FINAL - ET 60 - Electrician Theory Examination Marking Schedule

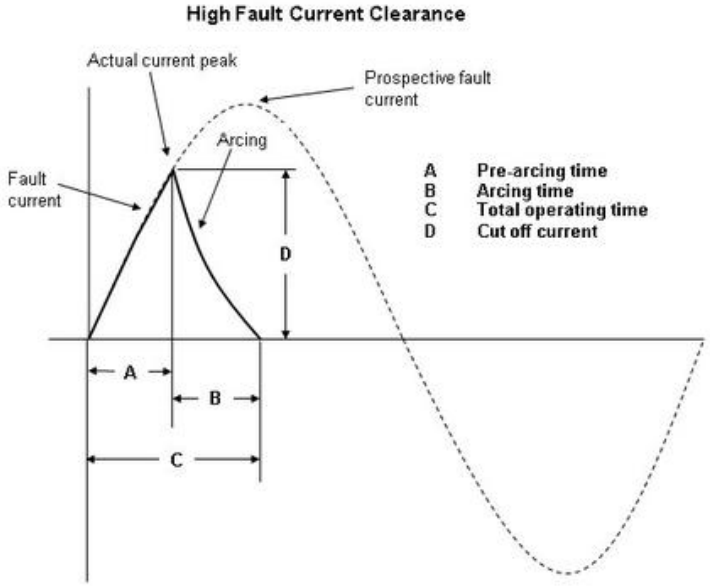
Notes:1. (1 mark) means that the preceding statement/answer earns 1 mark.

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

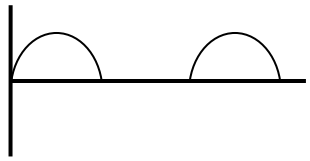
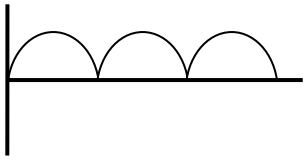
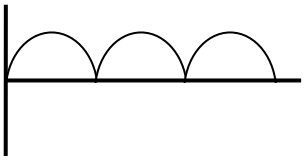
Power	W or P
Voltage	V or E or U
Phase	Active

Question 1	*Reference Marks*	*Marking notes*
(a) (i) An inverse time-current characteristic	(1 mark)	
(ii) An earth fault-loop impedance test.	(1 mark)	
(b) The contacts in the isolating switch have failed to open.	(2 marks)	Award 1 mark if candidate states "faulty isolating switch".
(c) $I = \frac{P}{V}$	(½ mark)	
$= \frac{6000}{230}$	(½ mark)	
$= 26.01$ A.	(1 mark)	
(d) Any ONE of: ● Under fault conditions, it prevents the touch voltages rising to dangerous levels. ● To ensure sufficient fault current flows to operate the protective device.	(2 marks)	
(e) Any ONE of: ● To confirm that the electrical protection for the final subcircuit will operate within the required time. ● To confirm that the electrical protection all other final subcircuits supplied from the main switchboard will operate with the required time.	(2 marks)	
(f) Any ONE of: ● Under fault conditions, it prevents the touch voltages rising to dangerous levels. ● To ensure sufficient fault current flows to	(2 marks)	

Question 1	*Reference Marks*	*Marking notes*
operate the protective device.		
(g) Battery maximum current = $\frac{(12 - 9)}{0.2}$ = 15 A Total number of lights = $\frac{15}{1.5}$ = 10	(½ mark) (½ mark) (½ mark) (½ mark)	
(h) (i) This is the value of fault current that cuts off (operates) the fuse that is less than the prospective short-circuit current.  (ii) This is the time it takes to interrupt the flow of current and extinguish the arc.	(1 mark) (1 mark)	
(i) To provide short-circuit fault protection to both the final subcircuit and the motor.	(2 marks)	
(j) Any ONE of: ● Fire risk (sodium + moisture produces hydrogen) ● Risk of chemical burns (sodium + water produces sodium hydroxide (caustic soda))	(2 marks)	

Question 2	*Reference Marks*	*Marking notes*
(a) Sec V_{PH} = Pri $\frac{V_L}{N_P}$	(½ mark)	
= $\frac{33000}{137.5}$	(½ mark)	
= 240 V	(1 mark)	
(b) Sec. VL = VPh x √3	(½ mark)	
= 240 x √3	(½ mark)	
= 415.68V	(1 mark)	
(c) Pri. I_L = $\frac{VA}{\sqrt{3} \times \text{Pri. } V_L}$	(½ mark)	
= $\frac{300000}{\sqrt{3} \times 33000}$	(½ mark)	
= 5.25A	(1 mark)	
(d) Sec. I_L = $\frac{VA}{\sqrt{3} \times \text{Sec. } V_L}$	(½ mark)	
= $\frac{300000}{\sqrt{3} \times 415.68}$	(½ mark)	
= 416.7 A	(1 mark)	
(e) (i) Yes	(1 mark)	
(ii) Because of the current flow through the impedance of the windings.	(1 mark)	

