Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2012

Marking Scheme

Construction Studies

Higher Level

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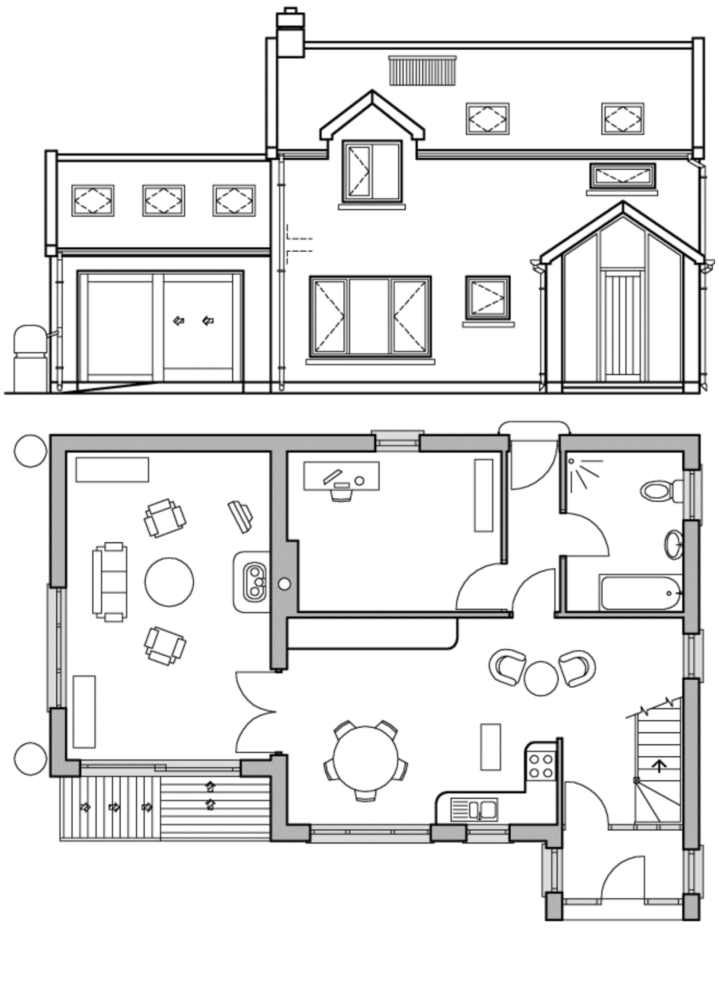
State Examinations Commission

Scrúdú Ardteistiméireachta 2012

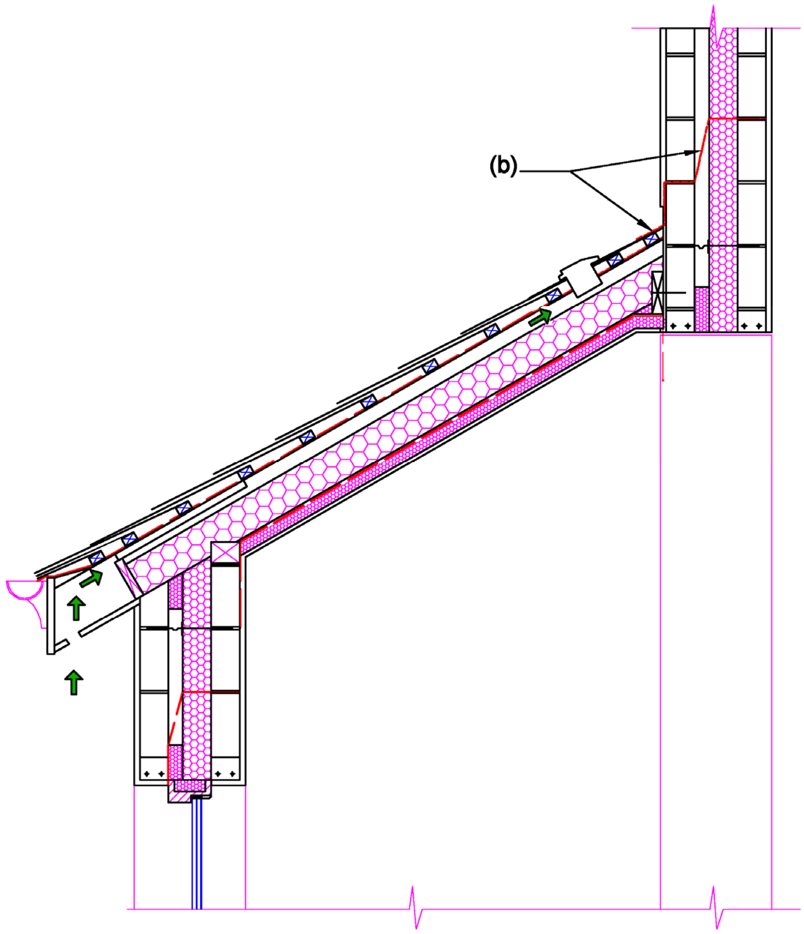
Staidéar Foirgníochta
Teoiric – Ardleibhéal



Construction Studies
Theory – Higher Level
Sample solutions

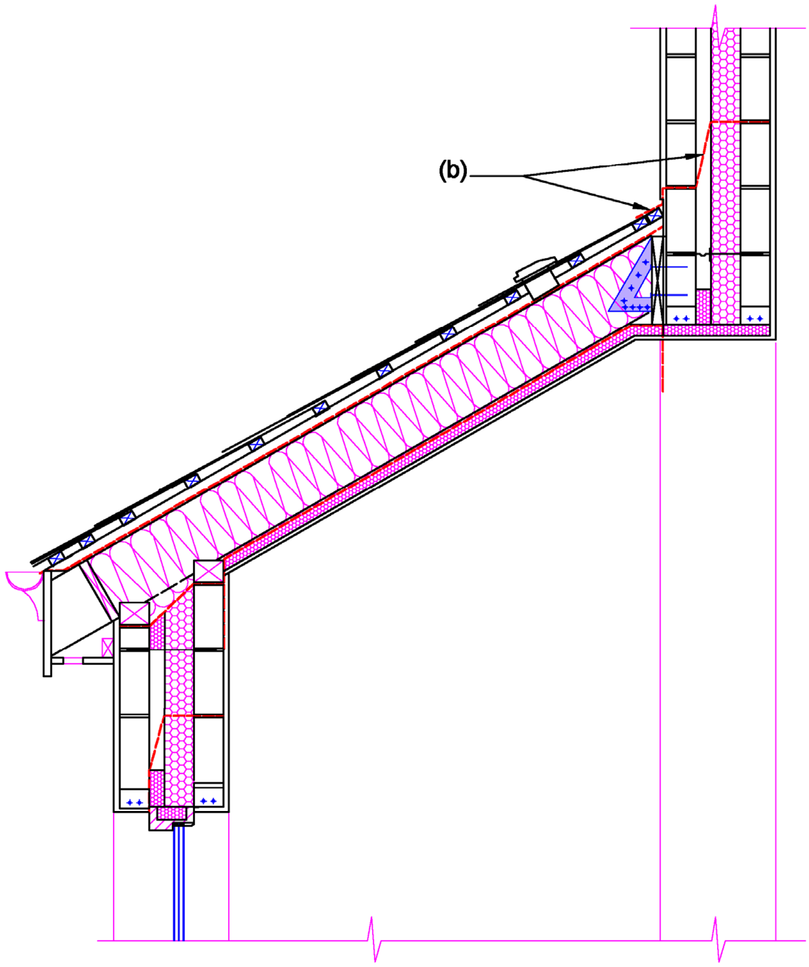
Ceist 1

Ventilated roof space



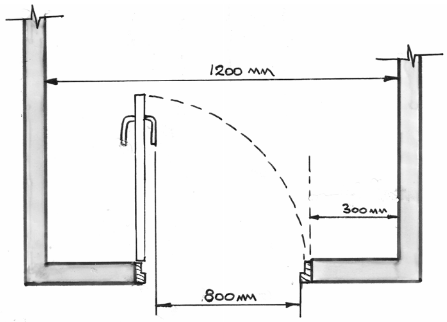
Possible alternative solution
Full – fill insulation

- Selected natural slates
- 50 mm × 35mm slating battens
- 50 mm × 35mm counter battens for ventilation
- Windtight membrane
- 225 × 40 rafters @ 600 mm centres
- Hangers to rafters
- Cellulose roof insulation pumped down to DPC cavity closer
- Timber boxing to contain cellulose insulation
- Intello membrane lapped down and sealed in scratch coat
- 50 mm insulated plasterboard with hardwall skim
- Double wallplates with DPC closing cavity
- Slate cavity closer
- 100 mm minimum insulation in wall
- Low conductivity basalt fibre wall ties



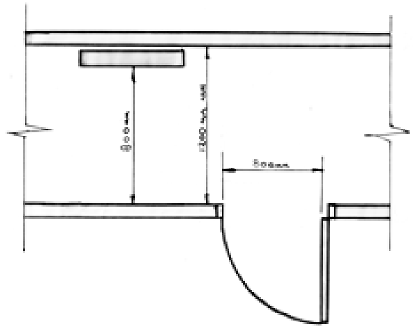
Ceist 2 (a) ***Functional requirements of a dwelling house designed for lifetime use***

Main entrance

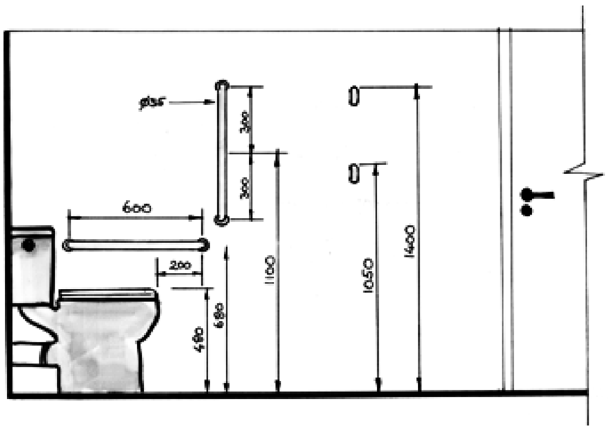


- Should provide accesssible entry for all users, level access (gradient of slope not to exceed 1:50)
- Good lighting at the main entrance (150 Lux)
- A porch to protect from the elements
- Clear area of 1200 mm × 1200 mm in front of main door
- Doors to have a minimun clear opening of 800mm
- Good practice - glazed vision panel to be incorporated into door
- The threshold ideally should be flush with the floor surface (otherwise max height 15mm)
- Sensor activating doors – rocker switch or remote control
- Doorbell at a height between 900 mm and 1200 mm .

