What are the main performance characteristics of low rise buildings?
Performance requirements

• Strength and stability
• Fire resistance
• Thermal insulation
• Sound insulation
• Weather resistance
• Sustainability
Transfer of loads to the foundations

Buildings are designed to resist dead, live and dynamic loads including self-weight, use, snow and wind.
• **Buildings must resist loads including:**
• Live loads ie people moving around and using the building
• Dead load ie the weight of the roof, walls, furniture in the building that does not move
• Dynamic loads including wind pressure and snow load
Strength and stability

- **Materials are tested for strength**
- Hardcore is graded
- Concrete is **slump tested** for consistency and wetness and is also **tested** for **compressive strength**
- Timber is **stress graded**
- Mortar is tested for **compressive** and **tensile strength**, **expansion** and **setting times**
(b) Complete the sentence about slump tests.

Put a cross \(\checkmark\) in one box to indicate your answer.

A slump test is used to measure a property of:

- A steel
- B concrete
- C mortar
- D hardcore
(c) Complete the sentence about stress grading.

Put a cross in one box to indicate your answer.

Stress grading indicates the strength of:

- A mortar
- B blocks
- C bricks
- D timber
Strength and stability

- **Building materials have strength classifications**
- Concrete ie normal, high strength, light weight
- Bricks ie load bearing bricks including commons and facing brick, engineering brick, damp proof course brick
- Blocks ie standard common block, standard facing block, architectural masonry facing block
- Mortar ie mortar mix type N is used for exterior walls, type O for repointing and type S for foundations or retaining walls
- Timber - C strength classes C16 and C24 are the two most commonly found in most merchants.
Cavity walls
Advantages of cavity walls
• Withstand driving rain penetrating inner leaf
• Good thermal insulation – warm in winter and cool in summer
• No need for external rendering or cladding
• Good sound insulation
• Can use cheaper materials for inner construction
Questions that have already come up in past papers

Sketch a diagram of a cross section through an external masonry cavity wall. You should annotate your diagram.

Sketch a diagram of a cross section through a solid ground floor. You should annotate your diagram.

Sketch a diagram of a cross section through a timber flat roof construction form. You should annotate your diagram.

Sketch a strip foundation. Sketch a suspended timber floor. Sketch a pitched roof construction.
Lateral Restraint – floors to walls

Walls must be properly connected to the floors and to the roof so that the walls do not spread and the building can resist uplift from strong wind loads.

Floor ties – galvanised steel straps secured to the inner leaf of masonry and over at least 3 joists. They are spaced at 2 m intervals.
Roof Ties
Galvanised steel strap ties the roof joist to the walls to protect against wind
Fire resistance

- Buildings need to be protected against fire and be able to maintain structural integrity in the event of a fire.

- **Fire resistant materials include:**
  - **Plasterboard** – plaster is made of gypsum, which is fire resistant.
  - **Concrete** - Concrete does not burn and it does not emit any toxic fumes when affected by fire.
  - **Brick** - As bricks are made in a fire kiln, they're already highly resistant to fire.
  - **Blockwork** – is made from concrete, which will not burn.
  - **Intumescent paint** – the heat in a fire triggers a catalytic reaction that causes the paint to expand by up to 50 x paint film thickness. This keeps materials such as steel and timber below its critical temperature and helps to maintain the building's structural integrity.
3. (a) Identify **two** fire-resistant materials.

- [ ] A  Plasterboard
- [ ] B  Blockwork
- [ ] C  Bitumen
- [ ] D  Timber
- [ ] E  Straw
**Fire Barriers**

Fire barriers stop fire spreading inside cavities and voids such as spaces inside walls, between floors and in loft spaces.
Fire compartments

Walls, separating floors, door closes, fire-resistant doors, fire escapes, refuge areas, cavity fire barriers, fire alarm systems, smoke detectors and sprinkler systems.

Compartment walls and floors contain fire in the compartment of origin, and stop fire spreading horizontally or vertically through a building.
(d) Identify two construction methods used to slow down the spread of fire in a building.

- □ A Compartments
- □ B Wet Risers
- □ C Barriers
- □ D Smoke Detectors
- □ E Fire Alarms
Thermal insulation
Reducing heat loss from a building
Reduce energy costs
Prevent heat loss through air gaps.
Insulation materials can be located in:
Cavity spaces
Walls
Roof spaces
Flooring
Double glazing (windows)
Draft strips around openings including doors and windows
(b) Buildings are insulated in order to reduce heat loss.

