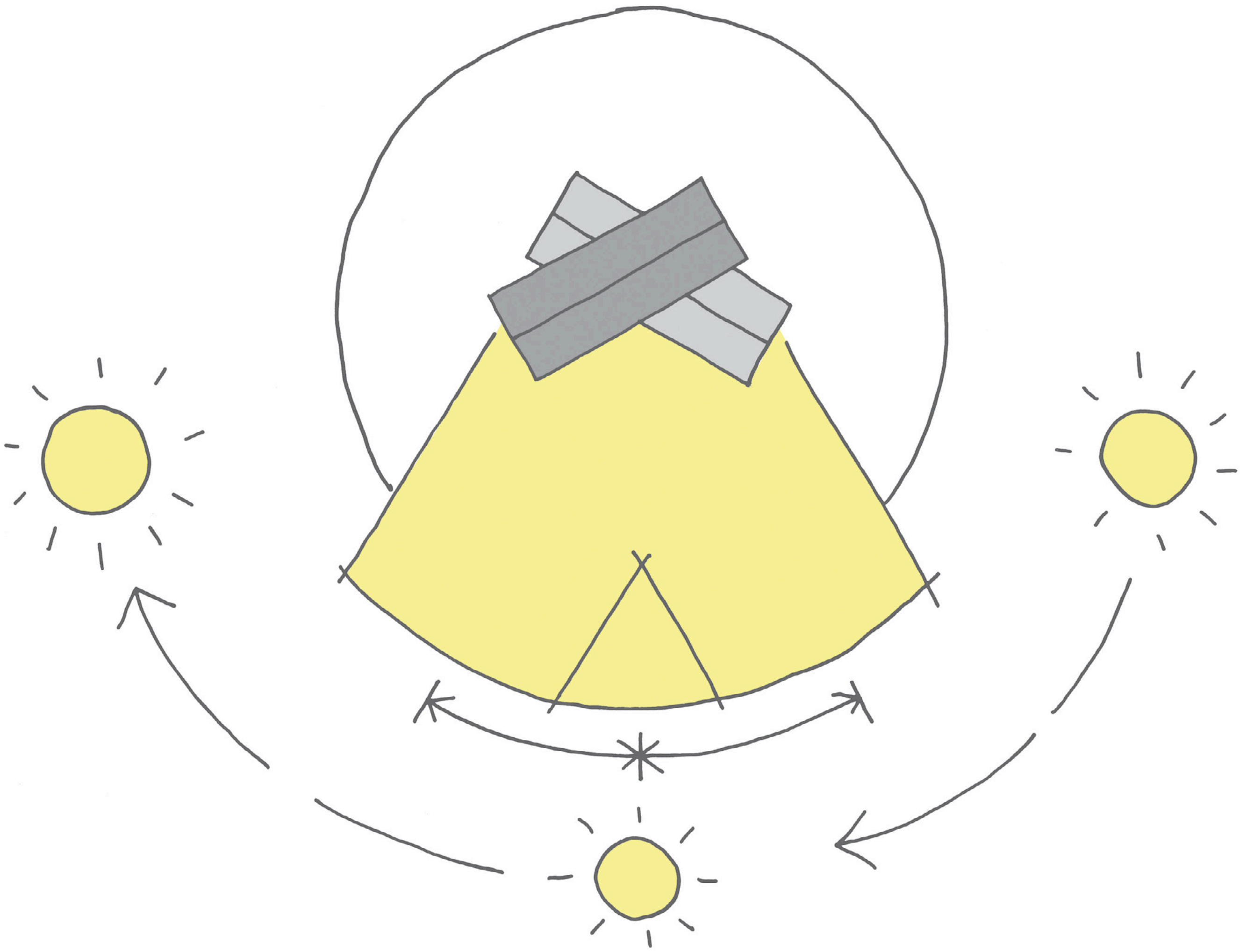


LEAVING CERTIFICATE 2014

CONSTRUCTION STUDIES

Theory – Higher Level | Sample Solutions

Trevor Hickey

Introduction

These sample answers are designed to give the reader a sense of how the theory paper should be answered.

It is important to realise that these sample answers are different from the official solutions. The official solutions are primarily a guide for the examiners (the dedicated group of teachers who correct the Leaving Cert during the summer) and contain most of the answers that a student might come up with for a given question.

The strength of the official solutions is that they are very comprehensive and detailed. The strength of these sample answers is that they look like what a student should be aiming to achieve in the exam – they are model answers. Because the official solutions have to be more comprehensive and detailed than a typical student answer they are not always a good guide to what a student's answer should look like in the exam.

It is very important to realise that both these solutions and the official solutions were written in the year of the exam and satisfied the building regulations that applied at that time. As the regulations change, so will the answer. If you are practising a question, always check that your answer is up to date with current regulations. The building regulations can be found at www.environ.ie.

Exam technique

Exam technique is essential to performing well in the theory paper. Put simply, this means reading the question carefully and structuring the answer so that it 'maps onto' the marking scheme. As you read through these sample answers be sure to notice how the question is phrased and how the answers are laid out to respond to the question.

Instructions to candidates

*(a) Answer **Question 1** and **four** other questions.*
(b) All questions carry equal marks.
(c) Answers must be written in ink.
(d) Drawings and sketches to be made in pencil.
(e) Write the number of the question distinctly before each answer.
(f) Neat freehand sketches to illustrate written descriptions should be made.
(g) The name, sizes, dimensions and other necessary particulars of each material indicated must be noted on the drawings.

These 'Instructions to Candidates' appear on the front cover of the exam paper. Let's take a closer look at them:

(a) this means that you must attempt Question 1 and any four other questions – five in total. If you do not attempt Question 1 you will only be marked out of 4 questions (i.e. max. 80%)
(b) this means that each question is worth 60 marks
(c) this means that you should write your answers with a blue or black pen – it's okay to write the labels to drawing questions (i.e. Q.1 & Q.7) in pencil
(d) this means that all drawings and sketches should be done in pencil – use an H or 2H pencil for drawings (i.e. Q.1 & Q.7) and an HB or B pencil for sketches – also, use colouring pencils to add colour to your sketches where appropriate*
(e) this means that the question number and part number should appear in the left margin beside the answer (e.g. Q.5(b))
(f) this means that sometimes a sketch is expected even if the question doesn't actually ask for one; so the golden rule is, if you know a sketch that goes with the topic you're writing about – put it on the page – it won't do any harm and it might pick you up some marks
(g) this means that you should label the parts of every sketch – this is another area where you can easily lose marks. Again, if you know it, put it on the page!

* Be careful with the use of colour – use colours where they have a meaning. For example, use red for damp proof layers, blue for airtight layers and yellow for insulation layers.

Layout of the exam paper

There are eleven questions on the paper. You must answer question one and any four other questions – five in total.
Q.1 is an architectural drawing question,
Q.5 is the 'heat energy/ U-values calculation' question,
Q.7 is usually the second architectural drawing question,
Q.10 is actually two questions – you can answer either. The second option requires an essay-type answer.

If you study the papers over the past ten years you will notice that the examiner tends to explore certain themes for a few years before moving on. For example, Q.2 looked at wheelchair accessibility from 2003 to 2005 and then again in 2010 and 2012. However, it is really important to know that the State Examinations Commission works deliberately to avoid exam papers becoming predictable. So it is not a good idea to try to predict the paper.