Internal corridor layout

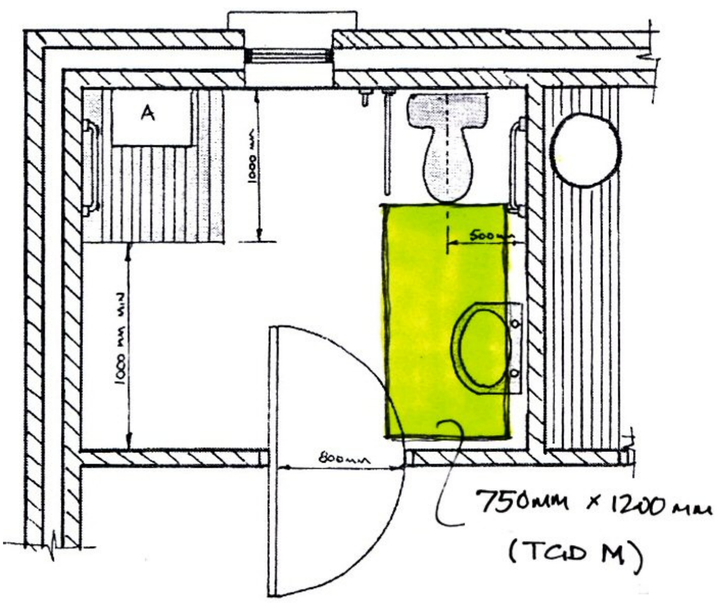


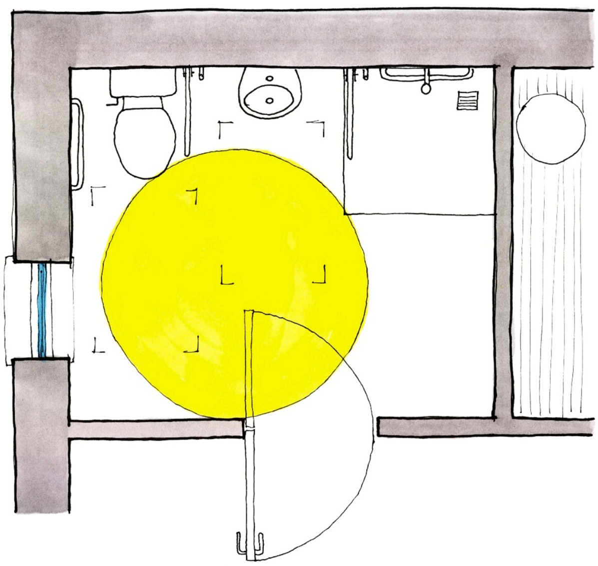
- Corridors to be kept to a minimum – allow open free circulation
- Minimum corridor width for wheelchair users 1200 mm
- Minimum door width of 800 mm
- Minimum corridor width of 800 mm with a short obstruction (ie radiator)
- Door handles and light switches at a height of between 900 mm and 1200 mm
- A turning circle of 1500 mm should be provided
- Recommended lighting level of 150 lux
- Motion/heat sensors for lights



Any other relevant information

(b) ***Layout of bathroom space – clear space and turning circle - alternative layouts acceptable***





(c) Preferred location for bathroom items

Window

- Low cill height to facilitate opening and closing
- Located near the toilet for ventilation
- Lever handles for ease of opening and sited at low level in sash.

Shower area

- Flush finish shower tray **or** wet shower area with no shower tray
- Vertical and horizonal grab rails
- Flip seat (A), 450-500 mm wide
- Fabric curtin for ease of use
- Shower recommended minimum 1000 mm × 1000 mm
- Horizontal and vertical 35 mm diameter grabrails fitted in shower cubicle
- Non-slip floor covering

Toilet

- Fold up grab rail 400 mm long on open side of toilet
- Fixed grabrail 600 mm long fitted on wall adjacent to toilet fitted at a height of 700 mm from floor
- Lever type handle fitted to toilet for ease of use
- Alarm cord/switch in toilet.

Wash hand basin

- Wall mouted sink with a clear knee space beneath -fitted at 800mm above floor level
- Located close to the toilet
- Lever taps or sensor taps installed for ease of use
- Sufficient turning circle for wheelchair – Ø 1500 mm

Grab rails

- Folding grab rails installed close to all appliances

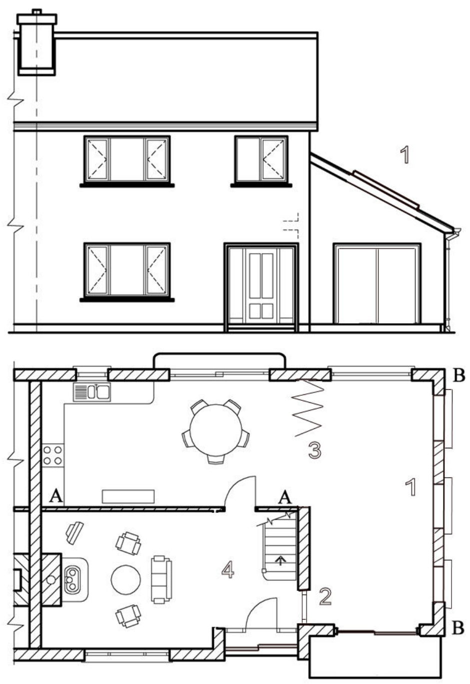
Buildings for Everyone – A Universal Design Approach – National Disability Authority
www.universaldesign.ie

Any other relevant information

Ceist 3

(a) ***Redesign of ground floor layout to increase penetration of sunlight - minimum***

- Install high performance glazing on southern elevation
- Install high performance windows - low-e double and triple glazing – thermally broken frames
- Roof lights inserted into roof- appropriately sized
- Storeroom doors to be replaced by glazed doors
- Glazed doors in slid wall between storeroom and existing dining room

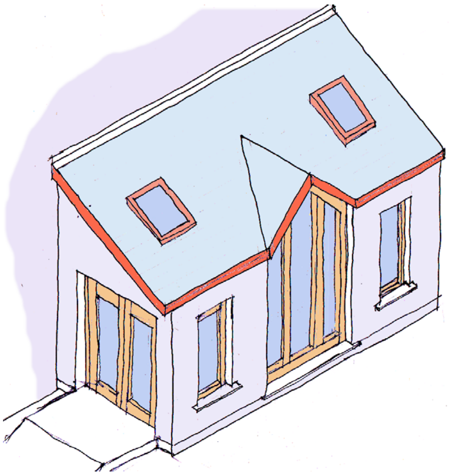
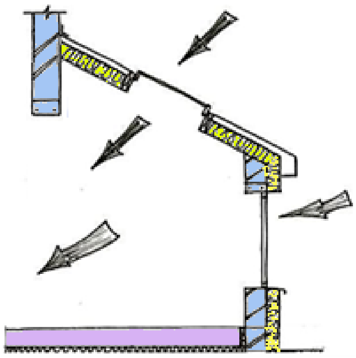
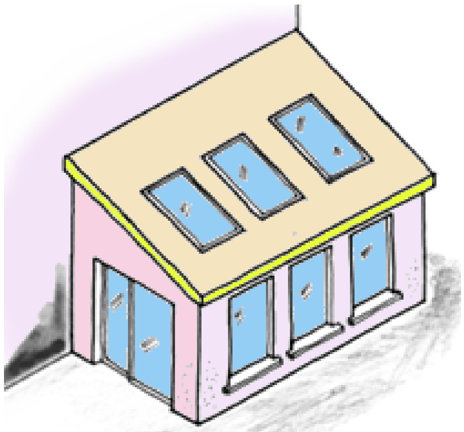


More extensive -

- Install internal glazing area at ***2*** to allow light penetration into hall way
- Remove wall between kitchen area and storeroom at **3**
- RSJ or lintels fitted to carry load – to structural engineers detail
- Retractable partition – bi-fold glazed doors to retain heat gained during the day
- Introduce draft lobby at front door by installing high-performance sliding door
- Remove separating wall between hall and living room at **4.**

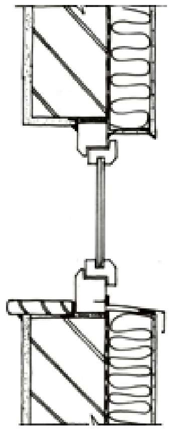
  Any other relevent informantion

Increased penetration of sunlight to the interior – such as

Upgrading thermal properties of external wall

- As original walls are hollowblock, external insulation is recommended
- Rigid insulation fixed with adhesive and bolts
- 80mm - 300mm insulation depending on eaves overhang
- Fibreglass mesh fixed over insulation
- Acrylic render applied 2 coats approx 3 mm each coat
- Window cills to be cut flush with external wall and windows moved to outer edge of existing wall
- Preformed aluminium cills fitted
- All internal window abutments taped - and sealed with mastic sealant
- Detailing to eliminate all thermal bridging
- Insulation carried below ground level to foundation
- Low water absorption EPS - type XPS - used below ground to rising wall.

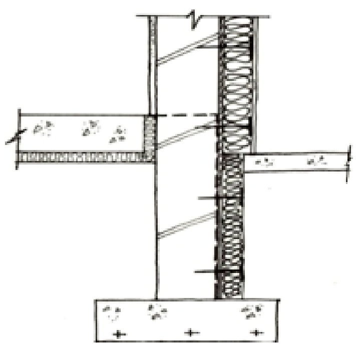


Glazing

- Low-e soft coat triple glazing
- Argon /krypton filled units
- Vertical emphasis on windows on southern elevation
- Detailing to ensure airtightness.

