higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

INSTALLATION RULES

(Second paper)

(11040432)

9 April 2021 (X-paper)
09:00–12:00

This question paper consists of 6 pages and 6 addenda.

108Q2A2109

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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. Answers must comply with the relevant codes and/or requirements of the SANS publications (latest edition) and occupational Health and Safety Act
5. Regulations.
6. Answers must show that candidates fully understand the context of the relevant question.
7. The necessary tables are supplied.
8. Candidates must obtain at least 50% for PAPER 1 as well as PAPER 2. 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. If not, both examinations must be rewritten. Candidates obtaining 75% in any one of the examinations will be permanently exempted from re-writing that examination. An appropriate statement to this effect will be issued.
9. For accreditation purposes all candidates must meet the requirements prescribed by the Department of Labour.
10. Work neatly.

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QUESTION 1: SANS 10142-1 OF 2017: INSTALLATION REQUIREMENTS: GENERAL CIRCUIT ARRANGEMENTS

1.1 A three-phase, four-wire circuit supplying only single-phase electrical equipment may supply any number of points if certain conditions are met.

State these conditions. (5)

1.2 When may flexible cords be used as part of an electrical installation? (5)

[10]

QUESTION 2: SANS 10142-1 OF 2017: INSTALLATION REQUIREMENTS: INSTALLATION OF CONDUCTORS AND CABLES

Briefly explain means the identification means of using colour or numbers for the following

2.1 AC circuits (4)

2.2 DC circuits (6)

[10]

QUESTION 3: SANS 10142-1 OF 2017: INSTALLATION REQUIREMENTS: EARTHING

Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (3.1–3.10) in the ANSWER BOOK.

3.1 An earth continuity conductor shall consist of compatible conductors.

3.2 An earth continuity conductor shall be able to carry the prospective fault current without excessive heating of the conductor, within the disconnecting time.

3.3 An earth continuity conductor shall be so arranged that it cannot be tampered with.

3.4 A metal wireway may be used as an earth continuity conductor if its resistance is low.

3.5 A fuse or switching device may be fitted in an earth continuity conductor if it is of the correct current rating.

3.6 Where electrical monitoring of the earthing is used, the operating coils must be fitted in the protective conductors.

3.7 The earthing terminal of a socket outlet shall be earthed.

3.8 All class 1 equipment shall be earthed.

3.9 Conductive parts that can be touched by the standard test finger do not need to be earthed.

3.10 Metallic fittings in bathrooms, if they are electrically isolated from earth, need not to be earthed.

(10 × 1) **[10]**

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QUESTION 4: SANS 10142-1 OF 2017: INSTALLATION REQUIREMENTS: CURRENT-CARRYING CAPACITY OF CONDUCTORS AND CABLE

4.1 The sustained current-carrying capacity I(A) of a cable buried directly in the ground can be calculated with the following equation.

$I = Is \times F1 \times F2 \times F3 \times F4 \ldots A.$



Explain each item of the equation. (5)

4.2 Calculate the sustained current-carrying capacity of a 10 mm^2 × 4 core armoured copper cable that is buried 0,8 m directly underground. The average temperature of the soil is 35 °C and thermal resistivity is 2,5 K-m/W.c. The cable is buried with three other cables separated 150 mm from one another. (5)

[10]

QUESTION 5: SANS 10142-1 OF 2017: VERIFICATION AND CERTIFICATION: TESTING

5.1 Briefly explain, with the aid of a sketch, how an earth resistance test is performed on an earth electrode. (6)

5.2 What is the maximum value allowed for earth resistance? (1)

5.3 What can be done if the reading in QUESTION 5.2 exceeds the maximum allowed value? (2)



5.4 What can be used to perform this test on concrete/tarred areas? (1)

[10]

QUESTION 6: SANS 10142-1 OF 2017: VERIFICATION AND CERTIFICATION: TESTING

Briefly explain how each of the following tests are performed:

6.1 Voltage, main distribution board – on load (2)



6.2 Voltage at available load (worst condition) (4)

6.3 Polarity at points of consumption (4)

[10]

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QUESTION 7: SANS 10142-1 OF 2017: VERIFICATION AND CERTIFICATION: TESTING

A 100 kVA, 11 kV/400 V three-phase transformer with an impedance of 4,8% supplies a factory that is 50 meters from the transformer. A 95 mm² × 4 core armoured copper cable buried directly underground supplies the factory.

