Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2020

Marking Scheme

Construction Studies

Higher Level

Note to teachers and students on the use of published marking schemes

Marking schemes published by the State Examinations Commission are not intended to be standalone documents. They are an essential resource for examiners who receive training in the correct interpretation and application of the scheme. This training involves, among other things, marking samples of student work and discussing the marks awarded, so as to clarify the correct application of the scheme. The work of examiners is subsequently monitored by Advising Examiners to ensure consistent and accurate application of the marking scheme. This process is overseen by the Chief Examiner, usually assisted by a Chief Advising Examiner. The Chief Examiner is the final authority regarding whether or not the marking scheme has been correctly applied to any piece of candidate work.

Marking schemes are working documents. While a draft marking scheme is prepared in advance of the examination, the scheme is not finalised until examiners have applied it to candidates' work and the feedback from all examiners has been collated and considered in light of the full range of responses of candidates, the overall level of difficulty of the examination and the need to maintain consistency in standards from year to year. This published document contains the finalised scheme, as it was applied to all candidates' work.

In the case of marking schemes that include model solutions or answers, it should be noted that these are not intended to be exhaustive. Variations and alternatives may also be acceptable. Examiners must consider all answers on their merits, and will have consulted with their Advising Examiners when in doubt.

Future Marking Schemes

Assumptions about future marking schemes on the basis of past schemes should be avoided. While the underlying assessment principles remain the same, the details of the marking of a particular type of question may change in the context of the contribution of that question to the overall examination in a given year. The Chief Examiner in any given year has the responsibility to determine how best to ensure the fair and accurate assessment of candidates' work and to ensure consistency in the standard of the assessment from year to year. Accordingly, aspects of the structure, detail and application of the marking scheme for a particular examination are subject to change from one year to the next without notice.

Coimisiún na Scrúduithe Stáit

State Examinations Commission

Leaving Certificate Examination, 2020

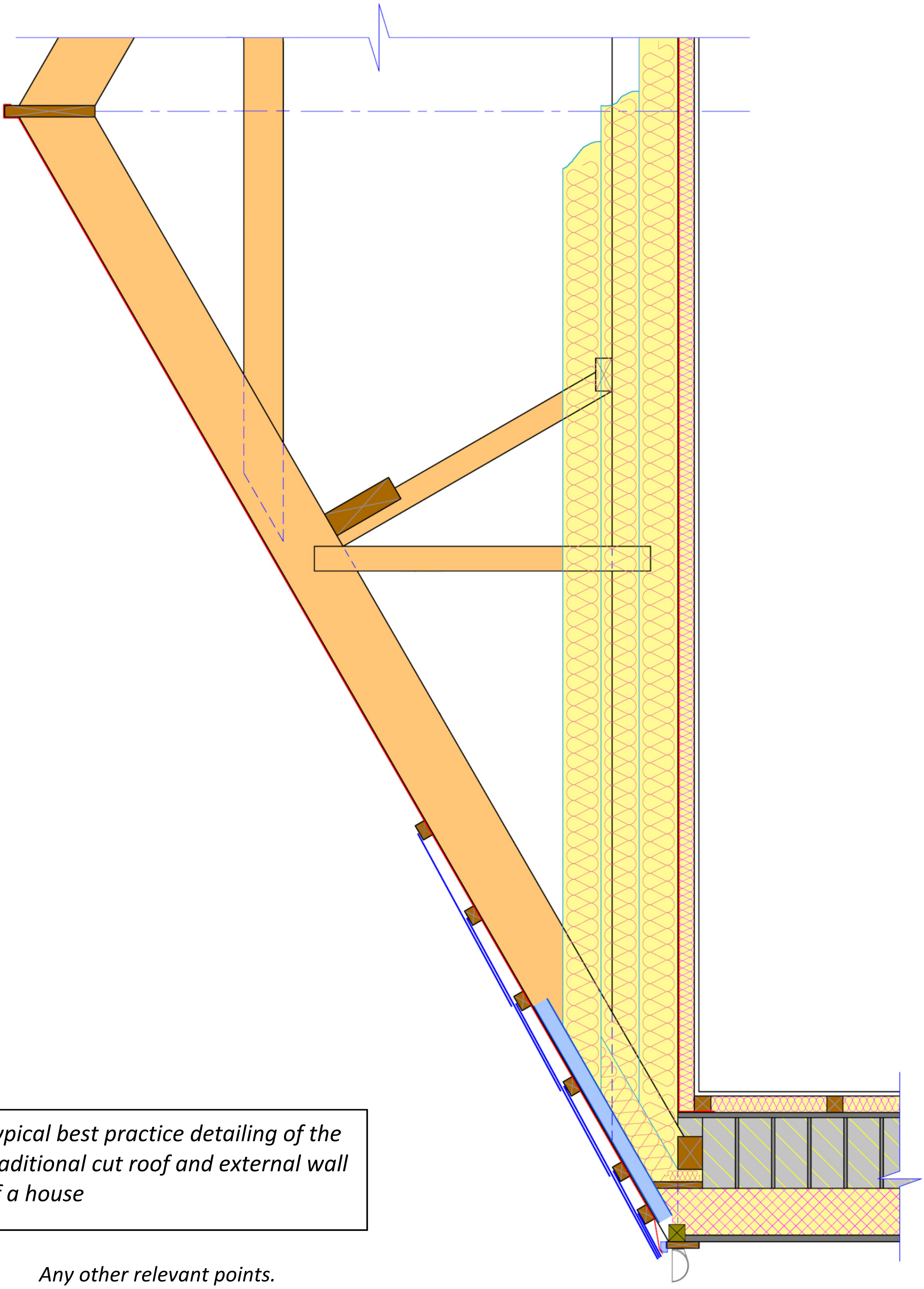
Construction Studies

Theory – Higher Level

Note: *Notes and graphics are for illustration and are not exclusive or exhaustive, other relevant notes and graphics are acceptable as responses and will be credited accordingly.*

Question 1.

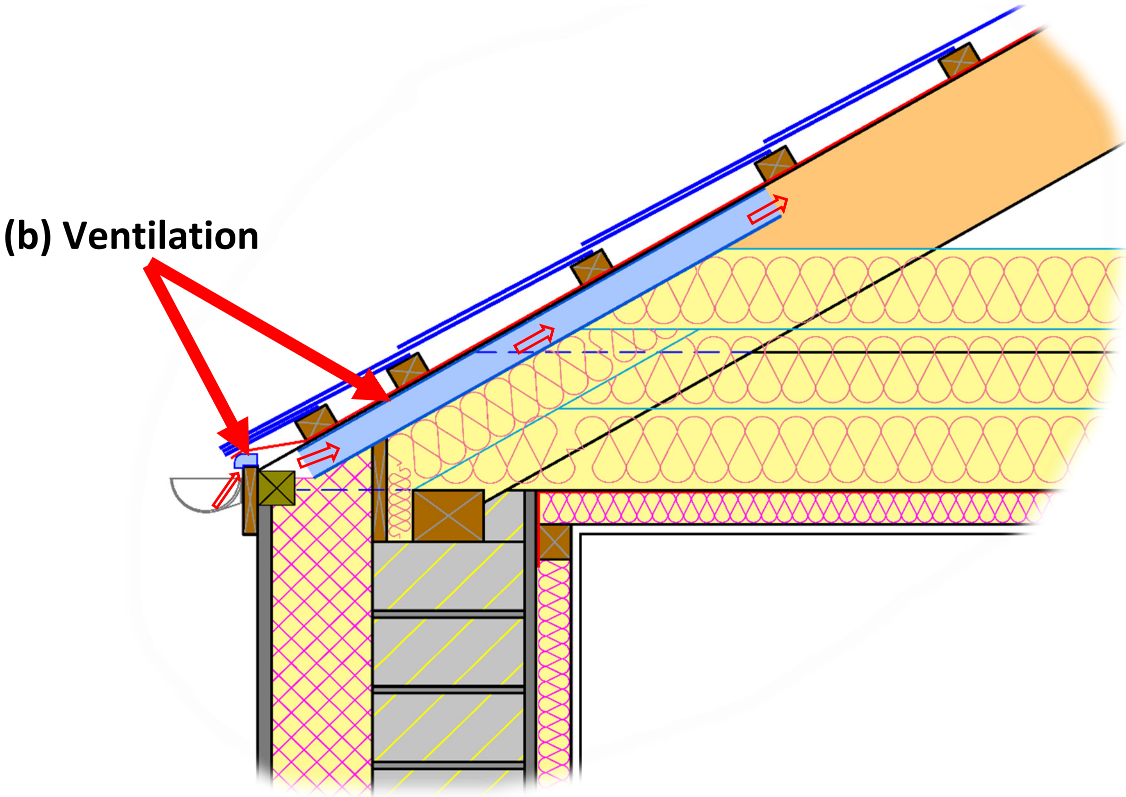
(a) Vertical section through one-half of the traditional cut roof and external wall of a house.



Typical best practice detailing of the traditional cut roof and external wall of a house

Any other relevant points.

(b) Typical design detailing to ensure ventilation of the roof structure.



External Wall – typical detailing
- External acrylic render
- 200 mm external insulation
- 215 mm concrete block on flat
- 19 mm internal sand cement plaster
- Air-barrier / Airtightness membrane
- 50 mm insulated service cavity
- 12.5 mm plasterboard tapered and filled or with a skim coat.

Roof structure – typical detailing
- 100 mm × 75 mm wall-plate secured using resin anchored bolts or galvanised brackets
- 200 mm × 50 mm rafters @ 400 mm centres fixed to wallplate
- Ceiling joist @ 400 mm centres fixed to wallplate
- 225 mm × 75 mm purlin
- Strut supporting the purlin
- Hanger
- Collar tie at each couple or @ 1200 mm centres
- ridge-board
- 350 mm insulation laid in 3 layers.

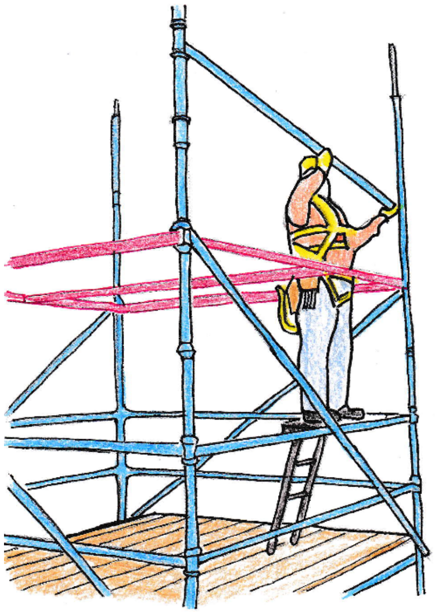
Eaves detail – typical detailing
- 50 mm × 50 mm treated facia batten
- 20 mm facia board and gutter
- 25 mm facia ventilator and 50 mm proprietary eaves ventilator
- Breather membrane laid over roof rafters
- 50 mm × 30 mm slating batten
- 3 courses of slates.

