,83
3,5	0,65	0,8
4,0	0,61	0,77
NOTE The correction factors given have been averaged over the range of conductor sizes. Consult SANS 10198-4 if specific conductor size correction factors are required.		

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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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