CONSTRUCTION TECHNOLOGY

2014. M76

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination, 2014

Construction Studies

Theory - Higher Level

(300 marks)

Friday, 13 June
Afternoon, 2:00 to 5:00

(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.*

2011-2021

PAST PAPERS

NAME: _____

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination, 2011

Construction Studies

Theory - Higher Level

(300 marks)

Wednesday, 22 June
Afternoon, 2:00 to 5:00

(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.*

1. The main external doorway of a dwelling house is designed to facilitate access for everyone, including a person with reduced mobility, as shown in the sketch.

The door is a framed wooden door with 12 mm thick vertical sheeting on both sides. The doorframe is 150 mm × 70 mm and is fixed in a 350 mm external concrete block wall with an insulated cavity.
The house has an insulated solid concrete ground floor with a 20 mm quarry tile finish.

(a) To a scale of 1:10, draw a vertical section through the centre of the door. The section should show the typical construction details from 500 mm below finished floor level, through the threshold, the door, the doorframe and the external wall to a level 300 mm above the concrete lintels over the doorframe.

(b) Show on the drawing the design detailing that ensures that rainwater is removed from the threshold area.

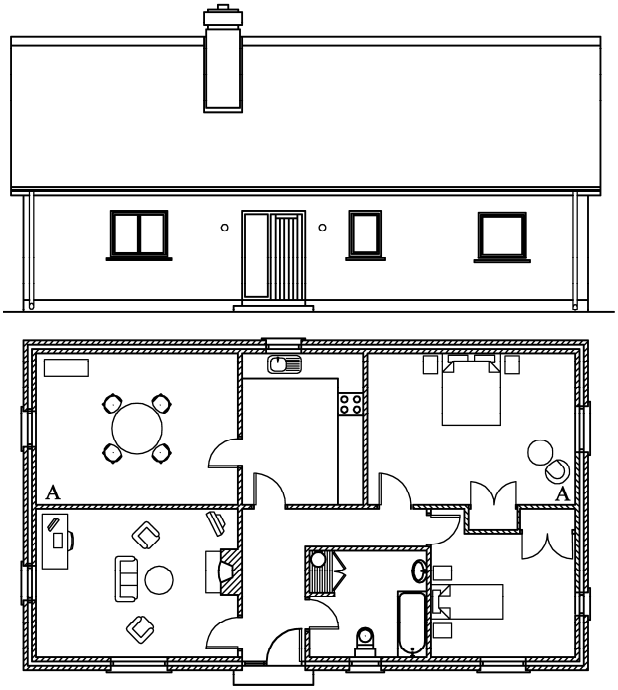
2. **(a)** Discuss in detail, using notes and freehand sketches, **three** functional requirements of a roof suitable for a dwelling house.

(b) Using notes and freehand sketches, show **two** different types of pitched roof structure suitable for a dwelling house having an internal span of 6.0 metres and one internal load-bearing wall.

For **each** roof type, indicate the design detailing that ensures the structural stability of the roof and include the typical dimensions of **three** structural members.

(c) Recommend a preferred roof structure for a dwelling house and give **two** reasons in support of your recommendation.

3. The plan and elevation of a house built thirty years ago are shown in the accompanying drawing.



The house is of traditional construction with a slated cut roof and a 300 mm external cavity wall of concrete block construction. The internal walls are of 100 mm solid block construction and the internal wall **A-A** is a load bearing wall.
The front elevation is south facing.
It has been decided to renovate the house to improve its thermal performance by:

- redesigning the external envelope to allow the increased penetration of sunlight into the interior of the house

and

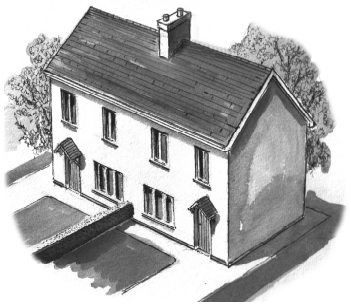
- redesigning the layout of the interior to optimise solar gain.

(a) For **each** of the above, show using notes and freehand sketches, a revised design detailing that will improve the thermal performance of the dwelling house.

(b) For **each** of the above, discuss in detail the reasons for your proposed design choices when redesigning the house shown.

4. **(a)** Discuss in detail, using notes and freehand sketches, the importance of **each** of the following in reducing the transmittance of sound in a dwelling house:

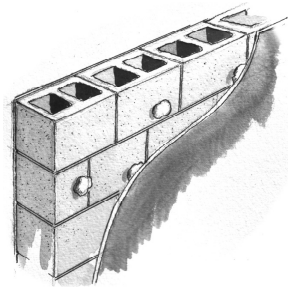
- mass
- completeness
- isolation.



(b) The party wall between the two semi-detached houses shown in the sketch is of concrete block construction. The occupants of one house can hear everyday sounds from the adjoining house. Discuss **two** possible reasons why sound is transmitted between the houses, and using notes and freehand sketches, show the revised design detailing that would improve the sound insulation properties of the party wall between both houses.

(c) To reduce the transmittance of sound through a timber stud partition between two adjoining bedrooms on the first floor in one of the houses, it has been decided to redesign the partition. Show, using notes and freehand sketches, a revised design for the stud partition and outline the sound insulation principles associated with the each design detail. Specify the materials used and give their typical dimensions.

5. The external wall of a house built in the 1970s is constructed using a single leaf 215 mm hollow concrete block. The wall is rendered externally and plasterboard is fixed to the internal surface using dabs of plaster adhesive, as shown in the accompanying sketch.



(a) Calculate the U-value of the external hollow block wall, given the following data:

External render	thickness	15 mm
Concrete hollow block	thickness	215 mm
Air space between plasterboard and block	width	10 mm
Internal plasterboard	thickness	12 mm

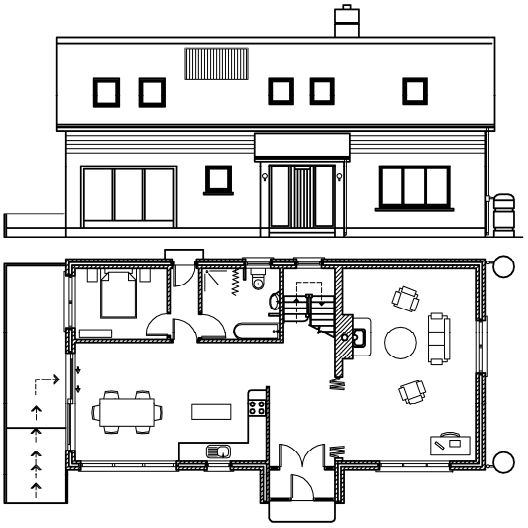
Thermal data of external wall of house:

Resistance of external surface	(R)	0.048	m^2	°C/W
Resistivity of external render	(r)	2.170	m	°C/W
Resistance of hollow block	(R)	0.210	m^2	°C/W
Resistance of airspace	(R)	0.170	m^2	°C/W
Conductivity of plasterboard	(k)	0.160	W/m	°C
Resistance of internal surface	(R)	0.104	m^2	°C/W

(b) It is proposed to upgrade the thermal properties of the wall by fixing expanded polystyrene to the external surface. Given the thermal conductivity (k) of expanded polystyrene as 0.037 W/m °C, calculate the thickness of expanded polystyrene required to achieve a U-value of 0.27 W/m^2 °C to meet the requirements of the current Building Regulations.

(c) In the past, many dwelling houses were built using hollow concrete blocks, as outlined at **5 (a)** above. Discuss **two** disadvantages of this type of construction, and using notes and freehand sketches, recommend a preferred external wall type suitable for a contemporary house.

6. The elevation and ground floor plan of a house are shown. The house has two additional bedrooms and a bathroom upstairs. The external leaf is of concrete block and cedar cladding construction, as shown. The house is designed to have low environmental impact.

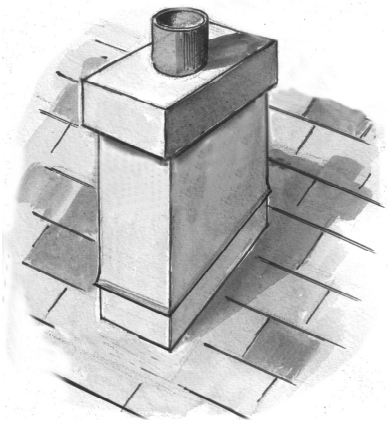


(a) With reference to the design shown, discuss in detail, using notes and freehand sketches, **three** features of the design that ensure the house has low environmental impact.

(b) Discuss in detail the importance of **each** of the following when designing environmentally sustainable housing:

- form of the house
- materials and labour
- design for lifetime use.

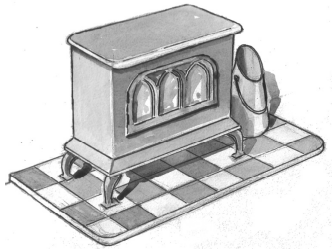
7. A concrete block chimney stack with a sand/cement render passes through a cut roof which is slated and is pitched at 45°, as shown in the sketch.



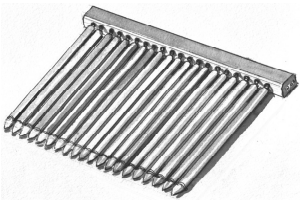
(a) To a scale of 1:5, draw a vertical section through the chimney stack and roof, showing the typical details of the chimney stack, flue, chimney capping and portion of the roof structure. Show clearly the design details necessary to prevent the penetration of water between the chimney stack and the adjoining roof surface.

(b) On your drawing, show **two** design details that will help prevent the occurrence of a downdraught in a chimney as shown. Include dimensions as appropriate.

8. **(a)** A wood burning stove, as shown in the sketch, is used to heat two independently controlled heating zones, one on each floor, in a two storey dwelling house. Using notes and a single-line diagram, show a typical design layout for the pipework necessary to independently heat each zone. Show **three** radiators on each floor, indicate the control valves and give the typical sizes of the pipework.

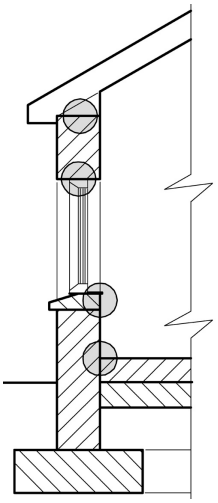


(b) It is proposed to connect a solar collector, as shown in the sketch below, to the system at **8(a)** above to heat domestic water. Show a design layout for the pipework necessary to connect the solar collector to the existing system and outline the modifications required to the existing system to accommodate the solar collector.



(c) Using notes and freehand sketches, show a preferred location for the solar collector and discuss in detail **two** factors that influenced your choice of location.

9. Careful design detailing is necessary in order to design a building envelope which is free of thermal/cold bridges. The drawing shows an outline section through a single storey house having a 350 mm external concrete block wall with an insulated cavity. The ground floor is an insulated solid concrete floor.



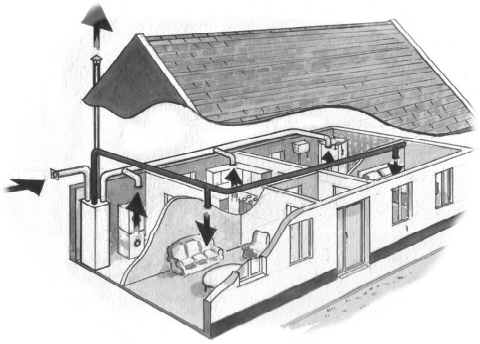
(a) Select any **three** locations from those circled on the sketch, and show clearly, using notes and annotated freehand sketches, the typical design detailing which will prevent the formation of thermal bridges at each location selected.

(b) Discuss in detail **two** advantages of designing a building envelope which is free of thermal bridges.

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:

- foundations suitable for a Passive House
- airtight building envelope
- windows and glazing.

(b) A Mechanical Heat Recovery with Ventilation (MHRV) system for a Passive House is shown in the accompanying sketch. Using notes and freehand sketches, describe how such a system operates.



(c) Discuss in detail **two** advantages and **two** disadvantages of using a Mechanical Heat Recovery with Ventilation system in a domestic dwelling.

OR

10. "A good neighbourhood is one where people can easily satisfy daily needs whilst feeling safe to do so. The most successful neighbourhoods are well connected – to employment centres, or places where people spend their leisure time. They are places where people can live at any stage of their lives – regardless of physical ability or social status. Successful neighbourhoods also tend to have a wide variety of things to do within them and have a strong connection to the area in which they sit – be it historical, cultural or visual."

Urban Design Manual – A Best Practice Guide (2009).
Department of the Environment, Heritage and Local Government..

Discuss the above statement in detail and propose **three** guidelines for best practice that would help create sustainable urban neighbourhoods.

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination, 2012

Construction Studies

Theory - Higher Level

(300 marks)

Friday, 15 June
Afternoon, 2:00 to 5:00

(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.*

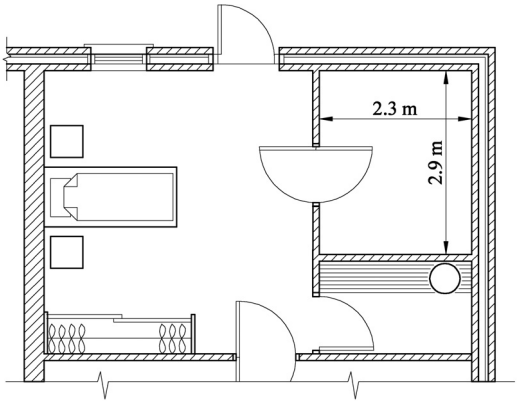
1. A triple-glazed bay window projects 1.5 metres from the external wall of a dwelling house, as shown in the accompanying sketch. The external wall is a 350 mm concrete block wall with an insulated cavity. The lean-to roof is an insulated slated roof and has a pitch of 30°. Insulated plasterboard is fixed to the underside of the rafters to form a sloped ceiling.

(a) To a scale of 1:5, draw a vertical section through the window, roof and front wall of the house. The section should show the typical construction details from 400 mm below the concrete lintels of the bay window, through the fixed frame of the window, wallplate and rafter to a level 400 mm above the abutment of the lean-to roof and the front wall of the house.

(b) Indicate on your drawing the design detailing that ensures moisture does not penetrate at the abutment of the roof and the wall of the house.

2. **(a)** Discuss in detail, using notes and freehand sketches, **two** functional requirements of a dwelling house designed for lifetime use. Refer in particular to the:

- main entrance **and**
- internal corridor layout.



(b) The layout of a bedroom and an adjoining bathroom, which is 2.3 m × 2.9 m, is shown in the accompanying drawing. The hot press is also shown.

Using notes and freehand sketches, show a preferred layout for the bathroom space to ensure that it is suitable for a person in a wheelchair. Indicate in your design sketches the location of the following:

window, shower area, toilet, wash hand basin and grab rails.

Include **three** typical dimensions.

(c) Discuss your preferred location for the bathroom items listed at **2(b)** above.

3. The drawing shows the elevation and plan of a semi-detached house with an adjoining storeroom. All external walls are of single leaf 215 mm hollow block construction and all roofs are slated. All internal walls are of solid block construction and the internal wall **A-A** is load-bearing. The storeroom wall **B-B** is south facing.
It has been decided to convert the storeroom in order to enlarge the living space.
In the conversion, you need to give consideration to:

- redesigning the ground floor layout to allow increased penetration of sunlight to the interior

and

- upgrading the thermal properties of the external walls.

(a) Show, using notes and freehand sketches, a revised design detailing for the dwelling house.

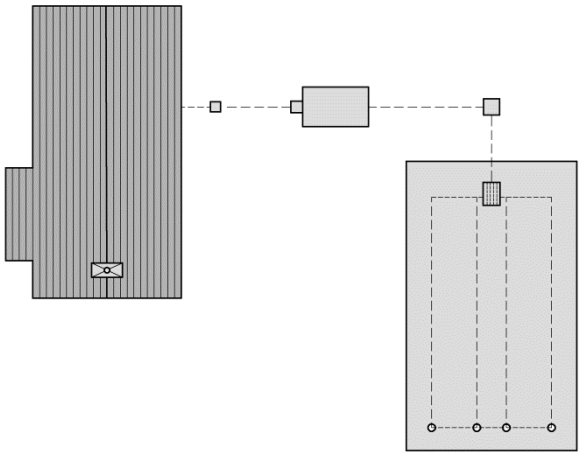
(b) For **each** of the above, discuss in detail the reasons for your proposed design choices.

4. The typical layout of an on-site wastewater treatment system suitable for a single house is shown in the accompanying drawing.

(a) Describe in detail, using notes and freehand sketches, the operating principles of a conventional septic tank system.

(b) Show, using notes and freehand sketches, the typical design detailing for the percolation area to ensure the safe treatment of waste from the septic tank. Include dimensions as appropriate.

(c) Discuss in detail **three** reasons why a proposed site for a dwelling house may be unsuitable for a conventional septic tank wastewater treatment system.



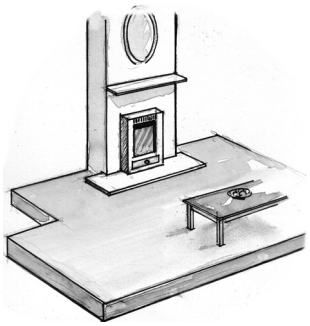
5. A house built in the 1970s has an un-insulated solid concrete ground floor with a sand/cement fine screed finish.

