ET 49 - Electrician Theory Examination Marking Schedule

Notes:1. (1 mark) means that the preceding statement/answer earns 1 mark.

2. This schedule sets out the accepted answers to the examination questions. A marker can exercise their discretion and decide on the overall accuracy of any answer that is presented in the candidate's own words.

3. Symbols and terms - alternatives

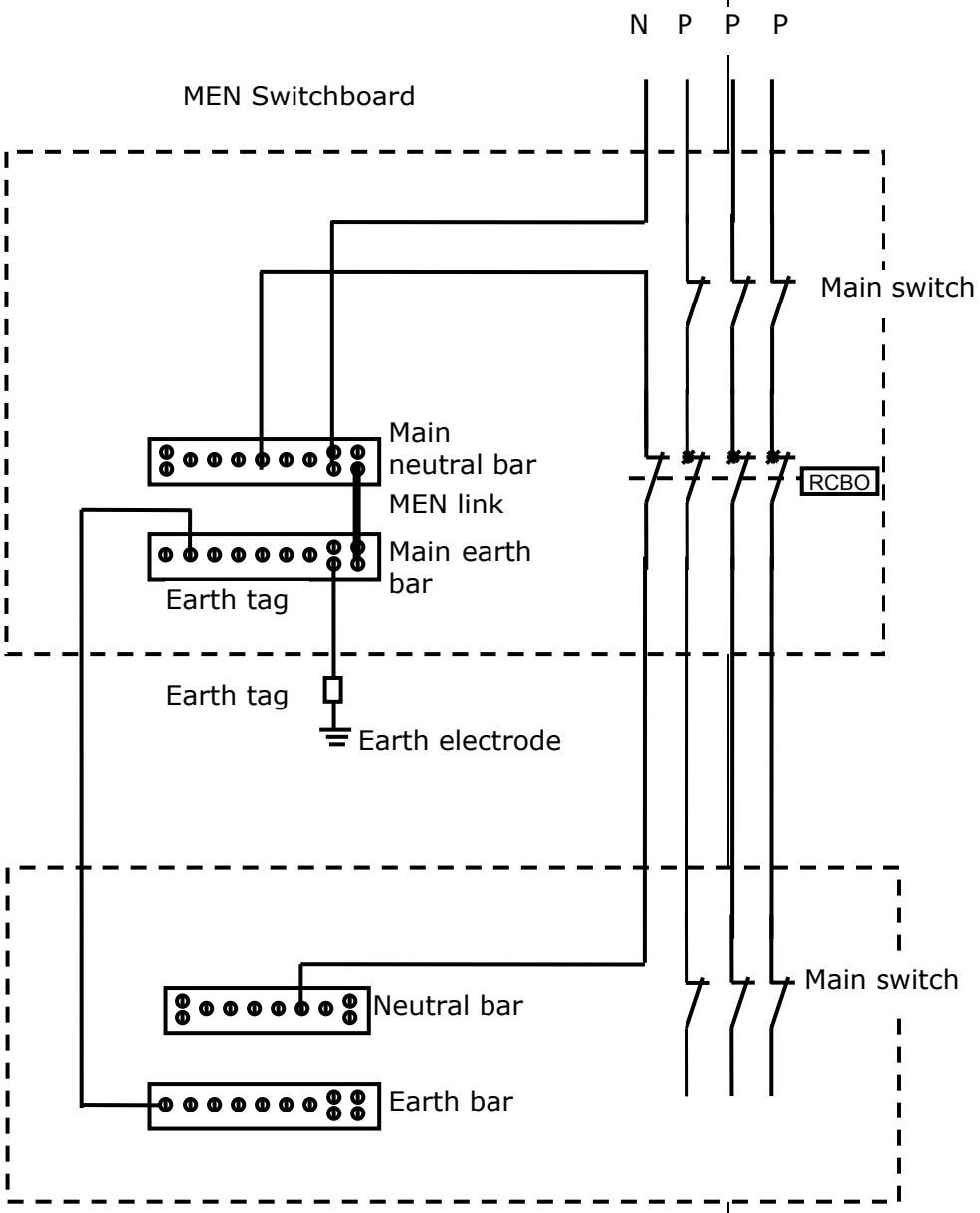
Power	W or P
Voltage	V or E or U
Phase	Active

