

Gravitational fields – A2 Physics P2

1. No.02

0 2

The Global Positioning System (GPS) uses satellites to support navigation on Earth.

0 2 . 1

One GPS satellite is in a circular orbit at a height h above the surface of the Earth. The Earth has mass M and radius R .Show that the angular speed ω of the satellite is given by

$$\omega = \sqrt{\frac{GM}{(R+h)^3}}$$

[2 marks]

0 2 . 2

Calculate the orbital period of the satellite when h equals 2.02×10^7 m.

[2 marks]

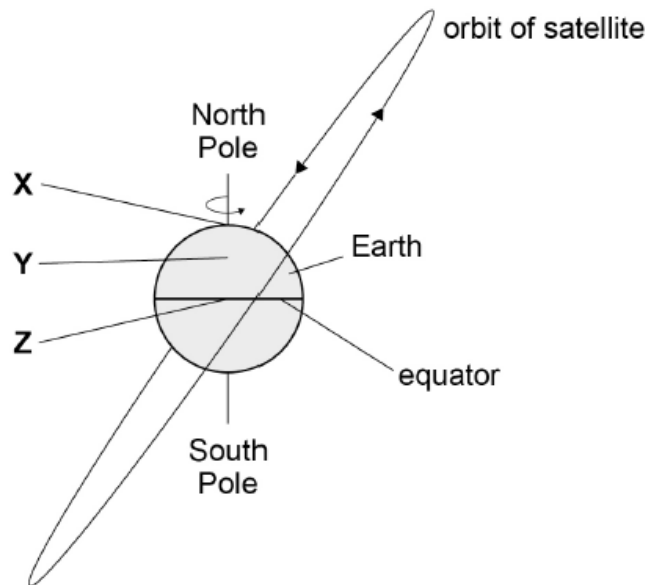
orbital period = _____ s

0 2 . 3

Figure 3 shows the orbital plane of the satellite inclined at an angle to the equator. **X**, **Y** and **Z** are locations on the Earth.

X is at the North Pole, **Y** is on a high mountain and **Z** is on the equator.

Figure 3



The satellite is to be launched from one of the locations.

State and explain which launch site **X**, **Y** or **Z** minimises the amount of fuel required to send the satellite into its orbit.

[2 marks]

02.4

The satellite has a mass of 1630 kg.

Calculate the gravitational potential energy of the satellite when in the orbit in Question 02.2.

[2 marks]

gravitational potential energy = _____ J

02.5

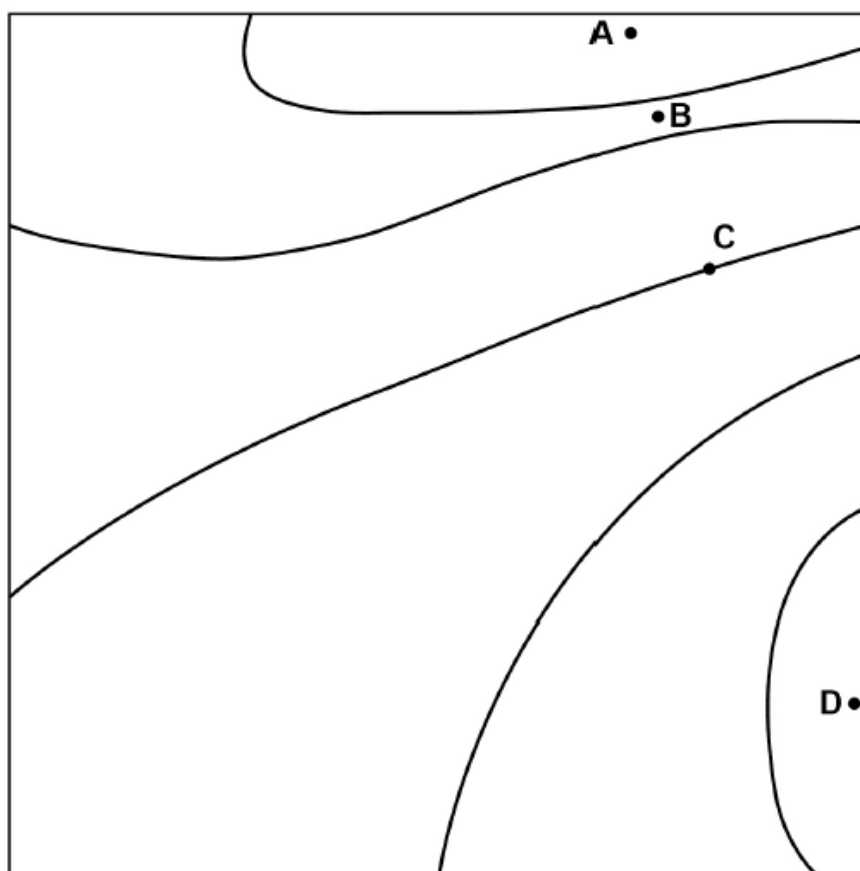
A different satellite is in a higher circular orbit.

