ER37

Candidate Code No.		Version of AS/NZS 3000 used	
For Board Use Only		(tick ONE Box)	
Result		2000	
Date			
Int		2007	

ELECTRICIAN'S REGULATIONS EXAMINATION

28 November 2009

QUESTION AND ANSWER BOOKLET

Time Allowed: Three hours

INSTRUCTIONS – READ CAREFULLY

You have 10 minutes to read this paper but do not start writing until you are told to do so by the supervisor.

Write your Candidate Code Number in the box provided above. Your name must NOT appear anywhere in this paper.

Answer all questions.

The pass mark for this examination is 60 marks.

Use a pen for written answers. **Do not** use pencils or red pens.

Drawing instruments and pencils may be used when diagrams are required. Marks are allocated on the basis of correctness.

Do not use correcting fluid or correcting tape.

Non-programmable calculators may be used.

It is recommended that the reference source for your answers be included in the space provided if a question can be answered from the Act, Regulations, Standard or Code of Practice. However, just stating a reference only will earn no marks.

For calculation questions all workings, including formulae, must be shown to gain full marks.

Warning – You could get 0 marks for any question, or part of a question, if you show anything hazardous or dangerous in your answer.

You may need to use the following documents in this examination:

- The Electricity Act 1992 reprint dated 19 August 2005
- The Electricity Regulations 1997 reprint dated 2 September 2005
- AS 60529 **or** AS 1939 Supplement 1-1990; AS/NZS 3000:2000 and Amendments 1, 2, A and 3 **or** AS/NZS 3000:2007; AS/NZS 3001:2001 **or** AS/NZS 3001:2008; AS/NZS 3004:2002 **or** AS/NZS 3004:2008; AS/NZS 3760:2003 and Amendment 1; NZS 3019:2004 **or** AS/NZS 3019:2007
- ECP 34; ECP 54

PLEASE HAND THIS PAPER TO THE SUPERVISOR BEFORE LEAVING THE ROOM

(turn over)

Question 1

(a) Refer to the Electricity Regulations and state **TWO** circumstances where an electrician may connect newly installed wiring to the supply without the work being inspected by an electrical inspector

(2 marks)

(1) _____

_____

(2) _____

_____

Ref: ……..……

(b) Refer to the Electricity Regulations and state the maximum permitted operating time for a Residual Current Device (RCD) installed for the protection of property.

(2 marks)

_____

Ref: ……..……

(c) The Electricity Regulations prohibit the use of pipes that convey certain types of material as earth electrodes. State **TWO** types of those materials.

(2 marks)

(1) _____

(2) _____

Ref: ……..……

(d) AS/NZS 3000 sets **TWO** basic requirements for an <u>electrical installation circuit arrangement</u>. Refer to AS/NZS 3000 and state those requirements.

(2 marks)

(1) _____

_____

(2) _____

_____

(turn over)

Question 1 continued

(e) Refer to AS/NZS 3000 and state the circumstances where live parts may be exposed on an industrial switchboard.

(2 marks)

_____

_____

_____

_____

Ref: ……..……

(f) Refer to AS/NZS 3000 and state the requirements for the minimum size of the neutral conductor in a three-phase final subcircuit cable that supplies a load of less than 100A.

(2 marks)

_____

_____

_____

_____

Ref: ……..……

(g) Refer to AS/NZS 3000 and state **TWO** circumstances in which low voltage cables can be installed in the same wiring system as extra-low voltage cables.

(2 marks)

(1) _____

_____

(2) _____

_____

Ref: ……..……

(turn over)

Question 1 continued

(h) A step-up transformer is used in an industrial installation to supply equipment that operates at a voltage higher than that at the point of supply. Refer to AS/NZS 3000 and state the requirement for this arrangement.

(2 marks)

_____

_____

Ref: ……..……

(i) Refer to AS/NZS 3000 and state the main precaution to be taken when testing a low voltage electrical installation.

(2 marks)

_____

_____

_____

_____

Ref: ……..……

(j) Refer to AS/NZS 3000 and state the <u>connection</u> requirement for the isolating switch for an automatically controlled fire pump motor.

(2 marks)

_____

_____

_____

Ref: ……..……

(turn over)

Question 2

(a) Refer to AS/NZS 3000 and state **THREE** selection and installation requirements for the earthing arrangements for an electrical installation.