Before the exam

Make sure you have everything you'll need:

- pens, pencils and colouring pencils
- eraser and sharpener
- tape/drawing clips
- T-square, set squares and compass.

When you're in the exam hall waiting for the paper to be given out, the invigilators will hand out the drawing sheets for Q.1. As soon as you are given a sheet, fix it to your drawing board/desk and get your drawing equipment ready so you can start drawing as soon as you are ready.

Timing

Try to stick to this timing:

- 10 minutes to choose which questions to answer
- 32 minutes to answer each question
- 10 minutes to read over and check your answers and add any last-minute details.

so it's...

- 2:00p.m. choose questions
- 2:10p.m. begin Q.1
- 2:42p.m. next question
- 3:14p.m. next question
- 3:46p.m. next question
- 4:18p.m. next question
- 4:50p.m. look over
- 5:00p.m. finish

Choosing which questions to answer

Taking time at the beginning of the exam to choose your questions is very important. Start by having a look through the paper to get a sense of what's there. Pick your four questions (plus Q.1), then carefully read through these questions to make sure you can answer all parts of the question. Don't just choose a question because you can see at a glance that it's about a topic you like – actually read the full question and make sure you can answer **every** part of it in full.

Answering questions in the best order

Begin with Q.1 (remember, it's compulsory). Then, if you are going to do another drawing question (Q.7), do it next while you have all your drawing equipment out. If you are doing Q.5 (U values) do that next because it will probably take less than 32 minutes to do it and having some extra time will take some of the pressure off.

After that, do the remaining questions in order of strength – that is, do the question you think you'll do best next and so on, leaving your weakest question until last. Doing it this way will give you confidence and keep you in a positive frame of mind.

Structuring your answers

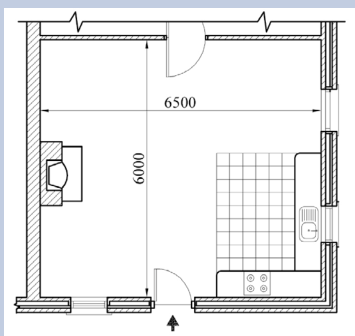
Once you have selected your four questions, take out your highlighter marker and highlight the key parts of each question.

Take Q.2 from the 2010 paper as an example:

2 The accompanying diagram shows an open-plan living, dining and kitchen space suitable for a person in a wheelchair. The floor is an insulated solid concrete ground floor.

(a) Using notes and ***freehand sketches***, show the design detailing at the entrance door to ensure that rainwater is removed from the threshold area and that the entrance is suitable for a person in a wheelchair.

(b) From the given diagram, select any **two** areas that need specific consideration to ensure suitability for a person in a wheelchair. For **each** area selected, using notes and ***freehand sketches***, show the specific design detailing that ensures the ease of use for a person in a wheelchair. Indicate on your design sketches typical dimensions as appropriate.



Performance criteria	Maximum mark
Any two details (2 x 16 marks)	
(a) Design detail 1 – note 8 marks, sketch 8 marks	
Note	8
Sketch	8
Design detail 2 – note 8 marks, sketch 8 marks	
Note	8
Sketch	8

As you can see, the examiner is looking for a note and a sketch for each detail:

- detail 1: 'rainwater is removed from the threshold area'
- detail 2: 'suitable for a person in a wheelchair'.

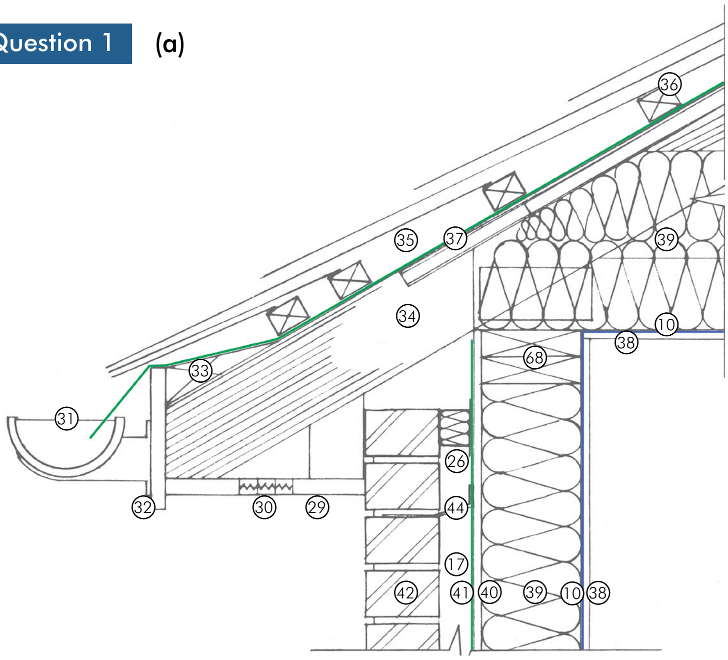
An answer that has only one note or one sketch will not score highly.

Remember:

- read the entire question very carefully
- highlight the key parts of the question
- make a note beside the question of how many notes and sketches are needed for each part of your answer
- structure your answer clearly so the examiner doesn't have to search for the answer; keep the note close to the sketch it goes with, then leave a space and do the next note and sketch
- avoid going over the 32 minutes per question – if you have not finished answering a question when the 32 minutes are up, move on and come back to it at the end.

Question 1

(a)



⑩ Airtightness layer
- airtightness membrane or
- panel (e.g.OSB3) or
- 12mm gypsum plaster (on blockwork)
- all connections and joints taped with appropriate airtightness tape

⑰ 50mm air cavity
- thermal resistance: 0.180 m^2K/W

㉖ Cavity closer/fire stop
- rigid insulation in masonry wall (e.g. EPS 100 or similar)
- proprietary fire stop in timber frame wall

㉙ Timber soffit

㉚ Air gap for ventilation
- proprietary vent cover

㉛ Rainwater gutter
- connected to rainwater pipe and drain

㉜ Timber fascia

㉝ Tilting fillet

㉞ Rafter/top chord (truss)
- roof truss to comply with IS 193 and IS EN14250
- design to comply with IS EN 1995 Design of Timber Structures

㉟ Roofing underlay (breather membrane/ windtight layer)
- all joints properly overlapped and sealed
- NSAI certified roofing membrane
- to comply with EN 13859-1

㊱ 50x50mm timber batten
- to comply with IS EN 1995 Design of Timber Structures

㊲ Proprietary eaves ventilator
- installed along continuous length of eaves

㊳ Plasterboard
- 12.5mm thick board
- joints taped and filled or
- 2mm gypsum plaster finish coat

㊴ Quilted insulation
- depth/thickness varies – scale from drawing
- mineral fibre, sheep's wool, hemp, cellulose etc.
- λ:0.034W/mK – 0.039W/mK

㊵ Oriented strand board
- OSB3 – airtight board
- design to comply with IS EN 1995 Design of Timber Structures

㊶ Breather membrane/windtight layer
- all joints properly overlapped and sealed
- to comply with EN 13859-1

㊷ Brickwork
- design to comply with IS EN 1996 Design of Masonry Structures

㊹ Wall tie
- to comply with with EN 845-1
- stainless steel ties in building regulations walls
- low thermal conductivity ties (e.g. Teplo) in Passivhaus walls

