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Pre-Leaving Certificate Examination, 2012

Construction Studies – Part 1 (Theory)

Marking Scheme

ExamCentre,
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Fonthill Business Park,
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Dublin 22.

Tel: (01) 616 62 62
Fax: (01) 616 62 63
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Pre-Leaving Certificate Examination, 2012

Construction Studies – Part 1 (Theory)

Ordinary Level
Marking Scheme (200 marks)

Answer Question 1 and **three** other questions. **All Questions 50 Marks**

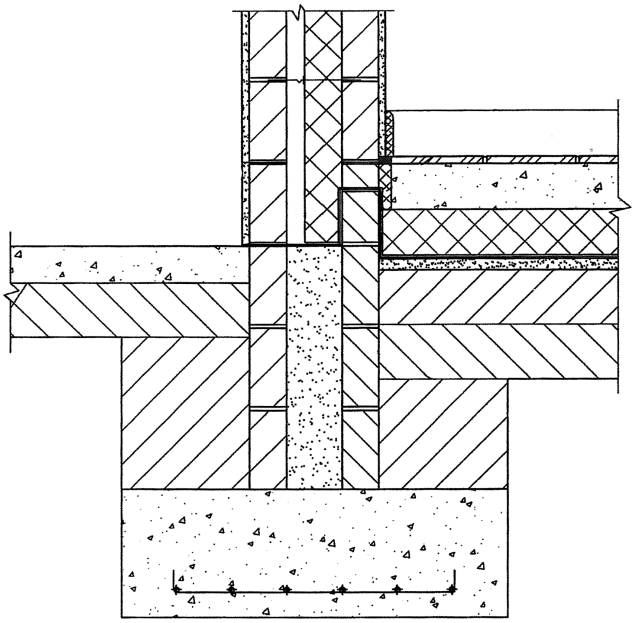
1. An extension has been added to the rear of an existing dwelling to provide more living space, as shown in the sketch. The external wall is constructed using a 350 mm insulated cavity wall and is plastered on both sides. The foundation is a traditional strip foundation. The extension has a solid concrete ground floor with a timber finish. (50)

(a) To a scale of 1:5 draw a vertical section through the external wall and ground floor. The section should show all the construction details from the bottom of the foundations to 400 mm above the finished floor level.

<u>Construction details</u>

Any 8: **(8 × 4m)**

- external plaster, 19 mm //
- concrete block outer leaf, 100 mm //
- cavity air space, 50 mm //
- thermal insulation, 100 mm //
- wall ties //
- inner leaf, 100 mm //
- internal plaster, 13 mm //
- D.P.C. in cavity wall //
- reinforced concrete foundation //
- cavity fill //
- hardcore and sand binding //
- D.P.M. / radon barrier //
- floor insulation, 150 mm //
- concrete floor, 150 mm //
- tongue and groove flooring (floating on battens) //
- floor seal //
- skirting board, 120 × 120 mm //
- concrete footpath, 100 mm // *etc.*

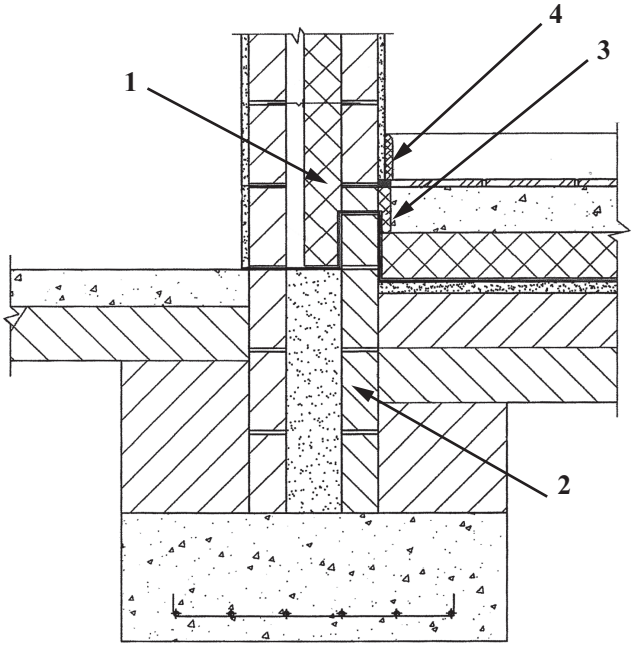


Any 4 typical dimensions **(4 × 1m)**
Scale **(4m)**, Draughtsmanship **(4m)**

** Any alternative detailing which complies with current building regulations is acceptable.

(b) Show clearly on your drawing **one** design detail which will prevent a thermal / cold bridge at the junction of the concrete floor and the external wall. **(6m)**

1. – overlap between cavity insulation and floor insulation
2. – inner leaf built with thermal blocks from foundation to floor level
3. – perimeter insulation at floor level
4. – flexible seal between wall and floor



2. The owner of a dwelling house built over 30 years ago, as shown in the sketch, has decided to improve the thermal properties of the house. (50)

(a) Discuss in detail **three** advantages of improving the thermal properties of this dwelling.

Any 3: **(3 × 6m)**

– helps to reduce heat loss in a building //
– saves money on heating costs //
– higher U-value for the dwelling //
– improves comfort levels in building //
– helps to reduce danger of condensation on surfaces //
– eliminates cold bridge effect at windows and doors //
– insulation on pipes helps prevent pipes bursting due to freezing // *etc.*

** Accept any other appropriate answer(s).

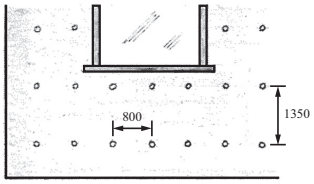
(b) Using notes and neat freehand sketches, show how thermal insulation could be fitted in an old dwelling, at the following locations:

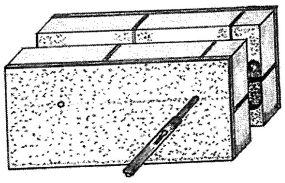
- an un-insulated cavity wall **(16m)**

Notes (8m), Sketch (8m)

– this operation is carried out by specialist companies registered with SEAI and specialising in insulation of houses
– holes of 22 mm diameter are drilled through the external leaf
– these holes are spaced at 800 mm horizontally and at 1350 mm vertically
– extra holes are drilled beneath window cills and above window and door heads, to ensure proper filling of the cavity
– the insulation in the form of polystyrene bead is then pumped into the cavity
– as the pumping takes place, a light coating of strong glue is applied to the beads
– when the glue sets, the beads will form a solid structure
– when the pumping is complete, the holes are filled and blended in with the external finish

** Accept any other appropriate material.
** Any appropriate sketch.



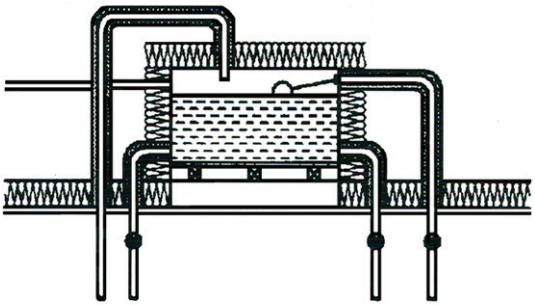


- a cold water storage tank in an attic. **(16m)**

Notes (8m), Sketch (8m)

– the top and sides of the tank are covered with insulation
– insulation is not placed under the tank
– rigid insulation is usually used, *e.g.* polystyrene board 65 mm – 100 mm
– fibre glass may also be used
– insulation is fitted between the attic joists, 150 mm
– insulation is placed at right angles and on top of the joists, 200 mm – 300 mm
– all pipes are insulated in pipe section form

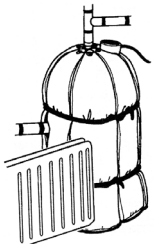
** Accept any other appropriate material.
** Any appropriate sketch.



3. The sketch shows a hot water storage cylinder and a radiator for a hot water system in a dwelling house. (50)

(a) Using a single-line labelled diagram, show the pipework required for the indirect hot water system.
Include the following in your diagram:

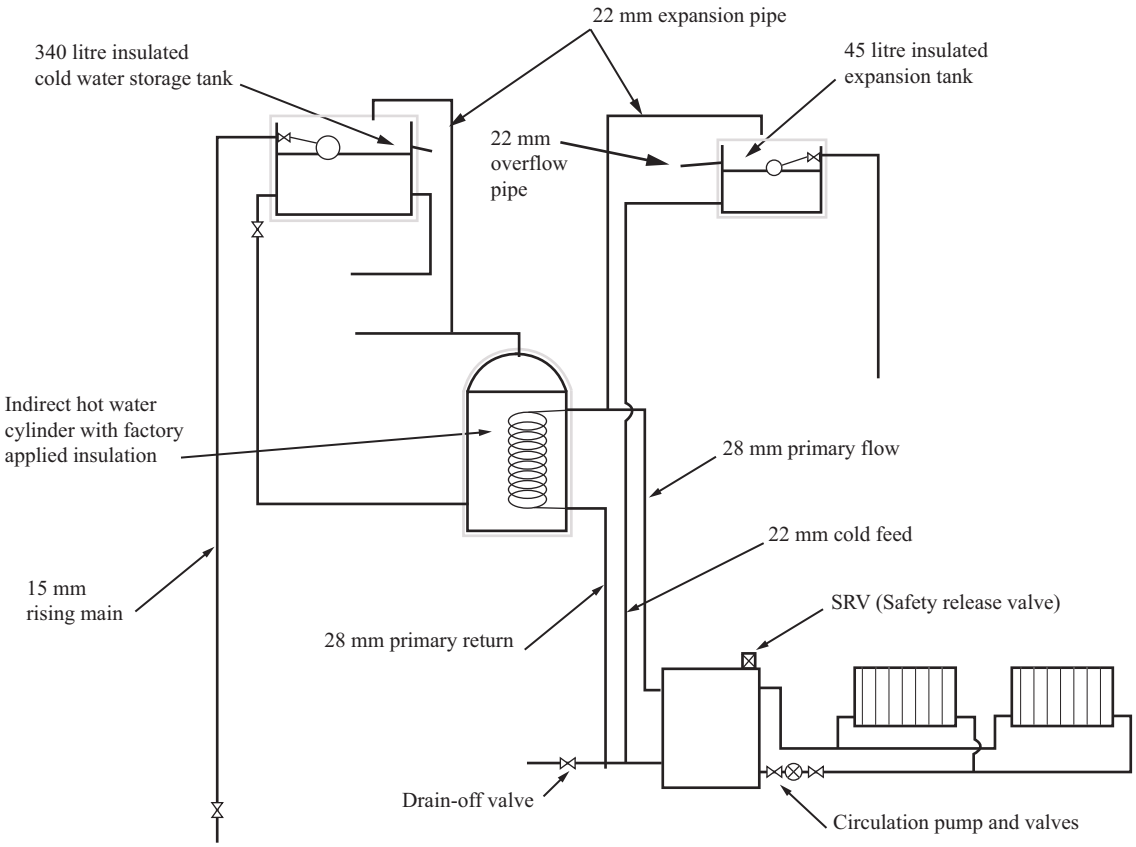
- rising main and cold water storage tank
- hot water cylinder
- boiler
- pipework for hot water
- two radiators
- all necessary valves.



