

13.1 Gravitational field

Name: _____ Class: _____ Date: _____

Total: 10 marks

Objective

Build the skills to answer exam questions on the **gravitational field** —its definition and field lines.

You must be able to:

- define **gravitational field strength** as force per unit mass
- represent a gravitational field with **field lines**

1 Worked examples

Study these first. Each one shows the method for a question type used later —follow the steps and you can do the Practice and Exam-style questions yourself.

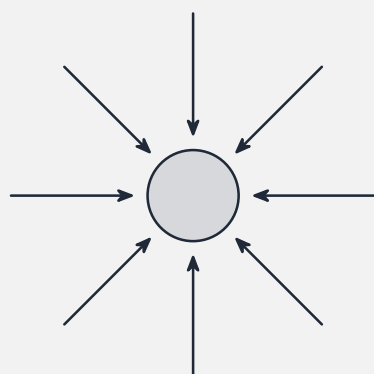
■ Field strength

A **gravitational field** is a region where a mass feels a force. The **field strength** is the force per unit mass on a small test mass:

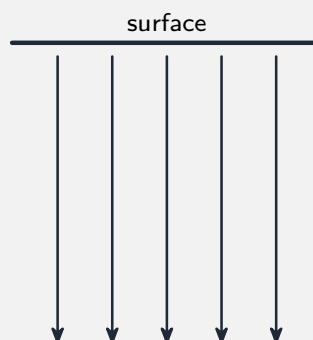
$$g = \frac{F}{m} \quad (\text{N kg}^{-1}).$$

It is a **vector**, pointing towards the source mass (the same value as the free-fall acceleration).

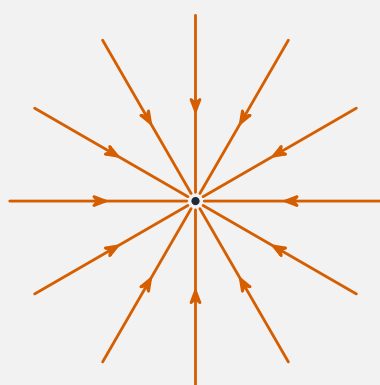
■ Field lines



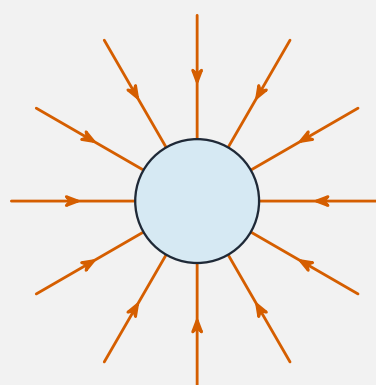
(a) radial field



(b) uniform field



point mass



uniform sphere

The radial gravitational field of a sphere

- around a **point mass** / **sphere**: **radial**, pointing **inwards**;
- near a surface (small region): **uniform** —parallel, equally spaced, pointing down.

Closer lines → stronger field.

2 Practice

Now apply the methods above.

2.1 Define **gravitational field strength**. [1]

2.2 State the unit of gravitational field strength. [1]

2.3 State what a gravitational **field line** represents. [1]

2.4 State the shape of the gravitational field around a **point mass**. [1]

3 Exam-style questions

3.1 Gravitational field strength is equal to: [1]

- **A** force $\times$ mass
- **B** force $\div$ mass

- **C** mass $\div$ force
 - **D** mass $\times$ acceleration
-

3.2 A mass of 2.0 kg experiences a gravitational force of 19.6 N. Find the **gravitational field strength**. [2]

3.3 Explain what **closer** field lines indicate. [1]

3.4 Sketch the gravitational field lines (a) around a point mass and (b) near a flat surface. [2]

4 Go further

You are now ready for the real exam questions on this subtopic. Open the **13.1 Gravitational field** past-paper sheet in the Library, or try these in **Practice mode**:

- 9702/41 N25 —Q3 (define field, derive g, direction)
- 9702/43 N25 —Q3 (gravitational field)
- 9702/43 J25 —Q1 (field strength)
- 9702/44 J25 —Q1 (gravitational field, structured)

Solutions

2.1 The **gravitational force per unit mass** on a small test mass at that point ($g = F/m$).

2.2 N kg^{-1} .

2.3 The **direction of the gravitational force** on a (test) mass at that point.

2.4 **Radial**, pointing **inwards** towards the mass.

3.1 **B** —force $\div$ mass.

3.2 $g = F/m = 19.6/2.0 = 9.8 \text{ N kg}^{-1}$.

3.3 A **stronger** gravitational field.

3.4 (a) **radial** lines pointing inward to the mass; (b) **parallel, equally spaced** lines pointing down towards the surface.