7 **(a)** State what is meant by the *gravitational potential energy* stored between two point masses that are separated by a distance from each other.

……..

……..

…… [2]

(b) The Moon orbits the Earth with a orbital radius of 3.84×10^8 m. The time it takes to complete one orbit is 27.3 days.

(i) Explain what is meant by a *geostationary* orbit.

……

..…… [1]

(ii) Hence, explain why the moon is not in a geostationary orbit.

……

..…… [1]

(iii) Calculate the angular velocity of the Moon.

angular velocity = …… rad s^{-1} [2]

(iv) Hence or otherwise, determine the mass of the Earth. Show your working clearly.

mass of Earth = …… kg [3]

(v) The mass of the Earth is M_e.
The mass of the Moon is M_m.
The orbital radius of the Moon is x.

1. Show that the kinetic energy of the Moon is $\frac{GM_eM_m}{2x}$.

[1]

2. Derive an expression for the total energy of the Moon in terms of M_e, M_m and x.

[1]

3. Explain why the total energy of the moon must be less than zero.

……..

……..

……..…... [1]

(vi) The Moon is moving away from the Earth at about 3.8 cm per year and the Earth's days are getting longer at about 2 ms per century.

1. State and explain the effect on the total energy of the Moon.

……..

……..

……..

……..

……..…... [3]

2. Explain how energy is conserved in the system.

……..

……..

……..…... [1]

3. Suggest why this will cause a day on Earth to be longer.

……..

……..

……..…... [1]

(vii) Between the Earth and the Moon, the point where the resultant gravitational field strength is zero is 34.6×10^7 m from the centre of the Earth.

A student is provided with the gravitational potential at two positions between the Earth and Moon as shown in the table.

Position	Distance from the centre of the Earth/ m	Gravitational potential/ J kg^{-1}
M	1.0×10^7	-40.2×10^6
N	37.4×10^7	-15.6×10^6

He states the following:

"An object at rest released at N will accelerate towards the Earth since the gravitational potential is lower at M."

Comment on his statement.

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……

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..... [3]

[Total: 20]

End of Paper