Any 8: **(8 × 4m)**

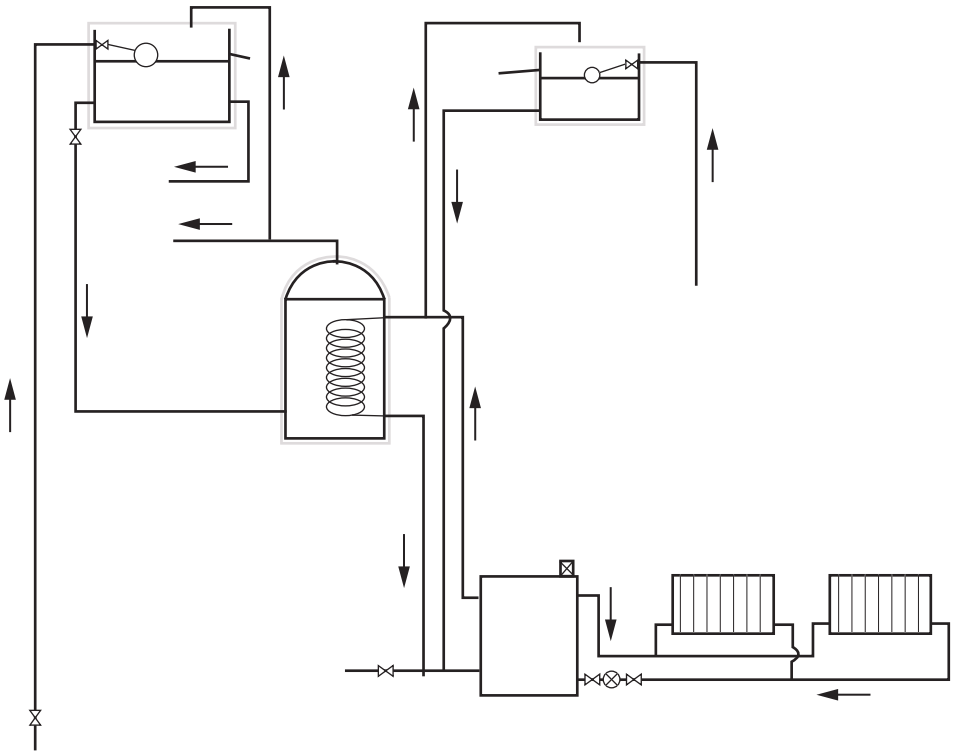
– cylinder and coil //
– boiler with safety valve //
– cold water storage tank //
– expansion pipe cylinder to storage tank //
– rising main //
– expansion tank with mains / overflow //
– hot water flow to bathroom / kitchen //
– primary flow from boiler to cylinder //
– primary return from cylinder to boiler //
– drain valve //
– circulation pump //
– flow pipe to radiators //
– return pipe from radiators //
– insulation on pipes and cylinder *etc*. //
– pipe sizes // *etc.*

Quality of sketch **(8m)**

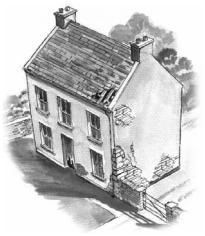


(b) Indicate clearly on your drawing, using arrows, the direction of flow of water in the system.

Any 5 arrows: **(5 × 2m)**



4. An old home pictured opposite is over one hundred years old. Although functional for its time, it now has a problem with dampness throughout the building. (50)



(a) Describe **three** locations where dampness may have penetrated this old building.

Any 3: **(3 × 8m)**

– floors //
  – rising damp can be a problem if a damp proof membrane was not laid. Water particles rise through capillary action, and damp spots can occur throughout the floor of the dwelling // *etc*.

– walls //
  – rising damp can affect walls if solid block / stone walls have been used with no cavity. These may eventually transmit damp from the external surface to the internal surface // *etc*.

– windows and doors //
  – window cills are an exposed part of a building where dampness often penetrates if no DPC has been incorporated into the design at the time of construction. The door threshold is also very vulnerable to the entry of water // *etc*.

– roof // *etc*.
  – broken tiles / slates may allow dampness to penetrate into the building. Old buildings may have no roofing felt. Poor detailing around chimney stack and blocked gutters and downpipes can lead to damp penetration in these areas // *etc*.

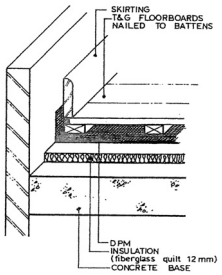
** Accept any relevant location and description.

(b) Describe, using notes and neat freehand sketches, how any **two** of these problems could be solved.

Any 2: **(2 × 13m)**
Notes (5m), Sketch (8m)

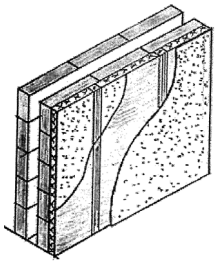
– floors //
  – the floor should be covered with an integrated layer of damp proof membrane and a raised suspended floor built above this // *etc*.

** Accept any other appropriate material.



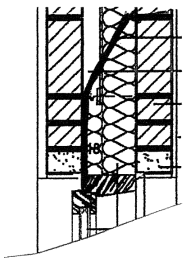
– walls //
  – the internal walls could be dry-lined. Battens are attached to the walls, and hardwall plasterboard with an integrated vapour barrier is attached // *etc*.

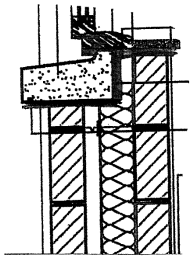
  ** Accept any other appropriate material.



– windows and doors //
  – effective window cills could be added. These must project out from the wall, contain a continuous drip and be wrapped in DPC. A new door threshold should be properly fitted and sealed. A weatherboard will help to prevent the entry of water // *etc*.

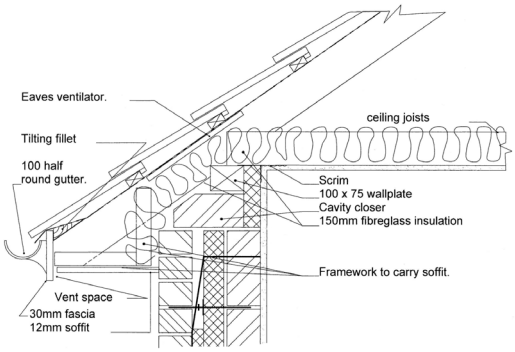
  ** Accept any other appropriate material.

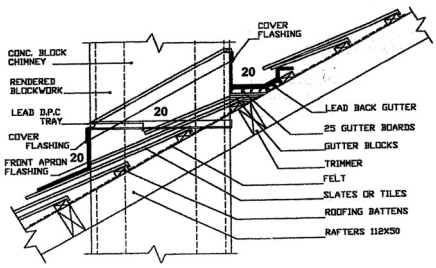




– roof // *etc*.
  – the roof structure should be recovered, felt included and all broken slates replaced. All gutters / downpipes should be cleared of any materials blocking them. DPC and lead flashings around the chimney stack should be repaired // *etc*.

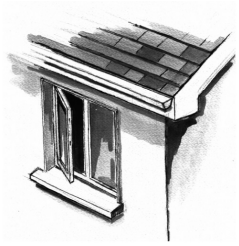
  ** Accept any other appropriate material.





5. A new double glazed window, as shown in the sketch, is fixed in the external wall of a new building. The external wall is a 350 mm cavity wall. The wall is plastered on both sides. (50)

(a) To a scale of 1:5 draw a vertical section through the cill detail of the window. Show clearly all the construction details from 300 mm below to 200 mm above the concrete cill.

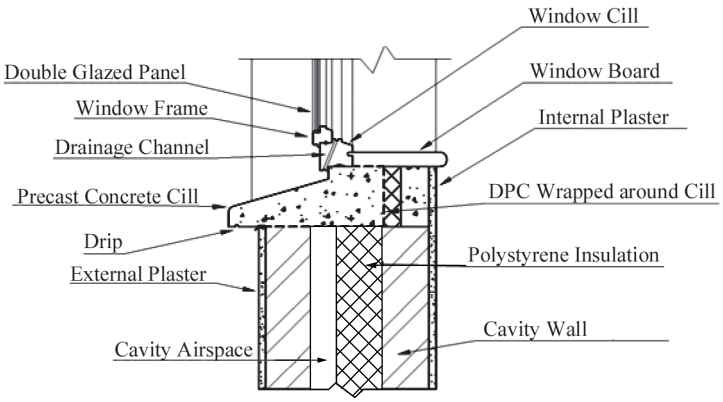


Construction details

Any 10: **(10 × 3m)**

– external plaster, 19 mm //
– outer leaf, 100 mm //
– cavity air space, 50 mm //
– insulation, 100 mm //
– inner leaf, 100 mm //
– internal plaster, 13 mm //
– D.P.C. wrapped around cill //
– precast concrete cill //
– throating //
– concrete backfill //
– window cill //
– double glazing //
– window board //
– cavity closed with proprietary cavity barrier //
– insulation at back cill (to prevent cold bridge) // *etc*.

