Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2021

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, 2021

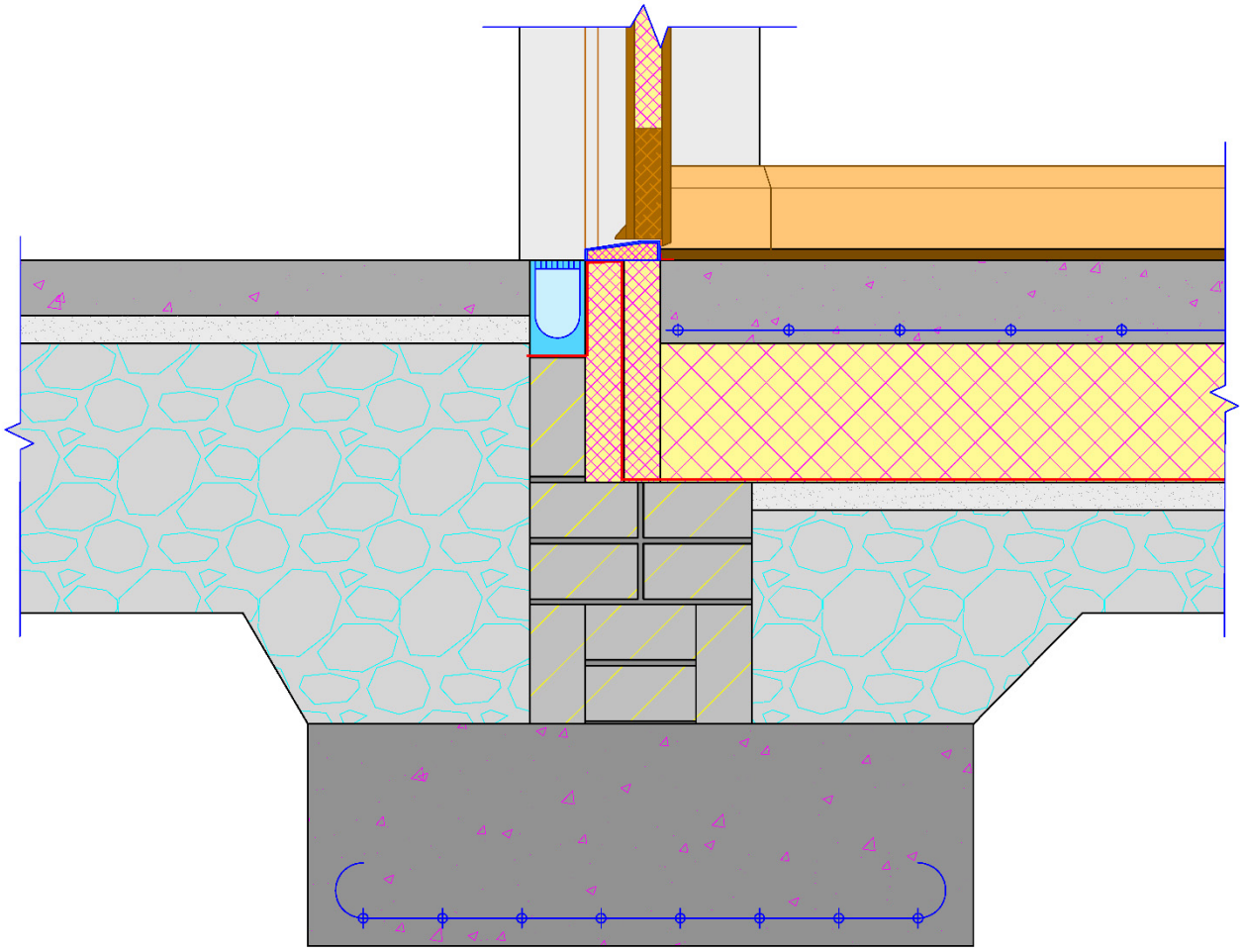
Construction Studies

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 the centre of the door, external wall, ground floor and foundation.



Any other relevant points.

Typical best practice detailing of a door threshold, external cavity wall and ground floor of a house

Foundation, external wall and level entrance – typical detailing

- R.C. Strip foundation typical - 1350 mm × 400 mm
- 400 mm Blockwork - deadwork
- Vertical insulation - thermal break
- Entrance substructure
- Level concrete entrance.

Solid ground floor – typical detailing

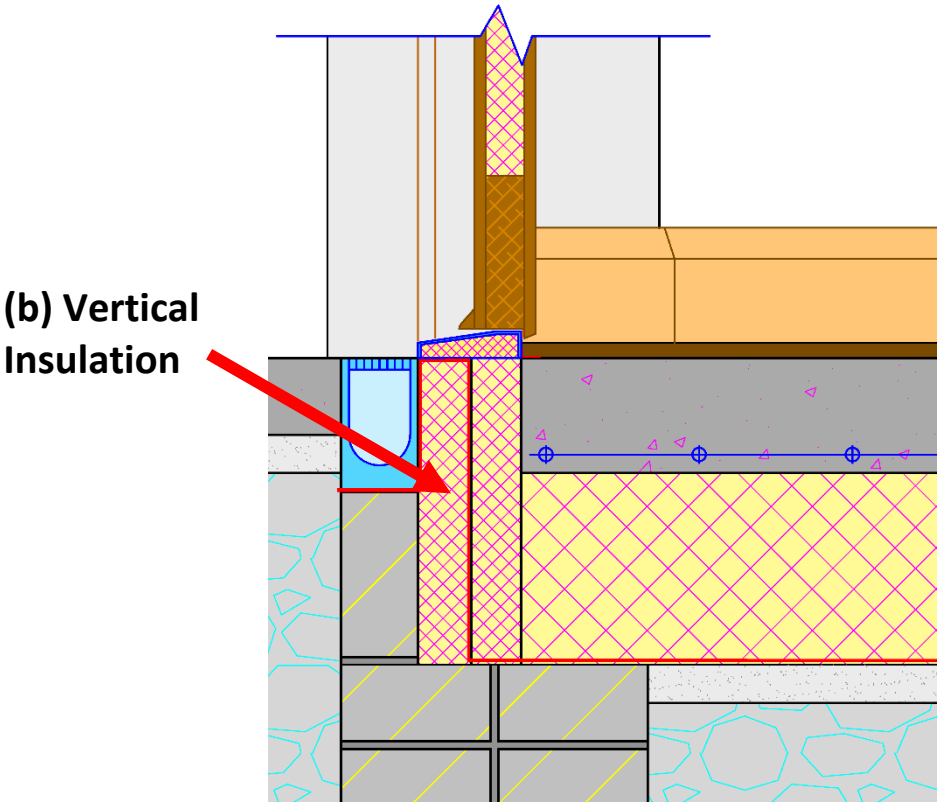
- Compacted hardcore
- Sand blinding
- Radon barrier / DPM
- 200 mm floor insulation
- 150 mm concrete floor / subfloor
- 20 mm hardwood flooring.

Door threshold and door – typical detailing

- Drainage channel
- Concrete threshold and wrap around DPC / Proprietary insulated door threshold
- 15 mm upstand or 15°
- Airtight tape at threshold
- External door / vertical sheeting
- Door insulation.

Any other relevant points.

(b) Typical design detailing that will prevent the formation of a thermal bridge at the threshold.



Question 2

(a) Duty of care that all workers have in maintaining high safety standards on a construction site.

Safety training

- Construction workers are legally required to complete a safe pass course
- Training is essential in order to develop awareness amongst workers of possible risks on site
- Workers have a legal obligation to attend and engage in all safety training provided
- Compulsory, national refresher safety training course every 3-4 years
- Workers should comply with safety standards as identified at training courses
- Regular monitoring of work practices
- Specialist training required on equipment/machinery/vehicles before use on site
- Enforcement of all good safe work practices
- Obligation to obtain and maintain a Safe Pass Certification.

Any other relevant points

Personal Protective Equipment (PPE)

- All construction workers are required by law to use personal protective equipment on site
- Workers should not carry out any work if the correct PPE has not been provided
- PPE such as Helmet, boots, high visibility clothing- waistcoat, jacket, trousers, gloves, safety glasses, ear protection, safety harness, etc
- Specific PPE to be worn when undertaking specialist and dangerous tasks
- Any defects in PPE provided should be reported immediately
- If the workers identify an item of PPE that is required but not provided, they should immediately inform the safety officer
- Ensure that all visitors to the site have appropriate PPE and if necessary, provide them with the PPE
- Employers should inform their employer of any medical conditions that have that might be affected by the use of PPE.

Any other relevant points

Vigilance

- Workers should be aware of and regularly review the site safety statement
- Report potential hazards or area of concern they may have over the health and safety of themselves or others
- Firm commitment from management to monitor and improve health and safety on site
- Safety officer - responsibility on site for the regular assessment of possible risks and the development of strategies to minimise danger to employees
- Awareness and reporting of any potential hazards
- Ongoing review of workers work practices on site
- All workers are aware of who the safety officer is on site
- Clear channel for identifying and reporting risks to management
- Report any accidents or near accidents
- Duty on all workers to observe best practice safety regulations.

Any other relevant points

(b) One possible risk associated with each task on a construction site.

Repairing a chimney stack

- Workers could fall from the roof, ladder or scaffolding
- Scaffolding itself could collapse with injury to those using it
- Workers may lose their balance or slip on the roof surface or ladder
- The chimney stack could fall if in an unstable state
- Building materials or tools used to fix the chimney may fall from a height and pose a risk to those on the ground.

Any other relevant points

Overhead electrical cables

- Electricity can "jump" or arc and kill or injure anyone working in close proximity to electricity wires
- Contact can be lethal with voltages as low as 230v
- Electric current can flow through wood or plastic (if damp or dirty) and cause fatal shocks
- Contact with live overhead lines can cause serious injury or death
- High plant or equipment e.g. excavators, MEWPs, scaffold poles, tipper vehicles and cranes, presents a particularly high risk for their operators.