(b) Discussion

- Warm, sunlit, spacious living spaces desired following alteration
- Health benefits associated with sunlight and natural light
- Tall windows allow for greater penetration of sunlight in winter
- Use of shades or *brise-soleil* to prevent overheating in summer
- External insulation preferable to internal dry lining
- Utilise the thermal mass of the block walls
- Reduced condensation resulting from elimination of thermal bridging
- Increased economic benefit
- Reduced dependence on fossil fuels
- Reduction of CO_2 emissions



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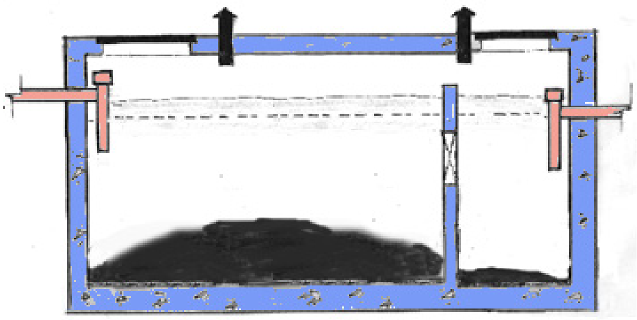
Ceist 4

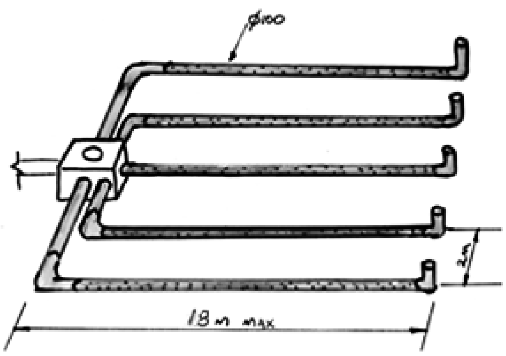
(a) Operating principles of a conventional septic tank

- Septic tank is a primary settlement tank providing a limited amount of anaerobic digestion
- Must be prefabricated and not in-situ constructed
- The septic tank is located 7.0 m minimum from house and 10.0 m from percolation area
- Size dependent on house occupancy – designed for minimum of four persons
- The tank must provide adequate retention time for settlement of suspended solids and adequate volume for sludge storage
- The tank incorporates two chambers, which are separated by means of a dividing wall that has openings located about midway between the floor and roof tank.



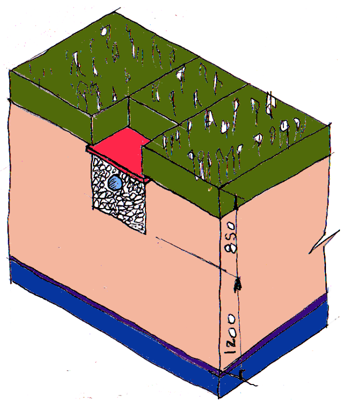
- Wastewater enters the first chamber of the tank, where the solids settle and the scum floats. The settled solids are broken down by anaerobic bacteria, reducing the volume of solids
- The liquid component flows through the dividing wall into the second chamber, where further settlement takes place, with the excess liquid then draining in a relatively clear condition from the outlet into a percolation area
- The wastewater is carried through a series of perforated percolation pipes which are laid in gravel
- On passing through the gravel, aerobic bacteria further break down the remaining impurities and the liquid then percolates the soil
- Wasterwater must be free from all contaminants before entering groundwater
- Septic tanks must be covered with a watertight cover and ventilated to prevent a buildup of methane.

Any other relevant information



(b) Typical design detailing for a percolation area

- Topsoil covering with Geotextile layer beneath
- Distribution box to distribute flow evenly to min 4 percolation pipes
- 100 - 110 mm perforated percolation pipe - 8 mm holes at 4, 6, and 8 o clock and 75 mm centres
- Pipe runs not to exceed 18.0 m
- Gravel surround to each percolation pipe with 2.0 m spacing between pipes
- Vents to allow for the safe discharge of gases
- The effluent filters initially through the gravel and then percolates into the subsoil where it undergoes further biological and chemical interactions that treat the contaminants.



(c) Reasons why a proposed site might not be suitable for a conventional septic tank system

- Site not large enough to accommodate the septic tank and percolation area
- Unsuitable or shallow subsoil, gravels and clays may percolate wastewater too quickly or too slowly
- Located close to a stream, river, lake, well, wetland, beach, boundary, house or other percolation area
- Site too steep
- Inaccessible for empting tank
- Water table too high – 2.0 m below original ground surface.

  www.epa.ie - Code of practice - wastewater treatment and disposal systems serving single houses.

Any other relevant information

Ceist 5

Material Element	Conductivity k	Resistivity r	Thickness T(m)	Resistance R
Sand cement screed		0.710	0.060	0.0426
Conc. Floor Slab	0.160		0.100	0.625
DPM	0.250		0.00025	0.001
Sand blinding	0.160		0.050	0.3125
Hardcore	1.330		0.225	0.1692
Subsoil	1.800		0.300	0.1667
Internal surface				0.104
				1.421

Formulae: **R=T/k** **R=T × r** **$U = 1/R^t$**

U - value: U = 1 / 1.421 = 0.704 **W/M^2K**

(b) (i) Cost of heat lost per year:

- Heat loss formula: = U-value × area × temp. diff
- Note : Area of room ; 9 mtrs × 7 mtrs = 63 m^2
- HLF = 0.704 ×63 x 15 = 665.28 Watts.(Joules / sec)
- Heating period P/A: 12 × 7 × 40 = 3,360 hrs

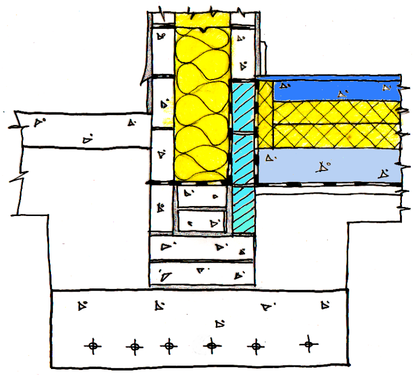
  3,360 × 60 × 60 =12,096,000 seconds

  $\frac{12,096,000 \times 665.28}{1000}$ = 8,047,226 kJ/ sec
- Litres p/a (Note: Calorific value of 1 litre oil = 37350 kJ)

  $\frac{8,047,226}{37350}$ = 215.45 litres
- Cost p/a 215.45 × 0.85 = € 183.13 *(Note: 1 litre oil costs 85cent.)*
- Cost of heat lost for one year through the concrete floor = € 183.13

(C) Design of ground floor - Passive standard - one example

- 25 mm fine screed
- 75 mm floor slab
- Min 250 mm to 400 mm expanded polystyrene in floor U-value ≤ 0.15W/m^2K
- Radon barrier
- Sand blinding – 3 to 8 mm diameter
- Hardcore – 15 to 35 mm diameter
- Low conductivity thermal block to inner leaf - and tanked
- 300 mm insulation in cavity of wall.



Ceist 6 – Doing more, with less for longer

(a) Use of roof space

- Allows for three extra bedrooms and bathroom which is economical in terms of space and materials required – one compact foundation – two floors and roof space used
- Reduced costs and energy requirements – small footprint with attic space used
- Enables maximum use of attic as a habitable space – more with less
- Less materials as form is compact – lower embodied energy, lower CO_2 - doing more, with less
- Solar panels fitted at optimum angle of 45° for solar gain - roof used to collect solar energy.

Any other relevant points

Roof lights

- Provide three times more daylight over a longer period than dormers - more light with less energy
- Reduced need for artificial light - more with less
- Reduced demand for fossil fuels and reduced lighting costs
- No shading, unobstructed light for longer.

Any other relevant point

Glazing – to maximise solar gain and thermal comfort

- High thermal performance units e.g. frames with thermal breaks and triple glazed, argon gas filled low-e soft coated glazing
- South facing principal elevation to maximise solar gain
- Fewer and smaller windows on the rear (North) elevation reduces heat loss
- Porch or draught lobby to reduce escape of heated air when door is opened
- Side lights to the front door for maximum solar gain to penetrate to the kitchen/dining area
- Internal screen door to the porch may be opened or closed to maintain thermal comfort
- South facing windows and sliding doors allow for maximum solar gain to the living areas
- West facing window enables evening solar gain to the sitting room – less heating required as solar gain is maximised – doing more with less for longer – as in above.

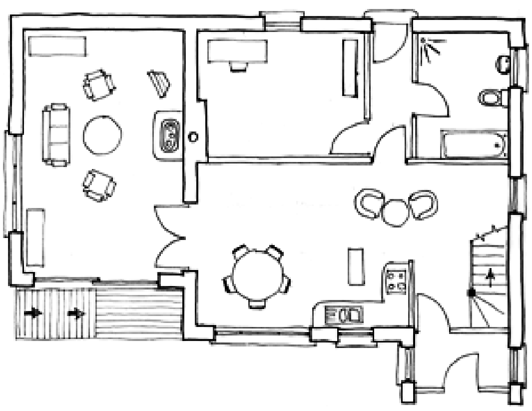
Any other relevant points

Solid Fuel Heating

- Wood burning stoves are carbon neutral
- Renewable - doing more, with less
- Stoves are far more efficient (70%) than open fires (30% efficient)
- Stoves may be used to heat radiators on the upper floor as well as the adjoining rooms on the ground floor
- Chimney stack on internal wall to maintain heat – more with less through good design.

Any other relevant points

Rainwater harvesting system – doing more with less, more use of rainwater less use of treated public water



- Rainwater collected from front and rear roof surfaces and water stored in above-ground storage tanks
- Above-ground storage system relatively inexpensive to install – less embodied energy requirements
- Modular storage units allow for increased storage facility
- Use of rainwater reduces quantity of expensive treated drinking quality water which alternatively enables economical use of expensive, scarce and limited natural resources – more with less for longer
- Rainwater may be used to water gardens and lawns, to flush toilets - provide a filter.

