Page 25 Wiring & Containment:
(Covering Outcome 4 of Unit 304 'Understanding the types, applications and limitations of wiring systems and associated equipment' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 EAL NVQ Level 3 1605 Diploma, and Outcome 2 of EAL Level 3 Electrotechnical Qualification '7345'.

To answer some of the following questions you will need the IET On-Site Guide BS7671:2008 +A3 2015

1) Briefly define the term 'Wiring system'

   Answer: The method/s used to provide electrical circuits in, or around a building or other situation where electrical equipment needs to be supplied with electrical energy.
   A wiring system comprises the circuit cables and, where required, additional mechanical protection

2) Give **one** example of a totally enclosed wiring containment system

   Answer: Steel or PVC Conduit

3) Give **one** example of a composite wiring system

   Answer: PVC PVC (twin & earth) cable

4) PVC SWA, FP and MICC cables are examples of what type of wiring system?

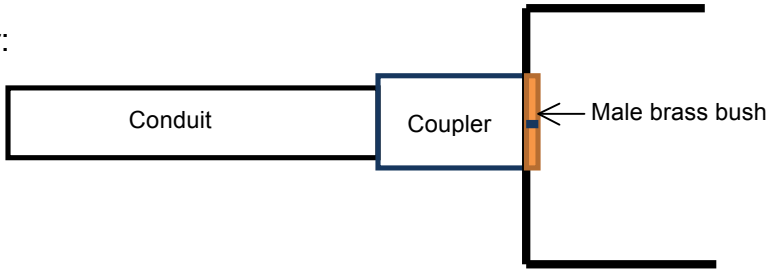
   Answer: Composite wiring systems

5) Cable basket, cable tray and ladder rack are all types of?

   Answer: cable support systems

6) With the aid of a drawing show the most suitable method of terminating galvanised steel conduit to a metal-clad surface mounted socket-box

   Answer:



7) Distance, Hospital and Spacer-Bar are all types of?

Answer: Conduit saddle for surface mounting

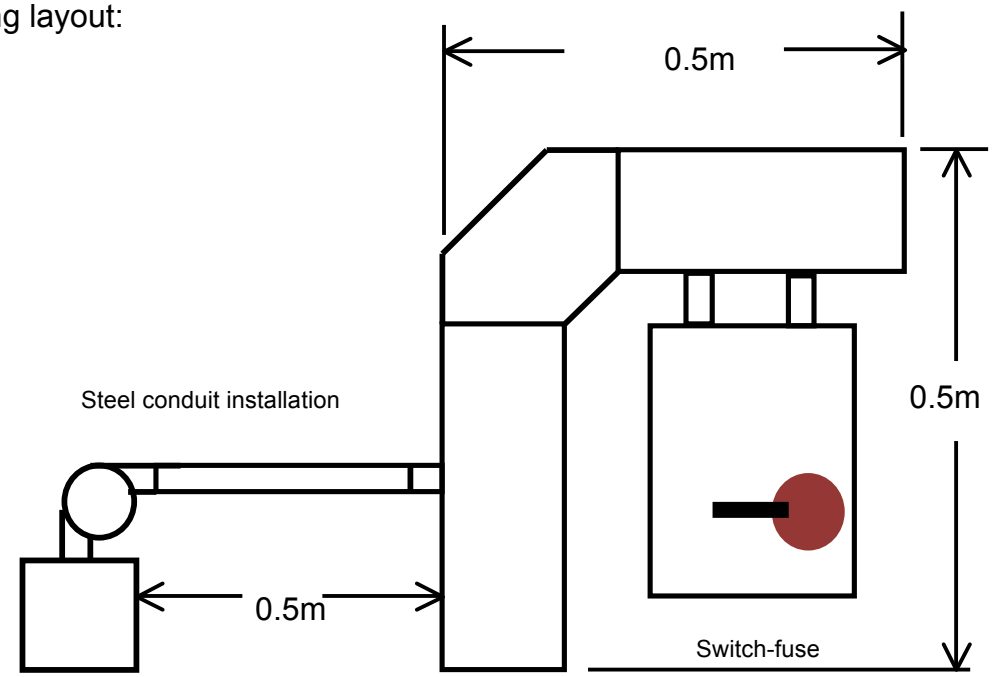
8) (i) State the method of joining two lengths of steel conduit when neither length can be turned is the use of a? (ii) Identify the materials required to make the joint.

Answer: (i) Running coupler. (ii) Coupler and lock-nut or locking-ring

9) A wiring containment system that has one removable side is called?

Answer: Trunking

10) List the materials required to assemble the wiring containment for the following layout:



Answer:

Steel conduit / switch-fuse

1	Metal box
6	Male brass bush
1	90° tangent bend
3	Coupler
0.5m	Galv. Steel conduit

Steel trunking

2	End stops complete with fixing screws
1	90° Gusset bend (Top lid) complete with fixing screws
2	Earthing straps
1m	Galv. Steel trunking

PAGE 26 Practice multiple-choice questions for wiring containment:

(Covering Outcome 4 of Unit 304 'Understanding the types, applications and limitations of wiring systems and associated equipment' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 or EAL equivalent) EAL NVQ Level 3 1605 Diploma, and Outcome 2 EAL Level 3 Electrotechnical Qualification '7345'.

Attempt the following:

No 1	20mm, 25mm and 32mm are diameters of	**Answer**
a	Standard power cables	
b	Standard conduits	X
c	Ducting	
d	MICC cables	

No 2	Stainless steel, galvanised and enamel are surface finishes available for	**Answer**
a	Conduit, trunking and cable tray	X
b	Conduit only	
c	Trunking only	
d	Cable tray only	

No 3	The cable capacity rating for a conduit allows for	**Answer**
a	Additional cables to be installed at a later date	
b	Expansion of cables when in use	
c	Sufficient cable temperature rise without damage	
d	Circulating air space to allow cable to shed heat in use	X

No 4	Joints in trunking, cable tray or metal ducting will require	Answer
a	Sufficient set-screws and nuts to secure the joint	
b	The ends of the containment to be pushed together	
c	Protective bonding straps across each joint	X
d	Labels to indicate the position of the joint	

No 5	The item used to join lengths of metal conduit is a	Answer
a	Connector	
b	Screwed sleeve	
c	Joiner	
d	Coupler	X

No 6	The device used to prevent undue strain on cables in a vertically mounted trunking is a	Answer
a	Clamp	
b	Pin rack	X
c	Support block	
d	Off-set	

