

**Semester 2 Examination, 2022 Question/Answer booklet**

**PHYSICS**

**Units 3 & 4**

**MARKING KEY**

**Time allowed for this paper**

Reading time before commencing work: ten minutes

Working time: three hours

**Materials required/recommended for this paper**

***To be provides by the supervisor***

This Question/Answer booklet

Formulae and Data booklet

***To be provided by the candidate***

Standard items: pens (blue/black preferred), pencils (including coloured), sharpener,

correction fluid, eraser, ruler, highlighters.

Special items: up to three non-programmable calculators approved for use in the WACE examinations, drawing templates, drawing compass and a protractor.

**Important note to candidates**

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised material. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

**Structure of this paper**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Section | Number of Questions | Questions to be answered | Suggested working time (minutes) | Marks available | Percentage of exam |
| Section One  Short Response | 10 | 10 | 50 | 54 | 30 |
| Section Two  Problem Solving | 6 | 6 | 90 | 90 | 50 |
| Section Three  Comprehension | 2 | 2 | 40 | 36 | 20 |
| **Total** | 180 | 100 |

**Instructions to candidates**



1. The rules for the conduct of Western Australian external examinations are detailed in the *Year 11 Information Handbook 2022: Part II Examinations.* Sitting this examination implies that you agree to abide by these rules.
2. Write your answers in this Question/Answer booklet preferably using a black/blue pen. Do not use erasable or gel pens.
3. You must be careful to confine your answers to the specific questions asked and follow any instructions that are specific to a particular question.
4. When calculating or estimating answers, show all your working clearly. Your working should be in sufficient detail to allow your answers to be checked readily and for marks to be awarded for reasoning.

In calculations, give final answers to three significant figures and include appropriate units where applicable.

In estimates, give final answers to a maximum of two significant figures and include appropriate units where applicable.

1. Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate in the original answer where the answer is continued, ie – give the page number.
2. The Formulae and Data booklet is not to be handed in with your Question/Answer booklet.



**Section One: Short Response 30% (54 marks)**

This section has ten (10) questions. Answer **all** questions. Write your answers in the spaces provided.

Suggested working time: 50 minutes.

**Question 1 (5 marks)**

1. Calculate the expected combined mass of these two particles in kilograms. Use your Formulae and Data Booklet.

(3 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

1. Calculate the electric charge on a Kaon meson.

(2 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |

**Question 2 (6 marks)**

1. Calculate the velocity of spaceship ‘X’ relative to ‘Y’ and ‘Z’.

(3 marks)

|  |  |
| --- | --- |
|  |  |
|  | 1 mark |
|  | 1 mark |
| 3 sf | 1 mark |

1. State and explain which observer or spaceship will view the length of Spaceship ‘Y’ as the longest **and** which will view the length as the shortest.

(3 marks)

|  |  |
| --- | --- |
| Longest: observer on spaceship ‘Z’; shortest: observer on spaceship ‘X’. | 1 mark |
| Velocity of spaceship ‘Z’ relative to spaceship ‘Y’ is zero; observers on ‘Z’ will observe true length of ‘Y’. | 1 mark |
| Velocity of spaceship ‘X’ relative to spaceship ‘Y’ is the highest value (0.940c); hence, will observe the greatest length contraction. | 1 mark |

**Question 3 (6 marks)**

Calculate ‘ϴ’ and, hence, the period (T) of the object’s circular motion. Show all working.

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

**Question 4 (5 marks)**

1. State the direction in which conventional current must be flowing in the copper tube.

(1 mark)

|  |  |
| --- | --- |
| Out of the page | 1 mark |

1. Calculate the strength of the magnetic field (B) between the poles of the horseshoe magnet if a current of 1.30 A is flowing in the copper tube.

(4 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

**Question 5 (7 marks)**

An electron in an electron microscope is accelerated by an electric potential to 15.0% of the speed of light.

1. Calculate the de Broglie wavelength for this electron. As part of your answer, calculate the **relativistic** momentum of the electron at this speed.

(4 marks)

|  |  |
| --- | --- |
| Relativistic momentum: | 1 mark |
|  | 1 mark |
| De Broglie wavelength: | 1 mark |
|  | 1 mark |

1. Atoms have a size that is on a scale of 10-10 metres. Explain how the electron beam in part a) would need to be changed to achieve maximum resolution of objects at this scale.