Any other relevant points

Solar Panels – - more energy produced on site to reduce electricity demand from grid

- The design incorporates a passive solar collector that can provide between 40% - 60% of domestic hot water requirements depending on time of year - more heated water for less cost
- Reduces dependency on finite and expensive fossil fuels – more with less
- Solar collectors reduce the output of CO_2
- Solar panel positioned on south facing roof to obtain maximum solar gain.
- Photovoltaic solar panels can provide electrical energy depending on the surface area installed
- Surplus energy can be sold to the national grid
- Northern hemisphere the sun travels across the southern sky from East to West
- Solar panels orientated south or 15° due east or due west of south
- Angle of inclination varies with seasons - rule of thumb for Ireland - angle of inclination of 45°
- Sunpath, elevation 78° summer and 30° in winter.
- House design - doing more with less for longer – such as at - www.irishvernacular.com

Any other relevant point

(b) Orientation of house – sun path across southern sky

- Longer elevation on an east-west axis
- Large areas of high performance windows (frames and glazing) on the southern elevation allow for maximum solar gain
- Passive heating reduces costs and the demand for scarce and increasingly expensive fossil fuels
- Provides high level of thermal comfort from a renewable energy source.

Any other relevant points

Flexibility of design

- Universal design principles facilitate design for people of all ages and abilities – temporary and permanent
- Ground floor study/office suitable for conversion to temporary bedroom with little additional cost
- Study/office situated in close proximity to the wheelchair accessible bathroom
- Small internal spans allow for ease of redesign and lower costs – standard materials
- Largely open plan living, kitchen and dining areas to facilitate ease of movement for persons of all ages and degrees of reduced mobility - temporary or permanent.
- Wooden ramp provides access to persons temporarily and permanently disabled - slope 15°
- Doors wide enough to facilitate passage of wheelchairs – 800 mm min
- No ground floor steps, flexibility of movement for all – more versatility with less obstacles.

Sourcing Materials
Timber - Internal Leaf

- Locally grown timber has less embodied energy costs and reduced transport costs
- Timber - carbon neutral
- Timber species that are sustainable and renewable i.e. capable of being harvested between 25-40 years i.e. from managed forests
- Some timbers are more naturally durable i.e. European Larch, Douglas fir, cedar and do not require treatment with chemical preservatives – more with less toxic chemicals
- Use of sustainable, renewable, and durable timbers reduce the volume of concrete required which has a high embodied energy – more with less damage to the environment.

Any other relevant points

Concrete – how to achieve more with less environmental damage

- No all round the house footpaths - concrete significantly reduced – more with less
- Concrete made from Portland cement has - high embodied energy
- Portland cement produces 900 Kg of CO_2 emissions for 1000 Kg of cement
- Ground Granulated Blast furnace Slag/Cement (GGBS) is manufactured from a waste product produced by the Steel industry – "Slag"
- Concrete made from GGBS cement has a low embodied energy
- Low Carbon Concrete uses 50% Normal Portland Cement and 50% GGBS cement which reduces the CO_2 emissions by 50%
- While GGBS is imported into Ireland the embodied energy value is still considerably low compared to that required to extract raw material from the landscape and its subsequent manufacturing costs.

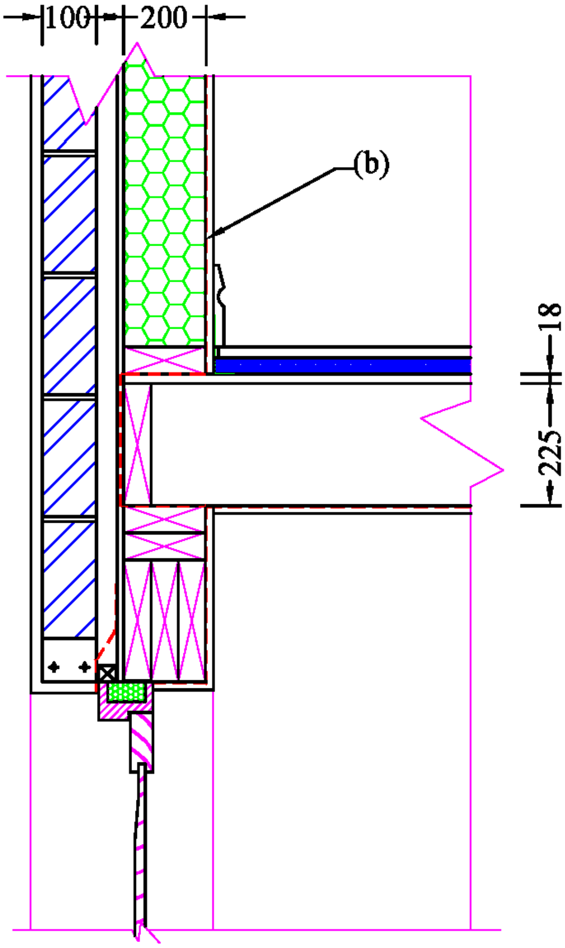
Any other relevant point

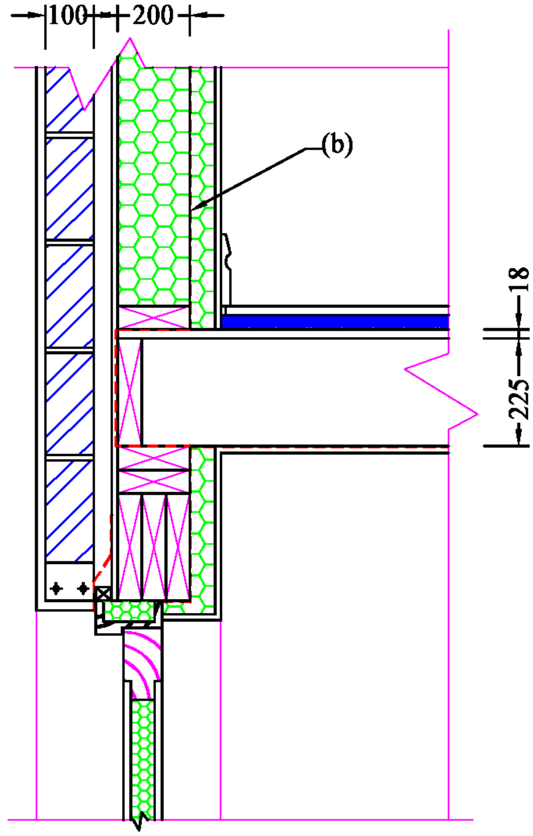
Local Materials

- Design for use of materials that are available locally
- Reduced transport costs and reduced CO_2 emissions
- Reduced demand for scarce and expensive fossil fuels.
- Reduces embodied energy content
- Stone, sand, block, hardcore etc all best sourced locally
- Local materials blend in – giving buildings a sense of local unique style
- Local labour employed – think global and act local.

Any other relevant point

Ceist 7



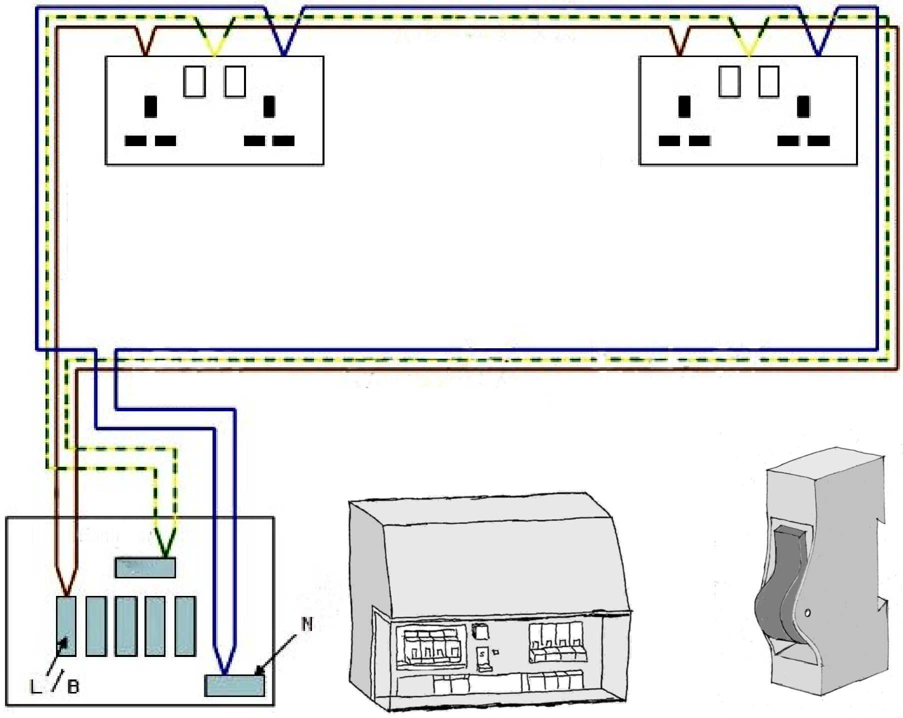


Alternative solution - insulated Passive door

- External render
- 100 mm outer concrete block
- Reinforced concrete lintel
- Breather membrane
- Sheeting / racking material - Oriented Strand Board (OSB)
- Vertical stud
- Vapour barrier
- Plaster slab – internal service cavity
- Solid timber lintels
- Thermally broken doorframe
- Door head
- Door panel
- Flooring joist
- Acoustic strip /acoustic mat
- Flooring joist – acoustic strip - plywood and floating wooden floor.

Any other relevant details

Ceist 8 (a)



Live - brown
Neutral - blue
Earth – green & yellow

Cables 2.5 mm^2 twin core and earth

(b) Safety features incorporated into circuit design

- The circuit is earthed. If a short circuit develops, the earth transmits current to ground and causes the fuse/MCB to break the circuit
- A fuse or MCB (mini circuit breaker) cuts off the supply of electricity to an electric circuit in the event of a fault
- A residual circuit breaker (RCB) is an electrical wiring device that disconnects a circuit whenever it detects that the electric current is not balanced between the phase conductor and the neutral conductor
- RCDs are designed to prevent electrocution by detecting the leakage current, which can be far smaller (typically 5–30 milliamperes) than the currents needed to operate conventional circuit breakers or fuses (several amperes).
- RCBs are designed to disconnect quickly, within 25 to 40 milliseconds, enough to protect a person from the possible harm caused by an electrical shock.
- Use of a socket residual circuit device (SRCD). A socket fitted with this device automatically diconnects power in the event of fault or short circuit
- Isolation of cables in conduits prevent contact with the user.