7.1 Calculate the prospective short-circuit current at point of control. Show all calculations. (8)

7.2 The prospective short-circuit current of batteries can be calculated using the following formula:

PSCC = Eb/Rbbr

Use this formula to explain each of the following:

7.2.1 Eb

7.2.2 Rbbr

(2 × 1) (2)

[10]

QUESTION 8: SANS 10142-1 OF 2017: ANNEXURE D: CALCULATION OF VOLTAGE DROP

Use ADDENDUM A (attached) to answer the following questions.

8.1 Calculate the estimated distance in meters between the DB and the pump. (3)

8.2 Calculate the voltage drop at the geyser. (3)

8.3 Calculate the total voltage drop at full load at the DB. (2)

8.4 Is the voltage drop in QUESTION 8.3 acceptable or not? Give a reason for your answer. (2)

[10]

QUESTION 9: SANS 10142-1 OF 2017: ANNEXURE L: CLASSIFICATION OF SAFETY SERVICES NECESSARY FOR MEDICAL LOCATION

Explain the following terms used for a medical location:

9.1 Urology room (2)

9.2 Radiological diagnostic room (2)

9.3 Anaesthetic room (1)

9.4 Operating plaster room (1)

9.5 Operating recovery room (1)

9.6 Heart catheterisation room (2)

9.7 Intensive care room (1)

[10]

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QUESTION 10: SANS 1973-3 OF 2008: SAFETY OF ASSEMBLIES WITH A RATED PROSPECTIVE SHORT-CIRCUIT CURRENT UP TO AND INCLUDING 10 KA: ELECTRICAL CHARACTERISTICS OF ASSEMBLIES

Complete the following sentences by writing only the missing phrases next to the question number (10.1–10.7) in the ANSWER SHEET.

10.1 The assembly shall be controlled by a switch disconnector or a circuit breaker that … (1)



10.2 Effective means shall be provided on all exposed conductive surfaces to ... (1)

10.3 When electrical equipment is fitted to a door or a hinged panel of an assembly, such door or panel shall … (2)

10.4 Metal hinges are considered sufficient to ensure continuity for doors with … (1)

10.5 In the absence of the minimum creepage distance being specified in the relevant product standard for a component (components), the minimum … (2)

10.6 In the absence of the minimum clearance distance being specified in the relevant product standard, the minimum … (2)

10.7 The dielectric strength for a power and control circuit shall be … (1)

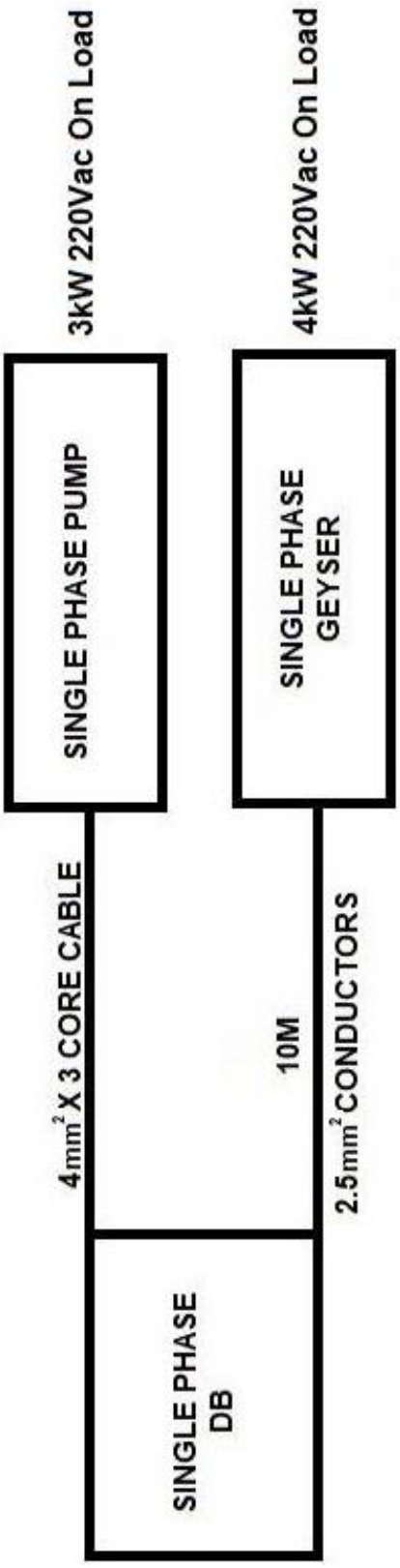
[10]



