WMS20

Part of Examcraft Group

CONSTRUCTION STUDIES

HIGHER & ORDINARY LEVEL

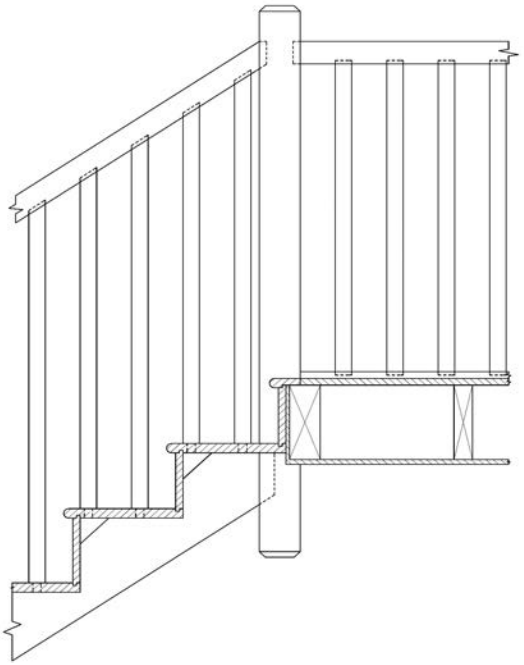
MARKING SCHEME

Pre-Leaving Certificate Examination 2024

Examcraft

HIGHER LEVEL

1. A cut-string wooden stairs leads to the first floor of a house, as shown. The first floor landing has a hardwood tongued and grooved floor, on 200 mm × 45 mm joists with a plasterboard ceiling beneath. The newel post is 100 mm × 100 mm and the rise of a step should not exceed 175 mm.



(a) To a scale of 1:5, draw a vertical section through the centre of the stairs and first floor landing. The section should show the typical construction details through the top **three** steps and the first floor landing, showing the newel post, balusters and handrails. Include the typical dimensions of **three** structural members of the stairs.

***Note**: On your drawing, show a 550 mm length of landing.*

(a) Any 10 X 4 marks (3 for drawing, 1 for annotation)	**40**
3 dimensions 3 x2 marks	**6**
Scale	**4**
Draughting	**4**
(b) One design details 6 marks	**6**
Total	**60**

Cut string stairs – typical detailing

- String 225 mm × 45 mm (or similar)
- Newel post 100 mm × 100 mm
- Thread 300 mm × 25 mm (or similar)
- Riser 175 mm × 18 mm (or similar)
- Balusters 40 mm × 40 mm (or similar)
- Handrail 60 mm × 60 mm (or similar)
- Glue block 75 mm × 75 mm (or similar)

First floor landing – typical detailing

- Trimmer joist 200 mm × 75 mm
- T + G flooring 18 mm
- First floor joists 200 mm × 45 mm
- 12.5 mm Plasterboard.
- Baserail 70mm x 25mm (or similar)

Any other relevant detail

(b) One design detail that ensures the safety of users on the first floor landing.

- Sphere Ø 100 mm not to pass between balusters
- Min. handrail height 900 mm

Any other relevant detail

2. The drawing shows the floor plan and front elevation of a semi-detached bungalow. The internal wall **A-A** is load-bearing. The rear wall of the house is south facing.
The owners intend to modify the internal layout to:
- make it fit for use by a person with limited mobility.

(a) Discuss in detail, **three** design considerations necessary when modifying the internal layout of the house shown to meet the needs of a person with limited mobility.

Three design considerations 18 marks 3x 6 marks	
Design consideration 1 - (3 for point, 3 for discussion)	**6**
Design consideration 2 - (3 for point, 3 for discussion)	**6**
Design consideration 3 - (3 for point, 3 for discussion)	**6**

External / Internal doors
- An unobstructed minimum space of 300 mm on the side next to the leading edge of a single leaf door not currently provided at either entrance doorways
- All internal doors should provide a minimum clear opening width of 800 mm.

Corridors
- The current hallway is too narrow in width to facilitate all people with limited mobility.

Living Room Design
- The room design does not allow for the recommended minimum Ø1500 mm turning circle.

Kitchens
- Access between the table and kitchen units is limited.

Bedroom Design
- Clear turning space is not provided for in the bedroom
- Ideally an en-suite should also be linked to the main bedroom of the house.

Bathroom
- The bathroom is too small to meet the needs of a person with limited mobility – does not meet minimum internal dimensions
- The bathroom does not allow for the recommended minimum Ø1500 mm turning circle
- A bath is not suitable for use by a person with limited mobility.

Any other relevant points

(b) Using notes and freehand sketches, show a revised internal layout that incorporates each of the design considerations you outlined at **2(a)** above.

Revised internal house layout 30 marks	
Revised internal layout	**15**
Note for design Consideration 1	**4**
Note for design Consideration 2	**4**
Note for design Consideration 3	**4**
Note for justification	**3**

External / Internal doors
- The main entrance doorway should provide a minimum clear opening width of not less than 1000 mm.
- A level threshold with no more than a 15 mm upstand.
- Provide a 300 mm clear space on the leading -edge side of the door externally and internally.
- Ensure that the entrance door contrasts visually with the adjacent walls.
- Internal doors should provide a minimum clear opening width of 800 - 850 mm and be hung so that they open against an adjoining wall.
- Doors should open inwards from circulation areas.

Corridors
- Provide an entrance hallway with a space minimum 1500 mm width adjacent to the entrance door.
- Provide a corridor width of 1050 – 1200 mm between walls.
- Provide a 300 mm clear are beside the leading edge of all doors at entrance level.

Living Room Design
- Provide a clear space of Ø1500 – 1800 mm turning circle.
- A clear access route of at least 750 mm wide between items, in front of windows and routes between doors.

Kitchen
- Provide between 1200 – 1500 mm opposite work surfaces of the kitchen.
- A clear turning circle of Ø1500 – 1800 mm should be provided.
- Provide 1200 mm clear space on at least two consecutive sides of the kitchen table.

Bedroom Design
- Provide clear access of 800 mm on both sides and at the end of the double bed.
- Provide a clear space for a turning circle of Ø1500 mm in the double bedroom.
- An en-suite bathroom should be incorporated into the bedroom design where possible.

Bathroom
- The size of bathroom room should be a minimum of 2400 x 2100 mm internal dimensions.
- Provide a turning circle of minimum Ø1500 mm, with a 200 mm overlap of the basin allowed.
- Ensure that the bathroom door opens outwards and against the wall.
- Provide a level access shower area of minimum dimensions 1100 × 1100 mm.
- Clear space of 700 × 1100 mm from any obstruction under the wash basin bowl.
- Centre of the toilet at 400 – 500 mm from a wall.
- Provide a clear access zone of 1100 × 700 mm min. from the front of the toilet.
- Grab rails provided to WC, toilet and shower space.
- Alarm cord / facility.

Any other relevant points

(c) Discuss in detail **two** reasons why provision for lifetime use should be considered in the design of a house.

Two reasons (2 × 6 marks)	
Reason 1 (3 for point, 3 for discussion)	**6**
Reason 2 (3 for point, 3 for discussion)	**6**

- Flexibility and ease of adaptability to meet people's changing needs over time in a cost effective wa.
- Sustainable design to improve comfort and energy efficiency.
- Allows for cradle-to-grave living with minimal interventions.
- Unexpected lifestyle changes may be accommodated with minimum disruption to other inhabitants and with limited increases in associated costs.
- Avoid the need for re-location or costly building works as you or your family's needs change over time.
- Enables the widest possible number of people to participate at home, in society, and to live independently.
- A house is instantly resalable and ready to live in without incurring substantial increased reconstruction costs.
- Integration of smart infrastructure at the outset of home design avoids costly re-fits and also benefits everyone in terms of comfort, efficiency and quality of services.

3. The drawing shows the ground floor plan of a two-storey, semi-detached house and a portion of the rear garden. Also shown is the location of a proposed single-storey space to be built in the rear garden of the house. The internal dimensions of the proposed space are 4.5 m × 3.0 m. The space is to be used as study area by both of the homeowners' teenage children for their exams. The space is to be is structurally connected to the existing house.
The rear wall **A**-**A** of the house is south facing.

(a) Discuss in detail **three** functional requirements of such a space to fulfil the needs of the teenagers.

3 functional requirements 3 X 5 marks 15 marks	
Functional requirement 1 (2 for point, 3 for discussion)	**5**
Functional requirement 2 (2 for point, 3 for discussion)	**5**
Functional requirement 3 (2 for point, 3 for discussion)	**5**

Thermal comfort
- No temperature extremes these make it difficult to concentrate.
- Prevent overheating in the warm weather.

Acoustic comfort
- The space supports solitude quiet, soundproof space provides less distractions.

Visual comfort
- Natural light, daylight maximised. Natural light, daylight has less of an effect on your eyesight than artificial light.

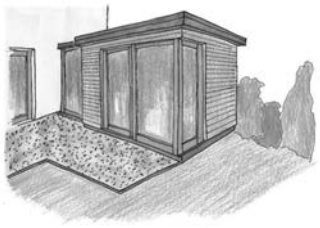
Ergonomic comfort
- Desk, chair, work tops at right height

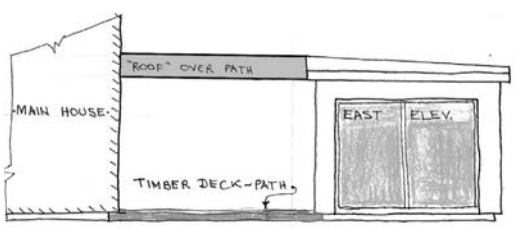
Multi-functional space
- For study and relaxation, can easily be reconfigured.