(a) Calculate the U-value of the concrete ground floor given the following data:

Sand/cement fine screed	thickness	60 mm
Concrete floor slab	thickness	100 mm
Damp proof membrane (DPM)	thickness	0.25 mm
Sand blinding	thickness	50 mm
Hardcore	thickness	225 mm
Subsoil	thickness	300 mm

Thermal data of concrete ground floor:

Resistance of internal surface	(R)	0.104	m^2	°C/W
Resistivity of fine screed	(r)	0.710	m	°C/W
Conductivity of concrete floor slab	(k)	0.160	W/m	°C
Conductivity of DPM	(k)	0.250	W/m	°C
Conductivity of sand blinding	(k)	0.160	W/m	°C
Conductivity of hardcore	(k)	1.330	W/m	°C
Conductivity of subsoil	(k)	1.800	W/m	°C

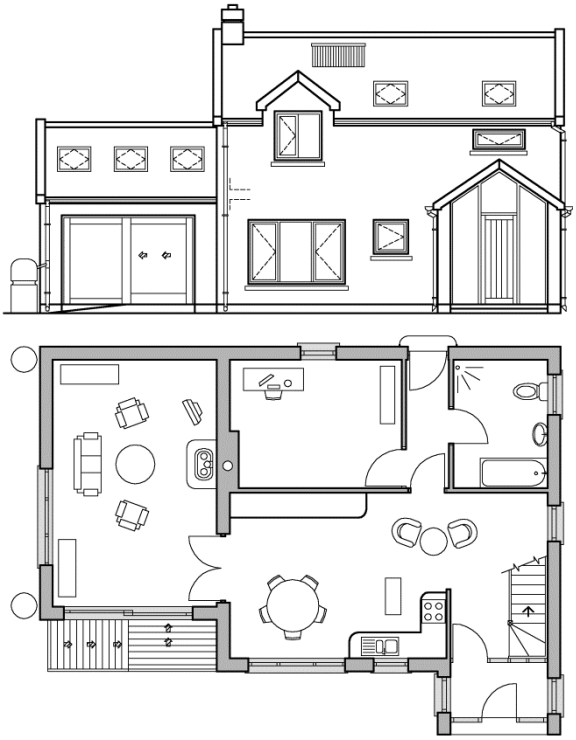


(b) Using the U-value of the concrete ground floor obtained at **5(a)** above and the following data, calculate the cost of heat lost annually through the un-insulated concrete floor slab:

Dimensions of floor	9.0 metres × 7.0 metres
Average internal temperature	20° C
Average external temperature of subsoil	5° C
Heating period	12 hours per day for 40 weeks per annum
Cost of oil	85 cent per litre
Calorific value of oil	37350 kJ per litre
1000 Watts	1 kJ per second.

(c) An insulated concrete ground floor is designed to prevent the penetration of radon gas through the floor and to meet the Passive House standard. Using notes and freehand sketches, show the typical design detailing for such a floor.

6. The elevation and ground floor plan of a house are shown. The house has a study / office as shown and also has three bedrooms and a bathroom upstairs.
The external wall is of timber frame construction with a concrete block outer leaf.
The house is designed to have low environmental impact, reflecting the sustainable ideal of doing more with less for longer.

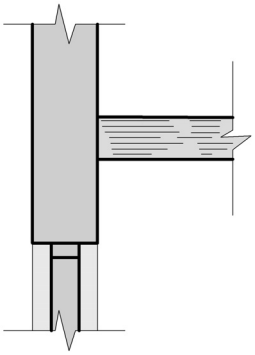


(a) With reference to the design shown, discuss in detail, using notes and freehand sketches, **three** features of the design that reflect the sustainable ideal of doing more with less for longer.

(b) Discuss in detail the importance of **each** of the following when designing an environmentally sustainable dwelling house:

- orientation of house
- flexibility of design
- sourcing of materials.

7. The main entrance door to a two storey dwelling house is a four-panel solid wooden door. The external wall in which the door is fitted is of timber frame construction with a rendered concrete block outer leaf. This wall supports the first floor joists, as shown in the accompanying outline drawing.



(a) To a scale of 1:5, draw a vertical section through a portion of the external wall, doorframe, door and first floor joists. The section should show the typical construction details from 400 mm below the top of the door to a level 500 mm above the first floor joists. Include typical dimensions.

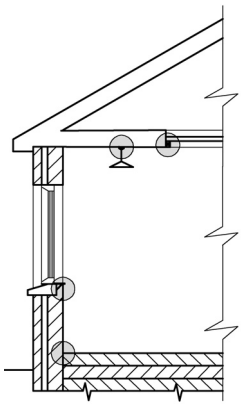
(b) Show clearly on your drawing the position of the vapour control layer to ensure an airtight structure.

8. **(a)** Show, using notes and freehand sketches, the correct wiring layout for **two** electrical sockets in a ring mains circuit for a domestic electrical installation. Indicate on your sketch the sizes and the colour coding of all electrical cables used in the circuit.

(b) Show, using notes and freehand sketches, **two** safety features that should be incorporated into the design of the above circuit to ensure that the circuit is safe for all users.

(c) Discuss in detail **two** strategies that would ensure the economical use of electricity in the home.

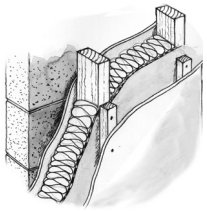
9. Designing for airtightness presents one of the most challenging aspects of contemporary house design.



(a) Discuss in detail the importance of careful design detailing in improving the airtightness performance of a dwelling house.

(b) The drawing shows an outline section through a portion of a single storey house of timber frame construction. The outer leaf is of rendered concrete block and the ground floor is an insulated solid concrete floor.
Select any **three** locations from those circled on the sketch and show, using notes and freehand sketches, the typical design detailing which will prevent air leakage at **each** of the locations selected.

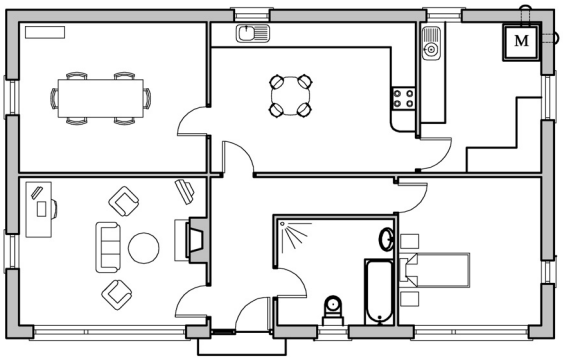
(c) Discuss the advantages of including a service cavity in an external wall of timber frame construction, as shown in the accompanying sketch.



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

- building form
- indoor environment
- energy performance.

(b) It is proposed to install a Mechanical Heat Recovery with Ventilation (MHRV) system for a Passive House, as shown in the drawing. The location of the MHRV unit - **M** - in the utility room is shown.
Draw a single line diagram of the given plan and show a typical design layout for the ducting to such a unit. Indicate clearly the direction of airflow in all the ducts and describe how a Mechanical Heat Recovery with Ventilation (MHRV) system works.



***Note**:*
While a plan of the room layout is required, it is not necessary to show the furniture.

(c) Discuss in detail **two** advantages and **two** disadvantages of Passive House construction.

OR

10. "A sustainable ethos in building will require the consideration of environmental implications associated with design, construction and operation of buildings and neighbourhoods; and greater emphasis on the improvement of existing buildings. Most buildings are used for several decades, and many survive for centuries. As the community's principal physical asset, getting good value requires that the building's full life cycle be considered, avoiding short-sighted attempts to merely minimise initial cost."

THE GREEN VITRUVIUS – PRINCIPLES AND PRACTICE OF SUSTAINABLE ARCHITECTURAL DESIGN (2011)
by Vivienne Brophy and J Owen Lewis (UCD). - *Earthscan Ltd, 14a St Cross Street, London ECIN 8XA, UK*

Discuss the above statement in detail and propose **three** guidelines that would promote the development of environmentally sustainable housing in Ireland.

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination, 2013

Construction Studies

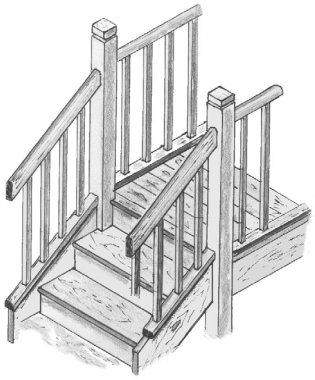
Theory - Higher Level

(300 marks)

Friday, 14 June
Afternoon, 2:00 to 5:00

(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.*

1. A closed-string wooden stairs leads to a landing with balustrade, as shown in the sketch. The landing has a hardwood tongued and grooved floor, on 200 mm × 50 mm joists with a plasterboard ceiling beneath. The newel post is 100 mm × 100 mm and the rise of a step should not exceed 175 mm.



(a) To a scale of 1:5, draw a vertical section through the centre of the stairs and through the landing. The section should show the typical construction details through the top three steps of the stairs and the landing, showing the newel post, balusters and handrails to the stairs and landing. Include the typical dimensions of **three** structural members of the stairs. Show the typical handrail height to stairs ***and*** landing.

Note*: On your drawing, show a 500 mm length of landing.*

(b) Indicate on your drawing **two** design features that ensure that the stairs is safe for all users.

2. **(a)** Discuss in detail the importance of **each** of the following in the development of a safety culture amongst workers on a construction site:

- training
- vigilance
- teamwork.

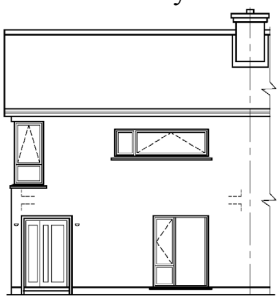
(b) Identify **two** possible risks to personal safety associated with **each** of the following:

- using a ladder on a construction site
- fitting a window in the second storey of a dwelling house.

Using notes and freehand sketches as appropriate, outline **two** specific safety procedures that should be observed to eliminate **each** risk identified at **2(b)** above.

(c) Recommend **three** best practice guidelines that should be observed when using electrical tools on a construction site.

3. The drawing shows the elevation, ground floor plan and portion of the rear garden of a two-storey semi-detached house. The rear wall **B-B** of the house is south facing.
The external walls are 350 mm concrete block walls with an insulated cavity.
All internal walls are of 100 mm solid block construction and the internal wall **A-A** is load-bearing.

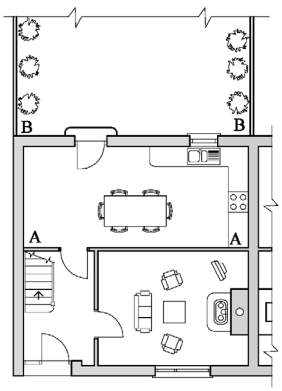


It is proposed to build a single-storey extension to the rear of the house to:

- allow increased sunlight into the interior of the house

and

- improve the view to the rear garden.

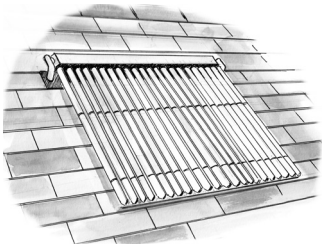


(a) Show, using notes and freehand sketches, a proposed design for the extension to the rear of the dwelling house ***and*** a revised layout for the ground floor to include the extension.

(b) For **each** of the above, discuss in detail the reasons for your proposed design choices.

4. It is proposed to use a wood-burning stove combined with a solar collector to provide central heating and hot water for a two-storey house.

(a) Using notes and a single-line diagram, show a typical design layout for the heating system and the domestic hot water system. Show two independently controlled heating zones, one on each floor, and include **three** radiators on each floor. Indicate the location of the control valves and give the typical sizes of the pipework.



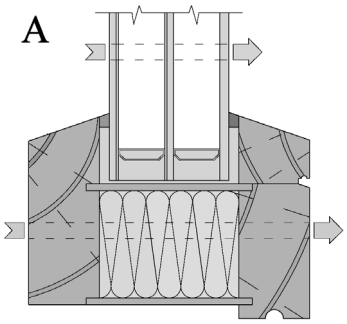
(b) Using notes and freehand sketches, discuss **two** design considerations that should be taken into account when siting a solar collector, as shown, to ensure maximum efficiency.

(c) Discuss in detail **two** advantages and **two** disadvantages of the heating system outlined at **4** above.

5. A section through a triple-glazed, high performance wooden window is shown at **A**. The frame is a thermally broken, insulated frame as shown. Two of the panes of glass have a low-emissivity (low-e) coating and the spaces between the panes are filled with argon gas.
A section through a traditional single-glazed solid wooden window is shown at **B**.

(a) For window **A**, using the given data, calculate the U-value of **each** of the following:

- the thermally broken wooden frame
  and
- the triple glazed argon-filled glazing unit.



Glass	thickness	4 mm
Space between panes of glass	each space	20 mm
Wood in thermally broken frame	each piece	30 mm
Rigid urethane insulation in frame	thickness	60 mm

Data for thermally broken wooden frame:

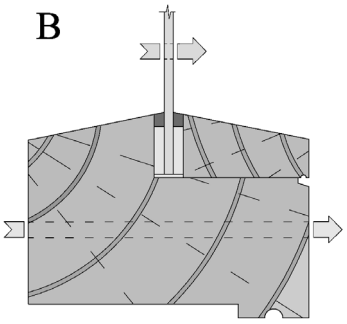
Conductivity of wood	(k)	0.150	W/m °C
Conductivity of rigid urethane insulation	(k)	0.021	W/m °C
Resistance of external surface of frame	(R)	0.950	m^2 °C/W
Resistance of internal surface of frame	(R)	1.400	m^2 °C/W

Data for triple-glazed unit:

Conductivity of glass	(k)	1.050	W/m °C
Conductivity of argon gas	(k)	0.160	W/m °C
Resistance of external surface of glass	(R)	0.075	m^2 °C/W
Resistance of internal surface of glass	(R)	0.110	m^2 °C/W
Total resistance of the low-e panes of glass	(R)	3.400	m^2 °C/W

(b) The traditional single-glazed solid wooden window shown at **B** has the following U-values:

- U-value of the solid wooden frame 0.317 W/ m^2 °C
- U-value of the single glazing 5.300 W/ m^2 °C



Using the U-values of the high performance window frame and glazing unit obtained at **5(a)** and the U-values of the traditional single-glazed wooden window given at **5(b)** above, discuss the performance of both windows under the following headings:

- thermal properties
- environmental considerations.

(c) Using notes and freehand sketches, show the design detailing of a window which is fixed in a 350 mm concrete block wall with an insulated cavity, to ensure minimum heat loss.
Note: *Show design details at the window head only.*

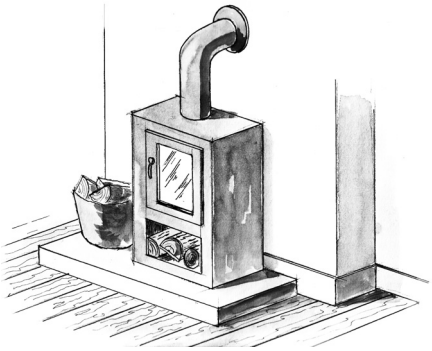
6. The elevation and ground floor plan of a house are shown. The house has three bedrooms and a bathroom in the attic space. The external wall is of timber frame construction with a rendered concrete block outer leaf. The house is designed to have low environmental impact and be suitable for first-time buyers.

(a) With reference to the design shown, discuss in detail, using notes and freehand sketches, **three** features of the design that contribute to the house having a low environmental impact.

(b) Discuss in detail the importance of **each** of the following when designing a house suitable for first-time buyers:

- modest in scale
- easy to modify
- proximity to services.

7. A chimney is designed to accommodate a modern wood-burning stove, as shown in the accompanying sketch. The chimney is located on an internal 215 mm solid concrete block wall between the living room and the kitchen. The flue from the stove to the main flue liner is 150 mm in diameter. The floor is an insulated solid concrete ground floor with a 20 mm floating hardwood finish.
The dimensions of the stove are: height 700 mm, width 550 mm, depth 450 mm.



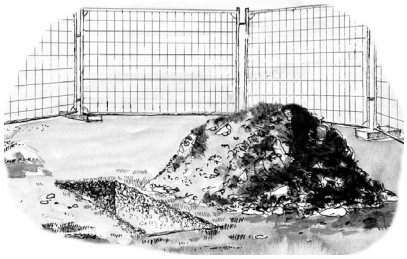
(a) To a scale of 1:5, draw a vertical section through the ground floor, hearth and chimney. The section should show the typical construction details from 400 mm below the finished floor to a level 300 mm above the top of the flue from the stove, and include the connection to the main flue liner in the chimney. Include **three** typical dimensions on your drawing.

(b) Indicate clearly on the drawing how the flue liners in the chimney are joined to ensure the safe removal of smoke and flue gases.

Note: *Show an outline of the stove only; it is not necessary to show a detailed drawing of the stove.*

8. **(a)** Discuss in detail, using notes and freehand sketches, **two** functional requirements of a foundation suitable for a dwelling house.

(b) A trial hole, as shown in the sketch, indicates a moderately firm clay subsoil for the foundations of a dwelling house. The external wall of the house is a 350 mm solid concrete block wall with an insulated cavity.
Consideration is being given at the design stage to using either:

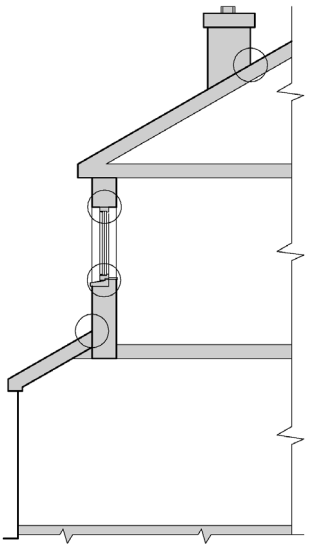


- a traditional strip foundation ***or***
- a raft foundation.

Show, using notes and annotated freehand sketches, the typical design detailing for **each** type of foundation.
Recommend a preferred foundation for the house and give **two** reasons for your recommendation.

(c) Discuss in detail **three** best practice guidelines that should be observed to ensure the maximum strength of concrete in a foundation.

9. A two-storey house, as shown in the drawing, is of timber frame construction with a rendered concrete block outer leaf. The chimney is also of rendered concrete block construction and both roofs are slated. Careful design detailing is required to prevent the penetration of dampness at the critical junctions circled in the drawing.



(a) Select any **three** locations from those circled on the drawing and show, using notes and freehand sketches, the typical design detailing which will prevent the penetration of dampness at **each** location.

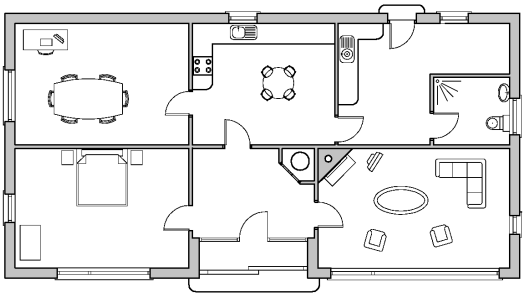
(b) Select any **two** junctions and specify a damp-proofing material suitable for each junction. Discuss the advantages of each material for the specified junction.