Question 1	*Reference Marks*	*Marking notes*
(a) Any ONE of: • The fault loop impedance is lower • Because the distribution transformer is close to the installation or on-site	(2 marks)	
(b) • To prevent a high voltage developing in the circuit. • To prevent damage to the CT winding insulation	(1 mark) (1 mark)	
(c) • To confirm that the protective devices can safely interrupt the installation PSSC.	(2 marks)	
(d) Flash over on switchboards due to inadequate kA rating of protective devices	(2 marks)	
(e) $R_2 = \frac{R_1 \times L_1}{L_2}$ $= \frac{75 \times 100}{375}$ $= 20M\Omega$	(½ mark) (½ mark) (1 mark)	
(f) (i) To stress the insulation at a voltage above 325V a.c. (or peak a.c. voltage.	(1 mark)	
(ii) Any ONE of: • To ensure capacitive or inductive reactance does not influence the test result.	(1 mark)	

Question 1			*Reference Marks*	*Marking notes*
		● A constant maximum voltage is a more stringent test than the momentary peaks of an a.c. waveform.		
(g)	(i)	This is the maximum current that the fuse is designed to carry continuously	(1 mark)	
	(ii)	The maximum fault current the fuse can safely interrupt.	(1 mark)	
(h)	Any TWO of: ● Broad range of options for starting and stopping ● Broad range of options for protection. ● Visual feedback of key technical parameters. ● Smoother starting ● Reduced mechanical stress on equipment on starting. ● Reduced electrical stress on equipment on starting		(2 marks)	
(i)	(i)	To prevent the star and delta contactors closing simultaneously	(1 mark)	
	(ii)	Any ONE of: ● An electrical interlock failure could prevent the motor starting. ● An electrical interlock failure could cause a phase-to-phase short. ● A mechanical interlock failure could prevent the motor starting. ● A mechanical interlock failure could cause a phase-to-phase short.	(1 mark)	
(j)	(i)	The maximum torque the motor can develop.	(1 mark)	
	(ii)	1500 rpm	(1 mark)	

Question 2	*Reference Marks*	*Marking notes*
(a) ● AS/NZS 3000 ● Section 8	(½ mark) (½ mark)	
(b) A certificate of compliance	(½ mark)	
(c) **<u>Test 1</u>** Protective earthing conductor test ● Ohmmeter ● Test between the end of the protective earthing conductor of the cable And the earth pin on the socket outlet. ● The resistance of the PEC is consistent with the characteristics of the cable. <u>Test 2</u> Insulation resistance test ● Insulation resistance tester ● 500V d.c. ● Test between each phase conductor Test between each phase conductor and the earth conductor Test between each phase conductor and the neutral conductor Test between neutral conductor and the earth conductor ● 1 MΩ minimum <u>Test 3</u> Correct circuit connections test (or polarity) ● Ohmmeter ● Each phase connected to the correct phase pin ● Neutral connected to neutral pin ● Earth connected to the earth pin	 (½ mark) (½ mark) (½ mark) (½ mark) (½ mark) (½ mark) (½ mark) (½ mark) (½ mark) (½ mark) (½ mark) (½ mark) (½ mark) (½ mark) (½ mark) (½ mark)	Tests 1 to 3 can be done in any order