Any other relevant points

Question 2

(a) Best practice guidelines that should be observed when using scaffolding on a site.

Erecting Scaffolding



Protection of construction workers and the public:

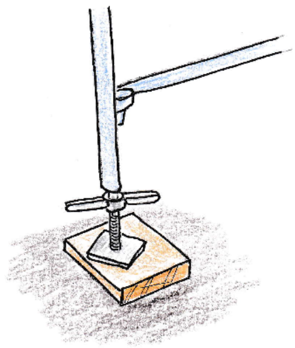
- Scaffolding only erected by qualified/ certified persons
- When erecting scaffolding the public must be excluded from both the area of work and a sufficient area around it

Scaffolders working at height

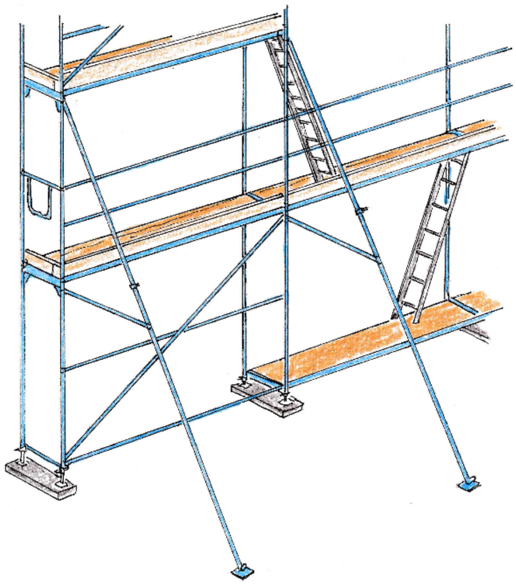
- A minimum 3 board working platform together with a single guard-rail is provided as scaffolding is erected
- Safety harnesses to be worn at all times by workers during erecting process
- Workers safety harnesses should be clipped on to a secure anchorage point
- Safe ladder access for scaffolders should be incorporated as early as possible into the erection process.

Any other relevant points

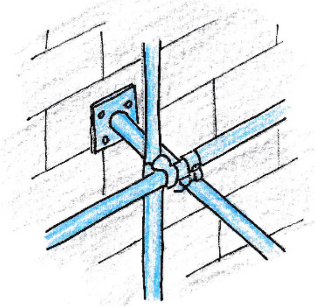
Scaffolding assembly



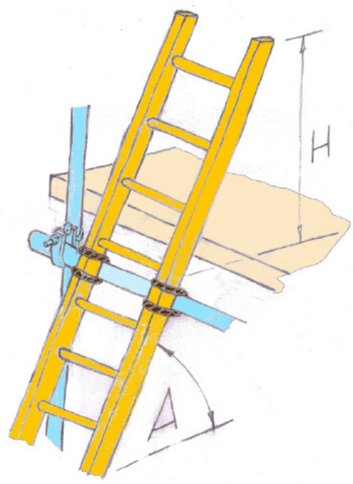
- The ground should be prepared in advance of the scaffolding being erected to:
    - ensure that it is adequate to support the imposed load of scaffolding
    - level enough so that scaffolding can be erected safely
- Timber sole boards to be placed under the centre of all base plates and should be 35 mm thick and at least 220 mm wide
- All scaffolding should be erected level
- Adjustable base plates allow the scaffolding to be easily levelled on commencement
- Scaffolding should be anchored to the building at distances (according to manufactured specifications) using ties while being erected by:
    - Bolting brackets to the building
    - Installing reveal ties which connect to the scaffolding
- Bracing of the scaffolding is required to stiffen the scaffold and prevent it from swaying
- Scaffolds up to 6 metres high should have raking tubes at a maximum of 6m intervals to support them. The tube should be at an angle of not more than 2 vertical to 1 horizontal and not more than 6m in length.



Any other relevant points

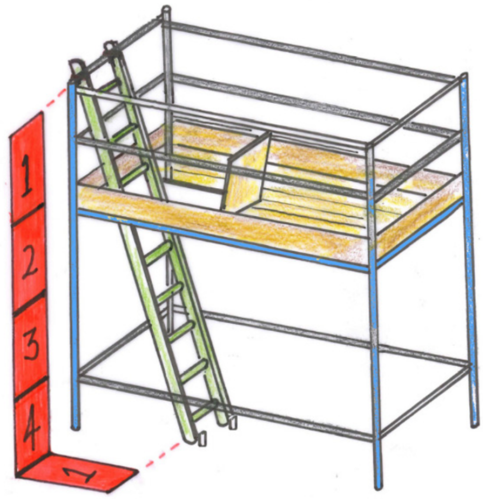


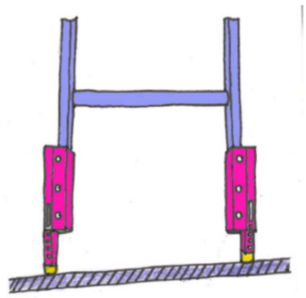
Accessing Scaffolding



- Ladder access towers, fixed to the outside of the scaffold, should be erected, where practicable using single lift ladders and self-closing ladder gates to separate the access tower from the working platform
- The top of ladder stiles should be securely fixed to the scaffold by lashings
- The ladder should be set, where practicable, at an angle of not more than 4 vertical to 1 horizontal and allow sufficient room for workers access and egress through the ladder access opening
- Each stile should be equally supported on a firm and level footing
- the ladder should extend at least 1m above the landing point unless a suitable alternative handrail has been provided;
- The maximum vertical distance between landings should be 9m
- Where the ladder is internal, guardrails or other protective measures should be in place around the opening to prevent someone stepping into the ladder access opening accidently
- The clear dimensions of an access opening in a platform shall be at least 450mm wide, measured across the width of the platform, and 600mm long
- Ladders should only be used on level ground or scaffold platform and should be positioned to ensure their stability during use and secured immediately
- Installation of motor hoists with guard gates/cages to the scaffolding.

Any other relevant points





Use of working platforms

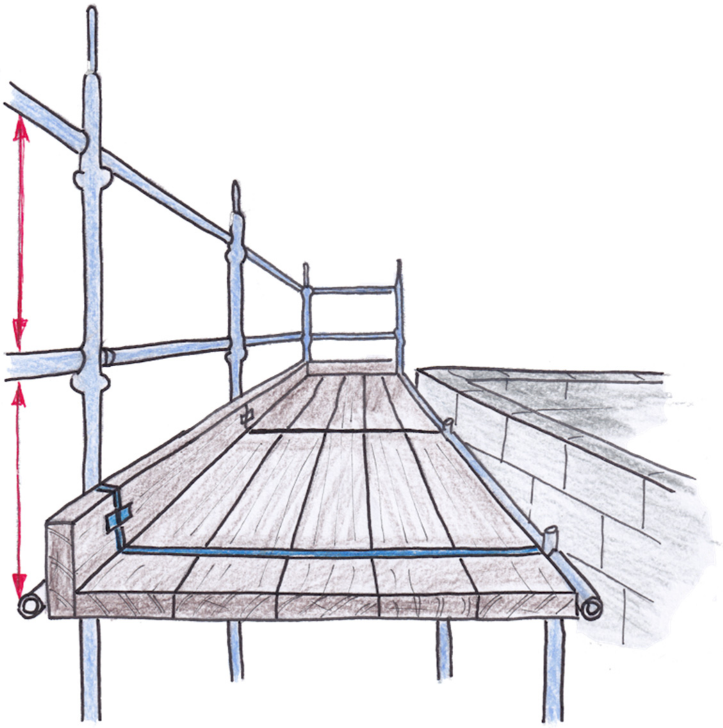
Platforms

- Working platforms should be wide enough and be sufficiently boarded out to allow safe passage of persons along the platform
- They should also be capable of resisting the loads imposed upon them, including high wind loads that could dislodge the scaffold boards
- A clear passageway, at least 450 mm wide, should be maintained for persons to pass between stored materials and the side of the platform
- Platforms should be maintained in a fully boarded or decked condition
- The maximum gap between the scaffold and the structure should be 225 mm.

Toe-Boards

- Toe-boards help prevent materials from falling and they also help prevent people falling between the guard-rail and platform
- Toe-boards and end toe-boards should be fixed to all working platforms where a person could fall a distance liable to cause personal injury or where an object could fall causing injury

- The toe-boards should have a height of at least 150 mm above the platform and they should be securely fixed to the standards.



Guard-Rails

- Guard-rails should be provided on all working platforms, Part 4 of the Safety, Health and Welfare at Work (General Application) Regulations 2007 details the requirements for guard-rails
- The height of the guard-rail should be at least 950 mm above the working platform
- An intermediate guard-rail must be provided such that the maximum distance between the rails and between the lower rail and the toe-board does not exceed 470 mm.

Falling Object Protection

- Signage positioned in critical locations in more than one language
- Measures must be taken to prevent materials from falling from working platforms such as netting on the external face of the scaffolding
- Exclusion zones beneath working platforms maybe required during specific construction tasks.

Any other relevant points

(b) Responsibilities of a Health and Safety Officer on a construction site.

The Health and Safety Officer is responsible for:

- carrying out safety inspections and risk assessments on site
- reviewing site procedures e.g. safety statement
- completing induction training of all new workers on the site
- investigating, recording and reporting all accidents that may occur on a site
- providing accident information when required
- identifying new and ongoing safety training requirements of workers
- ensuring that all correct PPE is availed of at all times by workers
- the enforcement of Health and Safety polices on site.

Other relevant information

Question 3

(a) Three design considerations when modifying the internal layout to meet the needs of a person with limited mobility.