Connection to existing building
- Required for ease of access in all weather conditions.

(b) Using notes and freehand sketches, show a proposed external design **and** an internal layout for the space that will meet **each** of the requirements outlined at **3(a)** above.

Proposed external and internal layout 30 marks	
External Design	
Notes	**5**
Sketches	**10**
Internal Design	
Notes	**5**
Sketches	**10**





Thermal comfort
- Use materials with a high thermal mass
- South facing glazing for natural heat
- The use of smart glass, overhangs, brise soleil to prevent overheating.
- Ventilation to prevent overheating
- Passive house method of construction
- Heat pump source of heating
- Building insulated to comply with current regulations

Visual comfort
- Maximise the use of daylight
- Large area of high-performance glazing (HPG) on Southern elevation
- Sliding glass high performance door to maximise daylight in the space
- Floor to ceiling glazing unit to maximise solar gain
- Eastern elevation to have large area of H.P. glazing – can be fixed panes or sliding panels
- Study desk located in South-West corner to provide maximum daylight onto desk

Acoustic comfort
- Use triple glazed glazing units to reduce sound from the outside.
- Construct the room use high density materials which reduce sound transmission.
- Use soft furnishings to absorb sound.

Ergonomic comfort
- Work top heights adjustable to suit person.
- Chair adjustable, desk.
- Chair on castors for ease of movement.

Multi-functional space
- Can easily be reconfigured
- Moveable study desks
- Foldable chairs
- Area to listen to music and area for relaxation,
- Bright colours to maximise daylight.

Connection to existing building
- Covered walkway protects from the rain but does not reduce light entering the existing house.

(c) For **each** of the requirements outlined at **3(a)** above, discuss in detail the reasons for your proposed design choices.

Discuss requirements and reasons for design choices	
Functional requirement 1 reason	**5**
Functional requirement 2 reason	**5**
Functional requirement 3 reason	**5**

4. **(a)** Using notes and freehand sketches, discuss the importance of **each** of the following when identifying a suitable site for a new house in a rural landscape:

- characteristics of existing dwellings
- characteristics of the proposed site.

Discussion on site suitability 24 marks (4x6 marks)	
Characteristics of existing dwellings	
Notes	**6**
Sketches	**6**
Characteristics of proposed site	
Notes	**6**
Sketches	**6**

Characteristic of existing dwellings -

- Care should be taken so that scaling and volume is relative to existing dwellings.
- The shape of the proposal should be informed and reflective of the local built vernacular.
- The materials to be used on the new proposal should reflect those of buildings in the local area.
- Natural materials are preferred over synthetic products
- Existing forms simple and geometrically regular, the new design should follow similar patterns.
- How existing dwellings relate to surrounding building should inspire a new development.
- The direction and position of vernacular dwellings in the landscape should inform new builds so that they too can maximise sunlight and shelter.
- Proposals should be sensitive to existing dwellings so as not to invade privacy or overshadow them in size and scale.

Characteristics of proposed site – *such as*

- the layout of the road along the site should inform the positioning of the entrance so that sufficient sightlines can be achieved – safe for vehicular access to main road from site;
- if an existing road is not in contact with the site, the construction of a long driveway will greatly increase costs;
- new proposals should be sensitive to prevent the destruction of existing features, such as stone walls, mature planting, field boundaries;
- existing trees can provide a shelter belt as these have taken up to 100 years to mature;
- the topography of the site should be used as inspiration for the form of a new house;
- existing mounds, slopes, contours on a site should not be removed to facilitate a new proposal but should be used to their potential as a natural shelter or privacy barrier;
- sites on top of hills may not get planning permission as a new proposal may break the skyline;
- the name of an area – often in Irish, may hint towards the previous use of the land and its soil conditions e.g. bog road and may inspire the new house design;
- the orientation and shape of the site will indicate if the new build will maximise solar gain by having a glazed elevation facing south;
- the presence of plants which only grow in wet land may be an indication of poor soil percolation;
- proximity to services such as water, broadband and electricity to the site - the further the distance the greater the costs;
- the presence of rivers, lakes or streams nearby may cause flooding and will inform the siting of the wastewater treatment plant and percolation area.

(b) Shown is an extract from a site location map. **A** and **B** are possible sites for a new house in a rural setting. Select your preferred site **A** or **B** and discuss **three** considerations you took into account when selecting your site.

Selection of preferred site 12 marks (3 x 4marks)	
Consideration 1	**4**
Consideration 2	**4**
Consideration 3	**4**

Why site A may be considered suitable for a new house

- Access can be gained from two site parameter boundaries
- Existing services are in close proximity to the site -neighbouring house already has connections with water, electricity, broadband resulting in cost-effective provision of public services
- Building close to an existing dwelling is favoured by the planning authority
- Reduced distance from leisure facilities, schools and employment
- Site **A** is the smaller site and would result in minimum area for manicured lawns in the countryside
- Less arable land is used as it is a smaller site
- Sufficient space exists to facilitate waste-water treatment and percolation area on the site
- The presence of an existing neighbouring house increases security.

Why site B may be considered suitable for a new house

- Less noise pollution as the site is located away from the main road.
- No existing houses in close proximity overlooking the property.
- Greater privacy as it is not adjacent to the main road.
- The lane leading to the site joins the main road on a straight point so clear sight lines can be obtained which increase safety when entering or exiting the site.
- Existing natural hedgerow boundary so minimal environmental visual impact.
- Existing tall vegetation can act as solar shading and increase privacy.
- Unobstructed views of the lake and forest so enhance health and wellbeing of the occupants.

(c) Draw a well-proportioned sketch of your selected site and the immediate boundaries.
On your sketch, show a preferred:

- location and orientation of a house on the site
- layout of the road entrance and the driveway to the house.

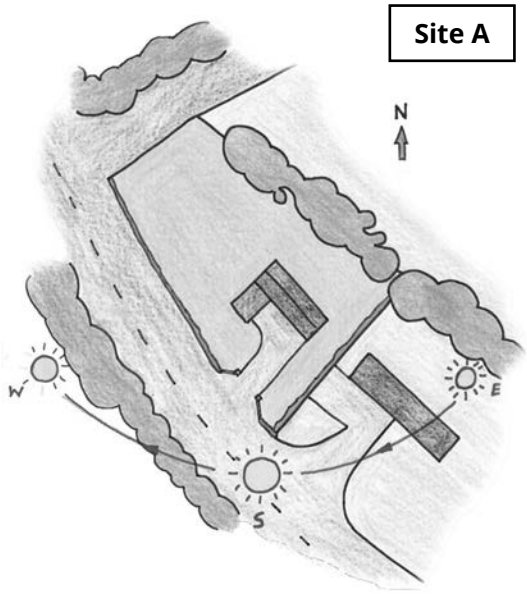
For **each** of the above, justify your design choices.

Sketch site 24 marks (6 x 4 Marks)	
Sketch of selected site	**4**
House location	**4**
Orientation	**4**
Road entrance	**4**
Driveway	**4**
Justification	**4**

House location and orientation

- The design / form of the building maximises solar gains by having the largest external perimeter facing south.
- Building's proximity to the road where services are normally located.
- The building is set back from the road to reduce the environmental impact on the landscape.
- House placed for greater privacy
- The built form and its positioning is inspired by local existing vernacular architectural characteristics.
- Maximum daylight penetration to the living areas/spaces which ideally should be located on the Southern elevation (Single room depth).
- Enabling maximum solar gain and daylight into the living spaces reduces the need for unnecessary heating and lighting.

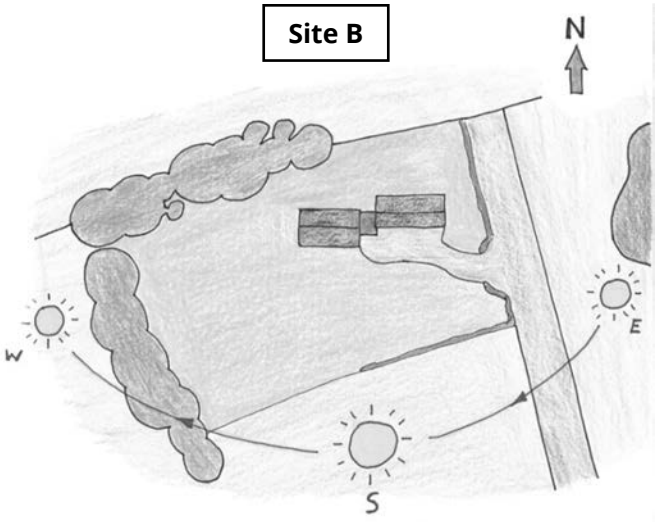
Site A



Road entrance and driveway

- Short driveway resulting in minimal hard surfaces and less strain on existing surface water disposal systems.
- Facilitates the planting of vegetation to help integrate the house into the landscape and increase privacy.
- Enables the driver to clearly see oncoming traffic from both sides
- Is set back – 5 metres - so that a car waiting to enter closed gates is not obstructing traffic.
- Sidewalls splayed at 45° for clear vision.
- Meets the criteria set out by the local authority – in design and measurements.