68 Head plate
- 44mm solid timber – width to suit design – scale from drawing
- design to comply with IS EN 1995 Design of Timber Structures

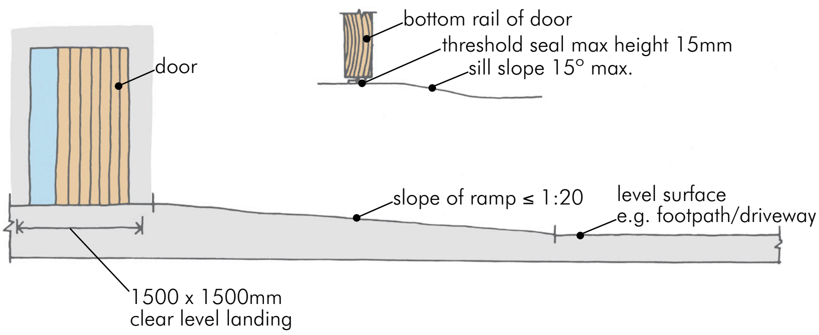
(b)

The airtightness membrane fixed to the underside of the ceiling joists/bottom chord is taped to the air-tightness membrane fixed to the inside of the timber studs in the wall, using proprietary airtightness tape. This is shown as a blue line on the drawing.

Question 2

(a)

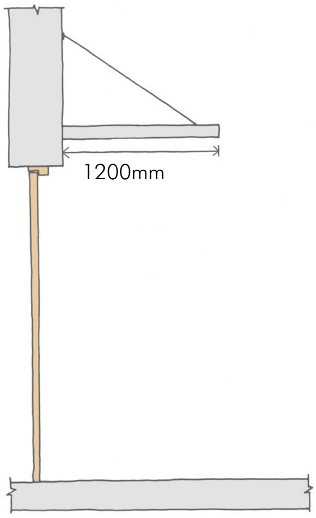
Threshold and access ramp



The approach to the door should be level. A ramp, with a maximum slope 1:20 should be created. A clear landing space, with a minimum area of 1500mm by 1500mm, should be provided in front of the door. This will ensure that all users, especially wheelchair users, have space to manoeuvre at the door.

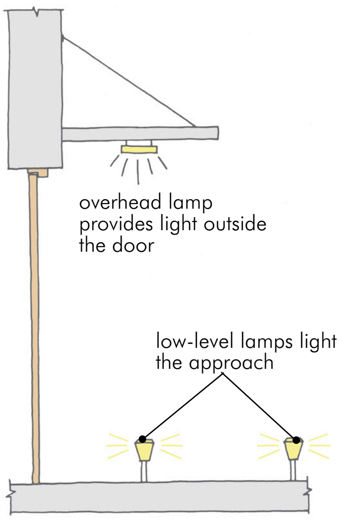
The door threshold seal should be a maximum of 15mm in height to ensure that it is not an obstacle to users. The slope of the door sill should not exceed 15° to ensure that wheelchair users can easily travel across it.

Weather protection



The entrance should be protected from the weather by a porch/canopy that extends 1200mm min. above the door. This will shelter all users as they get out their keys or wait for the door to be opened.

Suitable lighting



An overhead light should be provided to light the entire area outside the door. This will ensure that users are able to find their keys at night. It will also provide security by allowing the caller to be clearly seen through the side light (i.e. window) and identified before the door is opened.

Low-level lighting should be provided to ensure that the approach can be clearly seen by all users and that any obstacles (e.g. overhanging planting) can be safely avoided.

(b)

Provision for lifetime use should be considered at the design stage.

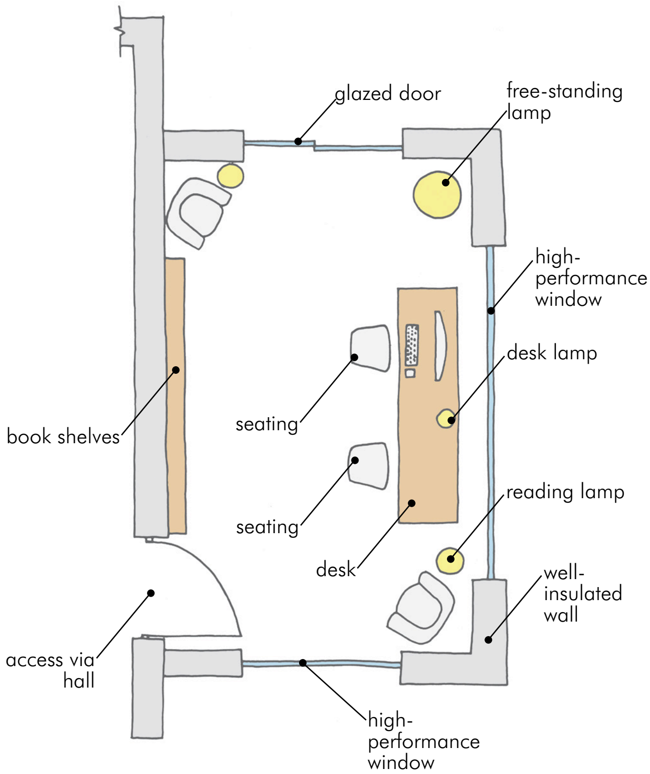
- To avoid the need to make changes to the building's structure when adapting the building in the future. Thought should be given to the layout of the internal spaces and how they might need to be used. For example, if an internal door might be needed to allow different access to a room, the door opening could be created (i.e. lintel installed) so that installing the door at a later date is a much simpler task.
- To facilitate the installation of accessible features at a later date. For example, should grab rails be needed in the bathroom in the future, the fixing for these (e.g. timber noggings in a partition wall) can be installed during construction so that they are already in place when needed.

Question 3

(a)

Three functional requirements of a study include:

1. thermal comfort – the study should be at a constant temperature of 20°C. The user should be able to adjust the temperature to suit their preference.
2. acoustic comfort – the user should not be disturbed by noise from the rest of the home or from outside.
3. lighting – a light level of 150–300 lux should be provided. The user should be able to adjust the level of light to suit the task at hand. This usually requires several light sources, including natural light and ceiling and desk lamps.



(b)

This design layout provides:

Thermal comfort:

- a comfortable temperature is essential in a study space
- the well-insulated walls (full fill cavity) could be augmented with 100mm of external insulation
- the windows and glazed door should comprise triple-glazed, argon filled low-e coated glazing units with insulated frames.

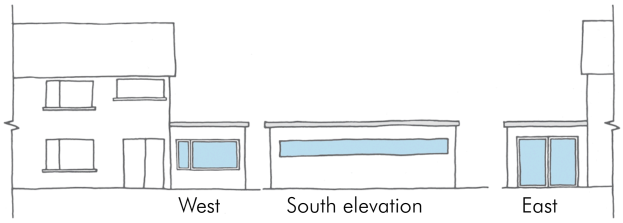
Acoustic comfort:

- a study must be quiet so that the users can concentrate
- access to the study is from the hall (rather than the kitchen/dining space) because the hall is a much quieter part of the home
- the high-performance windows should exclude external noise.

Lighting:

- an appropriate level of natural lighting through the use of glazing to the east, south and west façades
- the long 'slot' window to the south will illuminate the desk area without causing overheating (thermal comfort)
- artificial lighting in the ceiling as well as several reading lamps ensure an appropriate level of artificial lighting when needed.

