2 The distance between the Sun and the Earth is 1.5×10^{11} m

What is the gravitational force exerted on the Sun by the Earth?

$F = \frac{GMm}{r^2}$

mass sun = 1.99×10^{30} Kg
mass earth = 5.97×10^{24} Kg
G = 6.67×10^{-11} N $m^2 kg^{-2}$

A 3.5×10^{22} N ◯

B 1.7×10^{26} N ◯

C 5.3×10^{33} N ◯

D 8.9×10^{50} N ◯

(Total 1 mark)

3 A spacecraft of mass 1.0×10^{6} kg is in orbit around the Sun at a radius of 1.1×10^{11} m
The spacecraft moves into a new orbit of radius 2.5×10^{11} m around the Sun.

What is the total change in gravitational potential energy of the spacecraft?

energy/kg: $V = -\frac{GM}{r}$

$-GM \left(\frac{1}{r_{final}} - \frac{1}{r_{initial}} \right)$ (M = sun)

then multiply by m (satellite)

A -6.76×10^{14} J ◯

B -3.38×10^{14} J ◯

C 3.38×10^{14} J ◯

D 6.76×10^{14} J ◯

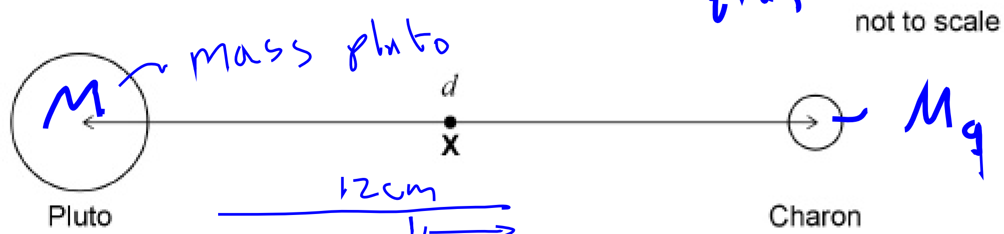
(Total 1 mark)

or: $GPE = -\frac{GMm}{r} \Rightarrow -GMm\left(\frac{1}{r_f} - \frac{1}{r_i}\right)$

5 Charon is a moon of Pluto that has a mass equal to $\frac{1}{9}$ that of Pluto.

The distance between the centre of Pluto and the centre of Charon is *d*.

X is the point at which the resultant gravitational field due to Pluto and Charon is zero.



What is the distance of **X** from the centre of Pluto?

A $\frac{2}{9}d$

B $\frac{2}{3}d$

C $\frac{3}{4}d$

D $\frac{8}{9}d$

so distance from Pluto is 3 times distance from Charon. So its a ratio of 3:1 - ie we are breaking d into 4 equal parts so of which X is 3 lots away from Pluto - so its 3d/4

(Total 1 mark)

6 The distance between the Sun and Mars varies from 2.1×10^{11} m to 2.5×10^{11} m.
When Mars is closest to the Sun, the force of gravitational attraction between them is F.

What is the force of gravitational attraction between them when they are furthest apart?

A $0.71F$

B $0.84F$

C $1.2F$

D $1.4F$

(Total 1 mark)

7 (a) Define the gravitational potential at a point.

energy used to move 1Kg from r out to infinity (or from infinity to r)

(2)

(b) Explain why gravitational potential is always negative.

because gravity is an attractive force and you have to do work against that force to increase r. (1)
and GP is defined as being zero at infinity (2)

(2)

(c) Show that the magnitude of the gravitational potential at the Earth's surface due to the mass of the Earth is about 6.3×10^7 J kg^{-1}.

$V = -\frac{GM}{r}$ $r = 6.37 \times 10^6$ m

$\therefore \frac{-6.67\times10^{-11} \times 5.97\times10^{24}}{6.37\times10^6} = -6.25\times10^7$ J/kg

(2)

(d) A satellite is launched into a geostationary orbit.

Describe and explain **two** features of a geostationary orbit.

1. Always above same point / above equator

2. has same period as earth – r is such tho T = T_{earth}

(2)

(e) The satellite has a mass of 1200 kg and the radius of its orbit is 4.23×10^7 m.

Calculate the gain in gravitational potential energy of the satellite when it is placed into orbit from the Earth's surface.

-6.25×10^7 J/kg at earth $V = -\frac{GM_{earth}}{r} = -9.41 \times 10^6$

care with signs   new radius

difference $= -9.41 \times 10^6 - -6.25 \times 10^7 = 5.3 \times 10^7$

we have 1200 kg so $5.3 \times 10^7 \times 1200$

gain in potential energy = 6.4×10^{10} J

(3)

(f) Impulse engines are used to place the satellite into an orbit with a longer period.

Discuss any changes this makes to the orbital motion of the satellite.

$R^3 \propto T^2$

so must be further away

will also have a lower velocity as V_G is increased & total energy fixed so E_K down.

will also have a lower velocity because as Vg increases, and assuming total energy is fixed, so Ek will decrease and hence veocity .... this only works though if the engines only apply a force directly along the radius of the rotation and so do not effect the satellites velocity

(4)

(Total 15 marks)