Candidate Name	Centre Number					Candidate Number				
Candidate A										

GCE A LEVEL
BUILT ENVIRONMENT

UNIT 3

MATERIALS, TECHNOLOGIES AND TECHNIQUES

SAMPLE ASSESSMENT MATERIALS

2 hours 30 Minutes

ADDITIONAL MATERIALS

In addition to this examination paper, you will require a calculator.

INSTRUCTIONS FOR CANDIDATES

Answer **ALL** questions.

Write your name, centre number and candidate number in the spaces provided at the top of this page.

Write your answers in the spaces provided in this booklet.

Use black ink or black ball-point pen.

Do not use pencil or gel pen.

Do not use correction fluid.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part question.
You are advised to divide your time accordingly.

The total number of marks available is 100.

You are reminded of the need for good English and orderly, clear presentation in your answers. The quality of your written communication, including appropriate use of punctuation and grammar, will be assessed in your answer to question 7.

Useful formulae

Area formulae of 2D shapes:

- square = side x side
- rectangle = length x breadth
- triangle = ½ base x height
- circle = πr^2
- sector of a circle: angle/360^o x $\pi r2$
- rhombus = ½ pq (where p and q are the two diagonals)
- parallelogram = base x height

Perimeter formulae of 2D shapes:

- regular polygon = side x number of sides
- irregular polygon = sum of all sides
- circle = $2\pi r$

Surface area formulae of 3D shapes:

- surface area of a cube = $6a^2$ (where a is the length of each side)
- surface area of a rectangular prism = 2ab+2bc+2ac (where a, b and c are the lengths of the three sides)
- surface area of a sphere = $4\pi r^2$
- surface area of a cylinder = $2\pi r^2 + 2\pi rh$ (where h is the height of the cylinder)

Volume formulae of 3D shapes:

- volume of a cube = a^3 (where a is the length of each side)
- volume of a rectangular prism = length x width x height
- volume of a sphere = $4/3\pi r^3$
- volume of a cylinder = $\pi r^2 h$

Formulae to calculate the maximum bending moment of:

- simply supported beams:
  - point load in centre WL/4
  - point load, off centre Wab/L
  - uniformly distributed load $wL^2/8$
- cantilever beams:
  - point load WL
  - uniformly distributed load $wL^2/2$

Energy consumption of an appliance or item of plant: P=1000E/t

*Answer **all** questions.*

1. (a) Outline the following properties of building construction materials: 3 x [2]

(i) brittleness
(ii) malleability
(iii) ductility.

(i) brittleness: Brittle materials will snap or fail when subjected to a load with little or no plastic movement or bending.

(ii) malleability: Malleable materials can be worked or re-shaped by hammering or similar without failing or breaking.

(iii) ductility: Ductile materials can withstand high levels of tension without breaking e.g. a ductile metal can be stretched into wire without breaking

(b) Describe how materials used in building construction may respond if they are exposed to high levels of humidity over a long period of time. [6]

High levels of humidity may result in surface condensation, particularly on cold surfaces such as glass. This may be annoying to occupants and can cause more serious problems such as mold growth on plaster which is unsightly and detrimental to health. Other effects may include corrosion of metals, rotting of timber and spoiling of decorations such as wall papers.

2. The outer walls of a house and garage are to be constructed from brick.

(a) Describe the properties of brick which make it suitable as a construction material. [6]

Attractive as an outer facing.

Good compressive strength for carrying imposed loads such as loads from intermediate floors and roofs.

Long lasting and durable - brickwork will require minimal maintenance

Re-cyclable. Bricks arising from demolition can be cleaned and re-used.

Standard brick sizes are easy to work with and enable accurate work.

(b) The side wall of the garage is to be built using standard sized bricks of length 215mm and height 65mm. The bricks are to be laid lengthwise and a 10mm mortar joint is to be used in the construction. [5]

The wall is 5.84m long and 2.39m high. It includes an opening for one window 1.35m wide and 1.125m high, and an opening for one door 0.9m wide and 2.25m high.