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

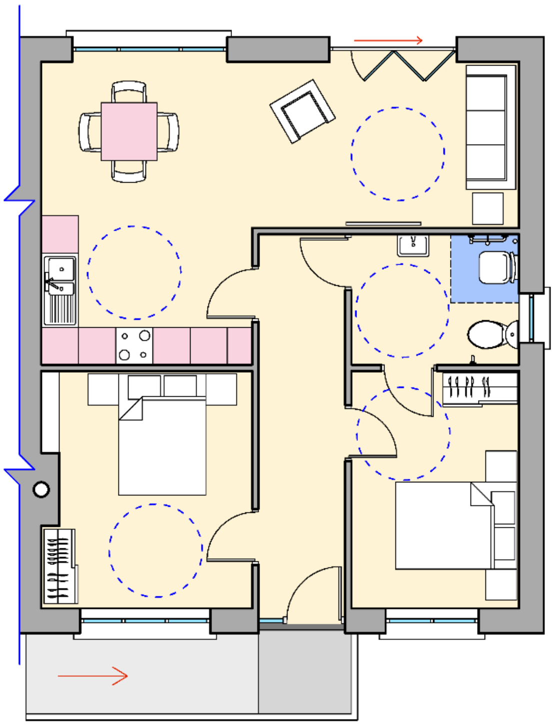
- Clear turning space is not provided for in the bedroom
- Ideally an en-suite should also be linked to the main bedroom of the house.

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) Revised internal layout to meet needs of a person with limited mobility and new kitchen/living space.



External / Internal doors

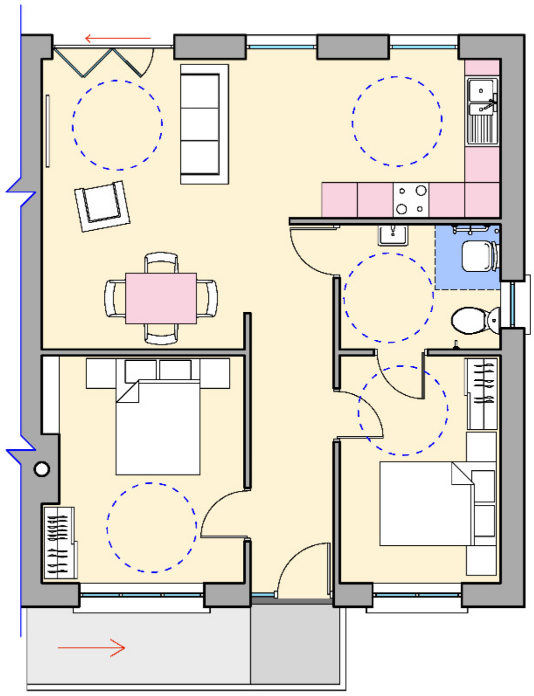
- The main entrance doorway should provide a minimum clear opening width of not less than 1000 mm
- A level threshold with no more than a 15 mm upstand
- Provide a 300 mm clear space on the leading - edge side of the door externally and internally
- Ensure that the entrance door contrasts visually with 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 bowel
- 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) Advantages and disadvantages of open-plan living in a domestic house.

Advantages

- Flexibility in layout for lifetime use
- Open-plan layouts allow daylight and sunlight to penetrate into the house which supports mental wellbeing
- Sociable aspect – increased interaction between occupants
- Ease of movement between spaces
- Supports the flow of air within the home
- Can add value to a property.

Disadvantages

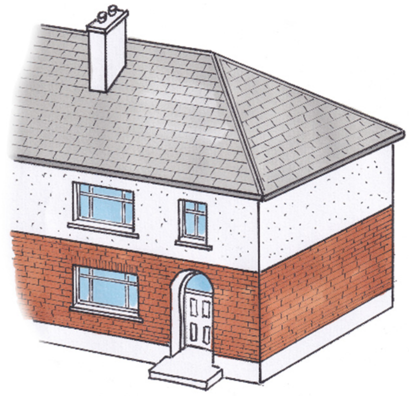
- Larger space increases the volume of air to be heated and can be more costly
- Reduced privacy for occupants
- Greater noise levels
- Unwelcome odours can spread through the entire space.

Any other relevant points

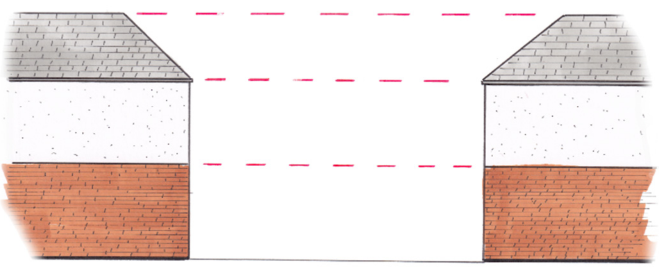
Question 4

(a) Importance of each characteristic when designing a house for a vacant site in an urban area

Materials and finishes

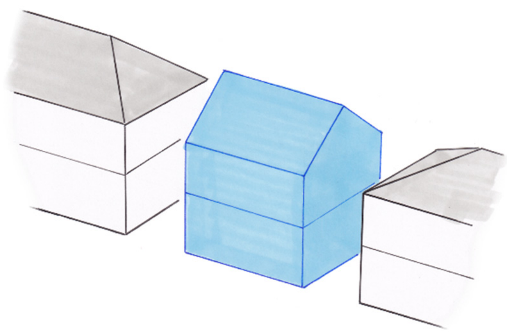


- When considering what external materials to choose for a new build in a built up area such as this site, consider what materials are already in use on neighbouring building e.g. brick, render, etc
- However, more natural materials e.g. timber cladding may also blend into a leafy neighbourhood
- If a materials e.g. stone, is readily available in the locality, this would suggest it could be sourced locally and therefore maintain jobs in the area while reducing the carbon footprint or the embodied energy of the build
- It is equally important to look at the environmental impact each material choice has in its production process and what carbon emissions are created - is the material natural or manmade?
- Are the materials sourced locally or transported from another country?
- Will it release toxins during its lifetime or benefit the environment e.g. green roof
- Adhering to local planning authorities' guidelines
- Examine the materials palette of the existing street – doors, windows, walls, roof, etc.

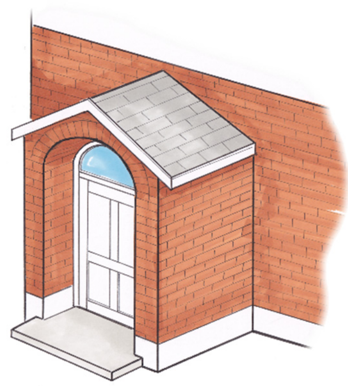


Any other relevant points

Shape and form

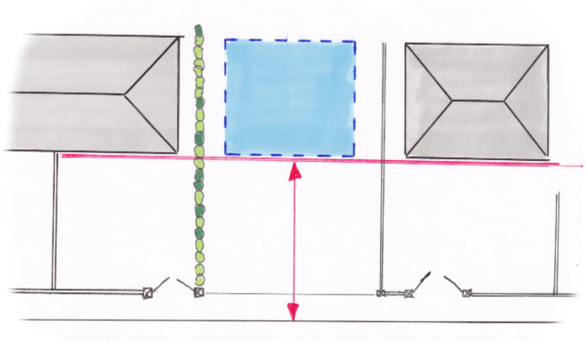


- What shapes currently exist in the surrounding location? Can inspiration be taken from these shapes? - e.g. pitch roof, barrel vault, mono pitch, hipped roof, etc
- Is the shape functional and vernacular to your locality or imported from a different country purely for aesthetic reasons
- The shape and form of the building is a complex mixture of meeting the needs of the owners internally, orientating the building to best avail of natural sunlight all while integrating into the surrounding location
- Would the shape of your proposal obstruct your neighbours natural light or overshadow their garden
- The height and distance from the road of existing building must be taken into account and can often set limitations on your design
- The shape and form must adhering to local planning authorities' guidelines.



Any other relevant points

Streetscape

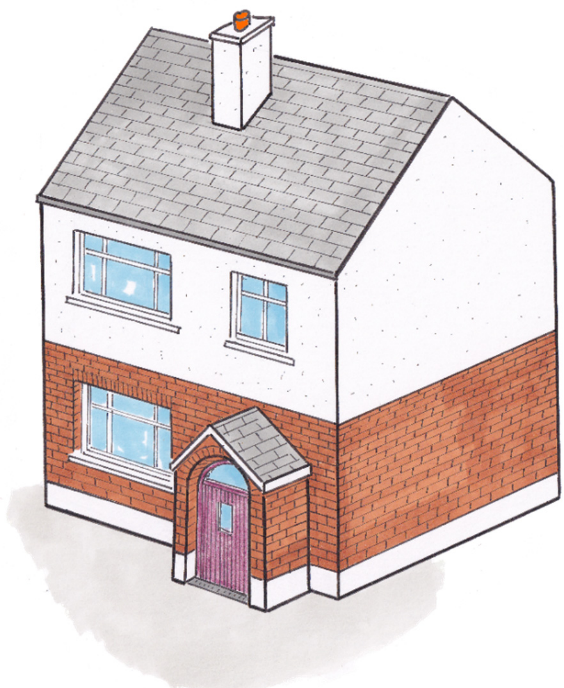


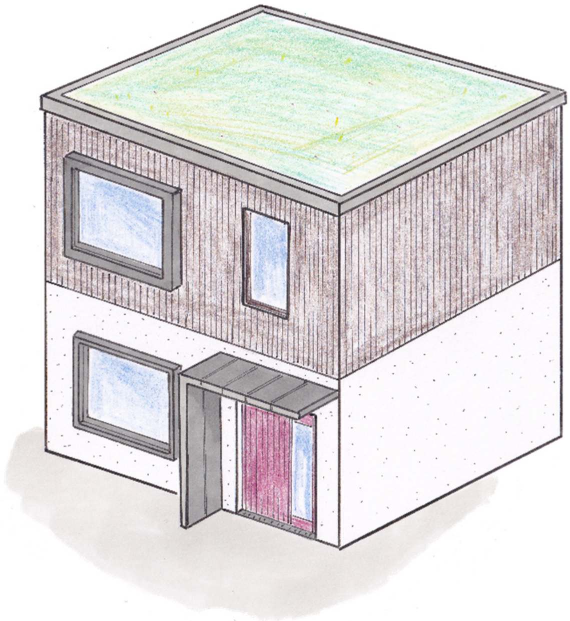
- It is important to be respectful and mindful of the materials used, the shape and the location of existing buildings along the streetscape
- Create a sympathetic building design and additions to fit in with the existing streetscape
- Good house design allows individuality without detracting from the character of the street or amenity of neighbours
- Creating good streetscape has less to do with individual building design than how the different buildings relate to each other
- Consideration should be given to:
  - House / street boundaries construction and how they relate to the existing
  - Established building line
  - Landscaping to enhance the quality of the streetscape – planting, shelter, visual identity
  - Existing fenestration of the street
  - Footpath and or cycling lane
  - Street set-back and house construction line

- One approach could be to mimic these characteristics of existing building and therefore aesthetically look similar but also have similar faults e.g. overshadow neighbouring south facing gardens or remove existing nature such as trees
- A different approach could be to respond to the individual site while getting inspiration from the existing built environment.