(3 marks)

(1) _____

_____

_____

_____

_____

(2) _____

_____

_____

_____

_____

(3) _____

_____

_____

_____

_____

Ref: ……..……..……..

(b) Refer to AS/NZS 3000 and state the minimum size main earthing conductor that must be installed with a three-phase 35mm^2 aluminium neutral screen mains cable.

(1 mark)

_____

Ref: ……..……..……..

(turn over)

Question 2 continued

(c) A 6mm^2 twin and earth TPS cable is to be protected by a Type C MCB. Refer to AS/NZS 3000 and state the maximum length of the circuit that can be installed that would still allow the protection to operate under fault conditions.

(1 mark)

_____

Ref: ……..……..

(d) A multi-phase electricity supply has active conductors are of different sizes. Refer to AS/NZS 3000 and state how is the minimum size of the earth continuity conductor is determined?

(2 marks)

_____

_____

_____

Ref: ……..……..

(turn over)

Question 2 continued

(e) A 11kV/400V, 100kVA, three-phase, delta-star transformer has a 5% impedance. When fully loaded a line current of 5.25A flows in its primary windings. Assume there are no internal losses.

(i) Calculate the fault level which would be produced by the transformer.

(1½ marks)

(ii) Calculate the prospective short circuit current that would flow if a short circuit of negligible impedance occurs across the transformer output terminals.

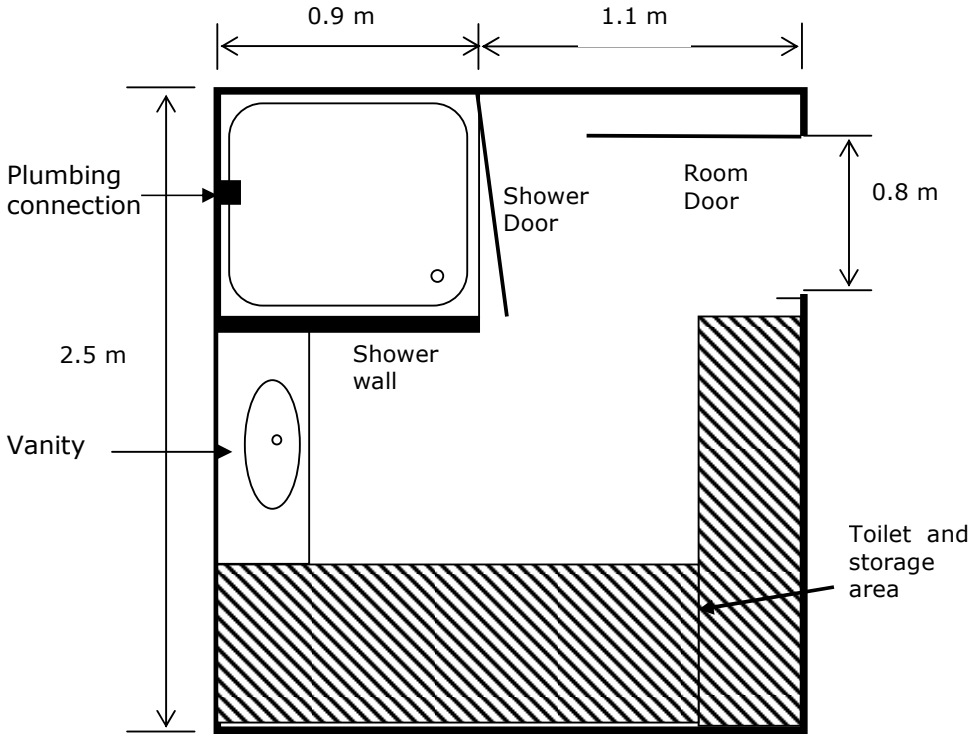
(1½ marks)

(turn over)

Question 3

The figure below represents an en-suite – it is not to scale and:

- The hand basin is of 10 Litre capacity.
- Nothing can be installed in, against or above the toilet and storage area or on the vertical surfaces of that area.
- The shower is enclosed with the door facing the room door
- All fittings operate at 230V



The customer wants to install in the en-suite:

- A light switch
- A heated towel rail and associated permanent connection
- A room heater and associated wall switch
- A socket outlet for a hair-dryer

(turn over)

Question 3 continued

(a) The light switch is required to be accessible when entering the ensuite.