Site B



5. (a) Calculation of the U-value of the wall

30 marks	
8 resistances 8x3 marks each	**24**
Total resistance	**3**
U- value	**3**

Material Element	Thickness	Conductivity	Resistivity	Resistance
External Surface				0.0480
External render	0.02	0.4608	2.17	0.0434
External blockwork	0.1	1.44	0.6944	0.0694
Cavity	0.04			0.1700
Insulation	0.06	0.037	27.027	1.6216
Internal block work	0.1	1.44	0.6944	0.0694
Internal plaster	0.013	0.16	6.25	0.0813
Internal surface				0.1220
Total resistance =				2.2252

U- value = 1/ Total resistance =1/2.2252= 0.4494W/ m^2 ^{0}C

(b) Cost of heat lost annually through the floor

15 marks (5 x 3)	
Heat Loss	**3**
Heating period	**3**
Kilo joules	**3**
Litres of oil	**3**
Cost of oil	**3**

- Heat lost
  Heat loss formula: = U -Value × area × temp. diff
  0.4494 × 115 × (21 – 4)
  0.4494 × 115× 17= 878.5770 Watts (Joules / sec)

- Heating period p/a:
  60 × 60 × 8 × 7 × 35 = 7,056,000 seconds

- Kilo joules p/a:
  7,056,000 × 878.5770 = 6,199,239,312 kJ/sec

- Litres p/a: (Note: Calorific value of 1 litre oil = 37350 kJ)
  6,199,239,312/ (37350 x 1000) = 165.97 litres of oil

- Cost p/a: (Note: 1 litre of oil costs €1.54)
  165.97 × 1.15 = €190.87

Cost of heat loss annually through floor = €190.87

(c) Thickness of insulation

Required thickness of insulation for U-value of 0.12 W/m2 °c (5 x3 marks)	
Resistance for U- value for 0.12 W/m2 °c (using R=1/U)	**3**
Resistance from calculated U-value from part (a)	**3**
Difference in resistances (required resistance)	**3**
Application of formula R = T/k	**3**
Required thickness of insulation in mm.	**3**

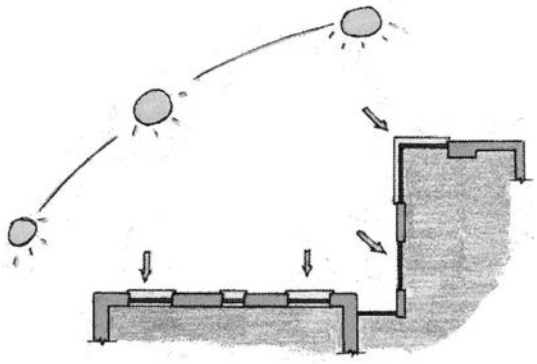
New desired U-value **=** 0.12 W/ m^2 ^{0}C
Resistance =1/0.12 = 8.3333
Required resistance of expanded polystyrene = new resistance – old resistance
= 8.3333 – 2.2252
= 6.1082

Material Element	Thickness	Conductivity	Resistivity	Resistance
Expanded Polystyrene	0.189	0.031	32.258	6.1082

Thickness = Conductivity × Resistance
Or
Thickness = Resistance/Resistivity
Thickness of expanded polystyrene 189 mm

6. **(a)** With reference to the design shown, discuss using notes and freehand sketches, three features of the design that contributes to the house having a low environmental impact.

30 marks	
Design feature 1	**Note 5**
	Sketch 5
Design feature 2	**Note 5**
	Sketch 5
Design feature 3	**Note 5**
	Sketch 5



- Larger windows facing south capturing the sun's heat and light therefore reducing heating and lighting costs.
- Retaining the existing cottage instead of replacing it with a new one, means that the embodied energy and carbon required to construct a new house are avoided.
- More sustainable to enhance the energy efficiency of the existing cottage through retrofitting.
- Reduced heat loss by maintaining smaller windows to the north face of the building.
- Low embodied energy construction materials used for the extension – timber frame.
- Simple building form – one room deep.
- Building envelope area minimised to reduce energy loss through external walls.
- High levels of insulation added to the existing cottage and used in the wall construction of
- the extension.
- Attic space is utilised as additional living spaces without having to use carbon negative building
- materials and increased the building form.
- Wood burning stove set into the fireplace to reduce draughts and heat loss through the chimney.
- Utilise thermal mass of existing chimney stack.

(b) Discuss in detail, using notes and freehand sketches, two modifications to the house shown that would further reduce the environmental impact of the house.

Justify your design choices.

18 marks	
Modification 1	**Note 3**
	Sketch 3
Modification 2	**Note 3**
	Sketch 3
Justification 1	**3**
Justification 2	**3**

Provide a draught lobby

- Create a porch/draught lobby inside the entrance of the house.
- Minimise air movement when opening external door
- To reduce the need to heat large areas
- Add door going down the hallway and a glazed partition with a door into the dining area.

Planting trees

- Plant trees due south to reduce overheating and glare in summer months
- Natural solar shading technique

Construct solar shading
- Incorporate built solar shading techniques to prevent glare and overheating from the sun during summer months when the sun is at a higher angle in the sky.
- Examples of these include: brise soleil, balconies, extended roof overhand, vertical pivot brise soleil, shutters, blinds, etc.

Install evacuated tube / solar panel
- Installed closest to south-facing aspect for domestic hot water heating.
- Efficient method of heating hot water for domestic use by using the power of the sun.
- To reduce the dependency on mains electricity and carbon footprint.

Install photovoltaic (PV) panels
- The use of photovoltaic panels reduces the dependency on electricity mains supply Therefore reducing carbon emissions.
- Installed on the southern aspect of the house – roof surface.
- To reduce running costs

Install a wind turbine
- Install a wind turbine(s) and associated equipment to take advantage of local wind speed to generate an off-grid supply for the home.
- Reduces the need for electricity from the national grid therefore reducing the demand on non-renewable methods of energy production which are harmful to the environment.

Install rainwater harvesting system
- collect rainwater from roof surfaces to be reused in house.
- Install a water collection tank below ground level to collect storm water for reuse in toilets and other appliances in the home.
- Individual collectors under each down pipe outside could be an alternative method with similar benefits.

Change chimney location
- Relocate the position of the chimney and stove.
- Centralise the location of the chimney stack so heat is radiated internally on all four sides.
- Maximising the thermal mass within the fabric of the house.

(c) Discuss in detail two advantages of designing a house that will enhance the health and wellbeing of the occupants.

2 advantages (2 x 6 marks)	
Advantage 1 (3 for point, 3 for discussion)	**6**
Advantage 2 (3 for point, 3 for discussion)	**6**

Advantages:
- The design of a house has a huge impact on the mental health and wellbeing of the occupants.
- Reduces stress levels for occupants of the house
- Provides a calm, secure, private space for occupants – better for health and wellbeing.
- Adequate natural light encourages occupants to appreciate nature - improved wellbeing.
- Natural light enhances occupants comfort level and enables a positive mental attitude.
- Natural light enhances colour definition and seasonal changes perceptible.
- Plentiful fresh air invigorates occupants - good for health and wellbeing.
- Being surrounded by nature reduces stress and improves mental health - connect the indoor and outdoor spaces with large glazing and opening doors out to the garden.
- Opening windows so the sound of nature can be heard inside calms the occupants.
- Using materials that are locally sources helps to link the occupants with their community giving them a sense of place and belonging.
- Designing a space with good air and thermal quality can be both comforting and refreshing
- Improves and encourages sound sleeping - essential for rest and wellbeing.
- Combinations of biophilic design, natural light and sound proofing will lead to improved wellbeing.

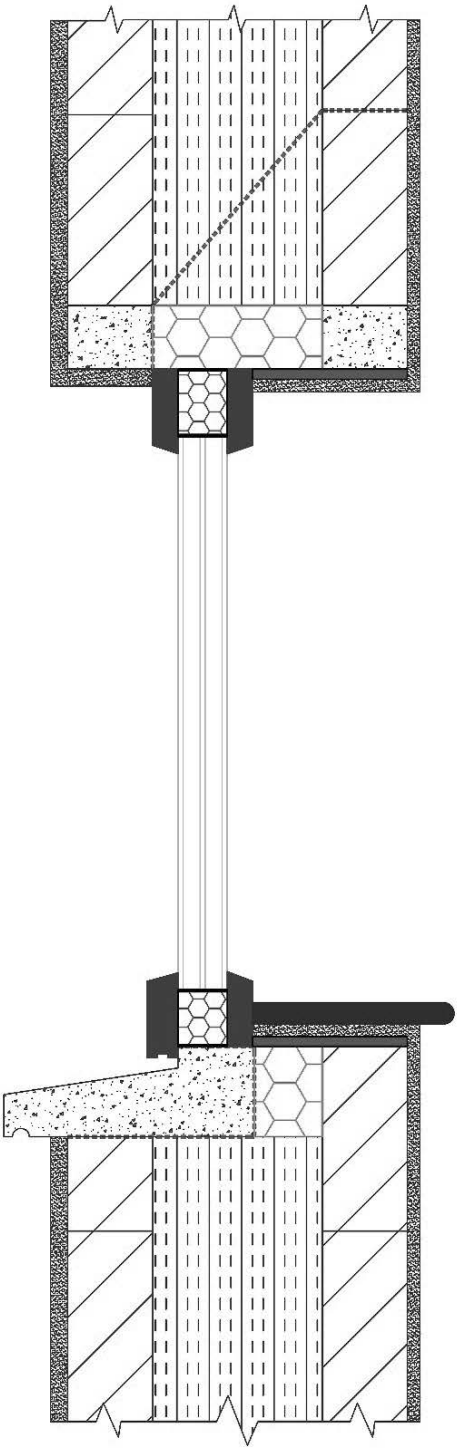
7. The sketch shows a wooden casement window fitted in the external wall of a dwelling house. The window, which is 800 mm in height, is a triple glazed, high performance window with a thermally broken insulated frame. The external wall is a 400 mm concrete block wall with a 200 mm full-fill insulated cavity. The wall has an external render and an internal plaster skim finish.

