Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2023

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.

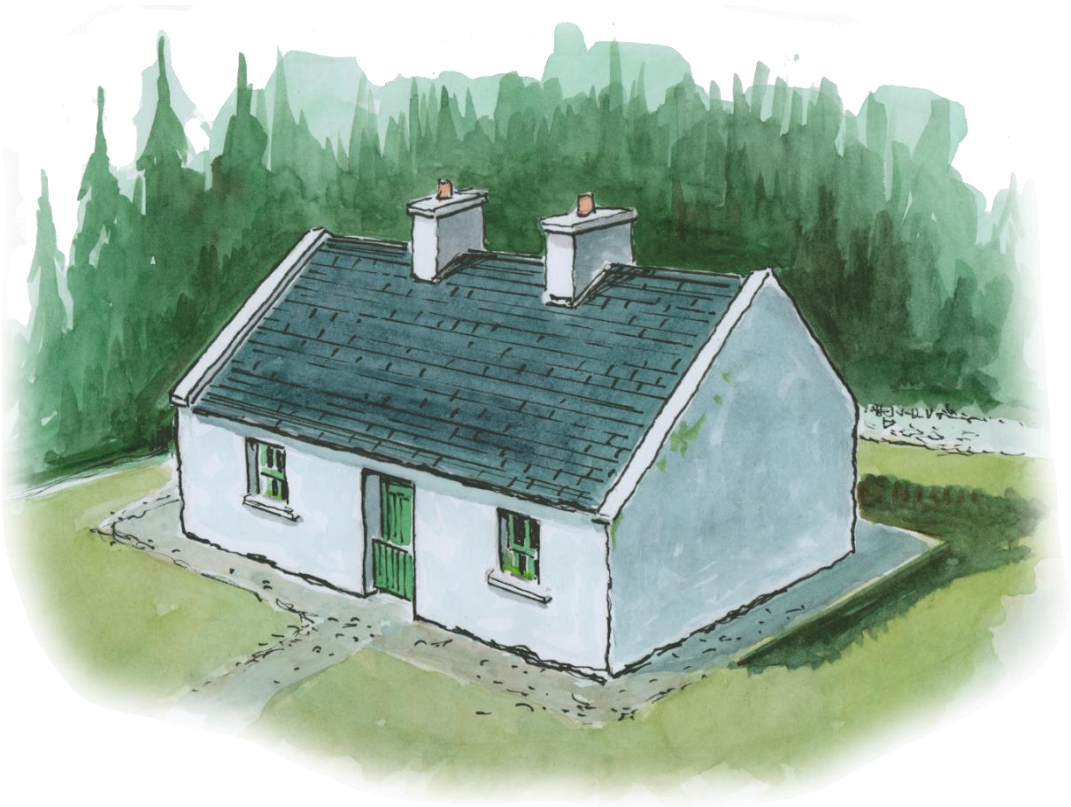
In the case of marking schemes that include model solutions or answers, it should be noted that these are not intended to be exhaustive. Variations and alternatives may also be acceptable. Examiners must consider all answers on their merits, and will have consulted with their Advising Examiners when 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, 2023



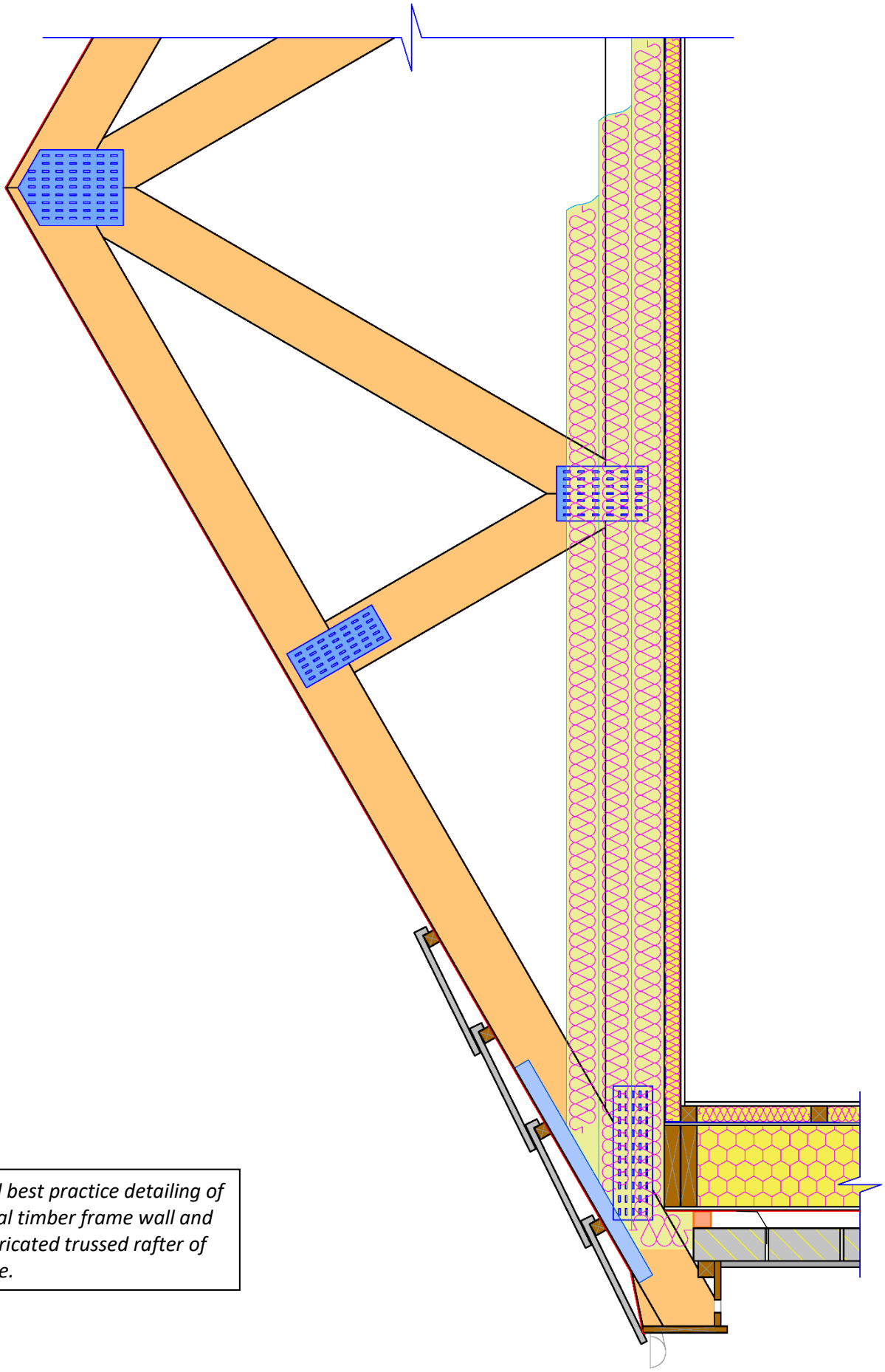
Construction Studies

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 trussed roof and external wall of a house.



Typical best practice detailing of external timber frame wall and prefabricated trussed rafter of a house.

External timber frame wall - typical detailing

- External render
- Concrete block + tie
- Firestopping / cavity closer
- Air space / residual cavity
- Breather membrane
- Racking board
- 250 × 50 mm Stud
- Insulation
- Air barrier membrane
- Insulated service cavity
- Plasterboard / skim.

Roof structure- typical detailing

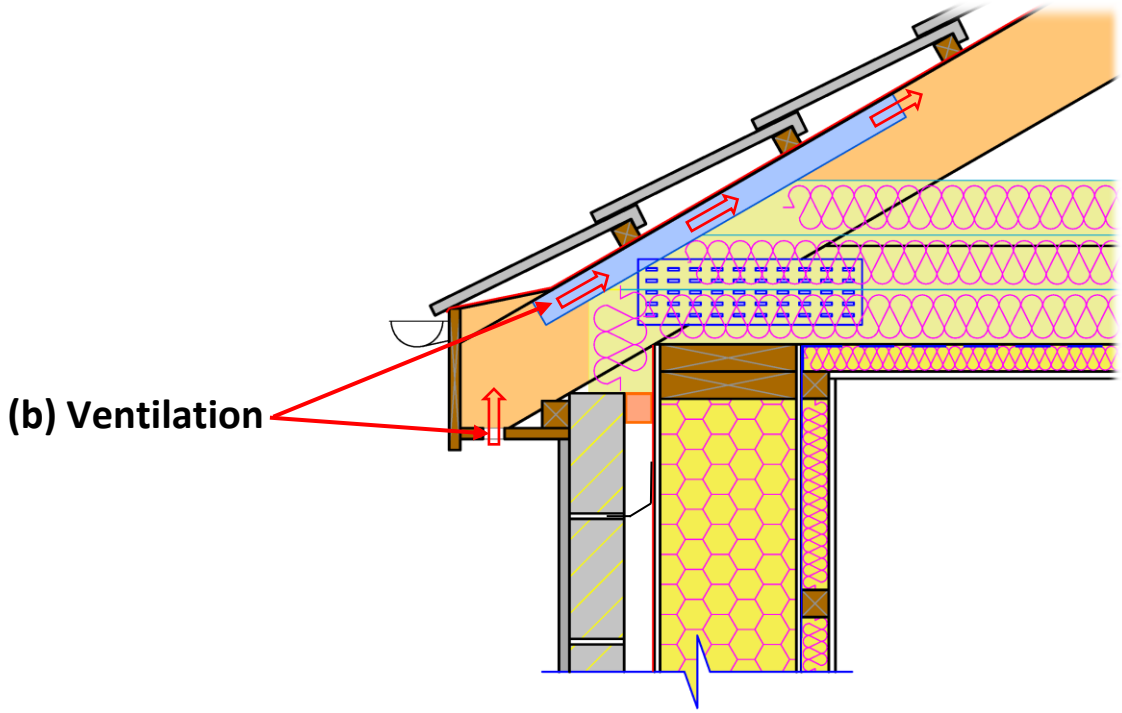
- Prefabricated roof truss 200 × 50 mm @ 400 - 600 mm centres
- Gang nail plates
- Attic insulation
- Insulated plasterboard (50 mm insulation + 12.5 mm plasterboard)
- Air-barrier / airtightness membrane / joint taping

Eaves detail- typical detailing

- Fascia / soffit / gutter (Any two)
- Tilting fillet
- Ventilation
- Wind tightness barrier
- Roof breather membrane
- Tiling battens 40 × 40 mm @ 400 mm centre
- Counter battens
- Three courses of concrete tiles

Any other relevant points.

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



Question 2

(a) Discuss the importance of maintaining a safe working environment on a construction site.

Communication

- Important that open and clear communication takes place between co-workers for teams to coordinate together so work is undertaken in a safe work place
- Important that regular site meetings and communication takes place so all onsite workers and neighbouring building residents know of hazardous operations being undertaken at times during the construction
- Clear visible and easy to understand signage should be exhibited at entrance to site and throughout construction site
- Clear concise communication should be given to inexperienced workers
- Establish a formal communication chain within a construction site. All site workers should have a point of contact to receive and give the accurate information to the correct people at the right time
- Have one central location where all project communication can be found – e.g. a site office or mobile app
- Always have a designated safety officer on site to ensure that both verbal and virtual communications are coordinated
- All communications should be clear, concise, and to the point using understandable terms to avoid misinterpretation which may lead to accidents

Any other relevant points:

Supervision

- Supervision of inexperienced workers by experienced workers should be established to ensure safe and best practice is undertaken
- Designated site safety supervisor should be adequately trained to carry out supervisory responsibilities on site
- Supervision of hazardous operations should be in place to reduce risk of injury to other workers and to the public
- Supervisors on a constructions site ensure that health and safety is effectively managed. Their role involves planning and allocating work, making decisions, monitoring performance and compliance, providing leadership, and building teamwork. Their roles and responsibilities have the potential to adversely impact safety performance
- People in a supervisory role should be provided with regular appropriate training courses to ensure they have knowledge of local hazards and control measures; and the experience and credibility to gain respect from others to enforce the rules effectively
- Supervisors also need to have other skills such as leadership, communication and ability to direct teams
- Young inexperienced workers may need very close and constant supervision
- High-risk activities will need to be closely monitored by supervisors

Any other relevant points:

Training

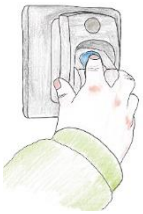
- All workers on a construction site are legally obliged to possess a current valid Safe Pass Certificate
- Safety officer ensures all workers are properly trained to carry out tasks and identify hazards to reduce injuries to construction workers
- Ongoing focussed training required to guard against complacency of experienced workers
- Inexperienced and new workers to site should be mentored by experienced workers
- Younger and inexperienced workers require additional training and support to highlight hazardous operations and processes
- Training highlights possible risks on site and develops an awareness among workers
- Young workers in particular are at high risk on a construction site and may need additional training

- Training should be provided to all workers before operating machinery or undertaking new procedures or practices

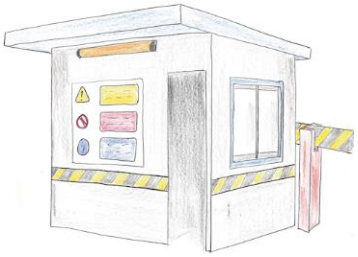
Any other relevant points

(b) Two best practice guidelines that should be observed for each on a construction site.

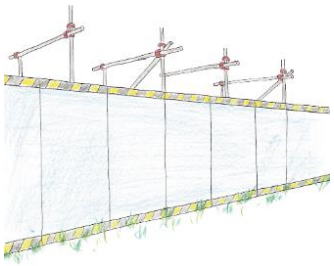
Site access



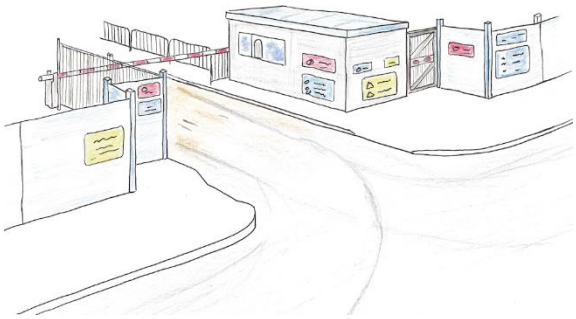
- Site access should be controlled with security fencing and/or hoarding to prevent unauthorised personnel and vehicles from accessing the site
- All signs must be clearly visible and comply with standards, both at the entrance point and on its approach to warn people of its existence
- Random testing of construction workers should be undertaken to ensure personnel have the ability to carry out onsite operations



- Safe pass and CSCS accreditations should be inspected of any new construction personnel
- All new personnel to the site should undergo a site induction by the safety officer
- Location and contact details of Site Health and Safety officers, contact details and location of local hospital should be highlighted
- The entrance and perimeter of a site must be identified by suitable signs
- There should be appropriate sight lines visible for all vehicles exiting the site
- If possible, the site should be fenced to control access, both for safety purposes, and to prevent damage, theft or vandalism
- Hoarding is a temporary construction, of at least 2.4m that is more difficult to climb than fencing and prevents viewing of the site interior



- Designated turnstiles, security gates, facial recognition technology and site security staff used to ensure that only authorised personnel can enter and exit
- Electronic access control systems (ACS) such as PIN codes, magnetic identity cards, proximity tokens or biometric devices can also be used to control access
- ACS provides up-to-date and accurate accounting for on-site personnel and can assist with controlling health and safety

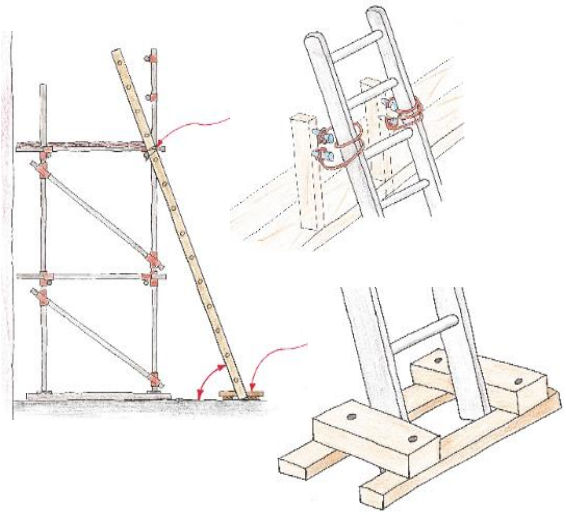


- A sign-in and reception area - located at the site entrance to document any visitors to the site
- The surface at the site access point should collect and keep sediment carried by tires, tracks, or other surface contact earthmoving vehicles so as not to bring it out onto the public road

Any other relevant points or sketches

Using a ladder

- A ladder should only be used after a risk assessment has been undertaken and the associated risks are deemed low and the duration of use, short
- A pre-use check should be carried out on the ladder prior to use and at the beginning of each day
- The 1-in-4 rule should be used to ensure the ladder is at the safest angle. This is where the ladder should be one unit of measurement out for every four units up (a 74^{o} angle)
- The ladder should be secured at the bottom and top if it is going to be a permanent structure on site to go between scaffolding levels
- A ladder should only be used on firm level ground. The ladder should be secured to prevent it from slipping either outwards or sideways
- The location of overhead power lines should be noted. No work within 6 m horizontally of any overhead power line unless it has been made dead
- If the task requires being on the ladder for 30 minutes or more, alternative equipment should be used
- The ladder should extend at least 1 metre or three rungs above where the operator is working
- Always maintain three points of contact when climbing or descending
- When carrying something it is essential that the free hand should always be placed on the underside of the ladder uprights. This technique has the advantage of allowing the individual to slide their free hand along the upright which maintains contact with the ladder while climbing or descending



Any other relevant points or sketches

(c) Two reasons why all construction sites must have a safety statement.

