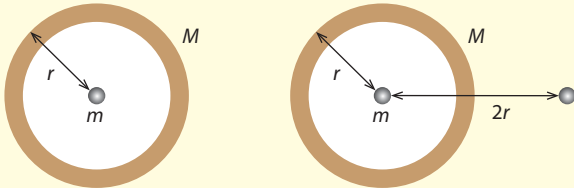


## ? Test yourself

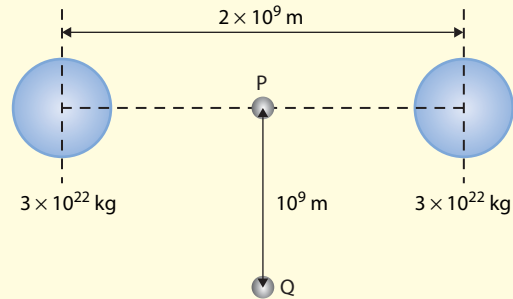
- 15 Calculate the gravitational force between:
- the Earth and the Moon
  - the Sun and Jupiter
  - a proton and an electron separated by  $10^{-10}$  m.
- 16 A mass  $m$  is placed at the centre of a thin, hollow, spherical shell of mass  $M$  and radius  $r$ , shown in diagram a.



- Determine the gravitational force the mass  $m$  experiences.
  - Determine the gravitational force  $m$  exerts on  $M$ .
- A second mass  $m$  is now placed a distance of  $2r$  from the centre of the shell, as shown in diagram b.
- Determine the gravitational force the mass inside the shell experiences.
  - Suggest what gravitational force is experienced by the mass outside the shell.

- 17 Stars **A** and **B** have the same mass and the radius of star **A** is nine times larger than the radius of star **B**. Calculate the ratio of the gravitational field strength on star **A** to that on star **B**.
- 18 Planet **A** has a mass that is twice as large as the mass of planet **B** and a radius that is twice as large as the radius of planet **B**. Calculate the ratio of the gravitational field strength on planet **A** to that on planet **B**.
- 19 Stars **A** and **B** have the same density and star **A** is 27 times more massive than star **B**. Calculate the ratio of the gravitational field strength on star **A** to that on star **B**.
- 20 A star explodes and loses half its mass. Its radius becomes half as large. Determine the new gravitational field strength on the surface of the star in terms of the original one.
- 21 The mass of the Moon is about 81 times less than that of the Earth. Estimate the fraction of the distance from the Earth to the Moon where the gravitational field strength is zero. (Take into account the Earth and the Moon only.)

- 22 The diagram shows point P is halfway between the centres of two equal spherical masses that are separated by a distance of  $2 \times 10^9$  m. Calculate the gravitational field strength at point P and state the direction of the gravitational field strength at point Q.



- 23 A satellite orbits the Earth above the equator with a period equal to 24 hours.
- Determine the height of the satellite above the Earth's surface.
  - Suggest an advantage of such a satellite.
- 24 The Hubble Space Telescope is in orbit around the Earth at a height of 560 km above the Earth's surface. Take the radius and mass of the Earth to be  $6.4 \times 10^6$  m and  $6.0 \times 10^{24}$  kg, respectively.
- Calculate Hubble's speed.
  - In a servicing mission, a Space Shuttle spotted the Hubble telescope a distance of 10 km ahead. Estimate how long it took the Shuttle to catch up with Hubble, assuming that the Shuttle was moving in a circular orbit just 500 m below Hubble's orbit.
- 25 Assume that the force of gravity between two point masses is given by  $F = \frac{Gm_1m_2}{r^n}$  where  $n$  is a constant.
- Derive the law relating period to orbit radius for this force.
  - Deduce the value of  $n$  if this law is to be identical with Kepler's third law.