Question 3	*Reference Marks*	*Marking notes*
(a) The description must show: ● Opening the isolator or removing the fuses. ● Doing a voltage test at the load side of the isolator (or the supply side of the contactor). ● Using the prove-test-prove method to confirm isolation has occurred. ● Locking the isolator open. ● Attaching a danger tag to the isolator.	(½ mark) (½ mark) (1 mark) (½ mark) (½ mark)	
(b) ● Earth continuity test. ● Insulation resistance test.	(½ mark) (½ mark)	
(c) Ensure the circuit is still isolated by using the prove-test-prove method.	(1 mark)	
(d) ● Use an ohmmeter ● Test between the frame of the hot water cylinder and earth reference (other than a bonded extraneous earth path) that is separate from the hot water cylinder final subcircuit.	(1 mark) (2 marks)	
(e) Any TWO of: ● Is the current rating of final subcircuit cable consistent with the increase in load. ● Are the HRC fuses correctly rated for the final subcircuit. ● Is the current rating of the isolator consistent with the increase in load. ● Is the current rating of the contactor consistent with the increase in load.	(2 marks)	

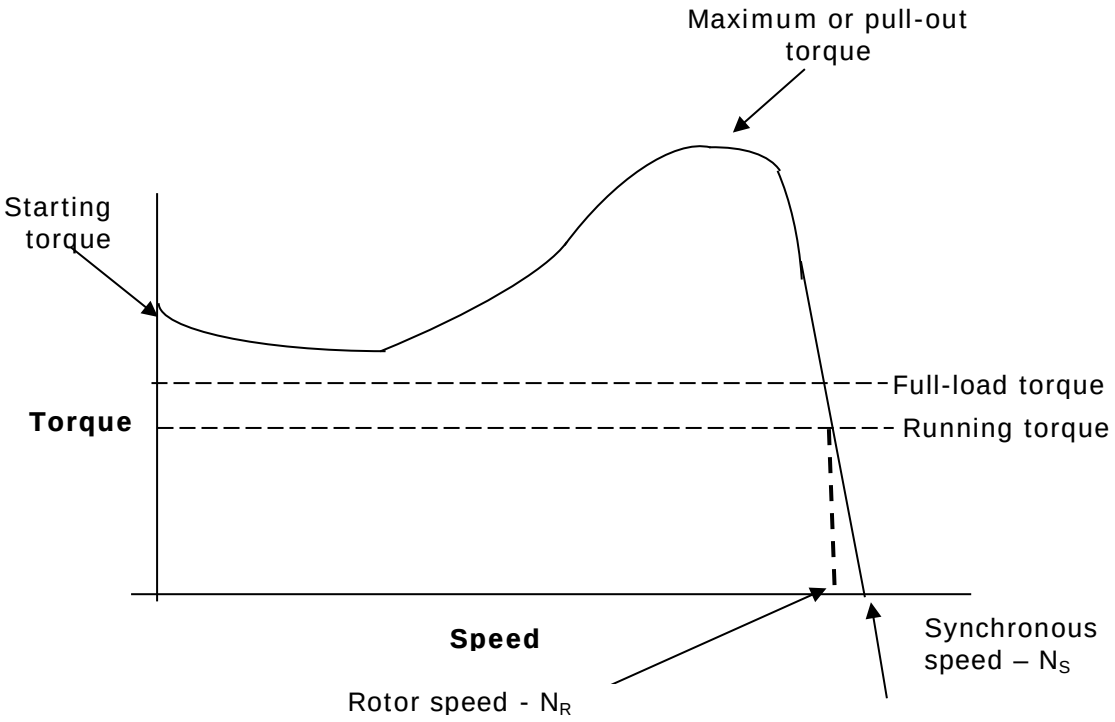
Question 4	*Reference Marks*	*Marking notes*
(a) (i) Single-phase half-wave rectifier		
Output waveform 	(1 mark)	
Ripple frequency F (50 Hz)	(½ mark)	
(ii) Centre-tapped full-wave rectifier		
Output waveform 	(1 mark)	
Ripple frequency 2 x f (100 Hz)	(½ mark)	
(iii) Single-phase full-wave bridge rectifier		
Output waveform 	(1 mark)	
Ripple frequency 2 x f (100 Hz)	(½ mark)	
(b) (i) To provide a stable, constant voltage supply to the connected load.	(1 mark)	
(ii) A Zener diode is designed to carry significant reverse current but a normal rectifier diode cannot.	(1 mark)	
(iii) Any ONE of: ● It limits the current through the Zener diode. ● It drops the supply voltage to the voltage rating of the Zenor diode.	(2 marks)	
(c) Any ONE of: ● The ripple amplitude is less ● The ripple frequency is greater.	(1 mark)	
(d) Any ONE of: • Inductor • Capacitor • Resistor	(½ mark)	