(c) Discuss in detail the importance of ensuring that moisture does not penetrate to the inner leaf of a wall of timber frame construction.

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

- building orientation
- thermal mass
- primary energy demand.

(b) It is proposed to install a Mechanical Heat Recovery with Ventilation (MHRV) system in a Passive House, as shown in the drawing.
Draw a single line diagram of the given room layout and indicate a preferred location for the MHRV unit. Show a typical design layout for the ducting to the MHRV unit and indicate clearly the direction of airflow in all the ducts. Describe how a Mechanical Heat Recovery with Ventilation (MHRV) system works.



Note: *Show a plan of the room layout only, it is not necessary to show the furniture.*

(c) Discuss in detail **two** design considerations that should be taken into account when deciding a preferred location for the MHRV unit in a Passive House.

OR

10. "It is worth questioning whether a large house built to passive standards but remote from schools, shops or workplace, may in the long term be less sustainable than a modestly-sized home built within walking or cycling distance from daily destinations. The cost of energy required to power but also to transport goods and people from place to place will increasingly form part of the debate on sustainability. Passive living is not just a factor of the energy rating of the fabric of the house, but of an holistic approach to how we as a society think about dwelling, about the reuse of existing space in the first instance and about the appropriateness of scale".

From House to Home: a long conversation - Orla Murphy, School of Architecture, UCD
HOUSE - AN EXHIBITION OF 21ST CENTURY HOMES IN THE WEST OF IRELAND (2012)
AVAYA: 25-29 Mervue Business Park, Mervue, Galway

Discuss the above statement in detail and propose **three** guidelines that would promote the development of environmentally sustainable housing in Ireland.

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination, 2014

Construction Studies

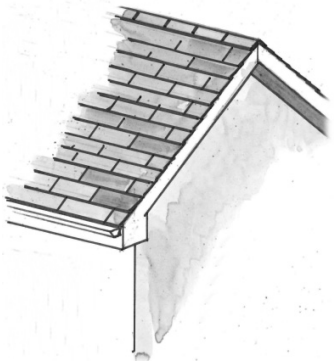
Theory - Higher Level

(300 marks)

Friday, 13 June
Afternoon, 2:00 to 5:00

(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.*

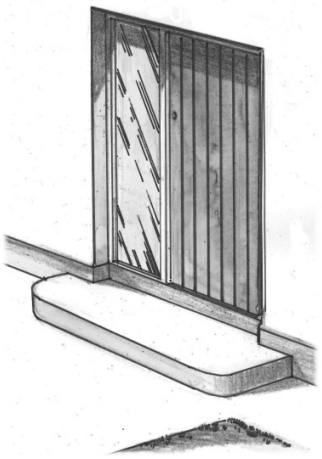
1. The sketch shows portion of the roof and external wall of a single-storey dwelling house.
The house has an internal span of 6.0 metres. The external wall is of timber frame construction, with a rendered concrete block outer leaf, a 200 mm timber frame inner leaf and a 60 mm insulated service cavity.
The roof, which is slated, has prefabricated trussed rafters and is pitched at 30 degrees.



(a) To a scale of 1:10, draw a vertical section through one external wall and one rafter length. Show the typical construction details from 400 mm below the ceiling joists, through the external wall and eaves, up to ridge level. Include the ventilation path to the roof and show **three** courses of slate at eaves.
Include **three** typical dimensions of the roof structure.

(b) Indicate clearly the design detailing to ensure airtightness at the junction of the ceiling and the external wall.

2. The sketch shows the main entrance to a dwelling house. It has been decided to upgrade this entrance to ensure that everybody can enter the house without special assistance.



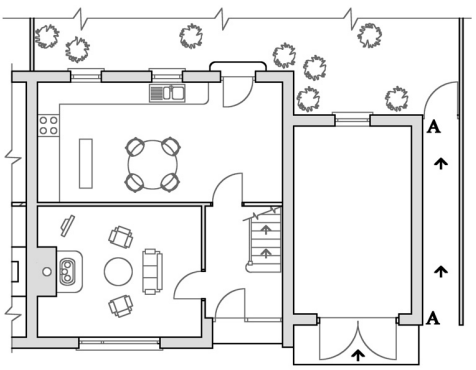
The following is to be provided at the main entrance:

- threshold and access ramp
- weather protection
- suitable lighting.

(a) For **each** of the above, using notes and freehand sketches, show appropriate design detailing to ensure that the house is accessible to all. Justify your design choices and include dimensions as appropriate.

(b) Discuss in detail **two** reasons why provision for lifetime use should be considered at the design stage of a dwelling.

3. The drawing shows the elevation, the ground floor plan and portion of the rear garden of a two-storey semi-detached house with an adjoining flat roofed storeroom.
The storeroom wall **A-A** is south facing. The external walls are 350 mm concrete block walls with a full-fill insulated cavity.
Planning permission is being sought to convert the storeroom to an attractive space suitable for use as a study.



(a) Discuss in detail **three** functional requirements of a space suitable for use as a study.

(b) Using notes and freehand sketches, show a proposed design layout for the study incorporating **each** functional requirement you have specified.

(c) Using notes and freehand sketches, show a revised external design for the study that will enhance its visual appearance.

4. A house in the vernacular tradition, as shown in the sketch, was built over 100 years ago without insulation and is now in need of significant refurbishment. The occupants have decided to refurbish the house on a step-by-step basis over a number of years.

(a) Discuss **two** advantages and **two** disadvantages of adopting a step-by-step approach to the refurbishment of the house.

(b) A survey of the house reveals:

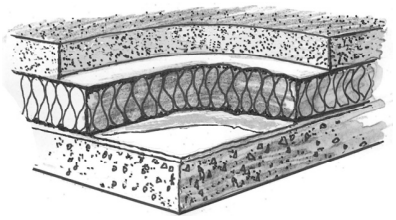
- external random rubble stone walls, 450 mm in thickness, with an internal and external lime render
- traditional cut roof with natural slates
- suspended timber ground floor.

Select any **two** of the above areas and, using notes and freehand sketches, describe the steps involved in upgrading **each** area selected.

Show how the refurbishment should be carried out in a manner that respects the character of the original house and ensures the reuse of materials.

5 **(a)** Using the following data, calculate the U-value of the insulated concrete ground floor:

Concrete floor slab	thickness	125 mm
Extruded polystyrene insulation	thickness	200 mm
Damp proof membrane (DPM)	thickness	0.30 mm
Sand blinding	thickness	30 mm
Hardcore	thickness	225 mm



Thermal data of floor:

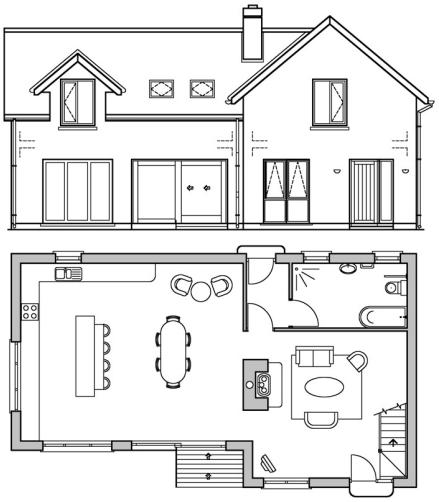
Resistance of top surface of floor	(R)	0.104	m^2	°C/W
Conductivity of concrete	(k)	0.160	W/m	°C
Conductivity of polystyrene insulation	(k)	0.031	W/m	°C
Conductivity of damp proof membrane (DPM)	(k)	0.450	W/m	°C
Conductivity of sand blinding	(k)	0.160	W/m	°C
Conductivity of hardcore	(k)	1.260	W/m	°C

(b) Using the U-value of the concrete ground floor obtained at **5(a)** above and the following data, calculate the cost of heat lost annually through the concrete ground floor:

Dimensions of floor	13.0 metres × 7.0 metres
Average internal temperature	21°C
Average external temperature	7°C
Heating period	12 hours per day for 39 weeks per annum
Cost of oil	95 cent per litre
Calorific value of oil	37350 kJ per litre
1000 Watts	1 kJ per second

(c) A solid concrete ground floor abuts a 350 mm concrete block external wall with an insulated cavity. Using notes and freehand sketches, show best practice design detailing which will prevent the formation of a cold bridge at the junction of the floor and the wall.
Show the typical design detailing from the bottom of the hardcore to the top of the skirting board.

6. The elevation and the ground floor plan of a house are shown. The house has three bedrooms and a bathroom upstairs. The external walls are of timber frame construction with a rendered concrete block outer leaf.
The house is designed to have low environmental impact.

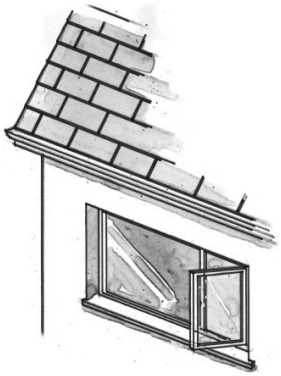


(a) With reference to the design shown, discuss in detail, using notes and freehand sketches, **three** features of the design that contribute to the house having low environmental impact.

(b) Describe, using notes and freehand sketches, **two** other design features that could be introduced to further reduce the environmental impact of the house.
Justify your choice of design features.

(c) Discuss the importance of designing low environmental impact housing.

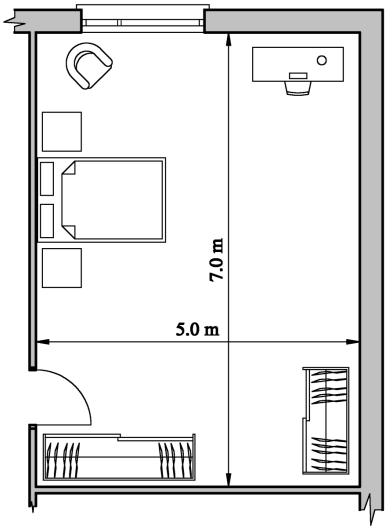
7. The sketch shows a wooden casement window fitted in the external wall of a dwelling house.
The window, which is 800 mm in height, is a triple glazed, high performance window with a thermally broken insulated frame.
The external wall is a 400 mm concrete block wall with a 200 mm full-fill insulated cavity. The wall has an external render and an internal hardwall plaster skim finish.



(a) To a scale of 1:5, draw a vertical section through the wall and the centre of the window. The section should show the typical construction details from 300 mm below the window cill, through the fixed frame of the window, to a level 450 mm above the window head.
Include **three** typical dimensions on your drawing.

(b) Indicate clearly on your drawing the typical design detailing to prevent the ingress of water at **both** the window head and cill.

8. It is proposed to redesign the existing bedroom shown in the drawing to accommodate a small en-suite bathroom. The bedroom is located on the first floor of the dwelling house.



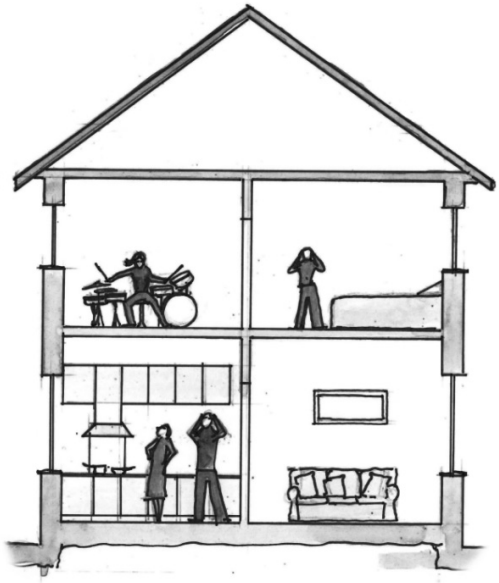
(a) Draw a freehand sketch of the bedroom shown and indicate a preferred location for the bathroom in the bedroom.
Show the location of the following:
door, window, shower, wash hand basin and *W.C.*
Justify your design choices.

(b) Using notes and freehand sketches, show the above-ground pipework necessary for the safe removal of waste from the shower, wash hand basin and W.C.
Include on your sketch typical sizes of the soil and vent pipe (*svp*) **and** of the waste pipe from each fitting.

(c) Outline **two** design considerations to ensure the economical use of water in the bathroom.

9. **(a)** Using notes and freehand sketches explain any **two** of the following:

- sound absorption
- sound reflection
- reverberation time.



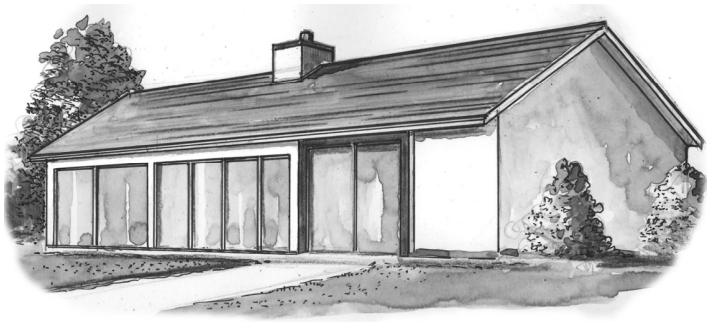
(b) A bedroom is located on the first floor of a house, directly above the kitchen, as shown in the sketch. Music from the bedroom can be heard in the adjoining rooms and in the kitchen beneath. The bedroom has a standard stud partition and a softwood floor on wooden joists, with a plasterboard ceiling beneath. It has been decided to upgrade the existing partition and floor to reduce the transmittance of sound from the bedroom.

Using notes and freehand sketches, show a revised design detailing that will reduce the transmittance of sound through the floor **and** the existing stud partition. Specify the materials to be used and give their typical dimensions.

(c) Explain the sound insulation principles associated with the design details you have shown.

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:

- building form
- indoor air quality
- foundation design.



(b) Using notes and freehand sketches, discuss the importance of orientation in the siting of a Passive House. Show the sun path in your sketch.

(c) A Passive House, as shown in the sketch, may overheat in summer. Discuss **two** reasons why overheating occurs and, using notes and freehand sketches, show **two** design details that would reduce the possibility of overheating.

OR

10. "Our common ground starts with the planet. As a species we have never been more vulnerable than we are today. The world is under stress and we are the cause of it. We are now at a tipping point and, as with all periods of great change, there is great opportunity. The world needs the way architects think, we should not keep ourselves aloof from the urgent situation we are in. The most resilient and sustainable form of human habitation is the town or the neighbourhood. We must build to create neighbourhoods. We must plan and design to avoid isolation and disconnection. We must design for what matters, which is ultimately happiness."

Adapted from: PRESIDENT'S INTRODUCTION - Michelle Fagan, President RIAI
IRISH ARCHITECTURE, Vol. 3, 2012 / 2013. RIAI, 8 Merrion Square, Dublin 2. ISBN: 978-0-9567493-2-1

Discuss the above statement in detail and propose **three** planning guidelines that would promote the development of resilient and sustainable neighbourhoods in Ireland.

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination, 2015

Construction Studies

Theory - Higher Level

(300 marks)

Friday, 12 June
Afternoon, 2:00 to 5:00

(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.*

1. The main entrance to a dwelling house is designed to facilitate ease of access for everyone. The door shown is a high performance insulated wooden door with vertical sheeting on both sides. The door frame is 150 mm × 70 mm in cross-section and is fixed in the external wall.
The wall has a 100 mm concrete block outer leaf, a 200 mm timber-frame inner leaf and a 60 mm insulated service cavity. The ground floor is an insulated solid concrete floor with a 20 mm quarry tile finish.

(a) To a scale of 1:10, draw a vertical section through the centre of the door. Show the typical construction details from 500 mm below finished floor, through the floor, the threshold, the external wall, the door and doorframe to a level 300 mm above the top of the door frame.

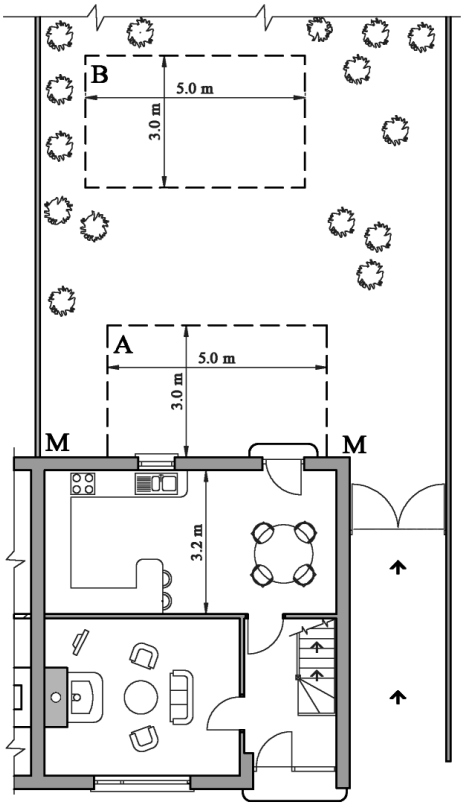
(b) On your drawing, show clearly the design detailing that ensures ease of access for all persons.

2. **(a)** Using notes and freehand sketches, discuss **three** functional requirements of an external wall for a new dwelling house.

(b) Using notes and freehand sketches, show the design detailing of **three** different, distinct external wall types suitable for a new dwelling house. For **each** wall type, specify the materials to be used and include typical dimensions.

(c) Evaluate the design of any **two** of the wall types at **2(b)** above. Recommend a preferred external wall type for a new house and justify your recommendation.

3. The drawing shows the ground floor plan of a two-storey semi-detached house and a portion of the rear garden. The external walls of the house are 400 mm concrete block walls with a full-fill insulated cavity.
The rear wall **M-M** is south facing.
The owners need an additional space for use as a study and occasionally as a family space. The space is to have internal dimensions of 5.0 metres × 3.0 metres as shown.



The following options are being considered:

(i) building a single-storey extension onto the rear of the house at **A**.

or

(ii) building a detached, free-standing space in the garden at **B**.

(a) Discuss in detail **two** advantages and **two** disadvantages of **each** option listed at (i) **and** (ii) above.

(b) Select **one** of the above options and, using notes and freehand sketches, show a proposed external design **and** internal layout for an attractive study/family space. Show in your design how the proposed space is to link with the surrounding rear garden.

(c) Discuss **two** advantages of designing a space that links with the rear garden.

4. **(a)** Discuss the importance of any **two** of the following in the eco-refurbishment of an old house built in the vernacular tradition:

- respect for local character
- breathable structure
- reuse of materials.