Explain how the linear speed of this satellite compares with the linear speed of the satellite in Question 02.1.

[2 marks]

2. No.11

The diagram shows gravitational equipotentials. Adjacent equipotentials are separated by an equal gravitational potential difference V .



Which point has the greatest gravitational field strength?

[1 mark]

- A ☐
- B ☐
- C ☐
- D ☐

3. No.12

A planet has radius R and density ρ . The gravitational field strength at the surface is g .

What is the gravitational field strength at the surface of a planet of radius $2R$ and density 2ρ ?

[1 mark]

A $2g$

☐

B $4g$

☐

C $8g$

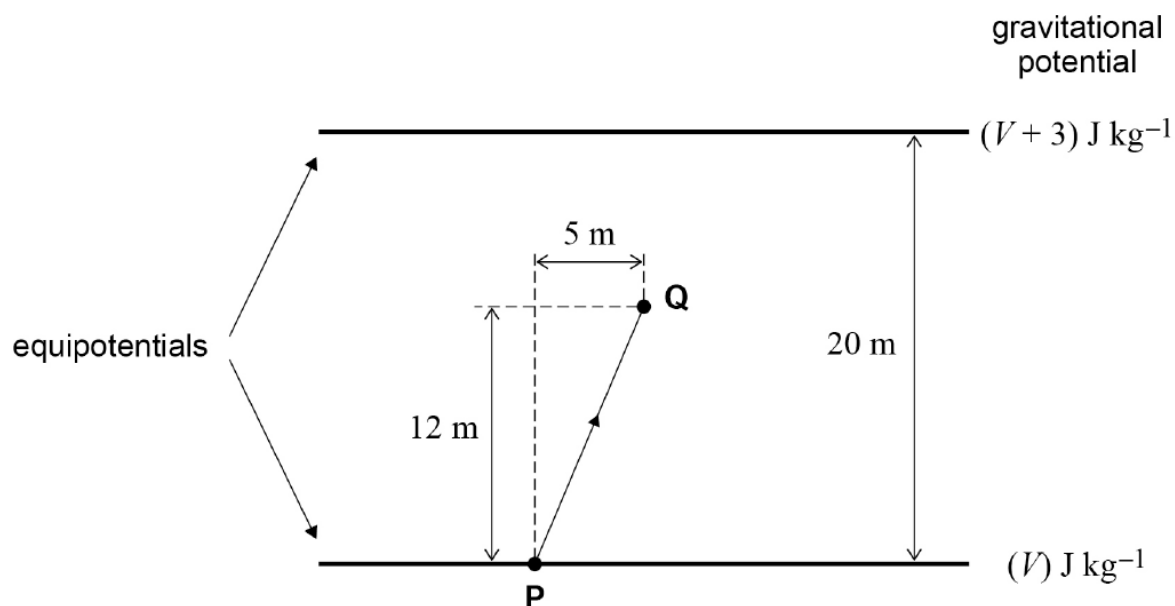
☐

D $16g$

☐

4. No.13

The diagram shows equipotential lines for a uniform gravitational field. The lines are separated by 20 m.



An object of mass 4 kg is moved from **P** to **Q**.

What is the work done against gravity to move the object?

[1 mark]

A 7.2 J

☐

B 7.8 J

☐

C 10.2 J

☐

D 36 J

☐