Any other relevant points

(b) Proposed external design for a house to be located on the vacant site.





Materials and finishes

- External finishes relate to neighbouring buildings – brick, render, slates, tiles
- Low carbon footprint materials that enhance and reflect the natural surroundings – green roof, timber cladding
- Use existing materials but from different colour pallet – manufactured brick but with grey colour similar to roof slates of surrounding buildings.

Shape and form

- The overall height of the proposal is in line with the neighbouring – eaves, ridge line, first floor windows cills
- Roof – hip or pitched roof profile similar to neighbours. Flat green roof used in keeping with the flat green space that the new proposal is replacing
- The shape and façade layout is similar to the existing built environment
- New house proposal has lower profile so as not to overshadow neighbouring gardens.

Streetscape

- The façade facing the road is in line with existing facades or set back to give hierarchy to existing buildings
- Façade features follow a horizontal emphasis similar to elements on existing buildings
- The fenestration of the new proposal is similar to that on the rest of the road.

Any other relevant points

(c) Advantages of developing vacant sites in urban areas.

- Help with the current housing needs
- Reduce visual pollution if the site had not been maintained
- Reduce areas for antisocial behaviour
- Bring families and people into local communities
- Increase curb appeal on the streetscape
- Increase overall property value in the area
- The site is already in close proximity to existing utility services
- Increases urban density making public transport affordable and possible.

Any other relevant points

Question 5

(a) Calculate the U-value of the solid concrete ground floor.

Material Element	Conductivity k	Resistivity r	Thickness T(m)	Resistance R
Internal Surface				0.104
Oak Flooring	6.666	0.150	0.02	0.003
Sand/cement fine screed		1.410	0.065	0.092
Floor insulation	0.022	45.455	0.2	9.091
Concrete floor slab	1.28	0.781	0.15	0.117
Radon barrier	0.25	4	0.00025	0.001
Sand blinding	0.16	6.25	0.04	0.25
Hardcore	1.35	0.741	0.2	0.148
Subsoil	1.6	0.625	0.3	0.188
			Total R =	R^t = 9.993
Formulae: R=T/k R=T × r U= 1/R^t U-value: U = 1 / 9.993 = 0.10 W/m^2 ^{0}C				
			U-value =	**0.10 w/m^2 ^{0}c**

(b) Cost of heat lost annually through the floor.

- Heat lost through wall
  Heat loss formula: = U -Value × area × temp. diff
  0.10 × 58.5 × (20 – 6) = 81.9 Watts (Joules / sec)

- Heating period p/a:
  60 × 60 × 9 × 7 × 39 = 8,845,200 seconds (2,457 hours)

- Kilo joules p/a:
  $\frac{8,845,200 \times 81.9}{1000}$ = 724,4212 kJ/sec

- Litres p/a: (Note: Calorific value of 1 litre oil = 37350 kJ)
  $\frac{724,421.88}{37,350}$ = 19.39 litres

- Cost p/a: (Note: 1 litre of oil costs 96c)
  19.39 × **0.96** **=** **€18.62**

Cost of heat loss annually through floor = €18.62

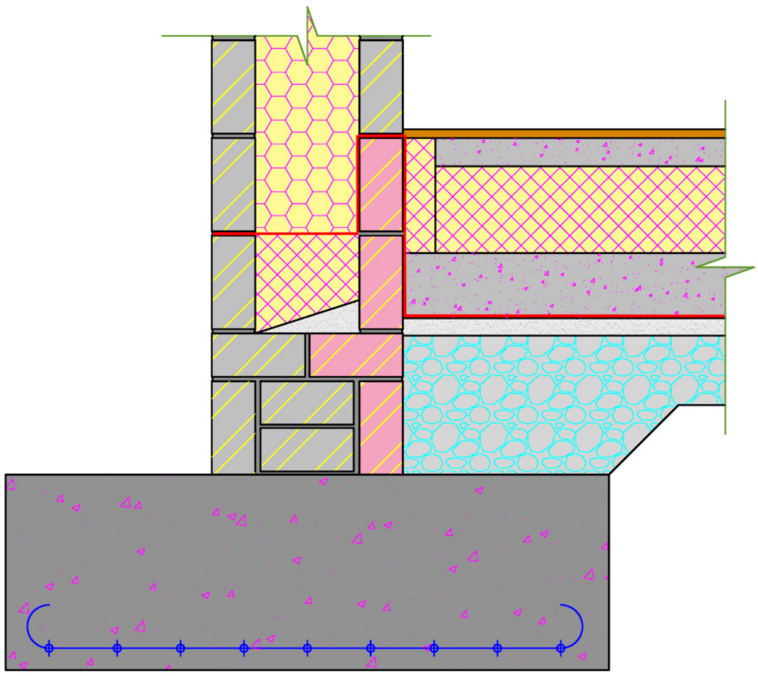
Alternative method:

Formula: $\frac{\text{U-value} \times \text{Area} \times \text{Temp Diff.} \times \text{Time (secs)} \times \text{Cost (Euros)}}{\text{Calorific value} \times 1000}$

$= \frac{\mathbf{0.10} \times 58.5 \times 14 \times 8{,}845{,}200 \times 0.96}{37{,}350 \times 1000}$

$= \frac{695{,}445{,}004.9}{37{,}350{,}000}$ = **€18.62**

(c) Best practice detailing that will prevent the formation of a thermal bridge at the junction of the concrete floor and external wall.



Question 6

(a) Advantages and disadvantages of retrofitting the vernacular cottage.

Advantages:

- Ethical responsibility to retain our natural heritage and vernacular architecture by making old buildings habitable
- The embodied energy and carbon required to construct a new house are avoided
- Not adding visual pollution to the landscape as the structure already exists
- The home would have character features and proportions unique to Ireland and its location rather than the generic interior of a new build
- Reduced carbon footprint as the structure already exists
- Less money required to make it habitable as the main structure is already built
- Many old buildings have good thermal mass
- Planning permission is not required when carrying out a retrofit only
- Maintaining / keeping / retaining Ireland's historic buildings.

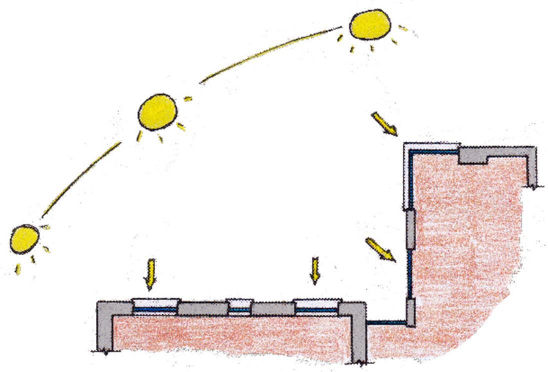
Any other relevant points

Disadvantages:

- The extent of renovations required is often not realised until the old building has been investigated
- The cost associated with the upgrade may be more than initially envisaged
- Smaller rooms and layouts may not be suitable for current lifestyles or the needs of the occupants
- Bringing the house up to current energy standards can further reduce the size of the rooms
- Difficult to fully assess the costs associated with retrofitting an old house
- Very difficult to achieve similar thermal insulation levels, airtightness and eliminate thermal bridges compared to a new build
- Materials must be carefully chosen when upgrading elements of the house e.g. breathable insulation in the walls
- Dampness especially rising damp may be problematic.

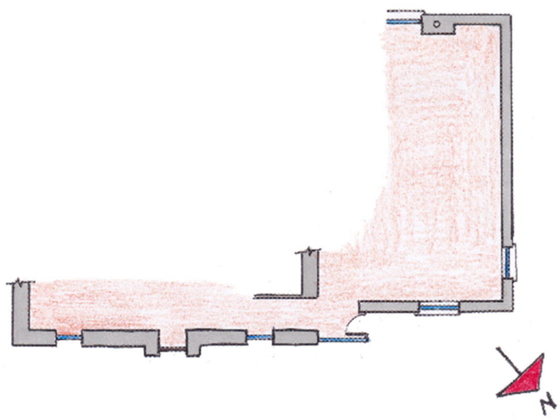
Any other relevant points

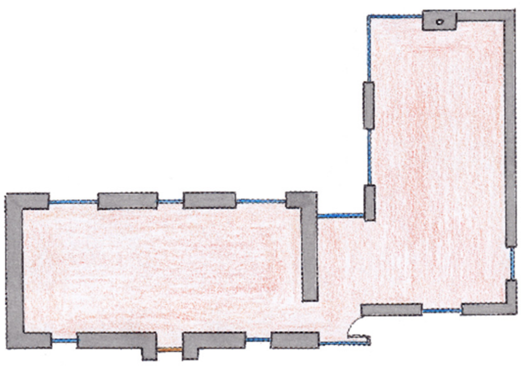
(b) Three feature of the design that contribute to the house having a low environment Impact

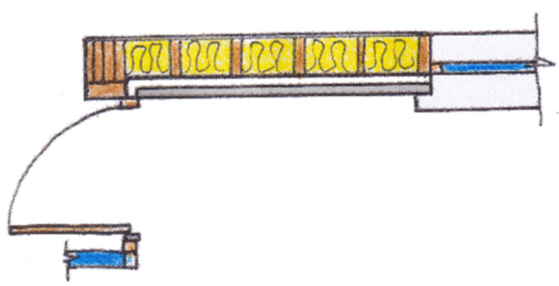


- Larger windows facing south capturing the suns heat and light therefore reducing heating and lighting costs
- Retaining the existing cottage instead of replacing it with a new one, means that the embodied energy and carbon required to construct a new house are avoided
- More sustainable to enhance 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.

Any other relevant points



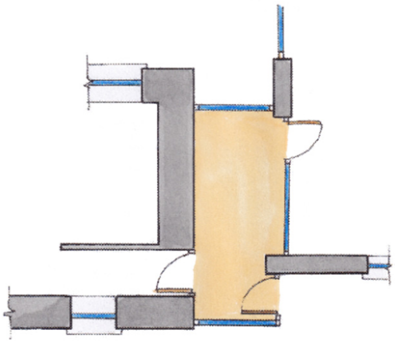




(c) Two modifications to further reduce the environmental impact of the house.