No 7	The best practice method of joining fixed metal conduit to a motor terminal box is	Answer
a	PVC SWA	
b	PVC conduit	
c	Direct connection of the conduit with the box	
d	Flexible conduit	X

No 8	Which one of the following containment systems may be used to support fluorescent luminaires?	Answer
a	Trunking	X
b	Cable tray	
c	Conduit	
d	Ducting	

No 9	Spacer-bar, distance and hospital, are all types of	Answer
a	Conduit	
b	Trunking support mechanisms	
c	Saddle	X
d	Support bracket	

No 10	Which one of the following wiring systems requires the introduction of fire barriers where it penetrates floors or ceilings?	Answer
a	Conduit 25mm and above	
b	Trunking with an area of over 710mm²	X
c	Cable tray	
d	Cable basket	

No 11	The wiring system required to supply the electric motor driving a petrol dispensing pump in a garage forecourt is?	Answer
a	Single cables in galvanised steel conduit	
b	PVC insulated MICC cable	X
c	FP 200 Gold	
d	PVC SWA cable	

No 12	Which of the following cable types will provide the greatest resistance to impact?	Answer
a	PVC SWA	
b	F.P.200 Gold	
c	MICC	X
d	Silicon impregnated flex	

PAGE 28 Industrial Electrical Installations:

(Covering Outcome 4 of Unit 304 'Understand the types, applications and limitations of wiring systems and associated equipment' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 or EAL equivalent)

The following questions concern the design stages of an electrical installation for an industrial location.

Q1: State **four** key factors that the electrical designer will need to consider when designing the electrical installation

Answer:

- The type of industrial premises the design is for
- Statutory regulations that apply to this type of premises
- The general electrical characteristics for the installation
- The maximum electrical demand of the premises

Q2: When the initial factors have been observed and information obtained state **three** specific electrical considerations that the designer will next need to answer

Answer:

- The type of electrical equipment to be installed
- The type of wiring system/s to be used
- The type of protective devices that will be needed

Q3: Briefly state the meaning of each of the following terms in relation to industrial premises:

i) Load centre

ii) Maximum demand

iii) Distribution circuit

Answer:

i) A part within the premises where major items of electrical equipment is located and operated.

ii) The total electrical load of the premises including machines, lighting and auxiliary equipment.

iii) Another word for 'sub-main', this is a circuit that has its origin at the main distribution board, or supply intake location, and supplies another distribution board located elsewhere, for example, at or near a load centre.

Q4: Identify the **device** and **type** of protective device shown in Figure 1 below. Also state **two** additional features observed on this device.

Fig:1



Answer:

The device is a Three – phase and Neutral, (TPN), **'Fuse – switch'** incorporating BS88 – 2 High Rupturing Capacity (HRC) fuses to system E (bolted).

(See Appendix 3 of BS7671:2008 +A3 2015)

Additional features:

- Visual indication showing the condition of the fuse-switch.
- Retractable handle.

or

- Neutral link

Q5: Briefly explain the difference between (i) a 'Fuse-switch' and (ii) a 'Switch-fuse'

Answer:

i) A fuse-switch is designed to be located at the origin or supply intake position of an installation, (*although in theory it could be used in other locations*). The protective devices, (fuses) are arranged so that when the switch is in the OFF state, the fuses are disengaged from the circuit.

ii) A switch-fuse is designed so that the protective devices, (fuses) remain in position and the circuit is isolated by a mechanical switch mechanism separate to the fuses but contained in the same enclosure.

Q6: Identify the isolator shown in figure 2 below and state **three** key features of the device.

Fig: 2



Answer:

The device is a **'Fire-fighters'** switch and is used to isolate the electrical supply to parts of an installation that may be hazardous to access in the event of fire. A typical example is found at a petrol dispensing station where the fire-fighters switch is used to isolate the power supply to the dispensing pumps on the forecourt.

Key features:

- Switch is painted RED
- When in the OFF state a retractable pin prevents the switch inadvertently becoming switch on.
- The OFF position is located so the ON/OFF switch arm is pushed upwards to switch off the circuit

(See 537.6 Fire-fighters switches: BS7671:2008 +A3 2015)

Selecting data using the IET On-Site Guide

(Covering Outcome 3 of Unit 304 'Understand principles for selecting cables and circuit protective devices' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91)

The following tasks will require reference to Appendix F of the IET On-Site Guide: BS7671:2008 +A3: 2015.

The main objective of this exercise is to locate and use technical information in preparation for and in the calculation of suitable circuit cable sizes.

Questions:

For each answer indicate the Table reference and column that is applicable

1) A 90°C thermosetting PVC insulated cable is to be installed in an ambient temperature of 35°C, what is the rating factor for this cable?

Ca from Table F1 is **0.96**

2) A non-sheathed mineral insulated cable is to be installed in a location where it cannot be touched and the temperature is expected to reach 40°C, state the rating factor applicable to this cable.

Ca from Table F1 is **0.92**

3) A new multi-core cable is to be supported on a vertical cable tray with 6 other multi-core cables. What is the rating factor to be applied to the new cable?

Cg from Table F3 is **0.73** (Note the final number of installed circuits will be 7)

4) A new single-phase circuit is to be installed to method B in an existing steel trunking. The new circuit is to be installed with 7 other single-phase circuits. What is the rating factor to be applied to the new circuit?

Cg from Table F3 is **0.52**

Note:

1. Reference Method B is enclosed
2. The final number of installed circuits will be 8 in number
3. In practice an assessment will need to be made in respect to the effect the new circuit is likely to have on the current carrying capacities of the existing circuits

5) A three-phase circuit uses single-core insulated cable enclosed in conduit on a wall. The cable is expected to carry a current of no more than 55A, what cable size, (i.e. cross-sectional-area), is needed?

Use table F4 (i), Column 5 (i.e. for Reference method B and 3-phase circuits)

Nearest current to 55A is 68A, cable size **16mm^2**

6) A single – phase 70mm^2 single core 70°C thermoplastic insulted cable is enclosed in steel conduit on a thermally insulated wall, what is the maximum current rating for this cable?

Use table F4 (i), Column 2 (i.e. Reference method A and single-phase circuits)

Current rating of this cable is **151A**

7) A multi-core cable with thermosetting insulation has a cross-sectional-area of 35mm^2 and supplies a single-phase circuit. What is the voltage drop per ampere per metre, (mV/A/m) for this cable?