- It is a legal requirement - under the Safety, Health and Welfare at Work Act 2005, every place of work must prepare a Safety Statement
- A Safety Statement safeguards the health and safety of all workers and visitors on a construction site
- A Safety Statement identifies hazards and risks on a construction site. The Statement puts a plan in place to control the hazards and reduce the risk of injuries if an accident was to occur
- All risk assessment results are recorded in the site safety statement
- Health and Safety Authority inspectors visiting construction sites will want to inspect and assess the safety statement
- Assess the level of risk associated with each hazard
- A safety statement helps reduce injury to workers, hence reducing loss of productivity, compensation pay-outs and increased insurance costs
- Employers are ethically bound to do all they can to ensure that employees do not suffer illness, a serious accident or death
- Moral obligation to help prevent injury or ill health at work

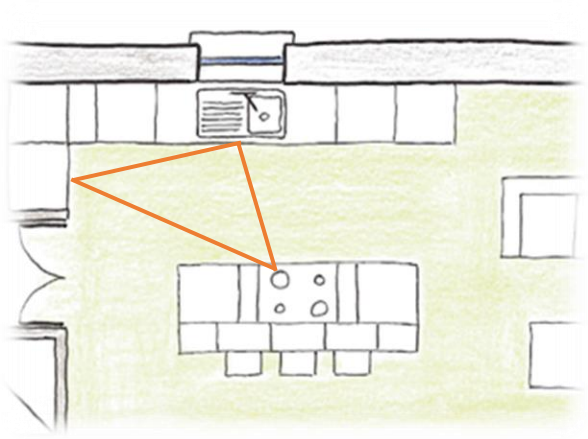
Any other relevant points

Question 3

(a) Three considerations for the proposed new kitchen/dining and living area on the first floor.

Primary functional needs of a kitchen/dining/living area:

The Work Triangle



- The work triangle includes three major points of contact in a kitchen - the hob, sink and fridge. The work triangle is based on the idea that a person should be able to access these points of contact with ease
- Ensure there is enough workspace to carry out all tasks necessary in the kitchen

Circulation Space

- Provide adequate circulation space around the kitchen area so that more than one person can work freely without causing obstructions
- In the dining area, there should be enough circulation space around the table so that chairs can be used without causing an obstacle
- There should be clear unobstructed circulation space to the selected egress points to enable exit in the event of a fire

Access & Egress

- In the event of a fire, there should be an alternative method of egress other than the entrance point
- A means of moving freely and independently from the ground floor to first floor for all occupants
- Upstairs windows or doors should meet the required regulations to function as an exit point
- Should meet the current building fire regulations

Services

- The location of electrical sockets and outlet points needs to be carefully considered in collaboration with the kitchen design
- It is best practice to have the hob, dishwasher, oven, microwave, and fridge with their own isolation switch as they have high electrical load. In the event of a fault with these appliances, the isolation switch would allow the kitchen to continue to function while the appliance is being repaired
- Allow for future flexibility and multi-functionality of the space by installing multiple sockets, light fittings, TV cables etc. This will future proof the space and prevent the need to install additional cables at a later stage
- Locate the sink near existing water/waste water pipes where possible
- Installing a service shaft to lift grocery bags up and waste refuse bags down

Human Sensory Experience:

Visual

- Exposure to natural light improves our circadian rhythms and sleep patterns, helps us to focus, enables us to be more productive and improve wellbeing
- Natural sunlight is important to our physical and psychological wellbeing
- Have large windows facing the south and towards the sea views. If sun is entering this space all day, it is naturally heating the space and reducing the need for artificial light or heat. This reduces energy bills and lowers the homes impact on the environment
- Alternative methods of reducing solar glare until trees grow to full height
- Take full advantage of the raised space and its connection with nature - being able to see plants, hear birds, observe change of seasons etc. reduces stress, improves mental health - a positive impact on health and well-being

Auditory/Tactile

- Triple glazed windows with flexible seals particularly facing the sea
- Good thermal qualities providing comfort to the occupants
- Adequate sound insulation in the floor to prevent sound transfer to bedrooms below
- High levels of insulation in the outer envelope especially at coastal region

Olfactory:

- An MHRV system to remove odours and moisture from the kitchen while providing fresh filtered air to the rest of the space
- Opening windows to allow natural airflow and fresh air inside the house and allow occupants experience the smells of the sea

Any other relevant points

(b) Revised internal layout for the kitchen/dining and living area that incorporates each of the design considerations.

The Work Triangle

- Incorporate a work triangle into the kitchen design to improve functionality
- Provide adequate workspace for the users

Circulation Space

- Provide a minimum of 1.2 metres between opposite kitchen workspaces to allow for functioning circulation space
- Adequate circulation space around the kitchen area so that more than one person can work freely without causing obstructions
- Circulation space around the dining table
- Opening windows and doors are not obstructed with furniture in the event of a fire
- Ample circulation space for people with impaired mobility

Access & Egress

- More than one exit point – via a door or opening window
- Space designed to meet fire regulations

Services

- Sink on the outer wall at the location of an existing waste water/fresh water outlet point from the existing toilet
- Service shaft to help lift heavy items
- Ample electricity points identified to service all areas for flexibility in design

Human Sensory Experience:

Visual

- Increase the size of the windows facing south to maximise solar gains and natural light
- Windows facing the sea (East) to be increased/created to have maximum exposure to the sea views and nature, enhancing the occupant's health and wellbeing
- Overhangs/brise soleil to the south to reduce glare and overheating during summer
- Lower cill levels to allow daylight and sunlight to penetrate deeper into the house
- Create a place to relax where the individual is not overlooked by neighbours

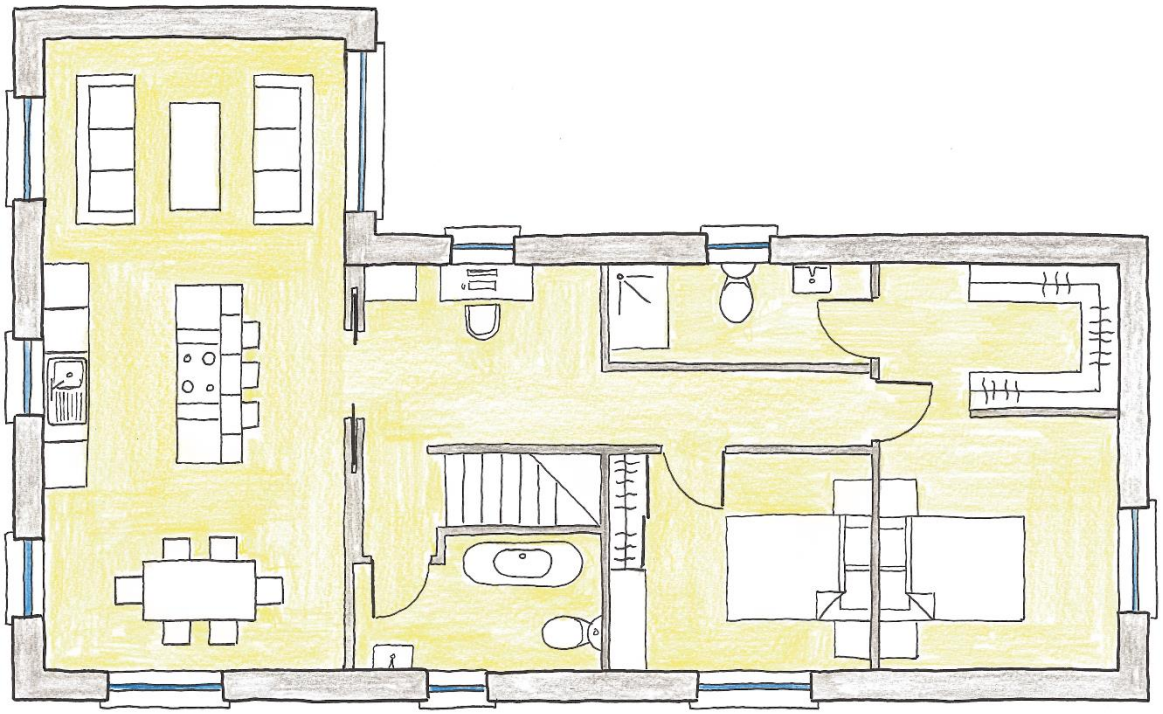
Olfactory

- MHRV system installed throughout the house to remove odours and moisture from the kitchen while providing fresh filtered air to the rest of the space
- Opening windows allowing natural airflow and fresh air inside that mimic the outside environments by the sea

Auditory/Tactile

- Triple glazed windows installed
- Additional insulation added to the envelope of the room to prevent noise pollution to the rest of the house
- Added insulation also provides thermal comfort to the occupants
- Construction of high thermal mass element so that its regulatory properties can increase the internal comfort levels and reduce overheating

Any other relevant points or sketches



(c) Two advantages and two disadvantages of locating a kitchen/dining and living area on the first floor of a house.

Advantages

- Better unobstructed views to the outside surrounding environment
- Greater use of natural light in the rooms that are used primarily during the daytime hours

- Rooms that don't need light during the daytime hours: bathrooms, bedrooms, store rooms can be located on the ground floor
- Useful solution on difficult sites that are steep or have restricted ground floor space
- Living areas on the first floor of a house will have greater privacy from neighbouring two-story dwellings. Traditionally, living rooms on the ground floor use hedges, fences and curtains which in turn block out the view and light

Any other relevant points

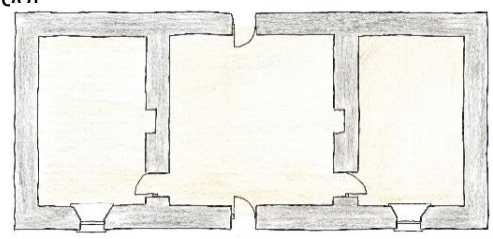
Disadvantages

- Kitchen leaks can have a more damaging effect to rooms beneath compare to if the kitchen was located on the ground floor
- The house is not futureproofed for increased mobility needs in later life. Persons with reduced mobility will find it difficult to use stairs regularly throughout the day for the use of the kitchen
- Installing new appliances or furniture is more difficult when the main living rooms are up a flight of stairs
- A kitchen and social rooms located on the first floor will have no access to the garden and outdoors unless expensive balconies are installed at the design stage
- Extra costs are associated with having living and kitchen on the first floor. Extra supports for the kitchen appliances will be required as well as improved sound insulation to reduce noise transmitted to the bedrooms beneath

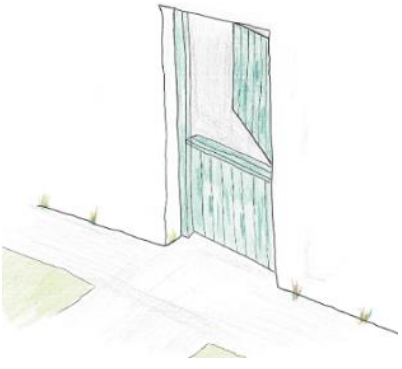
Any other relevant points

Question 4

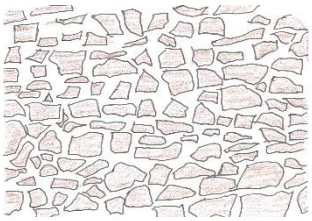
(a) Three features of vernacular Irish architecture evident in the cottage.



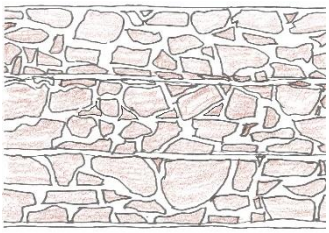
- Single storey structure with a steep pitched simple form roof
- The position of the chimney relative to the front door identified the two types of vernacular dwelling found throughout the Irish landscape. (Direct Entry Type cottage and Lobby Entry Type cottage)
- The proximity of the two chimneys to the front door shown in the graphic suggests this is a Direct Entry Type dwelling
- Rectangular, narrow and one room deep. Narrow design was due to the scarcity of timber for roofing
- Main entrance and window openings placed on the long e of the dwelling. These were relatively small in scale which helped to minimise weakening the walls
- A centrally placed chimney to provide heat, meal preparations and an evening communal gathering point for the occupants
- A half-door construction or half door placed outside the full door rather than the door cut in half. For protection from the weather
- Vernacular cottages were built of local stone. In most circumstances these external stone walls would be rendered in a lime render, inside and out



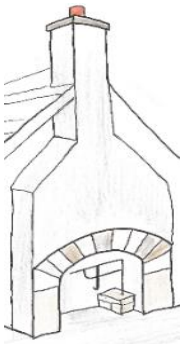
- Uncoursed, random rubble stonework was generally rendered
- Coursed, random rubble stonework was generally left exposed and very much higher quality stonework
- Lime render is breathable and facilitated rain-soaked walls to release the trapped moisture to the outside
- The external walls were whitewashed with lime wash every few years hence the Irish landscape was dotted with such whitewashed buildings
- Lime wash is caustic, and will burn skin if in contact. It was used because it was cheap, readily available and had the ability to act as a disinfectant
- Windows were timber & typically sash type frames with wide interior cills due to the thickness of the walls
- Size and number of windows were dictated by practicality (protection from the elements) and a window tax
- Window cills were of local stone, limestone/granite and were chunky in thickness c.100mm
- Natural slate sourced from a local quarry
- Traditional Irish vernacular buildings used a flush verge to gable walls. This verge was made from lime mortar and again was breathable
- The Void to Mass ratio of the two windows shown in the front elevations is low, c. 1:4, and is typical of Irelands historic vernacular dwellings - where protection from the elements overrode any appreciation of the landscape
- The sliding sash windows shown have four small panes of glass and this feature is typical of such rural dwellings
- Sash windows from c.1850 generally had joggled sashes. Generally, sash windows prior to c.1850 did not have joggles or horns



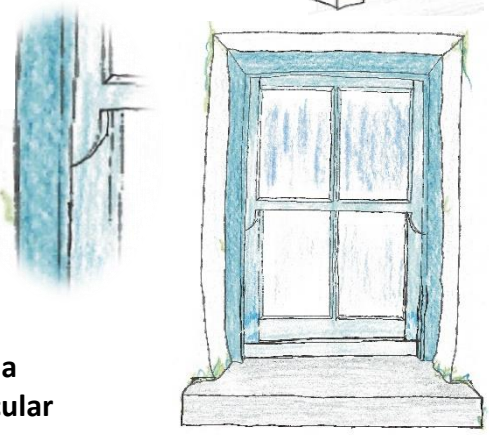
Uncoursed random rubble stonework



Coursed random rubble stonework



Joggled/Horns sash windows.

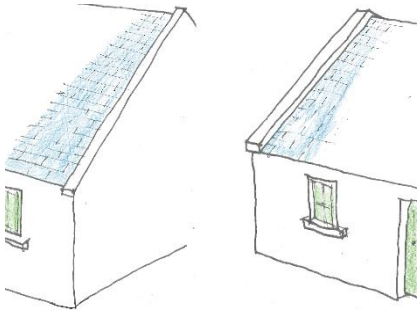


Any other relevant points or sketches

(b) Discuss the importance of each when carrying out a refurbishment of an old cottage built in the vernacular tradition.