Question 3	*Reference Marks*	*Marking notes*



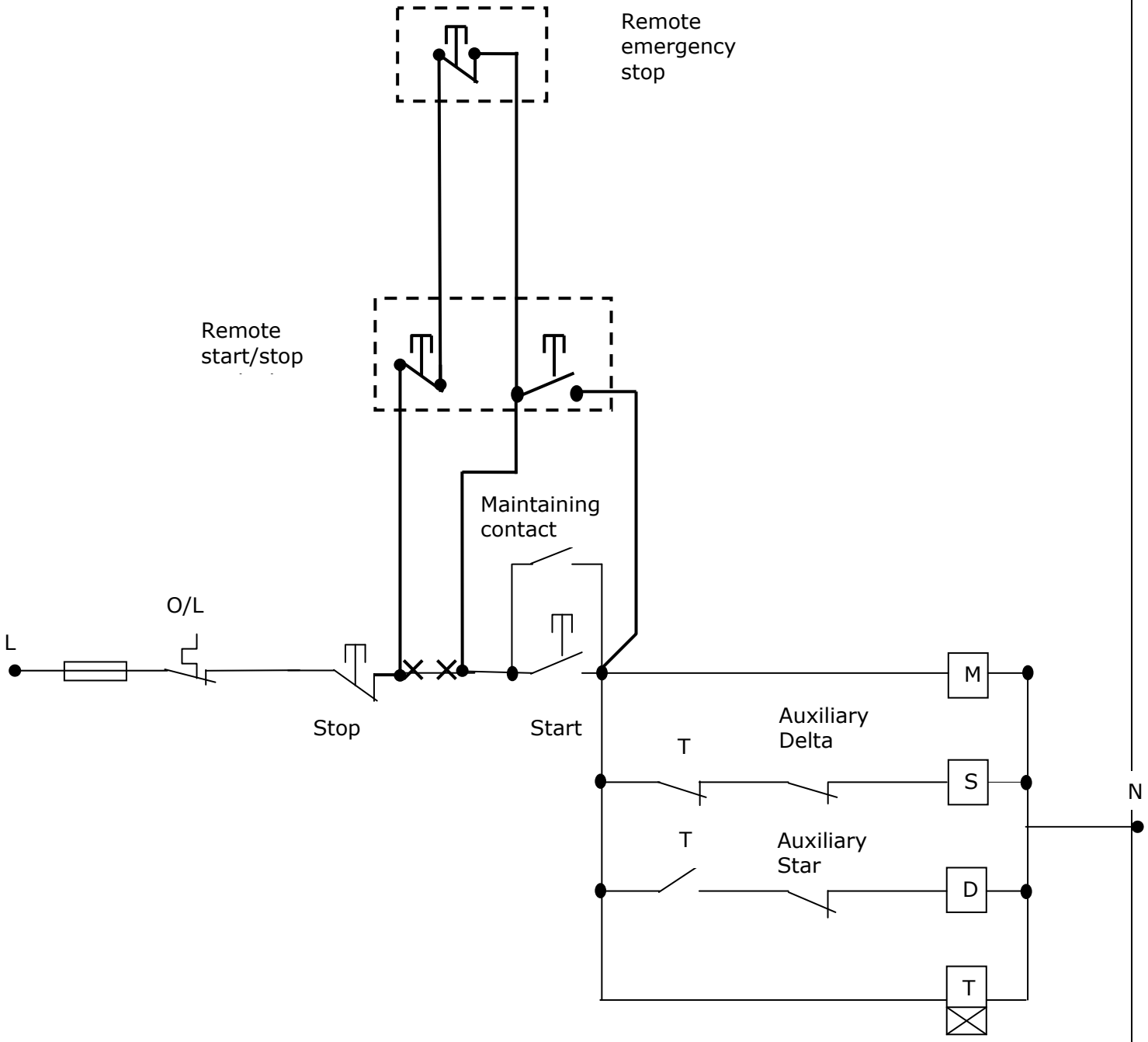
• Correctly connected incoming supply to main switch (MEN switchboard)	(1 mark)
• Correctly connected main neutral (MEN switchboard)	(½ mark)
• Correctly connected main earth (MEN switchboard)	(½ mark)
• Correctly connected MEN link (MEN switchboard)	(1 mark)
• Correctly connected earth electrode (MEN switchboard.)	(1 mark)
• Correctly connected RCBO (MEN switchboard)	(2 marks)
• Correctly connected main switch (Distribution switchboard)	(½ mark)

Question 3	*Reference Marks*	*Marking notes*
● Correctly connected neutral bar (Distribution switchboard) ● Correctly connected earth bar (Distribution switchboard) ● Working diagram No marks can be awarded for this question if there are any of the following hazards: <u>MEN switchboard</u> ● Phase/neutral transposition ● No MEN link ● No main neutral ● No main earthing lead or electrode <u>Either switchboards</u> ● Any short circuit ● Neutral switched (other than the RCBO) <u>Distribution Switchboard</u> ● Phase/neutral transposition ● Neutral/earth transposition <u>RCBO</u> ● The RCBO is installed on the distribution switchboard but there is no circuit protection on the MEN switchboard. ● The RCBO is supplied from the supply (incoming) side of the main switch on the MEN switchboard. ● The distribution board is not protected by the RCBO	(1 mark) (1 mark) (1½ marks)	