(b) A row of single-storey cottages is shown in the sketch. **One** of the cottages is in need of significant refurbishment.

A survey of the cottage reveals:

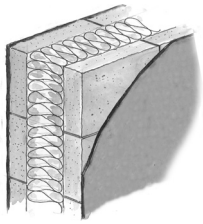
- un-insulated traditional cut roof with natural slates
- softwood windows, single-glazed with sliding sash
- un-insulated suspended timber floor.

Select any **two** of the areas at **4(b)** above and, using notes and freehand sketches, describe the steps involved in upgrading **each** area selected in a manner that respects the appearance and character of the original cottages.

5. **(a)** Using the following data, calculate the U-value of the external wall of a new dwelling house.
The wall is of concrete block construction, with a 250 mm cavity.
The cavity is a full-fill insulated cavity, with polystyrene bead insulation as shown.

Specification of external wall:

External render	thickness	16 mm
Concrete block outer leaf	thickness	100 mm
Cavity	width	250 mm
Concrete block inner leaf	thickness	100 mm
Internal plaster	thickness	12 mm



Thermal data of external wall:

Resistance of external surface	(R)	0.048	m^2	°C/W
Conductivity of external render	(k)	0.720	W/m	°C
Conductivity of concrete blocks	(k)	1.440	W/m	°C
Conductivity of polystyrene bead	(k)	0.031	W/m	°C
Conductivity of internal plaster	(k)	0.220	W/m	°C
Resistance of internal surface	(R)	0.122	m^2	°C/W

(b) Using the U-value obtained at **5(a) and** the data given below, calculate the cost of heat lost annually through the external walls of **each** of the following:

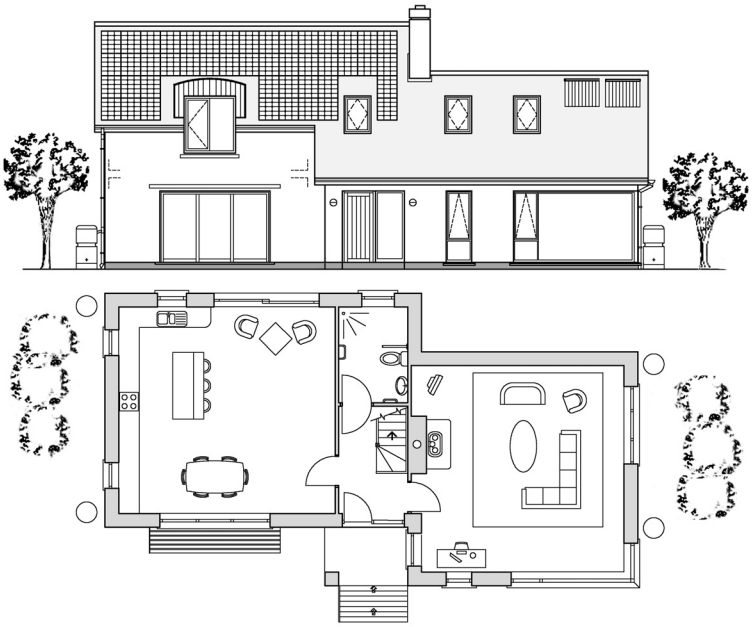
- the new house - as specified at **5(a)** above ***and***
- an existing house that complies with current Building Regulations, having a U-value of 0.21 W/m^2 °C for the walls.

Data for both houses:

Area of external wall of each house	150 m^2
Average internal temperature	20 °C
Average external temperature	6 °C
Heating period	8 hours per day, every day for 35 weeks per annum
Cost of oil	95 cent per litre
Calorific value of oil	37350 kJ per litre
1000 watts	1kJ per second.

(c) Using notes and freehand sketches, show best practice design detailing to prevent the ingress of water at the window head in the wall of the new house specified at **5(a)** above.

6. The elevation and ground floor plan of a house are shown. The house has three bedrooms and a bathroom upstairs. The external walls are of timber frame construction with a rendered concrete block outer leaf. The house is designed to maximise solar energy, as shown, and to have low environmental impact.



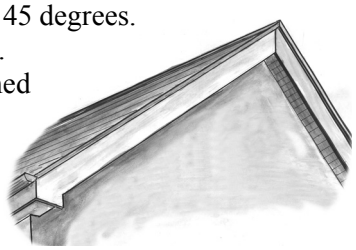
(a) Using notes and freehand sketches, discuss **three** features of the design that ensure that the house has low environmental impact.

(b) Using notes and freehand sketches, discuss the importance of any **two** of the following in designing a house to have low environmental impact:

- compact form
- flexible design
- low maintenance.

(c) Discuss in detail the importance of designing nearly zero energy buildings (NZEB) for the 21st century.

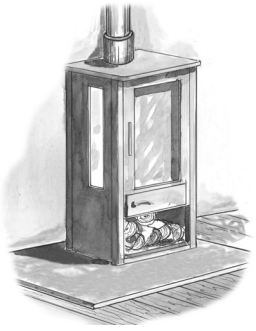
7. The roof of a new house, as shown, is a traditional cut roof and has a pitch of 45 degrees. The house has an internal width of 6.0 metres and the roof is highly insulated. Insulated plasterboard is also fixed to the underside of the rafters and is finished with a plaster skim coat. The external wall supporting the floor joists is a 400 mm concrete block wall with a full-fill insulated cavity. The 225 mm × 40 mm floor joists are supported centrally on a 100 mm internal load-bearing concrete block wall. The attic floor is finished with 25 mm tongue-and-groove floor boards.



(a) To a scale of 1:10, draw a vertical section through one half of the roof structure from eaves up to ridge, showing one external wall and one rafter length. Show the typical construction details from 500 mm below the floor joists up to the ridge and include three courses of slate at eaves. Include **four** typical dimensions of the roof structure.

(b) Include on you drawing, best practice design detailing to ensure ventilation of the roof structure.

8. A wood-burning stove combined with a solar collector is to provide central heating and hot water for a three bedroom, two-storey dwelling house.

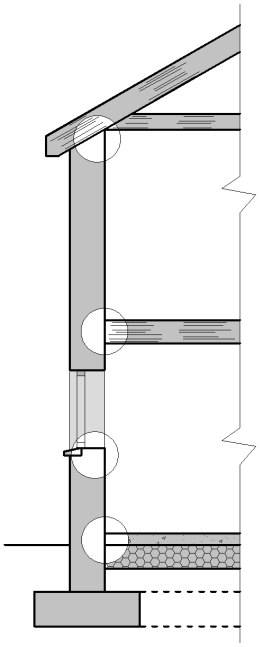


(a) Using notes and a single-line diagram, show a typical design layout for both the heating system **and** the hot water system. Show **two** independently controlled heating zones, one on each floor, and include **three** radiators on each floor. Indicate the location of the control valves and give the typical sizes of the pipework.

(b) Using notes and freehand sketches show a preferred location for a solar collector that will ensure its maximum efficiency.

(c) Using notes and freehand sketches, discuss **two** considerations that should be taken into account at the design stage of the house when selecting a location for **both** the chimney and the hot press. Justify your design choices.

9. It is proposed to design the external envelope of a dwelling house to be thermal bridge free. The drawing shows an outline section through a two-storey house having a 450 mm external concrete block wall with a 250 mm full-fill insulated cavity.
The roof is a traditional cut roof, the first floor has tongue-and-groove flooring on timber joists and the ground floor is an insulated solid concrete floor.

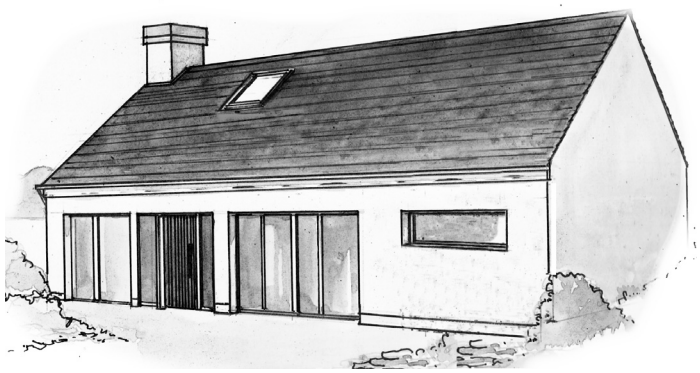


(a) Select any **three** locations from those circled on the drawing and, using notes and freehand sketches, show best practice design detailing that will prevent the formation of a thermal bridge at **each** location selected.

(b) Discuss the importance of designing a building envelope that is thermal bridge free.

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:

- airtight building envelope
- space heating demand
- indoor air quality.



(b) Using notes and freehand sketches, discuss the importance of thermal mass in the design of a Passive House.

(c) Using notes and freehand sketches, discuss the function of carefully designed solar shading for the Passive House shown.

OR

10. Light is what architecture is all about. It is as fundamental for the soul as air, fire, earth and water. Light has been one of the key elements of architecture since the Modern movement began (and glass technology improved) at the turn of the 20th century. Yet, light has traditionally been lacking in Irish homes. Many old cottages only have windows on the south side and none on the north. Now glass has improved and windows can be made with incredibly low U-values (meaning it doesn't let the cold through), so you can now have large glazed areas without heat loss. We need light and instinctively search for it. People move to the part of the room where there is natural light and children instinctively play in pools of light.

Adapted from *LOVE YOUR HOME Secrets to a Successful Space* by Dermot Bannon (2014)
Published by Gill & Macmillan. ISBN: 978 07171 6448 6

Discuss the above statement in detail and outline how advances in glazing technology have led to the increased use of glass in house design.
Recommend **three** best practice guidelines that would encourage better use of natural light in the design of contemporary dwelling houses.

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination, 2016

Construction Studies

Theory - Higher Level

(300 marks)

Friday, 17 June
Afternoon, 2:00 to 5:00

(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.*

1. A front porch with a flat roof projects 1.5 metres from the external wall of a house, as shown. The roof of the porch is insulated, and is covered with layers of bituminous felt, on plywood decking, on 200 mm × 40 mm roof joists. Insulated plasterboard is fixed to the underneath of the roof joists. The external wall of the porch and of the house is a 400 mm wall of concrete block construction with a full-fill insulated cavity. The window of the porch is triple-glazed, with a thermally broken wooden frame.

(a) To a scale of 1:5, draw a vertical section through the porch, showing the external wall, the flat roof and the window of the porch. Show the typical construction details from a level 300 mm below the fixed frame of the porch window, through the walls, the window head, lintels and flat roof to a level 400 mm above the abutment of the flat roof and the front wall of the house. Include **four** typical dimensions.

(b) Show on your drawing the design detailing to prevent the ingress of water at the junction of the flat roof and the main wall of the house.

2. **(a)** Discuss in detail the importance of **each** of the following in developing a positive safety culture among workers on a construction site:

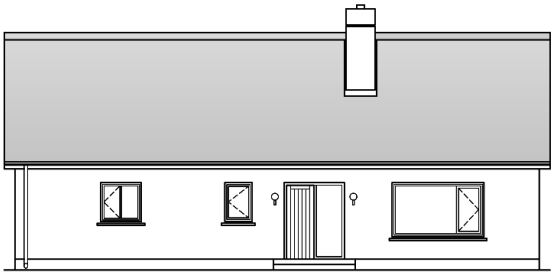
- safety training
- collective responsibility.

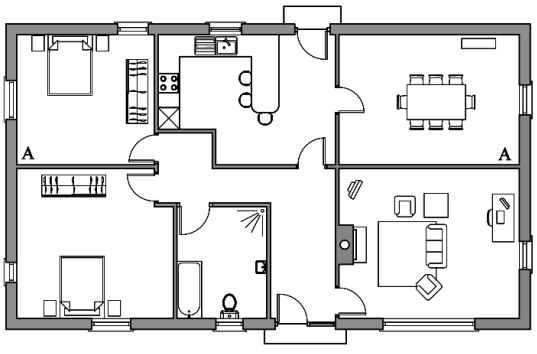
(b) Discuss in detail the importance of **each** of the following when deciding if the use of a ladder is appropriate, or not, for a proposed task:

- level of risk
- duration of task.

(c) Discuss in detail, using notes and freehand sketches, **three** specific best practice guidelines that should be observed when placing a ladder to access a scaffold platform on a construction site.

3. The drawing shows the plan and elevation of a two-bedroom bungalow built in the 1970s. The front elevation is south facing. The bungalow has a slated cut roof and a 300 mm external wall of concrete block construction with a full-fill insulated cavity. All internal walls are of 100 mm concrete block construction and the wall **A-A** is load-bearing.
In the existing design, many of the rooms have low levels of natural light.





(a) Show, using notes and freehand sketches, a revised design of the bungalow which will ensure a bright, light-filled interior.

In your revised design, you should consider:

- modifying the external envelope to improve the penetration of natural light

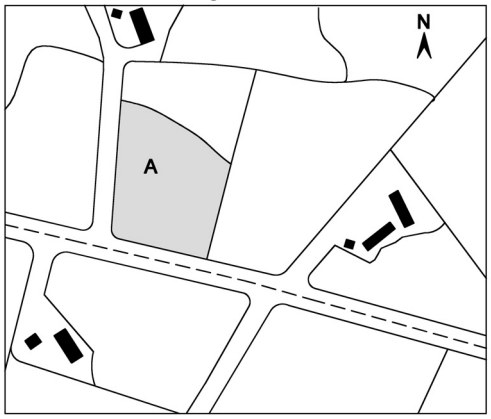
and

- revising the internal layout to optimise natural light.

(b) Discuss in detail the reasons for your proposed design choices in the redesign of the bungalow.

***Note**: It is not necessary to show the furniture in your design sketches.*

4. This site location map shows field boundaries, roadways and some domestic buildings. It is proposed to build a new house on the site marked **A**.



(a) Discuss in detail **three** reasons why site **A** may be considered suitable for a new house.

(b) Using a well proportioned freehand sketch, redraw the given site and the immediate surrounding boundaries. On your sketch show a proposed:

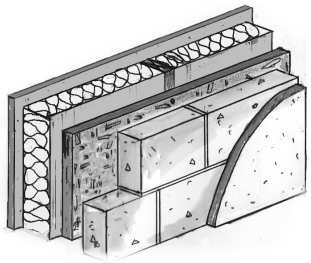
- location and orientation for a house on site **A**
- entrance gateway and access road to the house.

For **each** of the above, justify your design choices.

(c) Discuss in detail **two** advantages and **two** disadvantages of building one-off houses in the Irish rural landscape.

5. The external wall of a house of timber frame construction has the following specification:

External render	thickness	19 mm
Concrete block outer leaf	thickness	100 mm
Oriented Strand Board (OSB) sheeting	thickness	18 mm
Timber stud inner leaf	thickness	120 mm
Mineral wool insulation between studs	thickness	120 mm
Plasterboard	thickness	12.5 mm



Thermal data of outer leaf and cavity:

Resistance of the external surface	(R)	0.048	m^2	°C/W
Resistivity of the external plaster	(r)	2.170	m	°C/W
Conductivity of concrete block	(k)	1.320	W/m	°C
Resistance of the cavity	(R)	0.170	m^2	°C/W

Thermal data of inner leaf:

Conductivity of OSB sheeting	(k)	0.130	W/m	°C
Conductivity of mineral wool	(k)	0.040	W/m	°C
Conductivity of plasterboard	(k)	0.160	W/m	°C
Resistance of the internal surface	(R)	0.104	m^2	°C/W

***Note**: The timber studs of the inner leaf need not be considered in your calculations.*

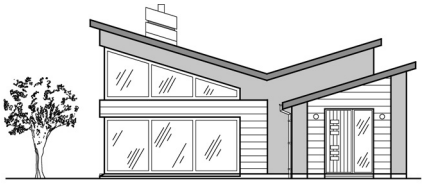
(a) Calculate the U-value of the above external wall.

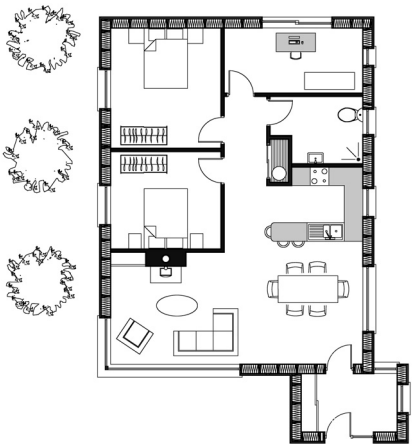
(b) Calculate the cost of heat lost annually through this wall, using the following data:

Area of external wall	150 m^2
Average internal temperature	18 °C
Average external temperature	6 °C
U-value of wall	as calculated above
Heating period	8 hours per day, every day for 38 weeks per annum
Cost of oil	96 cent per litre
Calorific value of oil	37350 kJ per litre
1000 Watts	1 kJ per second.

(c) It is proposed to upgrade the thermal properties of the above wall to meet the Passive House standard by fixing expanded polystyrene to the external surface. Given the thermal conductivity (k) of expanded polystyrene as 0.037 W/m °C, calculate the thickness of expanded polystyrene required to achieve a U-value of 0.15 W/m^2 °C.

6. The drawing shows a single storey house. The external walls are of insulated timber frame construction and are finished externally with rendered cement board and cedar cladding, as shown.
All internal partitions are of timber frame construction.
The house is designed to have low environmental impact.



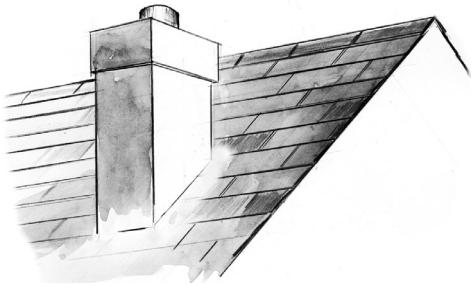


(a) Discuss in detail, using notes and freehand sketches, **three** features of the design that contribute to the house having low environmental impact.

(b) To meet the Nearly Zero Energy Building (NZEB) requirements, the production of on-site renewable energy is recommended. Using notes and freehand sketches show **one** means of generating on-site renewable energy for the dwelling house.

(c) Discuss in detail **two** advantages of generating renewable energy on-site.

7. A chimney stack projects through the pitched roof of a house as shown. The chimney stack is of solid concrete block construction with an external sand / cement render. The roof is a slated cut roof and is pitched at 45°.