Calculate the minimum number of bricks required to build the wall, assuming the window and door are positioned to minimise waste and allow the use of only whole or half bricks in the construction.

Show all calculations.

Bricks required for 5.84m run = 5840 / (215 + 10) = 25.96 = 26.

Bricks required for 2.39 height = 2390 / (65 +10) = 31.9 = 32

Bricks reqd. excluding openings = 26 x 32 = 832.

Less window (1350 / 225) x (1125 / 75) = 6 x 15 = 90.

Less door (900 / 225) x (2250 / 75) = 4 x 30 = 120

Total bricks required = 832 - (90 + 120) = 622.

3. Thermal comfort is important in the design and construction of a building.

(a) Describe how environmental factors may affect thermal comfort in a building. [6]

Solar gains particularly through windows can raise internal temperatures and lead to uncomfortable conditions.

Air movements arising from natural and / or mechanical ventilation can provide fresh air and reduce overheating.

High levels of humidity can cause condensation and produce the feeling of overheating.

Equipment such as cookers and laundry machines can produce radiant heat leading to unwanted heat gains.

Heating and air conditioning systems can control temperature and humidity levels and be used maintain comfortable conditions.

(b) Describe the factors which need to be taken into account when controlling heat flow in a building, and the controls required for a heating system to regulate the operation of equipment. [6]

Factors include activity levels and function e.g. areas of high activity will require lower temperatures and greater air movement that an area of passive activity such as a sitting area. Other factors include levels of insulation and heat retention, uncontrolled ventilation such as that provided by chimneys and poorly fitting windows and levels of solar gains.

Controls may include external solar shields, louvres in double glazing units on sensor, room thermostats and humidity sensors, all connected to programmable control units that allow users to set temperatures and other levels.

(c) Explain how the impact of temperature change on users of residential buildings can vary with type of building construction, and may be compounded by social and economic factors. [6]

Older houses will generally be less well insulated and more susceptible to draughts and other air movements. Their heating systems may be inefficient, difficult to control and expensive to run. Therefore seasonal changes in temperature will have a greater impact on occupants of older houses as they will be more difficult and expensive to heat in the winter may not have cooling / ventilation facilities other than openable windows. Occupants of high rise apartments may also have difficulties in summer months due to lack of private open space.

Occupants of dwellings built to modern standards will benefit from good levels of insulation and controllable heating and ventilation systems that are efficient and with the use of heat exchangers, should be more environmentally friedly and less costly to run.

4. (a) Loads on structures may be classified as live loads or dead loads. Describe, with examples, the difference between these two classifications of load. [6]

Live loads are loads added to a structure due to use and include items such as furniture and qoccupants e.g. the cars in a multi-storey car park impose live loads on the building structure.

Dead loads are loads that do not change with time. They are loads imposed on a structure by other building elements such as the weight of a roof being transferred to the load bearing walls and the loads of the roof and the load bearing walls being transferred to the building's foundations.

(b) The flat roof of a building is supported by a series of horizonal beams. Each beam carries a uniformly distributed load of 2.9kN/m, is 3.5m long and is simply supported at each end.

(i) Calculate the maximum bending moment in each beam. [4]
(ii) Calculate the distance from the left-hand wall to the position of the maximum bending moment in each beam. [1]

Show all calculations.

(i) ……..

Max BM from UDL = $WL^2 / 8$

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$2.9 \times 3.5^2 / 8 = 35.525 / 8 = 4.44$ kN/M

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(ii) ……..

Max BM will occur at centre point, therefore,

3.5 / 2 = 1.75 m

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5. Describe the main elements of integrated passive design and discuss the barriers to and the drivers for the widespread use of passive house design in Wales. [14]

Integrated passive house design is based on the principles of achieving and then maintaining acceptable internal environmental conditions whilst minimising energy use. It will involve design considerations on orientation to take into account prevailing wind directions and most importantly solar gains. The design may take advantage of solar gains using measures such as thermal mass of solid materials that may be used to store heat, glazing specifications that limit heat loss and use of controllable external shades. Balanced against limiting heat loss will be control of ventilation. This will be based on natural ventilation via available opening where possible and may involve measures that prevent conditioned air from leaving the building, or for capturing heat from extract air with the use of heat exchangers.built into mechanical systems..