(a) To a scale of 1:5, draw a vertical section through the wall and the centre of the window. The section should show the typical construction details from 300 mm below the window cill, through the fixed frame of the window, to a level 300 mm above the window head.
Include **three** typical dimensions on your drawing.

(b) Indicate clearly on your drawing the typical design detailing to prevent the ingress of water at **both** the window head and cill.

(a)	
Any 8 x5 marks	**40**
3 typical Dimensions	**6**
Scale	**4**
Draughting	**4**
(b)	
DPC cill detail	**3**
DPC head detail	**3**

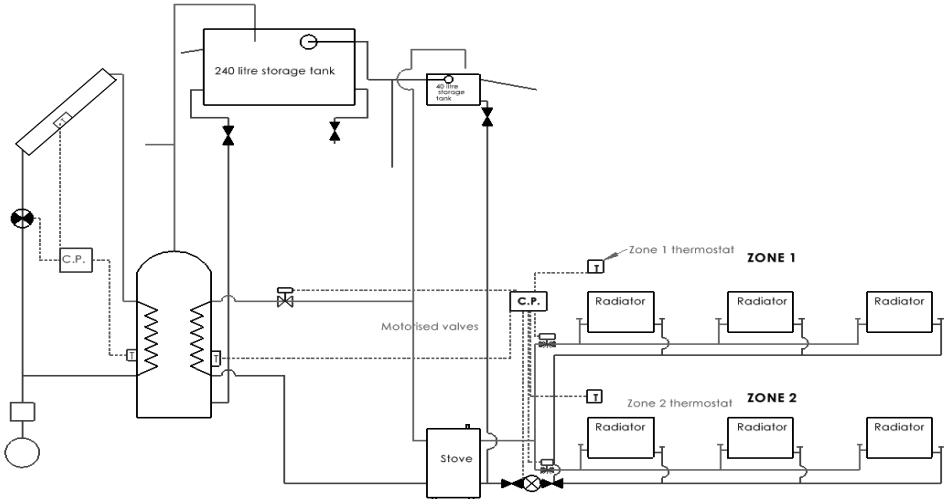
- External & internal leaf
- External & internal plaster
- 200 mm full-fill cavity insulation
- Lintels
- Cavity closer
- Airtightness tape
- Thermally broken window frame –
  (No thermal break - max 2 marks)
- Triple glazing
- Window cill
- Window board
- Insulation behind cill



8. A wood-burning stove combined with a solar collector is to provide central heating and hot water for a three bedroom, two-storey dwelling house.

(a) Using notes and a single-line diagram, show a typical design layout for both the heating system **and** the hot water system. Show **two** independently controlled heating zones, one on each floor, and include **three** radiators on each floor. Indicate the location of the control valves and give the typical sizes of the pipework.

Zoned heating system with solar panel	
Any 8 x 4 marks (Sketch 3, notes 1)	**32**
Size of pipes any 2 x 2 marks	**4**
Any 2 control valves 2 x 2 marks	**4**



(b) Discuss in detail **two** considerations when installing a solar collector for heating domestic hot water.

3 considerations 10 marks (2 x 5 marks)	
Consideration 1 (2 for point, 3 for discussion)	**5**
Consideration 2 (2 for point, 3 for discussion)	**5**

Considerations:

- The optimum location for solar collectors for all year-round energy collection is south facing and atan angle of 30º - 45º to the horizontal.
- Collectors are positioned so there are no shadows on them during the middle of the day – from trees, chimneys, part of the building or adjacent buildings.
- The solar collector should be ideally located on a roof surface – orientated south
- Is roof area large enough to install the solar collector pane.
- The roof will require additional work to install the collector brackets and fittings – additional expense.
- An appropriately sized cylinder should be chosen for the household hot water requirements
- The volume of your solar hot water cylinder is related to the maximum cylinder temperature
- Position of the hot water cylinder in relation to the solar collector – pipework should kept as short as possible to reduce heat loss.
- The solar collector area should meet the hot water needs of the household.
- The installation may require a planning application to the local county council – check with planning department.
- The cost of purchase and installation of the solar collector – could be substantial.
- SEAI grant application to offset the costs of purchase and installation.

(c) Discuss **two** advantages of installing an Air-to-Water heat pump system in the house as an alternative to the stove.

2 advantages of an air to water heat pump 10 marks (2 x 5 marks)	
Advantage 1 (2 for point, 3 for discussion)	**5**
Advantage 2 (2 for point, 3 for discussion)	**5**

Advantages:

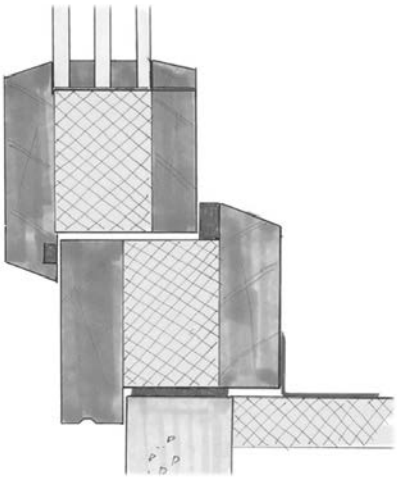
- Reduces the heating cost and increase energy efficiency heating a house.
- Easy installation and low maintenance.
- Heat pumps reduces the operational carbon emissions of a house.
- Reduces the burning of fossil fuels to heat a house.
- Heat pumps are environmentally friendly reducing harmful particulate and carbon dioxide emissions by over 60% - 80%.
- The installation of a domestic heat pumps is eligible for SEAI grants for homeowners.
- Low noise emissions and reduced heating time.
- Air-to-water heat pumps do not produce carbon emissions when operating.

9. The owners have decided to convert an upstairs room into a family entertainment room. They are concerned that the sound from this room will be heard in the adjoining rooms upstairs and in the kitchen beneath.

(a) Discuss in detail, using notes and freehand sketches, how **each** of the following contribute to reducing the transmission of sound in a dwelling house:
- completeness
- flexibility
- isolation.

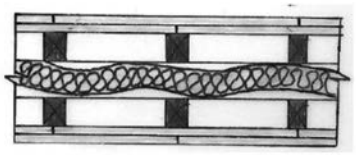
Completeness	**Note 4**
	Sketch 4
Flexibility	**Note 4**
	Sketch 4
Isolation	**Note 4**
	Sketch 4

Completeness



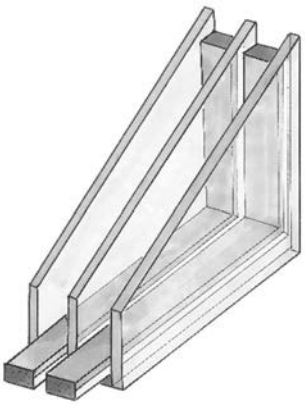
- Completeness is the elimination of all small gaps in the house structure, which increases its airtightness and uniformity
- Completeness of the structure depends on airtightness and uniformity:
- Blockwork joints to be filled and wall plastered on both sides
- Airtight membrane correctly installed throughout the house
- Window systems, doors and pipework carefully sealed at external junctions
- All window systems and external door designed with double seals installed
- High quality craftsmanship required to achieve a more complete (sealed and uniform) structure which will contribute to the overall acoustic properties of the house.

Flexibility



- Flexible materials are good at absorbing sound transmissions in a structure.
- The installation of an absorbent material (quilt, acoustic matting, resilient layer) in a structure will greatly reduce the transmission of sound through that structure.
- Quilt insulation between studs in a double stud partition.
- Quilt insulation between joist in an upper timber floor.
- Acoustic matting in an upper timber floor.

Isolation



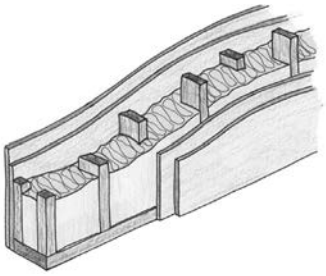
- As sound energy transmits through the different materials in a structure it decreases – sound level drops.
- Separating elements of a structure greatly reduces the transmission sound through it.
- Discontinuing a structural element is effective in reducing sound transmission:
- Double / triple glazing when sound travels from glass to gas / vacuum
- Separation in walls e.g. double stud partition.
- Advantage can be taken of isolation to improve sound insulation.