Scale **(5m)**, Draughtsmanship **(5m)**



(b) On the drawing indicate clearly one design detail that would prevent the cold bridge effect at the window.

Any 1: **(10m)**

– DPC wrapped around cill //
– insulation in position to prevent cold bridge // *etc*.

** Accept any other appropriate answer(s).

6. **(a)** List **two** specific safety precautions to be observed in **each** of the following situations and give **one** reason for each safety precaution listed: (50)

- cutting a pre-stressed concrete lintel

Safety precautions **(2 × 4m)**
Reasons **(2 × 2m)**

Any 2:
– place the lintel on solid supports, beneath the worker //
– carefully support the point on the lintel where cutting is carried out //
– use a good quality angle grinder with the correct disk fitted //
– enlist the help of another person //
– cut carefully and concentrate on the task in hand //
– use a mask, correct footwear and hard hat //
– always wear a high visibility jacket on site // *etc*.

** Reason must be appropriate to safety precaution given.
** Accept any other appropriate answer(s).

- using a veneer knife to cut veneers in the classroom

Safety precautions **(2 × 4m)**
Reasons **(2 × 2m)**

Any 2:
– use a good quality sharp knife //
– use a cutting mat //
– use a straight edge to guide the knife //
– run the knife lightly over the veneer //
– keep firm pressure on the straight edge while cutting //
– cut carefully and concentrate on the task in hand //
– watch for slippage of the knife // *etc*.

** Reason must be appropriate to safety precaution given.
** Accept any other appropriate answer(s).

- using a ladder when painting an external wall.

Safety precautions **(2 × 4m)**
Reasons **(2 × 2m)**

Any 2:
– make sure you use the correct ladder for the job //
– check that the ladder is in good working condition //
– the ground should be firm and stable //
– the angle of the ladder should be 75 degrees //
– check for overhead cables // *etc*.

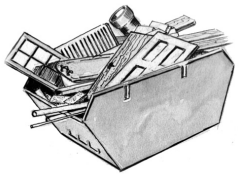
** Reason must be appropriate to safety precaution given.
** Accept any other appropriate answer(s).

(b) Show, using neat freehand sketches, **two** safety signs that should be displayed at the entrance to a construction site and explain the purpose of each safety sign.

Sketches **(2 × 4m)**
Purpose **(2 × 3m)**

** Any 2 suitable sketches.

7. Incorrect disposal of building materials can have a harmful impact on the environment. The sketch shows a skip filled with building materials, from a house that has been renovated. The skip is to be emptied at a landfill site.



(50)

(a) Name **two** building materials which are often disposed of at landfill sites. For **each** material outline **two** environmental hazards associated with their waste disposal at landfill sites.

Building Materials **(2 × 3m)**
Environmental Hazards **(2 × 10m)**

Any 2:

– wood //
  Any 2: (2 × 5m)
  - items such as wooden doors and windows rot very slowly //
  - the timber could contain residue of paints or preservative //
  - can lead to disease of plants and animals //
  - can lead to pollution of surrounding areas // *etc*.

– metal //
  Any 2: (2 × 5m)
  - will rust //
  - this could contaminate the water supply //
  - can affect marine life in the area if it gets into streams / rivers // *etc*.

– plastic //
  Any 2: (2 × 5m)
  - plastic materials will not biodegrade //
  - not a natural material and needs to be properly disposed //
  - take up space in landfill sites // *etc*.

– asbestos // *etc*.
  Any 2: (2 × 5m)
  - a toxic substance that should be removed by specialised companies //
  - can be a health hazard if dust particles are inhaled // *etc*.

(b) Outline **two** methods of managing the disposal of building waste in a more environmentally friendly way.

Any 2: **(2 × 7m)**

– a site management policy of Reduce, Re-use and Recycle should be put in place //
– special bins to be placed on a site and labelled to segregate different materials //
– other waste materials to be sent to waste management sites //
– blockwork and concrete may be ground down and used for driveways and road construction //
– all waste should be separated as the building is being renovated //
– wood, metal and plastic should be recycled //
– old slates and tiles may be reused //
– windows and doors in good condition may be reused //
– bricks may be reused // *etc*.

** Accept any other appropriate answer(s).

(c) Give **two** examples where wood can be reused on a construction site.

Any 2: **(2 × 5m)**

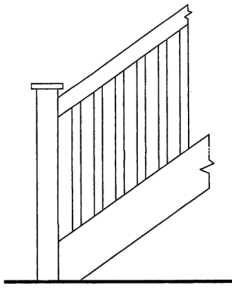
– can be used in formwork construction //
– good quality flooring boards can be planed and reused //
– good quality doors/windows can be easily restored and be refitted in the project //*etc*.

** Accept any other appropriate answer(s).

8. Explain, with the aid of notes and neat freehand sketches, any **five** of the following: (50)

Any 5: **(5 × 10m)**

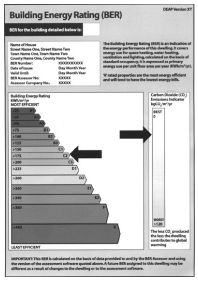
- newel post



Note (5m), Sketch (5m)
– post at the end of a flight of stairs //
– it supports the handrail and string //
– normally made from timber //
– may be decorative in appearance //
– normally 100 mm × 100 mm in section // *etc*.

** Accept any other appropriate answer(s).

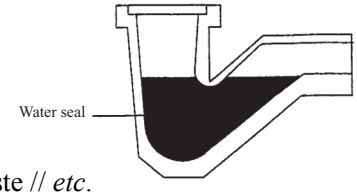
- energy rating



Note (5m), Sketch (5m)
– this tells the energy performance of the building //
– referred as the BER of a dwelling (Building Energy Rating) //
– takes into account CO_2 emissions with energy use //
– runs from a scale of A to G //
– A is most efficient, G is least //
– a BER certificate has to be provided for all houses being sold // *etc*.

** Accept any other appropriate answer(s).

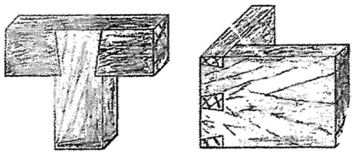
- gully trap



Note (5m), Sketch (5m)
– all waste outlets discharge into a gully trap //
– contains water seal to prevent foul smells coming back into the building //
– also prevents vermin entring the building //
– fitted to the head of a drain that takes rainwater or waste // *etc*.

** Accept any other appropriate answer(s).

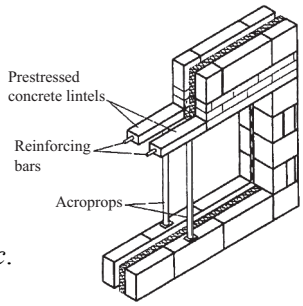
- dovetail joint



Note (5m), Sketch (5m)
– widely used joint in woodwork //
– very strong joint and attractive //
– used in drawer construction //
– two parts called the tail and the pins //
– slope 1:6 for hardwoods //
– slope 1:8 for softwood // *etc*.

** Accept any other appropriate answer(s).

- pre-stressed concrete lintel



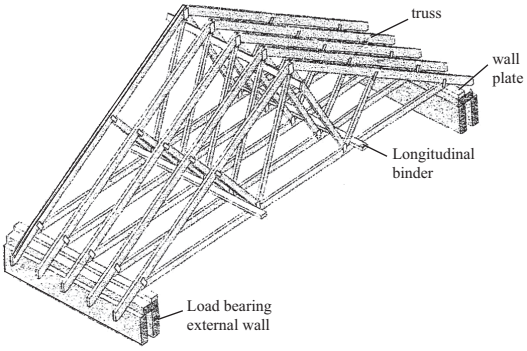
Note (5m), Sketch (5m)
– used to span window and door openings //
– provides support for brick / blockwork //
– available in various sizes //
– can be ready made to any sizes //
– speeds up the construction work //
– reinforcement bars are stretched during manufacture // *etc*.

** Accept any other appropriate answer(s).

- truss rafter

  Note (5m), Sketch (5m)
  – assembled in workshop //
  – smaller sections of timber than in cut-roof construction //
  – lifted into position on site by crane //
  – very quick assemble time //
  – difficult to convert attic space // *etc*.

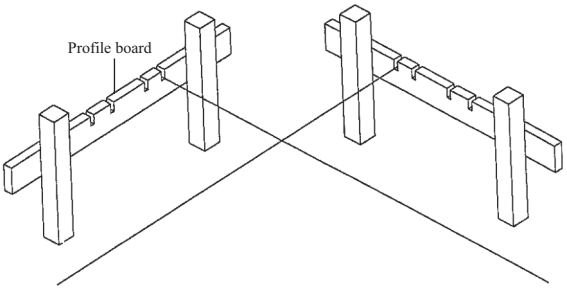
  ** Accept any other appropriate answer(s



- profiles boards

  Note (5m), Sketch (5m)
  – profile consists of a timber horizontal rail fixed to two vertical posts that are fitted into the ground //
  – used to mark the position and the width of the foundation trenches //
  – they also show the width of the walls //
  – profiles are set up clear of the trenches so as not to obstruct excavation work //
  – placed at all corners and at the end of cross walls // *etc*.

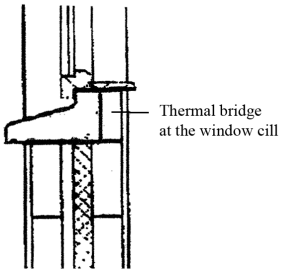
  ** Accept any other appropriate answer(s).



- thermal bridge

  Note (5m), Sketch (5m)
  – area in building where heat flow is higher than other areas //
  – occurs at openings in external walls when cavity is bridged with materials of poor insulation properties //
  – leads to increased energy costs due to heat loss in building //
  – leads to condensation on the internal surfaces of walls //
  – insulation should be continuous, as break will allow high loss in building // *etc*.

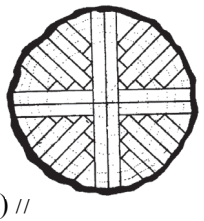
  ** Accept any other appropriate answer(s).



- quarter sawing

  Note (5m), Sketch (5m)
  – method to convert logs into useable timber //
  – also called radial sawing //
  – produces good quality boards //
  – expensive method of conversion //
  – produces attractive grain pattern in hardwoods (silver grain in oak) //
  – produces narrow boards // *etc*.