Use table F5 (ii), Column 1 for cross-sectional-area and Column 3 for mV/A/m

Value from column 3 is **1.25 mV/A/m**

8) An insulated and sheathed flat cable 10mm^2 is to be installed to Method C, i.e. clipped direct to a surface. What is the maximum current rating of this cable, and the mV/A/m?

Use table F6, Column 1 for cross-sectional-area and Column 8 for mV/A/m

Value from column 8 is **4.4 mV/A/m**

Note: Table F6 provides current carrying capacity and voltage drop data in a single table

9) An insulated and sheathed flat cable carries 25A for a length of 50m. If the cable is 6mm^2 what is the total voltage drop for this cable?

Use table F6, Column 1 for cross-sectional-area and Column 8 for mV/A/m

Value from column 8 is 7.3 mV/A/m

The total or Actual Voltage Drop (AVD) = $\frac{\text{mV/A/m x Design current Ib x Length L}}{1000}$

$$AVD = \frac{7.3 \times 25 \times 50}{1000}$$

AVD = 9.125 V

Note: In practice this value must be checked against the allowable voltage drop for the circuit. Remember the allowable voltage drop will depend on the type of circuit, (see paragraph 2 in Appendix F sub-section Voltage drop.

10) A single-phase multi-core thermosetting pvc insulated cable is to be installed with 3 other circuits in a conduit. The conduit is to pass through an area where the ambient temperature is likely to be 35°C. If the rating of the protective device is 32A what is the tabulated current rating of the cable when the rating factors are applied?

Use table F1 (i) for Ca. This is 0.96

Use table F3 for Cg. This is 0.65 (i.e. for 4 circuits enclosed)

Total rating factor: C = Ca x Cg

C = 0.96 x 0.65

C = 0.624

Tabulated current It = $\frac{\text{In}}{\text{C}}$ (**Note** In is the nominal current setting of the protective device)

$$It = \frac{32}{0.624}$$

It = **51.3A**

From Table F5 (ii) the nearest size cable to 51.3A is **10mm^2** rated at **52A.**

Note: It will be necessary to confirm the voltage drop of this cable before accepting 10mm^2 as being suitable.

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PAGE 32 Circuit Protection:

(Covering Outcome 2 & 3 of Unit 304 (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 and EAL NVQ Level 3 1605 Diploma, and Outcome 6 of EAL Level 3 Electrotechnical Qualification '7345'.

To answer the following questions you will need the IET Requirements for Electrical Installations: BS7671:2008 +A3 2015

Circuit protective devices:

Q1: State the **maximum** current rating currently available for a BS88-3 fuse.

Ans: 100A (fig 3A1 Appendix 3)

Q2: A circuit protected by a BS3036 fuse must disconnect in 5 seconds. If the fuse rating is 20A, what fault current will be required to achieve the disconnection time?

Ans: 60A (fig 3A2 (b))

Q3: A 100A BS88-2 fuse operates at a fault current of 200A, how long does it take for the fuse to operate?

Ans: Approximately 1200sec or 20minutes (fig 3A3 (b))

Q4: The type of fuse shown in figure 1 is called?



Ans: An HRC or HBC fuse to BS88-2 Fuse system E (bolted) (Appendix 3)

Q5: The Time / Current characteristic curves for circuit-breakers to BS EN 60898 and RCBO's to BS EN 61009-1 have a distinctive shape, what do the two parts of the curve represent?

Ans: The top part or curved section represents the characteristics of the thermal component of the circuit-breaker and the bottom part or straight section represents the characteristics of the magnetic component.

Q6: How long will it take to operate a 32A rated Type B circuit-breaker to BS EN 60898 if the circuit is subjected to an overload current of 100A?

Ans: Approximately 35 seconds (fig 3A4)

Q7: (i) State the operating current for each type of 100A rated circuit-breaker. (ii) summarize the multipliers applicable to each type of circuit-breaker current rating.

(i) Type B 500A

Type C 1000A

Type D 2000A or 1000A depending on disconnection time

(ii) Type B x5

Type C x10

Type D x20 or x10

Q8: A distribution circuit is designed to carry a maximum current of 85A.

(i) State the disconnection time applicable to this circuit if the supply system is TN-S

(ii) State the rating of a suitable Type B circuit-breaker for this circuit

(iii) What is the operating current for the circuit-breaker?

(iv)Identify the maximum earth-fault loop impedance permitted for this circuit

Ans:

(i) 5 seconds (411.3.2.3)

(ii) 100A (fig 3A4 Appendix 3)

(iii) 500A (fig 3A4 Appendix 3)

(iv) 0.44Ω (Table 41.3)

PAGE 34-36: Revision practice for Unit 301 (2330-07) or Unit 309 (2357-13)

Try these multiple – choice questions.

No 1	Which of the following best defines the purpose of an electric motor?	**Answer**
a	A machine that generates direct current	
b	A generator that produces alternating current	
c	A device that converts electrical energy into heat energy	
d	A machine that converts electrical energy into mechanical energy	X

No 2	The part of an AC motor that is fixed is called the?	**Answer**
a	Armature	
b	Rotor	
c	Stator	X
d	Yoke	

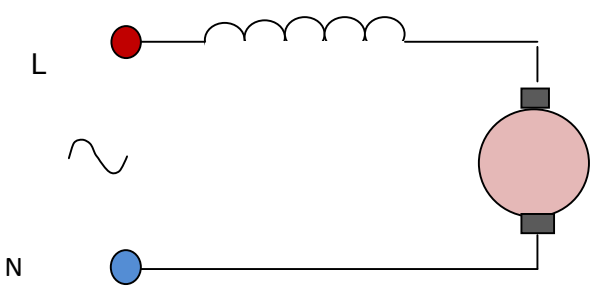
No 3	Silicon steel is used in the construction of which motor part?	**Answer**
a	Drive shaft	
b	Stator frame	X
c	Rotor windings	
d	Machine enclosure	

No 4	The phenomenon known as ‘cogging’ will occur if the?	**Answer**
a	Stator field is connected in parallel	
b	Stator field is connected in series	
c	Rotor bars are parallel to the rotor shaft	X
d	Rotor bars are skewed by 20º	

No 5	Torque in an AC induction motor can be improved by fitting?	Answer
a	Stator windings connected in series with each other	
b	A double-cage rotor	X
c	Capacitors across the supply terminals	
d	A rectifier to convert AC to DC	

No 6	Slip-rings and brushes are found on which of the following motors?	Answer
a	Wound rotor induction	X
b	Shunt wound	
c	Cage induction	
d	Single-phase series wound	

