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| NO | S O L U T I O N |
| **1(a)**  **1(b)** | 230V, 50Hz, single-phase, 2-wires  TT system  Max I = 22,000/(230) = 95A |
| **2** | (i) Construction sites, Festive lighting, trade-fairs, mini-fairs and exhibition sites  (any four)  (ii)SOA must be totally enclosed with all the live parts totally protected from direct contact. Socket outlets must be equipped with MCB and RCCB  (iii) Maximum length is 3m for flexible cables  (iv) No looping or expansion from the existing socket outlet. |
| **3(a)**  **3(b)** | |  |  |  |  | | --- | --- | --- | --- | | **No. & Types of Ccts** | **No. of cables** | **Cable Factor** | **Total cable factor** | | 1 nos single phase circuits of 2.5mm2 with 1.5mm2 cpc | 1 x 2  1 x 1 | 30  22 | 60  22 | | 1 nos. 3-phase 3-wire circuits of 4mm2 with  2.5mm2 cpc | 1x 3  1 | 43  30 | 129  30 | |  |  |  | **241** | | Hence select conduit with factor 404, two bend 3.5 m (3.4m) i.e. 25mm diameter | | | |   No, ohmmeter cannot be used for measuring insulation resistance as it cannot provide the 500V dc need to stress the insulation.  For a 200 points electrical installation the IR of 0.3Mohms is acceptable if the installation is divided into two sections of about 100 points each for measuring, the IR of each section will be more than 0.6Mohm which is above the required 0.5Mohms |

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| **NO** | S O L U T I O N |
| **4** | |  | | --- | | Basic start stop +self-holding + relay = 3marks (Stop may be omitted)  Correct connection to green light and T1 contacts = 3marks  T2 and recycle timer contact place correctly = 4 marks | |
| **5** | 1. When current of 4xIn flows in load A   Operating time for In Type C MCB = approx. 20s  2xIn Type B MCB = approx 150s  Since In Type C operates before 2xIn Type B MCB there is discrimination.   1. If In = 20A, min cable size for load A 20A MCB = 2.5mm2   Min cable size for load B 30A MCB = 4.0mm2 |
| 6 | A person can receive an electric shock in two ways, firstly by **coming into contact with live parts (direct contact)** and secondly by  **touching metallic parts that have become live due to a fault (indirect contact).** Electrical Separation of Supply This measure uses an isolating transformer where the secondary is not earthed to prevent electric shock through contact with exposed-conductive parts which might be energised by a fault in the basic insulation of the cable     |  |  | | --- | --- | |  | 240 = 20x Zs + 20x11.2  240/20 = Zs + 11.2  Zs = 12-11.2 =0.8ohms  Zs includes R1 + R2 and all earth  electrode resistances | |

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| **NO** | S O L U T I O N | **MARKS** | **TOTAL MARKS** |
| **B1**  **(a)** | |  |  |  |  | | --- | --- | --- | --- | | **Loads** |  | **DF** | Current Demand | | **40 nos. fluorescent lamps, each rated at 2x18W, 2x9w ballast, pf 0.8** | **= 40 x 2(18+9)/(230x0.8)**  **=11.74** | **0.9** | **10.57** | | **15 nos 50W discharge lamps floodlight** | **=15x50/230 =3.26** | **0.9** | **2.93** | | **13A SSO circuits**  **Largest cct 3.0kW**  **Remainder cct= (4 x 13.04)** | **13.04A**  **52.16A** | **1.0**  **0.5** | **13.04**  **26.08** | | **2 Storage water heaters, each rated at 1.5 kW**  **Total 3kW** | **13.04** | **1.0** | **13.04** | |  | **Total 1 phase demand** |  | **65.66 (1Ф)** | | **2 nos. air-conditioner, each rated at 9 kW with p.f. of 0.85 and efficiency of 90%** |  | **1.0** | **33.96(3Ф)** |   **Maximum three phase current demand = 65.66/3 + 33.96A =55.85A**  **10% spare capacity = 1.10 x 55.85A = 61.43A**  **Size of main breaker = 63A Three phase** | **1**  **3**  **1**  **1**  **2**    **2**  **1**  **3**  **3**  **1**  **2** | 20 |
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| **NO** | S O L U T I O N | **MARKS** | **TOTAL MARKS** |
| **B2(a)** | **(i)**  **Select In = 63A**  **(ii) From Table 4C1 Ca = 0.87**  **From Table 4B1 Cg = 0.80 ; No thermal insulation Ci = 1**  **It = In/(Ca\*Cg\*Ci) = 63/(0.87\*0.80\*0.1) = 90.52A**  **Select cable size of 35.0 mm2 which can carry 99A (Table 4D2A**  **column 5).**   1. **calculate the voltage drop :**   **Vd = Vc\*Ib\*L/1000 = (1.10\*54.3\*40)/1000 = 2.39V**    **Maximum allowable volt drop in CP5 is 4 % of 400V = 16v**  **As the actual voltage drop is 2.39V, the 35.0mm2 cable meets CP5 requirements.** | **2**  **1**  **1**  **1**  **2**  **2**  **1**  **1** | **11** |
| **B2**  **(b)** | (i) Earth fault loop impedance ZS = ZE + (R1 + R2)  With 2.5mm2 phase conductor and cpc 1.5mm2  ZE = 0.8 , ZS = 0.8 + (19.51 x 30 x1.38)/1000 = 1.61 Ω  For 32A BS88 fuse, from Table 41D(L) (5 secs) Zsmax = 1.84 Ω,  Hence size of cpc of 1.5mm2 is **acceptable** for shock protection.    (ii)For With 2.5mm2 phase conductor with cpc of 1.5mm2  ZS = 1.61 Ω  Earth fault current = 230/1.61= 142A  Operating time of 32A BS88 fuse at 142A < 2s  Using K2S2 ≥ I2t and t of 4s  K = 115, I =162A, t = 2s  S≥ 142(√3)/115= 1.74mm2  Hence 1.5mm2 cpc does **not meet** thermal constraint. | **2**  **1**  **1**  **1**  **1**  **1**  **1**  **1** | 9 |