  ** Accept any other appropriate answer(s).



9. The sketch shows a new timber window fitted in a newly constructed dwelling house. (50)

(a) Suggest a suitable timber for the window and give **two** reasons for your choice.

Wood **(2m)**
Reasons **(2 × 4m)**

Any 1:

– red deal //

Any 2:
- easy to work, plane and cut //
- provides good finish when painted or varnished //
- reasonably priced //
- strong and stable //
- easily available // *etc*.

– teak //

Any 2:
- resistant to moisture and insect attack //
- very stable timber //
- provides a good surface for painting or varnishing //
- it glues and works well //
- hardwood material // *etc*.

– oak //

Any 2:
- very resistant to decay //
- very strong and heavy timber //
- provides a good surface for painting or varnishing //
- it glues and works well //
- hardwood material // *etc*.

– ash //

Any 2:
- resistant to moisture and insect attack //
- very stable timber //
- provides a good surface for painting or varnishing //
- it glues and works well //
- hardwood material // *etc*.

– mahogany // *etc*.

Any 2:
- resistant to moisture and insect attack //
- very stable timber //
- provides a good surface for painting or varnishing //
- it glues and works well //
- hardwood material // *etc*.

** Reasons given must be appropriate for chosen wood.

(b) Describe, using notes and neat freehand sketches, the steps involved in preparing and painting the new timber window with a gloss paint.

Any 7: **(7 × 4m)**

– if painting is done outside, make sure weather conditions are correct, dry calm day //
– ensure that the wood has a moisture content of less than 18% //
– make sure the surface of the wood is clean, dry and free from dust and dirt //
– a preservative should be applied to protect the wood //
– timber should be sanded to provide a smooth surface for paint //
– all dust should be removed using a clean cloth and white spirits //
– any knots in the timber should be treated with knotting solution //
– this prevents resin from seeping through the paint //
– fill any cracks or holes with a suitable wood-filler; allow to set, then sand smooth //
– apply a coat of primer and allow to dry //
– apply undercoat, more than one coat may be required, lightly sand between coats //
– apply a coat of gloss paint using a good quality clean paintbrush // *etc*.

** Accept any other appropriate answer(s).

(c) List and explain **two** health precautions that should be observed when preparing and painting the new timber window.

Any 2: **(2 × 6m)**

– work in a well ventilated area //
– have dust extraction on sanders //
– wear protective clothing and dust masks //
– avoid paint coming into contact with skin //
– if applying paint by spraying, always work in proper ventilated spraying booth // *etc*.

** Accept any other appropriate answer(s).

Pre-Leaving Certificate Examination, 2012

Construction Studies – Part 1 (Theory)

Higher Level
Marking Scheme (300 marks)

Answer Question 1 and **four** other questions. **All Questions 60 Marks**

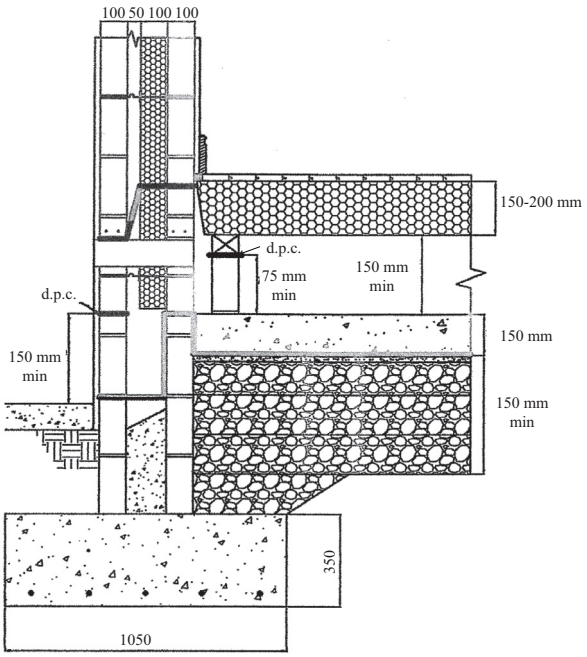
1. A new extension has been added to an existing dwelling as shown in the accompanying sketch. The external wall is a 350 mm concrete block wall with a 150 mm cavity. The cavity is fitted with rigid insulation board. The suspended timber floor is insulated and has a 25 mm tongued and grooved hardwood finish. (60)

(a) To a scale of 1:5, draw a vertical section through the external wall and suspended timber floor. Show all construction details from the bottom of the foundation to 400 mm above the finished floor level. Include **four** typical dimensions on your drawing.

<u>Vertical through external wall</u>

Any 11: **(11 × 4m)**
Drawing (3m), Notation (1m)

- reinforced concrete strip foundation //
- correct depth of foundation //
- cavity wall detail //
- cavity fill //
- insulation in cavity, 100 mm //
- air space, 50 mm //
- external / internal plaster //
- wall ties //
- air vent in wall //
- lintels over vent //
- DPC over vent //
- 25 mm tongue and groove flooring //
- skirting board //
- flexible sealant / tape //
- floor joist //
- 150 mm – 200 mm floor insulation //
- wallplate, 100 mm × 75 mm //
- tassel wall and DPC //
- 100 mm – 150 mm concrete subfloor //
- radon barrier //
- hardcore, 150 mm // *etc*.



Any 4 typical dimensions **(4 × 1m)**
Scale **(4m)**, Draughtsmanship **(4m)**

(b) Show clearly on the drawing how you would prevent radon gas from entering the building. **(4m)**

- radon barrier marked correctly on drawing

2. The owner of a house built in the 1970s has decided to upgrade the thermal properties of the external walls in their dwelling. The existing walls were constructed using 300 mm cavity wall construction with 40 mm expanded polystyrene insulation in the cavity. (60)

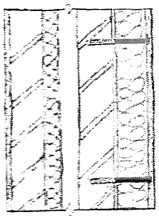
(a) Using notes and freehand sketches, outline **each** of the following methods that might be used to upgrade the thermal performance of the dwelling: **(3 × 15m)**

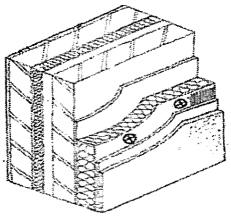
- an external insulation system
  Notes (7m), Sketch (8m)

  Any 1:

  Walls
  – the wall should be cleaned and brushed
  – all downpipes should be removed
  – apply a base coat of adhesive over the existing external plaster / rendering
  – rigid phenolic foam 80 mm – 300 mm is bonded to external wall
  – PVC / stainless steel anchor bolts are used to fix insulation to the wall
  – fibreglass mesh is laid on insulation boards
  – two coats of polymer or acrylic specialist renders are applied
  – specialist angle bead is fitted at the external corners and plinth
  – mastic type sealants are used at doors, windows and soffits

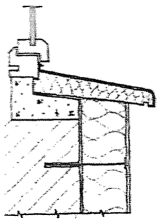
  ** Accept any other appropriate material.





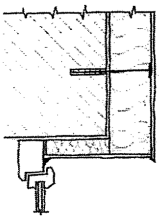
  Window cill
  – the existing cill may be cut flush with existing wall
  – a pre-formed phenolic foam/stainless steel window cill is fitted over existing cill
  – a base coat of adhesive is used
  – a pre-formed aluminium or PVC cladding window cill is fitted on top
  – sealant is applied to all junctions between the cill and wall

  ** Accept any other appropriate material.

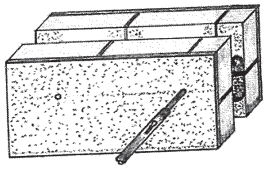


  Window/door head
  – high density rigid phenolic foam is fitted to the head and reveals using proprietary adhesive
  – apply two coats of acrylic external renders
  – apply proprietary angle bead to all external corners
  – use mastic sealants at all junctions

  ** Accept any other appropriate material.

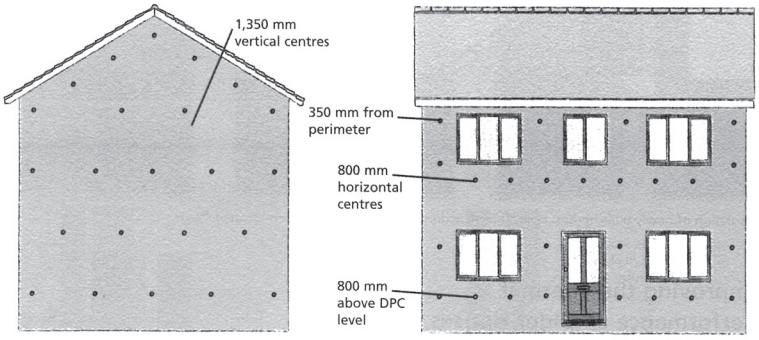


- an injection insulation system
  Notes (7m), Sketch (8m)



  - this operation is carried out by specialist companies registered with SEAI and specialising in insulation of houses
  - holes of 22 mm diameter are drilled through the external leaf
  - these holes are spaced at 800 mm horizontally and at 1350 mm vertically
  - extra holes are drilled beneath window cills and above window and door heads, to ensure proper filling of the cavity
  - the insulation in the form of polystyrene bead is then pumped into the cavity
  - as the pumping takes place, a light coating of strong glue is applied to the beads
  - when the glue sets, the beads will form a solid structure
  - the holes are then filled and blended in with the external finish

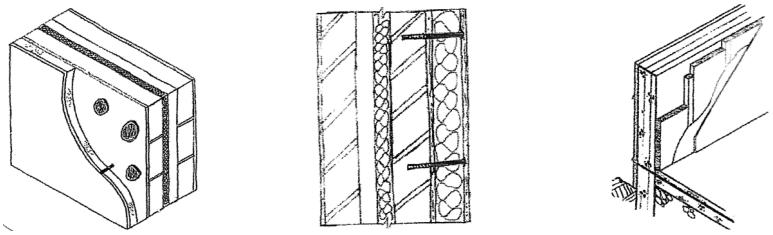
  ** Accept any other appropriate material.



Improving the thermal performance of older houses: typical drilling pattern for injecting insulation into a cavity wall.