(c)



Revised external design to enhance its visual appearance:

West elevation:

- the façade is enhanced by the replacement of the storeroom door with a window
- the window is similar in style to the windows in the main façade.

South elevation:

- the original blank wall is opened up with a long 'slotted' window that will bring light into the work space this will provide light on the working plane
- the level of light can be controlled to suit the user using a venetian-type blind
- if this window overlooks an adjoining property, transluscent glazing can be used.

East elevation:

- the original small window is replaced by a glazed door
- this allows access to the private rear garden
- it gives a view of the garden area and helps to link the indoor and outdoor spaces.

Question 4

(a)

Advantages of a step-by-step approach:

- the occupants can remain living in the home while the work proceeds
- the work can be paid for gradually avoiding the need for costly loans.

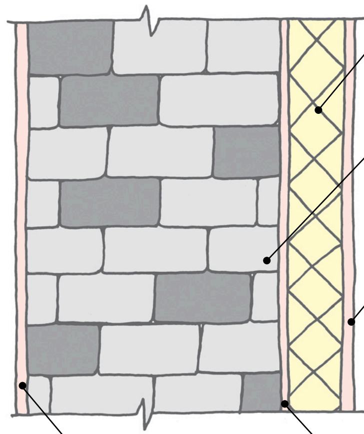
Disadvantages of a step-by-step approach:

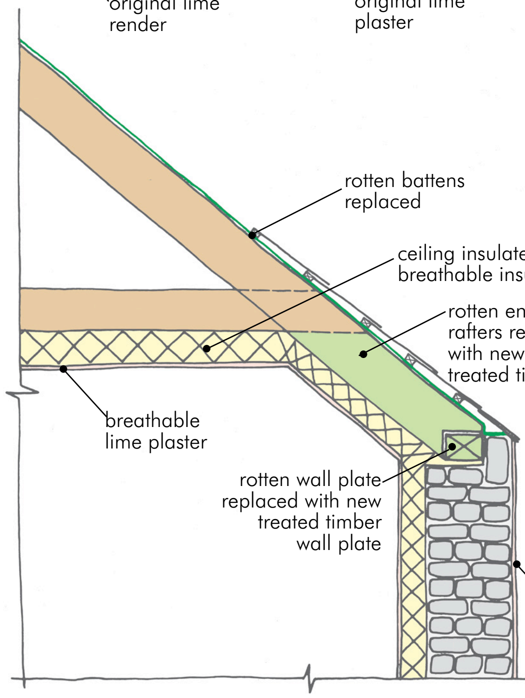
- there is more disruption to the occupants over a longer period of time
- it is difficult to integrate the various elements of the work to achieve a high standard of overall performance and finish.

(b)

The principles of conservation best practice should guide all work:

- do the research – analyse the building fabric and any other evidence (e.g. maps, drawings, documents, etc.)
- use expert advice – building conservation is a specialised area that should be led by experts with knowledge and experience of historic buildings
- promote the special interest – the features of the building that convey its distinctiveness should be protected
- minimum intervention – best summed up by the maxim 'do as much as necessary and as little as possible'
- repair rather than replace – the original building fabric should, whenever possible, be repaired rather than replaced with new materials
- promote honesty – repairs should generally be carried out without any attempt at disguise or artificial ageing
- use appropriate materials and methods – some modern materials can accelerate decay of the building fabric, for example, replacing lime mortar with cement mortar
- reversibility – allows for the future correction of unforeseen problems without lasting damage being caused
- avoid incremental damage – it is important to be aware of the potential cumulative impact of minor works to the character of heritage buildings
- avoid using salvaged materials – the re-use of architectural materials from other buildings can confuse the history of a building
- comply with the building regulations – apart from a few exemptions, the regulations apply to all works involving new construction, extensions to buildings, material alterations to existing buildings and material change of use of such buildings.





Walls:

- the walls should be insulated using materials that are compatible with the existing structure
- these materials should be flexible and breathable to ensure that the structure can continue to respond to changing climatic conditions
- suitable insulants include wood fibre and hemp
- these insulants are supplied with proprietary breathable renders
- the thickness of insulation used depends on the thermal performance required – a minimum of 150mm thickness should be used
- it is essential that water vapour generated indoors can pass through the building fabric to the outside this will prevent dampness in the structure
- loose or damaged plaster or render should be removed and replaced using lime-based materials.

Roof:

- this type of house typically suffers from rotten wall plates and rafters caused by the ingress of water due to damaged or missing roof slates
- the wall plate should be replaced with new pressure-treated timber
- the ends of the rafters that are rotten should be cut out and new pressure-treated timber should be bolted on to the existing rafter to repair it
- the ends of the existing rafters that are not rotten should be treated with a preservative as a preventive measure
- the ceiling should be insulated using a breathable insulant and finished with a breathable lime-based plaster
- the thickness of insulation used depends on the thermal performance required – a minimum of 150mm thickness should be used.

Respecting the character of the original house:

- the use of internal insulation to the walls and roof allows the thermal performance of the house to be upgraded without impacting on the appearance of the house
- the use of lime-based plasters and renders ensures that the finished appearance of the repaired and upgraded walls and ceilings is consistent with the original appearance of the building.

Question 5

(a)

**Note: This solution represents what the examiners are expecting to see. It is not the correct method of calculating the thermal transmittance of a floor.*

Layer/surface	Thickness (m)	Conductivity (W/mK)	Resistance (m^2K/W)
int. surface	-	-	0.104
floor slab	0.125	0.160	0.781
insulation	0.200	0.031	6.452
dpm	0.0003	0.450	0.001
sand blinding	0.030	0.160	0.188
hardcore	0.225	1.260	0.179
Total resistance (R_T)			7.704

$$U = \frac{1}{R_T} = \frac{1}{7.704} = 0.1298 = 0.13\ W/m^2K$$

(b)

Formula

$$\text{cost} = \frac{\text{time x rate x price}}{\text{1000 x calorific value}}$$

Where:

time = heating period (unit: seconds, s)

rate = U-value x area x temperature difference (unit: Watt, W)

price = price per unit of fuel (e.g. litre of oil) (unit: cent, c or euro, €)

Data:

- U-value walls = $0.13W/m^2K$
- area walls = 13.0m x 7.0m = $91m^2$
- mean indoor temperature = 21°C
- outdoor temperature = 7°C
- heating period = 12 hours per day for 39 weeks
- price of kerosene = 95c/litre
- calorific value of kerosene = 37,350kj/litre

time = 60 x 60 x 12 x 7 x 39
= 11,793,600 seconds

rate = U-value x area x temperature difference
= 0.13 x 91 x (21– 7)
= 165.62

input data into formula:

$$\text{cost} = \frac{\text{time x rate x price}}{\text{1,000 x calorific value}}$$

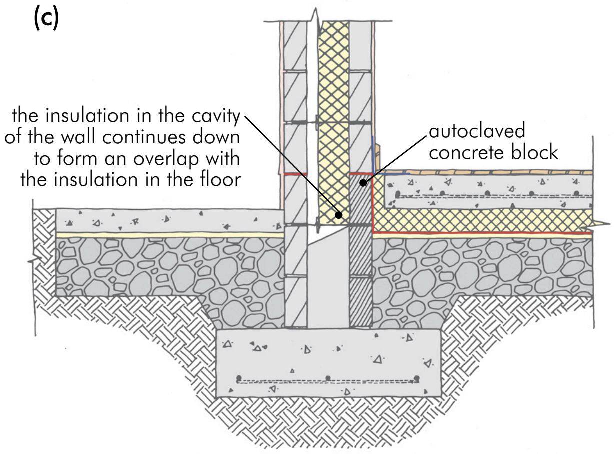
$$\text{cost} = \frac{11{,}793{,}600 \times 165.62 \times 95}{37{,}350{,}000}$$

$$\text{cost} = \frac{185{,}559{,}323{,}040}{37{,}350{,}000}$$

cost = 4,968.12c

cost = €49.68

(c)