Choice of materials

- Careful examination of existing cottage to determine what materials can be reused and repaired
- Replace any beyond repair materials with similar from architectural salvage to maintain the discoloration (patina) of age and respect the character of the house
- Materials that cannot be repaired should be sourced from the local surrounding area to tie in with the vernacular traditions of the design evolving from surrounding area
- Cement based products should be avoided as they lock moisture in. Permeable materials such as lime render and lime mortar, should be used instead to allow the structure to breathe



Local - Natural Quarry Slate & Flush Verges

- Surfaces are significant elements to the cottage vernacular character. Where possible, it is often better to leave well enough alone than to strip back the patina of age
- Any new materials and elements should be carefully considered as to the aesthetic impact it will have on the final cottage appearance

Any other relevant points

Crafts skills

- Great care must be taken with repairs and alterations so not to take away from the character of the cottage. Only experienced crafts persons should be employed to ensure the vernacular cottage retains its quality and features
- Skilled labour being used on the cottage should have knowledge of regional traditions and techniques
- Refurbishments are usually highly destructive, an approach of only repairing what cannot be kept should be taken, for example, patch repair bottom of doorframe instead of the complete doorframe
- Engage Conservation Specialists that have undertaken the RIAI accredited Conservation course
- Employ local tradespeople who still use the skills parallel to when the cottage was first erected such as stone masons using lime mortar and plasters using lime plaster
- Find craft skilled personnel who are willing to work on the project using the correct materials and techniques to restore the cottage while retaining its original character

Any other relevant points

Respect for local character

- Vernacular design evolved from its surrounding environment, giving the building a pleasant appeal on scale and form
- Vernacular cottages were built from materials gathered from the nearby countryside, this gave a local distinctiveness and character to local villages and individual buildings
- Vernacular architectural features and form evolved in regions differently, depending on the landscape. What was known traditionally to provide a dwelling type that offered shelter and protection from the elements was passed on and replicated. Over centuries differing styles and features in different regions display a uniqueness worth preserving
- Houses were built using local materials, refurbishment should reflect this approach as far as possible through research and investigation of local dwellings from that era
- No typical approach to eco-refurbishment to suit every cottage, best practice approach requires careful planning and research to ensure that the building retains its historic appeal
- A holistic approach is needed to balance the particular needs and history of a traditional cottage with environment concerns and current building regulations
- Vernacular cottages have lasted centuries because of their simplicity in design. Refurbishment should respect this viewpoint and keep the materials, approaches and detailing as simple as possible
- The “fabric first” approach involves upgrading the building fabric to reduce the need for fossil fuels for heating, to conserve energy, reduce carbon emissions and to future proof the dwelling
- Conservation officers, architects and engineers with vernacular design experience should be consulted to give best approach guidelines and practices to refurbishment projects
- Balancing the needs of the cottage now, compared to when it was built requires sensitivity by all involved in the refurbishment

Any other relevant points

(c) Two reasons to refurbish and maintain traditional Irish cottages.

- The reuse of existing buildings can help reduce the demand for new housing in the area. The existing building can be refurbished and provided to new occupants in the community quicker than a full new build dwelling
- An existing building will in most situations obtain planning permission sooner than a 'New Build'
- The traditional Irish cottage is a visual language of the original building location. It was not designed by an architect but instead the design and form happened casually because of the needs to have a dwelling in a certain place. This gives us an insight into the community and traditions of the locality from the past
- By reusing and upcycling the existing cottage, it reduces embodied carbon as the foundations, floors, walls, and roofing material is already there. The greenest building is the one that is already built
- The wider community benefits from refurbished vernacular dwellings that might otherwise be neglected and become dilapidated. An increase in population and visual appeal to the area will help to rejuvenate the community
- Maintaining our traditional buildings can contribute to increased tourism and consequently greater spending in the locality, increasing local employment and reducing the need for migration or emigration

Any other relevant points

Question 5

(a) Calculate the U-value of the flat roof.

Material Element	Conductivity k	Resistivity r	Thickness T(m)	Resistance R
External resistance				0.048
Waterproof covering		6.250	0.002	0.013
Roof insulation	0.022	45.455	0.150	6.818
Plywood decking	0.130	7.692	0.020	0.154
Clear cavity				0.170
Ceiling insulation	0.022	45.455	0.05	2.273
Plasterboard	0.250	4.000	0.0125	0.050
Internal resistance				0.122
			Total R =	$R^t = 9.647$
Formulae: **R=T/k** **R=T × r** **r=1/k** **U= 1/R^t**				
U-value: U = 1 / 9.647 = 0.104 W/m^2 ^{0}C				
			U-value =	**0.104 w/m^2 ^{0}C**

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

- Heat lost through flat roof:
  Heat loss formula: = U -Value × area × temp. diff
  0.104 × 38.25 × (18 – 5) = 51.714 Watts (Joules / sec)

- Heating period p/a:
  60 × 60 × 7 × 8 × 36 = 7,257,600 seconds (2,016 hours)

- Kilo joules p/a:

$$\frac{7{,}257{,}600 \times 51.714}{1000} = 375{,}319 \text{ kJ/sec}$$

- Litres p/a: (Note: Calorific value of 1 litre oil = 37350 kJ)

$$\frac{375{,}319}{37{,}350} = 10.04 \text{ litres}$$

- Cost p/a: (Note: 1 litre of oil costs €1.25)

10.04 **× 1.25 = €12.53**

Cost of heat loss annually through roof = €12.53

Alternative method:

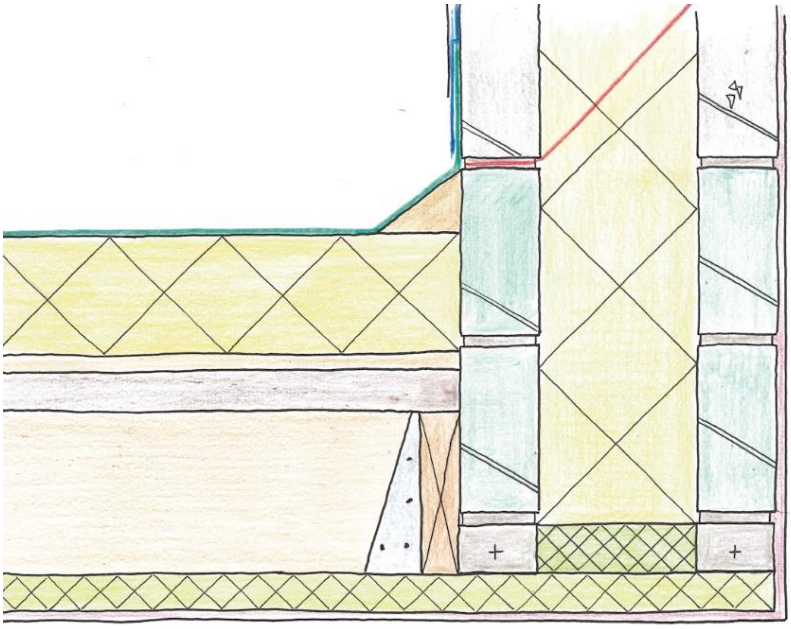
Formula: $\frac{\text{U-value} \times \text{Area} \times \text{Temp Diff.} \times \text{Time (secs)} \times \text{Cost (Euros)}}{\text{Calorific value} \times 1000}$

$$= \frac{\mathbf{0.104} \times 38.25 \times 13 \times 7{,}257{,}600 \times 1.25}{37{,}350 \times 1000}$$

$$\frac{469149408.1}{37{,}350{,}000} = \mathbf{€12.53}$$

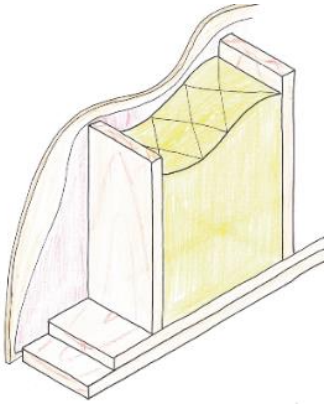
(c) Best practice design detailing that will prevent the formation of a thermal bridge at the junction of the flat roof and external block wall –

Thermal blocks and continuity of insulation

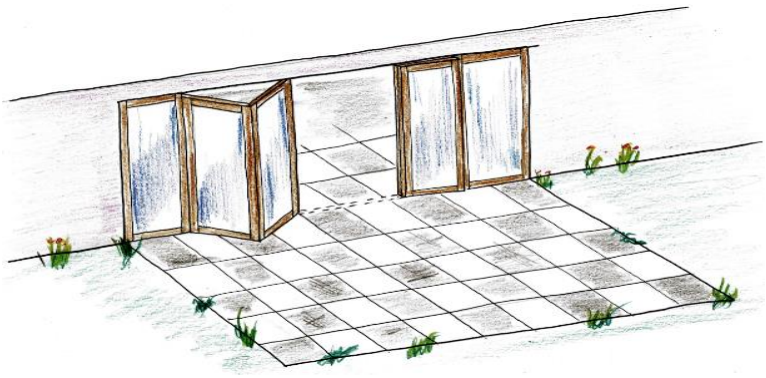


Question 6

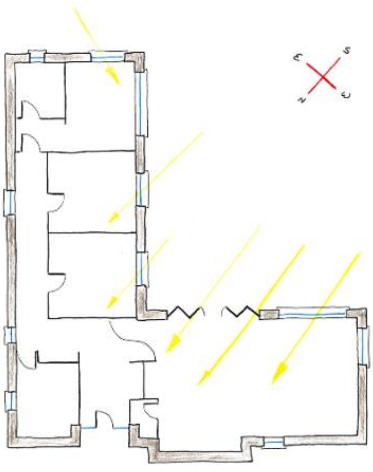
(a) Three feature of the design that contribute to the house having a low environment impact



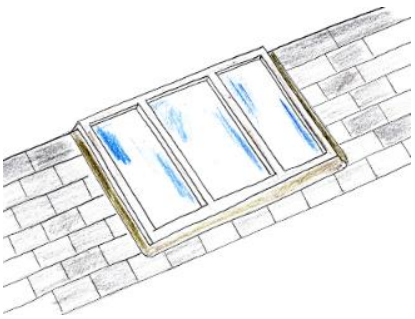
- Any reference, a note or sketch, that correctly identifies the orientation of the given building
- Timber frame construction from local sources which reduces transport movements; has lower carbon emissions and a reduction in localised air pollution
- Less embodied energy required to produce timber frame construction compared to a double leaf, concrete block, cavity wall construction design detail
- Locally sourced timber cladding Irish Larch, Cedar, Douglas Fir - from FSC certified forests are lower in embodied energy than imported timber & suitable for a low environmental building
- Locally sourced timber contributes to carbon sequestration (creates a carbon store/sink) in direct contrast to concrete production
- The house has large south facing glazed openings which fill all main living spaces with natural light – Narrow, one room wide spaces
- Reduced use of electric light bulbs – power generated currently predominantly using fossil fuels
- The heat from the sun entering through the large openings reduces the need for using non-renewable methods of heating theses spaces



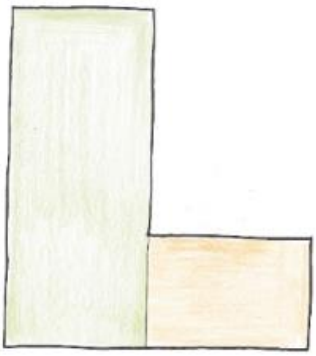
- Small, high-performance windows/glazing on the north side reduces heat loss and saves energy
- Simple building form that takes advantage of the orientation of the sun
- High levels of insulation in the floor, walls and roof construction
- One room deep design enables light and heat from solar gain to enter the single space building via the south, east, and west



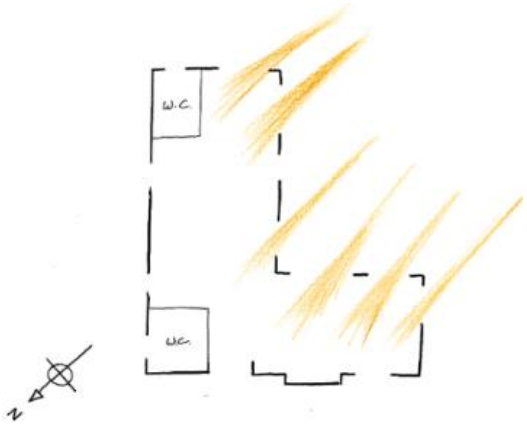
- High-performance glazing throughout the dwelling - having a U-value of at least 0.8 w/m^2 k - will significantly reduce heating costs



- L-Shape design takes advantage of the buildings orientation and allows light to enter a greater number of rooms throughout the day. It also provides natural shelter from the wind
- The absence of a chimney reduces draughts and increases airtightness
- One room deep living space with windows on three sides enable light to naturally light the interior
- Reduced artificial light energy consumption as a result of large windows on south south-east facades
- Ridge roof lights, permits the entrance of natural light and heat into the building throughout the day



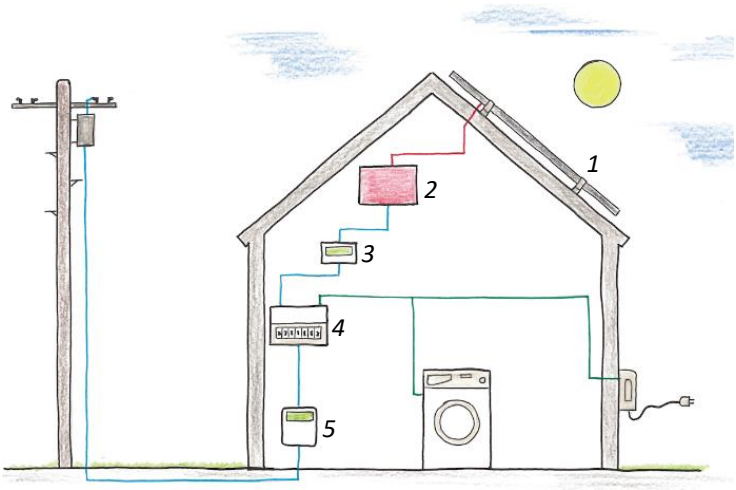
Any other relevant points/sketches



(b) Discuss the technologies and how each would further reduce the energy demand of the house.

Photovoltaic panels

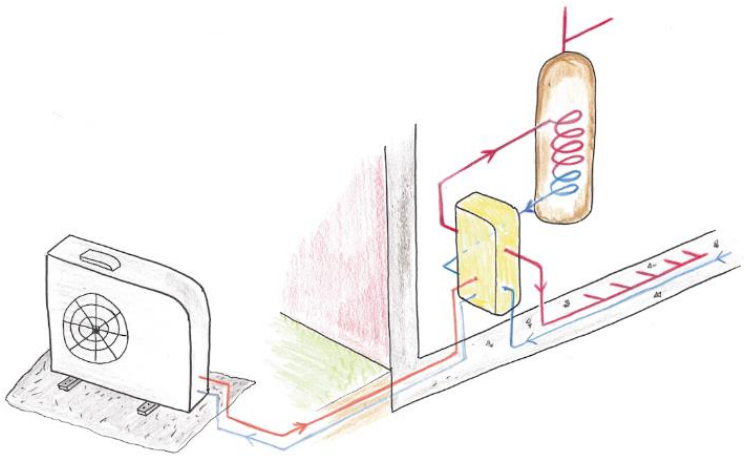
- Solar energy can be turned into electricity using photovoltaic (PV) panels, which converts solar energy/light into electrical energy using silicon cells
- Photovoltaic panels are becoming more economic for domestic electricity generation with the introduction of a zero rate of VAT for the supply and installation of panels for private dwellings since May 1st 2023
- PV cells produce direct current (DC). An inverter converts the DC voltage from the panel into alternating current (AC) which is used in homes
- Photovoltaic panels reduce the use of mains electricity, currently largely generated using fossil fuels, by replacing some of the mains power electricity from renewable sources
- Average annual consumption of electricity per household is 4.7 kW. An area of 21.0 m^2 of photovoltaic panels produces on average 3.12 kW of electricity per annum
- Microgeneration schemes allows homeowners sell any excess electricity back to Ireland's National grid



1. Photovoltaic panel
2. Inverter
3. Generation meter
4. Fuse box
5. Smart meter

Any other relevant points/sketches

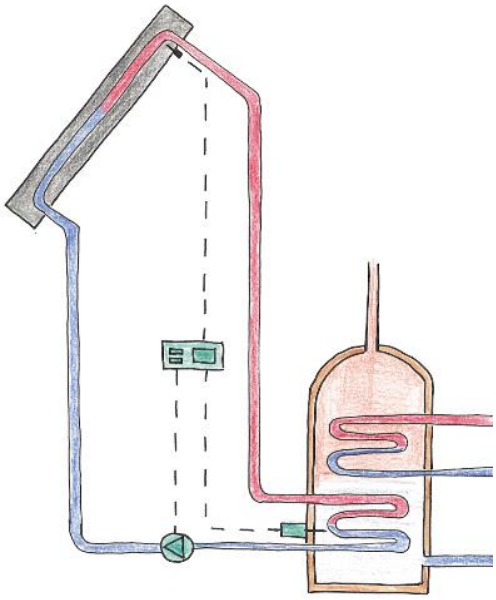
Air-to-water heat pump



- The Air to Water (ATW) system has an outdoor unit. Using a fan, the unit takes heat from the air outside and transfers the heat to a coolant liquid which circulated in a closed pipe system
- A compressor further increases the temperature of the coolant liquid which transfers the heat to a hot water tank via a heat exchanger
- The cooled coolant then returns to the outdoor unit to begin the cycle again
- Meanwhile, the newly heated water in the tank is circulated in a separate system to radiators or underfloor heating pipes, heating the house or fused for domestic hot water
- Currently Air to Water heat pumps have a "Co-efficiency of Performance" (C.O.P.) of between 3 - 4. This means that for every unit of electricity used the heat pump produces 3 - 4 units of heat

Any other relevant points/sketches

Evacuated Tubes



- Solar evacuated tubes are a type of solar thermal technology that converts sunlight into energy for primarily water heating
- The evacuated tubes consist of a glass outer tube and an inner tube with a heat pipe containing a small amount of liquid
- The air between the two tubes is evacuated to create a vacuum, which minimizes heat loss due to convection and conduction
- When sunlight hits the outer glass tube, the energy is absorbed by the inner tube's heat pipe, which contains water and a liquid with a low boiling point, such as ethanediol
- As the liquid absorbs the heat, it vaporizes and rises to the top of the heat pipe, where it is condensed and releases its heat to a transfer medium, such as water.
- The transfer medium carries the heat to the hot water cylinder tank where it transfers its heat to the water in the hot water cylinder
- The transfer medium is then transported by circulation pump back to the solar evacuated tubes.
- The evacuated tubes can track the sun's movement due to their cylindrical shape and can efficiently collect sunlight from a wide range of angles
- Solar evacuated tube systems are an environmentally friendly and cost-effective way to generate renewable energy and can have a significant impact on reducing greenhouse gas emissions and combating climate change

Any other relevant points/sketches

How do they reduce the energy demand of the house:

Photovoltaic panels produce limitless energy from the sun in the form of electricity. Air to water heat pumps help to heat liquid used to heat the house by using air. Solar evacuated tubes heat the water that can be used throughout the house. All the above help to reduce the amount of energy required to meet the needs of the house by using free natural infinite renewable sources.