(i) In which Zones **should** the light switch be installed?

(1 mark)

_____

_____

Ref: ……..……

(ii) What is the light switch IP rating for each zone?

(1 mark)

_____

_____

Ref: ……..……

(iii) What is the minimum mounting height above the floor for the light switch?

(½ mark)

_____

_____

Ref: ……..……

(b) The towel rail and associated permanent connection unit.

(i) In which Zones **should** the towel rail and permanent connection unit be installed?

(1 mark)

_____

_____

Ref: ……..……

(turn over)

Question 3 continued

(ii) What is the towel rail and permanent connection unit IP rating for each zone?

(1 mark)

_____

_____

Ref: ……..……

(iii) What is the minimum mounting height above the floor for the towel rail and permanent connection unit?

(½ mark)

_____

_____

Ref: ……..……

(c) The wall heater and associated wall switch.

(i) In which Zones **should** the wall heater and wall switch be installed?

(1 mark)

_____

_____

Ref: ……..……

(ii) What is the wall heater and wall switch IP rating for each zone?

(1 mark)

_____

_____

Ref: ……..……

(iii) What is the minimum mounting height above the floor for the wall heater and wall switch?

(½ mark)

_____

_____

Ref: ……..……

(turn over)

Question 3 continued

(d) The socket outlet must be visible at all times.

(i) In what Zone **can** the socket outlet be installed?

(½ mark)

_____

_____

Ref: ……..……

(ii) What is the socket outlet IP rating for that zone?

(½ mark)

_____

_____

Ref: ……..……

(iii) What electrical protection methods can be used for the socket outlet?

(1 mark)

_____

_____

Ref: ……..……

(iv) What is the minimum mounting above the floor height for the socket outlet?

(½ mark)

_____

_____

Ref: ……..……

(turn over)

Question 4

You are wiring a new domestic residence. The modular switchboard comprises:

- A main switch
- An earth bar
- A main neutral bar
- A neutral busbar No.1
- A neutral busbar No.2
- A 32A MCB for an oven
- MCB bank No.1, protected by RCCB No. 1.
- MCB bank No.2, protected by RCCB No. 2.

(a) (i) Which conductors and fittings are connected to the main neutral bar?
(2 marks)

_____

_____

_____

_____

(ii) Which conductors are connected to neutral bar No.1?
(1 mark)

_____

_____

(ii) Which conductors are connected to neutral bar No.2?
(1 mark)

_____

_____

(b) RCBO No.1

(i) There is a conductor connected to the supply neutral terminal of this RCCB. To where is the other end of this conductor connected?
(1 mark)

_____

(ii) There is a conductor connected to the load neutral terminal of this RCCB. To where is the other end of this conductor connected?
(1 mark)

_____

(turn over)

Question 4 continued

(iii) There is a conductor connected to the supply phase terminal of this RCCB. To where is the other end of this conductor connected?

(1 mark)

_____

(iv) There is a conductor connected to the load phase terminal of this RCCB. To where is the other end of this conductor connected?

(1 mark)

_____

(c) RCBO No.2

(i) There is a conductor connected to the supply neutral terminal of this RCCB. To where is the other end of this conductor connected?

(1 mark)

_____

(ii) There is a conductor connected to the load neutral terminal of this RCCB. To where is the other end of this conductor connected?

(1 mark)

_____

(turn over)

Question 5

It is proposed to install a 2.5 mm^2, four-core copper cable to supply a low voltage, three-phase, 12kW motor. For this question **you do not** need to consider the power factor or efficiency of the motor.

(a) Load requirements

Use the following information and information from the tables below and calculate whether the 2.5 mm^2, four-core copper cable will meet the load current requirements.

- The cable will be surface clipped (touching).
- The length of run between the switchboard and the motor is 30 metres.
- The ambient air temperature is between 21° and 25° C.
- The maximum permitted voltage drop is 2.5%
- The conductor temperature is 75° C
- Allowance needs to be made for a 50% load increase (the circuit may supply a motor control panel in the future).