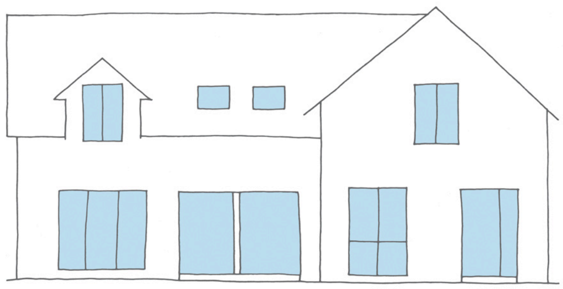


Prevention of thermal bridging at the wall–floor junction:

- thermal transmission is likely to occur at the wall –floor junction by conduction of heat energy down through the inner leaf of blockwork
- traditionally this heat flow path is not thermally broken
- to prevent this heat loss, at least three courses of aerated autoclaved concrete blocks are included in the inner leaf rising wall
- the aerated autoclaved concrete blocks reduce the amount of thermal transmission along this path
- also, a perimeter of edge insulation is installed around the concrete floor slab
- in addition, the wall insulation (in the cavity) is extended downward (below finished floor level) to create an overlap with the floor insulation
- the combination of these measures will significantly reduce thermal transmittance at the wall–floor junction.

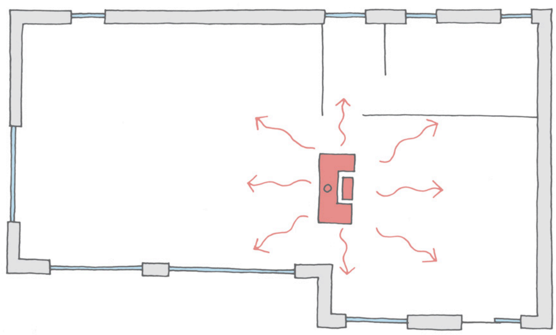
Question 6

(a)

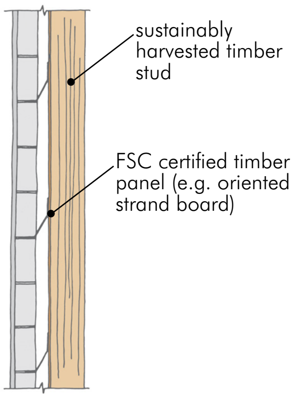


Three features that contribute to the house having a low environmental impact:

1 Glazing:
- the primary facade of the house has a significant amount of glazing
- this maximises solar gain
- maximising solar gain reduces the space heating and lighting requirements of the home
- this reduces energy consumption and carbon emissions.



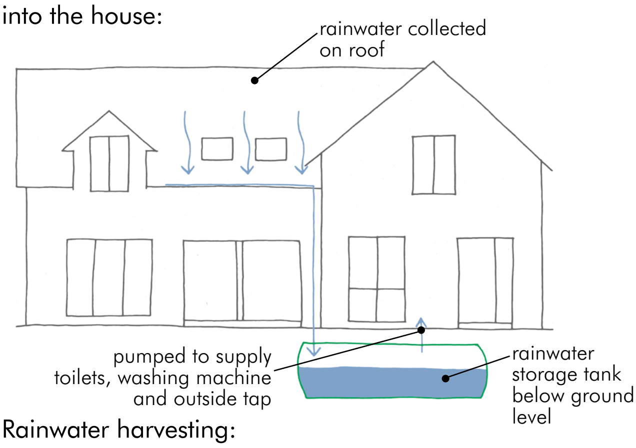
2 Open plan layout with central heat source:
- the solid fuel (e.g. wood) stove located in a central area provides heat to the entire ground floor of the home
- the masonry fire surround and chimney act as a thermal store holding heat energy and releasing it as the temperature drops when the stove is no longer in use.



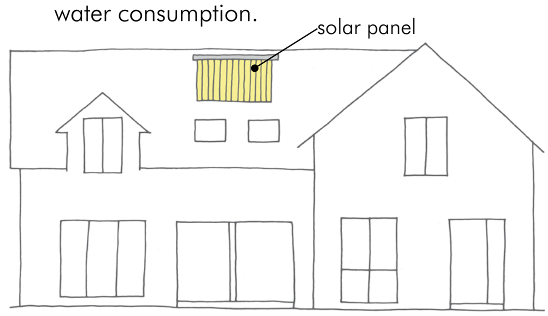
3 Timber frame construction:
- timber is a sustainable construction material provided it is sourced from a Forestry Stewardship Council (FSC) certified supplier
- a home built using a timber frame system contains less embodied energy than a traditional concrete cavity wall system.

(b)

Other design features that could be incorporated into the house:



Rainwater harvesting:
- a rainwater harvesting system could be installed
- this would greatly reduce the environmental impact of the home by reducing the water consumed in activities that do not require potable water
- for example, harvested rainwater can be used for flushing toilets and washing clothes:
  - toilet flushing accounts for approximately 20% of a typical household's water consumption
  - washing machine use accounts for approximately 10% of a typical household's water consumption.



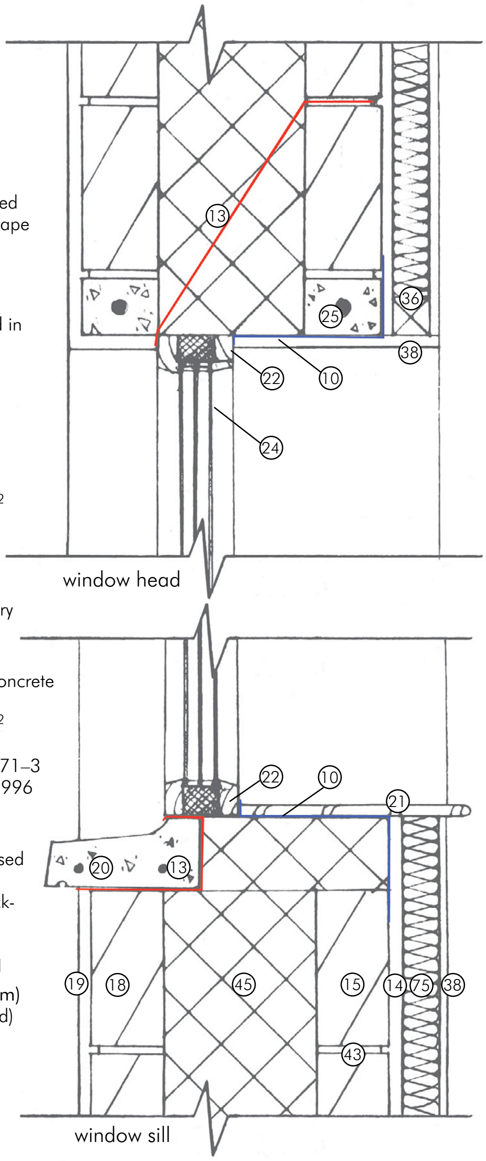
Solar water panels:
- solar water heating panels could be installed on the south slope of the roof
- the roof form of this house is ideal as it has roof slopes facing in four different directions
- solar water panels provide hot water for use in basins, baths and showers
- solar panels reduce energy consumption and carbon emissions.