Any other relevant points

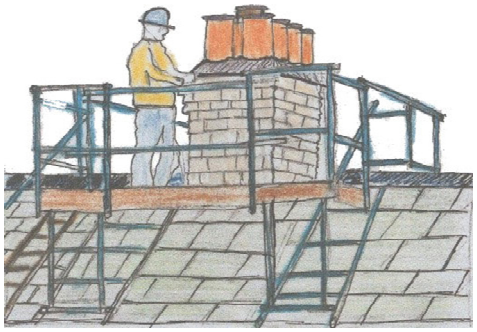
On-site health & hygiene

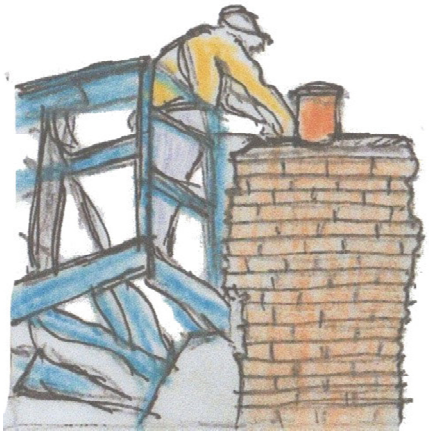
- Cross contamination of bacteria, fungus and viruses between workers onsite
- Workers contacting infectious disease from animals, vermin and parasites
- Workers consuming food in an unhealthy environment
- Workers becoming ill due to stagnant or contaminated drinking water
- Workers may contract Hepatitis or Covid where hygiene is poor.

Any other relevant points

(c) Two specific safety procedures that should be observed to eliminate each risk identified.

Repairing a chimney stack

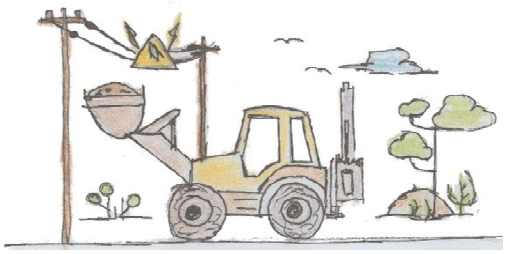




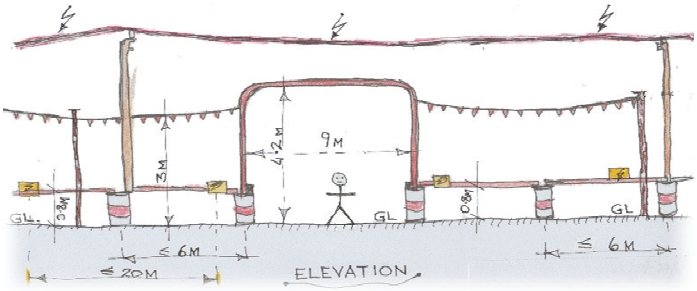
- Scaffolding should be constructed around the chimney stack to create a safe working platform
- Scaffolding to be erected by certified personnel only
- All scaffold should have the required safety hand rail, mid rail and toe boards fitted
- Scaffolding should be tied into the house/chimney
- Use of lifting machinery on level surface to allow workers access the chimney stack
- Secure attachment of workers to any lifting machinery
- Teleporter operators or similar should be experienced and suitably qualified to use such machinery
- Use slating jacks and boards if needed on slope of roof to create working platform
- Safety harness or other fall protection should be implemented
- Properly secured ladders at all levels on scaffolding
- Safety netting all around scaffolding-protection from falling objects.

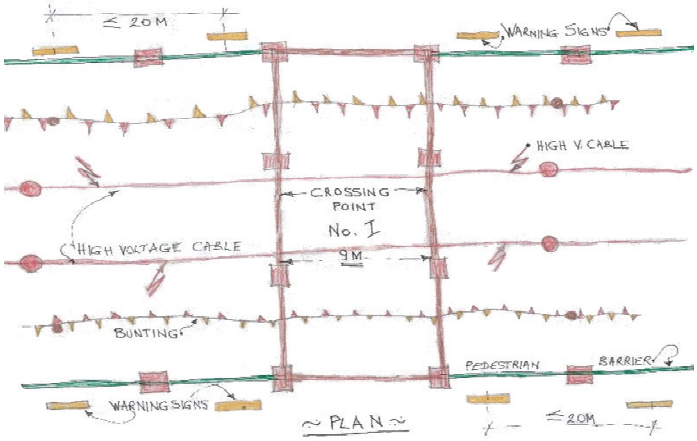
Any other relevant points

Overhead electrical cables



- Any work near electric overhead power lines must be carefully planned and carried out to avoid danger from accidental contact or close proximity to the lines
- Bunting is erected each side of electrical cable at a distance of 6 - 10 m and at a height of 3 - 4.2 m above ground
- Crossing points are erected for machinery with max. height of 4.2 m and width of 9 m
- Guard rail at ground level 0.8 m to 1.4 m above ground along the cables
- Warning signs at 20 m intervals along guarded area
- Avoid working in the area near or under overhead lines if possible
- Supervise access for plant and materials and the working of plant should be under the direct supervision of a suitable person appointed to ensure that safety precautions are observed
- Exclusion – plant, equipment or hand tools that could reach beyond the safe clearance limit should not be taken under the line
- Have an emergency contact number for ESB and other relevant utilities readily available for immediate contact
- At least one suitably qualified first aid worker on hand/close by.

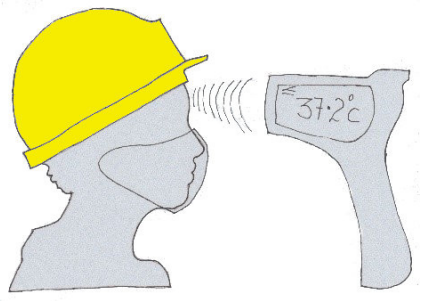




Any other relevant points

On-site health & hygiene

- Drinking water and water washing facilities at several locations
- Ensure all enclosed workers facilities are adequately ventilated
- Facilities for shelter, food preparation/consumption, personal hygiene and toilet facilities should be regularly cleaned
- Wear facemasks and maintain social distancing if possible
- Restrict the number of people working indoors in a small area
- Clean and disinfect frequently touched surfaces such as shared tools, machines, vehicles and other equipment, handrails, ladders, doorknobs, and portable toilets
- Health and hygiene signs to remind workers of their responsibilities
- Limit tool sharing if possible
- Practice proper hand hygiene
- Maintain access logs to record details of all workers should contact tracing information be required
- Modify work schedules to stagger worker in one area while maintaining productivity.



Any other relevant points

Question 3

(a) Three design considerations for home office space to enhance health and wellbeing.

Visual Comfort

- natural sunlight entering the office space throughout the day
- connection with nature
- artificial lighting installed in key working areas in the office
- maximising room volume
- minimal glare from the sun through the windows.

Thermal Comfort

- consistent optimum temperature in the office space while working
- fresh air supply to the office
- openings from the office space to the outside garden/space
- passive heating to reduce running costs and increase comfort
- manual heating control available in the office for users
- economic heating system would be preferable.

Ergonomic Comfort

- adequate space for office furniture and equipment
- enough space to comfortably move within the space and access equipment and fixtures
- how the office space is access - from the house or garden.

Olfactory Comfort

- constant fresh air supply to the space.

Storage

- adequate storage space for office materials
- shelves/filing cabinet/safe etc.

Flexibility

- ability to change the office layout to meet the needs or changing needs of the occupants throughout the day/week
- in the future the space could be utilised for a different use.

Acoustic Comfort

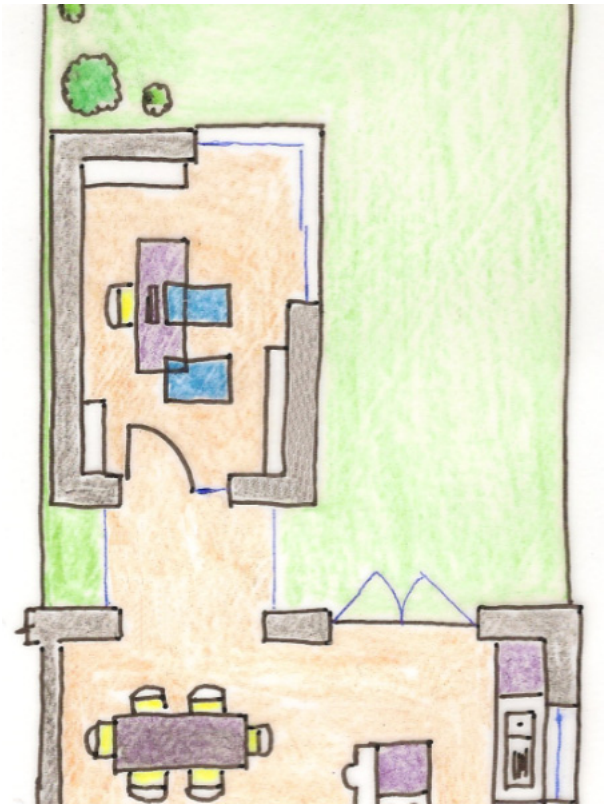
- the ability to block out noise pollution from the house or surrounding area while working
- allow the noise of nature into the space if required
- separate access to the office space.

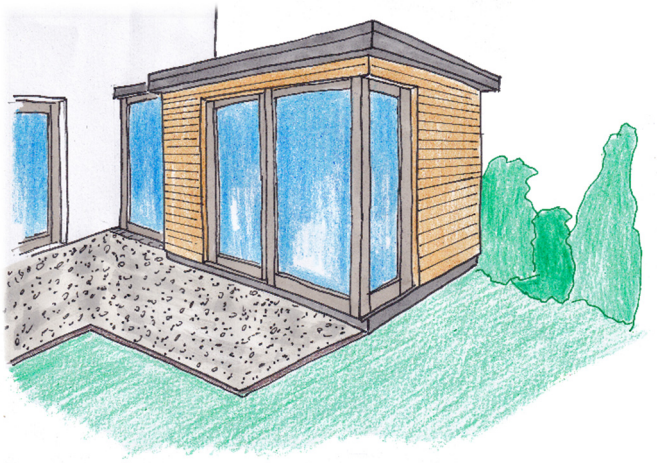
Services

- connections to wired or wireless technology in an efficient manner - e.g. numerous sockets at key locations, internet or television points.

Any other relevant points

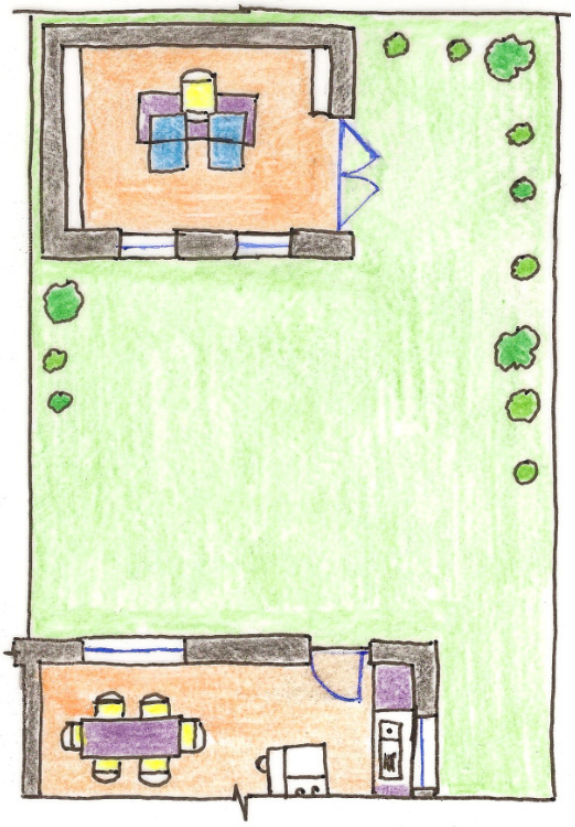
(b) Proposed design layout for home office space that incorporates the design considerations.





