Name of the Student:_____

Max. **Marks : 24 Marks**   **Time : 24 Minutes**

Q1.

The picture shows a toy hanging from a spring.

(Source: m4.sourcingmap.com/photo_new/20120821/g/ux_a12082100ux0119_ux_g03.jpg)

The toy has a mass of 0.066 kg. When it is hanging freely on the spring, the spring extends by 4.5cm.

When the toy is pulled downwards and released, it undergoes simple harmonic motion.

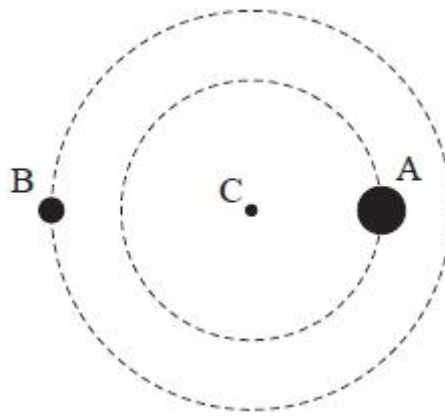Calculate the frequency of the oscillations.

....
....
....
....
....

Frequency = ...

(Total for question = 5 marks)

Q2.

The diagram shows two black holes, A and B, orbiting each other.

Assume that the centre of mass C of the system is the centre of a circular orbit for each black hole as shown in the diagram.

Black hole A is in an orbit of radius 2.9×10^{10} m and black hole B is in an orbit of radius 3.6×10^{10} m. Both orbit with the same period, so the total distance between them is 6.5×10^{10} m.

(a) Calculate the force between the black holes.

mass of Sun, $M_\odot = 1.99 \times 10^{30}$ kg
mass of black hole A = $36 M_\odot$
mass of black hole B = $29 M_\odot$

(2)

....

....

....

Force = ...

(b) By considering the orbit of one black hole about C, determine the period of the orbit.

(3)

....

....

....

....

....

Period = ...

(Total for question = 5 marks)

Q3.

Scientists are developing a space station equipped with large solar panels. The space station would be located in a geostationary orbit. The space station would transfer energy to Earth as microwaves.

(i) A space station in a geostationary orbit is above the equator and has a period of 24 hours.

Explain one advantage of locating the space station in a geostationary orbit.

(2)

....

....

....

....

(ii) Calculate the height h of the space station above the equator when it is in a geostationary orbit.

mass of Earth = 6.00×10^{24} kg
24 hours = 8.64×10^4 s

(4)

....

....

....

....

....

....

....

....

....

h = ...

(Total for question = 6 marks)

Q4.

Galileo is credited with inventing the first telescope in 1610. The picture shows an early demonstration of the telescope.

(Source: © CPA Media Pte Ltd/Alamy Stock Photo)

A converging lens was positioned at one end of the telescope. A diverging lens was placed at the other end and a person looked through this lens.

Galileo was the first person to observe Jupiter's larger moons.

Ganymede is Jupiter's largest moon. The distance between the centre of Ganymede and the centre of Jupiter is

1.07 × 10^6 km. Ganymede takes 171 hours to complete an orbit around Jupiter.

Calculate the mass of Jupiter.

(5)

....
....
....
....
....
....
....
....
....
....

Mass of Jupiter = ...

(Total for question = 5 marks)

Q5.

Astronauts on the 1971 Apollo 14 mission to the Moon brought back many rock samples. It is now believed that one of these contains a piece of rock that originated on Earth about 4 billion years (4 × 10^9 years) ago.

The piece of rock is believed to have been launched into space when an asteroid struck the Earth.

Four billion years ago, the Moon had a different orbital period, because it was closer to the Earth than it is today.

Calculate the period of the Moon's orbit four billion years ago, when the radius of its orbit was 1.34 × 10^8 m.

mass of Earth = 5.97 × 10^{24} kg

(3)

....
....
....
....
....
....
....
....

Period = ...

(Total for question = 3 marks)