

Solutions

Each answer shows the steps, then the **result**.

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

- $g = F/m$, so field strength is **force** $\div$ **mass**
- A** is force; **C** is GMm/r^2 without dividing by m ; **D** is potential

3.2

- $F = 19.6 \text{ N}$, $m = 2.0 \text{ kg}$; $g = F/m$

$$g = \frac{19.6 \text{ N}}{2.0 \text{ kg}} = \mathbf{9.8 \text{ N kg}^{-1}}$$

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

3.5

(a) the gravitational **force per unit mass** acting on a small test mass placed at that point

(b) the force on the test mass is $F = GMm/x^2$, where G is the gravitational constant

- field strength is the force per unit mass

$$g = \frac{F}{m} = \frac{GM}{x^2}$$

(c) the fields point in **opposite directions**, since each points towards the mass

- $g \propto 1/x^2$, so halving the distance makes the field at Q **four times** the field at P

(d) the curve starts at $(R, -g_0)$, since at X's surface the field points back towards X, i.e. negative

- it passes through zero at the midpoint $x = L/2$
- it ends at $(L - R, +g_0)$, becoming shallower up to the midpoint and steeper after it

(e) the two spheres are identical and the midpoint is equidistant from both, so their fields there are **equal in magnitude**

- and **opposite in direction**, so as a vector the two cancel to zero
- (the gravitational potential there is not zero — only the field is)