(a) To a scale of 1:5, draw a vertical section through the chimney stack and roof structure. Show the typical construction details of the chimney stack, flue, chimney capping and portion of the adjoining roof structure. Include the design details to prevent the penetration of rainwater between the chimney stack and the adjoining roof surface.

(b) On your drawing, show **two** considerations to be taken into account in the design of the chimney stack shown which will help prevent a downdraught.
Include typical dimensions as appropriate.

8. The sketch shows a semi-detached house with a storeroom in the rear garden. The owners wish to undertake an eco-refurbishment of the storeroom to make it suitable for use as a home office.

(a) Discuss **two** advantages and **two** disadvantages of refurbishing the storeroom for use as a home office.

(b) A survey of the storeroom reveals:

- walls: random rubble, unrendered, 450 mm thick
- roof: uninsulated, traditional cut roof with natural slate
- floor: stone flags on earth.

Select any **two** areas from the above and, using notes and freehand sketches, show the design detailing necessary to upgrade the storeroom to make it suitable for use as a home office. The refurbishment should be eco-friendly and should respect the character and appearance of the original storeroom.

Justify your design choices.

9. **(a)** State where the following electrical circuits are typically used in a domestic dwelling:

- ring circuit
- radial circuit.

(b) Two electrical light points, as shown, are controlled by a single switch. Using an annotated freehand sketch, show the design of a typical electrical circuit for the lights. Show the circuit from the consumer electrical distribution board to the light points and switch. Indicate the typical sizes and colour coding of the electric cables. In your sketch, show **two** safety features in the design of the lighting circuit to ensure that it is safe for all users.

(c) Show **two** features that could be incorporated into the design of a lighting system to ensure the economical use of electricity in the house.

10. **(a)** Minimising heat loss and storing heat gain are important considerations in Passive House design. Using notes and freehand sketches, show best practice design detailing to minimise heat loss and maximise heat storage in a Passive House for any **two** of the following:

- foundations
- ground floor
- walls.

(b) The Passive House shown overheats in summer. Discuss **two** reasons why overheating occurs and, using notes and freehand sketches, show **two** design details for the house that would reduce the possibility of overheating.

(c) Discuss **two** advantages and **two** disadvantages of making the Passive House standard a planning requirement for all new housing in Ireland.

OR

10. One of the greatest challenges and opportunities for sustainable development is the reuse of our existing buildings for multiple uses. This gives vitality, density, security, utility and beauty to our countryside, villages, towns and cities.

Repairing and Reusing an 18th Century House – Report by Robin Mandal Architects.
Issue 283 - The Journal of the Royal Institute of the Architects of Ireland, 2015.

Discuss the above statement in detail and recommend **three** best practice guidelines that would promote the refurbishment and reuse of existing buildings in Ireland.

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination, 2017

Construction Studies

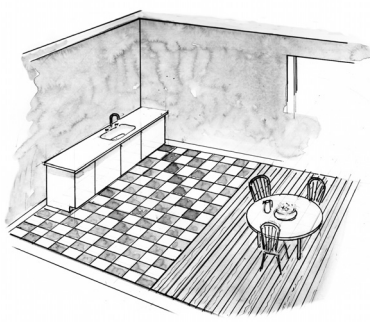
Theory - Higher Level

(300 marks)

Friday, 16 June
Afternoon, 2:00 to 5:00

(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.*

1. A dwelling house has an open-plan kitchen and dining area on the ground floor, as shown. The kitchen has a solid concrete floor with a 20 mm tile finish. The adjoining dining area has a suspended timber floor with a 20 mm tongue and groove hardwood finish on 200 mm × 40 mm joists. Both floors are highly insulated. The external wall of the house is a 400 mm concrete block wall with a full-fill insulated cavity.

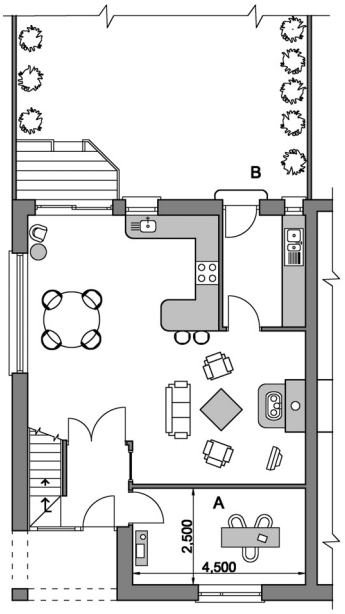


(a) To a scale of 1:10, draw a vertical section through the external wall of the kitchen and through **both** the concrete and timber floors. Show the typical construction details from the bottom of the strip foundation to a level 400 mm above the finished floor and include the abutment of both floors. Show a width of 1.5 metres for each floor.

***Note**: It is not necessary to show the kitchen cabinets or the furniture.*

(b) On your drawing show the typical design detailing for the cross ventilation of the suspended timber floor through the solid concrete floor.

2. **(a)** Discuss in detail, using notes and freehand sketches, **two** functional requirements of a bathroom designed for lifetime use.

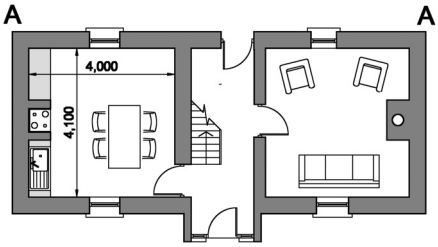


(b) The drawing shows the ground floor plan of a semi-detached house. The dimensions shown are in millimetres. It is proposed to provide a bathroom suitable for lifetime use by converting the office **A** into a bathroom. Discuss **two** advantages of converting the existing office **A** rather than building a new bathroom at location **B**, as shown.

(c) Using notes and freehand sketches, show a proposed design layout for the bathroom at **A**. On your design sketches, show the location of the shower area, W.C., wash basin and grab rails. Include appropriate dimensions.
On a separate sketch, show **one** design detail that will prevent the penetration of sewer gases into the bathroom at the W.C.

3. The drawing shows the ground floor plan and the front elevation of a farmhouse built in the 1950s. The dimensions shown are in millimetres. The walls are of random rubble construction and are rendered. The rear wall **A-A** is south facing. The owners intend to build a single-storey extension, not greater than 12.0 m^2 in area, to the rear of the kitchen. Consideration at the design stage is to be given to:

- optimising daylight into **both** the extension and the kitchen
- providing an open-plan kitchen/dining/living space.



(a) Using notes and freehand sketches show a proposed design layout that incorporates **each** of the above requirements.

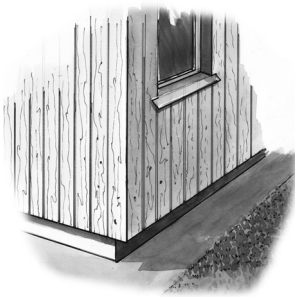
(b) Discuss **three** reasons for your proposed design layout.

(c) Discuss **two** advantages of building an extension to the farmhouse shown.

4. **(a)** Discuss**,** using notes and freehand sketches, **three** functional requirements of an external wall suitable for a new dwelling house.

(b) When specifying a high performance **external** wall for a new house, a choice is to be made between:

- a rendered cavity wall of concrete block construction ***or***
- a wall of timber frame construction with a rainscreen of cedar cladding, as shown ***or***
- a rendered wall of timber frame and hemp-lime construction.



Select any **two** of the above wall types, and using notes and freehand sketches, show the typical design detailing for **each** wall type selected.
Name the typical components of each wall and include typical dimensions.

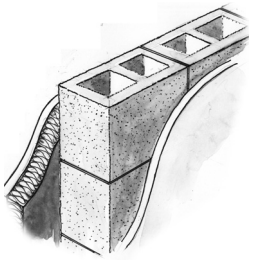
(c) Discuss the construction of **each** wall type selected under the following headings:

- environmental considerations
- ease of construction.

5. The external wall of a house built in the 1970s is of single-leaf, hollow-block construction with an external render. Plasterboard, with bonded expanded polystyrene, is fixed to the internal surface of the wall, as shown.

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

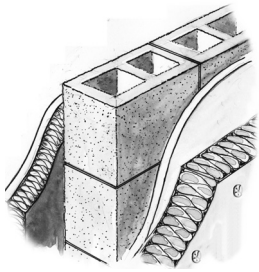
External render	thickness	16 mm
Hollow concrete block	thickness	215 mm
Expanded polystyrene	thickness	25 mm
Plasterboard	thickness	12.5 mm



Thermal data of external wall of house:

Resistance of external surface	(R)	0.048	m^2	°C/W
Resistivity of external render	(r)	2.170	m	°C/W
Resistance of concrete block	(R)	0.210	m^2	°C/W
Conductivity of expanded polystyrene	(k)	0.037	W/m	°C
Conductivity of plasterboard	(k)	0.160	W/m	°C
Resistance of internal surface	(R)	0.104	m^2	°C/W

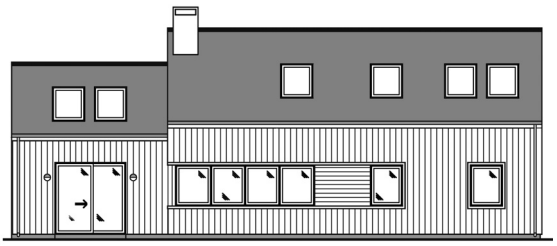
(b) It is proposed to upgrade the thermal properties of the above wall, to meet the Passive House standard, by fixing expanded polystyrene to the external surface, as shown. Using the given thermal data at **5(a)** above, calculate the thickness of expanded polystyrene required to achieve a U-value of 0.15 W/m^2 °C.

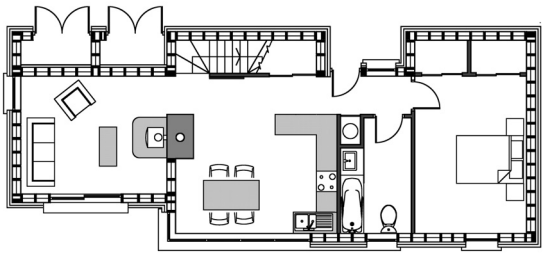


(c) Calculate the cost of heat lost annually through the upgraded wall at **5(b)** above, using the following data:

Area of external wall	140 m^2
Average internal temperature	18 °C
Average external temperature	6 °C
U-value of wall	0.15 W/m^2 °C
Heating period	8 hours per day, every day, for 36 weeks per annum
Cost of oil	98 cent per litre
Calorific value of oil	37350 kJ per litre
1000 Watts	1 kJ per second.

6. The drawing shows a dwelling house, which has two bedrooms and a bathroom upstairs.
The house is of timber frame construction with an external rainscreen of native larch.
The house is designed to be eco-friendly.





(a) Discuss in detail **two** advantages of eco-friendly house design in the 21st century.

(b) Using notes and freehand sketches, discuss in detail **three** features of the given design that contribute to making the house eco-friendly.

(c) Low operating costs are an important consideration in eco-friendly design. Using notes and freehand sketches, discuss **two** features that could be added to the design that would further reduce the operating costs of the house.

7. The slated roof of a new house is constructed using prefabricated trussed rafters and has a pitch of 45 degrees. The internal span of the house is 4.0 metres.
The roof is supported on external walls of timber frame construction, having a rendered concrete block external leaf.
Both the roof and the walls are highly insulated.

(a) To a scale of 1:10, draw a vertical section through the roof structure. Show the typical construction details from a level 400 mm below the ceiling up to ridge level, and include **both** external walls.
Show the typical design detailing at **one** of the eaves and include battens, membranes and **four** courses of slate at eaves. Label the components.

(b) On your drawing show the typical dimensions of **three** roof members.

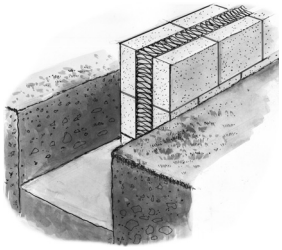
8. **(a)** Using notes and freehand sketches, discuss the importance of **each** of the following in providing adequate light on a work surface in a kitchen, as shown:

- natural light
- artificial light.

(b) A home office, as shown, measures 4.8 metres long by 3.5 metres wide. The office has a vertical window and unobstructed views. An average illumination of 500 lux of daylight is required on the work plane. Determine using the degree of efficiency method, or any other suitable method, the approximate area of glazing required to provide the stated illumination. Assume the illumination of a standard overcast sky to be 5000 lux.

(c) Using notes and freehand sketches, discuss **three** advances in glazing technology that make modern glazing systems more energy efficient.

9. **(a)** A reinforced concrete strip foundation supports a 400 mm concrete block external wall with an insulated cavity, as shown. Using notes and freehand sketches, show the typical design detailing of the **foundation**. Indicate the position of the reinforcement in the foundation. Specify **three** typical dimensions and discuss the reasons for the dimensions you have specified.



(b) Using notes and freehand sketches, discuss the importance of **each** of the following to ensure the maximum strength of concrete in the foundation:

- mixing
- placing
- compacting
- curing.

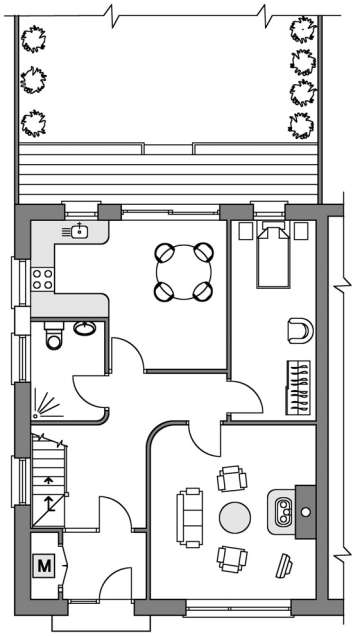
(c) Using notes and freehand sketches, describe **one** test that may be carried out to measure consistency in the quality of all concrete delivered to a site.

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

- airtightness
- indoor air quality
- solar shading.

(b) The diagram shows the ground floor plan of a semi-detached house. Also shown is the location **M** in the hallway, of the Mechanical Heat Recovery with Ventilation (MHRV) unit.

Draw a line diagram of the given room layout and show a typical design for the ducting to the MHRV unit. Indicate clearly the direction of the airflow in the ducts and describe how the MHRV system works.



(c) Discuss **two** advantages of siting the MHRV unit in the hallway, as shown.

OR

10. While there are undoubtedly many buildings whose heritage values dictate that they should be preserved unchanged, the reality is that few are of such importance that they and their settings are not capable of being remodelled to accommodate new uses - especially where they have outlived the functions for which they were constructed, and where adaptation and reuse is the most viable option for extending their lifespans and preserving the vitality of their urban locations. The alternative is to let them fall into disuse and disrepair, along with the ensuing deterioration of their urban environments.

Adapted from: **Use it or Lose it - Challenges in the Protection of Architectural Heritage** – by Paul Keogh.
VOL 6 IRISH ARCHITECTURE - THE RIAI ANNUAL REVIEW 2015/2016. ISBN: 978-0-9567493-5-2
Published by: The Royal Institute of Architects of Ireland, 8 Merrion Square, Dublin 2.

Discuss the above statement in detail and propose **three** best practice guidelines that would promote the adaptation and reuse of heritage buildings built after 1800, to prevent them from falling into disuse and disrepair.

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination, 2018

Construction Studies

Theory - Higher Level

(300 marks)

Friday, 15 June
Afternoon, 2:00 to 5:00

(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 are 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.*

1. A front porch projects 1.2 metres from the external wall of a dwelling house, as shown. The insulated wall of the porch is of timber frame construction with a rainscreen of vertical cedar cladding. The studwork is 250 mm × 50 mm.
The external wall of the house is a 400 mm rendered concrete block wall with a full-fill insulated cavity. The lean-to roof of the porch is an insulated slated roof and has a pitch of 30°. Insulated plasterboard is also fixed to the underside of the sloping rafters.

(a) To a scale of 1:5, draw a vertical section through the porch showing the external wall of the porch, the sloping roof, and the front wall of the house. Show the typical construction details of the porch from a point 300 mm below the wallplate, through the sloping rafters to a level 300 mm above and 200 mm below the abutment of the roof and the front wall of the house. Show **three** courses of slate at eaves.
It is not necessary to show window or door details.

(b) On your drawing, show the typical design detailing to prevent the ingress of rainwater between the roof of the porch and the front wall of the house.

Note: *Position your drawing carefully to ensure that the answer fits on the drawing sheet.*

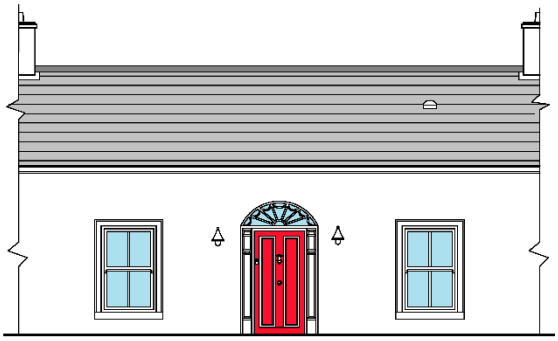
2. **(a)** Discuss in detail **one** possible safety risk associated with **each** of the following tasks on a construction site:

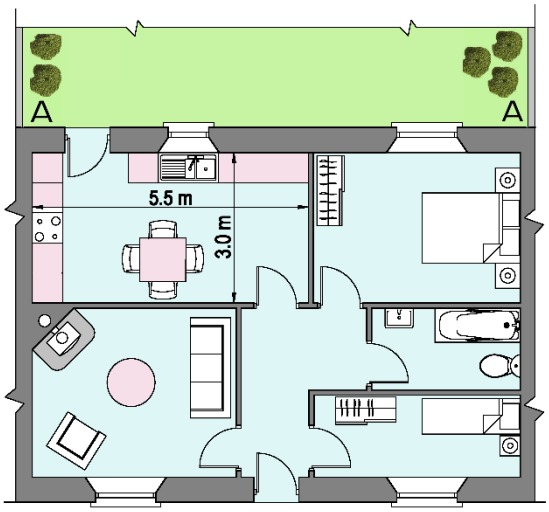
- excavating where there are underground electrical cables
- working in a deep trench
- working at height when slating a roof.

(b) For **each** risk discussed at **2(a)** above, show, using notes and freehand sketches, **two** best practice guidelines that should be observed to reduce the possibility of injury to a worker undertaking each task.

(c) Discuss in detail **three** strategies that would promote a positive safety culture among workers on a construction site.