Question 4			*Reference Marks*	*Marking notes*
(a)	A 10A fuse		(1 mark)	
(b)	(i)	• The higher the fault current	(½ mark)	
		• The less time it takes for the fuse to blow.	(½ mark)	
	(ii)	• With 40A flowing in the 20A fuse would take about 30 seconds to blow.	(1 mark)	
		• With 100A flowing in the 20A fuse would take about 0.25 seconds to blow.	(1 mark)	
(c)	6A	• 9A	(½ mark)	
		• 19A	(½ mark)	
	8A	• 12A	(½ mark)	
		• 28A	(½ mark)	
	16A	• 24A	(½ mark)	
		• 69A	(½ mark)	
	20A	• 30A	(½ mark)	
		• 90A	(½ mark)	
	25A	• 37.5A	(½ mark)	
		• 130A to 140A	(½ mark)	
	32A	• 48A	(½ mark)	
		• 200A	(½ mark)	

Question 5	*Reference Marks*	*Marking notes*

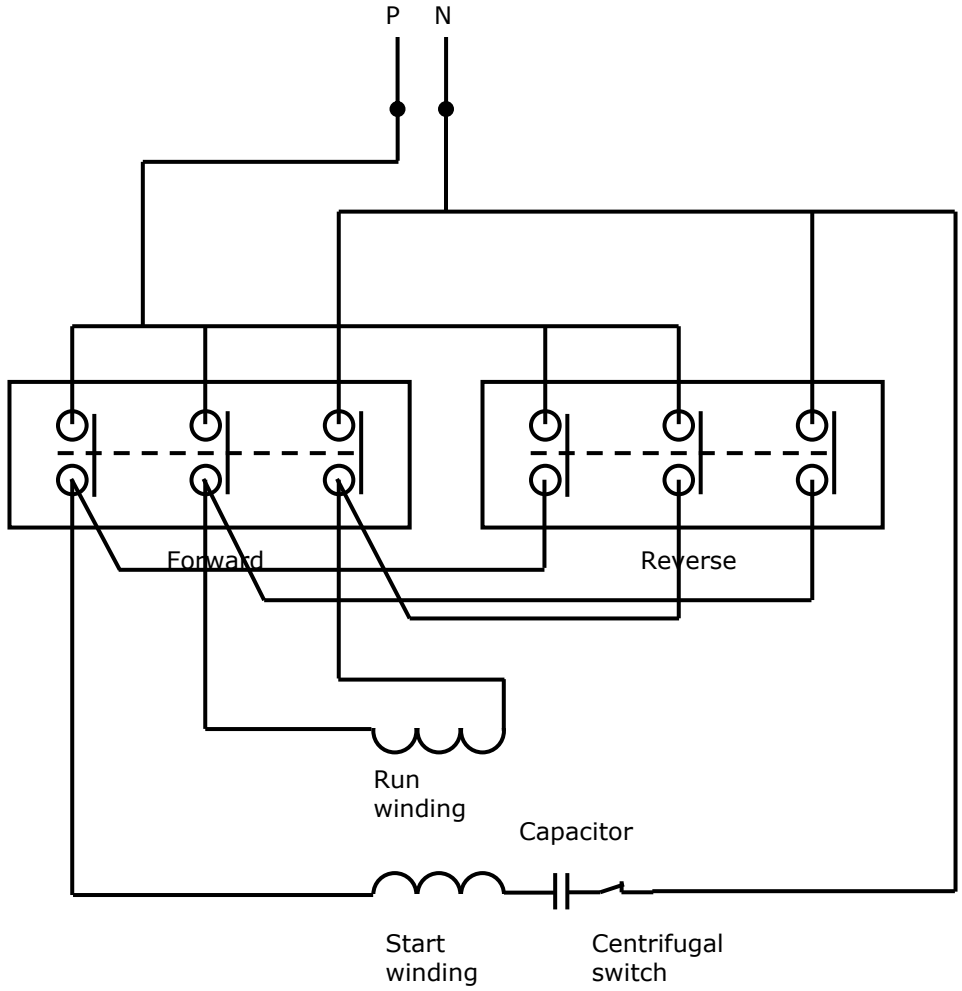
(a)



• Five conductors correctly connected.	(2½ marks)	
• One conductor removed	(½ mark)	
• Working circuit	(1 mark)	