Visual Comfort

- glazed openings in wall/roof responding to the sun path and orientation.
- windows/doors opening out to the garden.
- sufficient ceiling and desk lights
- increased height, sloped ceiling and volume to give pleasant spacious interior space
- natural or built solar shading to avoid glare in summer but allow winter solar gain.



Thermal Comfort

- triple glazed, low-e, thermally broken frames throughout
- largest glazed area to south to avail of passive heating and cooling
- thermostats to manually control internal temperature
- sufficient insulation to retain heat
- openings to provide fresh air and cross ventilation.

Olfactory Comfort

- MHRV to prevent the build-up of stale moist air.

Ergonomic Comfort/Storage/ Flexibility

- adequate space to position required furniture
- option to rearrange layout or add to furniture requirement
- suitable space for storage which can be easily accesses.

Acoustic Comfort

- adequate construction and insulation to prevent the transfer of noise into/out of the workspace
- high quality doors and windows for soundproofing.

Any other relevant points

(c) Advantages and disadvantages of working from a home office.

Advantages

- reduced time lost in commute
- increased free time to use for personal health and wellbeing
- no transport costs
- increased productivity
- greater flexibility
- cost reduction from buying food on the go
- better work-life balance
- reduced distractions.

Disadvantages

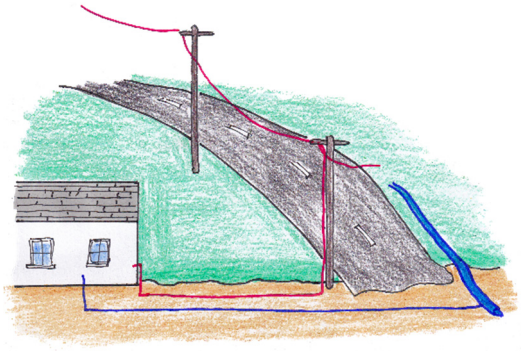
- no social interactions with colleagues
- loneliness and isolation
- distractions from the home environment
- being out of the loop and overlooked
- creating a dedicated work space
- always being available.

Any other relevant points

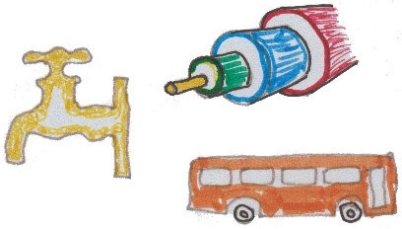
Question 4

(a) Discuss factors when selecting a site for a new house in a rural setting.

Availability of services



- Rural sites along main roads will generally have power and telecommunications services, but may not have a mains water supply, gas, sewerage or storm water services
- Where services are not available, it is important to get an estimate for bringing them to the boundary early in the site selection process
- The cost can be substantial in some cases, even over relatively short distances, and houseowners need to be aware
- Remote sites may have no economical access to any services.



Any other relevant points

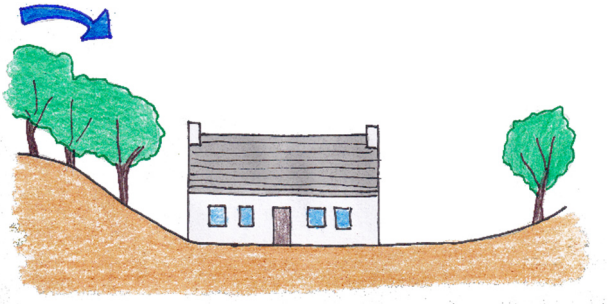
Existing trees and hedgerows

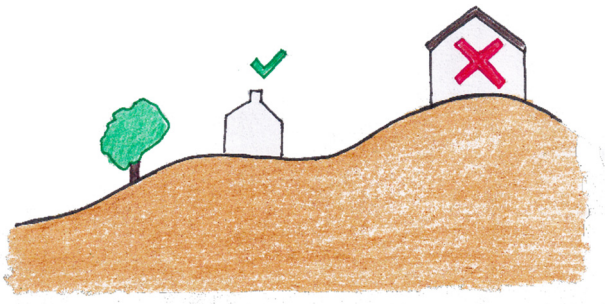
- Existing hedgerows provide a natural sound buffer
- Existing layer of privacy for the new property
- Enhance the health and wellbeing of the occupants by being surrounded by mature natural landscaping
- Maintains local flora and wildlife
- The removal of existing large trees to build over may have a negative effect on settlement in the future
- Natural integration into the countryside
- Reduce costs from planting new hedgerows
- Mature trees can be integrated into new house design.

Any other relevant points

Site topography

- Topography is the study of the forms and features of land surface in an area
- identify and use the natural sheltering features of the site; folds in the land or contours, existing trees and hedges
- Do not break the horizon or skyline or build on the highest part of the site
- Reduce where possible, cutting and filling into hills which can leave the landscape scarred
- Avoid a sense that a house has been “dropped into” the landscape - integrated into the site landscape without incurring additional costs
- Is the site low lying and susceptible to flooding?

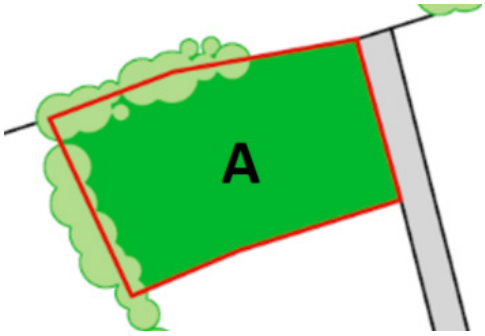




Any other relevant points

(b) Select a preferred site A or B and discuss the considerations taken into account when selecting this site.

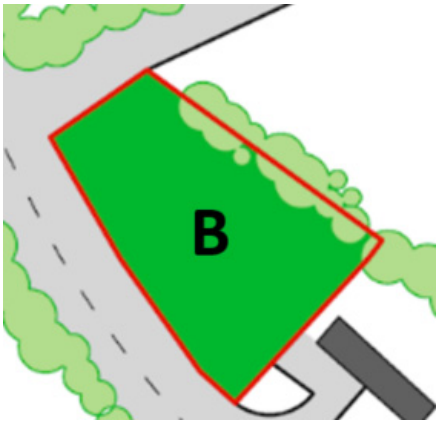
Why site A may be considered suitable for a new house - *such as*



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

Any other relevant points

Why site B may be considered suitable for a new house - *such as*



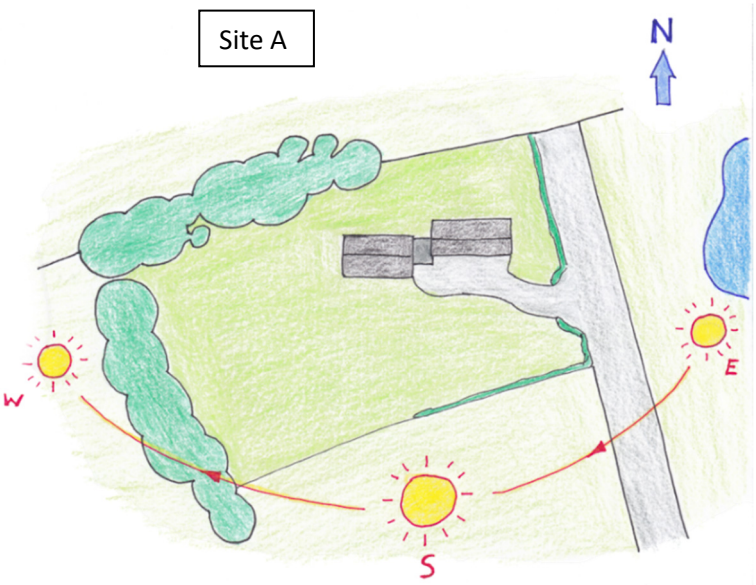
- Access can be gained from two site parameter boundaries
- Existing services are in close proximity to the site - neighbouring house already has connections with water, electricity, broadband resulting in cost-effective provision of public services
- Building close to an existing dwelling is favoured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

Any other relevant points

(c) Sketch of selected site to included house location, orientation, road entrance and driveway.

House location and orientation

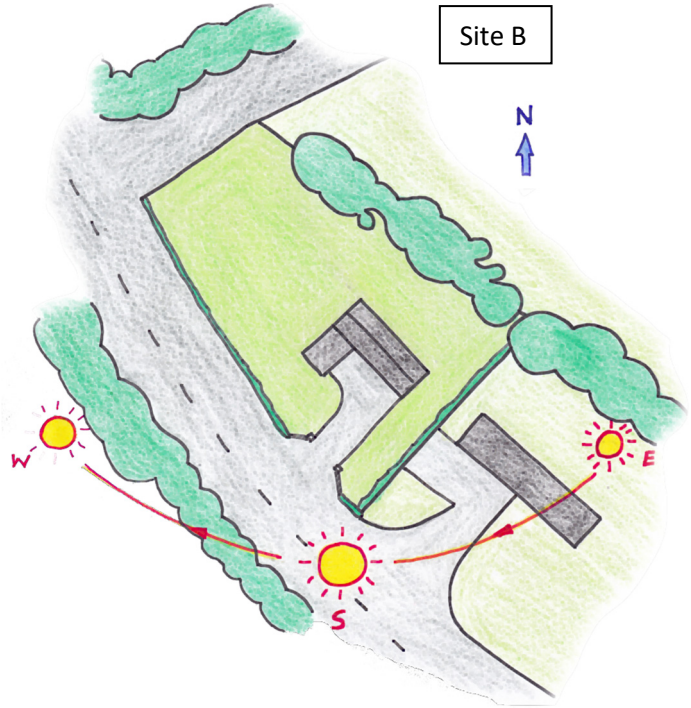
- The design / form of the building maximises solar gains by having the largest external perimeter facing south
- Building's proximity to the road where services are normally located
- The building is set back from the road to reduce the environmental impact on the landscape
- House placed for greater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



Any other relevant points

Road entrance and driveway

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



Any other relevant points

Question 5

(a) Calculate the U-value of the timber frame wall.