3. The drawing shows the ground floor plan and the front elevation of a terraced cottage. Also shown is a portion of the rear garden. The walls of the cottage are of random rubble construction and are rendered. The rear wall **A-A** is south facing. To provide additional living space, and to enhance the health and wellbeing of the occupants, it has been decided to build a single-storey extension, not greater than 18.0 m^2 in area, to the rear of the cottage.





(a) Discuss **three** considerations that should be taken into account in the design of the extension to ensure that the health and wellbeing of the occupants is enhanced by building the extension.

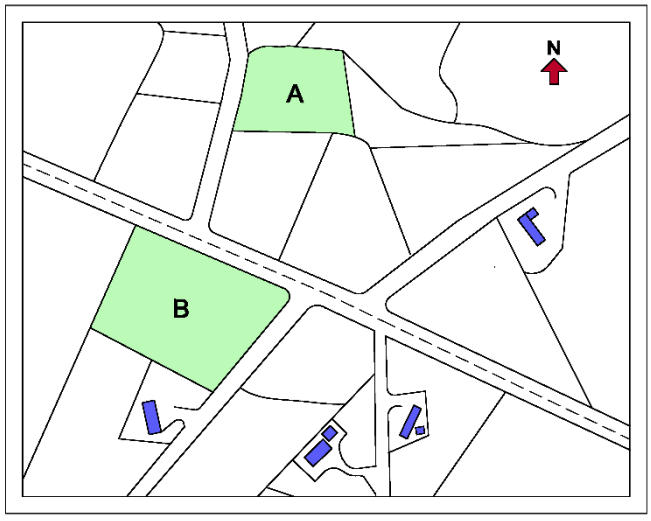
(b) Using notes and freehand sketches, show a proposed design layout for the extension and the necessary modifications to the existing layout of the cottage.

(c) Discuss how your proposed design meets **each** consideration discussed at **3(a)** above.

4. **(a)** Using notes and freehand sketches, discuss the importance of **each** of the following when identifying a suitable site for a new house in a rural landscape:

- characteristics of existing dwellings
- characteristics of the proposed site.

(b) An extract from a site location map is shown. **A** and **B** are possible sites for a new house. Select your preferred site and discuss **three** considerations you took into account when selecting your site.



(c) Draw a well-proportioned sketch of your selected site and the immediate boundaries.

On your sketch, show a preferred:

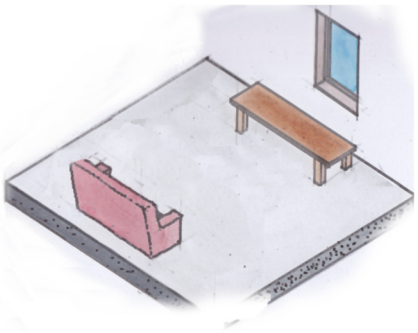
- location and orientation of a house on the site
- layout of the road entrance and the driveway to the house.

For **each** of the above, justify your design choices.

5. A house built in the 1970s has an uninsulated solid concrete ground floor, as shown, with a sand/cement fine screed finish.

(a) Calculate the U-value of the uninsulated concrete ground floor, given the following data:

Sand/cement fine screed	thickness	50 mm
Concrete floor slab	thickness	100 mm
Radon barrier	thickness	0.25 mm
Sand blinding	thickness	40 mm
Hardcore	thickness	200 mm
Subsoil	thickness	300 mm



Thermal data of the concrete ground floor:

Resistance of internal top surface of floor	(R)	0.104	m^2	°C/W
Resistivity of fine screed	(r)	0.710	m	°C/W
Conductivity of concrete floor slab	(k)	1.280	W/m	°C
Conductivity of radon barrier	(k)	0.250	W/m	°C
Conductivity of sand blinding	(k)	0.160	W/m	°C
Conductivity of hardcore	(k)	1.350	W/m	°C
Conductivity of subsoil	(k)	1.600	W/m	°C

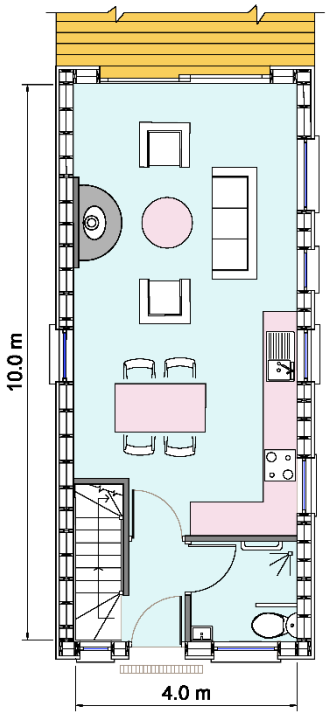
(b) Using the U-value of the concrete floor obtained at **5(a)** above and the following data, calculate the cost of heat lost annually through the uninsulated concrete floor slab:

- dimensions of floor slab — 6.0 metres × 12.0 metres
- average internal temperature — 21 °C
- average temperature of subsoil — 5 °C
- heating period — 10 hours daily for 38 weeks per annum
- cost of oil — 96 cent per litre
- calorific value of oil — 37350 kJ per litre
- 1000 Watts — 1 kJ per second.

(c) It is proposed to redesign the above floor and upgrade its thermal properties to meet the Passive House standard by including expanded polystyrene in the design of the floor.

Given the thermal conductivity (k) of expanded polystyrene as 0.037 W/m °C, calculate the thickness of expanded polystyrene required to achieve a U-value of 0.15 W/m^2 °C.

6. A young couple have obtained planning permission to build an eco-friendly house, with internal dimensions of 10.0 m × 4.0 m, as shown. There are two bedrooms and a bathroom upstairs. The couple have an interest in house construction and wish to self-build their house with the help of neighbours, family and friends. They have also engaged professional design supervision and an electrician. The house is of timber frame construction throughout, with an external rainscreen of native larch.



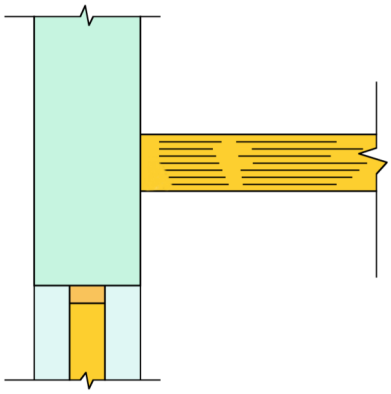
(a) Discuss **two** advantages and **two** disadvantages of self-build as a method of building a house.

(b) Discuss in detail, using notes and freehand sketches, **three** features of the design shown that make the house suitable as a self-build project.

(c) Suggest, using notes and freehand sketches, **two** modifications to the existing design that would further reduce the environmental impact of the house and help meet the nearly Zero Energy Building (nZEB) requirements.

Justify your design choices.

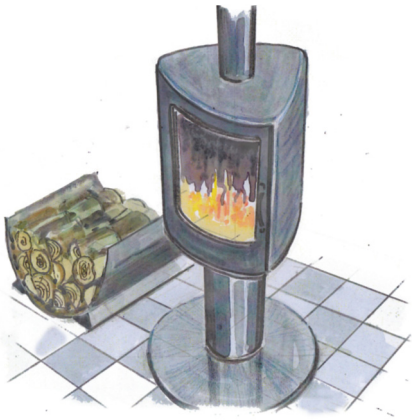
7. The main entrance door to a two-storey dwelling house is a high performance insulated wooden door, with vertical sheeting on both sides. The doorframe is thermally broken and is fitted in a 450 mm external concrete block wall with a full-fill insulated cavity. This external wall supports the first floor joists, as shown in the accompanying outline drawing. The first floor is a 25 mm floating wooden floor, on a 20 mm plywood deck, on 200 mm × 40 mm wooden joists, with a plasterboard ceiling beneath.



(a) To a scale of 1:5, draw a vertical section through a portion of the external wall, doorframe, door, first floor joists, and floor. Show the typical construction details from a level 400 mm below the top of the door to a level 300 mm above the first floor joists.

(b) Show clearly on your drawing best-practice design detailing to ensure airtightness at the junction of the external wall and the first floor.

8. A wood-burning stove as shown, combined with a solar collector, is used to provide central heating and hot water for a compact three bedroom, two-storey house.



(a) Using notes and a single-line diagram, show a typical design layout for both the central heating **and** the hot water systems. Show **two** independently controlled heating zones, one on each floor. Include **three** radiators on each floor and give the typical sizes of the pipework.

(b) Using notes and freehand sketches, describe **two** features that ensure that the system operates safely at all times. Discuss the importance of **each** safety feature outlined.

(c) Using notes and freehand sketches, show **two** design considerations that should be taken into account when selecting a preferred location of a chimney for the stove. Discuss the importance of **each** consideration outlined.

9. **(a)** Discuss in detail using notes and freehand sketches, **three** functional requirements of an attic space suitable for use as a bedroom.

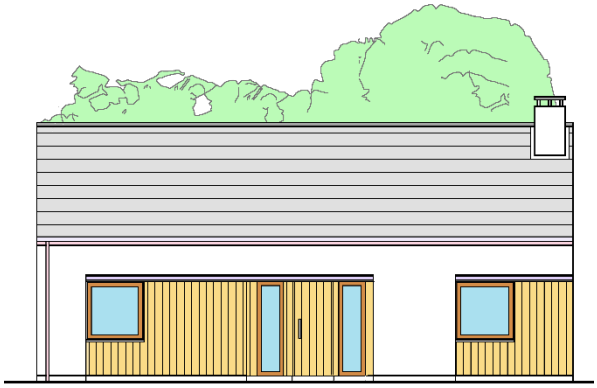
(b) A traditional cut roof, which is slated and has a pitch of 45°, is designed to provide a well-insulated bedroom in the attic space, as shown. Using notes and freehand sketches, show the typical design detailing for such a roof. Include the stud side walls and the insulation.
Show clearly the design detailing necessary to ensure the structural stability of the roof.
Label the main components and give their typical dimensions.

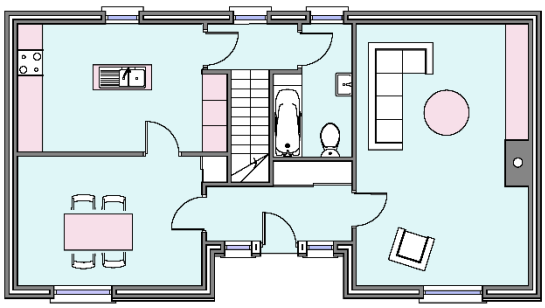
(c) On your sketch, show **one** design detail to prevent air leakage at the junction of the stud side wall and the sloped ceiling.

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

- space heating energy demand
- building form
- thermal bridging.

(b) The drawing shows a preliminary design of a dwelling house, having two bedrooms and a bathroom upstairs. The clients wish to upgrade this design to meet the Passive House standard.
Show, using notes and freehand sketches, **three** modifications you would make to this design to help meet the Passive House standard. Justify your design choices.





(c) Show, using notes and freehand sketches, a preferred orientation for your upgraded design.
Include the sun path in your sketch and discuss how your preferred orientation ensures the optimum thermal performance of the house.

***Note**: It is not necessary to show the furniture.*

OR

10. Green design is about being green, rather than simply appearing to be green. So greening your house is about more than just buying all sorts of expensive 'eco-bling' and adding it to your house. Ironically, that could be just another display of consumerism. Rather, greening your house is about making responsible environmental choices based on what you *want* to do, what you *can* do and what you can *afford*. This means that - before we get into the minutiae of sustainable building materials - we should address some fundamentals, chief among which is the need to build modestly and source locally.

From: **contemporary design secrets: the art of building a house in the countryside**
Jane Burnside (2013)
Published by: BOOKLINK. ISBN 978-1-906886-42-4

Discuss the above statement in detail and propose **three** best practice guidelines that would promote green, sustainable housing in Ireland.

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination, 2019

Construction Studies

Theory - Higher Level

(300 marks)

Friday, 14 June
Afternoon, 2:00 - 5:00

(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 are 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.*

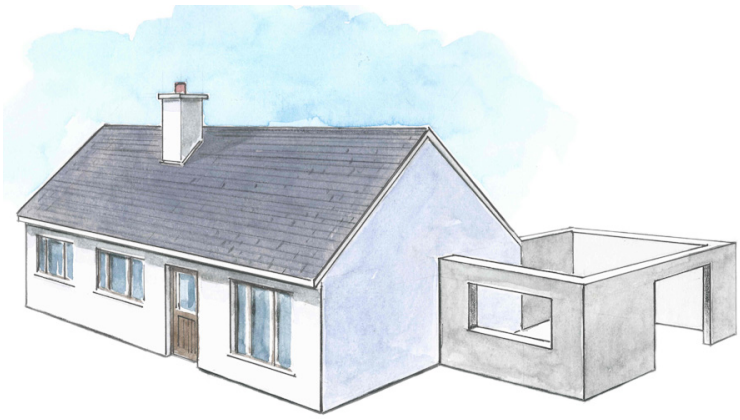
1. A triple glazed window with a wooden frame is fitted in the external wall of a dwelling house as shown. The fixed frame of the window is 100 mm × 80 mm. The wall is of timber frame construction with an external concrete block leaf. The internal timber frame is 250 mm × 50 mm and the outer leaf is of 100 mm concrete block construction with an external render finish. A 50 mm service cavity is also provided at the internal surface. Above the window head, an inset wooden panel is sheeted with vertical larch cladding of 130 mm × 20 mm to form an external rainscreen, as shown.
The window is 600 mm in height and has a thermally broken insulated frame.

(a) To a scale of 1:5, draw a vertical section through the fixed frame of the window and the external wall of the house. Show the typical construction detail from a level 400 mm below the window cill, through the window frame, up to a level 500 mm above the window head.

(b) On your drawing, show the typical design detailing to prevent the ingress of rainwater at the window cill.

2. **(a)** Discuss in detail, using notes and freehand sketches, **three** functional requirements of a roof suitable for a domestic dwelling house.

(b) The owners of a house located in a rural setting wish to build an extension to create an additional living space. The sketch shows the existing house and the proposed outline of the new extension at design stage.



Using notes and freehand sketches, show the design for **three** different, distinct roof profiles suitable for the proposed extension.

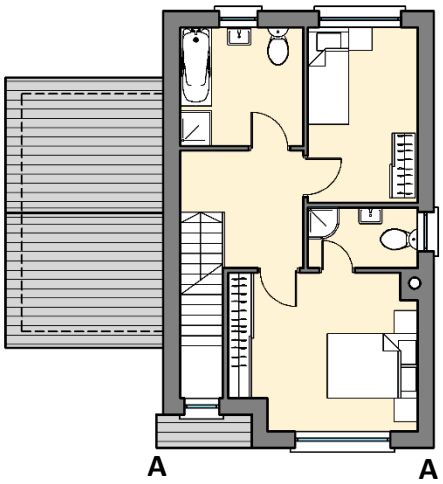
Recommend a preferred roof profile for the proposed extension **and** justify your recommendation.

(c) Select a different roofing material for **each** of the three roof types you have shown at **2(b)**. Give **one** advantage and **one** disadvantage for **each** material selected.

3. The drawing shows the elevation of a detached house and the plan of its first floor.
The front wall **A-A** is south facing.
The owners intend to apply for planning permission to build an additional bedroom and *en suite* bathroom. It is proposed to remove the roof of the single storey extension on the left and build the bedroom and bathroom over it.

(a) Discuss in detail, **three** design considerations for the proposed bedroom and *en suite* bathroom.

(b) Using notes and freehand sketches, show a proposed internal layout for the bedroom and *en suite* bathroom that incorporates each of the design considerations you outlined at **3(a)** above.
Justify your choices.



(c) Using notes and freehand sketches, show an external design for **your extension** that will enhance the overall visual appearance of the house.

4. The sketch shows a row of terraced townhouses built over 100 years ago. A young couple have purchased one of the houses and have decided to refurbish it as their family home.

(a) Discuss **three** benefits to the local community of refurbishing one of the townhouses as a family home.

(b) The owners commissioned a survey of the house which revealed the following:

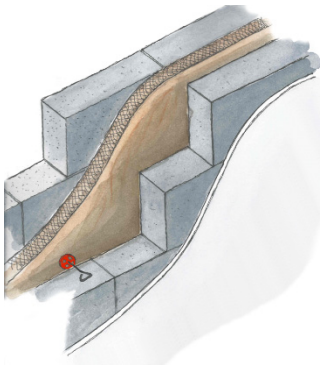
- traditional cut roof with natural slates
- softwood sliding sash windows with single-glazing
- solid external walls of brick construction, uninsulated and with internal lime render.

Select any **two** of the above areas and, using notes and freehand sketches, describe in detail the steps involved in upgrading each area selected in a manner that respects the appearance and character of the original townhouses.

5. The external wall of a house built in the 1990s is of 100 mm concrete block construction with a 100 mm partially filled cavity, as shown.

(a) Calculate the U-value of the wall, given the construction has the following sequence and data:

External render	thickness	16 mm
Concrete block outer leaf	thickness	100 mm
Clear cavity	width	50 mm
Polystyrene insulation	thickness	50 mm
Concrete block inner leaf	thickness	100 mm
Internal plaster	thickness	12 mm



Thermal data of the external wall:

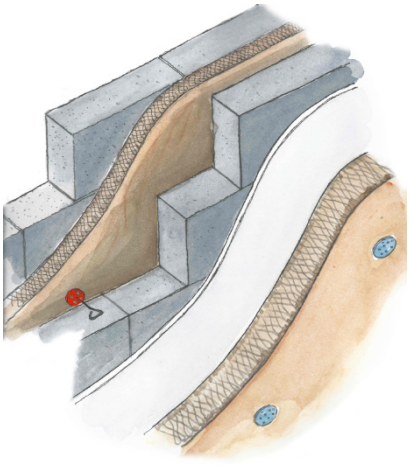
Resistance of external surface	(R)	0.048	m^2	°C/W
Resistivity of external render	(r)	2.170	m	°C/W
Conductivity of concrete external blockwork	(k)	1.440	W/m	°C
Resistance of clear cavity	(R)	0.170	m^2	°C/W
Conductivity of insulation	(k)	0.037	W/m	°C
Conductivity of concrete internal blockwork	(k)	1.440	W/m	°C
Resistivity of internal plaster	(r)	6.250	m	°C/W
Resistance of internal surface	(R)	0.122	m^2	°C/W

(b) Using the U-value of the wall obtained at **5(a)** above and the following data, calculate the cost of heat lost annually through this wall:

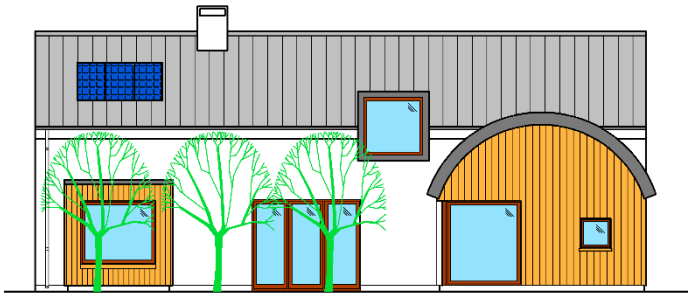
- area of external wall — 135 m^2
- average internal temperature — 19 °C
- average external temperature — 5 °C
- heating period — 9 hours daily for 36 weeks per annum
- cost of oil — 94 cent per litre
- calorific value of oil — 37350 kJ per litre
- 1000 Watts — 1 kJ per second.