(5 marks)

(turn over)

Question 5 continued

(b) Voltage drop requirements

Use the following information and information from the tables below and calculate the 2.5 mm^2, four-core copper cable will meet the voltage drop requirements.

- The cable will be surface clipped (touching).
- The length of run between the switchboard and the motor is 30 metres.
- The ambient air temperature is between 21^o and 25^o C.
- The maximum permitted voltage drop is 2.5%
- The conductor temperature is 75^o C
- Allowance needs to be made for a 50% load increase (the circuit may supply a motor control panel in the future).

(4 marks)

(c) State the minimum cable size that will meet both the load current and voltage drop requirements?

(1 mark)

(turn over)

Question 5 continued

The following are extracts from AS/NZS 3008.1.2.

Table 9

Current Carrying Capacities of Two-Core O.6/1 kV Insulated and Sheathed (including Neutral Screened) Cables with or without Earth Conductor, Armoured or Non-Armoured Cables

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Conductor size	Current carrying capacity A															
	Unenclosed				Enclosed								Buried Direct		Underground non-metallic wiring enclosure	
	Spaced		Touching		Non-metallic wiring enclosures in air – round cable		Non-metallic wiring enclosures in air – flat cable		In non-metallic wiring enclosures or unenclosed partially surrounded by thermal insulation		Completely surrounded by thermal insulation					
mm^2	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al
1	17	--	16	--	13	10	15	11	11	9	8	-	24	-	19	-
1.5	22	-	21	-	16	13	19	15	15	11	10	-	31	-	24	-
2.5	31	-	30	-	23	17	25	19	21	16	15	-	44	-	34	-
4	42	-	39	-	30	23	33	25	27	22	19	-	57	-	44	-
6	52	-	50	-	39	30	42	32	35	27	25	-	72	-	56	-
10	73	-	68	-	54	41	57	43	49	38	34	-	96	-	75	-
16	97	75	91	71	72	55	75	57	65	50	46	35	127	97	97	75
25	131	100	120	95	100	76	101	76	90	71	60	47	160	127	127	98
35	160	125	148	114	120	89	120	89	105	82	74	58	198	154	154	121

Note: The ratings are based on 30^0C ambient air temperature and 15^0C ambient soil temperature

(turn over)

Question 5 continued

Table 12

Current Carrying Capacities of Three-Core And Four-Core O.6/1 kV Insulated and Sheathed (including Neutral Screened) Cables with or without Earth Conductor, Armoured or Non-Armoured Cables

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Conductor size	Current carrying capacity A															
	Unenclosed				Enclosed								Buried Direct		Underground non-metallic wiring enclosure	
	Spaced		Touching		Non-metallic wiring enclosures in air – round cable		Non-metallic wiring enclosures in air – flat cable		In non-metallic wiring enclosures or unenclosed partially surrounded by thermal insulation		Completely surrounded by thermal insulation					
mm^2	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al
1	15	--	14	--	11	9	14	10	11	8	7	-	21	-	17	-
1.5	18	-	17	-	15	11	17	13	14	11	9	-	26	-	21	-
2.5	26	-	25	-	21	16	23	17	19	15	13	-	37	-	29	-
4	35	-	33	-	27	21	30	23	25	19	17	-	48	-	37	-
6	46	-	42	-	35	27	39	30	33	25	22	-	61	-	47	-
10	52	-	58	-	48	38	52	40	44	34	29	-	81	-	63	-
16	82	64	78	60	64	49	68	52	59	46	39	30	106	83	81	64
25	111	86	104	81	90	68	95	72	82	64	52	40	138	107	106	83
35	137	106	125	99	105	80	105	80	96	74	64	49	165	127	127	100

Note: The ratings are based on 30^0C ambient air temperature and 15^0C ambient soil temperature

Table 27(1)

Rating Factors for Variations in Ambient Temperature for Cables in Air or Heated Concrete Slabs and for Cables Buried Direct in the Ground or in Underground Wiring Enclosures – Air And Concrete Slab Temperatures