Material Element	Conductivity k	Resistivity r	Thickness T(m)	Resistance R
External resistance				0.048
External brick		1.300	0.1	0.130
Air cavity				0.440
OSB	0.130	7.692	0.009	0.069
Cellulose insulation	0.039	25.641	0.175	4.487
OSB	0.13	7.692	0.009	0.069
Plasterboard	0.25	4	0.0125	0.050
Internal resistance				0.130
			Total R =	$R^t = 5.424$
Formulae: **R=T/k** **R=T × r** **U= 1/R^t** **U-value:** U = 1 / 5.424 = 0.184 W/m^2 ^{0}C				
			U-value =	**0.184 w/m^2 ^{0}c**

(b) Thickness of internal insulation required to give a wall U-value of 0.15 w/m^2 ^{o}c.

Determine the Resistance for a U-value of 0.184 w/m^2 ^{0}c

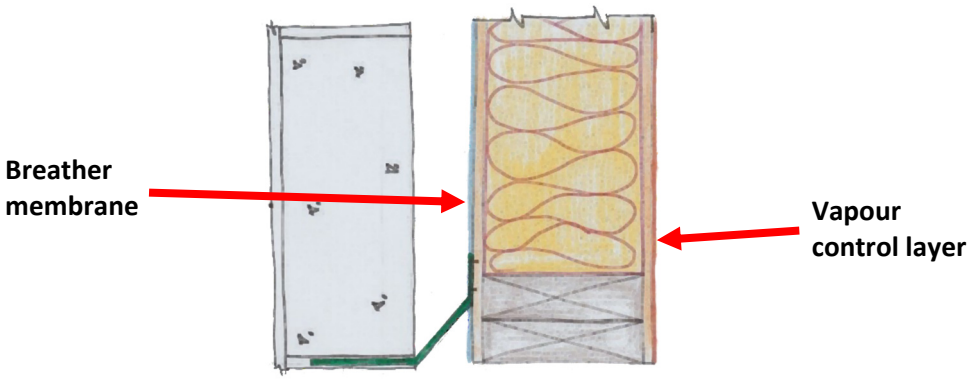
Use formula U= 1/Rt. & solve for R.
R = 1/ U-value R = **1/ 0.184** = 5.424 m^2 °c / W
Resistance for required U-value of 0.15 = 1/0.15 = 6.666 m^2 °c / W
Difference in Resistance = 6.666 – 5.424 = 1.243 m^2 °c / W

Use the formula R= T/k & solve for T.
1.243 = T/0.034
T = 4.727 × 0.034 **= 0.04226 metres** to achieve U value of **0.15 W/m^2 $^\circ$C.**

Thickness of required Expanded Polystyrene insulation = **42 mm -** accept **42/43 mm.**

Alternative calculation methods acceptable.

(c) Why moisture control and a vapour control layer need to be incorporated into timber frame construction.



There are two layers installed in timber frame construction to control moisture:

1. A **breather membrane** is positioned on the outer side of the timber frame, allowing vapour to escape from inside while repelling any water that tries to enter the building. To ensure maximum efficiency, all joints in the membrane should be properly sealed with tape to prevent accidental air-leakage.

2. A **vapour control layer** is positioned on the inner side of the timber frame, reduces vapour transfer in a building. The warm air inside a heated building will contain a lot of moisture in the form of water vapour, which can condense when it encounters a cold surface within a structure. The vapour control layer (VCL) reduces the water vapour transfer through any building and reduces the risk of condensation forming. Therefore, preventing moisture damage to the timber frame which may lead to dry rot in the structure. It is essential that the VCL is continuous and sealed at all laps for it to perform correctly.

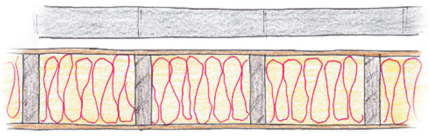
Any other relevant points

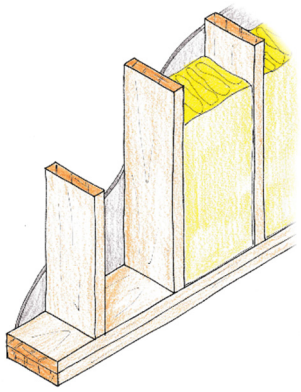
Question 6

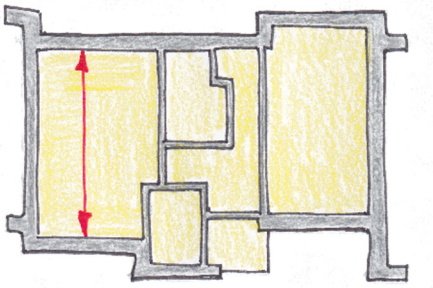
(a) Three feature of the design that contribute to the house having a low environment impact

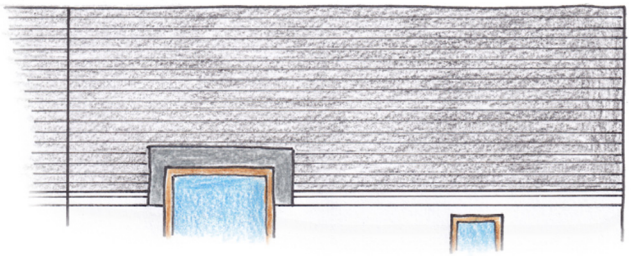
- Timber frame construction from local sources which reduces transport movements; has lower carbon emissions and a reduction in local air pollution
- Less embodied energy required to produce timber frame construction compared to concrete block construction
- One room deep design enables light to enter the room from both sides - heat from the sun entering the house will reduce heating costs
- High levels of insulation used in the construction will reduce heat loss through the exterior envelope
- The absence of a chimney reduces draughts and increases airtightness
- Cedar cladding sourced from FSC certified forests used on the front façade
- House is heated using a renewable heat source
- Simple building form – building envelope area minimised to reduce energy loss through external walls.

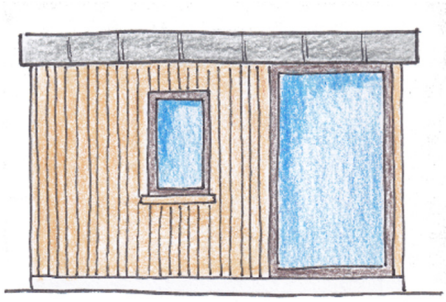
Any other relevant points







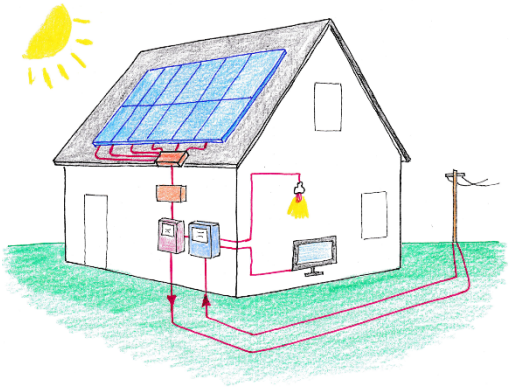




(b) Two features that could be added to reduce the house operation energy use

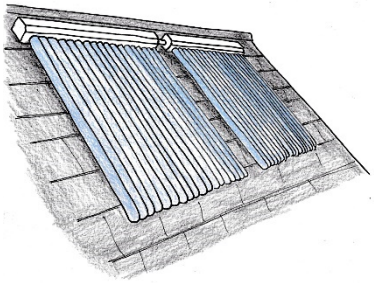
Install photovoltaic (PV) panels

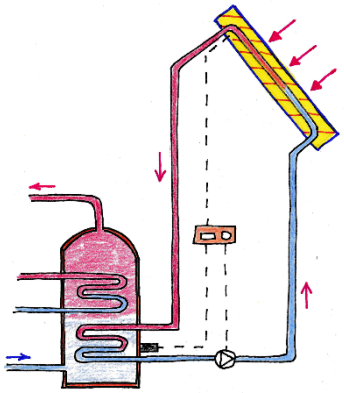
- The use of photovoltaic panels reduces the use of electricity and finite materials required to produce it
- The generation of electricity with PV panels would reduce carbon emissions from the house
- Panel installed on a south facing inclined surface – roof surface
- Panel will reduce the operating costs and negative impacts on the environment.



Install evacuated tube / solar panel

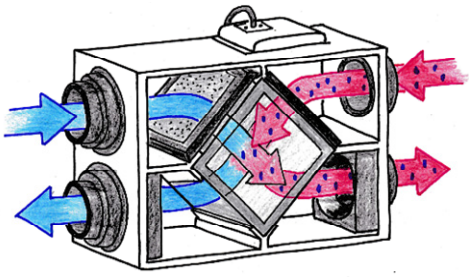
- Reduces the demand on the houses heating system – reduces energy use
- Efficient method of heating hot water for domestic use by using the power of the sun
- To reduce the dependency on mains electricity and operational carbon of the house
- Installed closest to south-facing aspect for maximum efficiency to heat domestic hot water.





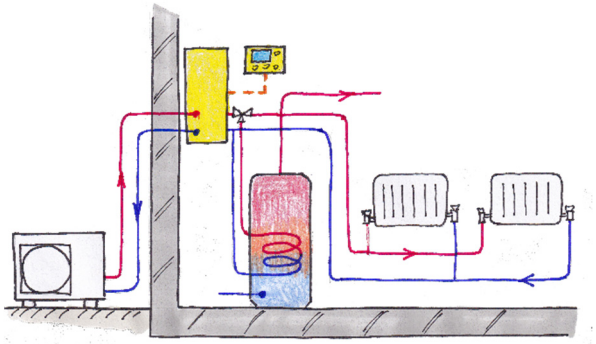
Install of a Mechanical Heat Recovery Ventilation (MHRV) system

- The installation of a MHRV system will recover up to 95% of the heat that is normally lost
- Reduce the demand for additional heating energy usage
- The system maximises the energy input for a house - assists maximise energy usage
- Improves indoor air quality for occupants.



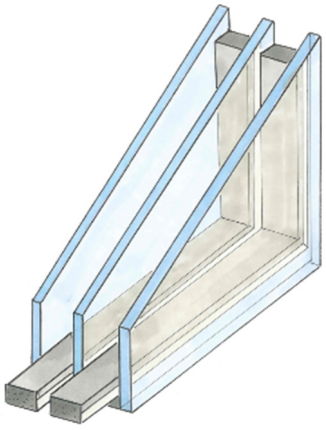
Install an Air to Water Heat Pump

- Air-to-water heat pumps extract heat energy from the outside air to heat a house
- Very energy efficient method of heating spaces and hot water in a house
- Low carbon footprint as the system does not burn any fossil fuels
- Easily installed or retrofitted into a domestic house
- The external unit extracts the air and the internal unit exchanges this air to heat the house.