Identify two locations where thermal insulation may be installed. (2)
<table>
<thead>
<tr>
<th>Question Number</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>3(b)</td>
<td>1 mark for each of:</td>
<td>(2)</td>
</tr>
<tr>
<td></td>
<td>- cavity (1)</td>
<td></td>
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<tr>
<td></td>
<td>- wall (1)</td>
<td></td>
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<tr>
<td></td>
<td>- floor (1)</td>
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<tr>
<td></td>
<td>- roof/loft/ceiling/attic (1)</td>
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<td></td>
<td>- basement/cellar (1)</td>
<td></td>
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<td></td>
<td>- draught strips/doors/apertures (1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- double/triple glazing/windows (1).</td>
<td></td>
</tr>
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<td></td>
<td>Accept misspellings.</td>
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<td></td>
<td>Up to a maximum of two marks.</td>
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</tbody>
</table>
Types of insulation:

- **Sheep’s wool** – excellent thermal insulation properties, good for sound insulation, can regulate humidity and doesn’t irritate the skin when installing. Very sustainable material.

- **Mineral wool** - Mineral wool (sometimes known as Rockwool) is made from volcanic rock, which is an abundant resource. The volcanic rock is heated to about 1500°C, which causes it to melt. The liquid volcanic rock is then spun at high speeds to produce rock fibers. Excellent thermal insulation properties but can be a skin irritant. Comes in rolls and is about £5 per square metre.

- **Glass fibre** - Has excellent thermal properties and can be installed in attics, basements and crawl spaces, interior and exterior walls’ Roofing and Flooring and for soundproofing. However if it gets damp it will encourage mould growth.

- **Cellulose** – this type of insulation is made of plant fibre. It has good insulation properties but is expensive to install. Good sound insulator, but heavier than fibreglass insulation.

- **Foams** – these are made from polyurethane and are installed by spraying. They need to be installed by a specialist. It’s especially effective in attics. Foam takes up less space than fibre glass insulation.
(e) Describe **one** benefit of using sheep's wool in construction projects.
<table>
<thead>
<tr>
<th>Question Number</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(e)</td>
<td>1 mark for identification of a benefit, and 1 mark for expansion of that benefit, up to a maximum of two marks. 2 marks for any one of the following description of a benefit:</td>
<td></td>
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<tr>
<td></td>
<td>- requires only a fraction of the energy to produce (1) as it is a natural material (1)</td>
<td></td>
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<tr>
<td></td>
<td>- reduces the heat loss in a building/keeps the building warm (1) thus saving money on heating bills/maintaining a comfortable internal environment (1)</td>
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<td></td>
<td>- it is a sustainable material (1) as it is renewable (1)</td>
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<tr>
<td></td>
<td>- cheaper than some other forms of insulation (1) thus lowering initial costs (1)</td>
<td></td>
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<td></td>
<td><strong>Do not</strong> accept cheaper or cheap without relative comparison. Accept any other appropriate answers.</td>
<td>(2)</td>
</tr>
</tbody>
</table>
Sound insulation

• **The purpose of sound insulation**
• Resist passage of sound through a building
• Prevent nuisance and sound disturbance to neighbours
• Reduce external infrastructure noise
• Reduce aircraft noise
• Provide confidentiality
(d) One purpose of sound insulation is to resist the passage of sound through a building.

Identify two other purposes of sound insulation for a building.

1

2
<table>
<thead>
<tr>
<th>Question Number</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(d)</td>
<td>1 mark for each purpose of sound insulation for a building identified, up to a maximum of two marks:</td>
<td></td>
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<tr>
<td></td>
<td>• Preventing nuisance and noise disturbance of/to adjacent neighbours (1)</td>
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<tr>
<td></td>
<td>• Reduce external infrastructure noise (1)</td>
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<td></td>
<td>• Reduce aircraft noise (1)</td>
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<td></td>
<td>• Provide confidentiality (1)</td>
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<tr>
<td></td>
<td>• The sound insulation could double up as thermal insulation (1)</td>
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<td></td>
<td>Accept any other appropriate answers, including examples of outside noises such as cars/lorries/animals, etc.</td>
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<td></td>
<td>Do <strong>not</strong> accept sound in and/or sound out in isolation as it is passage of sound.</td>
<td>(2)</td>
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</tbody>
</table>
Types of sound insulation

- Triple glazing
- Heavy-density blockwork
- Sound insulation quilt
- Plasterboard layers
- Flooring mats
- Carpeting
- Acoustic ceilings
Weather resistance

- **Purpose of weather resistance measures**
- Maintain an acceptable environment inside the building
- Provide thermal comfort for the occupants
- Control humidity levels
- Prevent water staining
- Prevent damage to finishes
Materials: Select waterproof and impervious materials and components such as:
- slate or clay roof tiles
- damp-proof membranes made of polyethylene to prevent rising damp
- lead flashings
- UPVC or aluminium window frames
- double glazing
- use of falls on window and door sills
- weather seals and sealants
- soffits

Double glazing with seal to improve weather resistance.

Lead flashings stop rain getting into attic space.

Clay roof tiles overlap to stop rain getting into attic space.

The ‘fall’ on the window sill allows rain to run off.

Fascia

Koof pitch allows rain to run off into guttering.