(b) The partitions are of standard timber stud construction and the first floor is a softwood floor on timber joists, with a plasterboard ceiling beneath. The partitions and the floor are to be upgraded to reduce the transmission of sound from the entertainment room.
Using notes and freehand sketches show a revised design detailing that will reduce the transmission of sound through the stud partition **and** the existing first floor.
Specify the materials to be used and give their typical dimensions.

Stud Partition

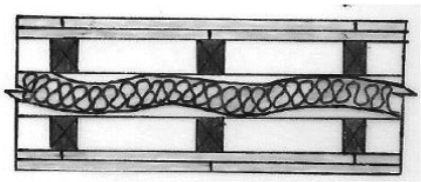
- Construct a staggered double stud partition wall with the studs staggered each side.
- An absorbent quilt is woven between the studs to absorb airborne sound - flexibility.
- Two layers of plasterboard with staggered joints is fixed on each side to reduce the transmittance of sound – this increases the mass of the wall.
- All electrical fittings in the wall are sealed and made airtight.
- The stud wall is sealed to adjoining walls, floor and ceiling – completeness.

Stud partition	**Note 5**
	Sketch 5
	Typical dimensions 2
	Materials 2



Alternative

- Construct two separate stud walls in which there is no material in contact – isolation.
- An absorbent quilt is placed between the stud wall in the cavity – flexibility.

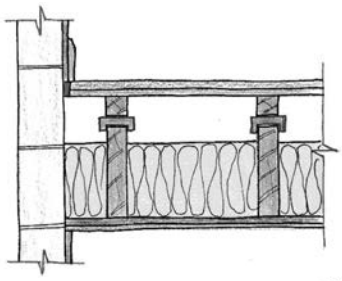


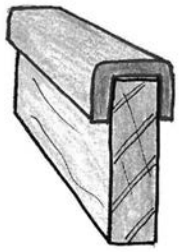
First Floor

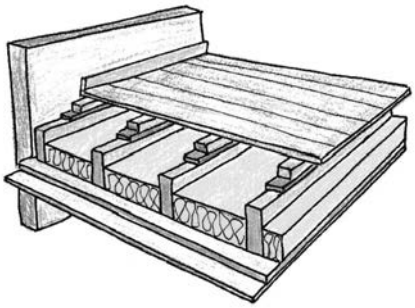
Acoustic isolation strips are placed over the flooring joists

- The flooring is fixed to battens floated over the acoustic strips.
- The flooring above and plasterboard below are sealed and made airtight.
- Acoustic matting is placed under the finished floating floor above to reduce the transmission of impact sound.
- Absorbent quilt is placed between the flooring joists to absorb airborne sound transmission– flexibility.
- Two layers of plasterboard with staggered joints are fixed on each side for the ceiling – this increases the mass of the wall.

Floor	**Note 5**
	Sketch 5
	Typical dimensions 2
	Materials 2

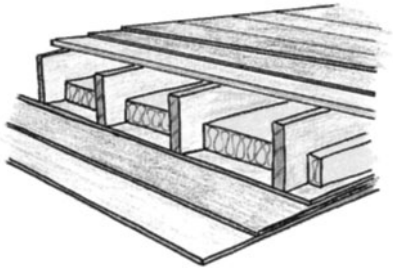






Alternative

- Acoustic matting is placed:
- between the upper decking and floating floor.
- between the two plasterboard slabs in the ceiling beneath



(c) Discuss **two** benefits that the sound insulation upgrades will have on the health and wellbeing of the occupants.

Impact 1	**Point 2**
	Discussion 2
Impact 2	**Point 2**
	Discussion 2

- Enhance the quality of life by reducing the noise levels in the house, reducing stress and anger in the household.
- Members of the family can participate in noise activities without disturbing other family members daily activities.
- Enhances the sleep quality of the family members
- Creates more harmonious environment in the household, where members can individually participate in activities.
- Avoid hearing loss problem, where noisy activities can be confined to one area in the house.

10. **(a)** Using notes and freehand sketches, discuss in detail the importance of any **two** of the following in the design of a Passive House:

- airtight building envelope
- space heating demand
- indoor air quality.

Any 2 terms, 32 marks (2 x 16 marks)	
Airtight building envelope	
Space heating demand	
Indoor air quality	
Note 8 marks & Sketch 8 marks	**16**
Note 8 marks & Sketch 8 marks	**16**

Airtight building envelope

- build tight and ventilate right
- airtightness prevents unregulated air leakage and unregulated air infiltration
- an airtight building envelope enables control of fresh air intake into a building
- airtight building envelope ensures no unregulated heat loss through building fabric, especially at junctions
- pen on section line - see continuous red line in sketch to indicate unbroken airtight barrier
- wall and floor junctions, wall and window junctions, wall and door junctions, ceiling and wall junctions, chimney and ceiling junctions
- air leakage is prevented by providing unbroken air barrier membrane on the warm side of the insulation and by taping of all junctions
- continuous airtight seal around the internal fabric of the external envelop eliminates draughts
- proprietary tapes to tape concrete to concrete, plasterboard to concrete, concrete to wood
- proprietary mastics to seal skirting to wall and floor, window boards to wall and window frame
- continuous gypsum skim coat, with scrim reinforcing at joints and junctions acts as an airtight layer
- intelligent barriers allow vapour diffusion when required
- airtight vapour barrier on warm side of insulation ensures interstitial condensation is reduced
- vapour barrier should be continuous and not be punctured
- a small tear in vapour barrier renders it ineffective
- winter – diffusion tight; summer diffusion open
- grommets used to seal around pipes and cables passing through vapour barrier
- best practice - service cavity eliminates risk of puncture of vapour barrier by services
- blower door test used to determine effectiveness of air tightness barrier.

Space heating demand A Passive House must meet **three** criteria for energy performance:

- **space heating demand** is the energy required to maintain an indoor temperature of 20°C all year round.
- **space heating** refers to the heating of the indoor spaces. It does not include hot water heating or other energy needs space heating demand for a Passive House is specified at ≤ 15 kWh/m^2 /a
- **heating load** is the energy required to maintain an indoor temperature of 20°C on a given day - the heating load must not exceed the amount of heat that can be supplied to the house via the fresh air required for good indoor air quality
- **heating load** is specified at ≤ 10 W/m^2

- The **primary energy demand** is the total energy consumed for all requirements (i.e. space heating, water heating, ventilation and electricity).
- primary energy is the energy required to deliver usable energy to the home - this includes the energy consumed during extraction, conversion, transport and so on
- in Ireland the primary energy conversion factor for electricity is currently 2.58. This means that for every unit of electrical energy consumed in the home, 2.58 units of energy have to be produced
- **primary energy demand** is specified at ≤ 120 kWh/m^2/a, however many Passive Houses exceed this and would achieve a primary energy demand of between 60 to 70kWh/m2/a.
- **primary energy demand** is specified at ≤ 120kWh/m^2a.

Indoor air quality

- Most life spent indoors – indoor air quality and healthy indoor environment most important.
- Space, warmth, light and air all affect the internal environment of a dwelling.
- Thermal comfort is the expression of satisfaction with surroundings – too hot, too cold or just right.
- Thermal comfort also influenced by humidity, draughts, temperature of surrounding surfaces, each individual's metabolic rate, clothing, etc.
- Increased levels of airtightness require careful design of ventilation system to ensure continuous supply of clean, warm, filtered, fresh air.
- Properly designed ventilation systems limit humidity and prevent mould growth and the build-up of pollutants through extraction.
- In Passive House this is achieved with Mechanical Heat Recovery with Ventilation (MHRV) system – ducted and ductless systems now available.
- MHRV unit, as shown, provides whole house ventilation and a regular controlled supply of fresh, cleaned air to all rooms.
- Warm moist air "extract air" is mechanically extracted from kitchen, utility room, bathrooms and toilets.
- Outdoor air passes through a fine filter in the heat exchange unit to ensure dust, pollen and other contaminants are removed from the air - this ensures clean, fresh air to all the house.
- In the MHRV unit, the 'extract air' and the 'outdoor air' do not mix - instead, they pass through a heat exchange unit. This unit is made up of a number of very thin metal or plastic plates. The heat in the extract air heats one side of each plate. The outdoor air passes on the other side of the plate and absorbs this heat energy. The outdoor air is now warm and filtered and is now called 'supply air'. The 'supply air' is pumped to the living spaces ('supply zones').
- MHRV system designed to provide minimum air temperature at 16.5° when outdoors at -10°
- During cold weather a post heater is used to raise the temperature of the incoming air to ensure a constant comfortable temperature of 20°C is maintained in the home at all times
- During warm weather a 'summer bypass' is used to bypass the heat exchanger so the supply air does not cause overheating.
- MHRV designed for maximum of 0.6 air changes per hour (ach/hr).
- Insulated ducting prevents condensation and mould growth in the ducts.
- Windows can be opened in summer for fresh air and to cool the house if overheating.
- Passive House designed to have indoor temperature at 20° throughout year.
- Filters in MHRV should be changed every three to six months to ensure air is properly cleaned.
- Relative humidity of the indoor air should be in the range 30% to 60% - within this range the benefits of water vapour in air are optimised.
- Filtered air prevents and the growth of mould, dust mites and other viruses and bacteria, reducing respiratory illnesses

- Internal CO_2 levels ideally less than 1000 ppm (parts per million)
- To prevent condensation and mould growth the temperature of internal surfaces (e.g. walls, ceilings, windows) should not fall below 12.6°C
- Inspect fuel-burning appliances regularly by professional for leaks and make repairs when necessary.
- Install a carbon monoxide alarms and test for radon gas
- Houseplants, such as the Spider plant - *Chlorophytum comosum* – shown, absorb some airborne contaminants, together with the medium in which they are grown, and reduce indoor air pollution, particularly volatile organic compounds (VOC) such as benzene, toluene, and xylene
- Plants remove CO_2 and release oxygen and water, although the quantitative impact for house plants on indoor air quality is relatively small

Performance criteria of MHRV system - three main requirements:

- 30m^3/hour/person of fresh air must be supplied.