Any other relevant points

(c) Two advantages of reducing energy demand in the home.

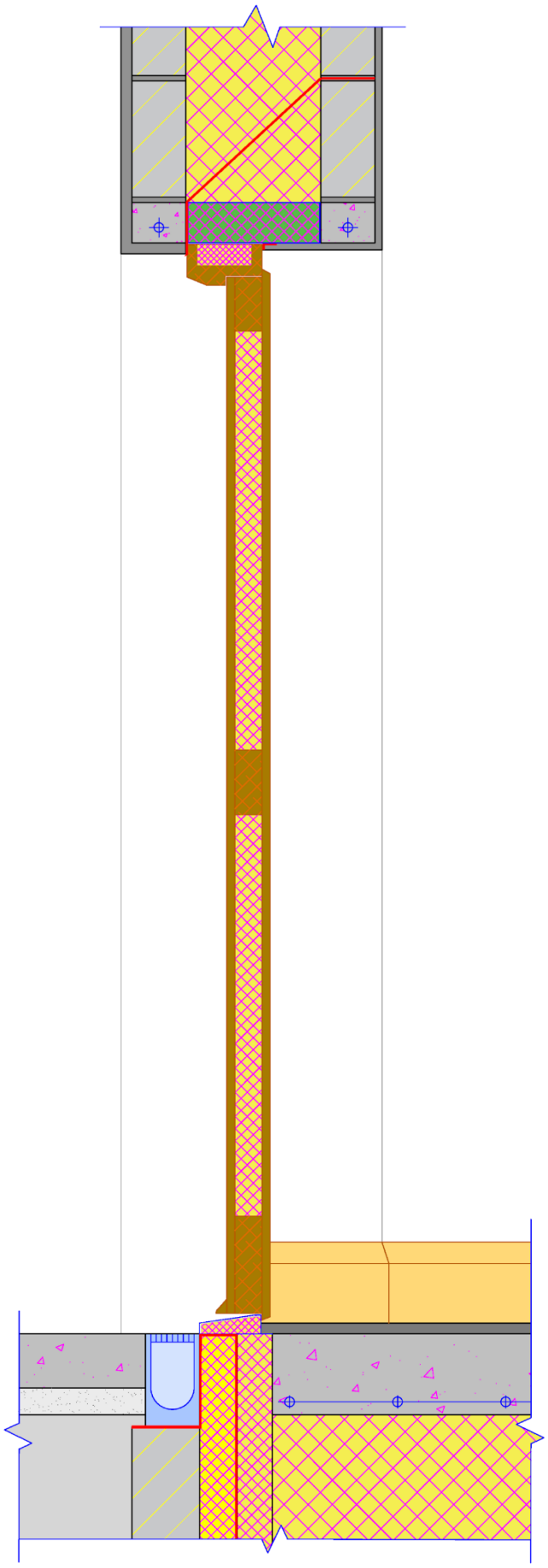
Advantages:

- Environmental- Increased efficiency can lower greenhouse gas (GHG) emissions
- Reduces the pollution that is emitted from non-renewable sources of energy
- Help stabilise electricity prices and volatility
- Economic benefits to home owners by reducing utility bills
- Money saved can be put to better use in the household
- The long-term benefits of reducing energy demand can also reduce the need to invest in new electricity generation and transmission infrastructure

Any other relevant points

Question 7

(a) Vertical section through centre of external door and ground floor.



Head of the door

- External & internal render
- Cavity wall
- Wall ties
- Full-fill insulated cavity 250 mm
- Cavity closer
- Damp proof tray/course
- Reinforced concrete lintels - 100 × 65 mm

External door

- Thermally broken frame 160 mm × 70 mm
- External door with sheeting
- Door insulation
- Proprietary insulated door threshold – 15 mm upstand or 15°
- Airtightness tape at door junction

Threshold

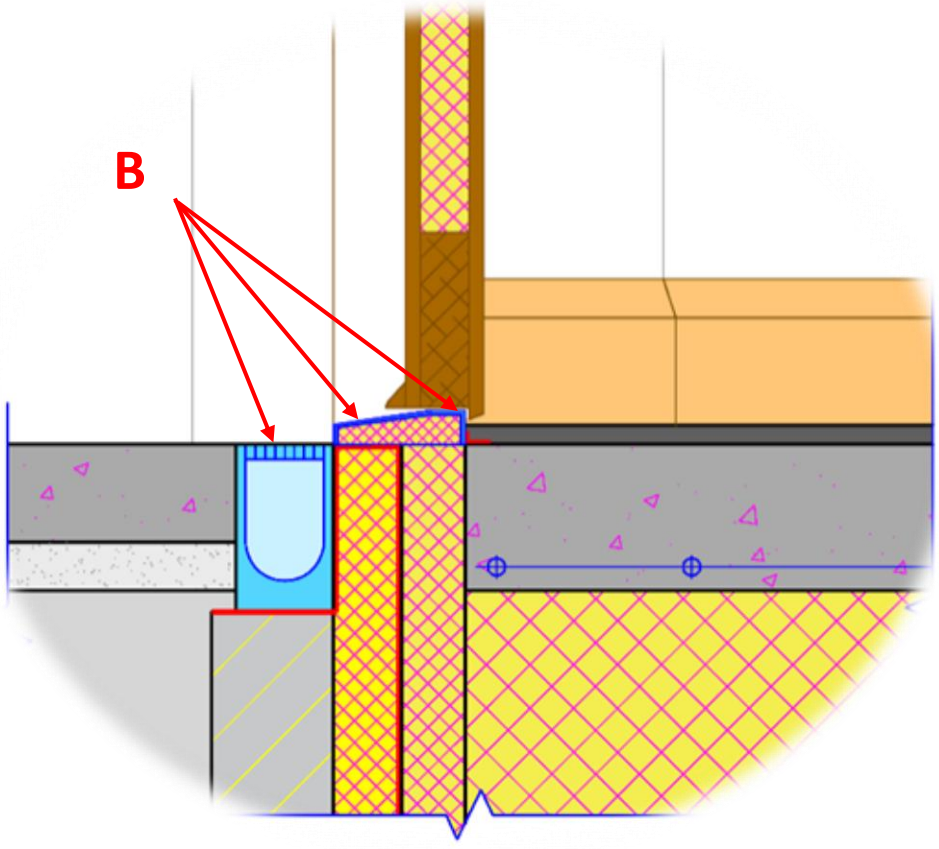
- Concrete floor tiles 20 mm
- Concrete floor / subfloor 150 mm
- Floor insulation 200mm
- Radon Barrier
- Vertical insulation – thermal break
- Drainage channel
- Entrance Substructure

Any other relevant detail

(b) Typical design detailing that will prevent the ingress of moisture at the threshold.

- Threshold drainage channel
- Sloped threshold cill
- Threshold upstand

Any other relevant detail



Question 8

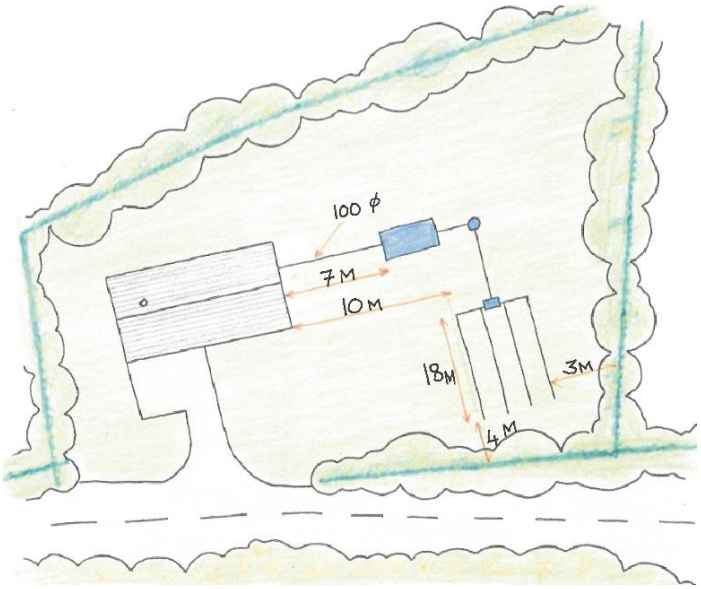
(a) Three functional requirements of a typical wastewater treatment system for a house.

- Efficiently and safely remove waste from the dwelling
- Treat the waste before it is discharged from the system and into the environment
- The pipework must be accessible so that maintenance can be carried out
- Pipes and fittings must be sound to prevent leaking, both inwards and outwards
- Ensure pipework gradient of 1:60 to prevent the build-up of solids which would block the pipe
- Pipework should be corrosion and abrasive resistant so that it does not get damaged by chemicals inside or gravel /stones on the outside
- The system must function effectively within the site boundaries and not impact on neighbours or the water course
- To not contaminate natural habitats
- The chosen system should be of the correct capacity to effectively treat all wastewater relative to the number of occupants in the dwelling
- Ensure foul odours are adequately carried off
- Changes in direction of the sewer line require access so access chambers must be installed

Any other relevant points

(b) Typical design layout necessary for a wastewater treatment system and percolation area suitable for a house. Describe how the system works.

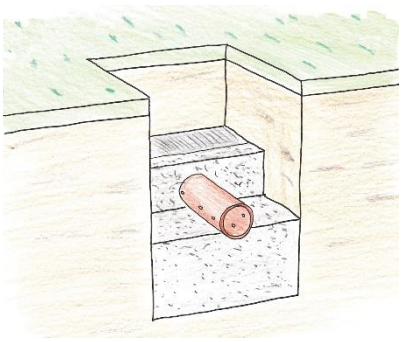
- Foul water flows from the house into the treatment system
- Solids settle on the bottom forming a sludge layer
- Anaerobic bacteria break this layer down and reduces its volume
- After further settlement, the excess liquid flows to a distribution box where it is distributed between a minimum of four percolation pipes
- These pipes which sit on/in a gravel base are perforated to allow liquid to flow through them
- Any remaining impurities are broken down by aerobic bacteria as the liquid passes through the gravel
- This process ensures that no contaminants are present by the time the liquid reaches the ground water



The trench dug for the percolation pipes must meet the following requirements:

- Slope of pipe from tank to distribution box: 1 in 60 for uPVC
- Slope of percolation trench from distribution box: 1 in 200
- Length of percolation pipe in each trench: 18 m maximum
- Minimum separation distance between percolation trenches: 2 m (2.5 m centre to centre)
- Diameter of pipe from septic tank to distribution box: 100-110 mm
- Percolation pipes: 100 mm bore, perforated (typically at 4, 6 and 8 o'clock) with perforations of 8 mm diameter at 75 mm centres along the pipe. Maximum of 6 pipes per distribution device

- 500 mm wide
- 850 mm deep
- Backfill 300 mm
- Washed gravel aggregate surrounding the pipe
- 150 mm similar aggregate over the pipe
- Geotextile layer to prevent saturation
- Topsoil to ground surface
- Access/inspection points and vents recommended for the ends of the percolation pipes. These should be visible and installed to prevent entry of water



Any other relevant points or sketches

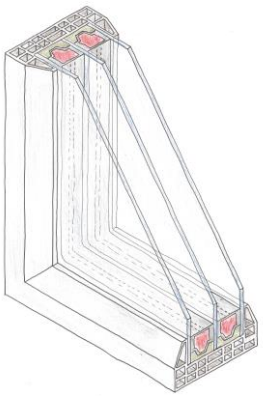
(c) Two reasons why it is important to properly treat and dispose of wastewater from a house.

- To prevent the contamination of nearby household wells or water tables with harmful bacteria and viruses
- To protect humans and animals from coming in contact with waste water containing harmful organisms
- To minimise the generation of foul odours and emissions and affecting the public
- To protect lakes, rivers, and coastal waters
- Poorly treated wastewater contains excessive amounts of phosphorus and nitrogen which have a damaging effect on the biodiversity of nearby water resources
- The main aim of proper wastewater treatment is to remove as much of the suspended solids as possible before the remaining water, called effluent, is discharged back to the environment Decaying solid materials use up oxygen in water which is harmful to plants and animals

Any other relevant points

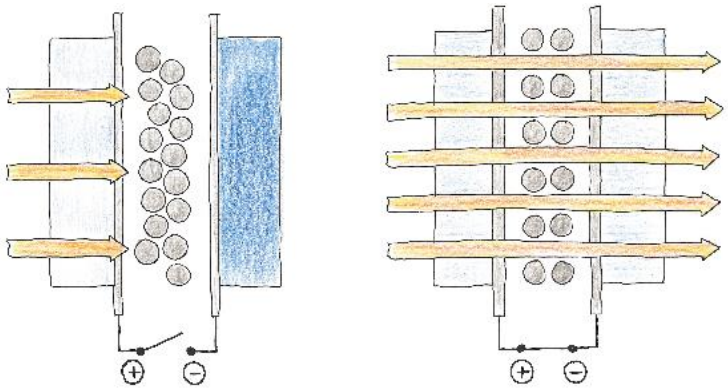
Question 9

(a) Two function requirements of a modern glazing system for a house.

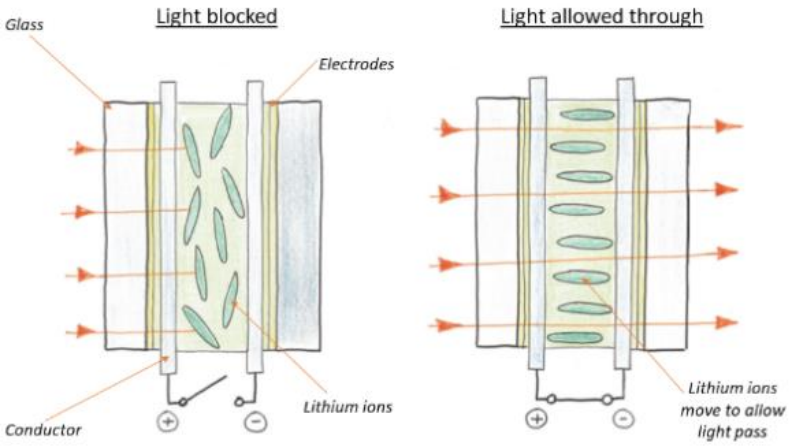


- Admit an abundance of daylight. Well designed and positioned windows at the design stage of a building will ensure adequate daylight to the building depending on room location/orientation and the rooms' function
- Buildings / windows - that are designed with the surrounding environment in mind will also allow occupants to have a view of the surrounding environment and nature
- Allow sufficient solar gain into the rooms and subsequently - prevent it from leaving
- Reduced energy costs. Carefully positioned and oriented glazing reduces significant need for artificial lighting and fossil fuel heating leading to more sustainable living
- Glazing placed on the east façade will allow morning light and heat enter the building
- South façade glazing will allow midday thermal and light gains
- West façade glazing will allow evening gains
- Glazing on roofs and other slanted surfaces can give consistent daylight and can be up to three times more effective than vertical window

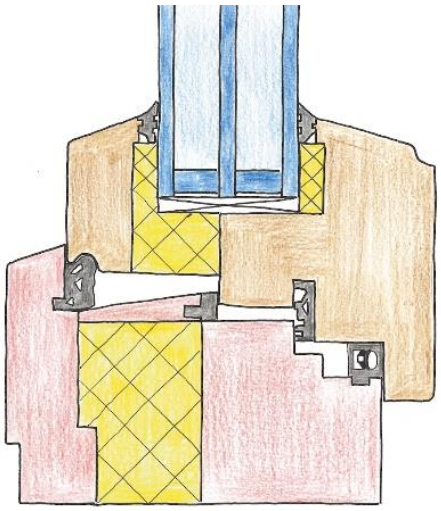
- Ability to prevent overheating. New advances in glazing technology, dynamic glass/smart glass, enables the glazing to change opacity to reduce glare and heat load into the building. Overheated building will be cooled, traditionally by energy appliances resulting in higher energy costs. Smart windows use one **of three technologies**:
    - Suspended Particle Devices (SPD)
    - Polymer Dispersed Liquid Crystal (PDLC)
    - Electrochromic glass (EC)



- EC smart glass changes transmittance by applying an electrical current by the switch of a button. Windows offer degrees of transparency and is built into double and triple glazing units. They require electricity to achieve a particular opacity, but not to maintain it. Current is passed through the window unit until it is at the desired opacity



- Emergency escape. Windows on upper floors may provide an alternative means of evacuating or rescue. Windows should have an openable section which provides an unobstructed clear open area of at least 0.33 m^2. The height and width should be not less than 450 mm. The bottom of the opening should not be more than 1100 mm above floor level
- Sound reduction into the building. Glazing units and frames should give the occupants protection from outside noise. For glazing units to perform, they must be fitted and bonded to the building fabric using an airtight system. Opening windows should be sealed with felt and rubber weather stripping. Acoustic glass fitted into framing units can also be used in high noise pollution areas



Any other relevant points

(b) Calculate using the degree of efficiency method, or any other suitable method, the appropriate area of glazing required to provide the stated illumination.