Drivers for passive design in Wales will be similar to many areas of the UK and will include social responsibility, where a growing number of people want to contribute to limiting global warming by controlling their individual impacts, levels of pollution, and use of non-renewable resources. Barriers will arise form cost,as passive new build design may be viable, but adapting existing building to passive principles is likely to be expensive and disruptive, although government initiatives, such as grants for increasing insulation levels, should help. The set up of the house building industry is also a barrier as major house builders are yet to be persuaded to adopt passive designs, although their use of whole house ventilation systems is becoming more widespread, and smaller developments, as may be likely in Wales, could be more readily adapted to adopt passive designs.

6. A medium-rise building has previously been let as residential units. The owner has decided to undertake a full refurbishment and convert the building into a mixed-use development.

The ground floor will be converted into a number of small commercial units and one large unit which will operate as a bar with a live-music licence. The remaining four floors will contain residential units.

(a) Reducing noise pollution in the refurbished building is an important consideration.

Explain how the owner can ensure that sound is managed appropriately in the refurbished building to address the comfort of residents in the building and neighbouring properties, and to fulfil relevant legal responsibilities. [8]

The important issue will be to mitigate / control the noise pollution arising from the bar from affecting the occupants of the residential units. Control measures will involve complying with or exceeding the minimum acceptable standards specified in the Building Regulations (Approved Document E) for noise reduction between uses. This will involve the use of sound absorbing materials within the wall and ceiliing finishes of the bar areas, dense party wall constructions and party floors, ideally constructed using precast planks, overlaid with a resilient foam layer, covered with a dense screed finish. Details to avoid flanking noise transmissions, possibly using accoustic blankets, or similar will also need to be considered.

(b) Explain the different types of artificial lighting the owner could install in communal areas, such as walkways and stairways, of the four floors containing residential units. [6]

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General lighting probably ceiling mounted to provide suitable visibilty levels in

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all communal areas.

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Accent lighting to highlight items such as direction signs and notice boards.

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Battery powered emergency lighting to provide some level of illumination and

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directional signage in the event of power failure.

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Integrated lighting of specific facilities such as lifts.

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7. The external envelope of a building is constructed from steel, timber and brick. The building is to be refurbished because these materials have degraded over time. [20]

Describe the possible causes of degradation in steel, timber and brick and recommend measures which could be taken to solve potential issues in this building, and prevent or reduce further degradation after refurbishment.

Steel. Corrosion resulting in degradation due to loss of material / thickness due to contact with moisture, contact bewteen dissimilar metals and breaking down of surface finishes, leading to loss of strength, cracking and possible failure.

Treatment will involve removing rust, treating corroded areas and replacing badly badly damaged sections / fixings, followed by re-coating.

Timber. Contact with water will produce rot, either wet rot or dry rot. Timbers effected by dry rot can be treated with a fungicide and may be retained if damge is not too severe. The source / cause of water contact must be removed. Dry rot is more severe and may spread across walls to affect timbers in other areas. Affected timbers must be removed for burning and then replaced. Surrounding walls / surfaces will need treatment, such as hacking off and applying chemicals to underlying walls before re-plastering. Timbers, such as Oak may also be affected by long term insect attack such as by death watch beetle, which will involve replacement of all affected timber.

Brick. Can be affected by spalling caused by frost action. Affected bricks will need to be cut out and replaced. Preventative measures may include re-pointing where mortar joints are raked out and renewed to remove a route for water penetration. Cavity brick walls may also be affected by cavity wall tie failure where corroded metal wall ties expand, causing joints to open, and eventually fail. Wall tie failure is addressed by cutting out sections of wall and replacing ties with new stainless steel wall anchors.