Extract requirement:

- kitchen 60m^3/hour
- bathroom 40m^3/hour
- toilet/ store/ utility/ en-suite 20m^3/hour

Air change requirement:

- the system must be balanced for the entire dwelling to ensure that a minimum air change rate of 0.3 air changes per hour (ac/h) is achieved, with maximum of 0.6 ac/h.

(b) Using notes and freehand sketches, discuss the importance of thermal mass in the design of a Passive House.

Thermal Mass 14 marks	
Notes	**7**
Sketches	**7**

Thermal Mass

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- Plants remove CO_2 and release oxygen and water, although the quantitative impact for house plants on indoor air quality is relatively small.

(c) Using notes and freehand sketches, discuss the function of carefully designed solar shading for the Passive House shown.

Design details for solar shading 14 marks	
Notes	**7**
Sketches	**7**

Importance of carefully designed solar shading in Passive House design
- Carefully designed solar shading filters the direct rays of the sun and helps prevent overheating and glare.
- Overheating occurs in Passive design if internal temperature greater than 25° for 36 days (10%) days annually.

Solar shading Extended roof overhang
- An overhang / extended eaves / to reduce the solar heat gain in summer.
- The angle of the sun is higher during the summer than it is during the winter.
- With a correctly designed overhang, direct solar heat and glare is reduced.

Brise Soleil
- This works on the same principal as the overhang and is used to reduce the amount of summer sun entering a building.

Vertical pivot *brise soleil*
- Pivot shading can be adjusted to suit the weather conditions at a particular time.
- External roller blinds, awnings and sliding screens can also be used.

Balconies
- Balconies must be designed and sized to filter the light and reduce overheating – avoid thermal bridge.

Blinds, shutters, curtains
- Not as effective, but assist in reducing overheating.

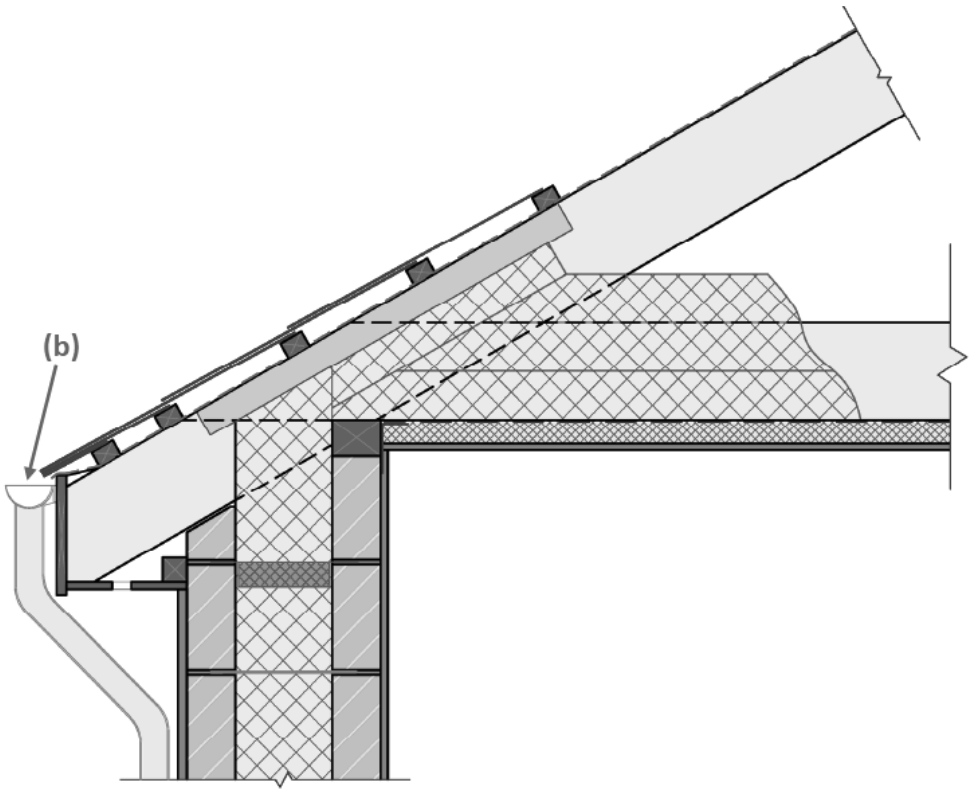
Alternative 10

Discuss the above statement in detail and outline how advances in glazing technology have led to the increased use of glass in house design.
Recommend **three** best practice guidelines that would encourage better use of natural light in the design of contemporary dwelling houses.

(a) Discussion of Statement (3 × 10 marks)	
Discussion Point 1 (3 for point, 5 for discussion)	**8**
Discussion Point 2 (3 for point, 5 for discussion)	**8**
Discussion Point 3 (3 for point, 5 for discussion)	**8**
Advances in glazing technologies	**6**
(b) Three best practice guidelines for repurposing an area in your home (3 × 10 marks)	
Guideline 1 (4 for point, 6 for discussion)	**10**
Guideline 2 1(4 for point, 6 for discussion)	**10**
Guideline 3 1 (4 for point, 6 for discussion)	**10**

ORDINARY LEVEL

1.



Specification – typical detail

- Slates
- Battens 50 mm × 30 mm
- Breather membrane
- Rafters 200 mm
- Ceiling joist
- Tilting fillet
- Fascia
- Soffit
- Ventilation
- Insulated plaster board, skim coat
- Attic insulation
- Airtight tape
- Wallplate
- 13 mm internal plaster
- Concrete block inner leaf 100 mm
- Cavity closer
- Wall tie
- Full fill insulated cavity
- Concrete block outer leaf 100 mm
- 19 mm external render.

N.B. Any alternative detailing which complies with current Building Regulations is acceptable.

Question 1 50 marks	
Part a	
Any 7 x 5	**35**
3 Typical dimensions	**4**
Draughting and accuracy 8,6,4	**8**
Part (b)	
Eaves gutter/ downpipe	**3**

(b) On your drawing show how rainwater runoff is removed at the eaves.

Eaves gutter / downpipe.

2. The sketch shows the uninsulated attic space of a dwelling house. The homeowners wish to add insulation to the roof at ceiling joist level and around water storage tank. The ceiling joists are 200 mm × 40 mm.

(a) Using notes and freehand sketches, show **one** suitable method of insulating the roof at ceiling joist level. Specify the type and thickness of insulation.

One suitable method of insulating the roof at ceiling joist level.

- The insulation roll is cut to the width between the ceiling joists
- The insulation roll is unrolled and tightly packed between the ceiling joists above the plasterboard
- Additional layers of insulation are positioned above the bottom layer in a crossed format.

Part (a) 22marks	
Method of insulating attic	
Note	**7**
Sketch	**7**
Preferred insulation type for attic	**4**
Thickness of insulation	**4**

Type of insulation

- Fibreglass insulation
- Blow in Cellulose
- Spray-foam insulation
- Hemp insulation

Thickness of insulation

- 300 mm insulation thickness minimum.

(b) The water storage tank and pipework in the attic are also to be insulated. On a separate sketch show, using notes and freehand sketches, how the water tank and pipework could be insulated.

Water tank

- Attic insulation at roof level is not placed under the water tank to allow heat to rise and prevent the tank from freezing during cold weather.
- Insulation is cut to size and positioned at the sides and the top of the water tank.

Part (b) 18 marks	
Method to insulating water tank	
Note	**5**
Sketch	**4**
Method of insulating pipework	
Note	**5**
Sketch	**4**

Pipework

- Polyethylene foam tubes are placed around all pipework in the attic.
- Duct tape is used to join two foam tubes together where they meet.
- Reflective pipe lagging insulation can also be used to surround all pipework.

(c) Discuss **two** advantages of highly insulating the attic space of a house.