Degree of efficiency method.

Formula: $Li = Lo \times WF \times E \times \frac{\text{Window area}}{\text{Floor area}}$

Li = Lux required

Lo = Standard overcast sky (C.I.E. = 5,000 Lux)

WF = Window factor is the reduction in incident light due to window position.

On a vertical wall, constant value 0.5

E = Efficiency coefficient: - Reduction for reflection, obstructions, glass, etc.

Constant value of 0.4

$$500 = 5000 \times 0.5 \times 0.4 \times \frac{\text{Window area}}{4.5 \times 4.2}$$

$$500 = 5000 \times 0.5 \times 0.4 \times \frac{\text{Window area}}{18.9}$$

$$500 = 1{,}000 \times \frac{\text{Window area}}{18.9}$$

$$500 \times 18.9 = 1{,}000 \text{ W}$$

$$9450 = 1{,}000 \text{ W}$$

$$W = \frac{9450}{1000}$$

Window area = 9.45 m^2

(c) Two advantages and two disadvantages of installing triple glazing in a modern window framing system.

Advantages:

- Reduced energy costs.
  Triple glazing gives a better thermal performance to the building. Triple glazing can achieve a U-Value as low as 0.6 W/m^2K due to the use of a low emissivity coating and argon gas filled spaces between glass panes. Double glazing on average have a U -Value of 1.6 W/m^2K while single glazing can have a U-Value as high as 5 W/m^2K
- Reduced heat loss through the building fabric.
  Triple glazing can be up to 40% better at insulating against heat loss than the best double glazing. Triple glazing provides improved thermal comfort resulting from reduced radiation heat transfer between the glazing surface and the room
- Improved acoustic insulation.
  Triple glazing units provide acoustic insulation under the following insulation principles;
  Heaviness - Triple glazing units are heavier and restrict vibrations and movement.
  Isolation – Argon gas filled cavities separate glass panes from each other.
  Completeness - Triple glazing units are sealed in a factory setting with a dual PIB and Polyurethane seal resulting in a uniform and complete unit
- Reduced condensation. Condensation forms on window panes when excess moisture in the air collides with cold surfaces. Windows are prone to condensation when it is colder outside than inside. To get rid of condensation, ventilation is needed with a subsequent loss in heat

- Double glazing reduces thermal transmittance. The inner pane of glass is not as cold as the outside and moisture doesn't form. Triple glazing can reduce the cold on the inner pane of glass even more with its super thermal efficiency, resulting in less condensation on the inside of windows

Disadvantages:

- Higher glazing costs. Double glazing is less expensive than triple glazing units. Triple glazing could add up to 30 % to the glazing cost of a building
- Overheating issues. If the building design plan includes extensive triple glazing, especially on the southern elevation, overheating can occur during summer months. To counteract overheating, an external solar shading system or an increase in thermal mass internally may have to be installed
- Weight issues. Triple glazing units are heavier and difficult to install. Triple glazing may require structural support around the window frame to with-stand the weight. With triple glazing, the added weight means hinges and opening mechanisms need to be more complex, which contributes to their higher cost. Bi-fold doors usually come double glazed due to the glazing weight
- Retrofit difficulties. Triple glazing is not suitable for retro fitting into existing door and window frames in most cases. The thickness and weight of the triple glazed units are incompatible with many existing frames so an entire new frame and unit would have to be installed

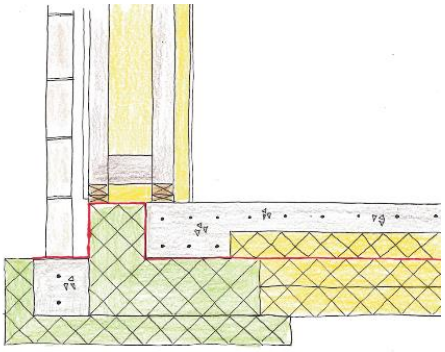
Any other relevant points

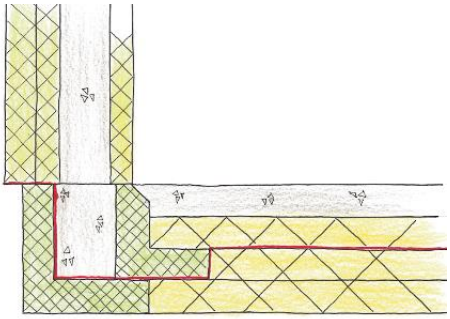
Question 10

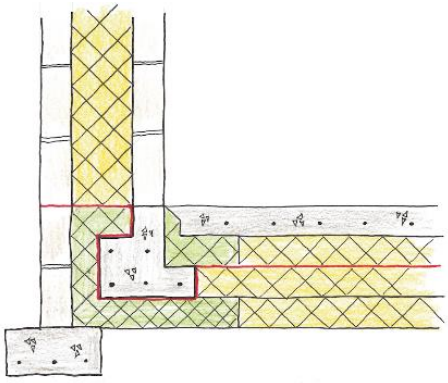
(a) Discuss the importance of any two Passive House design features.

Foundation design

- Foundation should be highly insulated to achieve a U-value of between 0.1 - 0.15 W/m²K
- No thermal bridges at the wall-floor junction to prevent heat loss and moisture ingress
- Use aerated concrete blocks at critical junctions
- Use insulation that has high compressive strength
- For insulated Passive raft-type foundations, the concrete slab is entirely surrounded by a 'bowl' of insulation. The concrete is never in direct contact with the ground
- The type of foundation system used (strip/raft/pile) depends on the ground conditions of the site

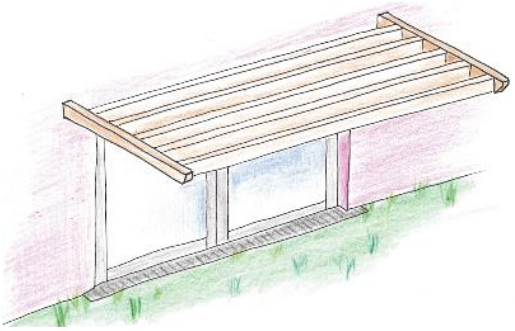


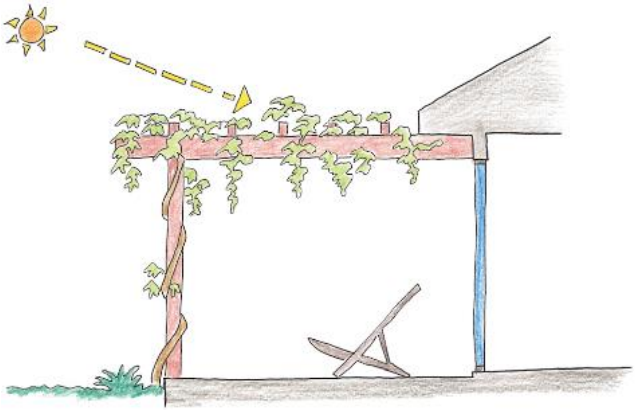




Any other relevant points/sketches

Solar shading





- The lack of solar shading in a Passive house can lead to overheating within the building
- The method should allow sun to enter during winter months when the sun is lower in the sky but block the stronger summer sun, which is at a steeper angle, from entering during the summer months
- Solar shading can be in the form of an overhang or deeper eaves
- Vertical or horizontal brise-soleil are made from individual components set at an angle fixed to the outside of the building
- Mechanical shading such as adjustable brise-soleil, external roller blinds, awnings and sliding screens can be adjusted and used to control solar gain at different times of the day and year
- A brise-soleil can be any material ranging from metal, plastic or timber
- Internal blinds and shades will reduce solar gain but will also impact the level of natural light entering the building
- Natural vegetation can be effective, environmentally friendly and aesthetically pleasing and come in the form of trees or climbing plants

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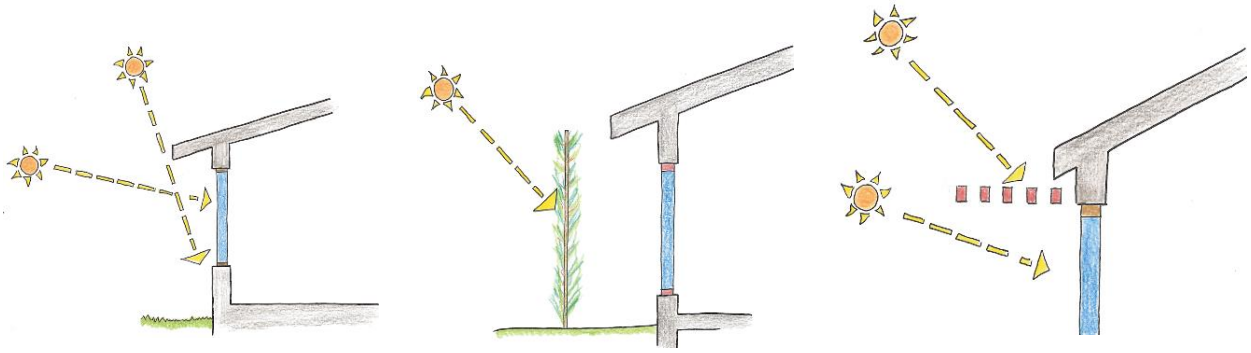
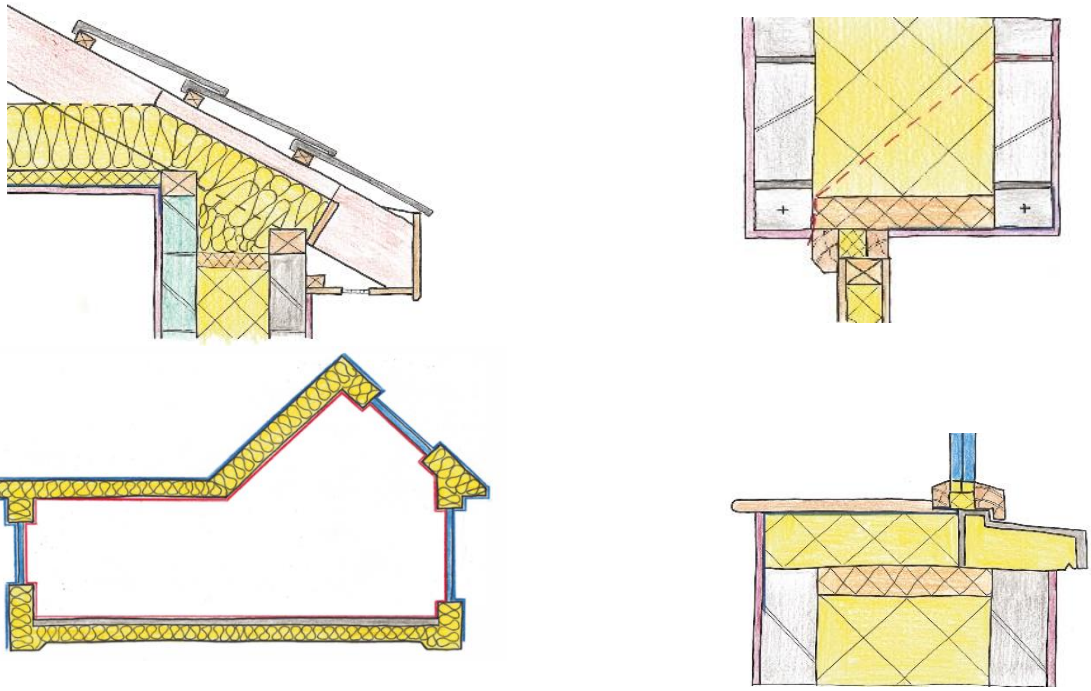


Any other relevant points/sketches

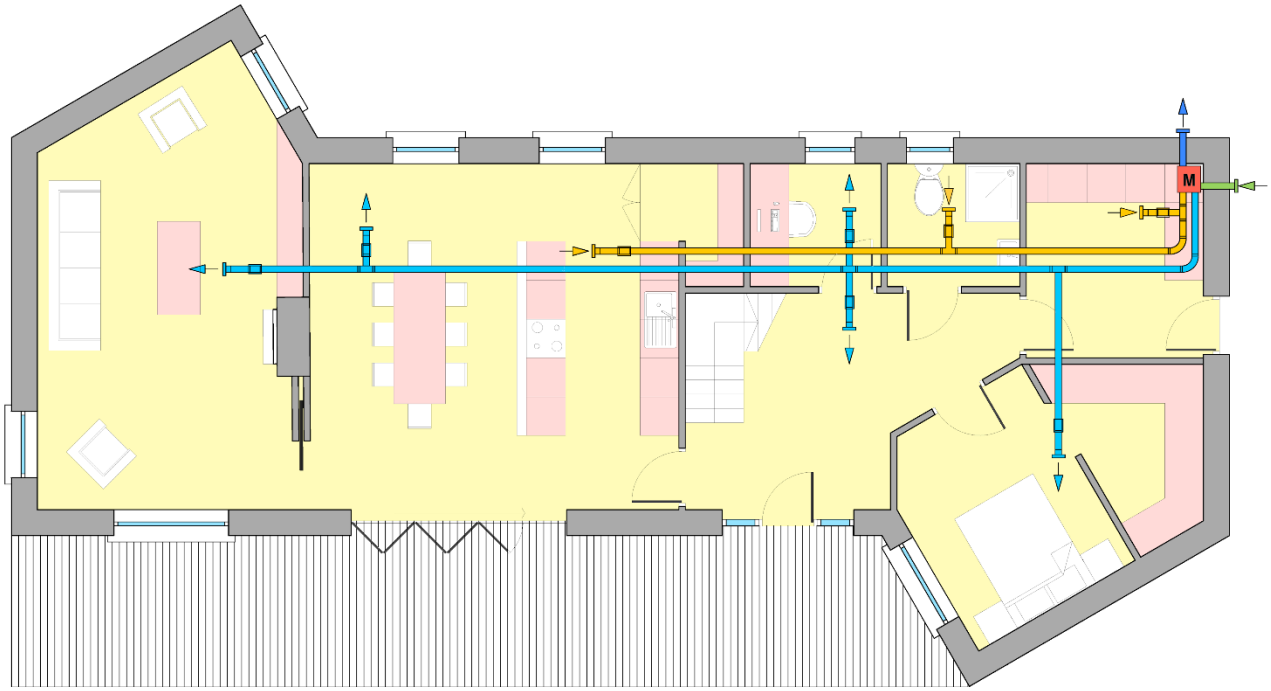
Thermal efficient building envelope (TEBE)

- The envelope of a building is where the passing of energy occurs
- Where a building envelope has been designed to be airtight and thermally efficient, a continuous red Line is shown on the internal side of the external wall on drawings
- All components of the building's envelope require to be at their optimum thermal performance including foundations, walls, windows and roof
- There should be no break in insulation or airtightness around the entire building
- By reducing the amount of energy that passes through the external envelope, the internal building temperature is more constant and predictable
- The greater the efficiency of the building envelope, the more energy efficient the building
- A TEBE reduces the reliance on the MHRV system to heat or cool the building
- TEBE reduces the energy consumption and costs, but it also gives the homeowner better control over the internal temperature, which increases occupant comfort
- Less energy is needed to heat or cool the building therefore reducing the buildings carbon footprint

Any other relevant points/sketches



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



- A Passive house uses a Mechanical Heat Recovery Ventilation (MHRV) system to provide a continuous controlled supply of fresh clean warm air into the house
- Stale moist air is simultaneously removed from rooms such as the kitchen, bathroom, or utility room as they are the rooms most likely to have air with high moisture and odour content
- A system of ducts run through the home with a vent to each room, usually in the ceiling
- Fans in the main MHRV exchanger unit supply or extract air from each room on a continuous basis
- Incoming fresh air from outside is passed through the heat exchanger where the heat energy is transferred from the warm extracted air into the incoming cool air without both coming in direct contact
- The incoming air also passes through a particle filter in the exchanger unit to remove dust and pollen before entering the home

- Both features ensure that fresh air entering the home is clean and at a comfortable temperature for the occupants

Any other relevant points

(c) Two design considerations when deciding the location of a MVHR unit in a house.