(c)

Designing low environmental impact housing is important because it reduces carbon emissions and the consumption of resources:
- housing is a significant source of carbon emissions
  - the SEAI states that the residential sector is responsible for 27% of Ireland's carbon emissions
  - houses must be designed to provide a comfortable indoor environment without the consumption of large amounts of carbon based energy.
- the construction of housing consumes a lot of resources
  - large amounts of virgin materials (e.g. stone, timber, steel, glass, plastic) are used in the construction of houses
  - large volumes of water are often consumed in the construction of houses.

Question 7

(a)



(10) Airtightness layer
- airtightness membrane or
- panel (e.g.OSB3) or
- 12mm gypsum plaster (on blockwork)
- all connections and joints taped with appropriate airtightness tape

(13) Damp proof course (DPC)
- to comply with EN 14909

(14) 12mm plaster
- gypsum based plaster applied in two coats
- 10mm base coat
- 2mm finish coat
- λ: 0.18W/mK

(15) Inner leaf concrete blockwork
- 440x215x100mm standard concrete blocks
- compressive strength 5N/mm²
- λ: 1.33W/mK
- blocks to comply with IS EN 771–3
- design to comply with IS EN 1996 Design of Masonry Structures

(18) Outer leaf concrete blockwork
- 440x215x100mm standard concrete blocks
- compressive strength 5N/mm²
- λ:1.33W/mK
- blocks to comply with IS EN 771–3
- design to comply with IS EN 1996 Design of Masonry Structures

(19) Render
- 20mm cement, lime, sand based render
- applied in 3 coats to total thickness 20mm
- : 1.00W/mK
- to comply with IS EN13914–1

(20) Precast concrete sill (100x70mm)
- pre-stressed steel (double cord)
- to comply with BS 5642-1

(21) Window board
- timber selection and finish to suit client

(22) Insulated window frame
- WEP certified or Passivhaus certified (as appropriate)

(24) Glazing unit (double or triple glazed)
- WEP certified or Passivhaus certified (as appropriate)

(25) Precast concrete lintel
- prestressed steel (double cord)
- lintel to comply with IS EN 845-2
- design to comply with IS EN 1996 Design of Masonry Structures

(36) 50x50mm timber batten
- to comply with IS EN 1995 Design of Timber Structures

(38) Plasterboard
- 12.5mm thick board
- joints taped and filled or
- 2mm gypsum plaster finish coat

(43) Mortar (cement, sand)
- design to comply with IS EN 1996 Design of Masonry Structures

(45) Rigid insulation
- 250 or 300mm – scale from drawing
- EPS 100 – expanded polystyrene board
- λ: 0.034W/mK
- or suitable alternative that provides equal performance
- NSAI certified insulation system

(75) Service cavity
- 50x50mm timber batten with mineral fibre, sheep's wool, hemp or similar insulation
- λ: 0.034W/mK – 0.039W/mK

(b)

The stepped damp proof course (cavity tray) at the head of the window prevents the ingress of wind- driven rain.

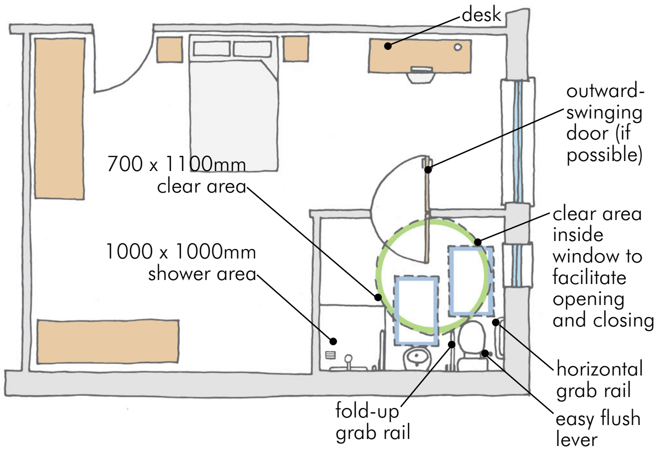
The precast concrete sill is wrapped in damp proof course to prevent the ingress of moisture. Once installed, the window frame is sealed to the structure at its perimeter using a flexible sealant.

Question 8

(a)

This bedroom is very large (35m²); it would be an ideal room for a person of limited mobility in the future.

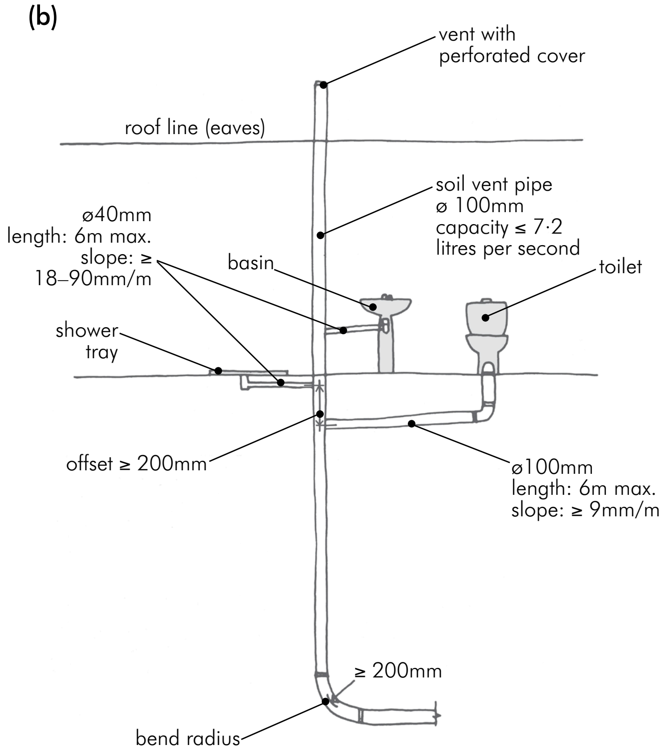
For this reason the bathroom has been designed in accordance with the guidelines from the Centre for Excellence in Universal Design.



The bathroom is located in the corner of the bedroom where it has two external walls. This gives more options for window location and efficient installation of water supply and drainage pipework.

The bed and desk have been repositioned to ensure optimal use of the space.

(b)



(c)

Economical use of water:

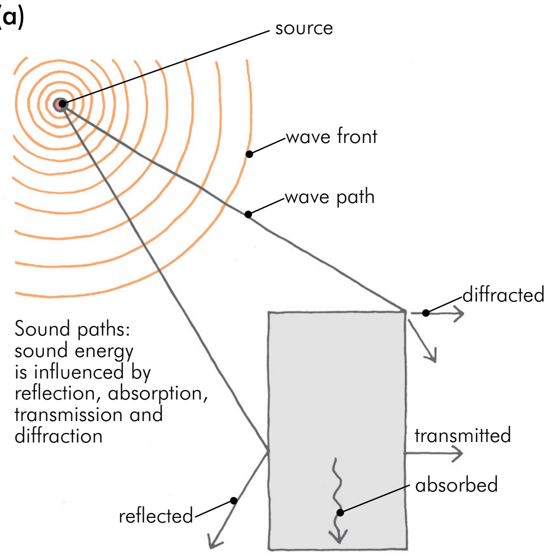
A typical family uses approximately 70% of their water in the bathroom. Changing water use habits and installing more efficient appliances will reduce water consumption in the bathroom.