1	2	3	4	5	6	7	8	9	10	11
Conductor temperature ^{0}C	Rating Factor Ambient temperature									
	15	20	25	30	35	40	45	50	55	60
150	1.07	1.05	1.03	1.00	0.98	0.96	0.94	0.91	0.89	0.87
110	1.08	1.06	1.03	1.00	0.97	0.93	0.90	0.87	0.83	0.79
90	1.15	1.09	1.05	1.00	0.95	0.91	0.85	0.80	0.74	0.66
80	1.17	1.12	1.06	1.00	0.95	0.89	0.82	0.75	0.68	0.59
75	1.18	1.12	1.06	1.00	0.94	0.88	0.80	0.72	0.63	0.53

(turn over)

Question 5 continued

Table 27(2)

Rating Factors for Variations in Ambient Temperature for Cables in Air or Heated Concrete Slabs and for Cables Buried Direct in the Ground or in Underground Wiring Enclosures – Soil Temperatures

1	2	3	4	5	6	7	8
Conductor temperature ^0C	**Rating Factor Ambient temperature**						
	10	**15**	**20**	**25**	**30**	**35**	**40**
110	1.02	1.00	0.97	0.94	0.92	0.89	0.86
90	1.04	1.00	0.96	0.93	0.91	0.87	0.83
80	1.04	1.00	0.95	0.92	0.88	0.83	0.78
75	1.04	1.00	0.95	0.91	0.86	0.81	0.75

Table 42

Three-Phase Voltage Drop at 50Hz of Multicore Cables with Circular Copper Conductors

Conductor size mm^2	**Three-phase voltage drop at 50 Hz, mV/A.m Conductor temperature, ^0C**									
	45		**60**		**75**		**90**		**110**	
	Max.	**0.8 p.f.**	**Max.**	**0.8 p.f.**	**Max.**	**0.8 p.f.**	**Max.**	**0.8 p.f.**	**Max.**	**0.8 p.f.**
1	40.3	-	42.5	-	44.7	-	46.8	-	49.7	-
1.5	25.9	-	27.3	-	28.6	-	30.0	-	31.9	-
2.5	14.1	-	14.9	-	15.6	-	16.4	-	17.4	-
4	8.77	-	9.24	-	9.71	-	10.2	-	10.8	-
6	5.86	-	6.18	-	6.49	-	6.80	-	7.22	-
10	3.49	-	3.67	-	3.86	-	4.05	-	4.29	-
16	2.19	-	2.31	-	2.43	-	2.55	-	2.70	-
25	1.39	-	1.47	-	1.54	-	1.61	-	1.71	-
35	1.01	-	1.06	-	1.11	-	1.17	-	1.24	-

Note: To convert to single-phase values multiply the three-phase value by 1.155

(turn over)

Question 6

Refer to AS/NZS 3000 and determine the maximum demand in amps of a single 230 volt domestic installation with the following loads:

32	75W indoor lighting points	1	3kw controlled water heater
15	75W outdoor lighting points	1	6kw spa pool
1	10kW electric range		
10	Single 10A socket outlets	10	Double 10A socket outlets
6 metres of lighting track			

(10 marks)

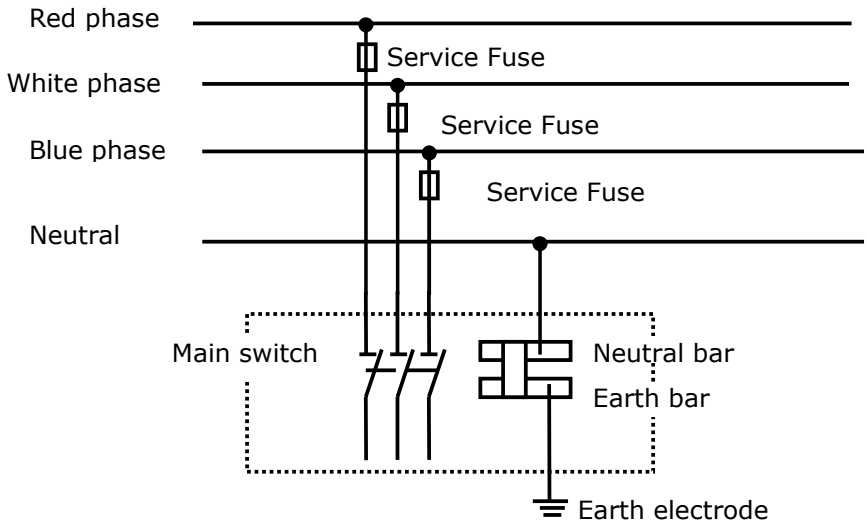
Load Group	Calculation	Load (A)
Group		
Group		
Group		
Group		
Group		
Total maximum demand		

Ref: ……..……..