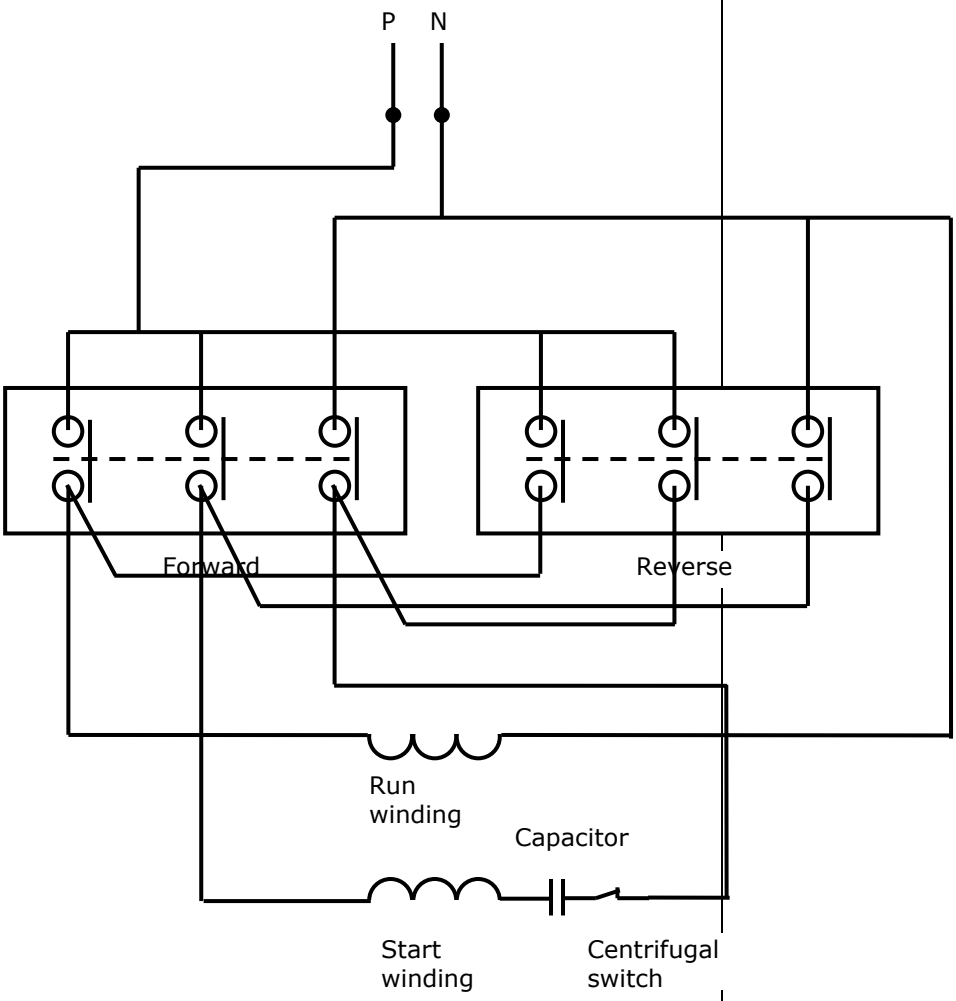
Question 5	*Reference Marks*	*Marking notes*

(b) Reversed run winding



Question 5	*Reference Marks*	*Marking notes*

Reversed start winding

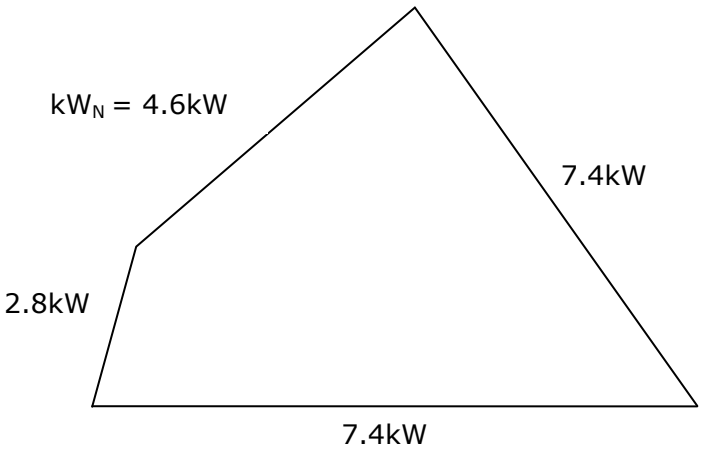


- Start winding correct – forward and reverse (2 marks)
- Run winding correct – forward and reverse (2 marks)
- Complete working circuit (2 marks)