- an internal insulation system.
  Notes (7m), Sketch (8m)
  - plasterboard incorporating vapour barrier, insulation and foil back stuck to wall using adhesive pads
  - rigid phenolic foam insulation with 12.5 mm plasterboard secured to wall
  - skim coat applied to plasterboard
  - treated battens attached to wall
  - thermal insulation fixed between battens
  - vapour barrier fitted
  - foil-backed plasterboard secured to battens (screwed/nailed)
  - skim plaster coat applied
  - need to remove radiators / electrical sockets

  ** Accept any other appropriate material.



(b) Outline **two** advantages of each system of insulation and recommend a preferred system to be used.

Advantages **(3 × 4m)**
Preferred System **(3m)**

- an external insulation system

  Any 2: (2 × 2m)
  – increases the U-value of wall to current building regulations //
  – upgrades the appearance of building //
  – no loss of internal space //
  – higher BER achieved //
  – maintenance free // *etc*.

  ** Accept any other appropriate answer(s).

- an injection insulation system

  Any 2: (2 × 2m)
  – increases the U-value of wall //
  – cheaper method than external //
  – external finish remains same //
  – quicker to carry out (normally in a day) // *etc*.

  ** Accept any other appropriate answer(s).

- internal insulation system.

  Any 2: (2 × 2m)
  – exterior not changed //
  – faster warm-up period for internal rooms //
  – increases the U-value of the building //
  – easy to install //
  – cheaper system than external //
  – allows you to alter electrical outlets and radiator positions // *etc*.

  ** Accept any other appropriate answer(s).

3. **(a)** Using notes and a single-line diagram, show a typical design layout of a wood burning stove fired heating system and hot water supply for a two storey house. The system has two independently controlled heating zones. Show **two** radiators on each floor. (60)

<u>Heating system</u>

Any 5: **(5 × 3m)**
Drawing (2m), Notation (1m)

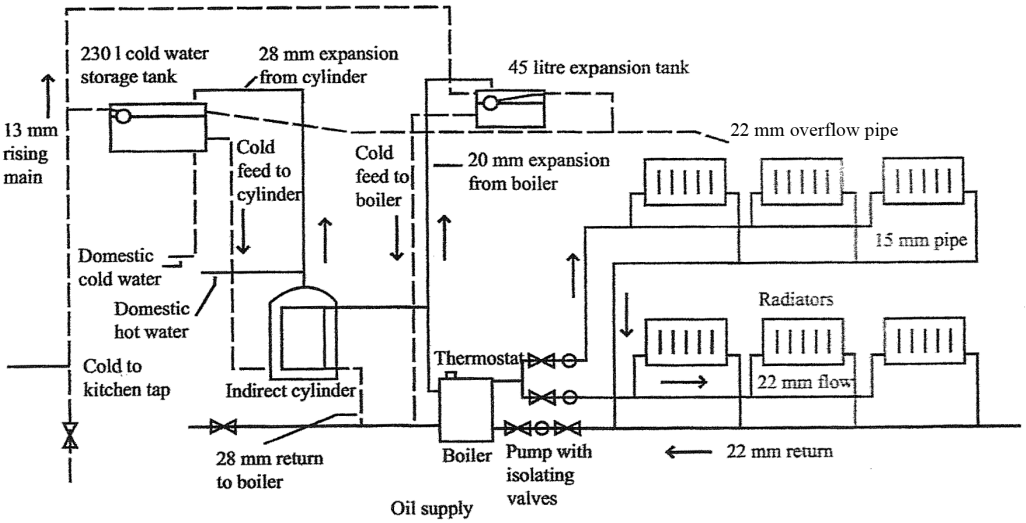
- radiators //
- header / expansion tank //
- expansion pipe //
- pipes to radiators //
- return pipes from radiators //
- thermostatic valve //
- lockshield valve //
- gate and drain valve // *etc.*

<u>Hot water supply</u>

Any 5: **(5 × 3m)**
Drawing (2m), Notation (1m)

- rising main //
- ballcock //
- cold water storage tank //
- overflow pipe //
- hot water cylinder //
- primary flow and return //
- boiler //
- hot water draw-off //
- expansion pipe // *etc.*

Scale **(3m)**, Draughtsmanship **(3m)**



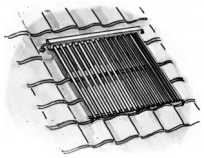
(b) Indicate on the drawing **three** necessary valves to ensure the safe running of the system and write a short note explaining their function.

Any 3: **(3 × 4m)**
Drawing (2m), Notation (2m)

– fire valve to cut off oil supply to the boiler in case of fire //
– thermostat on boiler to cut off heating if temperature gets too high //
– boiler high-limit thermostat //
– boiler control timer switch //
– vent valve to boiler //
– frost thermostat //
– pressure release valve on the primary flow // *etc*.

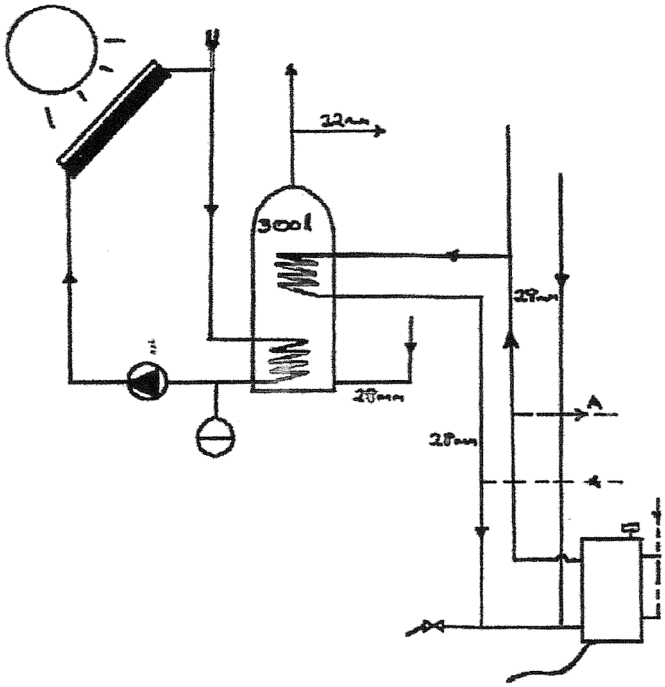
** Accept any other appropriate answer(s).

(c) A solar collector as shown in the sketch is to be incorporated into the existing system of providing hot water for domestic use. Show the design layout necessary to connect the solar panel to the existing system. **(12m)**



Sketch (8m), Notation (4m)

e.g.



4. A properly designed and constructed sewerage system is essential for the safe removal of waste from a domestic house in a rural area. (60)

(a) Discuss in detail **three** risks associated with a poorly designed sewerage system.

Any 3: **(3 × 6m)**

– water pollution of nearby wells, streams, lakes and watercourses if the system is not working correctly, *e.g.* overflowing or leaking //
– if the percolation area is not suitable, it will contaminate the surrounding soil. The percolation rate must be high enough to allow the effluent to pass through it without ponding, but low enough to allow purification of the effluent by filtration //
– the run-off or discharge from the treatment system will cause problems if directed to a watercourse or drain; drains may overflow, causing damage //
– using a septic tank that is not properly constructed could lead to inadequate treatment and disposal of sewage //
– pipes laid with incorrect gradients may cause back-up or overflow // *etc*.

** Accept any other appropriate answer(s).

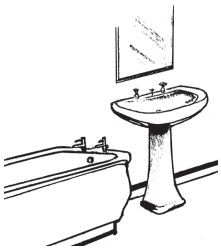
(b) Using notes and freehand sketches, show **three** considerations that should be taken into account when laying sewer pipes to ensure the safe removal of waste from a dwelling.

Any 3: **(3 × 6m)**
Drawing (2m), Notation (4m)

– self venting //
– self cleansing //
– easy access for inspection at junctions and manholes //
– pipes laid in straight lines between inspection chambers with as few direction changes as possible //
– must have adequate access points and rodding points for cleaning //
– manholes maximum distance of 90 m apart //
– the system must have adequate ventilation //
– piping normally of uPVC material, usual lengths of 6 m, easy to join and very strong //
– 100 mm diameter pipes normally used and laid at a gradient of 1 in 40 // *etc*.

** Accept any other appropriate answer(s).

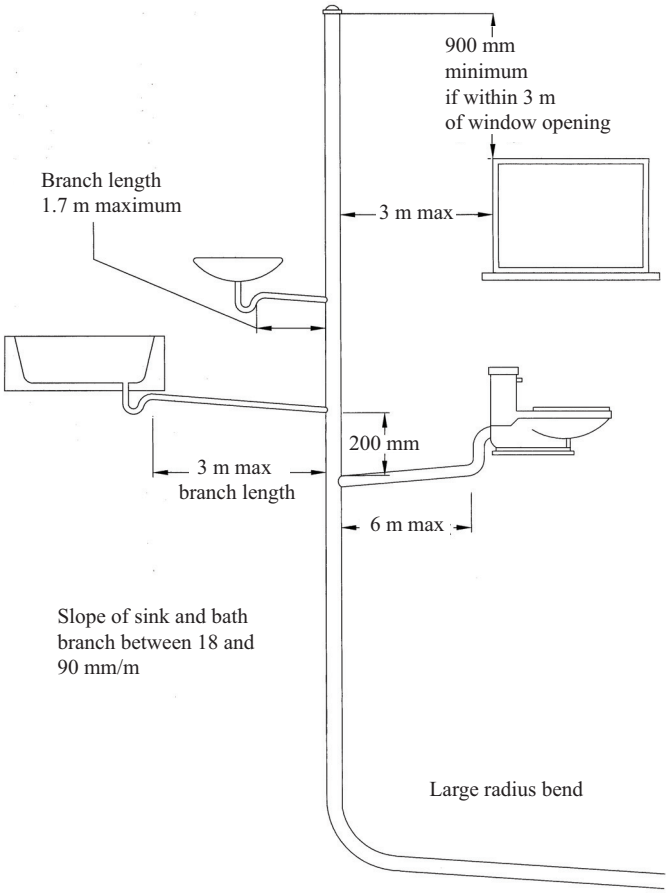
(c) The accompanying sketch shows a bathroom on the first floor of a dwelling house. Using notes and neat freehand sketches, show the typical pipe layout of single-stack system to remove waste safely from the bathroom.