Any other relevant points

(c) Economical use of electricity in the home
Lighting

- Smart metering to allow people easily see the energy they use
- Fit Compact Florescence Lamps (CFL) bulbs - use 80% less electricity than an incandescent bulb
- Use low energy lighting - incandescent lamps will be phased out by 2012.
- Use task lighting – desk lamp, reading lamp - not full room lighting
- Fit occupancy sensor lighting, motion sensors-
- Reduce need for artificial lighting - maximise use of daylight
- Avoid obstructions and shading at windows
- Paint walls and ceilings with high reflective paints and of light colour.

Heating

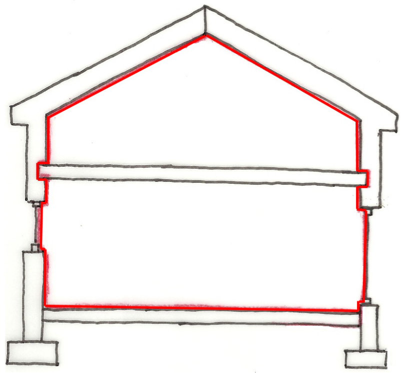
- Use timer switches especially with immersion heaters
- Zone heating – manual or automatic valves
- Correct insulation/lagging of hot water cylinder and all piping
- Upgrade levels of insulation to reduce demand
- Thermostatic heating controls, thermostatic room sensors.

General

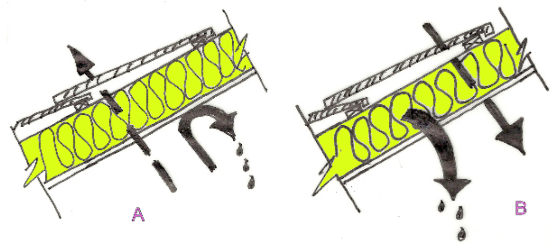
- Replace white goods with low energy rated equivalents
- Turn off machines when not in use, appliances use up to 20% of energy when on standby mode
- Use low temperature settings, maximum load on washing machines and dishwashers. ***www.esb.ie***

Any other valid ways to economise on electricity

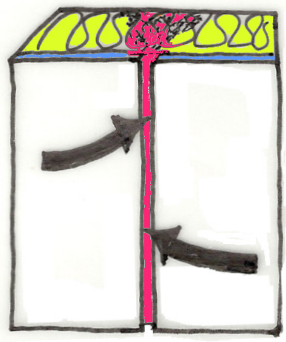
Ceist 9 - Design detailing to improve airtightness

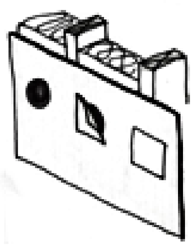


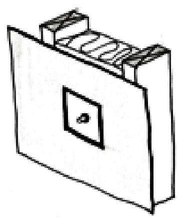
- Seal tight and ventilate right
- Continuous airtight seal around the internal fabric of the external envelop to eliminate draughts
- Pen on section line - see continuous red line in sketch
- Intelligent systems allow vapour diffusion when required
- Winter – diffusion tight, summer diffusion open
- Airtight vapour check barrier ensures interstitial condensation risk is reduced
- A relatively small tear can reduce the overall performance of the membrane by a factor of up to 1600
- Reduction in mould growth/structural damage
- Ensure overlap of 100 mm – 150 mm in vapour barrier -all joints to be taped and sealed for airtightness
- Grommets used for wiring/service pipes
- Air tightness in conjunction with wind tightness increases effectiveness of insulation



- Control ventilation
- Excessive air leakage leads to unnecessary heat loss and discomfort and can also allow dampness to penetrate the fabric of the building
- Junctions between floor and walls, walls and windows, ceilings and walls should be taped and sealed
- Skilled and trained craftsman to install airtightness membrane
- Proprietary tapes and sealants to be used
- Air blower door test used to determine effectiveness of air tightness barrier.

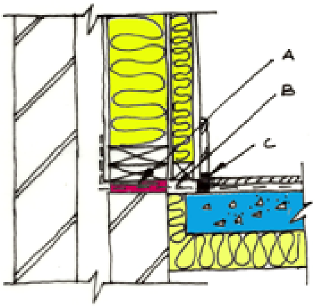






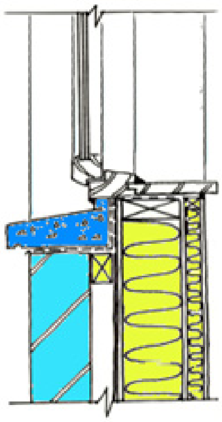
(b) Air leakage routes

Ground Floor



- Air tightness membrane and butyl sealing tape (B) carried under timber frame and fixed and bonded to concrete slab
- Elastic mastic sealant (C) placed under skirting boards
- Ensure all mortar joints in external wall are correctly pointed an sealed
- Service cavity for plumbing and electrical – no rupture of barrier.

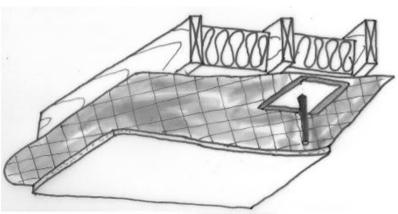
Window Cill

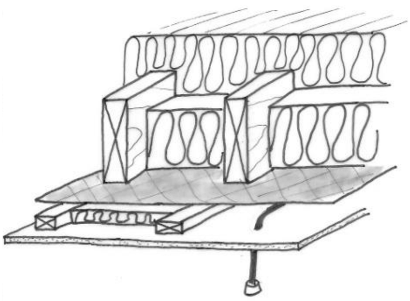


- Air continuity barrier bonded to damp proof membrane
- Joints at window ,window board and cill to be sealed using tape and mastic seal
- Draft seal between opening sash and frame.

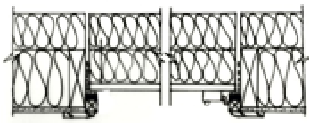
Light Fittings

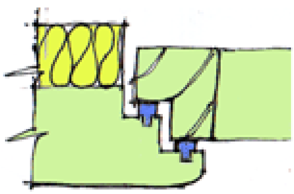
- Cables may pierce air continuity barrier
- Grommets used around cables
- Vapour barrier to be re sealed using tape and mastic sealant
- Avoid using recessed lighting, huge heat loss around lamps - if recess lighting used, enclosed casing to be used to ensure continuity
- Use service cavity where possible to ensure integrity of airtightness membrane.





Trapdoor





- Gasket/draught seal along batten
- Tape returned along joist
- Bolt to compress seal
- Insulation fixed at back of trapdoor
- Use proprietary trapdoor with sealed rebates
- Double gaskets for downward opening trapdoor.

(c) Advantages of Service Cavity

- Ensures integrity of air continuity barrier
- Additional insulation may be included in the cavity thus improving thermal property of wall
- Ease of work for service trades both plumbing and electrical
- Improved acoustic insulation
- Additional taping and sealing will ensure improved airtightness.

Ceist 10

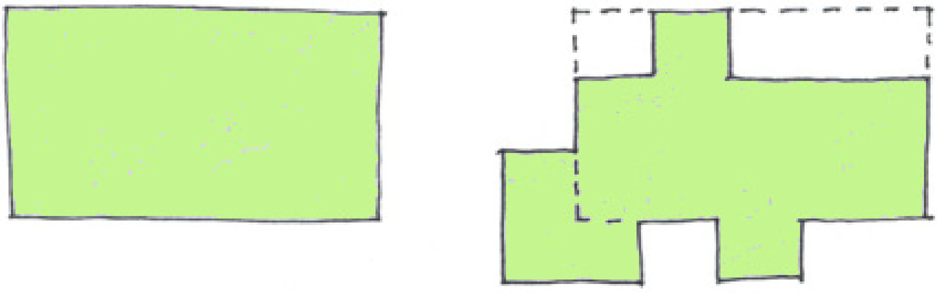
Building form:

- A passive house should have a compact form. A compact form is a simple house design that has a minimum of extensions or additions. Because heat is lost through external surfaces the greater surface area, the greater the heat loss.

- Compactness describes the relationship between the surface area of the home and its volume. In passive house design, the goal is to achieve a ratio of 0.7 or less - to have a large volume enclosed by the smallest possible area.

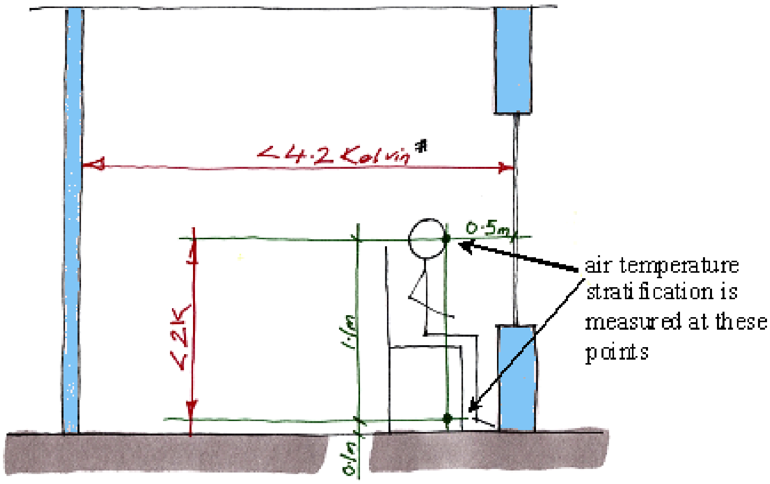
- Two houses with identical floor areas (and hence volumes, assuming equal heights) can have very different compactness ratios. *(see sketches)*

Footprint of two houses with identical volumes (assuming equal heights) - the house on the right has a greater surface area and hence a higher compactness ratio.