Reduced heat loss

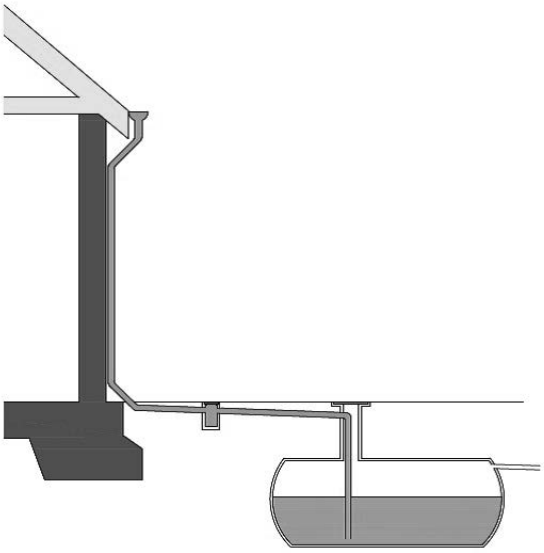
- Reduced energy bills
- Increased thermal comfort
- Improves the building energy rating (BER)
- Better for the environment

Part (c) 10 marks	
Advantage 1	**5**
Advantage 2	**5**

3. Rainwater can be collected from the roof, stored and reused in a dwelling house.

(a) Draw a large freehand sketch of the given house and underground storage tank. On your sketch show the pipework necessary to collect the rainwater from the roof and carry it to the underground tank.

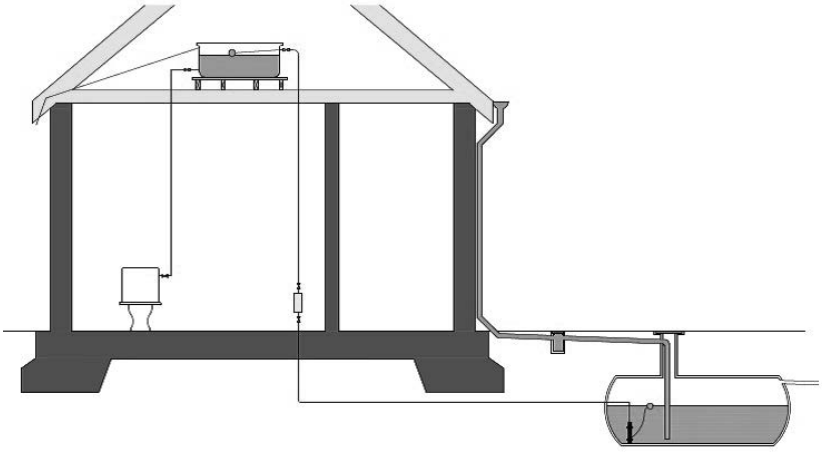
Part (a) 16 marks	
Sketch	**4**
Pipework to collect water from roof	**4**
Pipework from roof to storage tank	**4**
Filters and overflow pipe	**4**



Typical details:
- 125 mm eaves gutter
- 65 mm downpipe
- 100 mm underground pipe to storage tank
- Debris filter
- Underground water storage tank
- Overflow pipe**.**

(b) The stored rainwater is used for flushing toilets. On the sketch, show the pipework necessary to take rainwater from the underground tank to the storage tank in the attic. Show the pipework necessary to connect the toilet cistern to the storage tank in the attic.
Include all necessary pumps and valves.

Part (b) 28 marks	
Any 6 x 4 marks	**24**
Quality of sketch	**4**



Typical details:
- Submersible pump in water storage tank
- 12 mm pipe from storage tank to filter
- In line filter
- 230 litre attic storage tank
- Overflow pipe
- Ball valve
- 12 mm feed to toilet cistern.
- Toilet
- All necessary valves**.**

(c) Discuss **one** advantage of reusing rainwater in a dwelling house.

Part (c) 6 marks	
Advantage	**6**

- Sustainable living
- Reduces flooding around property
- Reduce the cost of water treatment due to reduced usage.

4. The sketch shows one corner of a strip foundation for the external wall of a dwelling house. The external wall is to be a 400 mm concrete block wall with a full-fill insulated cavity.

(a) Discuss **one** environmental reason why a strip foundation is considered the most suitable foundation for this house.

Part (a) 10 marks	
Valid detail one	**5**
Valid detail two	**5**

The foundation uses minimum ground area

- Minimum excavation needed
- Less machinery used. Less fuel used
- Minimum amount of concrete, aggregate and steel used.
- The strip foundation is widely used
- Easy to set out
- This form of foundation has proved successful over many years.
- Relatively easily constructed
- Easily filled and levelled
- This contributes to making trip foundations easy on the environment.

(b) Using notes and freehand sketches describe how to set out the foundation trench under the following headings:

- profiles
- width and depth of trench
- position of wall on strip foundation.

Part (b) 30 marks	
Profiles	
Note	**5**
Sketch	**5**
Width and depth of trench	
Note	**5**
Sketch	**5**
Position of wall on strip foundation	
Note	**5**
Sketch	**5**

Profiles

- Profiles consist of two upright members with a horizontal cross rail.
- The setting out of the foundation is carried out on the formation level of the site.
- The datum point is located and secured
- All levels for the building are then taken from this point.
- A laser or optical level is the most accurate way of doing this.
- The top of the profile may be the finished floor level.
- Other profiles are then levelled from this.

Width and depth of trench

- The outline rectangle of the building is located on the profiles.
- The width of the trench T = 1200mm is then marked on the profiles.
- The width of the wall W = 400mm is then marked on the profile
- The top of the foundation level is usually set out using a laser level and levelling staff.
- Depth of foundation is 600mm minimum
- The depth of the foundation depends on the type of soil.
- The bottom of the trench must be below the frost line as freezing and thawing causes. problems, rusts the steel and eventual cracking of the strip foundations.

Position of wall on strip foundation

- The width and position of the walls is set on the profiles.
- Lines are stretched from the profiles
- Position of wall may then be plumbed on to the level foundation.
- The width 400mm is then checked
- The wall must be positioned in the centre of the foundation.
- The projections on both sides of the wall must be equal.

(c) Using notes and freehand sketches, show how to determine the top surface of the foundation prior to placing the concrete to ensure that the foundation is level throughout.

Part (c) 10 marks	
Note	**5**
Sketch	**5**

- A series of pegs is driven into the base of the excavated trench.
- The top of the pegs A and B are set at the required level of the foundation.
- Other pegs are used as needed around the location of the foundation.
- The top position of the pegs is set using a laser level.

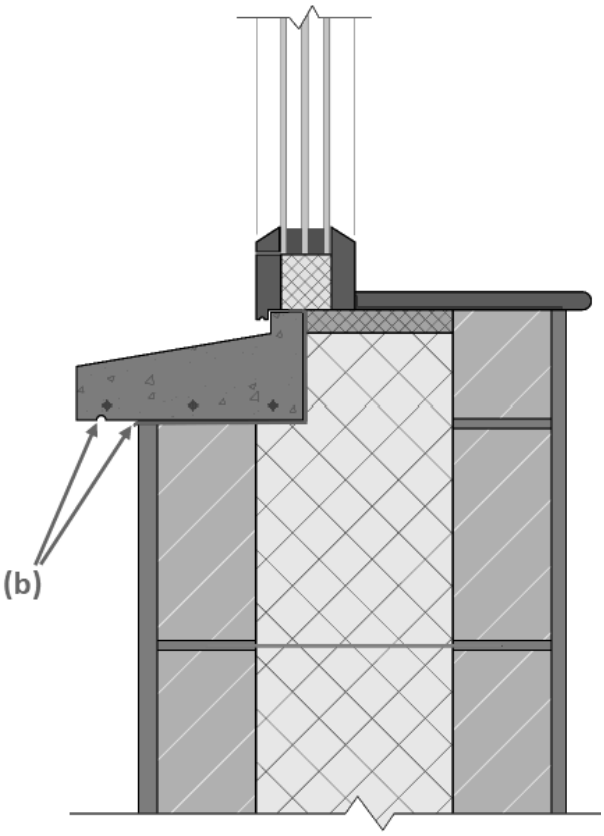
5. The sketch shows portion of a triple glazed wooden window. The window is fixed in a 400 mm concrete block wall with a full-fill insulated cavity. The wall is rendered on both sides. The fixed frame of the window is 120 mm × 80 mm and is thermally broken.

(a) To a scale of 1:5, draw a vertical section through the external wall and bottom portion of the window. Show the typical construction details from a level 400 mm below to a level 300 mm above the concrete window cill.
Include **three** typical dimensions on your drawing.

(b) Show on your drawing the typical design detailing to prevent water entering at the window cill.

Specifications:

- 19 mm external render
- 100 mm concrete block outer leaf
- Full filled insulated cavity
- Wall ties
- 100 mm concrete block inner leaf
- 13 mm internal plaster
- Cavity closer
- DPC
- Precast concrete window cill
- Throating / drip
- Window board
- Airtight tape
- Window frame 120 × 80 mm
- Triple glazing.



Part a	
Any 7 x 5	**35**
3 Typical dimensions	**3**
Draughting and accuracy 8, 6, 4	**8**
Part (b)	
Throating / drip / DPC	**4**

6. The sketch shows a construction worker using a jackhammer on a public footpath.

(a) Using a large freehand sketch, show **three** safety signs highlighting the use of personal protective equipment (PPE) that must be worn by workers while using a jackhammer.

For **each** sign, state how the personal protective equipment protects workers while using the jackhammer.