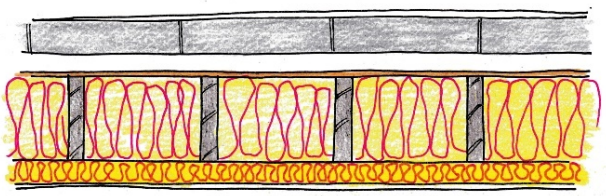
Triple glazed, thermally broken window frame system.

- Triple glazing and a thermal broken window system will enhance the thermal resistance of the external envelope
- Less heat loss through the windows will reduce operation energy usage
- Modern window glazing systems have double airtight sealing systems to enhance the airtightness at the window.



Additional insulation

- Installation of an insulated service cavity to the internal surfaces of the house
- Increases the insulation levels in the external envelope - reduces heat loss
- Service cavity prevents breaks in airtight membrane – increasing airtightness and efficiency.



Any other relevant points

(c) Two advantages of design a house to have low operational energy use

Operational carbon - carbon load created by the use of energy to heat and power a house.

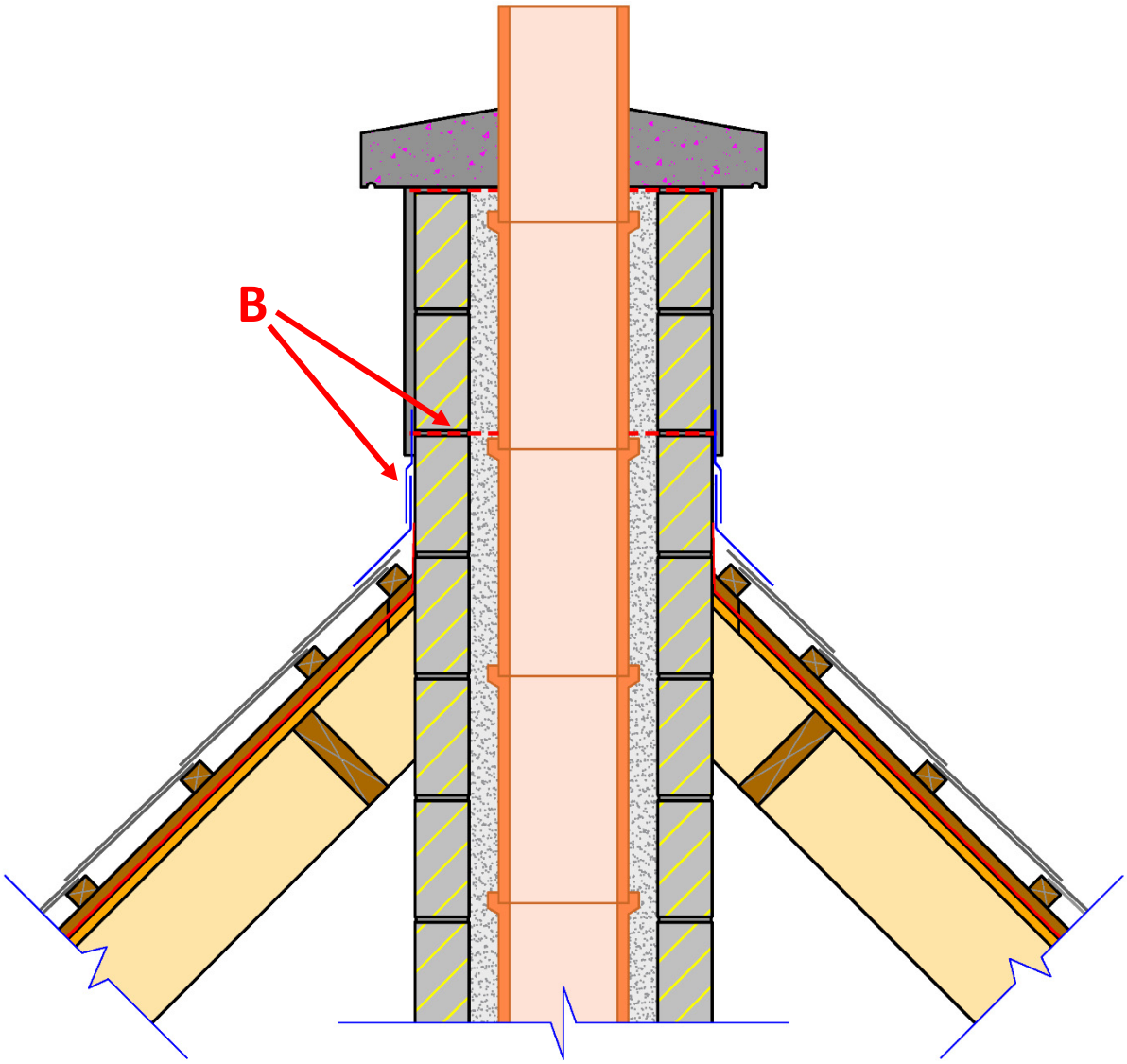
Advantages:

- Benefit the environment and our ecosystems by using less energy
- It lowers our exposure to chemicals and pollution therefore enhancing our personal health and wellbeing
- Costs less to run house
- Less finite resources being consumed in the energy used to operate the house.

Any other relevant points

Question 7

(a) Vertical section through centre of chimney stack and roof structure.



Chimney stack and roofing - typical detailing

Chimney stack

- Chimney blockwork
- External render
- Flue liners
- Lime sand fill / vermiculite
- Concrete chimney capping
- DPC beneath chimney capping
- Lead cover flashing × 2
- DPC at roof level

Roofing

- Rafter 200 × 50
- Chimney trimmer
- Windtight OSB layer
- Breather membrane
- Counter battens
- Slating batten 50 × 30
- 3 courses of slates
- Apron lead flashing

Any other relevant detail

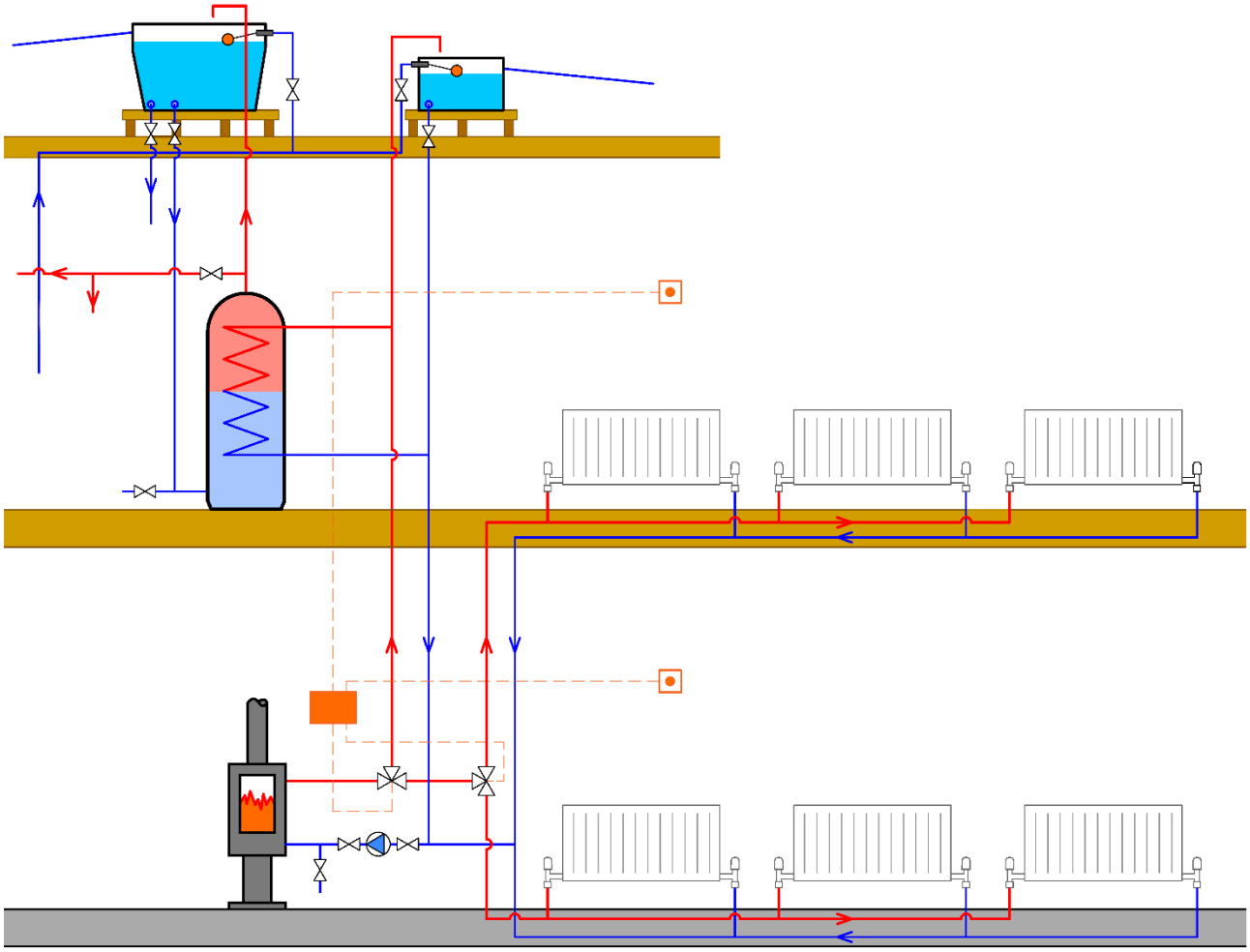
(b) Typical design detailing to prevent the penetration of moisture at junction.

- DPC at roof level
- Lead flashing × 2

Any other relevant detail

Question 8

(a) Typical design layout to provide hot water and central heating to a two-storey house.

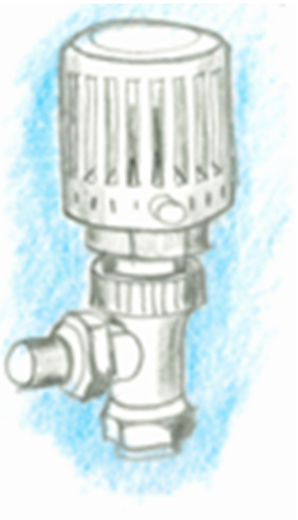


Typical sizes of pipework:

- Ø15 mm Cold water rising main
- Ø22 mm Primary flow and return to radiator
- Ø15 mm Pipes to radiators
- Ø22 mm Cold water feed to cylinder
- Ø28 mm Hot water feed
- Ø28 mm Overflow pipe

Any other relevant points

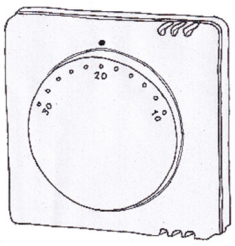
(b) Two features that increases the efficiency of the heating system.