Indoor environment:

The key factors necessary to achieve the required indoor environment in a passive house include:



Relative humidity

- the relative humidity of the indoor air should be in the range 35% to 55%
- this is the optimal range
- to prevent respiratory illnesses and the growth of mould, dust mites and other viruses and bacteria
- to avoid air that is uncomfortably humid or dry that might cause irritation of the eyes, nasal passages or skin.

Surface temperature

- the temperature of internal surfaces (e.g. walls, ceilings, windows) should not fall below 12.6°C
- this is to prevent condensation forming on the surface
- condensation (i.e. moisture) can to lead to mould growth.

Energy performance

There are three criteria that a passive house must meet for energy performance:

- The **space heating demand** is the energy required to maintain an indoor temperature of 20°C all year round. Space heating refers to the heating of the indoor spaces. It does not include hot water heating or other energy needs.

    - space heating demand $\leq$ 15 kWh/m^2/a

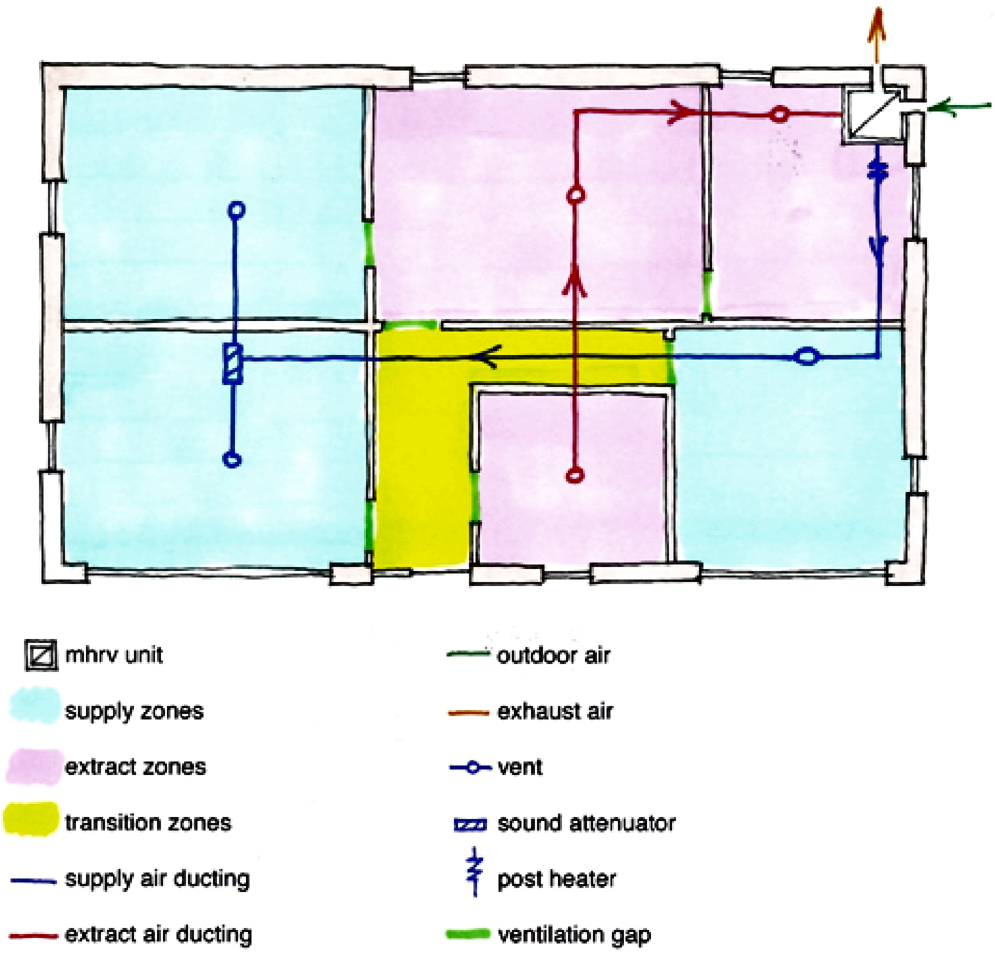
- The **heating load** is the is the energy required to maintain an indoor temperature of 20°C on a given day. The heating load must not exceed the amount of heat that can be supplied to the house via the fresh air required for good indoor air quality (≤ 10 W/m^2).

- heating load ≤ 10 W/m^2

- The **primary energy demand** is the total energy consumed for all requirements (i.e. space heating, water heating, ventilation and electricity). Primary energy is the term used to describe all of the energy required to deliver usable energy to the home. This includes the energy consumed during extraction, conversion, transport and so on. In Ireland the primary energy conversion factor for electricity is currently 2.58. This means that for every unit of electricity energy consumed in the home, 2.58 units of energy have to be produced. While the criterion is ≤ 120 kWh/m^{2}a, this is in fact quite a poor standard - a typical passive house would have a primary energy demand of between 60 to 70kWh/m^{2}a.

  - primary energy demand ≤ 120kWh/m^{2}a

b)



How a mechanical heat recovery ventilation system works:

- Mechanical ventilation heat recovery is used in passive houses to provide a continuous controlled supply of fresh, clean air. Moist, warm air (‘extract stale air’) is extracted from the kitchen, bathroom and utility room and drawn through a filter into the MHRV unit. At the same time, ‘outdoor air’ is drawn through a separate filter into the MHRV unit. The outdoor air passes through a fine filter to ensure dust, pollen and other contaminants are removed from the air - this provides better air quality than simply opening a window.

- In the MHRV unit, the 'extract air' and the 'outdoor air' do not mix - instead, they pass through a heat exchange unit. This unit is made up of a number of very thin metal or plastic plates. The heat in the extract air heats one side of each plate. The outdoor air passes on the other side of the plate and absorbs this heat energy. The outdoor air is now warm and filtered and is now called 'supply air'. The 'supply air' is pumped to the living spaces ('supply zones').
- During cold weather a post heater is used to raise the temperature of the incoming air to ensure a constant comfortable temperature of 20°C is maintained in the home at all times. During warm weather a 'summer bypass' is used to bypass the heat exchanger so the supply air does not cause overheating.
- A sound attenuator is used to ensure that noise does not travel from one space to another - this is particularly important for bedrooms.
- Eliminates the need to completely heat the fresh air as it enters the building (reduced energy requirements)
- Best practice suggest the MHRV unit be placed downstairs – in utility room – to allow for easier and regular filter changes as dirty filters contaminate incoming air and may create a health hazard.

Performance criteria:
There are three main requirements that a MHRV system must meet:

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

extract requirement:

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

air change requirement:

- the system must be balanced for the entire dwelling to ensure that a minimum air change rate of 0.3 air changes per hour is achieved.

(c) Advantages of passive house construction:

- low energy consumption - a typical passive house uses 75% less energy than a similar house built to building regulations standards,
- comfort - passive house construction provides a consistent level of comfort (a constant comfortable temperature of 20°C is maintained all year round),
- economical - a typical passive house significantly cheaper to 'run' than a similar house built to building regulations standards - 75% energy reduction,
- reduced environmental impact - lower energy consumption means that passive houses have a much smaller carbon footprint than houses built to building regulations standards. Reduced CO_2 emissions

Disadvantages of passive house construction:

- Workmanship - a very high level of workmanship is required on site - every member of the construction team must understand what is required to achieve passive house standard and ensure that their work is of the highest possible standard,
- Training - tradespersons and designers need to be trained to ensure they are competent to achieve passive house standards.
- Precise detailing – may take longer time to complete
- Mechanical system to provide same house temperature – some people prefer to regulate temperature manually – open and close windows for different temperature in different rooms
- It is argued that MHRV is not necessary in mild temperate climate of Ireland
- Filters need to be changed regularly to provide clean air – if not, contaminated air is supplied to occupants.

Any other relevant points

Additional information – Passive House

When designing a passive house the heat load is calculated on two sample days;

- a mild overcast day (high temperature, low solar gain) and
- a cold clear day (low temperature, high solar gain).

Whichever calculation produces the greater heat load is used when designing the house. Doing this ensures the house will perform adequately in a 'worst case scenario'. It is usually the mild, overcast day that creates a higher heat load, because on a cold clear day the benefit of solar gain outweighs the drawback of a cold temperature.

Note: the building regulations also have a requirement for primary energy demand but these are not the same - in the passive house standard everything is included (e.g. space heating, water heating, ventilation, lighting, appliances such as the dishwasher and the television) whereas in the building regulations only space heating, water heating, ventilation and lighting are included.

Question 10 - alternative

A sustainable ethos in building implies:

- Putting sustainability and environmental considerations at the heart of every design decision
- Doing more with less for longer, managing and conserving the earth's resources
- Leaving more of the earth's resources for future generations so that they too can meet their needs for shelter and food from the planet's resources
- Thinking globally and acting locally
- Minimum standard and acceptable standard not now sufficient,
- Best practice is now the only acceptable standard.

Consideration of environmental implications associated with design, construction and operation of buildings and neighbourhoods

- A whole-of -systems team approach needs to be adopted, with all specialists considering the interconnections between the building form, building components, building envelope, building systems and services and maximise the overall performance of the buildings
- At the design stage it is easier and more cost effective to factor in environmental considerations than to try and upgrade the building fabric at a later stage
- The design leader - usually the architect – should apprise all other specialists of the ethical responsibility to design and build sustainably and green and to oversee the entire process
- Ethically responsible design implies the integration of passive strategies, active systems and innovative technologies to maximise the building performance
- The construction process to be informed by a sustainable ethos – considering the embodied energy of materials and specifying renewable materials of low embodied energy where possible
- The operation of a building over its life cycle needs to consider not just initial building costs but a life cycle analysis of cost of maintaining the building over time
- The construction cost of good design is often no greater than that for poor design The individual building needs to be considered as part of the greater whole – how it sits in the neighbourhood - the impact of location affects the independence, mobility, health, longevity and quality of life of occupants. Well designed and well connected neighbourhoods that are walkable are attractive neighbourhoods in which to live.