Part (a) 27 marks	
Sign 1	
Reason	**3**
Sketch	**6**
Sign 2	
Reason	**3**
Sketch	**6**
Sign 3	
Reason	**3**
Sketch	**6**

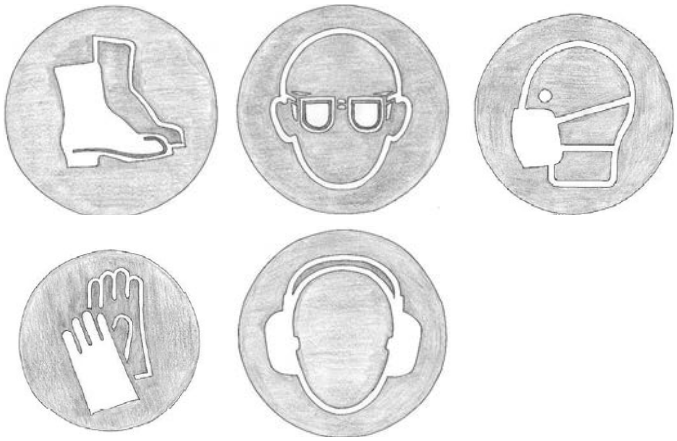
Ear protectors
- Protects workers hearing from the high decibel levels emitted when using the jackhammer.

Safety boots
- Protects workers from heavy materials and objects dropping or falling and injuring their feet.

Safety glasses
- Protects workers eyes from flying debris and dust while using the jackhammer.

Dust mask
- Protects workers lungs from dust particles while using the jackhammer.

Safety gloves
- Protects workers hands when moving debris broken off by the jackhammer.



(b) Describe **two** potential risks to a construction worker when using power tools on a construction site.
- Damage to hearing due to excessive noise
- Electrical injury due to encountering exposed live cables
- Exposure to dust and fumes if correct PPE is not used
- Overuse of hammer action tools resulting in Hand-Arm Vibration Syndrome (HAVS)
- Encountering underground services.

Part (b) 10 marks	
Risk 1	**5**
Risk 2	**5**

(c) Using notes and a freehand sketch, describe **one** safety precaution that will reduce the risk to the public while the footpath is being replaced.
- Erect signage to direct the public away from the work zone
- Ensure guard rails and exclusion zone notices are in place to limit the proximity of the public to the work area
- Ensure building material is stored at a safe distance from the open public zones
- Enclose work area with dust shelter to prevent dust particles being blown into the open public zones.

Part (c) 13 marks	
Note	**7**
Sketch	**6**

7. The draft design for a rear garden of a semi-detached house is shown. The homeowners wish to create a garden space to meet their family needs. The position of existing trees is shown.

(a) Discuss **two** reasons why it is important to create a garden space that meet the needs of the family.

Part (a) 10 marks	
Reason 1	**5**
Reason 2	**5**

- Safe area to socialise and entertain.
- Private area for the family to enjoy the outdoors.
- Promotes outdoor living
- Allows a multi-purpose area for all age groups to enjoy and use.
- An extension to the home making it a usable space for the family.
- Well-designed gardens allow herbs and vegetables to be grown.
- Providing extra storage for homeowners.

(b) Draw a large freehand sketch of the given design and show your preferred location for **each** of the following in the garden area:

- *outdoor dining/living space*
- *garden storage*
- *flower beds*
- *lawn area.*

Give **one** reason for selecting **each** location.

Part (b) 30 marks	
Sketch	**6**
Outdoor space	
Location	**3**
Valid reason	**3**
Garden storage	
Location	**3**
Valid reason	**3**
Flower beds	
Location	**3**
Valid reason	**3**
Lawn area	
Location	**3**
Valid reason	**3**

Outdoor dining/living space

- Located close to dwelling to allow ease of indoor and outdoor living
- Located to catch south facing sunlight
- Located away from the house to prevent shading from dwelling.

Garden storage

- Located close to entrance gate to allow ease of use when storing garden supplies
- Located at the back of the garden to allow freedom of movement around garden
- Located close to a side fence to prevent shading the garden area.

Flower beds

- Located in sight of the dwelling for occupants to enjoy the view
- Located to capture sunlight during the day
- Located along a boundary fence to allow ease of movement around garden.

Lawn area

- Located in occupants' line of vision
- Located close to the dwelling to bring nature close in the indoors
- Located at the rear of the garden to prevent occupants picking up dirt and water on a wet day

(c) Discuss **two** advantages of incorporating trees and plants into a garden design.

Part (c) 10 marks	
Advantage 1	**5**
Advantage 2	**5**

- Promotes wellbeing
- Improves air quality
- Attracts pollinators to the garden
- Improves the overall appearance of the garden
- Natural shade and shelter for the dwelling house
- Reduces flooding from rainwater run-off.

8. Explain, with the aid of notes and freehand sketches, any **five** of the following.

- Strip Foundation
- Rooflight
- Smart Meter
- Fascia Board
- Heat Pump
- Evacuated Tube
- Airtight Tape
- Ridgeboard
- LED Lighting

50 marks (5 x 10 marks)	
Notes	**5**
Sketch	**5**

Strip foundation
- Simple and common type of foundation used for domestic homes
- Sustainable and economic use of material
- Concrete is reinforced with steel to improve the foundations tensile strength
- Walls are placed centrally on the foundation and the loads are transmitted at 45º to the supporting ground.
- Strip foundations are used where the surrounding soil has a good bearing capacity.

Fascia board
- Gives a finished appearance to the roof and dwelling house
- Protects the interior of the dwelling from weather damage
- Forms part of the eaves of a roof along with the soffit
- Provided a surface for gutters to be fixed too
- Made from a variety of material with wood, PVC and aluminium the most common.

Airtight tape
- Highly adhesive tape which bonds to construction material
- Used in conjunction with airtight membrane to form an airtight and windtight structure
- Used to prevent draughts and to reduce heat loss from a structure
- Used at all junctions where different building elements meet, ceiling to wall, floor to wall
- Used to form an airtight seal at door and window frames.

Roof light
- Used on roof surfaces for a means of natural light
- Units are fitted with double, triple or quadruple glazing
- Allows attic space to be used as a usable room
- Form an important part of modern house design
- Gives more privacy compared to dormer windows.

Heat pump
- Used to extract heat from one area to another by means of the refrigeration cycle
- A fan is used to pass air over an evaporator coil which removes the heat energy from the air and passes it to the refrigerant.
- The refrigerant is then compressed, which increases the temperature, this heat is transferred to water running through radiators or underfloor heating.
- Heat pumps that use the ground for heating are called geothermal heat pumps.

Ridge board

- Horizontal member placed between the top end of the rafters
- Forms the apex of a cut roof
- Supported by the rafters or/and at the gable wall
- Gives rigidity and straightness to the roof
- Rafters are nailed to the ridge board
- Typical sizes - 225 × 32 mm, 225 × 25 mm.

Smart meter

- This meter is used to record the consumption of electricity.
- It records the usage of electricity in a domestic property.
- Provides greater awareness of energy use
- Promotes better energy management and efficiency in the home.
- Smart meters will replace existing meters
- The meter also shows the cost of electricity being used.
- Information on usage can be communicated to the supplier via mobile phone.
- The smart meter gives the householder control of electricity use.
- Smart meters may also be used to record the usage of water or gas.

Evacuated tube

- This tube forms part of a solar pane.l
- The tube is made of strong heat resistant glass.
- The air is removed from the tube giving a vacuum.
- A copper heat pipe P runs through the centre of the tube.
- The pipe contains an anti-freeze type liquid - glycol.
- As the heat rises, hot vapour rises to the top of the heat pipe.
- The top of the heat pipe connects with a header section.
- The hot fluid flows from the panel to the coil in the hot water cylinder.
- This in turn produces domestic hot water.
- It is environmentally friendly and helps reduce CO2 emissions.
- The tubes can be mounted to follow the path of the sun.

LED lighting

- This is a modern concept in lighting
- The term means Light Emitting Diodes.
- Lights of this type are now available for domestic and commercial use.
- Different fitting types are available for all situations.
- They are used to replace all traditional bulbs.
- LED lighting lasts longer
- LED lighting uses 90% less energy than halogen bulbs.
- A 60watt standard bulb may be replaced by an 8watt LED bulb.
- Initial cost is higher than that of traditional bulbs, but last far longer.

9. The sketch shows a detached rural house with a front porch. The porch is of timber frame construction with an external wooden cladding.

(a) Specify a suitable wood for the external cladding, and give **two** reasons for your choice.

Suitable wood for external cladding,

- Cedar
- Larch
- Douglas Fir
- Oak
- Teak

Part (a) 12 marks	
Suitable wood	**4**
Reason 1	**4**
Reason 2	**4**

Two reasons for your choice.

- Durable wood species
- Do not require preservative treatment due to containing natural oils
- Naturally resistant to insect attack
- Naturally resistant to moisture.

(b) The owner wishes to modify the porch to allow more natural light into the house. Using notes and freehand sketches, show **two** modifications to the porch that would allow more natural light to enter the house.

Part (b) 26 marks	
Modification 1	
Notes	**8**
Sketches	**5**
Modification 2	
Notes	**8**
Sketches	**5**

- Install roof lights
- Insert a window in the entrance door
- Install windows in the external walls
- Replace the roof with a glass roof.

(c) Discuss **two** reasons why homeowners would wish to build a front porch to their house.

- Increase the usable space
- Create an extra draught barrier
- Blend in with neighbouring properties
- Additional security to home
- Improved insulation of existing home
- Increase the resale value of the property.

Part (c) 12 marks	
Advantage 1	**6**
Advantage 2	**6**

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