No 7	The stator winding that remains in circuit when a single-phase motor runs at full speed, is the?	Answer
a	Auxiliary winding	
b	Start winding	
c	Main winding	X
d	Series winding	

No 8	The type of motor shown in the circuit diagram is? 	Answer
a	DC series motor	
b	AC shunt motor	
c	DC compound motor	
d	AC universal motor	X

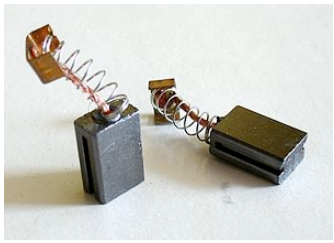
No 9	Shading rings are found in which of the following AC motors?	Answer
a	Cage wound	
b	Shaded – pole	X
c	Permanent magnet	
d	Universal	

No 10	A motor normally fitted to a domestic vacuum cleaner is the?	Answer
a	Universal motor	X
b	Cage induction motor	
c	Wound rotor motor	
d	Shunt wound motor	

No 11	Which of the following statements is correct for the synchronous motor?	Answer
a	Rotor speed lags the stator field speed	
b	Armature speed lags the field speed	
c	Rotor speed and stator flux speed are out-of-phase	
d	Rotor revolves at the same speed as the stator flux	X

No 12	A faceplate starter is used with which one of the following machines?	Answer
a	AC wound rotor	
b	AC cage induction	
c	AC universal	
d	DC compound	X

No 13	The current flowing in an electric motor when at full load speed is controlled by the?	Answer
a	Resistance of the stator windings	
b	Impedance of the armature windings	
c	Back – emf applied to the shunt field windings	
d	Back – emf generated in the rotor or armature	X

No 14	The objects shown in the photograph are? 	Answer
a	Anti-vibration devices	
b	Carbon brushes	X
c	Connector blocks	
d	Temperature sensing devices	

No 15	In which of the following direct current motors does the same current pass through both the armature and the field?	Answer
a	Series	X
b	Shunt	
c	Compound	
d	Separately excited	

No 16	Which of the following motor circuits will not require power factor correction?	Answer
a	3-phase AC induction motor	
b	1 – phase Capacitor start motor	
c	Compound connected motor	X
d	AC universal motor	

No 17	The device that detects the rise of temperature in motor windings is called a?	Answer
a	Transistor	
b	Thermostat	
c	Thermionic sensor	
d	Thermistor	X

No 18	Which one of the following is not a recognised method of providing direct current?	Answer
a	Battery	
b	Solar photovoltaic panels	
c	An alternator	X
d	Rectifier	

No 19	One problem caused by armature reaction is?	Answer
a	Field windings overheat	
b	Armature windings can burn out	
c	The commutator can become scored	
d	Arcing can occur at brushes	X

No 20	A motor is identified as having 6 poles. When connected to a 50Hz AC supply, what is the synchronous speed of the stator flux?	Answer
a	3000 rpm	
b	1500 rpm	
c	1000 rpm	X
d	750 rpm	

PAGE 37 -38 Electrical Machines: (Covering Outcome 8 'Understand the operating principles and applications of DC machines and AC motors of Unit 309 NVQ Level 3 Diploma 2357 – 13 and EAL NVQ Level 3 1605 Diploma, and Outcome 9 of EAL Level 3 Electrotechnical Qualification '7345'.

The following questions relate to alternating current motors, both three-phase and single-phase.

Electric motors have many applications in industrial, commercial and domestic situations.

Question 1:

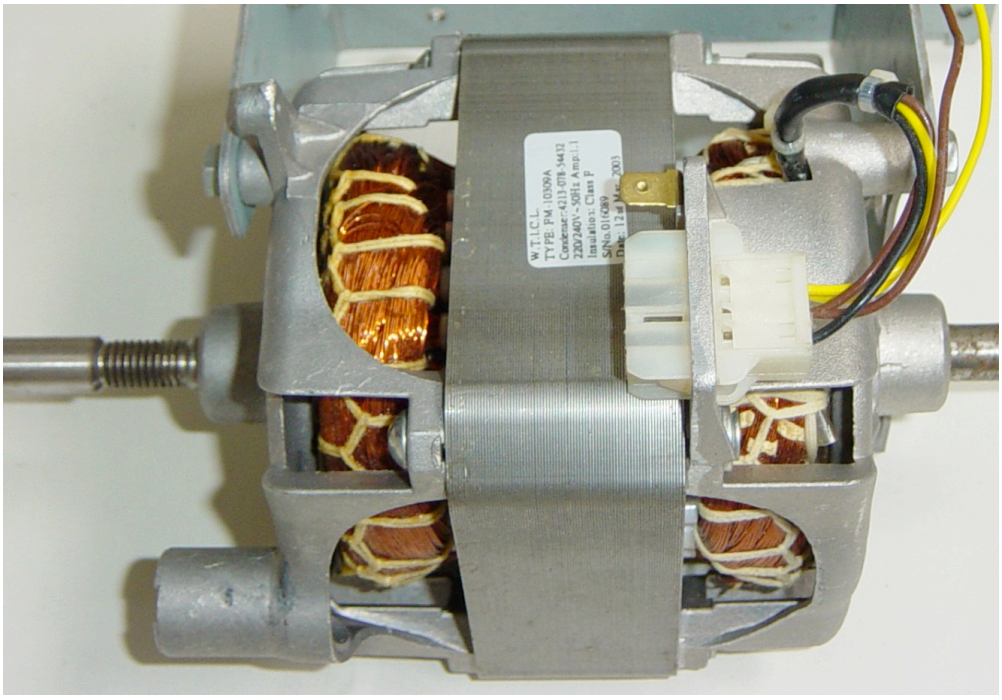
Give **one** example where electric motors may be used in each of the following locations:

i. A manufacturing industry
ii. A supermarket
iii. A three-bedroom house

Answer:

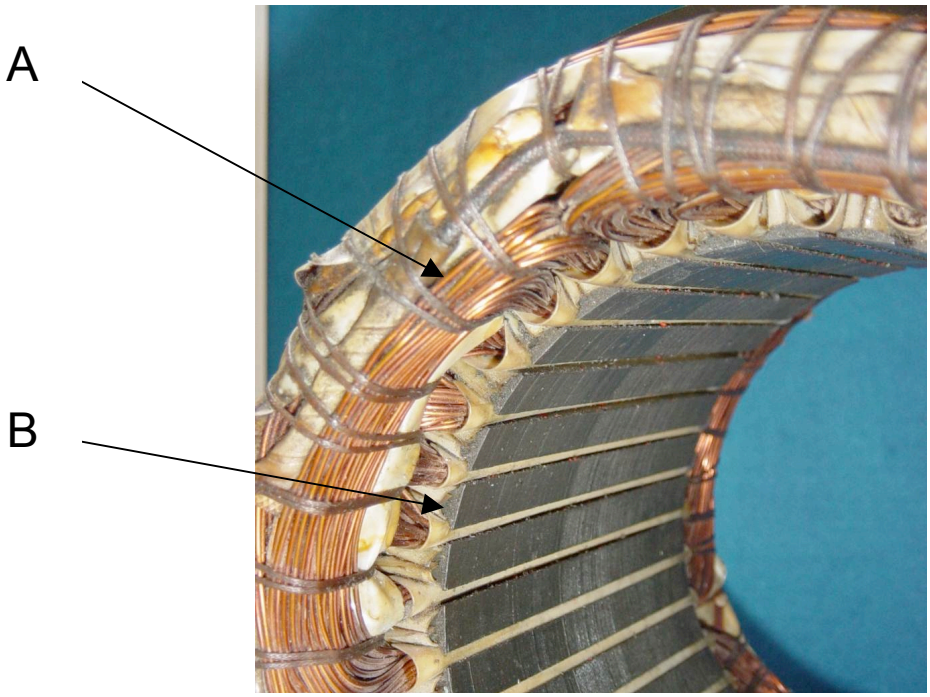
i. Production line conveyor, hoist or pump
ii. Air conditioning and refrigeration compressors, evaporator or condenser fans
iii. Central heating circulating pump, extract fan in a bathroom

The most common type of electric motor is the **induction motor**.



The image shows an open-frame induction motor used to drive the drum of a domestic washing machine

Figure 1 shows a section of the **stator** for a typical 3-phase induction motor.



Question 2:

Identify the name, material and purpose of the parts indicated by the letters in figure 1 above.

- A = **Stator winding** made from copper wire with lacquer insulation. The purpose of the stator windings is to produce a rotating magnetic field inside the stator frame.
- B = **Stator core or frame**, made from laminated silicon steel. The stator is designed to support the stator windings and to contain the electro-magnetic field produced by the stator windings.
- When the stator of a 3 – phase motor is connected to the supply the stator windings will produce a rotating magnetic field in the open space inside the stator frame, it is this rotating magnetic flux that will induce a current into the rotor when the rotor is inserted into the stator frame.

The **speed** of the stator rotating flux will depend on **two** conditions:

Question 3:

Identify the two conditions that determine the speed of the revolving stator flux and state the name given to the speed of this flux.

Two conditions are: **Frequency** of the power supply and the number of **pairs-of-poles** of the motor.

The speed of this flux is called the '**synchronous speed'**.

For a three-phase motor the minimum number of winding sets will be **1**, i.e. one winding per phase. Together the **three windings** will produce an electro-magnetic field consisting of one North and one South – pole, this is called one Pair of Poles.

Because the rotating electro-magnetic field is being created by the stator windings it is often referred too as the Stator flux

For a standard a.c. power supply operating at a frequency of 50Hz, and a stator with one set of windings producing one pair-of-poles, the speed of the revolving electro-magnetic field is 3000 rpm.

As stated this is the Synchronous Speed of the motor and is represented by the abbreviation **ns**

To calculate the synchronous speed of a three-phase motor the following formula is used:

$$ns = \frac{f \times 60}{p}$$

Question 4:

Complete the following key:

ns = synchronous speed in revolutions per minute (RPM)

f = frequency of the power supply in Hertz (Hz)

Note: the figure 60 can be omitted if the synchronous speed is to be expressed in revolutions per second or **ns**

Question 5:

Complete the following problem.

Calculate the synchronous speed of a 3-phase induction motor if the frequency is 50Hz and there are four sets of stator windings.

$$Ns = \frac{f \times 60}{p}$$

$$Ns = \frac{50 \times 60}{4}$$

$$Ns = 750rpm$$

Note: four sets of windings will produce 8 - poles

therefore 8-poles will give four pairs of poles

The cage rotor:

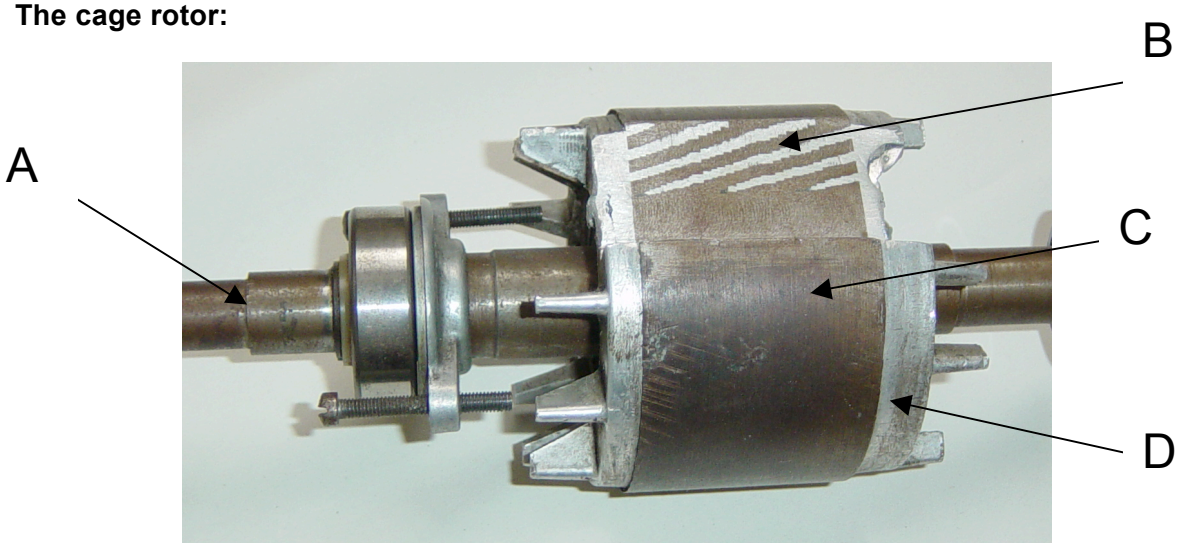


Figure 2 shows a cut-away view of a cage rotor

Question 6:

Identify the name, material and purpose of the parts indicated by the letters in figure 2 above.