Question 5	*Reference Marks*	*Marking notes*
(a) Welding load	(½ mark)	
kW = kVA x pf		
= 12000 x 0.7	(½ mark)	
= 8400 watts	(1 mark)	
kW_T = 9 kW + 15 kW + 8.4 kW	(½ mark)	
= 32.4 kW	(1 mark)	
(b) kvA = $\sqrt{kW^2 + kVAr^2}$	(½ mark)	
= $\sqrt{32.4^2 + 28.6^2}$	(½ mark)	
= 43.22 kVA	(1 mark)	
(c) pf = $\frac{kW}{kVA}$	(½ mark)	
= $\frac{32.4}{43.22}$	(½ mark)	
= 0.75	(1 mark)	
(d) P = $\sqrt{3} \times V_L \times I_L \times pf$	(½ mark)	
I_L = $\frac{P}{\sqrt{3} \times V_L \times pf}$	(½ mark)	
= $\frac{32.4}{\sqrt{3} \times 400 \times 0.75}$	(½ mark)	
= 62.35 Amps	(1 mark)	

Question 6	*Reference Marks*	*Marking notes*
(a) Any TWO of: ● The MCB may be destroyed. ● The MCB may not clear the fault before damage occurs to the installation. ● Unwanted operation of upstream devices ● A fire could be initiated	(2 marks)	
(b) (i) The rewireable fuses are rated for maximum fault currents of 1 kA	(1 mark)	
(ii) Any TWO of: ● MCBs ● HRC fuses ● RCBOs	(1 mark)	
(c) 63A This is maximum continuous current. the fuse is designed to carry. 440V This maximum open-circuit voltage. the fuse is designed to withstand. AC40 40,000A is the maximum prospective short circuit current. The fuse can safely interrupt.	(½ mark) (½ mark) (½ mark) (½ mark) (½ mark) (½ mark)	
(d) Only the protective device protecting that final subcircuit operates.	(2 marks)	
(e) Any ONE of: ● The breaking capacity of the MCBs is too low for the PSSC of the installation. ● The PSSC level of the installation has increased.	(1 mark)	

Question 7	*Marks*	*Reference*	*Marking notes*

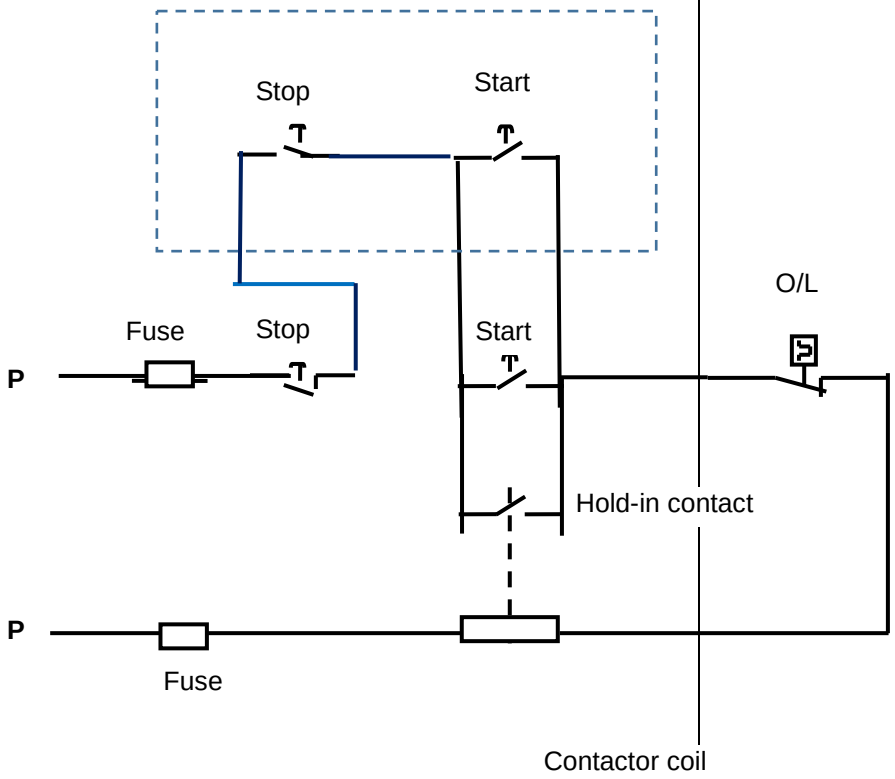
(a)