(c) It is proposed to upgrade the thermal properties of the above wall, to meet the Passive House standard, by fixing expanded polystyrene to the external surface, as shown.

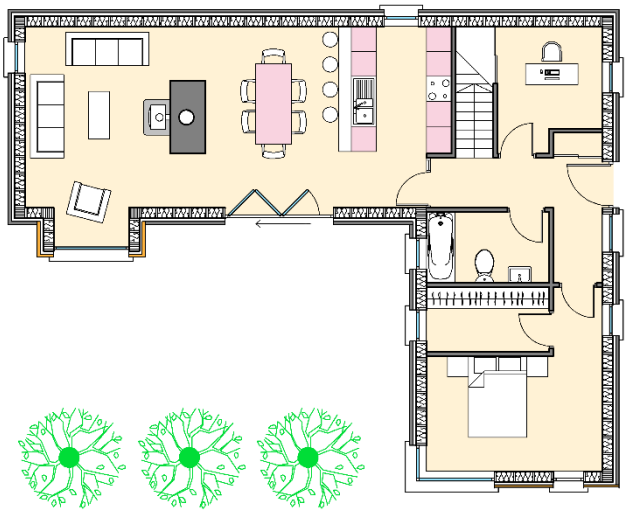
Given the thermal conductivity (k) of expanded polystyrene as 0.031 W/m°C, calculate the thickness of expanded polystyrene required to achieve a U-value of 0.15 W/m^2 °C.



6. The elevation and ground floor plan of a house are shown. The house has two bedrooms and a bathroom upstairs. The external walls are of timber frame construction with a rendered concrete block and timber cladding finish. The house is designed to have low environmental impact.



(a) With reference to the design shown, discuss using notes and freehand sketches, **three** features of the design that contribute to the house having a low environmental impact.



(b) Using notes and freehand sketches, discuss in detail **each** of the following renewable energy technologies and identify how each contributes to making a home more eco-friendly:

- evacuated tubes
- wind turbines
- photovoltaic panels.

(c) Discuss in detail **two** advantages of using local craft skills when building the house shown.

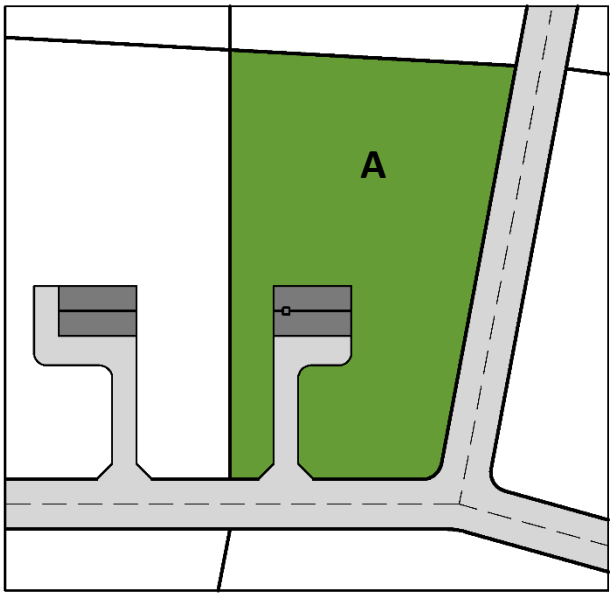
7. The main hall of a two-storey dwelling has a closed riser wooden stairs. The bottom of the stairs has a bullnose step as shown. The newel post is 120 mm × 120 mm and the rise of a step should not exceed 175 mm.

(a) To a scale of 1:5, draw a vertical section through the centre of the stairs. The section should show the typical construction detail through the bottom **three** steps of the stairs, showing the newel post, string, balusters and handrail.

Include the typical dimensions of **three** structural members of the stairs.

(b) Indicate on your drawing **three** design features that ensure the stairs is safe for users.

8. **(a)** Discuss **three** considerations to ensure the proper treatment and disposal of sewage when selecting a site for a house in a rural location.



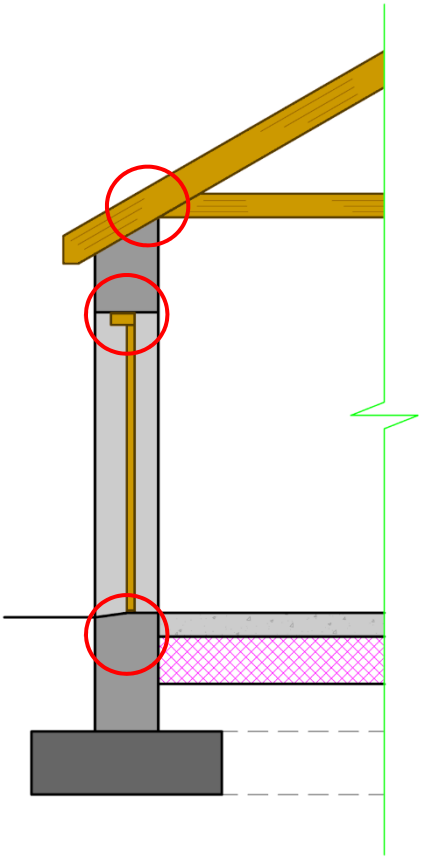
(b) The drawing shows a site layout map. The outline of a new house and driveway is shown on site **A**. Using notes and freehand sketches, show the design layout necessary for a typical wastewater treatment system and percolation area on this site.

Include typical dimensions for the system.

(c) Using notes and freehand sketches, discuss an alternative method, other than a typical percolation area to ensure the safe treatment of wastewater from a dwelling house.

9. Thermal envelope continuity is essential to ensure a dwelling house is thermal bridge free. The drawing shows an outline section through the external door of a single-storey house having a 450 mm external concrete block wall with a 250 mm full-fill insulated cavity.

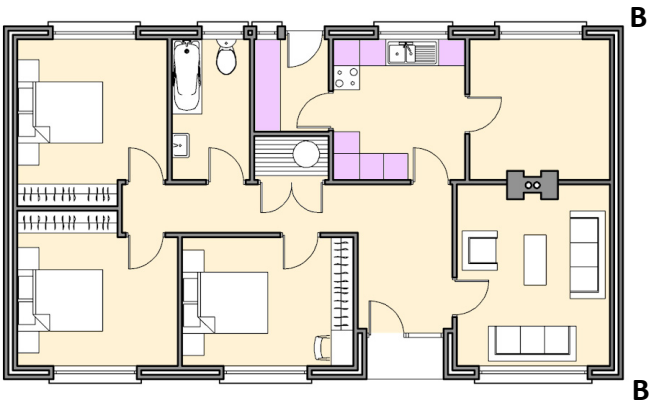
The house has a traditional cut roof with an insulated solid concrete ground floor. The external door and frame are thermally broken.



(a) Using notes and freehand sketches, show best practice design detailing that will prevent the formation of a thermal bridge at **each** location circled on the drawing.

(b) Discuss **two** negative impacts of thermal bridging as a result of poor design detailing.

10. The plan and elevation of a bungalow built in the 1970s are shown.
The wall **B-B** is south facing. The owners intend to carry out a deep retrofit upgrade of their house to meet the ***EnerPHit*** Passive House standard.



(a) Using notes and freehand sketches, outline **three** design considerations necessary to achieve the ***EnerPHit*** Passive House design standard.

(b) Discuss in detail, using notes and freehand sketches, how you would retrofit the given house to include each consideration you specified at **10(a)** above.

(c) Discuss **two** advantages of retrofitting an existing house to meet the ***EnerPHit*** standard.

OR

10. "Global warming is now a generally recognised phenomenon and sustainability is recognised as being a necessity, not an option. One of the main culprits blamed for global warming is carbon dioxide (CO_2), so it is worth taking a look at what can be done about it.
CO_2 is produced by each of us every day, and our personal carbon footprint is a measure of how many tonnes of CO_2 are emitted directly or indirectly, as a result of the consumption of goods and services. When building your own home you should take every opportunity to build in the most sustainable way so as to minimise your own carbon footprint."

Adapted from: **Building Your Own Sustainable and Energy Efficient House.**
by Henry Skates
Published by: The Crowood Press Ltd. ISBN: 978-1-84797-258-3

Discuss the above statement in detail and propose **three** best practice guidelines that would ensure that buildings are built in the most sustainable way possible and thus minimise their carbon footprint.

There is no examination material on this page

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination, 2020

Construction Studies

Theory - Higher Level

(300 marks)

3 hours

(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 are 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.*

1. The sketch shows a dwelling house with a traditional slated cut roof. The roof has a pitch of 30^{o} and flush eaves as shown. The internal span of the house is 6.0 metres and the roof is highly insulated. The external wall of the house is a 215 mm single leaf wall of solid concrete block construction with 200 mm external insulation and acrylic render external finish. Insulated plasterboard is fixed to the underside of the ceiling joists. A 50 mm service cavity is also provided at the internal surface of the wall.

(a) To a scale of 1:10, draw a vertical section through one half of the roof structure from just below eaves up to ridge. Show one external wall and one rafter length. Include the typical construction details from 600 mm below the ceiling joists up to the ridge and include **three** courses of slate at eaves.

Include **four** typical dimensions of the roof structure.

(b) On your drawing, show the typical design detailing to ensure ventilation of the roof structure.

2. **(a)** Discuss in detail, using notes and freehand sketches, **two** specific best practice guidelines to be observed for **each** of the following when using scaffolding on a construction site:

- erecting scaffolding
- accessing scaffolding
- use of working platforms.

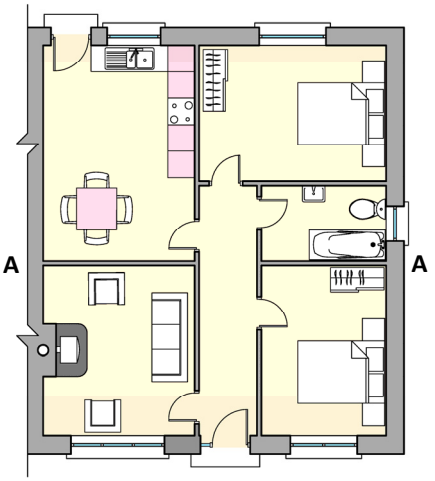
(b) The on-site Health and Safety Officer performs a key role in maintaining a safe working environment on a construction site.

Discuss in detail **three** responsibilities of a Health and Safety Officer on a construction site.

3. The drawing shows the floor plan and front elevation of a semi-detached bungalow. The internal wall **A-A** is load-bearing. The rear wall of the house is south facing.

The owners intend to modify the internal layout to:

- make it fit for use by a person with limited mobility
- create a bright open-plan kitchen/living space.



(a) Discuss in detail, **three** design considerations necessary when modifying the internal layout of the house shown to meet the needs of a person with limited mobility.

(b) Using notes and freehand sketches, show a revised internal layout that incorporates each of the design considerations you outlined at **3(a)** above **and** include the open-plan kitchen/living space.

Justify your choices.

(c) Discuss **two** advantages and **two** disadvantages of open-plan living in a domestic house.

4. The sketch shows a vacant site located between two existing dwellings in an urban area. The owners are at the design stage for a new house to be built on this site. It is proposed that the characteristics of existing dwellings should have an influence on the external house design.

(a) Using notes and freehand sketches, discuss the importance of considering **each** of the following characteristics when designing a house for this site:

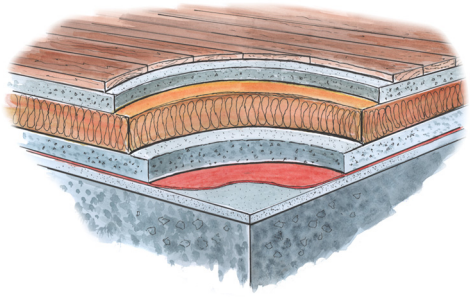
- materials and finishes
- shape and form
- streetscape.

(b) Using notes and freehand sketches, show a proposed external design for a house to be located on this site, which incorporates each of the characteristics discussed at **4(a)** above.

Justify your proposed design solution.

(c) Discuss in detail **two** advantages of developing vacant sites in urban areas.

5. A house built to nZEB standards has a highly insulated solid concrete ground floor with a hardwood finish, as shown.



(a) Calculate the U-value of the floor, given the construction has the following sequence and data:

Hardwood flooring	thickness	20 mm
Sand/cement fine screed	thickness	65 mm
Floor insulation	thickness	200mm
Concrete floor slab	thickness	150 mm
Radon Barrier	thickness	0.25 mm
Sand blinding	thickness	40 mm
Hardcore	thickness	200 mm
Subsoil	thickness	300 mm

Thermal data of the ground floor:

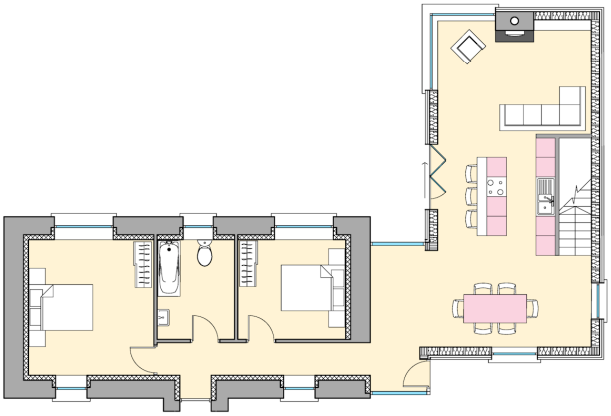
Resistance of internal top surface of floor	(R)	0.104	m^2	$^oC/W$
Conductivity of hardwood flooring	(k)	6.666	W/m	^oC
Resistivity of fine screed	(r)	1.410	m	$^oC/W$
Conductivity of floor insulation	(k)	0.022	W/m	^oC
Conductivity of concrete floor slab	(k)	1.280	W/m	^oC
Conductivity of radon barrier	(k)	0.250	W/m	^oC
Conductivity of sand blinding	(k)	0.160	W/m	^oC
Conductivity of hardcore	(k)	1.350	W/m	^oC
Conductivity of subsoil	(k)	1.600	W/m	^oC

(b) Using the U-value of the floor obtained at **5(a)** above and the following data, calculate the cost of heat lost annually through this floor:

- dimensions of floor slab — 6.5 metres × 9.0 metres
- average internal temperature — 20 ^oC
- average temperature of subsoil — 6 ^oC
- heating period — 9 hours daily for 39 weeks per annum
- cost of oil — 96 cent per litre
- calorific value of oil — 37350 kJ per litre
- 1000 Watts — 1 kJ per second.

(c) Using notes and a freehand sketch, show best practice design detailing that will prevent the formation of a thermal bridge at the junction of the concrete floor and an external concrete block wall with a full-fill insulated cavity.

6. The elevation and ground floor plan of an Irish vernacular cottage, which has been retrofitted and extended, are shown. The existing cottage has been upgraded to meet **EnerPHit** Passive House standard. The new extension on the right has two bedrooms and a bathroom upstairs. The external walls of the extension are of timber frame construction with an external corrugated metal cladding finish. The house is designed to have low environmental impact.



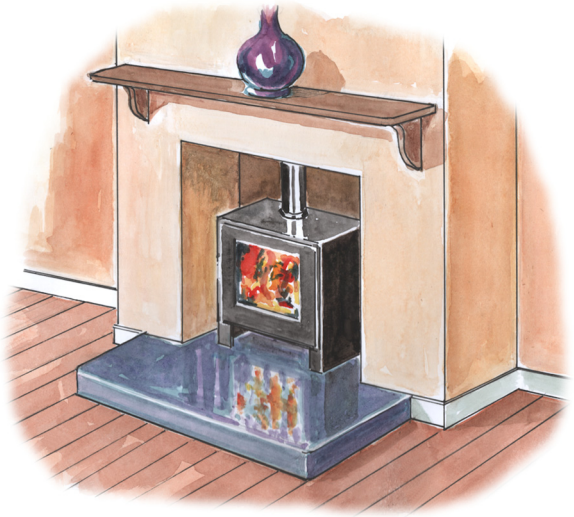
(a) Discuss **two** advantages and **two** disadvantages of retrofitting the vernacular cottage shown.

(b) With reference to the design shown, discuss using notes and freehand sketches, **three** features of the design that contribute to the house having a low environmental impact.

(c) Discuss in detail, using notes and freehand sketches, **two** modifications to the house shown that would further reduce the environmental impact of the house.

Justify your design choices.

7. Space heating is provided in a family living area by a wood-burning stove inset into a chimney breast, as shown. The chimney has been constructed to accommodate the stove and is located on a 200 mm internal solid concrete block wall. A 150 mm diameter cast iron flue connects the stove to the chimney flue. The living area has an insulated solid concrete ground floor with a 20 mm hardwood finish. The dimensions of the stove are: height 600 mm, width 550 mm, depth 400 mm.



(a) To a scale of 1:5, draw a vertical section through the ground floor, hearth and chimney. Show the typical construction details from 350 mm below the finished floor to a level 300 mm above the top of the cast iron flue from the stove and include the connection to the flue liner in the chimney.

Include **three** typical dimensions on your drawing.

(b) On your drawing, show the typical detailing to provide an independent air supply to the stove.