Any 4: **(4 × 5m)**

– 100 mm single stack //
– stack extending over windows //
– large radius at base //
– WC / WHB and bath connections //
– pipe sizes / branch lengths // *etc*.

Draughtsmanship **(4m)**



5. A house built over twenty years ago has a pitched roof and is insulated with a fibreglass quilt placed between the ceiling joists. (60)

(a) Calculate the U-value of the roof, given the following data:

Concrete roof tiles	thickness	20 mm
Fibreglass insulation	thickness	150 mm
Plasterboard	thickness	12.7 mm

Thermal data of roof:

Resistance of external surface of tiles	(R)	0.053 m^2	°C/W
Conductivity of tiles	(k)	0.833	W/m °C
Resistance of internal surface of tiles	(R)	0.123 m^2	°C/W
Conductivity of fibreglass	(k)	0.033	W/m °C
Conductivity of plasterboard	(k)	0.160	W/m °C
Resistance of loft space	(R)	0.176 m^2	°C/W

Any 7 lines: **(7 × 4m)**
Correct U-value calculation **(4m)**

Layer	**Thickness**	**Conductivity**	**Formula**	**Resistance**
Units	Metres	W/m °C		m^2 °C /W
Tile (external surface)				0.053
Tiles	0.020	0.833	T/K	0.024
Insulation	0.150	0.033		4.545
Loft Space				0.176
Plasterboard	0.0127	0.160	T/K	0.079
Tile (internal surface)				0.123

– total resistance = 5.000 //
– U-value = 1 / total resistance //
= 1 / 5.000 //
= 0.20 W/m^2 °C

(b) Using the thermal data below and the U-value obtained at **(5a)** above, calculate the cost of the heat lost annually through the roof.

Thermal data:

Area of the roof	140 m^2
Average internal temperature;	17 °C
Average external temperature;	6 °C
Heating period	11 hours per day for 41 weeks per annum
Cost of oil	85 cent per litre
Calorific value of oil	37350 kJ per litre
1000 watts	1 kJ per second

Any 4: **(4 × 4m)**
Correct cost calculation **(2m)**

– formula: rate of heat loss = U-value × area of roof × temperature difference //
– = 0.2 × 140 × (17 – 6) //
– = 0.2 × 140 × 11 //
– = 308 watts (J / s)

– heating period p/a = s × min × hr × days × weeks //
– 60 × 60 × 11 × 7 × 41 = 11365200 s //

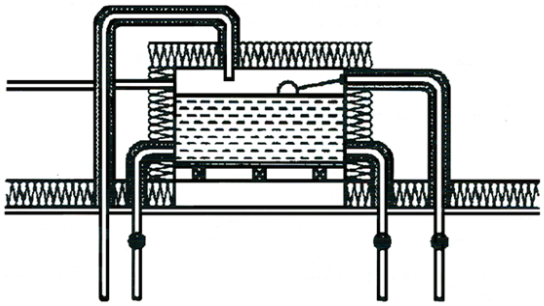
– kilo joules p/a
– $\frac{11365200 \times 308}{1000}$ = 3500482 kJ

– litres p/a (calorific value of 1 litre of oil = 37350 kJ)
– $\frac{3500482}{37350}$ = 93.7 litres

– cost p/a (1 litre costs 85 cent)
– 93.7 × 0.85 = €79.65 per year

(c) Using notes and freehand sketches, show the insulation in the attic around the cold water storage tank. **(10m)**

Notes (5m), Sketch (5m)
– the top and sides of the tank are covered with insulation
– insulation is not placed under the tank
– rigid insulation is usually used, *e.g.* polystyrene board 65 mm – 100 mm
– fibre glass may also be used



6. **(a)** Using notes and freehand sketches, discuss in detail **three** planning guidelines that should be observed when designing a new house for a rural area to ensure a low environmental impact. (60)

Any 3: **(3 × 12m)**

Landscape //
Any 3: (3 × 4m)
– the house should match in with landscape //
– the house should not be obtrusive //
– check existing building styles in area //
– check existing building traditions for the area // *etc.*

** Accept any other appropriate answer(s).

Maintain existing features //
Any 3: (3 × 4m)
– respect and retain the existing local landscape //
– plant trees and shrubs at building stage //
– the house should not break the skyline; choose a site with a gentle fold or slope //
– avoid planting exotic plants and evergreen trees along site boundaries //
– conserve all existing stone walls // *etc.*

** Accept any other appropriate answer(s).

Design and form //
Any 3: (3 × 4m)
– the house should suit the area and not compete with the surrounding topography //
– building materials should be sourced locally //
– materials to match in with local building materials and techniques //
– buildings should be solid and of simple construction techniques //
– dwellings should be single room wide //
– build an entrance porch where appropriate //
– windows to have vertical emphasis // *etc.*

** Accept any other appropriate answer(s).

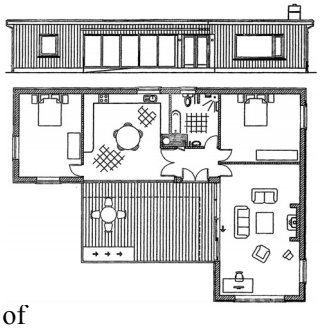
Orientation //
Any 3: (3 × 4m)
– take into account prevailing wind direction //
– take into account path of the sun //
– use passive solar energy design //
– design of planting to shelter from winds and to provide privacy // *etc.*

** Accept any other appropriate answer(s).

Access and road boundaries // *etc.*
Any 3: (3 × 4m)
– must have safe access to/from public roads //
– avoid high walls //
– entrance to respect natural contour of the land //
– driveway to blend in with existing roadway //
– ensure the scale of house is in sympathy with the size of the site and other surrounding buildings // *etc*.

** Accept any other appropriate answer(s).

(b) The accompanying drawing shows the elevation and plan of the proposed house.



With reference to the design shown, discuss in detail, using notes and freehand sketches, the importance of **each** of the following in ensuring that the house has a low environmental impact:

- scale and layout **(8m)**
  Note (5m), Sketch (3m)
  – narrow plan, the house is only one room wide and there is a lot of glazing to ensure passive solar energy will reach all rooms
  – house construction is small in scale, it requires smaller quantities of materials and will be easier to build
  – modesty of scale ensures less excavation and materials for construction, ensuring less disruption to environment
  – combined kitchen and dining area is economical use of space
  – low-lying building which will not break the skyline
  – infrequently used room positioned on the cold, north side of the house
  – compact building reduces the surface to volume, which will help to reduce the heat loss

** Accept any other appropriate material.

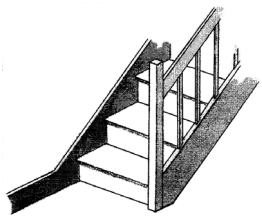
- selection of materials **(8m)**
  Note (5m), Sketch (3m)
  – use of locally sourced material for cladding and decking
  – renewable materials if grown in locally managed forests
  – only small amount of concrete used is good for environment
  – locally available materials reduce transport costs and emissions of CO_2
  – use of low-e triple glaze having high U-value reduces heating costs
  – use of insulation that utilises wool and recycled paper is low embodied energy
  – use of flat roof construction reduces the amount of materials required

** Accept any other appropriate material.

- energy requirements. **(8m)**
  Note (5m), Sketch (3m)
  – a large glazed area to living rooms enables passive solar energy gain
  – use triple glazed windows
  – large glazed area allows cooling in hot weather
  – all rooms have windows, reducing artificial light requirements
  – built to maximise solar energy gain - elevation south facing or 15 degrees east or west of due south
  – small glazed area on north face of building to limit heat loss
  – the use of a wood burning stove will produce less carbon

** Accept any other appropriate material.

7. A closed string timber stairs provides access from the ground floor to the first floor in a domestic building. (60)

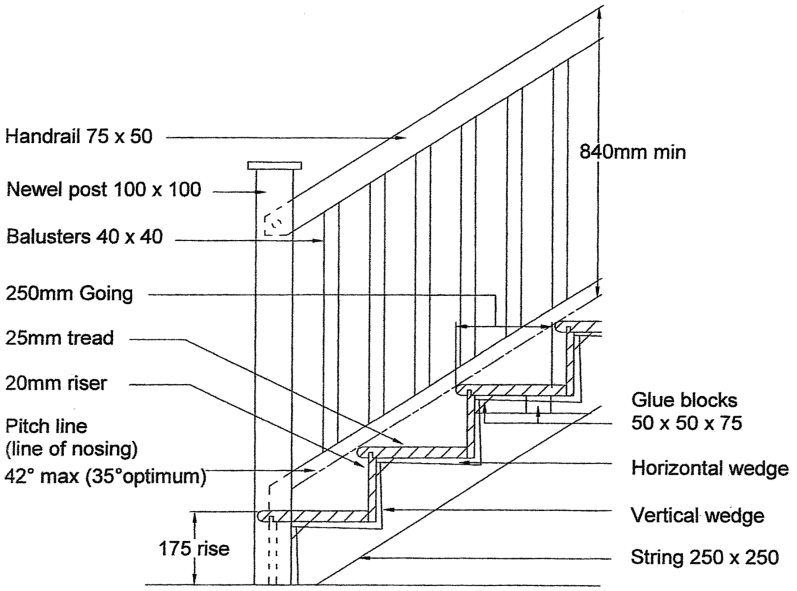


(a) To a scale of 1:5, draw a vertical section through the bottom **three** steps of the stairs. Show the newel post, balusters and handrail of the stairs. Show clearly four dimensions of the main structural members of the drawing.

Any 8: **(8 × 5m)**
Labeling (2m), Sketch (3m)

- newel post, 100 mm × 100 mm //
- string, 250 mm × 28 mm //
- balusters, 40 mm × 40 mm //
- handrail, 75 mm × 50 mm //
- risers, 20 mm //
- treads, 25 mm //
- going //
- rise //
- wedges //
- glue blocks //
- pitch line //
- handrail height 840 mm minimum // *etc*.