(3 marks)

|  |  |
| --- | --- |
| The de Broglie wavelength of the electron beam would need to be increased in magnitude. | 1 mark |
| Hence, the relativistic momentum of the electron beam would need to be decreased. | 1 mark |
| This can be achieved by reducing the relativistic speed and mass of the electrons. | 1 mark |

**Question 6 (4 marks)**

Calculate the tension (T) in the metal strut.

|  |  |
| --- | --- |
|  |  |
|  | 1-2 marks |
|  | 1 mark |
|  | 1 mark |

**Question 7 (4 marks)**

A particle interaction called ‘electron capture’ can be represented by the following incomplete equation:

1. Write the name and symbol of the unidentified particle in the spaces provided below.

(2 marks)

|  |  |
| --- | --- |
| Electron neutrino | 1 mark |
|  | 1 mark |

1. Using relevant conservation laws, explain how you determined the unidentified particle in part a).

(2 marks)

|  |  |
| --- | --- |
| To conserve electric charge, the particle must have a neutral charge (Q = 0). | 1 mark |
| To conserve baryon number, the particle must have a quantum number B = 0; and to conserve lepton number, the particle must have a quantum number L = 1. | 1 mark |

**Question 8 (5 marks)**

1. The intensity of the incident electromagnetic radiation is slowly increased whilst the wavelength remains constant. Explain what happens to the current measured in the ammeter.

(2 marks)

|  |  |
| --- | --- |
| Increasing the intensity of the incident electromagnetic radiation without changing the wavelength will increase the number of photons incident on the metal surface. | 1 mark |
| This will increase the rate of production of photoelectrons and, hence, increase the reading on the ammeter. | 1 mark |

1. The intensity of the incident electromagnetic radiation is returned to its original value and its wavelength is continually increased. Explain what would be observed by the ammeter over time.

(3 marks)

|  |  |
| --- | --- |
| Increasing the wavelength of the incident electromagnetic radiation will decrease its photon energy. | 1 mark |
| This will decrease the kinetic of the photoelectrons and, hence, decrease the reading on the ammeter. | 1 mark |
| Eventually, the frequency of the incident radiation will become less than the threshold frequency and zero photoelectric current will be detected in the ammeter. | 1 mark |

**Question 9 (7 marks)**

1. An electron undergoes a downward transition between n = 6 and n = 4. As a result, a photon of wavelength 548 nm is emitted. Calculate the value (in eV) of energy level n = 6.

(4 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

1. If an electron of energy 5.00 eV bombards a mercury atom in ground state, calculate **all** the possible energies of the electrons after they have been scattered.

(3 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

**Question 10 (6 marks)**

1. Explain how the airplane can create a ‘weightless’ environment at the top of the vertical circle. Include a diagram showing the force(s) acting on the airplane at this point, including the resultant force.

(3 marks)

W = mg

∑F = Fc

|  |  |
| --- | --- |
| Vector diagram shows two (2) vectors: net force/centripetal force (∑F or Fc). | 1 mark |
| Both vectors are the same length. | 1 mark |
| If weight = centripetal force, normal force (N) will be equal to zero. | 1 mark |

1. Calculate the speed ‘v’ at which this airplane would need to be travelling to simulate a weightless environment at the top of the vertical circle.

(3 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

**END OF SECTION ONE**

**Section Two: Problem Solving 50% (90 marks)**

This section contains six (6) questions. Answer **all** questions. Answer the questions in the space provided.

Suggested working time is 90 minutes.

**Question 11 (15 marks)**

1. Explain how the motion of a bobsled changes on the banked turn as its speed ‘v’ increases.

(2 marks)

|  |  |
| --- | --- |
| For a fixed value of ‘ϴ’, increasing ‘v’ will cause a corresponding increase in ‘r’. | 1 mark |
| For this to occur, the car must move higher up on to the banked track. | 1 mark |

Using appropriate equipment, the officials gathered the following data.

|  |  |  |  |
| --- | --- | --- | --- |
| v (kmh-1) | v (ms-1) | v (m2s-2) | r (m) |
| 95 | 26.4 | 697 | 193 |
| 100 | 27.8 | 772 | 215 |
| 105 | 29.2 | 853 | 238 |
| 110 | 30.6 | 936 | 264 |
| 115 | 31.9 | 1020 | 285 |
| 120 | 33.3 | 1110 | 312 |

1. Complete the table by calculating the missing values in the table above. Show any calculations in the space below.

(2 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |

1. On the grid on the next page, plot a graph of ‘v2’ against ‘r’. Place ‘r’ on the y-axis. Draw a line of best fit or the data.