8. The main bathroom located on the first floor of a dwelling house is shown.

(a) Discuss in detail, using notes and freehand sketches, **two** considerations that should be taken into account when locating a bathroom on the first floor of a house.

(b) Using notes and a freehand sketch, show the above-ground pipework necessary for the safe removal of waste from the following fittings:

- shower
- wash basin
- water closet (W.C.)
- kitchen sink on ground floor.

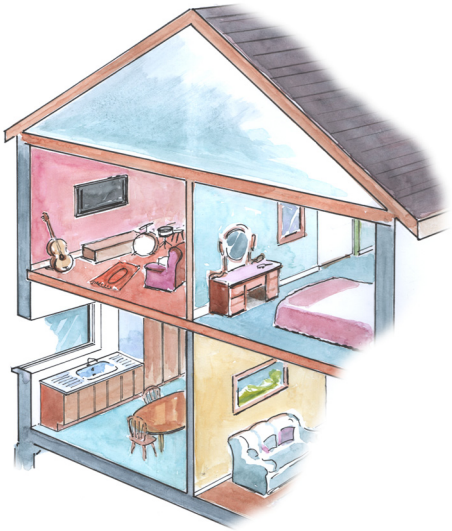
Include on your sketch typical sizes of the soil and vent pipe (*svp*) **and** of the waste pipe from each fitting.

(c) Outline **two** considerations to minimise blockages occurring in a drainage system.

9. The owners have decided to convert an upstairs room into a family entertainment room. They are concerned that the sound from this room will be heard in the adjoining rooms upstairs and in the kitchen beneath.

(a) Discuss in detail, using notes and freehand sketches, how **each** of the following contribute to reducing the transmission of sound in a dwelling house:

- completeness
- flexibility
- isolation.



(b) The partitions are of standard timber stud construction and the first floor is a softwood floor on timber joists, with a plasterboard ceiling beneath. The partitions and the floor are to be upgraded to reduce the transmission of sound from the entertainment room.

Using notes and freehand sketches show a revised design detailing that will reduce the transmission of sound through the stud partition **and** the existing first floor. Specify the materials to be used and give their typical dimensions.

(c) Discuss **two** benefits that the sound insulation upgrades will have on the health and wellbeing of the occupants.

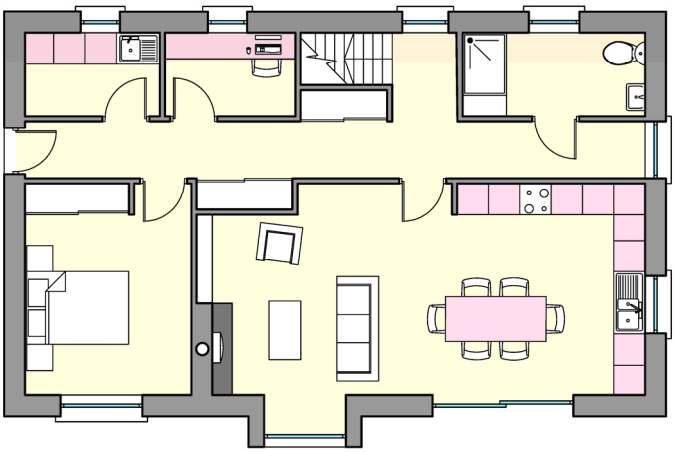
10. The drawing shows the draft design of the ground floor plan of a new dwelling house. The homeowners propose to install a Mechanical Ventilation with Heat Recovery (MVHR) system into their new home.

(a) Discuss in detail, using notes and freehand sketches, **three** considerations that should be taken into account when designing a MVHR system for a domestic house.

(b) Draw a line diagram of the given house plan. Show on your diagram the location of the MVHR unit and a typical layout for the system ducting. Indicate clearly the direction of the airflow in the ducts.

Describe how the MVHR system works.

***Note**: It is not necessary to show the furniture.*



(c) Discuss **two** advantages of installing a MVHR system into a domestic house.

OR

10. "Worldwide, buildings are responsible for over 40% of the total primary energy use and related greenhouse emissions. Through standards and energy efficiency programs, several countries have succeeded in improving the energy performance of new and existing buildings. Designing and retrofitting electrical power systems to be energy efficient have been primary components in the effort to reduce energy consumption by the built environment."

Adapted from: **Optimal Design and Retrofit of Energy Efficient Buildings, Communities, and Urban Centers**.
by Moncef Krarti.
Published by: Butterworth-Heinemann. ISBN: 978-0-12-849869-9

(a) Discuss the above statement in detail.

(b) Propose **three** best practice guidelines that would ensure all buildings are retrofitted in the most sustainable way possible to minimise their primary energy use and improve their energy performance.

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Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination, 2021

Construction Studies

Theory - Higher Level

(240 marks)

Friday, 18 June
Afternoon, 2:00 - 5:00

(a) *Answer **any four** questions.*

(b) *All questions carry equal marks.*

(c) *Answers must be written in ink.*

(d) *Drawings and sketches are 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.*

1. The sketch shows an external wooden door which is designed to facilitate ease of access for everyone to the dwelling house. The door is highly insulated with vertical sheeting on both sides. The wall of the house is a 400 mm wall of concrete block construction with a full-fill insulated cavity. The ground floor is a highly insulated solid concrete floor with a 20 mm tongue and groove floating hardwood finish.

(a) To a scale of 1:5, draw a vertical section through the centre of the door, the external wall and the ground floor. Show the typical construction details from the bottom of the strip foundation to a level 400 mm above finished floor level.

Show a width of 1.0 metre on each side of the door.

(b) On your drawing, show the typical design detailing that will prevent the formation of a thermal bridge at the threshold.

2. **(a)** Under **each** of the following, discuss in detail the duty of care that all workers have in maintaining high safety standards on a construction site:

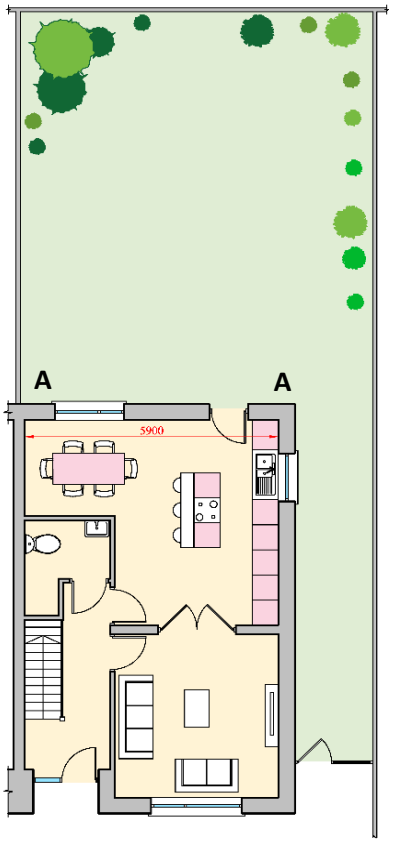
- safety training
- personal protective equipment (PPE)
- vigilance.

(b) Discuss in detail **one** possible risk associated with each of the following:

- repairing a chimney stack
- overhead electrical cables
- on-site health & hygiene.

(c) Using notes and freehand sketches, outline **two** specific safety procedures that should be observed to eliminate each risk identified at **2(b)** above.

3. The drawing shows the ground floor plan of a two-storey semi-detached house and its rear garden. The rear wall **A-A** is south facing. The owners require a home office space, which will enhance health and wellbeing while working from home. It is proposed to build a single-storey office space, not greater than 18.0 m^2 in area, at the rear of the house.



(a) Discuss in detail, **three** design considerations that should be taken into account in the design of this home office space to enhance health and wellbeing.

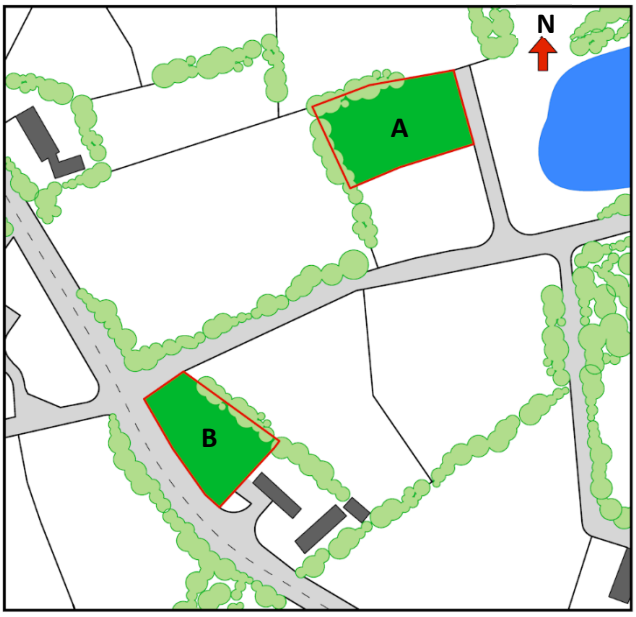
(b) Using notes and freehand sketches, show a proposed design layout for the office space that incorporates each of the design considerations you outlined at **3(a)** above.

Justify your design choices.

(c) Discuss **two** advantages and **two** disadvantages of working from a home office.

4. **(a)** Using notes and freehand sketches, discuss in detail **each** of the following factors when selecting a site for a new house in a rural setting:

- availability of services
- existing trees and hedgerows
- site topography.



(b) Shown is an extract from a site location map. **A** and **B** are possible sites for a new house in a rural setting. Select your preferred site **A** or **B** and discuss **three** considerations you took into account when selecting your site.

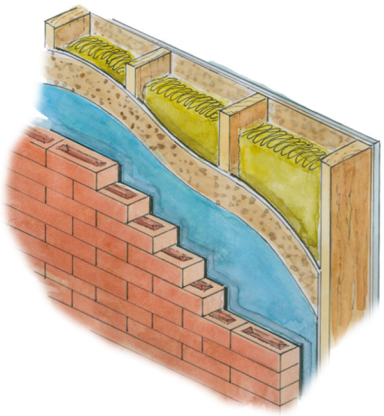
(c) Draw a well-proportioned sketch of your selected site and the immediate boundaries.

On your sketch, show a preferred:

- location and orientation of a house on the site
- layout of the road entrance and the driveway to the house.

For **each** of the above, justify your design choice.

5. The sketch shows a proposed external wall design detail for a new house of timber frame construction.



(a) Calculate the U-value of the wall, given the construction has the following sequence and data:

External brick	thickness	100 mm
Clear cavity	width	50 mm
Orientated strand board (OSB)	thickness	9 mm
Timber stud	thickness	175 mm
Cellulose insulation between studs	thickness	175 mm
Orientated strand board (OSB)	thickness	9 mm
Plasterboard	thickness	12.5 mm

Thermal data of the external wall:

Resistance of external surface	(R)	0.048	m^2	$^oC/W$
Resistivity of external brick	(r)	1.300	m	$^oC/W$
Resistance of clear cavity	(R)	0.440	m^2	$^oC/W$
Conductivity of OSB	(k)	0.130	W/m	^oC
Conductivity of cellulose insulation	(k)	0.039	W/m	^oC
Conductivity of OSB	(k)	0.130	W/m	^oC
Conductivity of Plasterboard	(k)	0.250	W/m	^oC
Resistance of internal surface	(R)	0.130	m^2	$^oC/W$

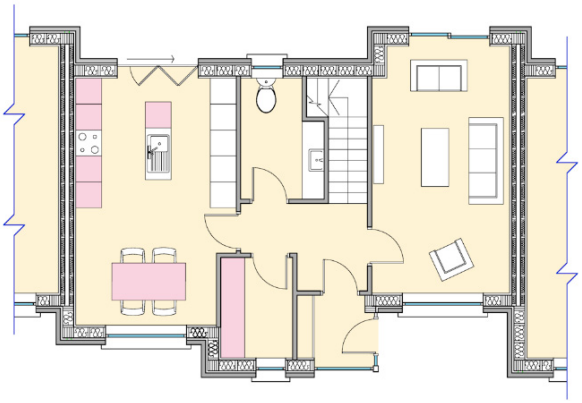
***Note**: The timber studs need not be considered in your calculations.*

(b) It is proposed to redesign the above timber frame wall and upgrade its thermal properties to meet the Passive House standard by adding sheep wool insulation to the design of the internal leaf.

Given the thermal conductivity (k) of sheep wool insulation as 0.034 W/m ^oC, calculate the thickness of additional insulation required to achieve a U-value of 0.15 $W/m^2\ ^oC$.

(c) Using notes and freehand sketches, discuss why a moisture control layer and a vapour control layer need to be incorporated into timber frame construction.

6. The elevation and ground floor plan of a terraced house constructed in an urban location are shown. The external walls are of timber frame construction with a rendered concrete block and cedar cladding finish. Central heating is provided using a renewable heat source. The house is designed to have low environmental impact.

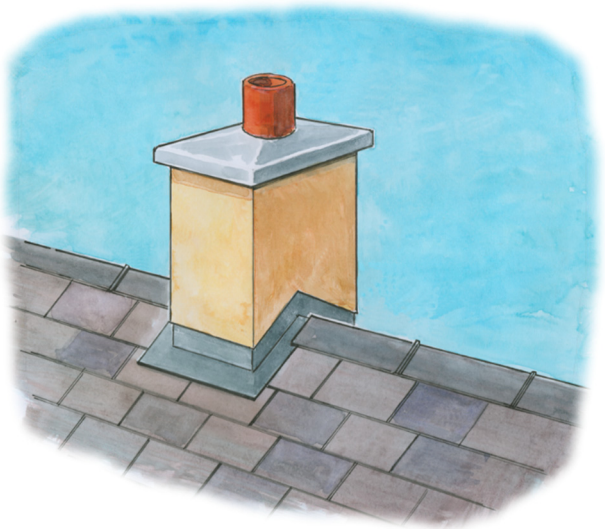


(a) With reference to the design shown, discuss using notes and freehand sketches, **three** features of the design that contribute to the house having a low environmental impact.

(b) Operational energy use is an important consideration in designing for low environmental impact. Using notes and freehand sketches, discuss **two** features that could be added to the house that would further reduce its energy use.

(c) Discuss in detail **two** advantages of designing a house that will have a low operational energy use when the house is built.

7. A chimney stack projects through a pitched roof at ridge level as shown. The chimney is of solid concrete block construction with a sand/cement render finish. The traditional cut roof has a pitch of 45° with a slate finish.

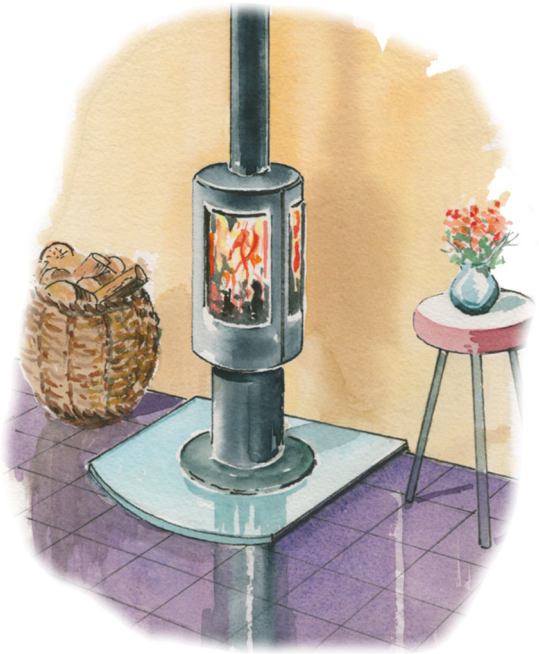


(a) To a scale of 1:5, draw a vertical section through the centre of the chimney stack and roof structure. The section should show the typical construction details through the chimney stack, flue liner, chimney capping and portion of the roof structure.

On your drawing include **three** courses of slate at each side of the chimney stack.

(b) On your drawing, show **two** typical design details to prevent the penetration of moisture at the junction of the roof and chimney stack.

8. The sketch shows a wood-burning stove used to provide hot water and central heating for a two-storey dwelling house.

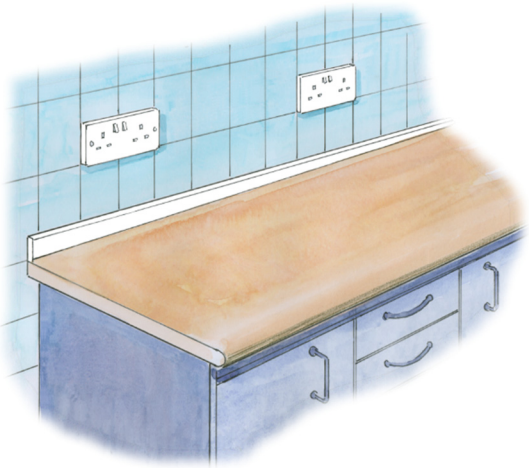


(a) Using notes and a single-line diagram, show a typical design layout for both the heating system **and** hot water system. Show **two** independently controlled heating zones, one on each floor. Include **three** radiators on each floor and give the typical sizes of the pipework.

(b) Using notes and freehand sketches, describe **two** features that increase the efficiency of the heating system. Discuss the importance of **each** feature identified.

(c) Discuss **two** advantages of installing an Air-to-Water heat pump system in the house as an alternative to the stove.

9. **(a)** Discuss in detail, **three** considerations when designing the layout for sockets in the electrical system of a domestic house.



(b) Using notes and freehand sketches, show the design of a typical wiring layout for a ring main circuit to include:

- distribution board
- **three** electrical sockets.

Indicate the typical sizes and colour coding of the electrical cables.

(c) The current Building Regulations require all new houses to have a renewable energy ratio (RER) of 20%. Discuss **two** benefits for the homeowner of generating their own electricity by using micro-generation to help meet this energy requirement.

10. The sketch shows the proposed design for a dwelling house in a rural setting. The design is inspired by vernacular Irish architecture.

(a) Discuss **two** reasons why solar overheating may occur in the house shown and discuss **two** effects solar overheating may have on occupants.

(b) Using notes and freehand sketches, suggest **two** ways to reduce the possibility of solar overheating while being sympathetic to the design of this house.

(c) Using notes and freehand sketches, discuss **two** features of the given house design that contribute to the house responding to its rural setting.

OR

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

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

(a) Discuss the above statement in detail.

(b) Propose **three** best practice guidelines that would promote the reuse or repurposing of some existing buildings in Ireland.

There is no examination material on this page