Thermostatic radiator valves

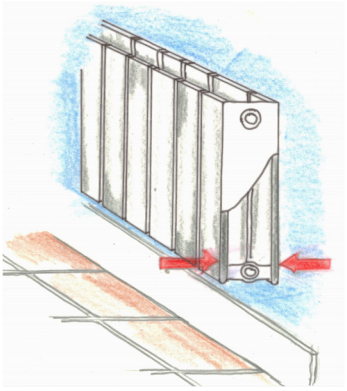
- Radiator temperature can be set or adjust using thermostatic values which are fitted
- The valves allow greater heating control of individual radiators
- Thermostatic valves are easily installed to new or existing radiators
- Allows rooms to be efficiently heated to different temperatures

Room thermostats



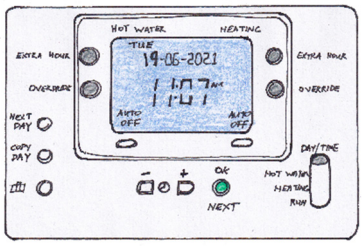
- The thermostat switches the heating to the room on and off according to the temperature chosen
- A programmable room thermostat gives greater control, enabling the setting of different temperatures for different times of the day
- This control reduces the excessive heating of a room - efficient use of heat energy.

Radiator design



- Replace the radiators with new more energy efficient radiator such as – double panel or aluminium
- Double panel radiators produce an increased amount of heat than standard radiators
- Aluminium radiators are designed to heat up much quicker and also run at an extremely high temperature - makes them generally cheaper to run.

Time switches and programmers

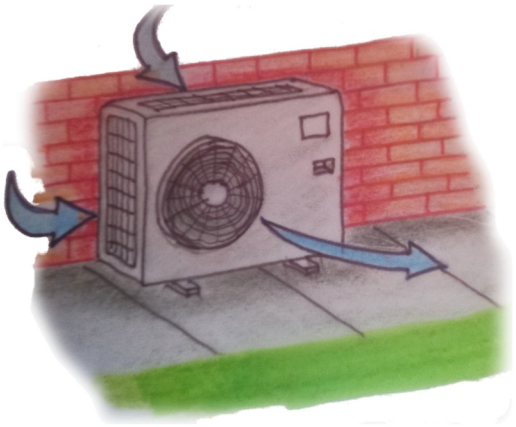


- A time switch will turn the system on and off at pre-set times
- A programmer allows the operation of the heating and hot water circuits independently at different times of the day
- A controller gives more flexibility - it operates the system at set times and also responds to temperature fluctuations.

Any other relevant points

(c) Two advantages of installing an Air-to-water heat pump.

Air-to-water heat pumps extract their heat energy from the outside air in order to heat a house. An air-to-water heat pump has an outside heat exchanger unit that is like a car radiator but instead of expelling heat to the air it takes heat from the air. The air is pulled through the heat exchanger by a fan whenever the heat pump is on. The heat pump heat exchanger has a refrigerant running through it which is able to absorb heat at a low temperature. The heat pump can heat a house even when it is as low as -15 degrees outside. This refrigerant is then compressed or pumped up to a higher temperature by the compressor just like a fridge. This higher temperature heat is then passed to the water that circulates around through the radiators or underfloor heating to heat a house or hot water.



Advantages:

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

Any other relevant points

Question 9

(a) Three considerations when designing the layout for sockets in the electrical system of a domestic house.

Socket layout

- The position of all sockets in rooms should be carefully considered – function of the room and its requirements into the future
- Height of sockets - 900 - 1200mm above floor level
- The number of sockets per room or in the house – costs associated with the installation
- Ensure all sockets are clearly visible, easy to reach and operate using one hand
- All proposed sockets in a house wiring layout can be reached with conduit and cabling.

Safety

- All socket outlets proposed are designed to the current safety standards – designed to protect the user against contact with live parts (isolation)
- Specified safety features and wiring to the sockets are sized and insulated for the requirements of the layout
- Socket layout must be connected to a miniature circuit breaker (MCB) to protect against any fault
- Use of a socket residual circuit device (RCD) in the circuit which will disconnect power in the event of a fault in the circuit
- Socket electrical system is to be earthed to current standards.

Distribution board

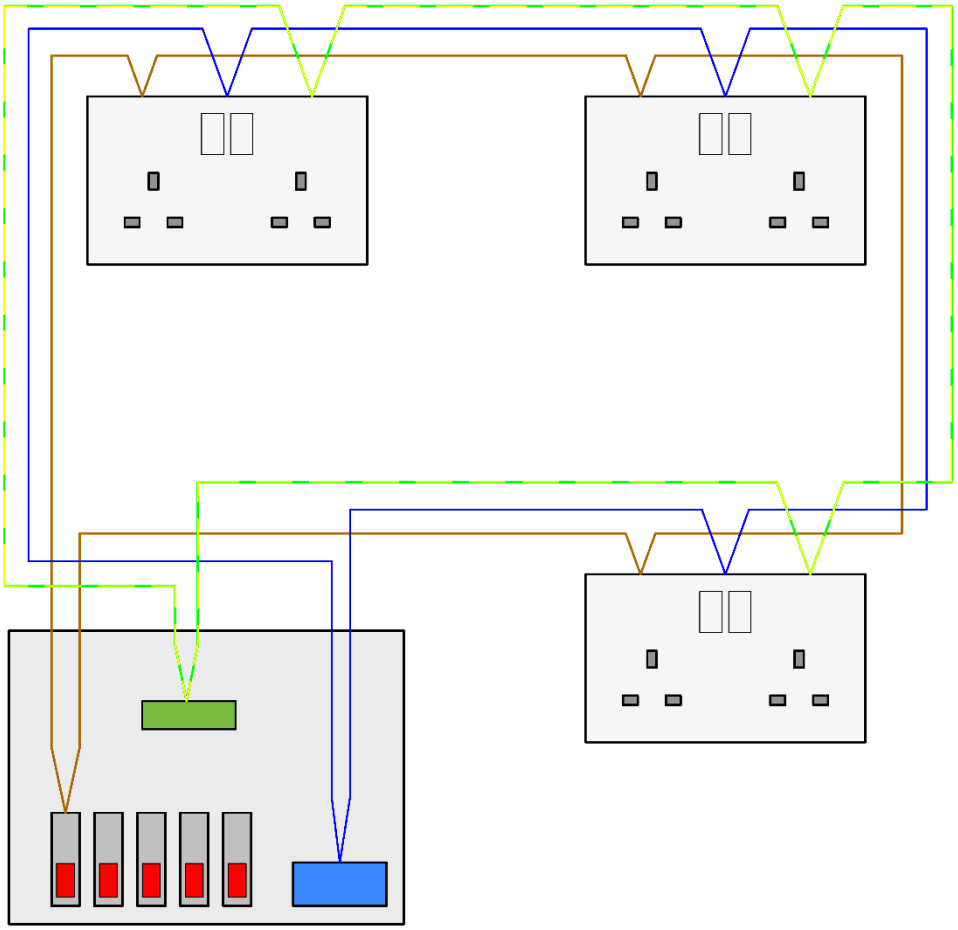
- The distribution board is position in the building to allow easy access to the electricity supply board and other electrical systems
- Allow cable access between distribution board and socket circuit
- The electrical system is correctly earthed – allow any current transit to the ground when there is a fault.

Installation

- Consideration is given to the installation of wiring conduit in the fabric of the building
- Installation of the socket layout and wiring must be completed by a suitably certified electrician
- The socket layout and installation must comply with current regulations
- A certification of installation must be provided by an electrician to connect to the ESB network on completion of the build.

Any other relevant points

(b) Typical wiring layout for a ring main circuit.



Ring main circuit – typical detailing

- 2.5 mm^2 insulated cable
- Live – Brown/Red
- Neutral – Blue
- Earth – Green & Yellow

Any other relevant points

(c) Two benefits for homeowner of generating their own electricity by micro-generation.

- Reduce household electricity costs by generating electrical power through micro-generators
- The use of micro-generators will reduce the household carbon footprint
- Generation of clean electricity to help combat climate change
- Excess electricity can be sold back to the national grid – generate a household income
- Reduce the burning of fossil fuels which release high levels of greenhouse gases and carbon dioxide into the atmosphere.
- Households become independent from the primarily coal-powered energy grid - reduce your reliance on grid electricity and the costs that come with it.

Any other relevant points

Question 10

(a) Two reasons why solar overheating may occur

Two effects overheating may have on its occupants

Why solar overheating may occur in the house

- House oriented with excessive south facing glazing may accumulate high levels of solar gain
- Inadequate or no solar shading incorporated into the design of the house - overhangs - brise soleil
- Lack of trees or vegetation about the house to provide natural solar shading
- insufficient ventilation – natural or mechanical
- Increasing levels of airtightness can reduce the amount of 'fresh' air entering the house
- Lack of thermal mass within the fabric of the house
- Triple-glazed windows reduce heat losses through conduction – little heat loss
- High levels of insulation in the fabric of the house reduces heat transmission – retains heat
- The activities of occupants such as cooking, bathing, showering all generate additional heat
- Occupants themselves generate heat, the amount of which is dependent on their activity level
- Heat gain from the house services such as - boilers, hot water storage and distribution pipework
- Electrical appliances generate heat when in use - e.g. fridge.

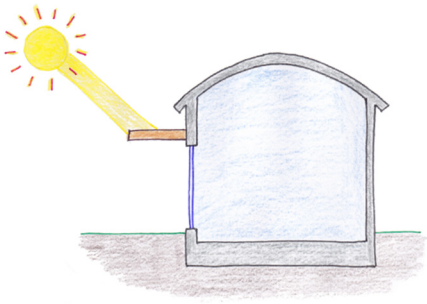
Any other relevant points

Effects solar overheating may have on its occupants

- The occupants would be uncomfortable when using or living in an excessively warm room(s)
- Excessive heat in a house may cause the dehydration of the occupants, this could lead to - headaches, lethargy, and constipation
- Occupant in the house would become exhausted very quickly due to the heat – bodies overheating
- Occupants could get irritable, angry or grumpy in warm indoor conditions as stress hormones may rise in tandem with the temperature
- Overheating may cause occupants to sweating, leading to discomfort
- Heatstroke could affect some occupants if the temperatures were very high which could lead to - red skin, headache, and dizziness
- Overheating could lead to heat stress which can affect occupants in different ways - an inability to concentrate, muscle cramps, heat rash, severe thirst, confusion
- High indoor temperatures affect the quality and continuity of sleep for occupants. Sleep disturbance has been linked to reduced productivity at work, as well as poor physical and mental health
- Occupants' productivity and concentration may also be reduced when in a hot environment
- Increased cardiovascular strain.