Question 6	*Reference Marks*	*Marking notes*
(a) ● The main fuse will not operate due to the high impedance of the earth fault loop. ● Any metal not normally live could be live at up to 230V. ● The main switch does not isolate the installation. ● Internal components of equipment are live with control switch in the off position. ● Fire hazard at a high-resistance joint	(2 marks)	
(b) (i). ● A voltmeter ● Remote (independent) earth ● Trailing lead (ii). ● Insert the remote earth stake in the ground a reasonable distance away from the installation earth ● Use the trailing lead to connect the remote earth to the voltmeter. ● Use the voltmeter whether the frame of the meter box is live. (iii) ● Use the voltmeter to test at the supply side of the main switch. ● Use the voltmeter to test at the earth/neutral bar. No transposition ● About 230V at the supply side of the main switch. ● About 0V if at the earth/neutral bar. With transposition ● About 0V at the supply side of the main switch. ● About 230V if at the earth/neutral bar.	(½ mark) (½ mark) (½ mark) (½ mark) (½ mark) (½ mark) (½ mark) (½ mark) (1 mark) (1 mark) (1 mark) (1 mark)	1. No marks for (b) if a remote earth is not used. 2. Award all marks for (b) if it is stated that because the meter box is live, there is a transposition

Question 7	*Reference Marks*	*Marking notes*
(a) (i) $I_{ph} = \frac{P}{V_L \times \sqrt{3}}$	(½ mark)	
$= \frac{18000}{400 \times \sqrt{3}}$	(½ mark)	
$= 25.98A$	(1 mark)	
$I_{fault} = \frac{V}{R}$		
$= \frac{231}{(6 + 9.75)}$	(½ mark)	
$= 14.67A$	(1 mark)	
$I_{total} = I_{fault} + I_{load} = 14.67 + 25.98$	(½ mark)	
$= 40.65A$	(1 mark)	
(ii) (1) The 40A fuses have a fusing factor (gG Utilisation Category) of 1.5	(½ mark)	
Fusing current = 1.5 x 40 = 60A. Because the fault current is 40.65 the fuses will not operate or the fuses will not operate within 0.4s	(½ mark)	
(2) Vd across protective earthing conductor equals touch voltage		
$Vd_E = I \times R$		
$= 14.67 \times 9.75.$	(½ mark)	
$= 142.35V$	(½ mark)	
Touch voltage hazard of 142.35V exists between frame and earth	(1 mark)	
(b) $I = 61A$		
$R = \frac{V}{I}$	(½ mark)	
$= \frac{230}{61}$	(½ mark)	
$= 3.77\Omega$	(1 mark)	

Question 8	*Reference Marks*	*Marking notes*
(a) $I_{PH} = \frac{V_{PH}}{R_{PH}}$	(½ mark)	
$= \frac{400}{20}$	(½ mark)	
$= 20A$	(1 mark)	
$I_L = I_{PH} \times \sqrt{3}$	(½ mark)	
$= 20 \times \sqrt{3}$	(½ mark)	
$= 34.64A$	(1 mark)	
(b) $I = \frac{V}{R}$	(½ mark)	
$= \frac{400}{20}$	(½ mark)	
$= 20A$	(1 mark)	
(c) $R_T = \frac{\text{Product}}{\text{Sum}}$	(½ mark)	
$= \frac{20 \times 40}{20 + 40}$	(½ mark)	
$= 13.33\Omega$	(1 mark)	
$I = \frac{V}{R}$	(½ mark)	
$= \frac{400}{13.33}$	(½ mark)	
$= 30A$	(1 mark)	

Question 9	*Reference Marks*	*Marking notes*
(a) (i) Any THREE of: ● The protection will still be effective under fault conditions. ● The pump will operate normally ● The neutral would be switched ● The pump circuitry would be live when the isolating switch is in the "off" position.	(3 marks)	
(ii) The RCCB will trip as the PEC would carry the return current.	(1 mark)	
(b) Any ONE of: ● Circuit connections test (polarity) ● Visual check	(1 mark)	
(c)  ● Correct graphical representation ● Correct solution for kWn = 4.6kW (allow 4.3kW - 5kW) ● $I = \frac{P}{V}$ $= \frac{4600}{230}$ $= 20A$	(2 marks) (1 mark) (½ mark) (½ mark) (1 mark)	