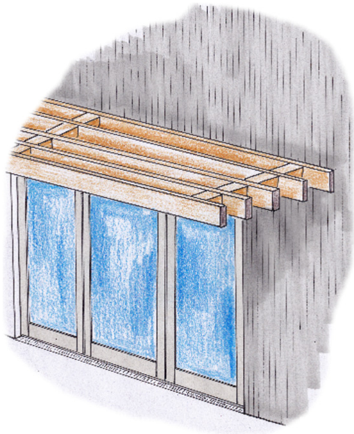
Provide a draught lobby

- 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

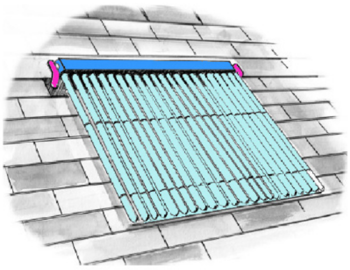


Construct solar shading

- 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.

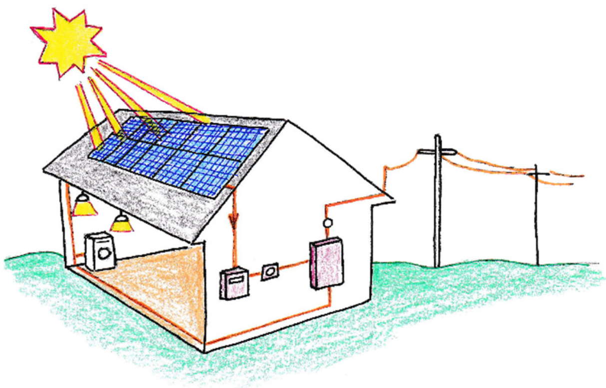
Install evacuated tube / solar panel

- 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



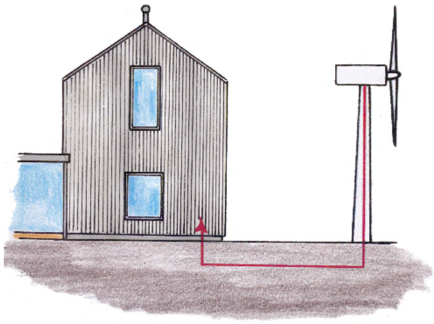
Install photovoltaic (PV) panels

- 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 and negative impacts on the environment



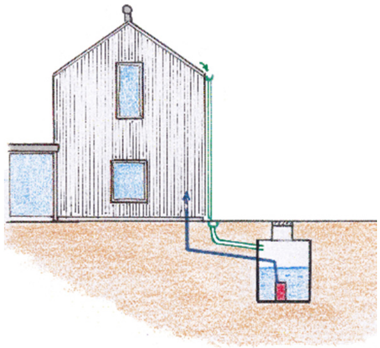
Install a wind turbine

- 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



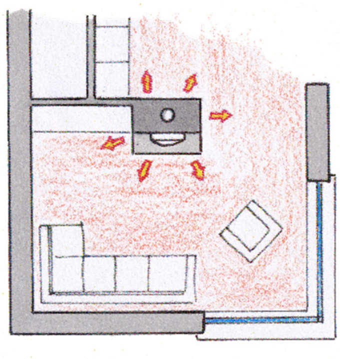
Install rainwater harvesting system

- 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.



Any other relevant points

Question 7

(a) Vertical section through ground floor, hearth with a stove and chimney.

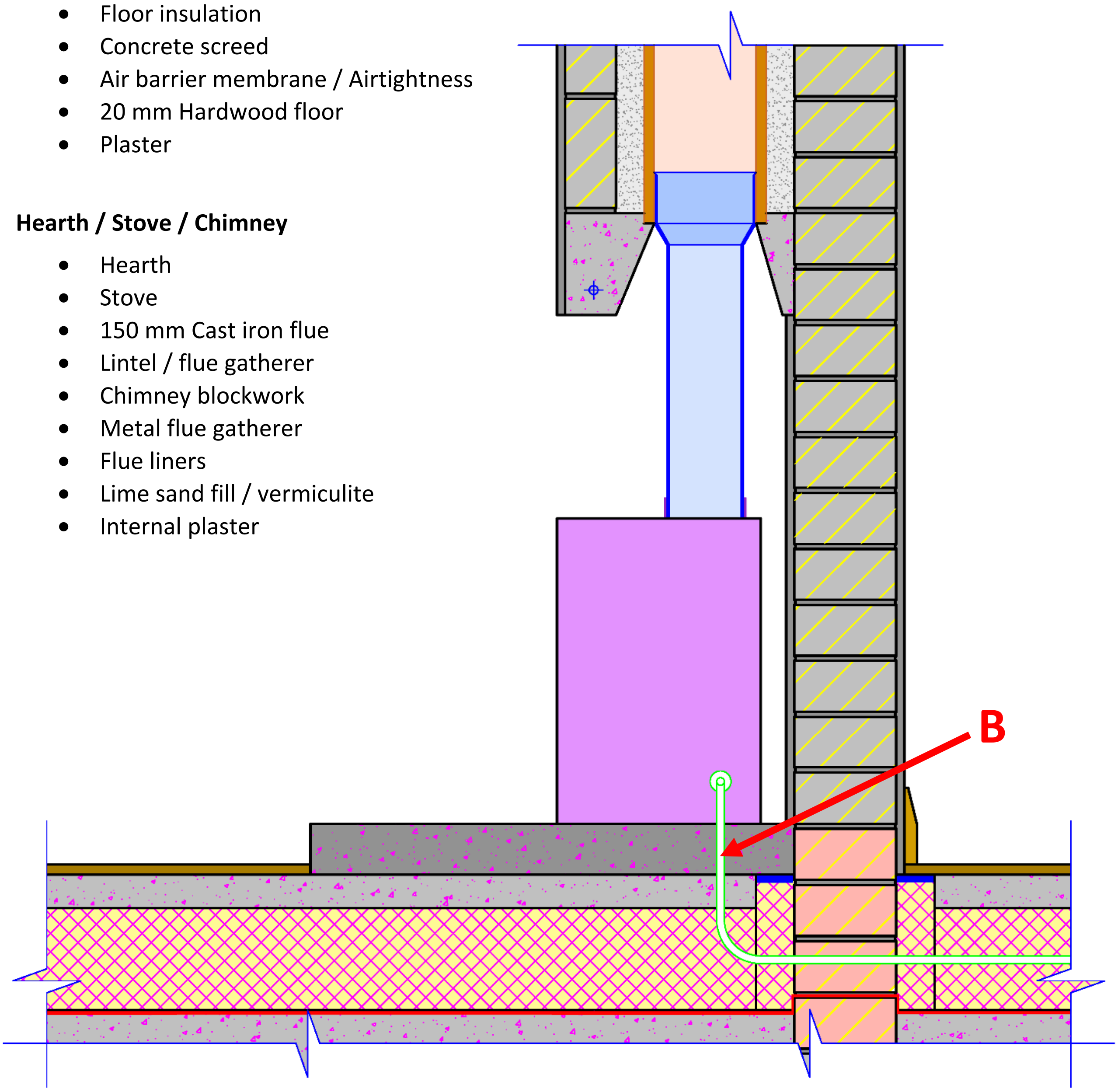
Stove and chimney – typical detailing

Ground Floor

- 200 mm Internal wall
- Concrete floor 100 - 150mm
- Concrete subfloor
- Floor insulation
- Concrete screed
- Air barrier membrane / Airtightness
- 20 mm Hardwood floor
- Plaster

Hearth / Stove / Chimney

- Hearth
- Stove
- 150 mm Cast iron flue
- Lintel / flue gatherer
- Chimney blockwork
- Metal flue gatherer
- Flue liners
- Lime sand fill / vermiculite
- Internal plaster



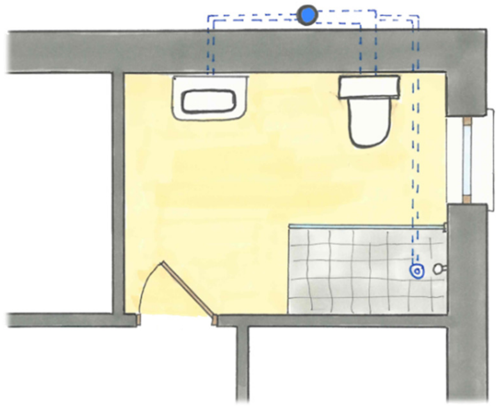
(b) Typical detailing to provide an independent air supply to the stove.

Provision of independent air supply on the drawing.

- *Any other relevant detail*

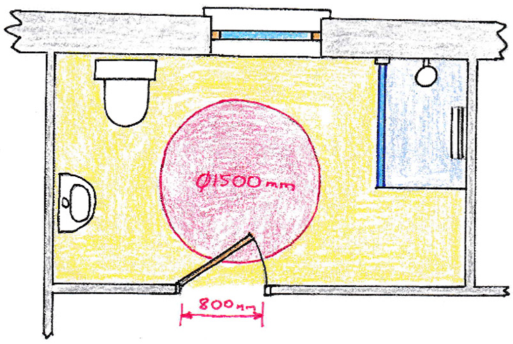
Question 8

(a) Two considerations when locating a bathroom on the first floor of a house.



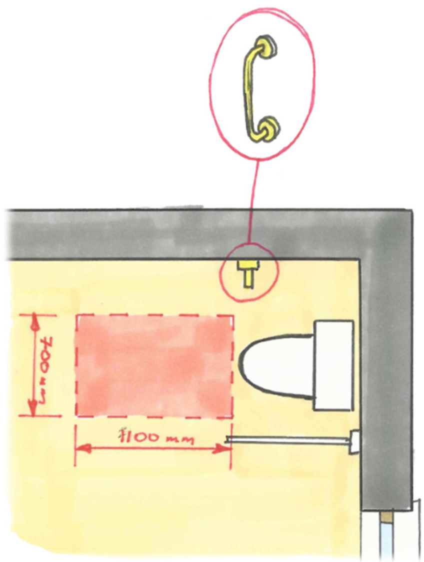
Position

- WC located on an external wall of the house:
    - to allow short pipes runs from fittings to soil vent pipe
    - Installation of a window to provide natural light to the bathroom
    - to allow natural ventilation
- Bathroom position to the rear of the house to prevent a soil vent pipe being visible to the front of the house
- Provision of storage space in the bathroom.



Accessibility

- Access to the bathroom
    - Width of door – 850 mm min. (900 mm to 1000 mm recommended)
- Circulation / internal layout
    - Min. internal dimension of 2100 mm × 2400 mm
    - Turing circle Ø1500 mm to Ø1800 mmm
    - Non-slip floor coverings or non-slip tiles
- Fittings layout
    - Suitable height for wash basin and WC
    - Use of spatula type lever taps or sensor taps
    - Provide level access to the shower
    - Provide activity space in front of each fitting
- Handrails
    - Grab rails installed to wash basin, shower and WC (drop-down and fixed).