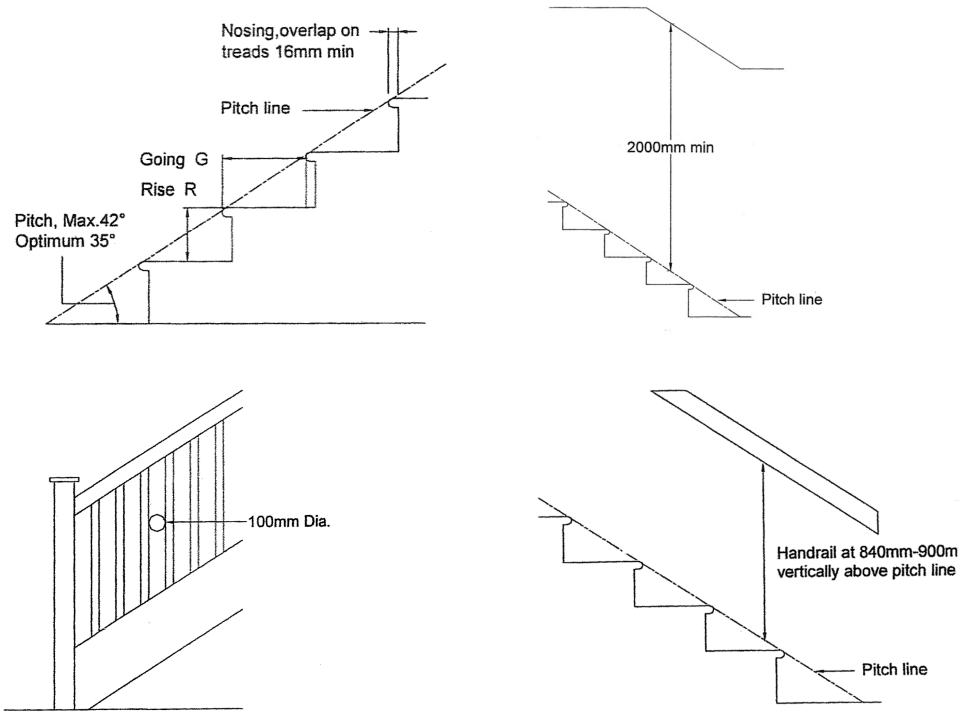
Four structural members **(4 × 1m)**.
Scale **(2m)**, Draughtsmanship **(2m)**



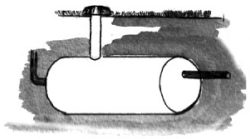
(b) Using notes and freehand sketches, show **three** design considerations that would ensure that the stairs are safe for all users.

Any 3: **(3 × 4m)**
Notes (3m), Sketch (2m)

- pitch not more than 42 degrees //
- 2R + G = 550 - 700 //
- all treads same size //
- all risers same size //
- maximum number of treads = 16 //
- nosing overlap 16 mm minimum //
- proper guarding provided on stairs //
- minimum gap between balusters 100 mm //
- handrails fitted at correct height, 840 mm to 900 mm vertically of pitch line //
- sufficient headroom provided // *etc*.



8. The proposed introduction of water charges to homeowners in the near future will encourage the installation of underground storage tanks, as shown, to provide water for domestic use.



(60)

(a) Using notes and a single-line diagram, show the pipework / filters necessary to convey rainwater to the underground tank and back into a separate storage tank in the attic of the house.

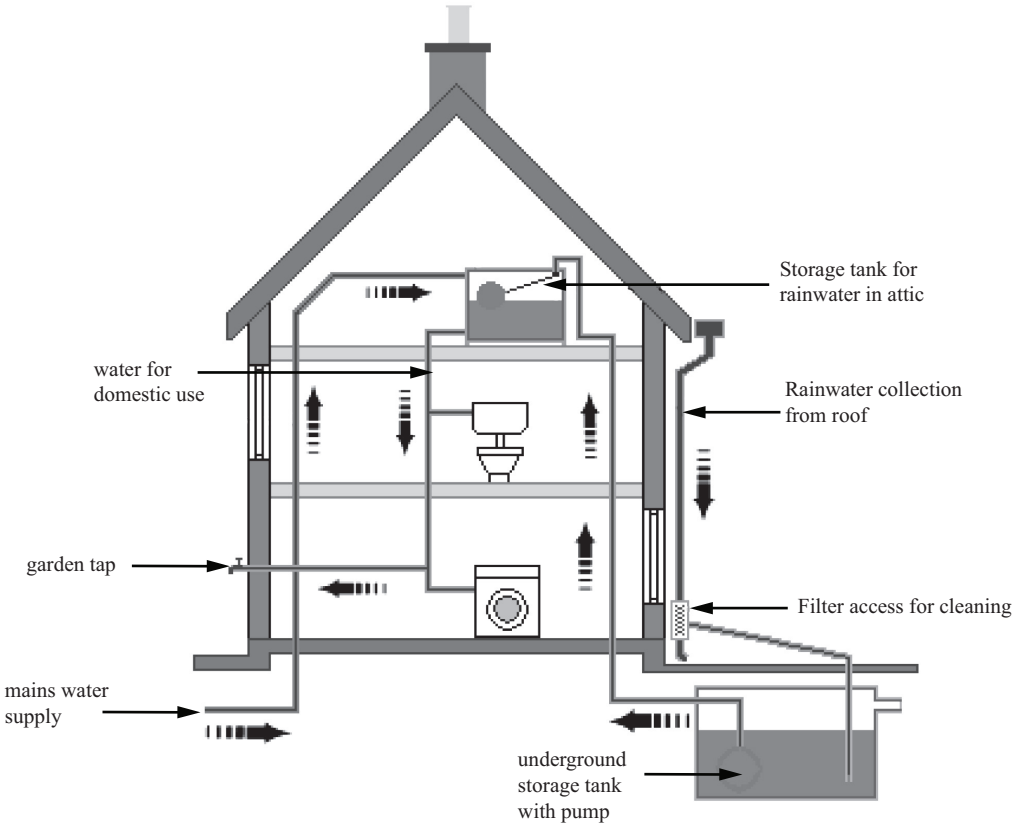
Notes:

Any 5: **(5 × 3m)**

– collection of rainwater in gutters of 125 mm is typical //
– stopends on gutters; typically water runs down the building in 65 mm downpipes //
– rainwater from downpipe runs into gully //
– water runs from gully through a pipe connecting to an underground storage tank //
– a filter is fitted to this pipe to trap sediment //
– an alternative filter may be located in the storage tank; it can be accessed from the top for maintenance and cleaning //
– storage tank has overflow pipe to sump //
– a submersible pump pumps the water back into the house //
– a separate water storage tank is located in the attic to store water for use //
– this tank is plumbed to provide water for use in toilets, washing machines, outdoor taps for gardening, general cleaning of pavements, cars // *etc*.

** Accept any other appropriate answer(s).

Diagram **(8m)**
Labelling **(7m)**



(b) Discuss **two** advantages of using stored rainwater and give **two** suitable uses for this water.

Advantages

Any 2: **(2 × 6m)**

– reduces domestic water consumption //
– less water running in drainage system which reduces risk of flooding //
– reduces the wastage of chlorinated drinking water //
– less damaging to appliances // *etc*.

** Accept any other appropriate answer(s).

Uses

Any 2: **(2 × 5m)**

– ideal for general gardening, watering plants, flowers - no chlorine //
– used for water in toilets, washing machines and household tasks //
– used for outdoor cleaning, washing cars / pavements // *etc*.

** Accept any other appropriate answer(s).

(c) Recommend **two** other procedures that a homeowner could follow to limit the use of water in the dwelling.

Any 2: **(2 × 4m)**

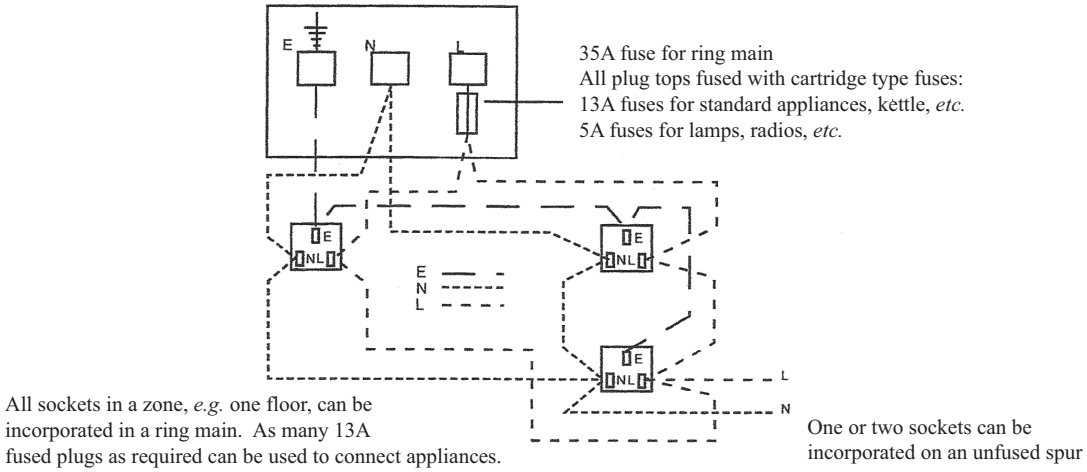
– having showers instead of baths //
– only running washing machines / dishwashers when fully loaded //
– avoid unnecessary running of water in bathrooms, *i.e.* when cleaning teeth //
– WC to have two-flush action // *etc*.

** Accept any other appropriate answer(s).

9. Proper installation of electrical circuits in the home is of great importance to the safety of all users. (60)

(a) Using notes and freehand sketches, show the correct wiring for two sockets in a ring system of a domestic electrical installation.