Considerations

Accessibility

- The unit must be easily accessed for routine maintenance purposes
- Filters need to be changed to ensure pollen dust or pollutants are removed from the incoming air Ease of access is needed to do this efficiently

Noise

- Ensure unit is installed on a solid wall or floor using anti-vibration mounts to reduce noise
- It is preferable not to locate the unit near bedrooms as the noise produced may disturb sleeping

Aesthetics

- Locate in a discrete area of the house - plant room, utility room or an easily accessible space
- If it is in a prominent area, enclose it in a press to minimise the visual impact

Optimum Functionality

- Locate 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)
- Locate the unit inside the insulated external envelope to minimising heat loss through the ducting

Any other relevant points

Question 10

"People regardless of age, size, ability, or disability are positively contributing to the social, economic and cultural life of our communities. However, finding suitable and appropriate homes that can accommodate our changing needs over time can be difficult – whether for families with young children, a person with a temporary or permanent injury, someone with a disability, or an older person living independently. Universal Design can meet everyone's needs through flexible homes designed to adapt to lifecycle and lifestyle patterns of people over time."

Adapted from: **Universal Design Guidelines for Homes in Ireland**
Published by National Disability Authority

(a) Discuss the above statement in detail.

Discussion of the above statement– such as

- Universal Design caters for changing needs of people over time so that they can continue living in their own homes and communities as they get older or become disabled
- People of diverse abilities should be able to use buildings and places comfortably and safely, as far as possible without special assistance
- Given the diversity of the population, a Universal Design approach, which caters for the broadest range of users from the outset, can result in buildings and places that can be used and enjoyed by everyone and for their entire life
- The proportion of the world's population aged over 65 is set to more than double by 2050
- Design focussed on principles of extending standard design to a person with some type of performance limitation is to maximize the number of potential people who can readily use a building for the entirety of their life
- Universal Design refers to the design and composition of an environment so that it can be accessed, understood and used to the greatest extent possible by all people, regardless of their age, size, ability or disability.' *Synopsis of the Disability Act, 2005.*

- Many people's abilities are in decline as they age, such as mobility, dexterity, stamina, strength, hearing, sight, or memory. Familiarity with a particular environment is important. Hence, it's important that the living environment does not require retrofitting or vast change
- There's a 60% chance that a new home will be occupied by a person with some form of disability at some stage in the life of the home
- New homes designed and built with Universal Design at the forefront, makes everyone's life more comfortable, efficient, accessible, and safer
- The concept 'Aging in place' is beneficial to those who want to stay in their own homes as they get older while also being user-friendly when younger families and friends come to visit
- A home designed and built with Universal Design in mind allows the environment to function as well for a newborn as for a grandparent, and everyone in between
- When home environments are people-centred in design, convenient and a pleasure to use, everyone benefits. Fundamentally, Universal Design is good design
- 87% of people would prefer to remain in their own homes as they age. *National Council on Ageing and Older People (NCAOP)*
- Benefits of Universal Design include flexibility and ease of adaptability to meet people's changing needs over time in a cost and energy effective way
- Homes built with Universal Design in mind can create an enabling home environment for the widest possible number of people by providing opportunities for easy adaptations

Any other relevant, cogent, well-argued points

(b) Propose three best practice guidelines that would ensure all buildings are designed and constructed to be flexible to meet people's needs over their life.

- Planning authorities to develop and publish clear, and up to date, planning guidelines outlining the requirements of all houses to meet accessibility and use by all needs
- Legislate that all new builds and retro fits must be future proofed to allow the building to be used throughout all stages of a person's life
- Increase the awareness of the public for creating user friendly and adaptable housing
- Continuing Professional Development (C.P.D.) for architects and planners on the creation of homes that will adapt and cater for the needs of owners throughout all stages of their life
- Legislation and amendments to planning regulations to ensure and oblige the construction industry to build to a Universal Design standard
- Design 'Soft spots' in internal walls to allow easy adaption and change from a smaller room lay-out to larger rooms without excessive construction work
- Design 'Hard-spots' in all bedroom and W.C. ceilings so a hoist track can be quickly and easily installed if required in the future
- Designers to design buildings to be easily and cost effectively adapted as the needs of the owner's change
- Designers to design user-friendly spaces not only inside but also around buildings
    - Provide a permeable paving that is firm, is 900 – 1200mm wide and slip resistant to the clothesline, shed or any storage provided in the garden. The pathway should be level and close-laid, suitable for wheeled vehicles
    - Avoid ramps and steps in the garden and ensure additional planting is of low maintenance

Any other relevant, cogent, well-argued points

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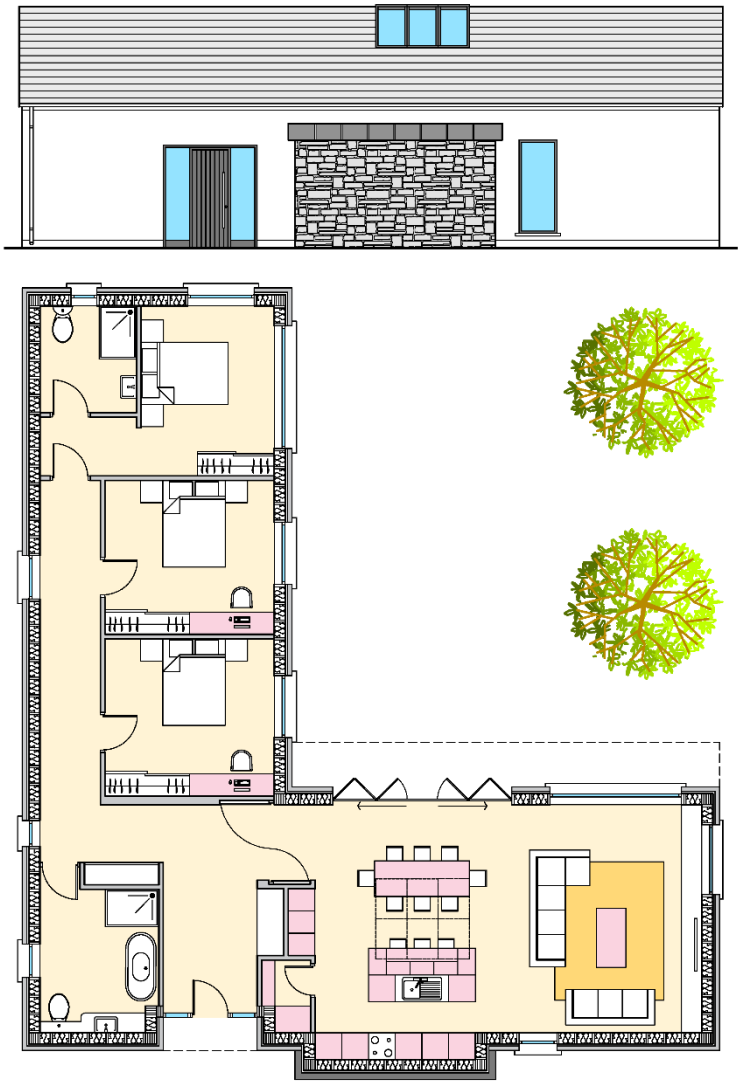

Construction Studies

Theory – Higher Level

Marking Scheme

Question 1

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) Vertical section through one-half of the trussed roof and external wall of a house ***External timber frame wall 5 × 4 marks Roof structure 3 × 4 marks Eaves detail 4 × 4 marks***	
External timber frame wall • External render • Concrete block + Tie • Firestopping / cavity closer • Air space / residual cavity • Breather membrane • Racking board • Stud • Insulation • Air barrier membrane • Insulated service cavity • Plasterboard / skim	**4** **4** **4** **4** **4**
Roof structure • Prefabricated roof truss - rafter / ceiling joist / hanger/ strut (Any two) • Gang nail plates & truss fixing • Attic insulation • Insulated plasterboard - ceiling • Air tightness tape - junction wall + ceiling • Air-barrier membrane at ceiling	**4** **4** **4**
Eaves detail • Fascia / soffit / gutter (Any two) • Tilting fillet • Ventilation • Wind tightness barrier • Roof breather membrane • Counter battens • Tiling battens • Three courses of concrete tiles	**4** **4** **4** **4**
Scale – 4 marks **Drafting** – 4 marks	**8**
(b) Indicate design detailing that will ensure ventilation of the roof structure (4 marks)	
Design detailing to ensure ventilation of the roof	**4**
TOTAL	**60**

Question 2

PERFORMANCE CRITERIA		MAXIMUM MARK
(a) Importance of maintaining a safe working environment on a site.		***(3 × 6 marks)***
Communication	(3 for point, 3 for discussion)	**6**
Supervision	(3 for point, 3 for discussion)	**6**
Training	(3 for point, 3 for discussion)	**6**
(b) Two best practice guidelines that should be observed for each on a construction site.		***(4 × 8 marks)***
Site access		
Guideline **1**	(4 for note, 4 for sketch)	**8**
Guideline **2**	(4 for note, 4 for sketch)	**8**
Using a ladder		
Guideline **1**	(4 for note, 4 for sketch)	**8**
Guideline **2**	(4 for note, 4 for sketch)	**8**
(c) Two reasons why all construction sites must have a safety statement		***(2 × 5 marks)***
Reason **1**	(3 for point, 2 for discussion)	**5**
Reason **2**	(3 for point, 2 for discussion)	**5**
	TOTAL	**60**

QUESTION 3

PERFORMANCE CRITERIA		MAXIMUM MARK
(a) Three considerations for the proposed new kitchen/dining and living area		***(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 layout for the kitchen/dining and living area		***(22 marks)***
Revised internal layout for the kitchen/dining and living area on the first floor		**14**
Design consideration **1**		**2**
Design consideration **2**		**2**
Design consideration **3**		**2**
Justification		**2**
(c) Two advantages and two disadvantages of locating a kitchen/dining and living area on the first floor		***(4 × 5 marks)***
Advantage **1**	(3 for point, 2 for discussion)	**5**
Advantage **2**	(3 for point, 2 for discussion)	**5**
Disadvantage **1**	(3 for point, 2 for discussion)	**5**
Disadvantage **2**	(3 for point, 2 for discussion)	**5**
	TOTAL	**60**

Question 4

PERFORMANCE CRITERIA		MAXIMUM MARK
(a) Three features of vernacular Irish architecture evident in image		***(6 × 5 marks)***
Vernacular Feature 1		**5**
Notes		**5**
Sketches		
Vernacular Feature 2		**5**
Notes		**5**
Sketches		
Vernacular Feature 3		**5**
Notes		**5**
Sketches		
(b) Refurbishing of an old cottage built in the vernacular tradition (any two)		***(2 × 7 marks)***
Choice of material	(4 for point, 3 for discussion)	**7**
Craft skills	(4 for point, 3 for discussion)	**7**
Respect for local character	(4 for point, 3 for discussion)	
(c) Two reasons to refurbish and maintain traditional Irish cottages		***(2 × 8 marks)***
Reason **1**	(4 for point, 4 for discussion)	**8**
Reason **2**	(4 for point, 4 for discussion)	**8**
	TOTAL	**60**

QUESTION 5

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) U-value of flat roof	***(10 × 3 marks)***
External surface resistance	**3**
Waterproof covering	**3**
Roof insulation	**3**
Plywood decking	**3**
Clear cavity	**3**
Ceiling insulation	**3**
Plasterboard	**3**
Internal resistance	**3**
Total resistance	**3**
Calculation of U-value (w/m^2 °C or w/m^2k)	**3**
(b) Cost of annual heat loss through flat roof	***(5 × 3 marks)***
Heat loss formula and calculation	**3**
Heating duration - calculation for one year	**3**
k/Joules - calculation for one year	**3**
Litres of oil - calculation for one year	**3**
Annual cost – calculation of heat loss PA	**3**
(c) Best practice design detailing that will prevent thermal bridge	***(15 marks)***
Notes / discussion	**5**
Sketch	**10**
TOTAL	**60**

QUESTION 6

PERFORMANCE CRITERIA		MAXIMUM MARK
(a) ***Three features of low environmental impact***		***(6 × 5 marks)***
Design Feature 1		**5**
Notes		**5**
Sketches		
Design Feature 2		**5**
Notes		**5**
Sketches		
Design Feature 3		**5**
Notes		**5**
Sketches		
(b) ***Energy technologies and how each further reduces energy demand***		***(6 × 3 marks)***
Photovoltaic panels		**3**
Notes		**3**
Sketches		
Air-to-water heat pump		**3**
Notes		**3**
Sketches		
Evacuated tubes		**3**
Notes		**3**
Sketches		
(c) Two advantages of reducing energy demand in the home		***(2 × 6 marks)***
Advantage **1**	(3 for point, 3 for discussion)	**6**
Advantage **2**	(3 for point, 3 for discussion)	**6**
	TOTAL	**60**

Question 7

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) ***Vertical section through external door, wall, and ground floor.*** ***Head of the door 4 × 4 marks External door 4 × 4 marks Threshold 4 × 4 marks***	
Head of the door • External & internal render • Cavity wall • Wall tie • Full-fill insulated cavity • Cavity closer • Stepped Damp proof tray/course • Reinforced concrete lintels	**4** **4** **4** **4**
External door • Airtightness tape at Door frame head • Thermally broken doorframe • External door with sheeting • Door insulation • Proprietary insulated door threshold • 15 mm upstand or 15° slope • Airtightness tape at door threshold	**4** **4** **4** **4**
Floor Level • Skirting board • Concrete floor tiles • Concrete floor • Floor insulation • Radon barrier • Vertical insulation – thermal break • Drainage channel • Entrance- Level surface	**4** **4** **4** **4**
Scale - 4 marks **Drafting** - 4 marks	**8**
(b) Design details that will prevent ingress of moisture at the threshold	***(4 marks)***
Design detailing to prevent ingress of moisture	**4**
TOTAL	**60**

Question 8

PERFORMANCE CRITERIA		MAXIMUM MARK
(a) ***Three functional requirements of a wastewater treatment system***		**(3 × 8 marks)**
Functional requirement **1**	(3 for point, 5 for discussion)	**8**
Functional requirement **2**	(3 for point, 5 for discussion)	**8**
Functional requirement **3**	(3 for point, 5 for discussion)	**8**
(b) ***Typical layout for wastewater treatment system and percolation area and describe how the system works***		***(26 marks)***
Typical layout for **treatment system** and **percolation** area:		
Notes		**6**
Sketch		**10**
Description of how the system works		**6**
Four typical dimensions		**4**
(c) ***Two reasons to properly treat and dispose of wastewater***		***(2 × 5 marks)***
Reason **1**	(2 for point, 3 for discussion)	**5**
Reason **2**	(2 for point, 3 for discussion)	**5**
	TOTAL	**60**

Question 9

PERFORMANCE CRITERIA		MAXIMUM MARK
(a) Two functional requirements of a modern glazing system		***(4 × 4 marks)***
Functional requirement **1**		**4**
Notes		**4**
Sketches		
Functional requirement **2**		**4**
Notes		**4**
Sketches		
(b) Calculate the appropriate area of glazing required		***(7 × 4 marks)***
Formula		**4**
Correct entry into formula		**4**
Floor area		**4**
Using formula Li = Lo × WF × E		**4**
Solve for w (window area) line 1		**4**
Solve for w (window area) line 2		**4**
Window area		**4**
(c) Two advantages and two disadvantages of installing triple glazing		***(4 × 4 marks)***
Advantage **1**	(2 for point, 2 for discussion)	**4**
Advantage **2**	(2 for point, 2 for discussion)	**4**
Disadvantage **1**	(2 for point, 2 for discussion)	**4**
Disadvantage **2**	(2 for point, 2 for discussion)	**4**
	TOTAL	**60**

Question 10

PERFORMANCE CRITERIA		MAXIMUM MARK
(a) ***Discuss two Passive House design features***		***(4 × 5 marks)***
Foundation design		
Notes		**5**
Sketches		**5**
Solar shading		
Notes		
Sketches		**5**
Thermally efficient building envelope		**5**
Notes		
Sketches		
(b) ***Typical layout for MVHR and describe how the system works***		***(26 marks)***
Line diagram of given house		**5**
Location of MVHR unit		**5**
Layout of system ducting		**5**
Direction of airflow in ducts		**5**
Decription of how the system works		**6**
(c) Two consideration when locating MVHR unit		***(2 × 7 marks)***
Design consideration **1**	(4 for point, 3 for discussion)	**7**
Design consideration **2**	(4 for point, 3 for discussion)	**7**
	TOTAL	**60**

Question 10 (Alternative)