(turn over)

Question 7

The figure below represents a low voltage, three-phase 400V supply to an electrical installation. **The installation is live**.



Three-phase consumer switchboard

This figure is relevant to both questions (a) and (b).

(a) Refer to AS/NZS 3000 and state **THREE** reasons why testing the polarity of mains cables is necessary.

(3 marks)

(1) _____

_____

_____

(2) _____

_____

_____

(3) _____

_____

_____

Ref: ……

(turn over)

Question 7 continued

(b) You have been asked to carry out a polarity test on this installation as there **may be** a mains transposition between one phase and the neutral.

The equipment you have to carry out the test is:

- A voltmeter
- A trailing (or flying) lead
- A temporary earth

Describe how you would carry out a polarity test on the **installation** using this equipment. In your description state:

- The connection arrangement for the equipment
- The points on the installation being tested
- The expected test result at each point if a transposition has taken place.
- The expected test result at each point if no transposition has taken place.

(7 marks)

(turn over)

Question 8

(a) Describe **FOUR** electrical hazards that may be present if the impedance of a low voltage installation main neutral is of a higher value than that of the main earth.

(4 marks)

(1) _____

_____

_____

_____

(2) _____

_____

_____

_____

(3) _____

_____

_____

_____

(4) _____

_____

_____

_____

(turn over)

Question 8 continued

(b) Refer to AS/NZS 3000 and state the **TWO** requirements for the switching and connection of a range in a new domestic installation.

(2 marks)

(1) _____

_____

_____

_____

(2) _____

_____

_____

_____

Ref: ……..……..

(c) AS/NZS 3000 requires that socket outlets be installed so they will not be subjected to undue mechanical stress or damage. Refer to AS/NZS 3000 and state **TWO** installation methods required for the protection of a socket outlet against undue mechanical stress or damage.

(2 marks)

(1) _____

_____

_____

_____

(2) _____

_____

_____

_____

Ref: ……..……..

(turn over)

Question 8 continued

(d) An air compressor motor circuit is protected by fuses labelled gM at a switchboard. Describe the main characteristics of a fuse labelled gM that distinguishes it from a fuse labelled gG.

(2 marks)

_____

_____

_____

(turn over)

Question 9

You are wiring a new domestic residence that includes recessed luminaires and other permanently connected equipment.

(a) Refer to AS/NZS 3000 and answer the following:

(i) All of the recessed luminaires operate at extra-low voltage and are supplied by associated auxiliary transformers. The transformers are supplied by 230V final subcircuits.

Are these circuits required to be protected by an RCD? Include the reference source in your answer.

(2 marks)

_____

_____

_____

_____

Ref: ……..……

(ii) There is a final subcircuit to a bathroom that only supplies a permanently connected hair dryer. Is this circuit required to be protected by an RCD? Include a reason and the reference source for your answer.

(1 mark)

_____

_____

Ref: ……..……

(b) Refer to NZECP 54 and answer the following:

(i) Some ceiling battens and joists need to be "checked out" to allow the recessed luminaires to be installed. Is this permitted? Include the reference source in your answer.

(2 marks)

_____

_____

_____

_____

Ref: ……..……

(turn over)

Question 9 continued

(ii) If some of the recessed luminaries have no manufacturer's instructions, can they still be installed? Include a reason and the reference source for your answer.

(2 marks)

_____

_____

_____

_____

Ref: ……..……

(iii) Can an OA type recessed luminaire be modified to be installed in a moist area?

(2 marks)

_____

_____

_____

_____

Ref: ……..……

(iv) Under what conditions can a recessed luminaire be installed in loose, sprayed or flammable insulation?

(1 mark)

_____

_____

Ref: ……..……

For Candidate's Use

In the box, write the number of **EXTRA** sheets you have used. Write **NIL** if you have not used any

For Examiner's Use Only		
Questions Answered	**Marks**	
1		
2		
3		
4		
5		
6		
7		
8		
9		
TOTAL		