Any other relevant points

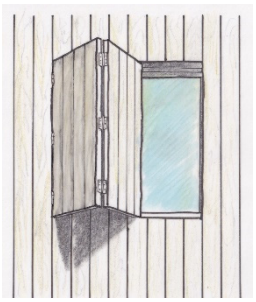
(b) Two design features that would reduce the possibility of overheating while being sympathetic to the design of this house.



Overhang roof

- Extended roof overhang at eaves level
- Total extended surround both vertical and horizontal around the largest opening to provide both sun and weather shelter. Natural materials sympathetic to the design to be used.

Brise Soleil

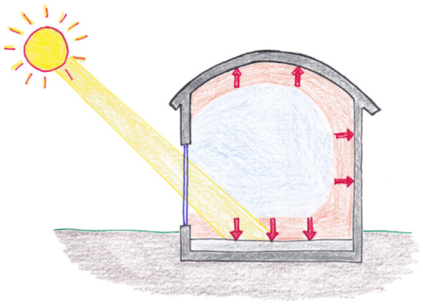


- Louvered screen to protect internal spaces from excessive glare and overheating
- Vertical emphasis and material choice to match current design
- Screen can be fixed or adjustable.

Shutters

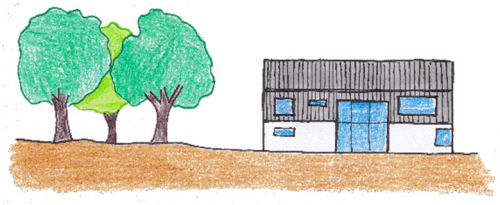
- Internal shutters that could be closed during times of high sunshine
- External sliding shutters inspired by Irish vernacular architectural features.

Thermal Mass



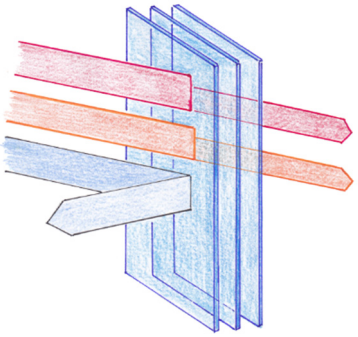
- Polished concrete internal floors to absorb heat during the day and reduce internal temperatures. At night, the heat will be released back into the room
- Solid mass internal walls in direct sunlight
- External insulation with concrete walls to absorb heat and release it back slowly.

Natural Vegetation



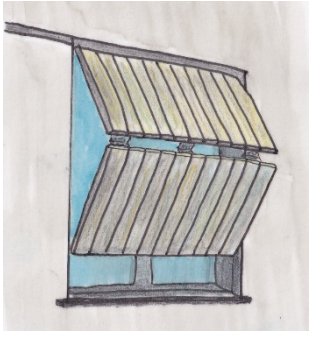
- Plant deciduous trees or tall perennials to shade during the summer but allow light in during the winter
- Install a pergola with hanging vines or sliding fabric – act as solar shading and provide additional outdoor seating space during the summer.

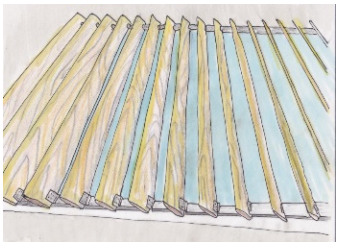
Dynamic Glass



- Standard float glass with an electrochromic coating applied on one of the surfaces
- Can be manually controlled by smart devices or automatically adjusts its tint in response to environmental conditions
- Filters out infra-red and ultraviolet light.

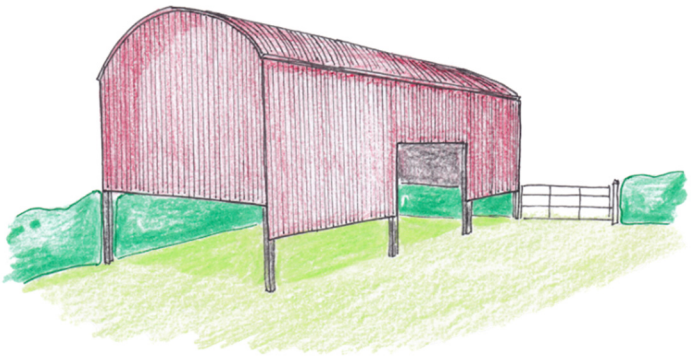
Any other relevant point



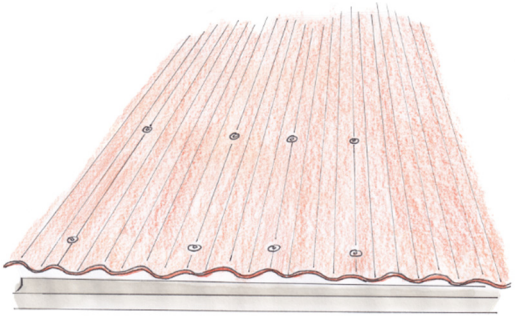


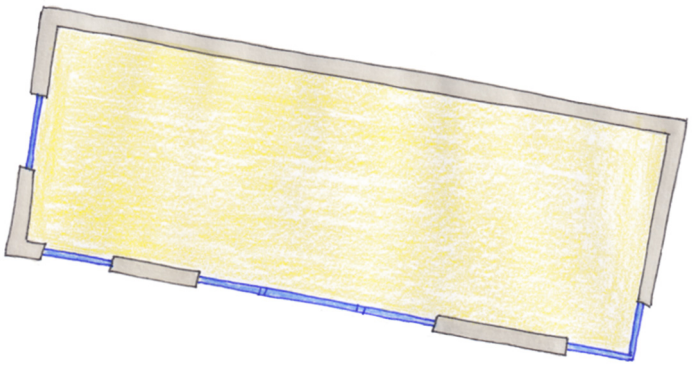
(c) Two features of the given house design that contribute to the house responding to its rural setting.

- Dome-shaped roof profile similar to haybarns found in countryside
- House is rectangular, narrow and one-room deep in plan
- Nestled into the contours and features of the landscape – trees, vegetation, ground terrain
- External corrugated metal cladding on the upper section of the house reflects materials used in agricultural buildings
- White rendered finish to the lower aspect of the house – similar to lime render finish on rural houses
- Proportion of the external materials applied similar to typical agricultural haybarn
- House is construction in a longhouse form
- Narrow plan width - one room deep form of traditional vernacular dwellings
- Minimum hard surfaces to allow vegetation to flourish about the house.



Any other relevant points





Question 10

"There is considerable potential to convert and re-use former schools, churches, mills and farm buildings in the county which will preserve these historic buildings which presently lie empty. This is an approach which underpins sustainable development in that it retains our built heritage while bringing empty structures into use. The reuse of these buildings can help to reduce the demand for new housing while also preserving the vernacular design of the area."

Adapted from: ***County Roscommon Rural Design Guidelines*** *by Roscommon County Council.*

Published by: Roscommon County Council.

(a) Discuss the above statement in detail.

Discussion of the above statement– such as

- The reuse of local buildings can help to reduce the demand for new housing while also preserving the vernacular design of the area
- Historic buildings of distinctive character need to be preserved as far as possible unchanged. These buildings bestow a sense of character on many villages, towns and cities - give a distinctive character and unique sense of place to many villages and towns
- The re-use or repurposing of buildings should meet the needs of a dwelling today, even if this means that considerable remodelling is needed to make the building suitable for re-use
- Rather than allow a building fall into disrepair and disuse, best-practice guidelines for reuse encourage uses that meet a need today, and remodelling is necessary to make the building suitable for a new use
- Current issues like the lack of suitable land, time required to process a planning application, construct time for a house and housing demand – all existing builds should be examined and considered for re-use
- The potential re-use of existing buildings would not require a planning application (in some case), thereby housing could be provider quicker to a community
- The greenest building is the one that is already built. It is important to recognise that the reuse or continued use of older buildings is a key component of sustainable development and energy conservation practice
- A study found that the construction of new buildings on Brown-field sites was almost always more expensive than retaining and reusing the existing buildings - the only exception was where the extent of building repair and refurbishment required was very high
- The refurbished existing building was also found to perform better in environmental terms, minimising the depletion of non-renewable resources being therefore more sustainable
- Distinctive heritage buildings in local communities express a continuity with the past, reflecting the style, construction techniques and materials of the past – should be retained where possible
- If the re-use of a building is not considered then it is likely to degrade, and over time fall into the "dangerous building category" posing a safety risk, and eventually may have to be demolished and the heritage value is lost forever
- Re-use extends the lifespan of the building and protects our streets in village and town - heritage value of an area/community
- Upgrading heritage buildings in both rural and urban areas helps to bring back the charm of urban living – brings life - people and families back into villages and towns
- Buildings often outlive their original uses - the present-day uses of buildings will, in many instances, be very different to the functions for which they were first designed and built
- Convert old commercial units into residential buildings and vice versa.

Any other relevant, cogent, well-argued points.

(b) Propose three best practice guidelines that would promote the re-use or repurposing of some existing buildings in Ireland – such as

- The Irish Government supports the re-use of building through the recently published *Rebuilding Ireland: Action Plan for Housing and Homelessness* - commits to support and facilitate the reuse and/or development of older / vacant buildings for residential use, as well as conversion/upgrading of vacant properties
- Government and local authorities should support and actively encourage the re-use and repurposing of existing buildings:
- Speeding up the planning process itself where re use of existing buildings is involved
- Successful re-use or repurposing should be promoted as exemplars of best practice and should encourage others to follow example.
- Retention of traditional skills re- learned, and the use of local materials used in restoration work – all leading to increased local employment and the keeping alive of old traditional skills of past generations
- Substantial financial grants / supports should be provided for individuals and organisations undertaking a refurbishment for reuse of a heritage building – traditional buildings grants, better energy homes grant, SEAI energy grants, etc
- Local planning authorities to develop, publish and promote clear planning guidelines outlining the requirements for repurposing of existing buildings in the most sustainable way possible
- Respect of the existing building and encourage minimal intervention where required
- Ensure that any new additions can be distinguished from the original building
- Where appropriate, public money and resources should be used to encourage thoughtful refurbishment
- Conservation architects/designers should form part of the local authority planning teams to ensure best advice especially to clients that may not be in a position to afford the professional fees of a privately employed architect
- Repurposing house and building on the main streets of our towns and villages through well-planned and designed residential units, particularly above shops, could help to rejuvenate smaller town centres - such revitalised localities would allow people to walk or cycle to work schools or shops
- Renovation of existing buildings offers an opportunity to reduce heat loss from buildings while providing comfortable healthy living environments
- Renovation also reduces embodied carbon in construction materials compared to new dwellings
- The wider community benefits when the amenity value of a street or area is enhanced by refurbishment and reuse of a heritage building. Pride in our shared dwellings, villages, town's and cities.
- Care should be taken to check whether the structure is on the Record of Protected Structures and if so the services of a Conservation Architect grant aided by the local authority should be employed.