Privacy

- Located to the rear of the house
- Installation of small sized windows to North facade
- Installation of frosted glass into glazing systems for privacy.

Visual

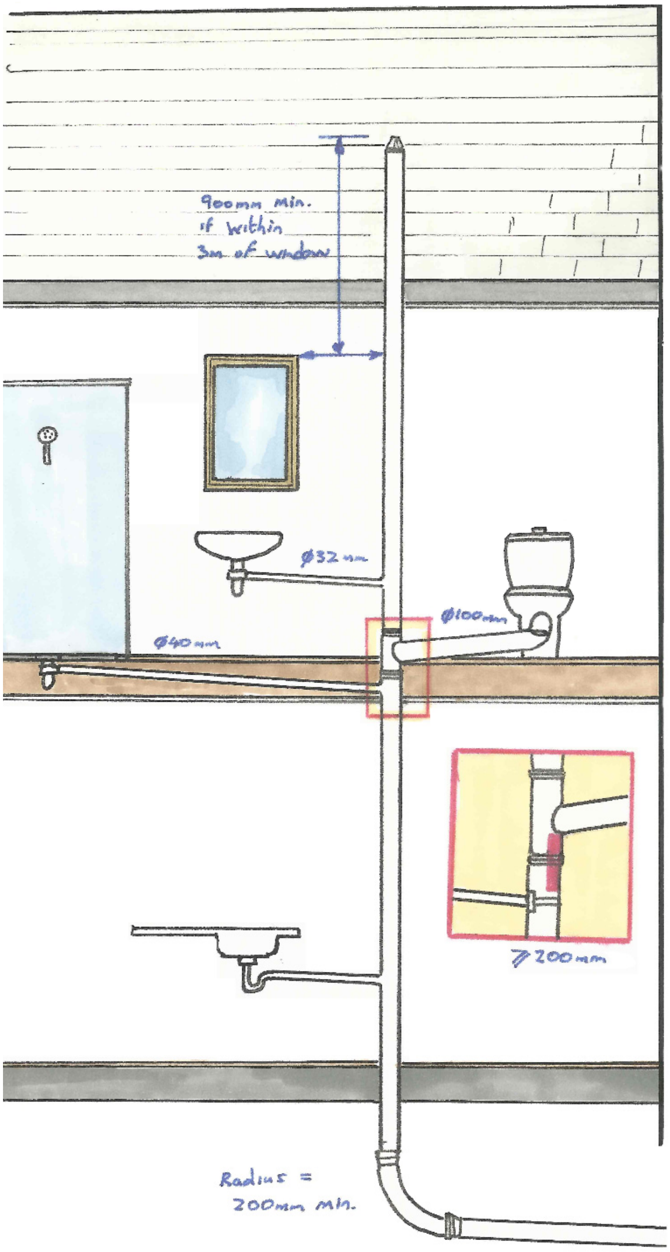
- Good visual contrast in the bathroom between walls, floor and fittings
- Light switches installed at appropriate height or use of motion/heat sensors for automatic lighting
- Bathroom fittings clearly laid out in the room.

Air Quality

- Installation of a window or vent to provide natural ventilation
- Installation of mechanical ventilation systems for (additional) ventilation of the space.

Any other relevant points

(b) Above-ground pipework necessary for the safe removal of waste.



SVP
- Ø110 mm soil vent pipe (svp)
- 200 mm min. radius at base of the svp
- SVP vented at the top
- 900 mm min. if within 3 m of window
- 200 mm offset between connection pipes,

Shower
- Ø40 mm discharge branch pipe to 110 mm stack
- Max. length of branch pipe for 40 mm pipe is 4.0 m
- Slope of 18 to 90 mm/m recommended
- Deep seal trap recommended.

Wash basin
- Ø32 mm discharge branch pipe to 110mm stack
- Max length for 32 mm pipe is 1.7 m
- Slope of 18 to 90 mm/m recommended
- Deep seal trap recommended.

Water closet (W.C.)
- Ø100 mm discharge branch pipe to 110mm stack
- Max. length of 6.0 m for single WC
- Slope of 9 mm/m recommended
- Offset of 200 mm at stack connection.
- Pipes from all fittings are correctly sized (correct diameter).

Kitchen sink
- Ø40 mm discharge branch pipe to 110 mm stack
- Max length for Ø40 mm pipe is 3.0 m
- Slope of 18 to 90 mm/m recommended
- Deep seal trap recommended.

Any other relevant points

(c) Two considerations to minimise blockages occurring in an above-ground drainage system.

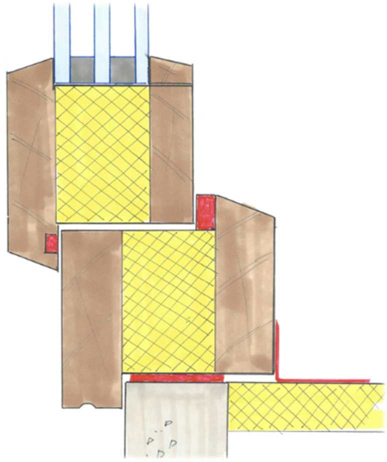
- Ensure that all internal surfaces of pipes and fittings are smooth
- Pipes from all fittings are correctly sized (correct diameter)
- Pipes must be installed at the correct gradient
- The diameter of the soil vent pipe must be correctly sized (Ø110 mm usually) to transport the volume of waste from all fittings attached
- Large radius bends should be installed at turns in the soil vent pipe
- All joints in the piping system are correctly installed
- Soil vent pipe open at top to vent gases / prevents back siphonage.

Any other relevant points

Question 9

(a) Discuss how each contribute to reducing the transmission of sound in the dwelling house.

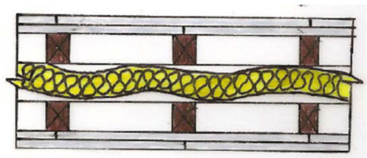
Completeness



- 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.

Any other relevant points

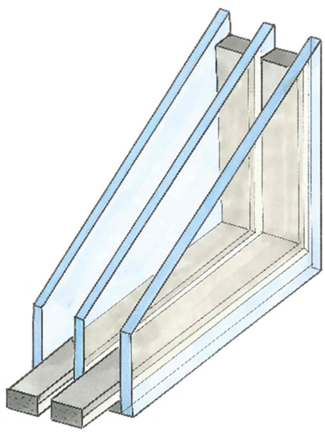
Flexibility



- 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.

Any other relevant points

Isolation

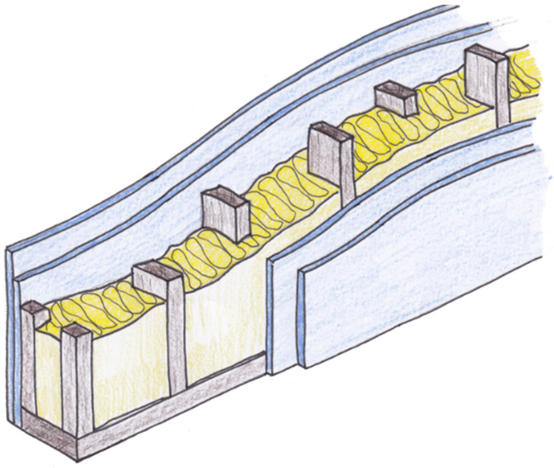


- As sound energy transmits through the different materials in a structure it decreases – sound level drops
- Separating elements of a structure greatly reduces the transmission sound through it.
- Discontinuing a structural element is effective in reducing sound transmission:
  - Double / triple glazing 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.

Any other relevant points

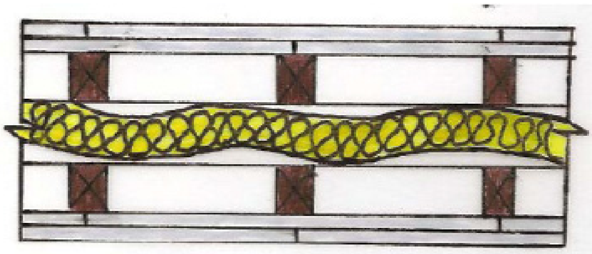
(b) Revised design detailing that will reduce the transmission of sound.

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 increase 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.

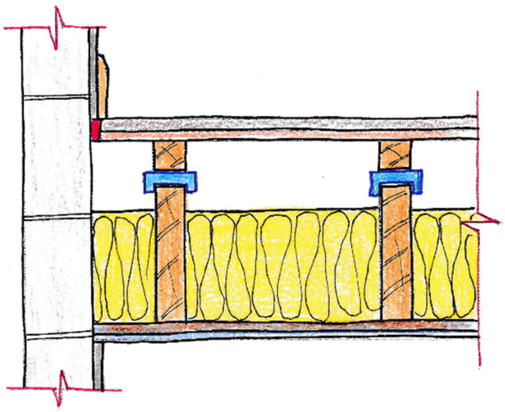
Alternative



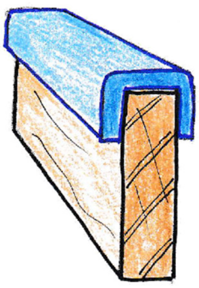
- Construct two separate stud walls in which there is no material in contact – isolation
- An absorbent quilt is placed between the stud wall in the cavity – flexibility.

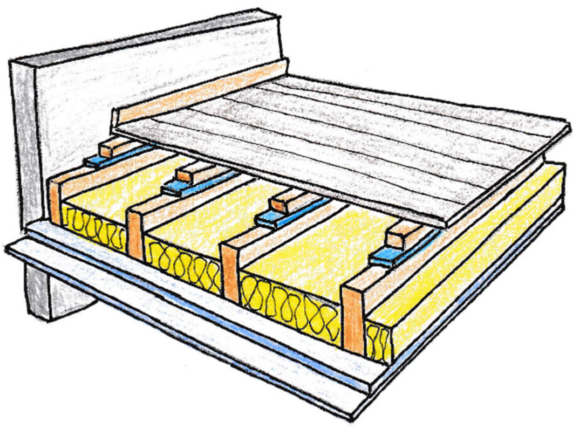
Any other relevant points

First Floor



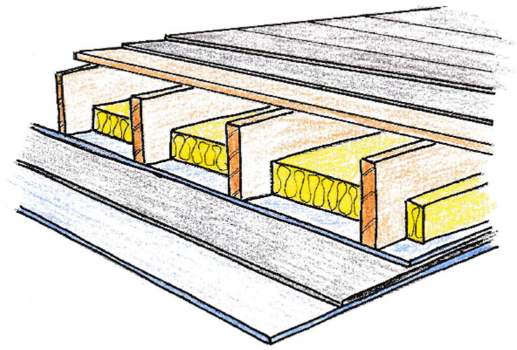
- Acoustic isolation strips are placed over the flooring joists
- The flooring is fixed to battens floated over the acoustic strips
- The flooring above and plasterboard below are sealed and made airtight
- Acoustic matting is placed under the finished floating floor above to reduce the transmission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





Alternative

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



Any other relevant points

(c) Two impacts that sound insulation upgrades will have on the occupants.