A = drive shaft, made from steel and used to transfer torque to the load

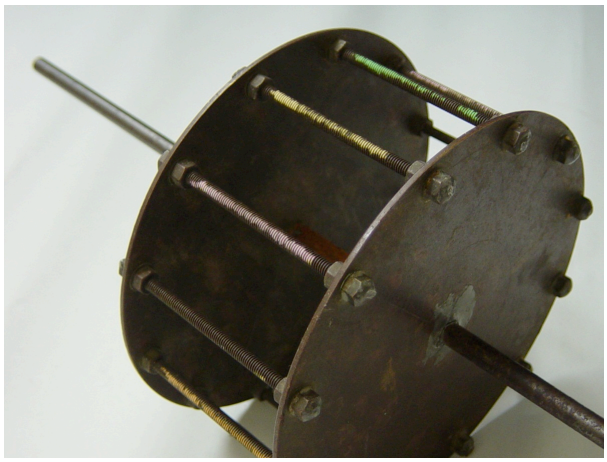
B = cage rotor made from aluminium. Current is induced into this cage that develops the rotor flux

C = rotor core made from laminated silicon steel and is designed to support the aluminium cage bars and provides a low reluctance path for the stator flux.

D = aluminium end ring, sometimes called the 'shorting ring' and links all the rotor bars together

©

The model rotor illustrated below shows the cage construction. The only difference between the model and the ‘real’ rotor is the bars in the model are parallel or straight between the end rings unlike the real rotor where the bars are skewed to maximise the production of torque.



Electrical Machines: (Covering Outcome 8 'Understand the operating principles and applications of DC machines and AC motors of Unit 309 NVQ Level 3 Diploma 2357 – 13 and EAL equivalent)

No 1	Efficiency of a machine is found by comparing	**Answer**
a	Output current with input current	
b	Input power with output power	
c	Output power with input power	X
d	Input current with output current	

No 2	Which one of the following is **not** classed as a machine?	**Answer**
a	Air compressor	
b	Hydraulic lift	
c	Escalator	
d	Door-bell transformer	X

No 3	Shunt, series and compound are all types of	**Answer**
a	d.c. generator	
b	d.c. motor	
c	d.c. motor or generator	X
d	a.c. motor	

No 4	A face-plate starter is used for starting	**Answer**
a	a.c. wound-rotor induction motors	
b	a.c. cage induction motors	
c	d.c. shunt motors	X
d	d.c. series generator	

No 5	Which one of the following machines incorporates carbon-brushes and a commutator?	Answer
a	a.c. single – phase series motor	X
b	a.c. single-phase induction motor	
c	a.c. three-phase induction motor	
d	a.c. wound rotor induction motor	

No 6	A typical IP rating for a submersible pump is	Answer
a	X2	
b	X6	
c	X7	
d	X8	X

No 7	The surface temperature of a hand-held machine with metallic enclosure is	Answer
a	55ºC	
b	70ºC	X
c	80ºC	
d	90ºC	

No 8	A portable electrical machine provided with a flexible cable will generally be fitted with a	Answer
a	BS EN 60309-2 plug	X
b	BS EN 60309-2 socket-outlet	
c	BS1361 plug	
d	BS1363 plug	

No 9	Electrical life support machinery in a hospital will require	Answer
a	Careful installation	
b	Battery power supply	
c	A safety service	
d	Continuity of service	X

No 10	Information regarding the power supply requirements of a machine can be found from	Answer
a	The machine data plate	X
b	A competent person	
c	Maintenance records for similar products	
d	Maintenance records for the machine	

SPARKS

PAGE 40 – 41: Laws of Illumination:

(Covering Unit 309 'Understand the electrical principles associated with the design, building, installation and maintenance of electrical equipment and systems' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91)

Question 1: Artificial lighting:

A. Complete the following statements: Artificial light can be produced by one of <u>three methods</u> these are:

i. By passing a current through a filament of tungsten wire or similar.

ii. By passing an electric current through a gas such as mercury vapour

iii. By current passing through a semiconductor chip

B. The passage of current through a tungsten filament causes the filament to heat-up to about 2500ºC, at this temperature a considerable amount of heat is produced and an amount of light. This is called '**<u>incandescence</u>**'

C. If current is made to pass through a gas or metallic vapour, such as mercury, light will be produced. This is called ' **<u>electrical discharge'</u>**

Question 2: Lighting terminology:

Define the flowing terms and show the symbol used to represent the unit and / or quantity:

Term	Definition	Unit/s
Luminous Intensity	The luminous intensity of a light source	Candela (Cd) / symbol (I)
Luminous Flux	The total 'flow' of light from the source to the surface being illuminated	Lumens (Lm) / symbol (Φ) or (F)
Illuminance	The light level on a surface	Lux (Lx) / symbol (E) 1Lx = 1Lm/m²
Luminaire	The complete light fitting including lamp and any associated control gear required to start and run the lamp	N/A
Luminous efficacy	A value representing how efficient the light source, (lamp), converts electrical energy into light energy	Lumens per watt Lm / W

Question 3: Point-to-Point Lighting problems:

Point –to-Point lighting calculations concern specific points of illumination taking into account the light intensity, the distance the light source is from the surface and the angle at which the light 'strikes' the surface. The calculations are precise do not consider the illumination of whole areas such as floors, walls and ceilings.

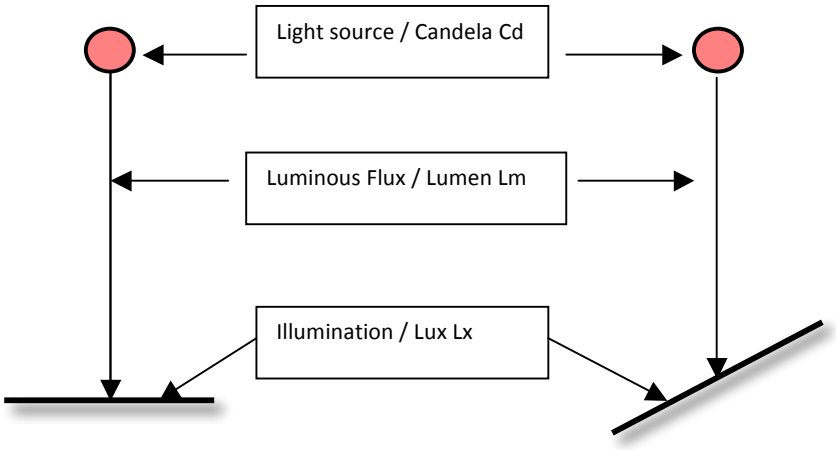
State the names of the **two** laws that apply to point-to-point lighting calculations:

i. Inverse Square Law

ii. Cosine Law

Question 4: Application of terminology:

In the following diagrams use correct terms and symbols to complete the picture



Question 5: Formulae:

State the formula for each Law:

(i) $E = I / d^2$

(ii) $E = (I / h^2) \times \cos\theta$

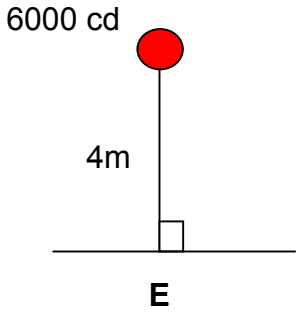
And

(i) **$h = \sqrt{d^2 + x^2}$** where (d) is the distance between light source and surface perpendicularly from the source. (x) is the point, other than that immediately beneath the light source, and (h) is the actual distance between the source and the surface point being considered.