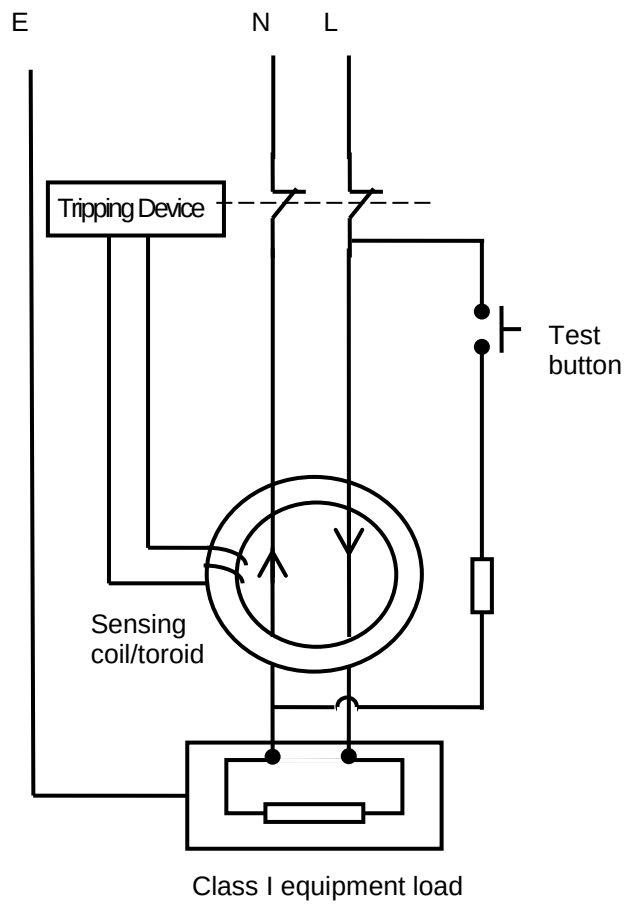
• The starting torque	(½ mark)		
• The pull-out torque	(½ mark)		
• Full-load torque or running torque	(1 mark)		
• Rotor speed – N_R	(½ mark)		
• Synchronous speed N_S.	(½ mark)		

Question 7	Marks	Reference	Marking notes

(b)



(i)	•	Correctly connected fuses	(1 mark)
	•	Correctly connected start button	(½ mark)
	•	Correctly connected stop button	(½ mark)
	•	Correctly connected hold-in contact	(½ mark)
	•	Correctly connected coil	(½ mark)
	•	Correctly connected thermal overload	(½ mark)
	•	Working circuit	(½ mark)
(ii)	•	The remote stop is in series with the local stop button	(1 mark)
	•	The remote start in parallel with the local start button	(1 mark)
	•	There is no link between the stop and the start buttons in the starter	(1 mark)

Question 8	*Reference Marks*	*Marking notes*
(a)  Class I equipment load		No marks can be awarded for part (a) if: ● There is no earth connection ● The test circuit is connected on the supply side of the main contacts
● Correctly connected test circuit and resistance	(1 mark)	
● Correctly connected sensing coil/toroid	(1 mark)	
● Correctly connected phase, neutral and earth.	(1 mark)	
● Correctly connected tripping circuit	(1 mark)	
(b) (i) 10 milliamps.	(½ mark)	
(ii) 300 milliamps.	(½ mark)	
(c) (i) ● Type A.	(½ mark)	
(ii) ● Tripping is ensured for residual sinusoidal alternating currents.	(1 mark)	
● Tripping is ensured for residual pulsating direct currents.	(1 mark)	
(d) Because Type AC RCDs do not have a residual pulsating d.c. function	(½ mark)	

Question 8			*Reference Marks*	*Marking notes*
(e)	(i)	Yes The RCD detects the imbalance regardless of the polarity of the supply.	(½ mark) (½ mark)	
	(ii)	Yes The RCD would detect and imbalance between the phase and neutral currents.	(½ mark) (½ mark)	

Question 9	*Reference Marks*	*Marking notes*
(a) pf = cosΦ	(½ mark)	
= cos 35^0		
= 0.8191 lag	(½ mark)	
(b) Input power = $\frac{\text{Output power}}{\text{Efficiency}}$	(½ mark)	
= $\frac{10000}{0.815}$	(½ mark)	
= 12270 W	(1 mark)	
(c) I_L = $\frac{P_{Input}}{\sqrt{3} \times V_L \times pf}$	(½ mark)	
= $\frac{12270}{\sqrt{3} \times 400 \times 0.8191}$	(½ mark)	
= 21.62A	(1 mark)	
(d) (i) N = $\frac{60f}{P}$	(½ mark)	
= $\frac{60 \times 60}{2}$	(½ mark)	
= 1800 rpm	(½ mark)	
Slip speed = N x slip	(½ mark)	
= 1800 x 4%	(½ mark)	
= 72 rpm	(½ mark)	
(ii) Rotor speed = N – slip speed	(½ mark)	
= 1800 - 72	(½ mark)	
= 1728 rpm	(1 mark)	