- 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.

Any other relevant points

Question 10

(a) Three design considerations when designing a MVHR system for a domestic house.

System design and layout

- Location of the MHVR unit on an internal corner of the external envelope so that the extraction and induction pipes are not on a similar surface (otherwise stale air would be reintroduced into the system through the induction pipe)
- The unit should be located in the internal environment, inside the insulation layer minimising any heat loss
- The design of the ducting layout should be as direct as possible to maximise efficiency of the system. Limit use of 90 degree bends and reduce / lower operating noise
- Ducting configuration layout is individually designed for each house plan
- Careful consideration is given to the ducting materials, sizing, bends and sharps edges when designing the layout
- It is important that ducts are insulated, where necessary, to minimise heat loss through the system and to reduce the risk of condensation
- Room diffusers should be located centrally in rooms to provide equal air quality and flexibility for floor layouts.

Fit for purpose

- MVHR system must be fitted in an airtight house if comfort conditions and efficiency are to be maintained
- The MVHR system sizing and configurations meet the requirements of the house layout and volume
- The system is designed to run efficiently – depending on volume flow, fan performance characteristics, total pressure of ducting, etc.

Year - round operation

- Important that the system is capable of operating throughout the year continuously.
- Incorporate a summer by-pass valve

Accommodation and Access

- MVHR units, their ancillary equipment, and system ducting can take up a significant amount of space through the house which needs to be considered at the planning stage
- In order for the MVHR system to work efficiently it will need to be maintained regularly. Therefore, it is important that the unit be located in an area that can be easily accessed.

System Filters

- The system filters can be easily accessed in the MVHR unit
- Need to plan for at least twice annual changing or every quarter replacement of filters.

Noise

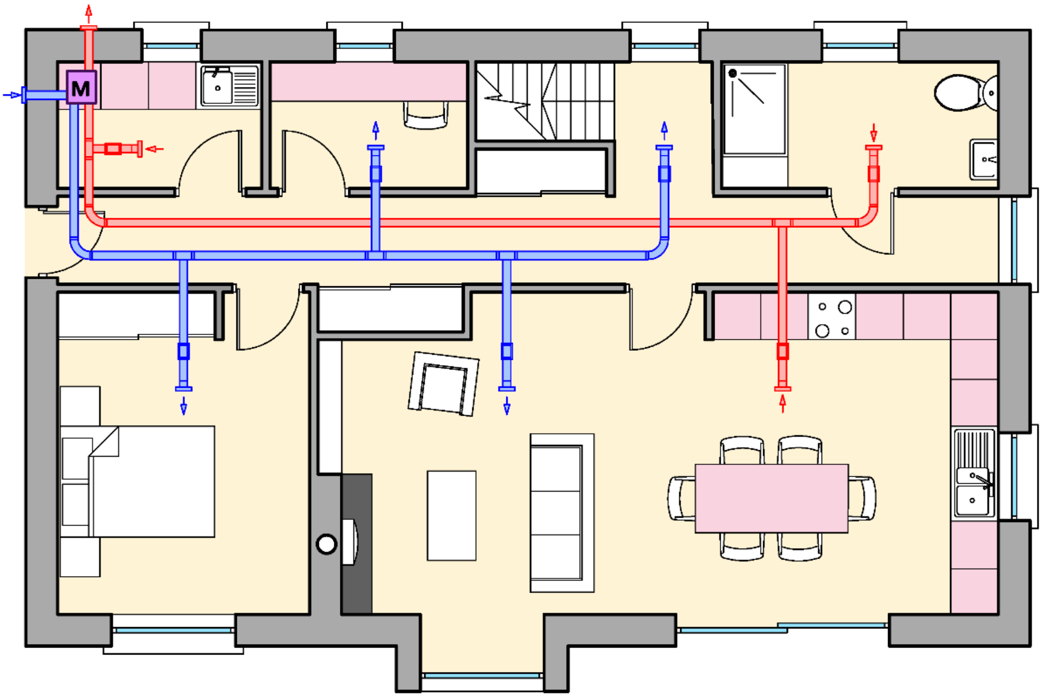
- As noise may be generated from the unit, it would best not to locate the MVHR unit adjacent to sleeping areas
- The MVHR unit should be installed on a solid wall or floor using anti-vibration mounts to reduce noise transmission.

Commissioning and maintenance

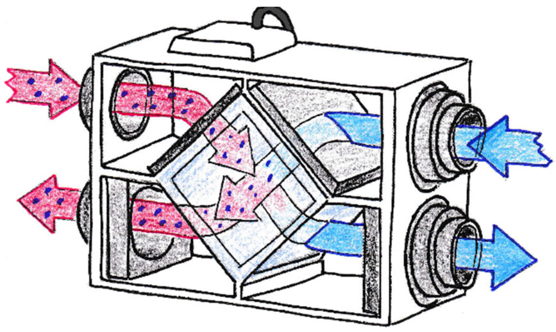
- Following the installation of a MVHR system in a house, it should be commissioned to ensure that it is configured correctly to deliver the design air flows as efficiently as possible
- Planned annual maintenance of the system should be carried out to ensure problem-free efficiency operation.

Any other relevant points

(b) Typical layout for a MVHR system in the given house plan and describe how the system works.



- A Mechanical Heat Recovery Ventilation (MHRV) system works by providing a constant supply of fresh air into the home while extracting warm moist stale air from rooms with high moisture and odour content – kitchen, bathroom, utility area
- Through a system of ducts, fans mechanically supply air to the home and extract the stale air on a continuous basis
- Both the supply and extract fans ventilate at an equal rate meaning that the air coming into and out of the home is balanced
- Warm stale air is extracted out through the system ducting via the MVHR heat exchanger unit
- The incoming fresh air from outside is passed through the heat exchanger, most of the heat energy is transferred from the extract air into the incoming air stream



- The outgoing stale air and incoming fresh air never come in direct contact
- The incoming fresh air passed through a particle filter to remove any dust or pollen before entering the home
- This fresh, clean, heated air is now circulated throughout the home through its own separate ductworks to create and maintain high levels of comfort for the occupants.

Any other relevant points

(c) Two advantages of installing a MVHR system into a domestic house.

- Improves indoor air quality for occupants
- Minimise heat loss – up to 95% of heat that is usually wasted is recovered
- Consistent comfort conditions are provided for the occupants
- Constant supply of fresh, clean, health air into the home
- Occupants in MVHR ventilated home will experience respiratory-related health improvements
- Occupants have more control of their internal living environment.

Any other relevant points

Question 10.

"Worldwide, buildings are responsible for over 40% of the total primary energy use and related greenhouse emissions. Through standard and energy efficiency programs, several countries have succeeded in improving the energy performance of new and existing buildings. Designed and retrofitting electrical power systems to be energy efficient have been the primary components of the efforts to reduce energy use consumption by the built environment."

Adapted from: ***Optimal Design and Retrofit of Energy Efficient Buildings, Communities, and urban centers.***

by Moncef Krarti.

Discuss the above statement in detail and propose three best practice guidelines that would ensure all buildings are retrofitted in the most sustainable way possible to minimise their primary energy use and improve their energy performance.

Discussion of the above statement– such as

- Ireland continues reduce primary energy use of buildings through the implementation of new building standards and retrofit upgrade programmes by the Department of house and its agencies
- Part F and L 2019 Building Regulations reflect the requirements introduced by the Energy Performance of Buildings Directive (EPBD) at EU level which introduces the requirements of nearly zero energy buildings (NZEB)
- Part L (Conservation of Fuel and Energy) of the Building Regulations 2019 sets out the statutory minimum energy performance standards that apply to the construction of dwellings
- The aim of Part L is to limit the use of energy and related carbon dioxide (CO_2) emissions arising from the operation of buildings, while ensuring that occupants can achieve adequate levels of lighting and thermal comfort
- Building Energy Rating (BER) certification scheme was introduced for new dwellings in 2007, which indicates a houses energy performance. BER certification is mandatory whenever a dwelling is commissioned or offered for sale or for rent in Ireland
- Sustainable Energy Authority of Ireland (SEAI) currently offer energy efficiency grants to home owners to upgrade – house insulation, heating controls, heat pumps systems, solar water heating and solar electricity
- Energy efficiency and sustainability should be considered at an early stage of the design process
- There must be a focus on constructing or upgrading the fabric of a building and not rely on renewable sources for BER compliance
- Designers and homeowners must make careful ethical decisions on the fabric of the building – fabric first approach
- Ireland has also made mandatory provision for a reasonable proportion of the remaining energy load to derive from renewable energy sources – 20%
- Designers must give carefully consideration when developing a house design to ensure optimum efficiency of renewables – considering orientation, roof size and angle, position of hot water storage, maintenance and sizing of units
- Change from fossil fuels to green energy derived from the sun, wind and water
- The renovation and re-use of existing buildings is considered a more sustainable approach than a completely new building on a "brown" or "green" field site. Demolition waste has in the past accounted for a large proportion of landfill, while the use of new building materials contributes a large amount of energy use to the building life cycle. A building's embodied energy remains with the building throughout its life cycle.