Greater emphasis on the improvement of existing buildings

- Many existing buildings and houses are draughty and have high energy demand – the building fabric needs to be upgraded – external insulation, attic insulation, glazing to be replaced with low-e, double and triple glazed argon filled units
- Window and door frames to be thermally broken to minimise heat loss.

Most buildings are used for several decades, and many survive for centuries.

- Well designed and constructed building last for centuries, people become familiar with them and value and care them
- Some older buildings become iconic – church, library, school and need continual upgrading
- Domestic dwellings of durable construction last for centuries and need upgrading to higher environmental performance.

As the community's principal physical asset, getting good value requires that the building's full life cycle be considered, avoiding short-sighted attempts to merely minimise initial cost.

- An asset adds value, buildings provide shelter and security for individuals and families
- Building can also be beautiful – both traditional and modern – beautiful buildings give visual pleasure and contribute to the sense of place
- Buildings contribute to complexity of the visual landscape – delight at elegant proportions, correct size and scale, use of light, colour and shade, the joy of observing good craftsmanship
- People travel to visit and experience buildings – museums, churches, public buildings
- Buildings express respect for the past and reflect regional identity
- Buildings being also flexible to allow new uses in the present
- The tension between the initial cost of a building and its life cycle costs have – buildings should be designed to be durable over life cycle use – initial costs may be high but lifetime costs lower
- Low initial build costs means higher costs over lifetime use – poor insulation standards, substandard material specification, poor craft standards – minimum standard rather than best practice.

Three guidelines that would promote the development of environmentally sustainable housing in Ireland.
…such as

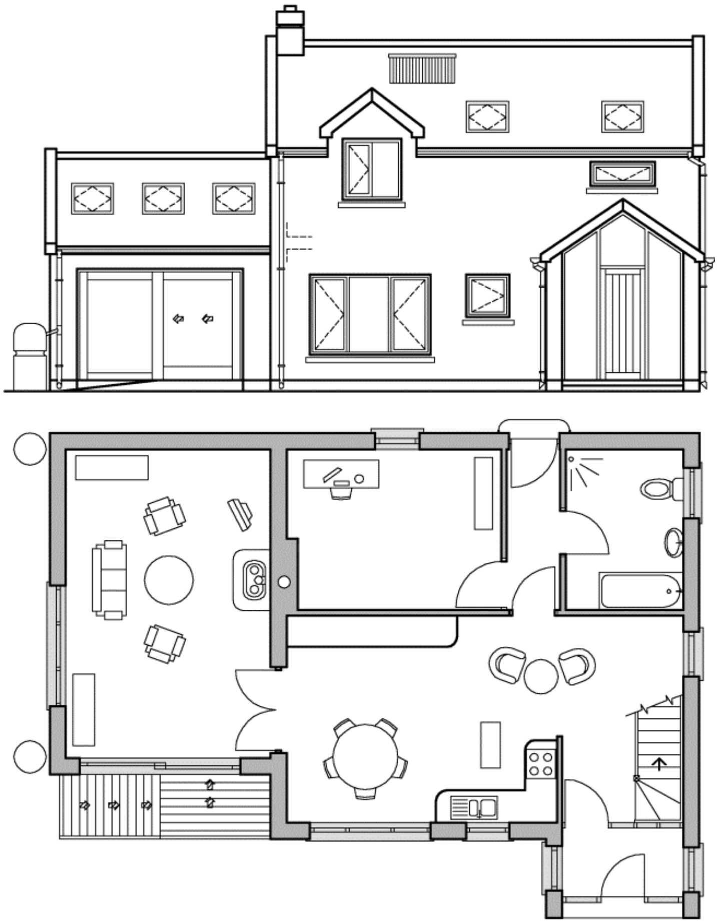
- Make universal design principles the norm - build robust, resilient and flexible housing suitable for lifetime use
- Upgrade building regulations to make sustainability a condition of planning
- Promote urban renewal / regeneration on sustainable principles
- Build only houses of low-environmental impact – embodied energy calculated for all materials
- Adopt purposeful design strategies for neighbourhoods - to include cycle and walking paths, interconnected green car-free and safe walk/cycle routes
- Design for higher densities to reduce energy needs and to promote a sense of community and belonging
- Publish sustainable planning guidelines to be implemented for all housing developments
- Promote consultation between planning authorities and local communities to encourage sustainable planning to make urban living an attractive option, learning to live in community and not in isolation
- Design flexible of buildings to meet changing needs from birth to old age – lifetime use and universal design principles applied, plan for climate change - modest scale of buildings, easy to heat, service, clean
- Design multi-use buildings – retail ground floor, residential over
- Promote the use of renewable energies - solar panels, on-site generation of electricity where possible, small scale wind turbines, energy saving electrical fittings, LEDs, A-rated appliances, orientation
- Provide grants/incentives to encourage sustainable design, education to focus on sustainability and energy use - low embodied energy design
- Develop models of good practice e.g. eco-village at Cloghjordan, Co Tipperaray www.thevillage.ie/
- Incentivise car pooling / car sharing, walking trains to school
- Promote concept of a good neighbourhood – one where one can spend all one's life with neighbours and friends and feel supported in all life stages through a culture of mutual care
- Develop exemplars of good practice in urban design as outlined in *Urban Design Manual – A Best Practice Guide (2009). Department of the Environment, Heritage and Local Government* – www.environ.ie
- Promote concept of urban living as desirable, purposeful, communal having a culture of care, with people giving voluntarily of their time to enhance the quality of life for all members of the neighbourhood.

Any other cogent, well argued points

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Scrúdú Ardteistiméireachta 2012

Staidéar Foirgníochta
Teoiric – Ardleibhéal



Construction Studies
Theory – Higher Level
MARKING SCHEME

CEIST 1

PERFORMANCE CRITERIA	MAXIMUM MARK
Any 12 points × 4 marks (Drawing 3, Annotation 1)	
Slates Battens Felt / breather membrane Rafter Roof insulation Vapour control layer Ventilation to roof Wall plate / hanger to main wall Insulated plasterboard Fascia / Soffit / Gutter Lead Flashing Cavity wall + wall ties Cavity closer - slate / insulation Internal and External Plaster Wall insulation Stepped DPC in cavity Lintels Wallplate Window frame Triple-glazed unit	**4** **4** **4** **4** **4** **4** **4** **4** **4** **4** **4** **4**
Scale and Drafting	**8**
(b) ***4 marks for design detail***	
Design detail	**4**
TOTAL	**60**

CEIST 2

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) ***2 functional requirements, (note 6 marks, sketch 5 marks)***	
Functional requirement 1 Notes Sketches	**6** **5**
Functional requirement 2 Notes Sketches	**6** **5**
(b) Preferred layout for bathroom space (5 × 4 marks)	
Window Shower area Toilet Wash hand basin Grab rails	**4** **4** **4** **4** **4**
3 typical dimensions	**3**
(c) ***Discussion of preferred location (5 × 3 marks)***	
Window Shower area Toilet Wash hand basin Grab rails	**3** **3** **3** **3** **3**
Total	**60**

CEIST 3

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) Revised design detailing (4 × 10 marks)	
Design detailing : Layout / glazing Note and sketch - (2 × 10 marks)	**10** **10**
Design detailing : Upgrade thermal properties Note and sketch - (2 × 10 marks)	**10** **10**
(b) Discussion - (2 × 10 marks)	
Discussion - reasons for revised floor layout	**10**
Discussion - reasons for external wall upgrade	**10**
Total	**60**

CEIST 4

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) ***Operating principles*** - septic tank ***(discussion 7 marks, sketch 7 marks)***	
Operating principle 1	
Discussion	**7**
Sketches	**7**
Operating principle 2	
Discussion	**7**
Sketches	**7**
(b) ***Design detailing of percolation area*** **- any 4** ***(note 2 marks, sketch 2 marks)***	
Soil Geotextile layer Distribution box Perforated pipes Washed clean gravel *(8mm - 32 mm)* Vents	**4** **4** **4** **4**
Dimensions - any two	**4**
(c) ***3 reasons why a site might be unsuitable (3 × 4 marks)***	
Reason 1	**4**
Reason 2	**4**
Reason 3	**4**
Total	**60**

CEIST 5

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) 10 points × 3 marks for each point	
Correct tabulation	**3**
Screed	**3**
Concrete floor slab	**3**
DPM	**3**
Sand blinding	**3**
Hardcore	**3**
Subsoil	**3**
Internal surface	**3**
Total Resistance	**3**
U-value (1 mark for the formula)	**3**
(b) 5 points × 3 marks for each point	
Heat loss formula and calculation	**3**
Heating duration for one year	**3**
k/joules calculation for one year	**3**
litres of oil for one year	**3**
Annual cost of heat lost	**3**
(c)(5 + 10 marks)	
Passive insulated ground floor with radon barrier	
Notes	**5**
Sketches	**10**
Total	**60**

CEIST 6

PERFORMANCE CRITERIA	
(a) Features of design - doing more with less for longer (6 × 5 marks)	
Feature 1 Note - (5 marks) Sketch - (5 marks) **Feature 2** Note - (5 marks) Sketch - (5 marks) **Feature 3** Note - (5 marks) Sketch - (5 marks)	**5** **5** **5** **5** **5** **5**
(b) Discussion (3 × 10 marks)	
Orientation of house **(5 for point, 5 for discussion)**	**10**
Flexibility of design **(5 for point, 5 for discussion)**	**10**
Sourcing materials **(5 for point, 5 for discussion)**	**10**
Total	**60**