- toilet:
  - installing a dual flush toilet will reduce water consumption by approximately half over the course of a year
  - a standard toilet flush uses 6 litres of water; a dual flush toilet uses 2.6 litres (low flush) and 4 litres (full flush).

- shower:
  - installing an 'eco' shower will reduce water use by approximately half (compared to a mixer shower)
  - reducing the time spent in the shower will also reduce the amount of water consumed.

Question 9

(a)

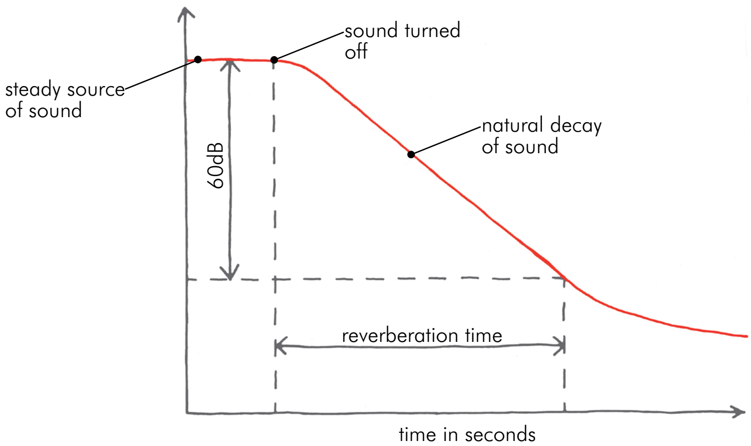


Sound reflection:

Sound is a form of wave energy. When a sound wave is transmitted from a point source the waves travel outwards in all directions. When a sound wave hits a hard surface the sound is reflected by that surface.

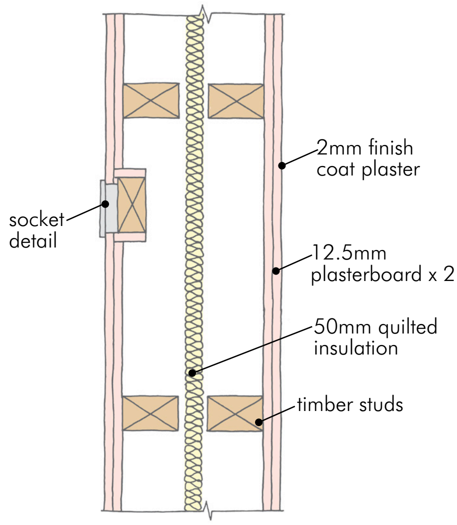
Reverberation time:

The angle of reflection is equal to the angle of incidence. Sound and light are similar in this sense.



Reverberation is the term used to describe the continuation and enhancement of a sound caused by rapid multiple reflections between the surfaces of a room. The reverberation time is the time taken for a sound to decay by 60dB from its original level. The reverberation time depends on the floor area of the room, the sound absorption of the surfaces of the walls, floor and ceiling and the frequency of the sound.

(b)

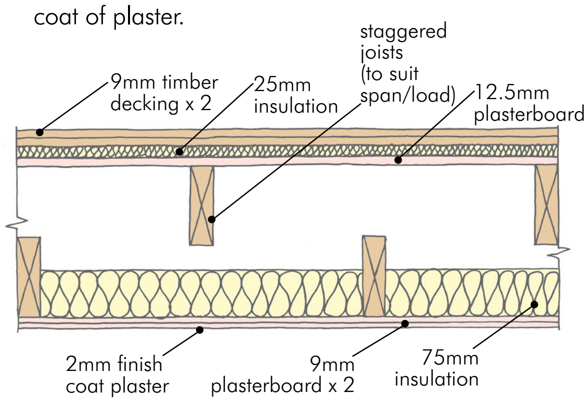


Internal wall (stud partition):

- plasterboard is removed from one face of the existing partition
- the partition is lined with 50mm quilted insulation (e.g.mineral wool, sheep's wool, hemp etc.)
- a second stud frame is built with a 50mm gap between the frames
- an additional layer of 12.5mm gypsum plasterboard is added to the original face and plastered with a 2mm finish coat of plaster
- two layers of 12.5mm gypsum plasterboard are fixed to the new frame (staggered joints) and plastered with a 2mm finish coat of plaster.

Floor:

- the existing floor is reconstructed as shown in the sketch
- the floor and ceiling below are supported by separate joists
- the floor consists of two layers of 9mm timber decking supported on a 25mm absorbent quilt of insulation on a 12.5mm layer of plasterboard
- the ceiling is made up of two layers of 9mm gypsum plasterboard, plastered with a 2mm finish coat of plaster.



(c)

There are four principles of sound insulation:

1 Heaviness:
- heavyweight structures (e.g. concrete) with high mass transmit less sound energy than lightweight structures
- the plasterboard in the wall and floor above add weight to the structure.

2 Completeness:
- airtightness – airborne sound will travel through any gaps in the structure
- uniformity – sound will take the 'path of least resistance'. A small poorly insulated area can significantly reduce the performance of the whole structure, e.g. when a window is slightly ajar the sound insulation of the whole wall drops dramatically
- the plaster finish coat on the plasterboard provides completeness to the structure
- the perimeter of the wall and the floor could also be sealed to the adjoining structures using airtightness tape to further improve the completeness of the structure.

3 Flexibility:
- flexible materials (e.g. mineral fibre insulation) absorb sound energy
- the quilted insulation used in the wall and floor provide flexibility.

4 Isolation:
- discontinuous construction is effective in reducing sound transmission
- sound energy is lost when it travels from one medium to another (e.g. plasterboard to air)
- the staggered studs and joists provide isolation on the wall and floor.

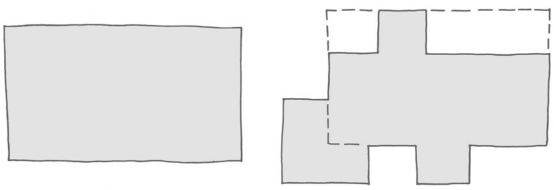
Question 10

(a)

Building form:

A passive house must 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 the surface area, the greater the heat loss.

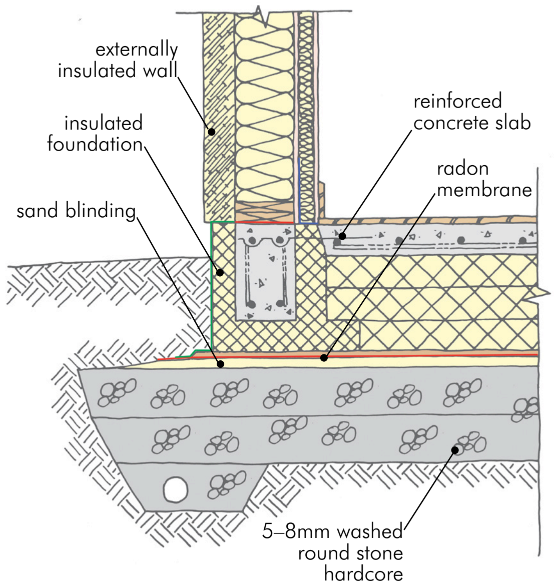
Compactness describes the relationship between the surface area of the home and its volume. In passive house design, the goal is to achieve a ratio of 0.7 or less; in other words to have a large volume enclosed by the smallest possible area.