(ii) **$\cos\theta = d / h$**

Question 6: Calculation using the first law

(i) The intensity of a light source is 6000cd and is located perpendicular to a surface 4m from it, what is the illuminance at the surface?

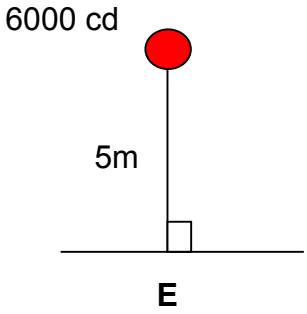


$E = I / d^2$

$E = 6000 / 4^2$

$E = 375$ lx

(ii) Calculate the illuminance if the surface is 5m away from the source.



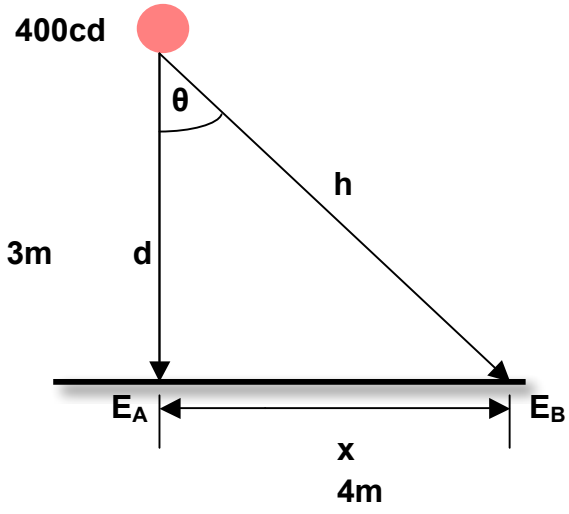
$E = I / d^2$

$E = 6000 / 5^2$

$E = 240$ lx

Note the illumination reduces the further the source is from the surface.

Question 7: Calculation using the second law:



$E_B = (I / h^2) \times \cos\theta$

To find h use Pythagoras Theorem:

$h = \sqrt{d^2 + x^2}$

$h = \sqrt{3^2 + 4^2} = \sqrt{25}$

$h = 5$m

To find the Cosine of the angle (θ):

$\cos\theta = d / h$

$\cos\theta = 3 / 5$

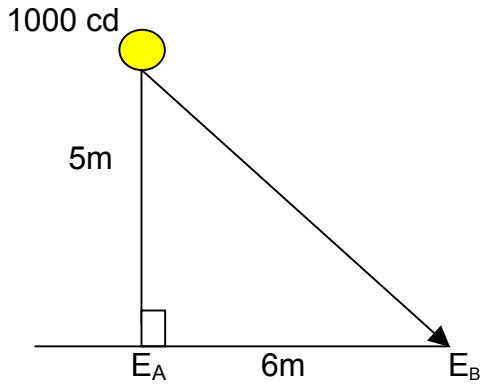
$\cos\theta = 0.6$

$E_B = (I / h^2) \times \cos\theta$

$E_B = (400 / 5^2) \times 0.6$

$E_B = 9.6$ lx

Question 8:



Calculate the illuminance at point **E_B**

$E_B = (I / h^2) \times \cos\theta$

1st find h

$h = \sqrt{d^2 + x^2}$

$h = \sqrt{5^2 + 6^2}$

h = 7.8m

Next find Cos θ

Cos θ = d / h

Cos θ = 5 / 7.8

Cos θ = 0.64

Now find the illuminance at E_B

$E_B = (I / h^2) \times \cos\theta$

$E_B = (1000 / 7.8^2) \times 0.64$

E_B = 10.52 lx

Luminaires & Lighting Installations

To answer most of the following questions you will need BS7671:2008 +A3 2015 Requirements for Electrical Installations

11) Identify **five** examples of outdoor lighting installations

Answer: Roads; car parks; public gardens; sporting areas; monuments and floodlighting (See 714.1)

12) Give **one** example of *street furniture*

Answer: Bus shelter, or advertising panels, road signs, telephone kiosk (See 714.1)

13) Define the term *'highway power supply'*

Answer: An electrical installation comprising an assembly of associated highway distribution circuits, highway distribution boards and street furniture, supplied from a common origin

14) Identify the type and characteristics of a switch required for the isolation of supplies to high voltage (HV) signs.

Answer: Fire-fighters switch located in the low voltage circuit supplying the high voltage equipment (537-6.1)

15) Define the following terms found in Regulation group (559.3 and 559.4)

- Festoon
- Pelmet
- Track

Answer:

Festoon – a number of lighting points connected to a common flexible cable

Pelmet – luminaire located behind a cover designed to direct the lighting and prevent discomfort glare

Track – a power track system onto which luminaires can be inserted and moved to a desired position

16) State the maximum operating voltage of a standard ceiling rose

Answer: 250V a.c. (559.5.1.201)

17) A device designed to support a pendant luminaire must be capable of carrying a mass of how many kg?

Answer: 5kg (559.5.2)

18) Identify the meaning of lamp-holder references, (B15, B22, E14, E27 and E40),

Answer: B refers to ‘bayonet’; E refers to ‘Edison Screw’, the numbers represent the diameter of the lamp base in mm

19) Define the terms: Luminaire, Ballast and Stroboscopic

Answer: Equipment that distributes, filters or transforms the light transmitted from one or more lamps and which includes all the parts necessary for supporting, fixing or protecting the lamps, but not the lamps themselves, and where necessary, circuit auxiliaries together with the means of connecting them to the supply.