Three best practice guidelines that would ensure all buildings are retrofitted in the most sustainable way possible to minimise their primary energy use and improve their energy performance – such as

- Retrofitting or renovating an existing property can significantly reduce your annual heating energy requirements and carbon dioxide emissions by between 75 and 90% compared to an average existing building
- Housing continues to pose one of the greatest energy efficiency challenges in Ireland due to the considerable portion of older houses
- Under Part L for existing buildings, major renovation is where more than 25% of the surface area of the building envelope undergoes renovation. This will require that the final energy performance of the completed dwelling should achieve the cost optimal level
- Continue to upgrade the current stock of old housing through deep retrofit (Grant Aided) programmes to current standards
- Government agency (i.e. SEAI) to implement and oversee all energy efficient upgrades to ensure compliance with National standards
- a whole-of -systems team approach needs to be adopted, with all specialists considering the connections between the building form, building components, building envelope, building systems and services to maximise the overall performance of the buildings
- planning authorities to develop and publish clear planning guidelines outlining the requirements for sustainable homes
- incentivise through grants/incentives to improve the energy performance design for all domestic dwellings
- through programmes of education, publish and disseminate easy-to-follow, graphic rich guidelines for the general public on the fundamental benefits of energy efficiency upgrades to homes
- Provide building professionals with training in sustainable design and low energy, airtight construction methods and promote the use of materials with low embodied energy, such as wood cob, rammed earth, hemp-lime.
- High level of insulation should be added to floors, walls and the roof to ensure a high energy efficient envelope
- Reasonable care should be taken to ensure continuity of insulation and to limit local thermal bridging at key junctions (i.e. around openings) - eliminating of all thermal bridges
- Materials should be carefully chosen for each structural element when retrofitting an older building to ensure optimum efficiency and the structure can continue to breath – natural materials such as wood fibre, hemp insulation, thermal lime plaster, sheep wool insulation
- An airtight external envelope which maximises wind tightness must be carefully planned and provided to limit air permeability and uncontrolled ventilation – workmanship must be carefully monitored
- Installation of Mechanical Ventilation with Heat Recovery (MVHR) should be considered to maximise heat efficiency in the home – below 3 $m^3/hr/m^2$ airtightness requires a MVHR
- Upgrade all external doors and windows to current building standards which thermally broken frame and triple glazing or better
- Technologies such as solar panels, heat pumps, photovoltaic panels, wind turbines, geothermal heat and wood pellet burners should be utilised as much as possible
- Each building could be a net producer of energy and a zero-carbon emitter in the future
- Optimise use of resources and embodied energy
- Continue to enhance the National building standards to improve the energy performance of the housing stock
- Specify energy saving electrical fittings, LEDs, A-rated appliances

Any other relevant, cogent, well-argued points.

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination, 2020

Construction Studies

Theory – Higher Level

Marking Scheme

Question 1

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) Vertical section through one half of the roof structure ***External Wall Roof structure Eaves detail 11 × 4 marks + 4 marks***	
External Wall • External acrylic render • External insulation • Concrete block on flat • Internal plaster / Air barrier membrane • Insulated service cavity • Plasterboard/skim	**4** **4** **4** **4**
Roof structure • Wallplate 100 × 75 • Rafter 200 × 50 • Ceiling joist • Purlin 225 × 75 • Strut • Hanger • Collar tie • Ridgeboard • Insulation	**4** **4** **4** **4**
Eaves detail • Facia and gutter • Ventilation • Breather membrane • Slating batten 50 × 30 • 3 courses of slates	**4** **4** **4**
Four typical dimensions (1 × 4 marks)	**4**
Scale - 4 marks **Drafting** - 4 marks *Excellent: 8 Good: 6 Fair 4*	**8**
(b) Design detailing to ensure the ventilation of the roof (4 marks)	
Design detailing (2 × 2 marks)	**4**
TOTAL	**60**

Question 2

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) Best practice guidelines when using scaffolding	***(6 × 7 marks)***
Erecting scaffolding	
Guideline **1** (3 for note, 4 for sketch)	**7**
Guideline **2** (3 for note, 4 for sketch)	**7**
Accessing scaffolding	
Guideline **1** (3 for note, 4 for sketch)	**7**
Guideline **2** (3 for note, 4 for sketch)	**7**
Use of working platforms	
Guideline **1** (3 for note, 4 for sketch)	**7**
Guideline **2** (3 for note, 4 for sketch)	**7**
(b) Responsibilities of a Health and Safety officer	***(3 × 6 marks)***
Responsibility **1** - *(3 for point, 3 for discussion)*	**6**
Responsibility **2** - *(3 for point, 3 for discussion)*	**6**
Responsibility **3** - *(3 for point, 3 for discussion)*	**6**
TOTAL	**60**

QUESTION 3

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) Three design considerations when modifying the internal layout	***(3 × 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**
(b) Revised internal house layout	***(30 marks)***
Revised internal layout (meet the needs of a person with limited mobility + open-plan kitchen/living space)	**15**
Note for design Consideration **1**	**3**
Note for design Consideration **2**	**3**
Note for design Consideration **3**	**3**
Note for Open-plan kitchen/living space	**3**
Note for justification	**3**
(c) Advantages and disadvantages of open-plan living space	***(12 marks)***
Advantage **1**	**3**
Advantage **2**	**3**
Disadvantage **1**	**3**
Disadvantage **2**	**3**
TOTAL	**60**

QUESTION 4

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) Importance of each characteristic for a vacant site in an urban area	***(6 × 4 marks)***
Materials and finishes	
Notes	**4**
Sketches	**4**
Shape and form	
Notes	**4**
Sketches	**4**
Streetscape	
Notes	**4**
Sketches	**4**
(b) Proposed external design for a house to be located on the vacant site	***(24 marks)***
Notes	**6**
Sketches	**14**
Justification	**4**
(c) Advantages of developing vacant sites in urban areas	***(12 marks)***
Advantage **1** *(3 for point, 3 for discussion)*	**6**
Advantage **2** *(3 for point, 3 for discussion)*	**6**
TOTAL	**60**

QUESTION 5

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) U-value of concrete ground floor (11 points × 3 marks)	
Surface resistance	**3**
Oak flooring	**3**
Sand/cement fine screed	**3**
Floor insulation	**3**
Concrete floor slab	**3**
Radon barrier	**3**
Sand blinding	**3**
Hardcore	**3**
Subsoil	**3**
Total resistance (R)	**3**
Calculation of U- value	**3**
(b) Annual heat loss through concrete floor (5 × 3 marks)	
Heat loss formula and calculations	**3**
Heating duration for one year	**3**
k/Joules calculation for one year	**3**
Litres of oil for one year	**3**
Annual cost of heat loss	**3**
(c) Best practice design detailing to prevent thermal bridge (12 marks)	
Design detail	
Notes	**4**
Sketch	**8**
TOTAL	**60**

QUESTION 6

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) ***Advantages and disadvantages of retrofitting the vernacular cottage***	***(4 × 3 marks)***
Advantage **1**	**3**
Advantage **2**	**3**
Disadvantage **1**	**3**
Disadvantage **2**	**3**
(b) Three features of low environmental impact design	***(6 × 5 marks)***
Design Feature 1	
Notes	**5**
Sketches	**5**
Design Feature 2	
Notes	**5**
Sketches	**5**
Design Feature 3	
Notes	**5**
Sketches	**5**
(c) Two modifications to further reduce environmental impacts of the house	***(6 × 3 marks)***
Modification 1	
Notes	**3**
Sketches	**3**
Modification 2	
Notes	**3**
Sketches	**3**
Justification **1**	**3**
Justification **2**	**3**
TOTAL	**60**

Question 7

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) ***Vertical section through ground floor, hearth with a stove and chimney*** ***Ground floor Hearth/Stove Chimney***	***9 x 5 marks***
Ground Floor • 200 mm Internal wall • Concrete floor / subfloor • Floor insulation • Concrete screed • Radon /DPM • Insulated block • Airtightness • 20 mm Hardwood floor • Plaster	**5** **5** **5** **5**
Hearth / Stove / Chimney • Hearth • Stove • 150 mm Cast iron flue • Lintel / flue gatherer • Chimney blockwork • Metal flue gatherer • Flue liners • Lime sand fill / vermiculite • Internal plaster	**5** **5** **5** **5** **5**
Three typical dimensions (3 × 1 mark)	**3**
Scale and drafting marks *(Excellent, Good, Fair)* *8 6 4*	**8**
(b) Typical detailing to provide an independent air supply to the stove	***(4 marks)***
Independent air supply design detail	**4**
TOTAL	**60**

Question 8

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) Considerations when locating a bathroom on the first floor	***(4 × 5 marks)***
Consideration 1	
Notes	**5**
Sketches	**5**
Consideration 2	
Notes	**5**
Sketches	**5**
(b) Above-ground pipework necessary for the safe removal of waste	***(28 marks)***
Typical layout above-ground: (to include shower, wash basin, water closet and kitchen sink)	
Notes	**12**
Sketch	**12**
Typical dimensions - Any four	**4**
(c) Considerations to minimise blockages occurring	***(2 × 6 marks)***
Consideration **1** - *(3 for point, 3 for discussion)*	**6**
Consideration **2** - *(3 for point, 3 for discussion)*	**6**
TOTAL	**60**

QUESTION 9

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) How each contribute to reducing the transmission of sound	***(6 × 4 marks)***
Completeness	
Notes	**4**
Sketches	**4**
Flexibility	
Notes	**4**
Sketches	**4**
Isolation	
Notes	**4**
Sketches	**4**
(b) Revised design detailing that will reduce the transmission of sound	***(28 mark)***
Stud Partition detail	
Note	**4**
Sketch	**6**
Floor detail	
Note	**4**
Sketch	**6**
Materials to be used	**4**
Typical dimension	**4**
(c) Benefits that sound insulation upgrades will have on occupants	***(2 × 4 marks)***
Benefit **1** - *(2 for point, 2 for discussion)*	**4**
Benefit **2** - *(2 for point, 2 for discussion)*	**4**
TOTAL	**60**

QUESTION 10

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) ***Three design considerations when designing a MVHR system***	***(6 × 4 marks)***
Design consideration 1	
Notes	**4**
Sketches	**4**
Design consideration 2	
Notes	**4**
Sketches	**4**
Design consideration 3	
Notes	**4**
Sketches	**4**
(b) Typical layout for MVHR system and describe how the system works	***(24 marks)***
Line diagram of the given house	**4**
Location of MVHR unit	**4**
Layout for the system ducting	**4**
Direction of airflow in ducts	**4**
Description of how the system works	**8**
(c) ***Two advantages of installing a MVHR system***	***(2 × 6 marks)***
Advantage **1** - (3 for point, 3 for discussion)	**6**
Advantage **2** - (3 for point, 3 for discussion)	**6**
TOTAL	**60**

Question 10 (Alternative)

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) Discussion of Statement	***(3 × 10 marks)***
Discussion Point **1** *(4 for point, 6 for discussion)*	**10**
Discussion Point **2** *(4 for point, 6 for discussion)*	**10**
Discussion Point **3** *(4 for point, 6 for discussion)*	**10**
(b) Three best practice guidelines to sustainable building	***(3 × 10 marks)***
Guideline **1** *(4 for point, 6 for discussion)*	**10**
Guideline **2** *(4 for point, 6 for discussion)*	**10**
Guideline **3** *(4 for point, 6 for discussion)*	**10**
TOTAL	**60**