CEIST 7

PERFORMANCE CRITERIA	MAXIMUM MARK
***Timber frame - 9 points × 5 marks** (4 marks for sketch, 1 mark for annotation)*	
Doorframe Door Render Concrete block outer leaf and lintel Breather membrane Sheathing material Timber stud Insulation Airtight membrane, tape and sealant Plaster slab Solid timber lintel Stepped dpc Cavity barrier / fire check Finished floor Acoustic layer Plywood sheeting First floor joists	**5** **5** **5** **5** **5** **5** **5** **5** **5**
Any 4 typical dimensions ***(4 × 1 mark)***	**4**
Scale & Drafting	**8**
(b) ***Vapour barrier - 3 marks***	
Position of vapour barrier	**3**
TOTAL	**60**

CEIST 8

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) *Correct wiring layout for an electrical ring mains circuit (6 × 4 marks)*	
Correct wiring diagram to include consumer unit	**4**
Sockets – correct connections	**4**
Size of cables	**4**
Live colour - colour coding	**4**
Neutral colour - colour coding	**4**
Earth - colour coding	**4**
(b) 2 safety features	
Safety feature 1	
Notes	**6**
Sketches	**6**
Safety feature 2	
Notes	**6**
Sketches	**6**
(c) *2 strategies to ensure economical use of electricity*	
Strategy plus elaboration 1	**6**
Strategy plus elaboration 2	**6**
Total	**60**

CEIST 9

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) Discussion on airtightness: (2 × 10 marks)	
Discussion – point 1 ***(5 for point, 5 for discussion)***	**10**
Discussion – point 2 ***(5 for point, 5 for discussion)***	**10**
(b) Three locations (6 × 5 marks)	
Location 1	
Note	**5**
Sketch	**5**
Location 2	
Note	**5**
Sketch	**5**
Location 3	
Note	**5**
Sketch	**5**
(c) ***Discuss advantages of service cavity*** **(*2 × 5 marks)***	
Discuss advantage 1 - ***(2 for point, 3 for discussion)***	**5**
Discuss advantage 2 - ***(2 for point, 3 for discussion)***	**5**
Total	**60**

CEIST 10

PERFORMANCE CRITERIA	MAXIMUM MARK
(a) ***Discussion of 2 design details (note 5 marks, sketch 5 marks)***	
Note 1	**5**
Sketch 1	**5**
Note 2	**5**
Sketch 2	**5**
(b) Mechanical heat recovery system	
Design layout for ducting	**10**
Direction of airflow	**5**
Explanation of how the system works	**5**
(c) ***2 advantages and 2 disadvantages of Passive House construction***	
Advantage 1	**5**
Advantage 2	**5**
Disadvantage 1	**5**
Disadvantage 2	**5**
Total	**60**

Ceist 10 (Alternative)

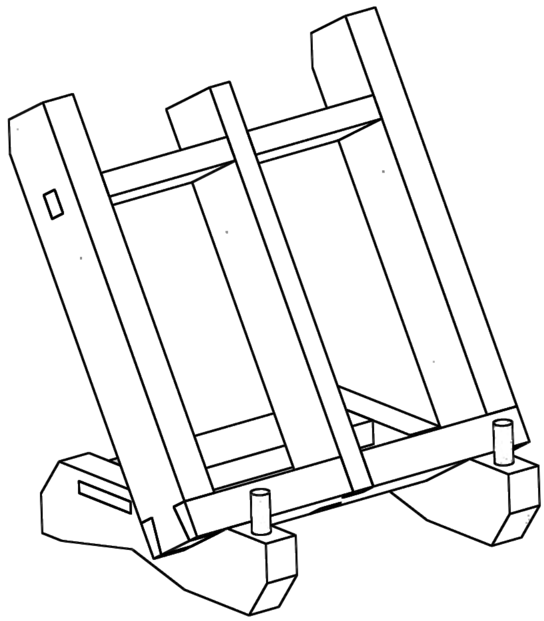
PERFORMANCE CRITERIA	
Discussion of Statement (3 × 10 marks)	
Discussion – point 1 ***(4 for point, 6 for discussion)*** Discussion – point 2 ***(4 for point, 6 for discussion)*** Discussion – point 3 ***(4 for point, 6 for discussion)***	**10** **10** **10**
Three guidelines (3 × 10 marks)	
Guideline 1 ***(4 for point, 6 for discussion)***	**10**
Guideline 2 ***(4 for point, 6 for discussion)***	**10**
Guideline 2 ***(4 for point, 6 for discussion)***	**10**
Total	**60**

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Scrúdú Ardteistiméireachta 2012
Leaving Certificate Examination 2012

Scéim Mharcála
Marking Scheme

(150 marc)

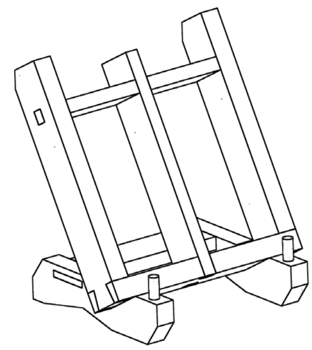


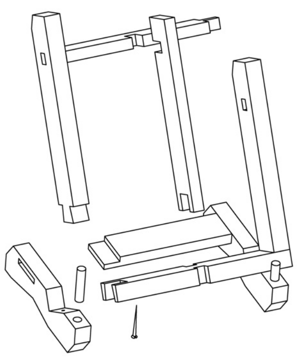
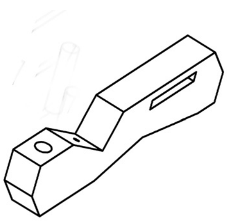
Staidéar Foirgníochta
Triail Phraticiúil

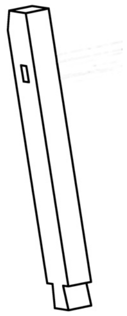
Construction Studies
Practical Test

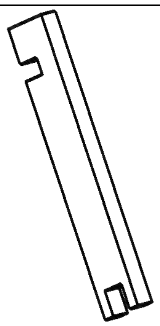
Construction Studies 2012
Marking Scheme – Practical Test

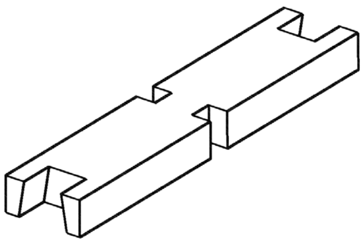
Note:
The artifact is to be hand produced by candidates without the assistance of machinery. However the use of a battery powered screwdriver is allowed.
Where there is evidence of the use of machinery for a particular procedure a penalty applies.
Component is marked out of 50% of the marks available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

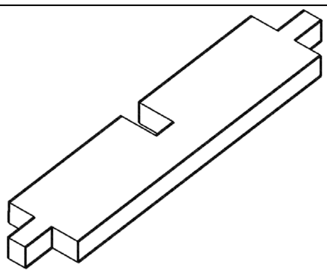
	A	OVERALL ASSEMBLY	MARKS
	1	Overall quality of assembled artifact	**8**
	2	Dowel located and fitted correctly	**4**
	3	Design and applied shaping to edges • design • shaping *(2 × 2 marks)*	**4**
		Total	**16**

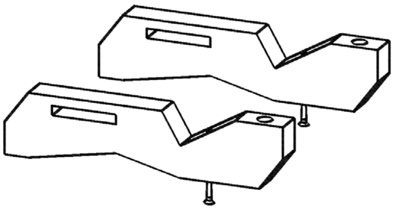
	B	MARKING OUT	Marks
	1	Left side - vertical • joints - mortice *(2 marks)* - dovetail *(2 marks)* • top slopes *(1 mark)*	**5**
	2	Right side - vertical • joints - mortice *(2 marks)* - dovetail *(2 marks)* • top slopes *(1 mark)*	**5**
	3	Middle – vertical • joints - bridle *(2 marks)* - halving *(2 marks)*	**4**
	4	Bottom rail • joints - dovetail pins *(2 × 2 marks)* - trenches *(2 marks)*	**6**
	5	Top rail • joints - tenons *(2 × 2 marks)* - halving *(2 marks)*	**6**
	6	Base - left and right • mortices *(2 × 2 marks)* • notches *(4 × 2 marks)* • chamfers *(4 × 1 marks)*	**16**
	7	Base – back rail - tenons *(2 × 2 marks)*	**4**
		Total	**46**

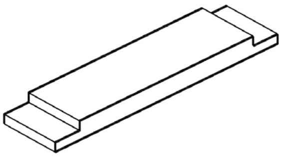
TWO SIDES	C	PROCESSING	Marks
	1	Shaping chamfers *(2 × 1 mark)*	**2**
	2	Two mortices *(2 × 3 marks)*	**6**
	3	Dovetails • slopes *(4 × 2 marks)* • shoulders *(4 × 1 marks)*	**12**
		Total	**20**

MIDDLE VERTICAL	D	PROCESSING	Marks
	1	Bridle joint - bottom • sawing vertically *(2 × 1 mark)* • trenching *(2 marks)*	**4**
	2	Halving joint - top • sawing across grain *(2 × 1 mark)* • paring trench *(1 mark)*	**3**
		Total	**7**

BOTTOM RAIL	E	PROCESSING	Marks
	1	Two dovetail pins • sawing vertically *(4 × 1 marks)* • trenching *(2 × 2 marks)*	**8**
	2	Bridle joint • sawing across the grain *(4 × 1 mark)* • paring trench *(2 × 1 mark)*	**6**
		Total	**14**

TOP RAIL	F	PROCESSING	Marks
	1	Two tenons • sawing vertically *(4 × 1 mark)* • sawing shoulders *(4 × 1 mark)*	**8**
	2	Trench • sawing shoulders *(2 × 1 mark)* • paring trench *(1 mark)*	**3**
		Total	**11**

BASE - SIDES	G	PROCESSING	Marks
	1	Chamfers *(4 × 1 mark)*	**4**
	2	Two mortices *(2 × 3 marks)*	**6**
	3	Shaping slopes *(8 × 2 marks)*	**16**
	4	Holes - screws • drilling and countersinking screws + position *(2 × 2 marks)*	**4**
		Total	**30**

BASE - BACK RAIL	H	PROCESSING	Marks
	1	Two tenons • sawing vertically *(2 × 2 marks)* • sawing shoulders *(2 × 1 mark)*	**6**
		Total	**6**