PERFORMANCE CRITERIA		MAXIMUM MARK
(a) Discussion of Statement (People regardless of age, size, ability…)		***(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 that would ensure all buildings are designed and constructed to be flexible		***(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**

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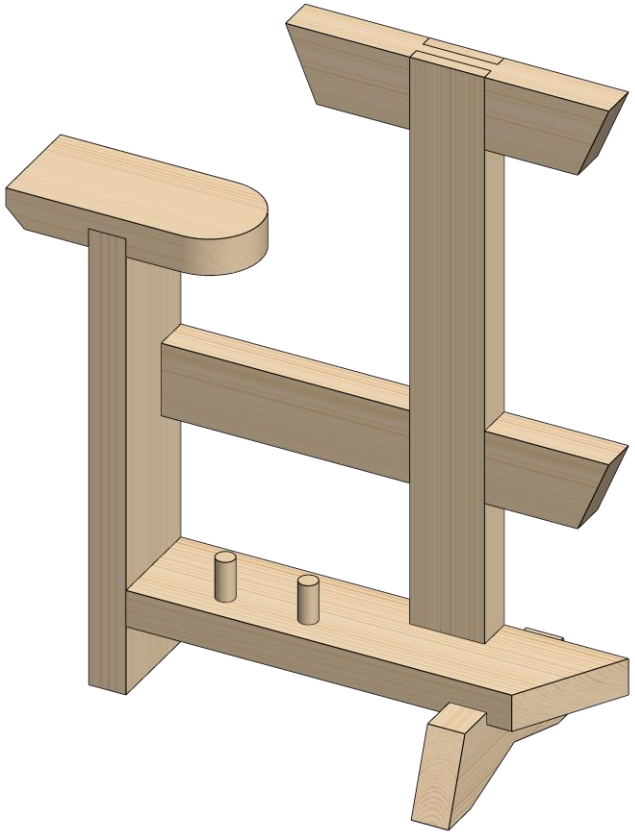
Practical Test

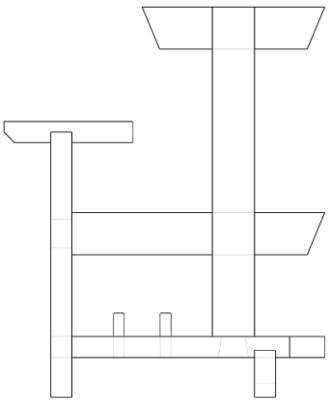
Common Level

(150 marks)



Marking Scheme

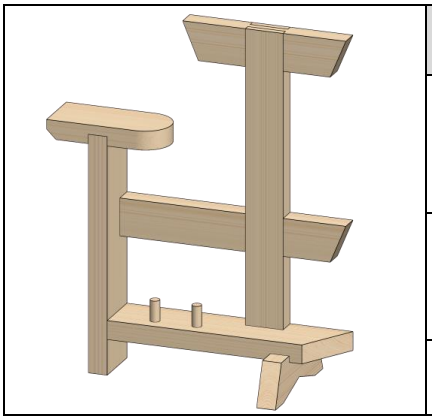
Day 1



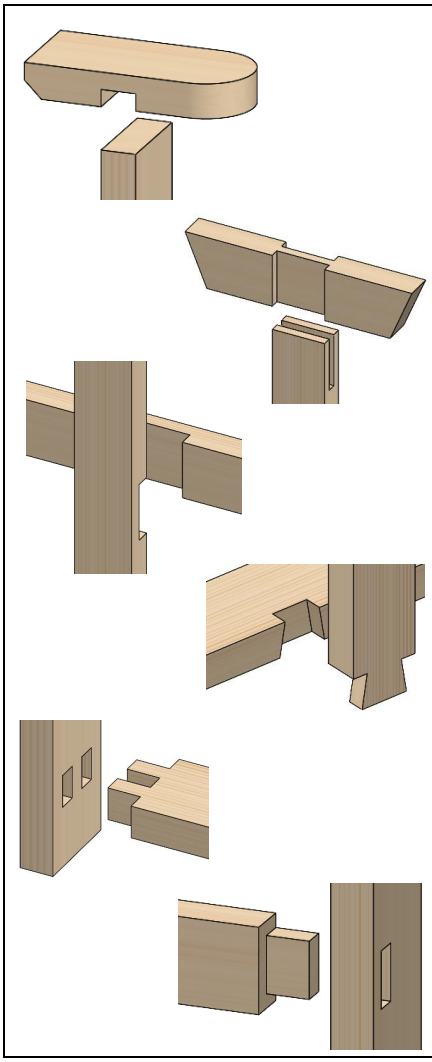
Marking Scheme – Practical Test

Note:

- The artefact is to be hand produced by candidates without the assistance of machinery.
- However the use of a battery powered screwdriver is allowed.
- Where there is evidence of the use of machinery for a particular procedure a penalty applies.
- Component is marked out of 50% of the marks available for that procedure.

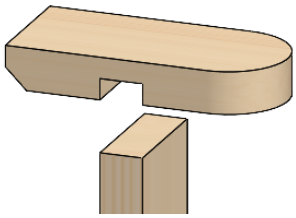
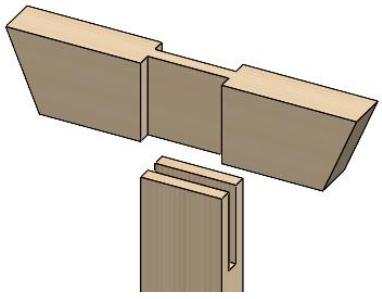


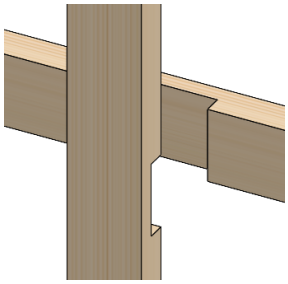
(i)	OVERALL ASSEMBLY	Marks
a.	Overall quality of assembled artefact	**10**
b.	Design and applied shaping to edge	**4**
	Total	**14**

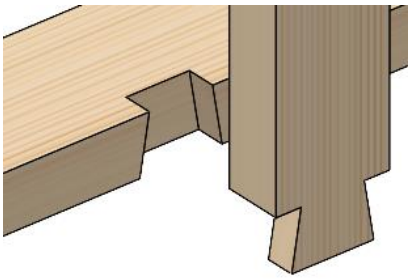


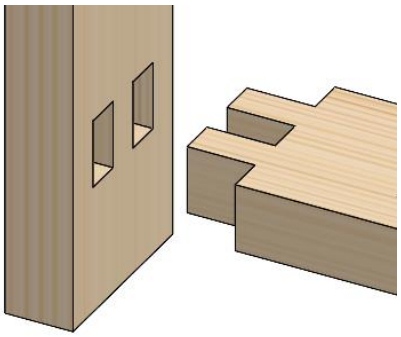
(ii)	MARKING OUT	Marks
a.	Housing joint • Trench *3 marks*	**3**
b.	Bridle joint • Trenches *2 × 2 marks* • Bridle *3 marks*	**7**
c.	Cross halving joint • Trenches *2 x 2 marks*	**4**
d.	Dovetail joint • Tail *3 marks* • Trench *3 marks*	**6**
e.	Double mortice and tenon joint • Tenons *2 × 2 marks* • Mortices *2 × 2 marks*	**8**
f.	Bare faced mortice and tenon joint • Mortice *3 marks* • Tenon *3 marks*	**6**

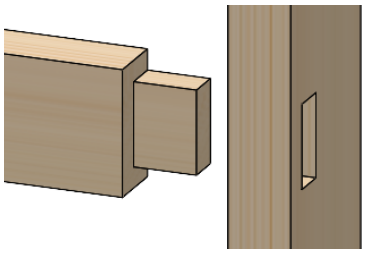
	g.	Leg • Trench *3 marks* • Slopes *4 x 1 marks*	**7**
	h.	Slopes, chamfer and curve • Slopes *4 × 1 mark* • Chamfer *2 marks* • Curve *2 marks*	**8**
		Total	**49**

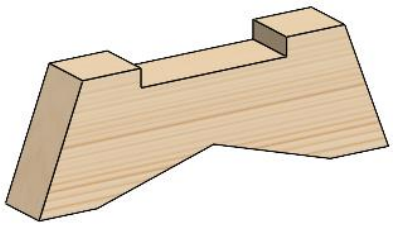
Processing of Jewellery Stand			
Housing joint	**(iii)**	**PROCESSING**	**Marks**
	a.	Trench • Trench *4 marks*	**4**
		Total	**4**
Bridle joint	**(iv)**	**PROCESSING**	**Marks**
	a.	Trenches • Sawing across the grain *4 × 1 mark* • Paring of trenches to depth *2 × 2 marks*	**8**
	b.	Bridle • Sawing with the grain *2 × 1 mark* • Paring bridle *2 marks*	**4**
		Total	**12**

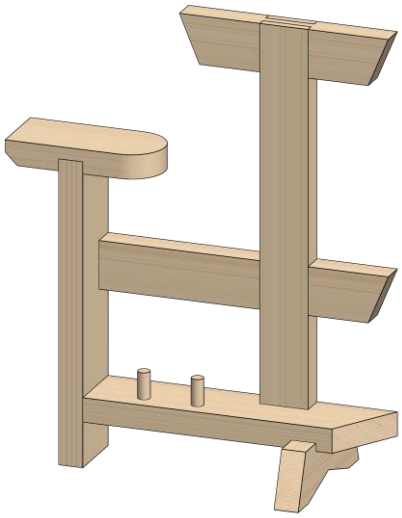
Cross halving joint	(v)	PROCESSING	Marks
	a.	Trenches • Saw across the grain *4 × 1 mark* • Paring of trenches to depth *2 × 2 marks*	**8**
		Total	**8**

Dovetail joint	(vi)	PROCESSING	Marks
	a.	Dovetail • Sawing of dovetail *4 × 1 mark* • Paring dovetail *2 × 2 marks*	**8**
	b.	Dovetail trench • Sawing across the grain 2 *× 1 mark* • Paring trench to depth 2 *marks*	**4**
		Total	**12**

Double mortice and tenon	(vii)	PROCESSING	Marks
	a.	Tenons • Sawing with the grain *4 × 1 mark* • Sawing cross the grain *2 × 1 mark* • Vertical paring *2 marks*	**8**
	b.	Mortices • Remove mortices *2 × 3 marks*	**6**
		Total	**14**

Bare face mortice & tenon	(viii)	PROCESSING	Marks
	a.	Mortice *3 marks*	**3**
	b.	Tenon 6 *marks*	**6**
		Total	**9**

Leg	(ix)	PROCESSING	Marks
	a.	Trench • Sawing across the grain *2 × 1 mark* • Paring of trench to depth *2 marks*	**4**
	b.	Short slopes *2 × 1 mark*	**2**
	c.	Bottom groove • Sawing to depth *1 mark* • Paring with the grain 2 × 2 marks	**5**
		Total	**11**

Shaping & drilling	(x)	PROCESSING	Marks
	a.	Short slopes *4 × 1 marks*	**4**
	b.	Curve *3 marks*	**3**
	c.	Chamfer *2 marks*	**2**
	c.	Drilling, countersinking and insert screw accurately *2 marks*	**2**
	d.	Dowels • Cutting of dowel to length *2 × 1 mark* • Drilling dowel holes accurately *2 × 2 marks*	**6**
		Total	**17**

	OVERALL COMPLETION OF PIECE	Marks
	Grand Total	**150**

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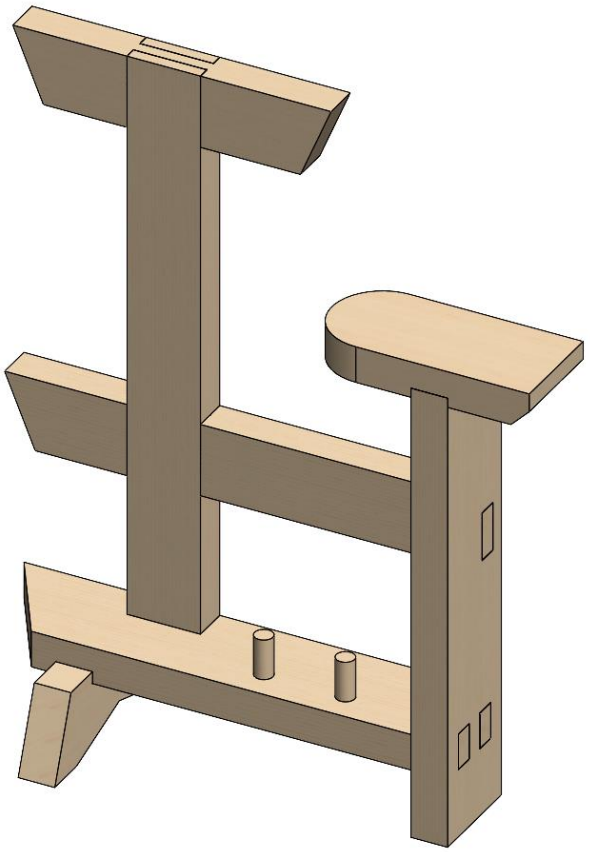
Leaving Certificate Examination, 2023

Construction Studies

Practical Test

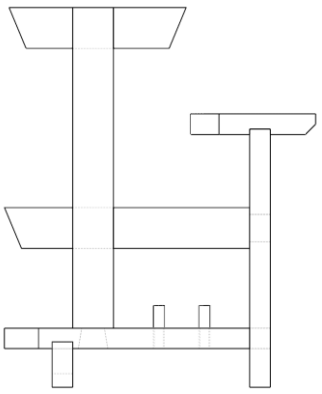
Common Level

(150 marks)



Marking Scheme

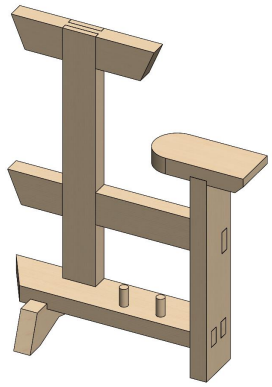
Day 2



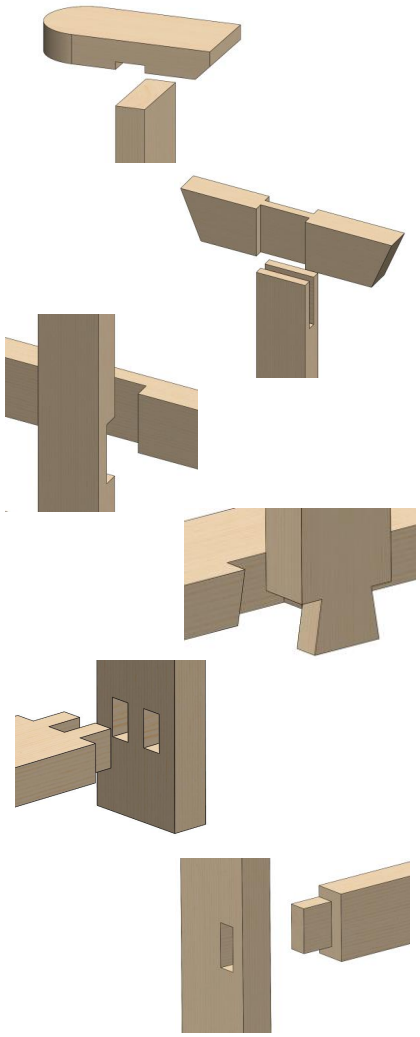
Marking Scheme – Practical Test

Note:

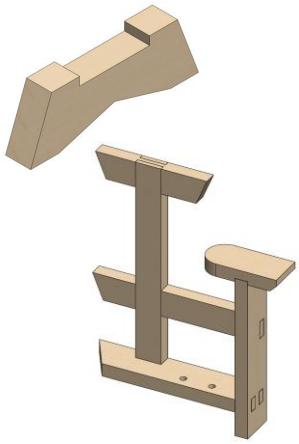
- The artefact is to be hand produced by candidates without the assistance of machinery.
- However the use of a battery powered screwdriver is allowed.
- Where there is evidence of the use of machinery for a particular procedure a penalty applies.
- Component is marked out of 50% of the marks available for that procedure.