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

Higher-density housing like terraced houses and apartments provide much better compactness ratios than individual houses because they have fewer surfaces exposed to the outdoors.

Foundation design:



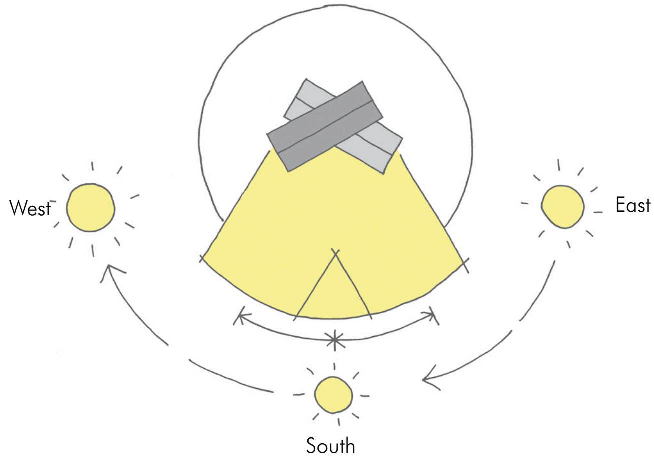
An insulated foundation is necessary to avoid thermal bridging down through the loadbearing walls.

Insulated foundations prevent this by 'wrapping' the substructure in insulation. High-density loadbearing polystyrene (EPS 300) is used.

A number of proprietary systems are available in Ireland. Each of these systems ensures that there is no thermal bridging between the ground and the substructure.

(b)

Orientation:



The glazed façade of the passive house shown in the sketch should be oriented within 30° of south. This will maximise solar gain as the sun moves across the sky. This is especially important in the cold winter months when the sun angle is low and the daylight hours are reduced.

(c)

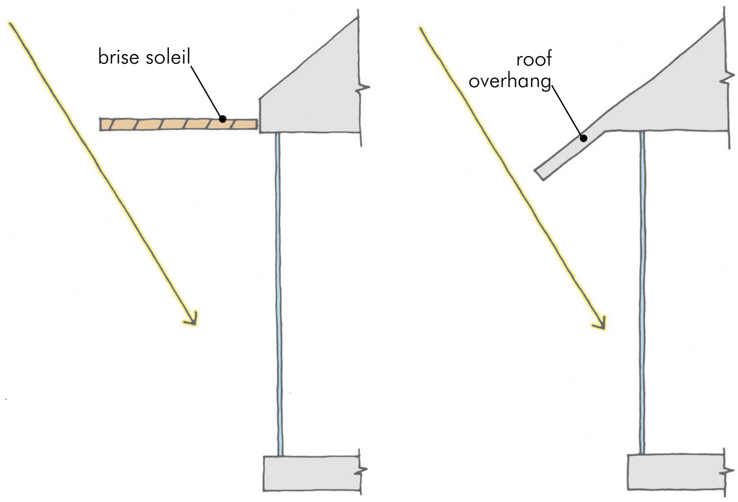
Overheating:

Overheating is defined in the Passivhaus standard as an indoor air temperature of 25°C or higher. The Passivhaus standard requires that overheating must be limited to less than 10% of the year.

Two reasons why a passive house may overheat:

1 failure of the mechanical ventilation system – a mechanical fault or loss of power to the mechanical ventilation system would mean that the air is not being renewed. This would lead to an increase in indoor air temperature
2 excessive occupancy – if a very large number of people were to occupy the home for an extended period of time and the mechanical ventilation system was not switched to boost mode this would cause overheating.

Two design details to prevent overheating:



- brise soleil:
  - a brise soleil could be installed above the glazing
  - this would reduce the solar gain during the warm summer months when the sun angle is high.
- roof overhang:
  - the roof plane could be extended to create an overhang
  - this would also reduce the solar gain during the warm summer months when the sun angle is high.

Question 10

(Alternative)

In this excerpt the President of the RIAI is making the following points:

'The world is under stress and we are the cause of it.'

I think this is a reference to the strain being placed on our natural resources by rapid global population growth and to anthropogenic carbon dioxide increase and climate change.

The world's population has grown from two billion people in the late 1920s to over 7.25 billion this year. Each of these people needs a home, energy, food and water. This rapid increase in resource consumption is depleting the planet's natural resources.

Ninety-five percent of the world's energy requirements are met using carbon-based fuels (i.e. oil, gas, coal). This is causing significant carbon dioxide emissions. The level of carbon in the atmosphere rose above 400ppm in 2013 – the first time since records began.

This anthropogenic carbon dioxide increase is causing global warming. Ten of the hottest years on record have occurred since the year 2000.

'The most resilient and sustainable form of human habitation is the town or the neighbourhood. We must build to create neighbourhoods.'

Here the President of the RIAI is stating that in Ireland in particular we must move away from the tradition of building one-off houses in rural settings. One in three homes in Ireland is a one-off house in the countryside. This is not a sustainable way to build.

Only when homes are built in proximity to each other is it possible to provide the resources required in a sustainable way. A community requires a critical mass of people to make them work. Schools, shops, clubs, bus routes and other everyday facilities cannot be sustained without enough people to use them and make them socially and economically viable. Any model that depends on large numbers of people using their car to access everyday activities is not sustainable.

In future, the focus must be on providing homes that are in sufficient proximity for communities to develop and grow. This will require designing and building homes in higher density (units per hectare) and providing these homes with a high level of local resources. When people who live near each other share resources (e.g. neighbourhood parks, schools, clubs), relationships are built and communities flourish.

'We must plan and design to avoid isolation and disconnection.'

To me, this is a reference to the principles of inclusivity and connection.

Inclusivity is an important concept that relates to the ability of all people to use the neighbourhood on equal terms. This is about more than providing wheelchair access – it's about meeting the needs of all people regardless of ability. To achieve this the neighbourhood should have a mix of home types (e.g. houses, apartments), a layout that is easy to access and a range of public spaces that are accessible and open to everyone.

Three planning guidelines that would promote the development of resilient and sustainable neighbourhoods are:

1 variety – every neighbourhood should include a mixture of building types, including residential, retail, commercial and recreational. This will facilitate a variety of activities and lead to an active community life. Active communities are more resilient because people have positive relationships with their neighbours and are more likely to help each other out and work together on community projects. A mix of building types will also allow some people to work and live in the same area, avoiding the need for commuting long distances by car.

2 public realm – neighbourhoods should have public spaces (e.g. parks) that are safe, secure and enjoyable to use. A well-designed public space will be constantly used by the local people. Good-quality public spaces make a neighbourhood an attractive place to live. Attracting people to an area leads to growth and ensures that schools, shops and other facilities remain open.

3 adaptability – homes should be designed so that they can be adapted to meet the needs of the occupants as they get older. This is a very important feature of home design that ensures that people can continue to live in their homes even if they become less mobile or the family gets bigger. An example of this is would be ensuring that there is access to the rear of homes so that an extension can be easily built on without the need for heavy machinery (e.g. cranes).