TOTAL: 100

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ADDENDUM A



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ADDENDUM B

Table 6.8 — Multicore PVC insulated armoured cables buried directly in the ground (SANS 1507)
Current-carrying capacity

Soil temperature: 25 °C
Maximum conductor temperature: 70 °C

1	2	3	4	5
Nominal conductor size mm²	**Standard rating[a] — Copper cables** A			
	Cables buried in the ground		**Cables in pipes or ducts buried in the ground**	
	Two-core	**Three-core or four-core**	**Two-core**	**Three-core or four-core**
	Cu	**Cu**	**Cu**	**Cu**
1,5	29	24	23	20
2,5	37	32	31	26
4	50	42	41	34
6	62	53	51	43
10	83	70	68	58
16	107	91	88	75
25	142	119	116	96
35	171	143	139	116
50	203	169	165	138
70	249	210	203	171
95	299	251	244	205
120	339	285	278	234
150	380	320	311	263
185	430	361	354	298
240	496	416	410	344
300	554	465	459	385
400	624	522	517	441

NOTE See table 6.4(b) for voltage drop.

[a] Standard conditions of installation:
Depth of burial 0,5 m;
Thermal resistivity of soil 1,2 K m/W; and
Each cable is thermally independent.

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ADDENDUM C

SANS 10142-1:2017
Edition 2

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

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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ADDENDUM D

Table 6.13 — Correction factors for grouping of cables buried in the ground

1	2	3	4	5	6	7	8	9	10	11
Cable or pipe arrangement	Number of cables in group	Correction factors								
		Cables buried directly in the ground					Cables installed in pipes in the ground			
		Centre-line spacing mm								
		Touching	150	300	450	600	Touching	300	450	600
Horizontal spacing	2	0,81	0,87	0,91	0,93	0,94	0,90	0,93	0,95	0,96
	3	0,70	0,78	0,84	0,87	0,90	0,82	0,87	0,90	0,93
	4	0,63	0,74	0,81	0,86	0,89	0,78	0,85	0,89	0,91
	5	0,59	0,70	0,78	0,83	0,87	0,75	0,82	0,87	0,90
	6	0,55	0,67	0,76	0,82	0,86	0,72	0,81	0,86	0,90
	7	0,52	0,65	0,75	0,81	0,86	0,70	0,80	0,86	0,89
	8	0,50	0,64	0,74	0,81	0,85	0,69	0,79	0,85	0,89
	9	0,48	0,63	0,74	0,80	0,85	0,68	0,78	0,84	0,88
	10	0,47	0,62	0,73	0,80	0,85	0,67	0,78	0,84	0,88
	11	0,45	0,61	0,72	0,80	0,84	0,66	0,77	0,84	0,88
	12	0,44	0,60	0,72	0,79	0,84	0,65	0,77	0,83	0,87

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ADDENDUM E

Table 6.16 — Correction factors for depth of cables buried in the ground

1	2	3
Depth m	**Correction factors**	
	Cables buried directly in the ground	**Cables installed in pipes buried in the ground**
0,5	1,0	1,0
0,6	0,98	0,99
0,8	0,96	0,98
1,0	0,94	0,96
1,25	0,92	0,95
1,5	0,9	0,94

6.2.10 Correction factors for neutral currents

6.2.10.1 Where the neutral conductor carries current without a corresponding reduction in the load of the phase conductor, the current that flows in the neutral conductor shall be taken into account in ascertaining the rating of the circuit.

Select the appropriate correction factor from table 6.17.

NOTE Neutral current can be caused, for example, by

a) unbalanced circuit conditions, and

b) harmonic current in three-phase circuits.

Table 6.17 — Correction factors for neutral imbalance

1	2
Neutral current as percentage of phase current %	**Correction factors**
0	1,00
25	0,97
50	0,94
75	0,90

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ADDENDUM F

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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