Any other relevant, cogent, well-argued points.

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination, 2021

Construction Studies

Theory – Higher Level

Marking Scheme

Question 1

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) Vertical section through door threshold, external wall, floor and foundation ***Foundation, wall + entrance*** ***Floor*** ***Threshold + door*** ***4 × 4 marks*** ***4 × 4 marks*** ***4 × 4 marks*** (3 for drawing, 1 for annotation)	
Foundation, external wall and level entrance	**4**
• R.C. foundation	**4**
• Blockwork - dead work	
• Vertical Insulation - thermal break	**4**
• Entrance substructure	
• Level concrete surface	**4**
Solid ground floor	
• Compacted hardcore	**4**
• Sand blinding	**4**
• Radon barrier / DPM	
• Floor insulation	**4**
• Concrete floor / subfloor	
• 20 mm hardwood flooring	**4**
Door threshold and door	
• Drainage channel	**4**
• Concrete threshold and wrap around DPC / Proprietary insulated door threshold	**4**
• 15 mm upstand or 15°	**4**
• Airtight tape at threshold	
• External door / vertical sheeting	**4**
• Door insulation	
Scale - 4 marks **Drafting** - 4 marks *Excellent Good Fair* *8 6 4*	**8**
(b) Design detailing to prevent a thermal bridge at threshold ***(4 marks)***	
Design detailing to prevent a thermal bridge	**4**
TOTAL	**60**

Question 2

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) Discuss the duty of care all workers have on a construction site	***(3 × 6 marks)***
Safety Training (3 for point, 3 for discussion)	**6**
Personal Protective Equipment (3 for point, 3 for discussion)	**6**
Vigilance (3 for point, 3 for discussion)	**6**
(b) One possible safety risk associated with each	***(3 × 6 marks)***
Repairing a chimney (3 for point, 3 for discussion)	**6**
Overhead electrical cables (3 for point, 3 for discussion)	**6**
On-site health & hygiene (3 for point, 3 for discussion)	**6**
(c) Two specific safety procedures to eliminate risks identified	***(6 × 4 marks)***
Repairing a chimney stack	
Safety procedure **1** (2 for note, 2 for sketch)	**4**
Safety procedure **2** (2 for note, 2 for sketch)	**4**
Overhead electrical cable	
Safety procedure **1** (2 for note, 2 for sketch)	**4**
Safety procedure **2** (2 for note, 2 for sketch)	**4**
On-site health & hygiene	
Safety procedure **1** (2 for note, 2 for sketch)	**4**
Safety procedure **2** (2 for note, 2 for sketch)	**4**
TOTAL	**60**

QUESTION 3

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) Three design considerations for this home office space	***(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) Proposed design layout for home office space	***(30 marks)***
Design layout for home office space	**15**
Design Consideration **1**	**4**
Design Consideration **2**	**4**
Design Consideration **3**	**4**
Justification	**3**
(c) Advantages and disadvantages of working from a home office	***(4 × 3 marks)***
Advantage **1**	**3**
Advantage **2**	**3**
Disadvantage **1**	**3**
Disadvantage **2**	**3**
TOTAL	**60**

Question 4

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) Factors when selecting a site for a new house in a rural setting	***(6 × 4 marks)***
Availability of services	**4**
Notes	**4**
Sketches	
Existing trees and hedgerows	**4**
Notes	**4**
Sketches	
Site topography	**4**
Notes	**4**
Sketches	
(b) Selection of preferred site and discuss considerations for site	***(3 × 4 marks)***
Consideration **1**	**4**
Consideration **2**	**4**
Consideration **3**	**4**
(c) Sketch site showing: house location, orientation, road entrance & driveway	***(24 marks)***
Sketch of selected site	**4**
House location	**4**
Orientation	**4**
Road entrance	**4**
Driveway	**4**
Justification	**4**
TOTAL	**60**

QUESTION 5

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) U-value of the timber frame wall	***(10 × 3 marks)***
External surface resistance	**3**
External brick	**3**
Air cavity	**3**
Orientated strand board	**3**
Cellulose insulation	**3**
Orientated strand board	**3**
Plasterboard	**3**
Internal resistance	**3**
Total resistance	**3**
Calculation of U-value (w/m^2 °c or w/m^2k)	**3**
(b) Required thickness of insulation for U-value of 0.15 W/m^2 °c	***(5 × 3 marks)***
Resistance for U- value for 0.15 W/m^2 °c (using R=1/U)	**3**
Resistance from calculated U-value from part (a)	**3**
Difference in resistances (required resistance)	**3**
Application of formula R = T/k	**3**
Required thickness of insulation in mm.	**3**
***(c)* Moisture control and vapour control layers in timber frame construction**	***(15 marks)***
Notes / discussion	**8**
Sketch	**7**
TOTAL	**60**

QUESTION 6

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) ***Three features of low environmental impact design***	***(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) **Two features that could be added to reduce its energy use**	***(4 × 5 marks)***
Feature 1	**5**
Notes	**5**
Sketches	
Feature 2	**5**
Notes	**5**
Sketches	
(c) Two advantages of design a house to have low operational energy use	***(2 × 5 marks)***
Advantage **1** (2 for point, 3 for discussion)	**5**
Advantage **2** (2 for point, 3 for discussion)	**5**
TOTAL	**60**

Question 7

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) ***Vertical section through centre of chimney stack and roof structure*** ***Chimney stack*** ***Roofing*** ***4 × 5 marks*** ***4 × 5 marks*** **+ 6 marks** (4 for drawing, 1 for annotation)	
Chimney stack • Chimney blockwork • External render • Flue liners • Lime sand fill / vermiculite • Concrete chimney capping • DPC beneath chimney capping • Lead flashing • DPC at roof level	**5** **5** **5** **5**
Roofing • Rafter 200 × 50 @400mm centres • Chimney trimmer 200 × 50 • Windtightness OSB layer • Breather membrane • Counter battens 50 × 25 • Slating Batten 50 × 25 • Apron lead flashing	**5** **5** **5** **5**
Three courses of slates on each side	**6**
Scale - 4 marks **Drafting** - 4 marks E*xcellent, Good, Fair* *8 6 4*	**8**
(b) Two design details to prevent the penetration of moisture at junction	***(2 × 3 marks)***
Design detail **1**	**3**
Design detail **2**	**3**
TOTAL	**60**

Question 8

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) Typical design layout to provide hot water and central heating (7 × 4 marks) + 4 marks (3 for drawing, 1 for annotation)	
Wood-burning stove Radiators ground floor and first floor Zone control panel Zone thermostats Cylinder and coil Header/expansion tank/ storage Rising main Feed to expansion tank Cold feed from expansion tank Expansion pipe or vessel Flow pipe to radiators Return pipe from radiators Control valves (radiators, isolating valves, drain off valves - any 2) Pump Typical sizes of pipework - **any two**	**4** **4** **4** **4** **4** **4** **4** **4**
(b) Two features that increase the efficiency of the heating system (4 × 5 marks)	
Feature 1 Notes /discussion Sketches **Feature 2** Notes / discussion Sketches	**5** **5** **5** **5**
(c) Two advantages of Air-to-water heat pump (2 × 4 marks)	
Advantage **1** (2 for point, 2 for discussion) Advantage **2** (2 for point, 2 for discussion)	**4** **4**
TOTAL	**60**

Question 9

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) Three considerations when design the layout for sockets	***(3 × 6 marks)***
Consideration **1** *(3 for point, 3 for discussion)*	**6**
Consideration **2** *(3 for point, 3 for discussion)*	**6**
Consideration **3** *(3 for point, 3 for discussion)*	**6**
(b) Typical wiring layout for ring main circuit	***(30 marks)*** (4 for drawing, 1 for annotation)
Distribution board	**5**
Three sockets	**5**
Live cabling	**5**
Neutral cabling	**5**
Earth cabling	**5**
Cable size (2) and colour (3)	**5**
(c) Two benefits for homeowner of generating their own electricity	***(2 × 6 marks)***
Benefit **1** *(3 for point, 3 for discussion)*	**6**
Benefit **2** *(3 for point, 3 for discussion)*	**6**
TOTAL	**60**

Question 10

PERFORMANCE CRITERIA		MAXIMUM MARK
(a) ***Two reasons for overheating + two effects on occupants***		***(4 × 6 marks)***
Reason **1** for overheating	*(3 for point, 3 for discussion)*	**6**
Reason **2** for overheating	*(3 for point, 3 for discussion)*	**6**
Effect **1** on occupants	*(3 for point, 3 for discussion)*	**6**
Effect **2** on occupants	*(3 for point, 3 for discussion)*	**6**
(b) Two ways to reduce solar overheating while being sympathetic		***(4 × 6 marks)***
Method 1		**6**
Notes		**6**
Sketches		
Method 2		**6**
Notes		**6**
Sketches		
(c) ***Two features that contribute to the house responding to rural setting***		***(4 × 3 marks)***
Feature 1		**3**
Notes		**3**
Sketches		
Feature 2		**3**
Notes		**3**
Sketches		
	TOTAL	**60**

Question 10 (Alternative)

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

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination, 2021

Construction Studies

Ordinary Level and Higher Level

(150 marks)

COURSEWORK -
DESIGN AND REALISATION

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, models or working drawing(s)	**40**
B	**Report Writing** • Design folio detailing planning, research, execution and evaluation of coursework • Sequence of manufacture including photographic evidence and/or sketches • Critical appraisal and conclusions from coursework experience	**35**
C	**Manipulative Skills** • Marking-out of materials • Processing of materials • Assembly and finishing of materials	**40**
D	**Presentation of Project** • Overall quality and presentation of artefact • Overall quality and presentation of design folio • Range and depth of skills evident in the coursework	**35**
	Total	**150**

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