**Q1.**

Figure 3 shows a lunar eclipse.

**Figure 3**

The Greek astronomer Eratosthenes used observations of a lunar eclipse to estimate the size of the Moon compared to the Earth.

Measurements from a similar experiment are summarised in Figure 4.

| Umbral contact | Time (h:min) |
|---|---|
| 1st | 19:14 |
| 2nd | 20:47 |
| 3rd | 23:52 |
| 4th | 01:25 |

**Figure 4**

(i)

From earlier observations, Eratosthenes had calculated that the diameter of the Earth was around 14,000 km.

Analyse the observations in Figure 4 in order to calculate a value for the diameter of the Moon. Show each stage in your calculation clearly.

**(3)**

Diameter of the Moon = ..... km

(ii) Calculate the percentage error in this value for the diameter of the Moon.

Use information from the Formulae and Data Sheet.
Use the equation:

$$\text{Percentage error} = \frac{(\text{Calculated diameter} - \text{true diameter})}{\text{True diameter}} \times 100\%$$

**(2)**

Percentage error = ..... %

(iii) State **one** reason why it is hard to obtain an accurate value for the Moon's diameter using Eratosthenes' method.

**(1)**

.....

.....

**(Total for question = 6 marks)**

## Mark Scheme

**Q1.**

| Question number | Answer | Mark |
|---|---|---|
| | (i) **4700** (4683) (km) | **(3)** |
| | *Correct time gap(s):*<br>2nd Contact – 1st Contact = 20:47 – 19:14 = *1h 33m*<br>3rd Contact – 1st Contact = 23:52 – 19:14 = *4h 38m* | *Either of:*<br>*(1)*<br>*(1)* |
| | *Correct ratio:*<br>Moon/Earth ratio = 4h 38m / 1h 33m = *2.99* or 0.334<br>(allow 3 or 0.33) | *(1)* |
| | (Hence, Moon's diameter = 0.334 × 14 000km = 4683km) | |
| | (ii) **34% (0.34)** | **(2)** |
| | (F&DS gives Moon's diameter as 3500km) | |
| | Error = 4700 – 3500 = 1200km<br>(accept 1183, allow ECF from (i)) | *(1)* |
| | Percentage Error = 1200km / 3500km = 34% (0.34)<br>(allow 1183/3500 = 33.8%) | |
| | *(ii) Any **one** of:*<br>• hard to estimate exact time of contacts<br>• slow progress of eclipse<br>• fuzzy edges of shadow regions<br>• weather conditions<br>• compound error from diameter of Earth. | ***(1)*** |