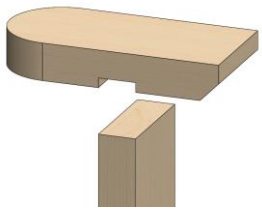
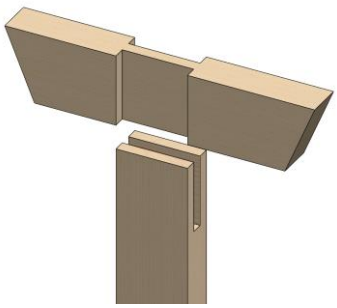


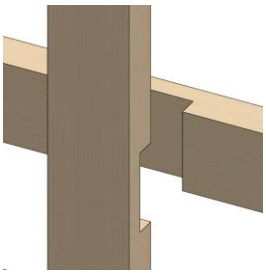
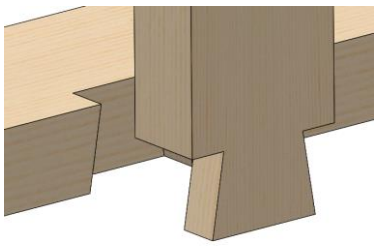
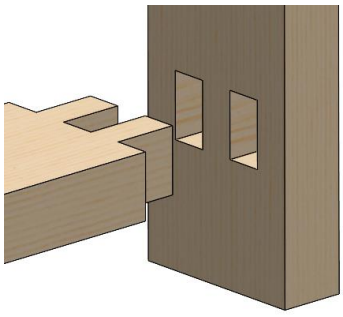
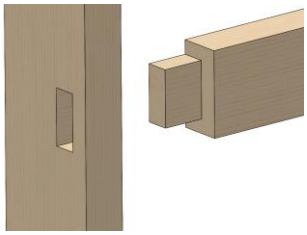
(i)	OVERALL ASSEMBLY	Marks
a.	Overall quality of assembled artefact	**10**
b.	Design and applied shaping to edge	**4**
	Total	**14**

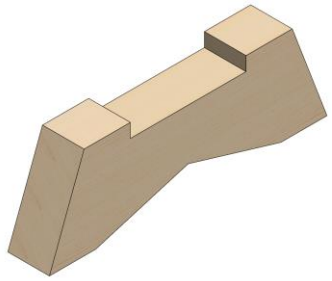


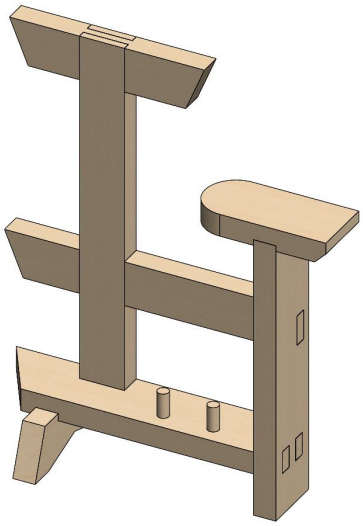
(ii)	MARKING OUT	Marks
a.	Housing joint • Trench *3 marks*	**3**
b.	Bridle joint • Trenches *2 × 2 marks* • Bridle *3 marks*	**7**
c.	Cross halving joint • Trenches *2 x 2 marks*	**4**
d.	Dovetail joint • Tail *3 marks* • Trench *3 marks*	**6**
e.	Double mortice and tenon joint • Tenons *2 × 2 marks* • Mortices *2 × 2 marks*	**8**
f.	Bare faced mortice and tenon joint • Mortice *3 marks* • Tenon *3 marks*	**6**

	g.	Leg • Trench *3 marks* • Slopes *4 x 1 marks*	**7**
	h.	Slopes, chamfer and curve • Slopes *4 × 1 mark* • Chamfer *2 marks* • Curve *2 marks*	**8**
		Total	**49**

Processing of Jewellery Stand			
Housing joint	**(iii)**	**PROCESSING**	**Marks**
	a.	Trench • Trench *4 marks*	**4**
		Total	**4**
Bridle joint	**(iv)**	**PROCESSING**	**Marks**
	a.	Trenches • Sawing across the grain *4 × 1 mark* • Paring of trenches to depth 2 × 2 marks	**8**
	b.	Bridle • Sawing with the grain *2 × 1 mark* • Paring bridle *2 marks*	**4**
		Total	**12**

Cross halving joint	(v)	PROCESSING	Marks
	a.	Trenches • Saw across the grain *4 × 1 mark* • Paring of trenches to depth *2 × 2 marks*	**8**
		Total	**8**
Dovetail joint	**(vi)**	**PROCESSING**	**Marks**
	a.	Dovetail • Sawing of dovetail *4 × 1 mark* • Paring dovetail *2 × 2 marks*	**8**
	b.	Dovetail trench • Sawing across the grain 2 *× 1 mark* • Paring trench to depth 2 *marks*	**4**
		Total	**12**
Double mortice and tenon	**(vii)**	**PROCESSING**	**Marks**
	a.	Tenons • Sawing with the grain *4 × 1 mark* • Sawing cross the grain *2 × 1 mark* • Vertical paring *2 marks*	**8**
	b.	Mortices • Remove mortices *2 × 3 marks*	**6**
		Total	**14**
Bare face mortice & tenon	**(viii)**	**PROCESSING**	**Marks**
	a.	Mortice *3 marks*	**3**
	b.	Tenon 6 *marks*	**6**
		Total	**9**

Leg	(ix)	PROCESSING	Marks
	a.	Trench • Sawing across the grain *2 × 1 mark* • Paring of trench to depth *2 marks*	**4**
	b.	Short slopes *2 × 1 mark*	**2**
	c.	Bottom groove • Sawing to depth *1 mark* • Paring with the grain *2 × 2 marks*	**5**
		Total	**11**

Shaping & drilling	(x)	PROCESSING	Marks
	a.	Short slopes *4 × 1 marks*	**4**
	b.	Curve *3 marks*	**3**
	c.	Chamfer *2 marks*	**2**
	c.	Drilling, countersinking and insert screw accurately *2 marks*	**2**
	d.	Dowels • Cutting of dowel to length *2 × 1 mark* • Drilling dowel holes accurately *2 × 2 marks*	**6**
		Total	**17**

	OVERALL COMPLETION OF PIECE	Marks
	Grand Total	**150**

Coimisiún na Scrúduithe Stáit
State Examinations Commission

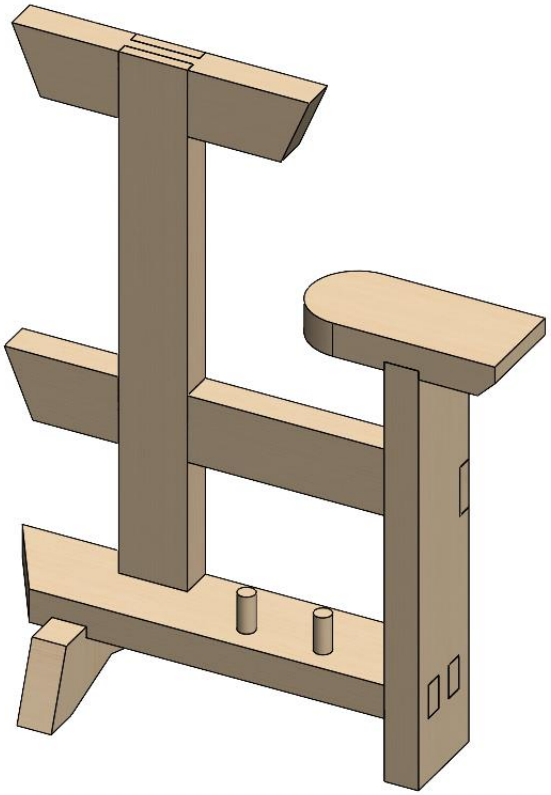
Leaving Certificate Examination, 2023

Construction Studies

Practical Test

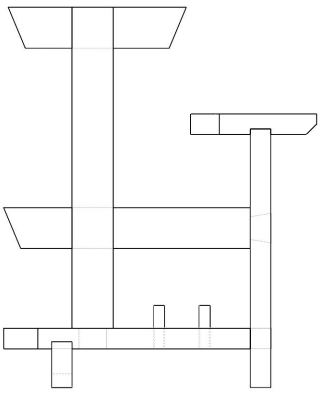
Common Level

(150 marks)



Marking Scheme

Day 3



Marking Scheme – Practical Test

Note:

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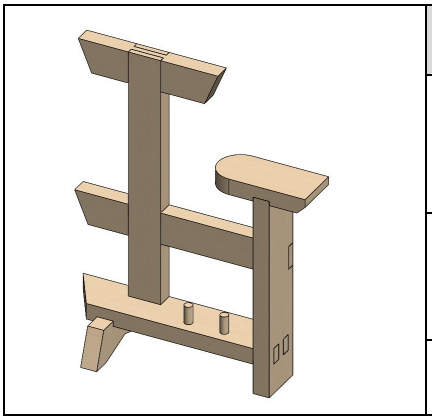
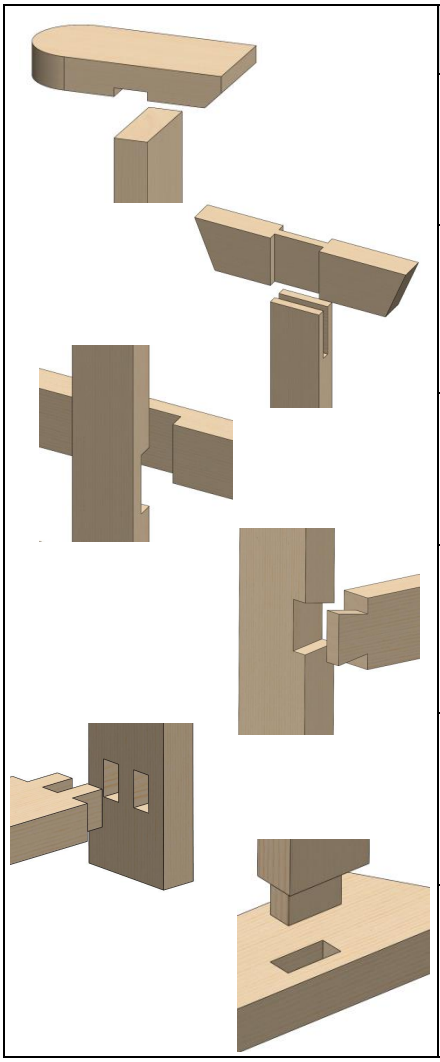
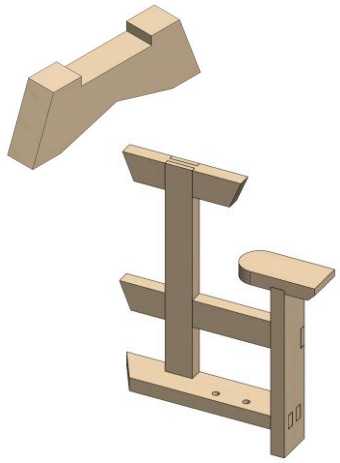
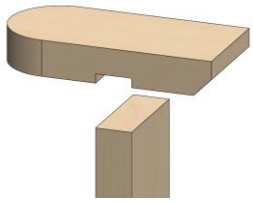
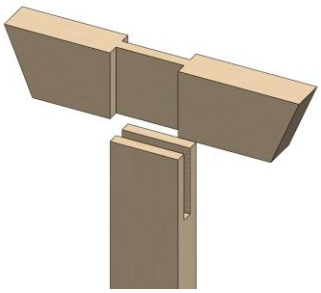


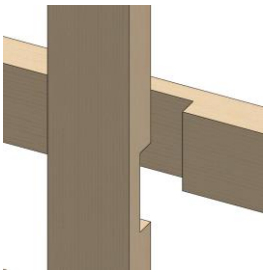
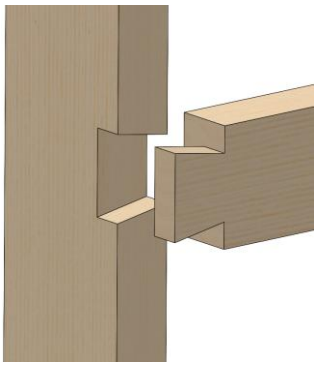
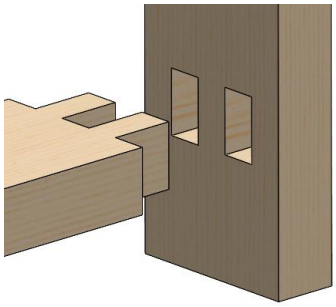
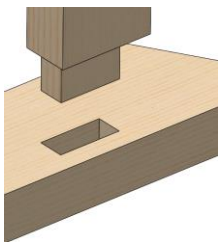
(i)	OVERALL ASSEMBLY	Marks
a.	Overall quality of assembled artefact	**10**
b.	Design and applied shaping to edge	**4**
	Total	**14**

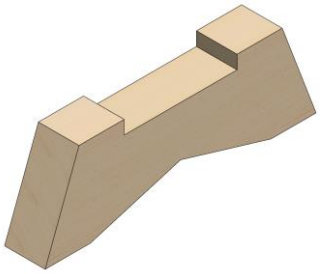


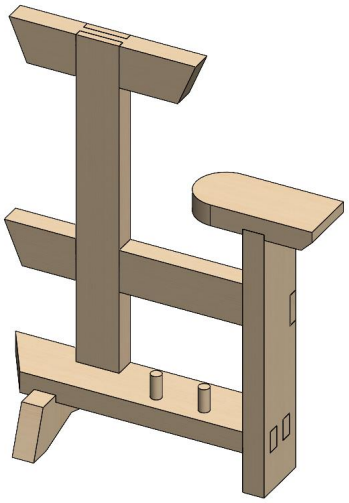
(ii)	MARKING OUT	Marks
a.	Housing joint • Trench *3 marks*	**3**
b.	Bridle joint • Trenches *2 × 2 marks* • Bridle *3 marks*	**7**
c.	Cross halving joint • Trenches *2 x 2 marks*	**4**
d.	Dovetail joint • Tail *3 marks* • Trench *3 marks*	**6**
e.	Double mortice and tenon joint • Tenons *2 × 2 marks* • Mortices *2 × 2 marks*	**8**
f.	Bare faced mortice and tenon joint • Mortice *3 marks* • Tenon *3 marks*	**6**

	g.	Leg • Trench *3 marks* • Slopes *4 x 1 marks*	**7**
	h.	Slopes, chamfer and curve • Slopes *4 × 1 mark* • Chamfer *2 marks* • Curve *2 marks*	**8**
		Total	**49**

Processing of Jewellery Stand			
Housing joint	**(iii)**	**PROCESSING**	**Marks**
	a.	Trench • Trench *4 marks*	**4**
		Total	**4**
Bridle joint	**(iv)**	**PROCESSING**	**Marks**
	a.	Trenches • Sawing across the grain *4 × 1 mark* • Paring of trenches to depth *2 × 2 marks*	**8**
	b.	Bridle • Sawing with the grain *2 × 1 mark* • Paring bridle *2 marks*	**4**
		Total	**12**

Cross halving joint	(v)	PROCESSING	Marks
	a.	Trenches • Saw across the grain *4 × 1 mark* • Paring of trenches to depth *2 × 2 marks*	**8**
		Total	**8**
Dovetail joint	**(vi)**	**PROCESSING**	**Marks**
	a.	Dovetail • Sawing of dovetail *4 × 1 mark* • Paring dovetail *2 × 2 marks*	**8**
	b.	Dovetail trench • Sawing across the grain 2 *× 1 mark* • Paring trench to depth 2 *marks*	**4**
		Total	**12**
Double mortice and tenon	**(vii)**	**PROCESSING**	**Marks**
	a.	Tenons • Sawing with the grain *4 × 1 mark* • Sawing cross the grain *2 × 1 mark* • Vertical paring *2 marks*	**8**
	b.	Mortices • Remove mortices *2 × 3 marks*	**6**
		Total	**14**
Bare face mortice & tenon	**(viii)**	**PROCESSING**	**Marks**
	a.	Mortice *3 marks*	**3**
	b.	Tenon 6 *marks*	**6**
		Total	**9**

Leg	(ix)	PROCESSING	Marks
	a.	Trench • Sawing across the grain *2 × 1 mark* • Paring of trench to depth *2 marks*	**4**
	b.	Short slopes *2 × 1 mark*	**2**
	c.	Bottom groove • Sawing to depth *1 mark* • Paring with the grain *2 × 2 marks*	**5**
		Total	**11**

Shaping & drilling	(x)	PROCESSING	Marks
	a.	Short slopes *4 × 1 marks*	**4**
	b.	Curve *3 marks*	**3**
	c.	Chamfer *2 marks*	**2**
	c.	Drilling, countersinking and insert screw accurately *2 marks*	**2**
	d.	Dowels • Cutting of dowel to length *2 × 1 mark* • Drilling dowel holes accurately *2 × 2 marks*	**6**
		Total	**17**

	OVERALL COMPLETION OF PIECE	Marks
	Grand Total	**150**

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Form A

Leaving Certificate Examination

Construction Studies

Practical Coursework
Marking Scheme

Marking Criteria		Marks
A	**Planning of Project** • Coursework selection, exploration and management planning • Investigation and relevant research • Design development through annotated sketches, with working drawing(s) and/or models	**40**
B	**Report** • Sequence of manufacture including photographic evidence and/or sketches • Critical appraisal and conclusions from coursework experience • Overall quality of communication and presentation of the design folio	**35**
C	**Manipulative Skills** • Marking-out of materials • Processing and assembly of materials • Range and depth of skills evident in the artefact	**40**
D	**Completion of Project** • Artefact well finished • Creativity and appropriateness of coursework • Overall quality, coherence and presentation of coursework	**35**
	Total	**150**

Note*: While the general headings and marks above will largely remain the same, breakdowns may vary for any given year.*