20) Identify the functions of the following component found in a low pressure mercury (MCF), luminaire



Two functions:
i) To provide the initial discharge voltage to start the lamp

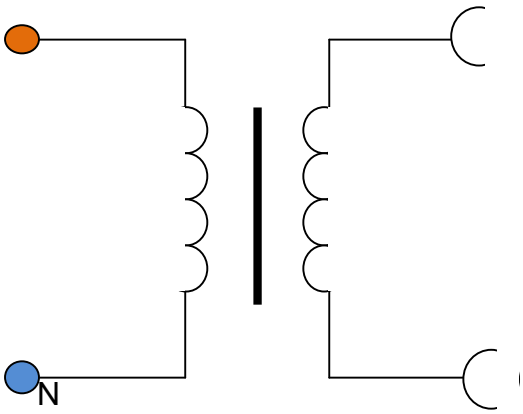
ii) To control the current flowing through the lamp when ON

PAGE 43 – 44: Transformers: (Covering Unit 309 Outcome 5 'Understand the fundamental principles which underpin the relationship between magnetism and electricity' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 or EAL equivalent)

Task 1: Identify the correct name and give **one** example for each of the transformers below:

(A) Equal number of turns each side

L

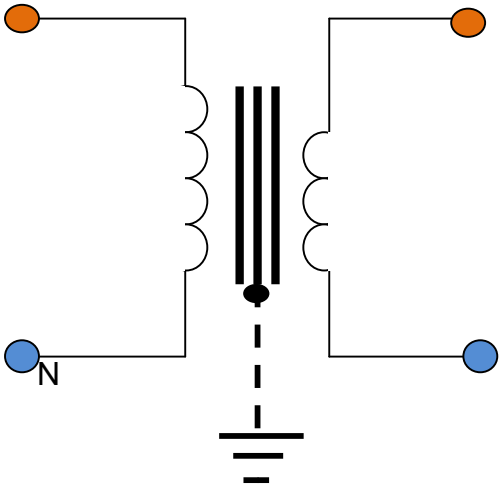


Answer:
Isolating transformer supplying one item of equipment BS EN 61558-2-6

Shaver socket-outlet

(B) Fewer turns on one side and earthed core

L

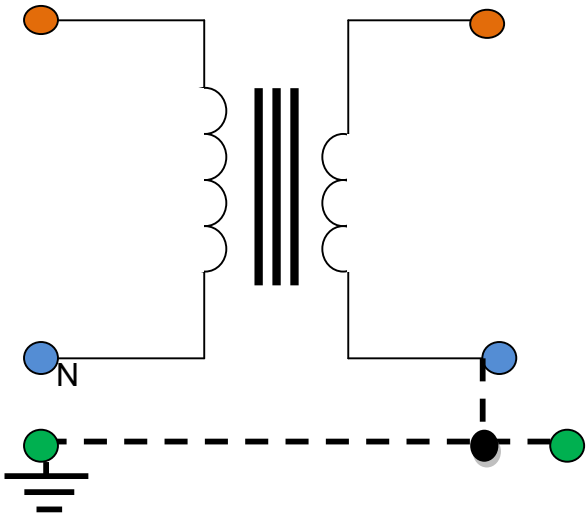


Answer
Safety isolating transformer supplying Separated Extra Low Voltage (SELV) BS EN 61558-2-6

Battery charger (via suitable rectifier unit)

(C) Fewer turns on one side and neutral earthed

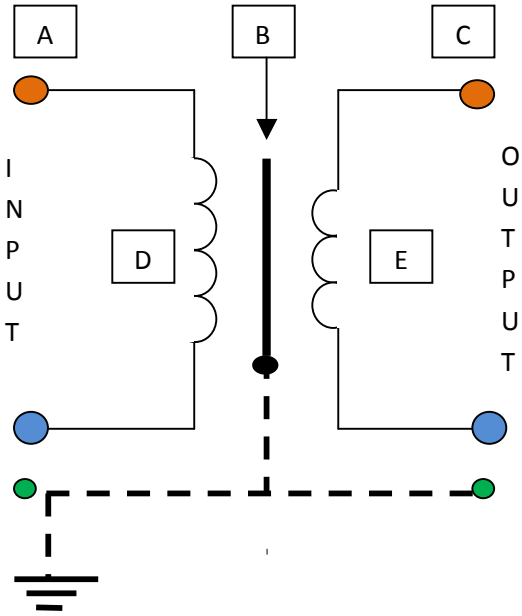
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Answer
Safety isolating transformer supplying Protected extra low voltage (PELV) BS EN 61558-2-6

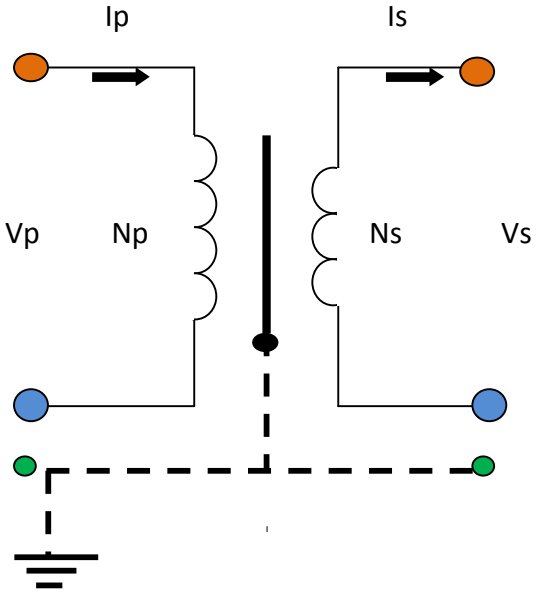
Computer power supply

Task 2: State the correct name of each part shown and identify the material used in its construction



Answer:
A – Primary
B –core, laminated steel
C – Secondary
D – Primary winding, copper wire
E – Secondary winding, copper wire

Task 3: State the 'Transformation Ratio' for the following double-wound transformer



Answer:

$$\frac{Np \times Vp \times Is}{Ns \times Vs \times Ip}$$

Task 4: Produce formulae for each of the following: i) Ns, ii) Vp, iii) Ip

(i) Ns	(ii) Vp	(iii) Ip
$Ns = \frac{Np \times Vs}{Vp}$	$Vp = \frac{Np \times Vs}{Ns}$	$Ip = \frac{Ns \times Is}{Np}$
Or	Or	Or
$Ns = \frac{Np \times Ip}{Is}$	$Vp = \frac{Vs \times Is}{Ip}$	$Ip = \frac{Vs \times Is}{Vp}$