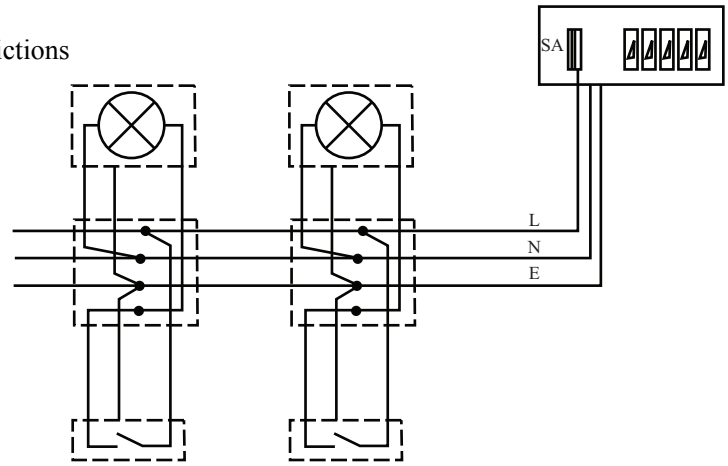
Notation **(12m)**, Sketch **(12m)**



(b) Using notes and freehand sketches, explain the principles of earthing in a domestic electrical installation.

Notation **(12m)**, Sketch **(12m)**

- 1.5 mm^2 twin and earth cable
- 1 mm^2 can be used with restrictions
- live - brown
- neutral - blue
- earth - yellow / green



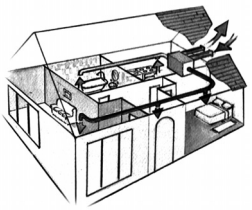
(c) Discuss **three** considerations that should be taken into account to ensure safe and economic use of electricity in the home.

Any 3: **(3 × 4m)**

- use of lighting controls, sensors, timers, motion sensors, dimmers //
- use of low energy lighting //
- timers on heating //
- running dishwashers / washing machines with full loads //
- boiling kettles with correct amount of water //
- ensuring all lights turned off when not required //
- all sockets unplugged when not in use // *etc*.

** Accept any other appropriate answer(s).

10. **(a)** Using notes and freehand sketches, discuss in detail the importance of any **two** of the following in the design of a Passive House: (60)



Any 2: **(2 × 12m)**

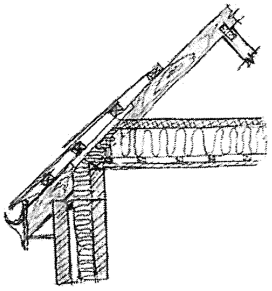
- insulated building envelope
  Note (6m), Sketch (6m)

Key Points

– building to be constructed with an A1 Building Energy Rating //
– building designed to be airtight, all joints taped to prevent air infiltration //
– use of triple glazing and high performing draught seals at doors and windows //
– low thermal bridging // *etc*.

Roof

– to have U-value of 0.15 W/m^2/K
– use of wider rafters to allow greater insulation thickness
– use of rigid insulation board when attic space is being converted
– insulation laid between and over ceiling joists of thickness 400 mm – 600 mm
– all joints taped to increase airtightness



** Accept any other appropriate material.

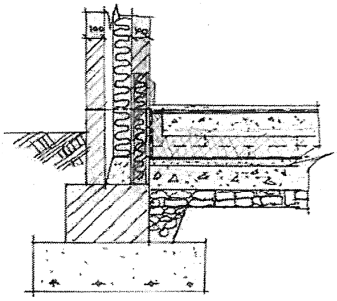
Walls

– U-value of 0.175 W/m^2/K
– insulated cavity 200 mm – 300 mm in width
– inner leaf of timberframe structures thicker to accommodate insulation
– insulation blocks used from foundation up to skirting level
– all joints taped to increase airtightness

** Accept any other appropriate material.

Floors

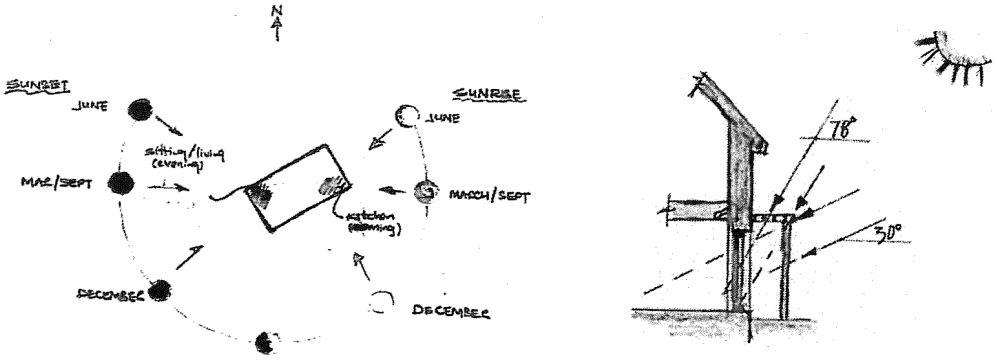
– to have U-value 0.15 W/m^2/K
– two layers of floor insulation, joints staggered and taped to prevent cold bridges
– edge insulation to floor slab
– use of insulated internal blocks on inner leaf from foundation to above concrete subfloor
– all joints taped to increase airtightness



** Accept any other appropriate material.

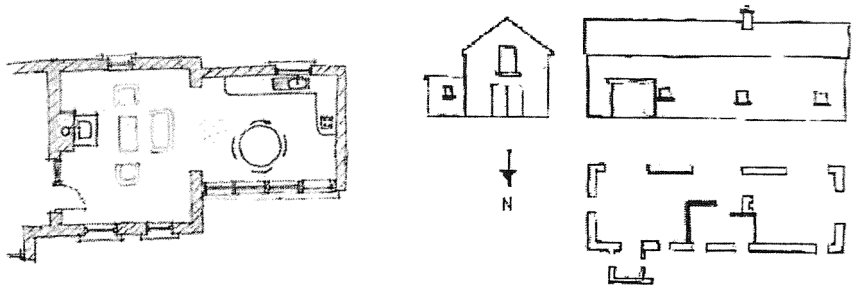
- orientation and shade
  Note (6m), Sketch (6m)
- south facing building to maximise sun gain
- triple glazed low-e argon filled to maximise sun gain in south facing glazing
- keep glazing to north to minimum
- position all living rooms on south facing elevation
- large overhanging roofs to reduce sun and provide shade in summer
- use of window blinds to prevent direct sunlight in summer

** Accept any other appropriate material.



- shape and form of the building
  Note (6m), Sketch (6m)
- deep plan, south facing - open plan layout
- optimum roof pitch 45 degrees for maximum benefit of solar panels
- maximum glazing to south, main living in this area
- minimum glazing to north, least-used areas
- draught lobby and sun trap to doors
- direct access from sun space to living areas
- mass of walls and floors to act as heat sink
- kitchen / dining room space combined
- compact form to minimise surface to volume ratio

** Accept any other appropriate material.

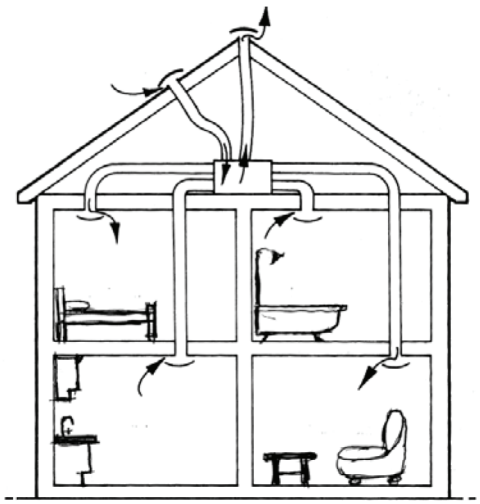


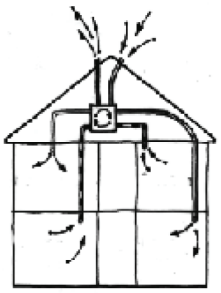
(b) Using notes and freehand sketches, describe how a Mechanical Heat Recovery and Ventilation system (MHRV) operates for a Passive House. **(16m)**

Note (8m), Sketch (8m)

- removes pre-heated air from kitchen, bathroom and utility rooms
- conducts this pre-heated air to air exchange unit, where heat is extracted
- the extracted heat is used to heat fresh, colder air
- warm fresh air is distributed throughout the house using an independent ducting system
- system collects up to 93% of heat from exhaust air in dwelling
- filters are fitted to prevent allergens and pollen entering the dwelling

** Accept any other appropriate material.





(c) Overheating in summer can be a problem with Passive Houses.
Using notes and freehand sketches, show **two** design details to overcome these problems.

Any 2: **(2 × 10m)**
Note (5m), Sketch (5m)

- brise soleil over large glazed area //
- extended soffit - overhang - but not excessive //
- blinds, curtains heavily lined or timber shutters to filter sun //
- openings positioned opposite each other for through-and-through ventilation //
- have opening sashes //
- porches positioned to prevent direct sunlight coming into the building // *etc.*

** Accept any other appropriate answer(s).

OR

10. "Domestic architecture often combines one or two styles, or is varied or adapted locally depending on the climate, location, materials available, the skills of the builder and workers, economic status, lifestyle, social concerns or restraints and fashions."

Hearthstones (1993)
Caneta S Hankins

Discuss the above statement in detail and propose **three** guidelines that would help create more environmentally sustainable housing in Ireland.

Discuss:

Any 3: **(3 × 10m)**
Point (4m), Discussion (6m)

– architecture evolved through people's needs //
– in Ireland, buildings utilised local materials - limestone, granite, sandstone //
– tradesmen travelled following the work //
– roof development from thatched roofs to modern pitched roofs //
– damp proof courses, slates, lead //
– traditional villages, folk parks, heritage towns, old mills //
– retaining facades, Georgian buildings and other period building styles //
– a little of us remains where we have been, retention of part of our historic past //
– old skills, crafts preserved //
– part of our cultural heritage for all to see // *etc*.

** Accept other relevant points supported by reasonable argument.

Guidelines:

Any 3: **(3 × 10m)**
Point (4m), Discussion (6m)

– energy analysis of any design…low embodied energy design //
– ethical designing, energy consideration for future generations //
– non-toxic materials //
– modest scale to meet needs - reduction in needs, a light footprint on the planet //
– build close to amenities where possible - save energy //
– build in clusters where possible - community life, safety //
– use sustainable energies - wind, solar, geothermal, *etc*. //
– grants to encourage sustainable design - especially for the elderly and disadvantaged // *etc*.

** Accept other relevant guidelines supported by reasonable argument.

Notes: