



GALACSY

Data Response Round

Saturday

1 June 2013

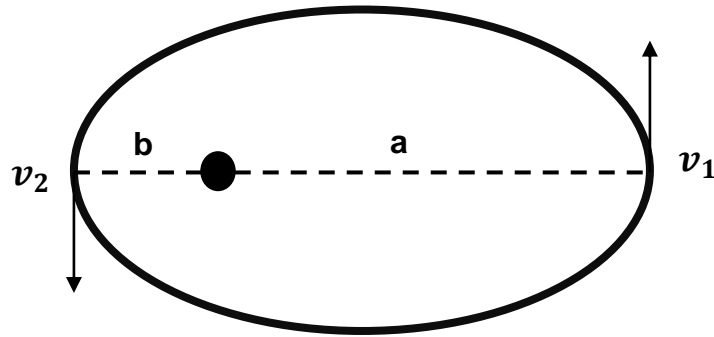
30 minutes

Information for participants

- This round will consist of 40% of the Preliminary Rounds.
- There are 4 questions.
- Marks are given at the end of each question. There is no negative marking.
- Write your answer neatly on the answer paper.
- You are **only** allowed to use a scientific calculator.

This question paper consists of 2 printed pages including the cover page.

Question 1: [5]



Using two different methods, determine the value of $\frac{v_1}{v_2}$ in terms of **a** and **b**.

Question 2: [5]

Estimate the average temperature on earth provided that the Solar radiation intensities is 1400 W m^{-2} .

Question 3:

This question is about the technique “Gravitational Slingshot”.

A spaceship wants to gain speed by “Slingshot” around Jupiter. Its initial velocity is v_1 , the Jupiter velocity initially is v_2 . In order to determine the final velocity of the spaceship (v_1'), the scenario can be simplified as if the spaceship collides elastically with Jupiter.

- Derive an expression for the for v_1' in terms of v_1 , v_2 and v_2' (with v_2' is the final speed of Jupiter. [2]
- Let m and M be the mass of the spaceship and the Jupiter respectively. Derive an expression for v_1' in terms of v_1 , v_2 , m and M . [3]
- Use the approximation $m \ll M$ to arrive at the following relationship. [3]

$$v_1' = v_1 + 2v_2$$

- Give an account for the increase in total energy of the spaceship. [2]

Question 4: [10]

Based on the famous equation, $E = mc^2$, which describes the total energy of a moving object which has a rest mass of m_0 , find the relationship between the mass of that object and its speed.

(Hint: start with the following relationship: $\frac{dE}{dt} = \mathbf{F} \cdot \mathbf{v}$)