223
(c) Outline two methods of making sure windows can resist the weather.

1. 

2. 

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(c)</td>
<td>1 mark for each method of achieving weather resistance identified:</td>
<td></td>
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<tr>
<td></td>
<td>Use of:</td>
<td></td>
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<td></td>
<td>• sealants (1)</td>
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<td></td>
<td>• falls e.g. sloping windowsills (1)</td>
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<td></td>
<td>• double glazing (1)</td>
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<td></td>
<td>• draught strips/weather seals (1).</td>
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<td></td>
<td>Accept any other appropriate answers. Up to a maximum of two marks.</td>
<td>(2)</td>
</tr>
</tbody>
</table>
Low-rise buildings have particular performance requirements.

(a) Match the material to its performance requirement for low-rise buildings.

Draw a straight line to match each material to its associated performance requirement.

**Each** material has only one performance requirement.

<table>
<thead>
<tr>
<th>Material</th>
<th>Performance requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flashings</td>
<td>Strength</td>
</tr>
<tr>
<td>Sheep’s wool</td>
<td>Thermal insulation</td>
</tr>
<tr>
<td></td>
<td>Stability</td>
</tr>
<tr>
<td></td>
<td>Security</td>
</tr>
<tr>
<td></td>
<td>Weather resistance</td>
</tr>
</tbody>
</table>
Sustainability:
Preserving resources for future generations and reducing the impact of construction activities on the environment.

- **Building orientation for light and heat** – south facing buildings get more natural light and heat from the sun. You install solar panels on south-facing roof structures for this reason.

- **Re-use of brownfield sites** These are sites that have previously been developed or built on. They may have existing buildings on them that need demolishing. There may be site contamination. Drainage, services and foundations may already be in place. This may be an advantage or a disadvantage. Easier to gain planning permission a brownfield site.

- **Reduce use of Greenfield sites** Avoid building on green spaces that have never been developed before. There will be no services or existing infrastructure so you would have to put these things in place and this costs time and money. It will be much more difficult to obtain planning permission, as people are likely to object to your proposal.
• **Use local materials**  eg Welsh slate, Cornish granite, York stone, and locally grown timbers.
• **Less freight**  being moved long distances by road.
• **less processing** and produces less waste and pollution
• Creates a sense of **local identity**

• **Use Renewable Materials** such as **timber** which is **fast growing**. It does not need intensive processing so it is **low energy**
• **Natural fibres** such as **wool, straw** and **hemp** can be used to insulate buildings

• **Reuse Materials**  no need to reprocess the material into something else.
• Use **salvaged** materials where possible eg redressed granite
• **Reuse building materials** this saves energy and cost of quarrying and cutting stone ie **reclaimed brick**
• Use demolition rubble as **hardcore** for new roads

• **Renovate** existing buildings instead of new build

• **Recycle** it should be a last resort as recycling uses more energy!
(e) In the UK, which is the best direction for a building to face to make the most use of natural light?

- A  North
- B  South
- C  East
- D  West
Many functional elements contribute to making a building safe, secure, sustainable and comfortable.

(a) Match the property to how it is achieved in a low-rise building.

Draw a line to match each property to how it is achieved.

<table>
<thead>
<tr>
<th>Property</th>
<th>How It Is achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stability</td>
<td>Developing a brownfield site</td>
</tr>
<tr>
<td></td>
<td>Provision of ventilation</td>
</tr>
<tr>
<td></td>
<td>Construction of a suitable foundation</td>
</tr>
<tr>
<td>Sustainability</td>
<td>Developing a greenfield site</td>
</tr>
<tr>
<td></td>
<td>Provision of artificial light</td>
</tr>
</tbody>
</table>
10 Explain **one** reason why timber frame housing is a sustainable form of construction.

(Total for Question 10 = 2 marks)
<table>
<thead>
<tr>
<th>Question Number</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>2 marks for any one of the following explanations. Award 1 mark for identification of how it is sustainable and 1 mark for appropriate explanation, up to a maximum of two marks:</td>
<td></td>
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<tr>
<td></td>
<td>- it is a renewable resource (1) because it uses timber from a managed forest (1)</td>
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<td></td>
<td>- it reduces carbon footprint/is eco-friendly (1) because of a reduction in embodied energy/supports biodiversity (1)</td>
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<td>- reduces waste (1) because it is produced off-site (1)</td>
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<td></td>
<td>- fast form of construction/reduction in erection time (1) therefore reduces energy consumption during construction phase (1)</td>
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<tr>
<td></td>
<td>- improves U value/reduces energy consumption (1) because it is easy to incorporate high levels of insulation within the structure (1).</td>
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<td></td>
<td>Do <strong>not</strong> accept sustainable on its own.</td>
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<td></td>
<td>Accept any other appropriate answers.</td>
<td>(2)</td>
</tr>
</tbody>
</table>