(4 marks)

(4 marks)

r (m)

v2 (m2s-2)

|  |  |
| --- | --- |
| Axes correctly labelled – ‘r’ on y axis. | 1 mark |
| Axes labelled with correct units (see graph above). | 1 mark |
| Points correctly plotted. | 1 mark |
| Line of best fit correctly drawn. | 1 mark |

1. Calculate the gradient of the line of best fit. Show clearly how you did this. Include units in your answer.

(4 marks)

|  |  |
| --- | --- |
| Uses points from the line of best fit: (1070, 300) and (560, 150) | 1 mark |
|  | 1 mark |
|  | 1 mark |
| Units: s2m-1 | 1 mark |

1. Use the gradient from part d) to calculate an experimental value for ‘g’ (acceleration due to gravity on the Earth’s surface).

(3 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

**Question 12 (18 marks)**

1. Explain how a current reading can be sent to the meter without the clamp touching the conductor.

(4 marks)

|  |  |
| --- | --- |
| The AC current in the conductor creates an alternating magnetic field around the iron lamp. | 1 mark |
| This changing magnetic field induces eddy currents in the iron clamp which will alternate with the AC current. | 1 mark |
| The alternating eddy currents will create a change in flux in the secondary coil wound onto the clamp. | 1 mark |
| Hence, an alternating emf is induced in the coil and a current/signal is sent to the meter. | 1 mark |

1. Calculate the peak current (IPEAK) in the conductor.

(2 marks)

|  |  |
| --- | --- |
|  | 1 mark |
| (accept a positive value only) | 1 mark |

1. Calculate the maximum magnitude of the magnetic field strength at the distance where the clamp is positioned.

(2 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |

1. Calculate the maximum flux change experienced by the coil if its cross-sectional area is 4.00 cm2. [If you were unable to calculate an answer for part c), use a value of 1.30 x 10-4 T]

(4 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

1. Hence, calculate the average EMF (Ɛ) generated in the secondary coil if it consists of 250 turns.

(3 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

1. Would this particular type of circuit clamp work for a DC circuit? Explain.

(3 marks)

|  |  |
| --- | --- |
| No. | 1 mark |
| A DC power supply would not create a change in flux through the iron clamp. | 1 mark |
| Hence, no change in flux will occur through the secondary coil and zero EMF/current will be induced. | 1 mark |

**Question 13 (14 marks)**

1. Calculate the tension in each cable when the tarmac sections are in the position shown.

(4 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
|  | 1. mark |

1. Hence, calculate the magnitude and direction (find the angle with the vertical) of the force on each hinge when the tarmac sections are in this position. (If you were unable to calculate a value for part a), use 2.70 x 104 N)

(6 marks)

|  |  |
| --- | --- |
|  | 1-2 marks |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

1. Use this data to calculate the average force of friction experienced by the bin on the tarmac.

(4 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

**Question 14 (13 marks)**

1. Calculate the horizontal component (uh) of the athlete’s launch velocity ‘v’.

(2 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |

1. Using the vertical displacements shown, calculate the vertical component (uv) of the athlete’s launch velocity ‘v’.

(4 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

1. Hence, calculate the magnitude of the launch velocity ‘v’ and the launch angle ‘ϴ’. [If you were unable to calculate answers for parts a) and b), use values of 8.00 ms-1 and 3.40 ms-1 respectively]

(4 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

1. State how the horizontal length of the athlete’s jump could be expected to change if it took place in Mexico City. Explain two (2) reasons for your answer. Air resistance can be considered in this question.

(3 marks)

|  |  |
| --- | --- |
| Expected range would be greater than 6.85 metres. | 1 mark |
| REASON 1: At this altitude, g < 9.80 ms-2. Hence, flight time would be longer. | 1 mark |
| REASON 2: At this altitude, air resistance is lower than at sea level (the air is thinner). | 1 mark |

**Question 15 (17 marks)**

1. Each H-2+ ion achieves a speed of 6.19 x 105 ms-1. Calculate the magnitude of the accelerating potential (in Volts). The mass of a H-2+ ion is 3.34 x 10-27 kg.

(4 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

1. In Stage 2 (Velocity Selection), the effects of an electric field and a magnetic field combine to ensure the velocity of the H-2+ ions are constant and in a straight line.
2. Given the direction of the electric field in STAGE 2, state the direction of the magnetic field by circling the correct option.

(1 mark)

|  |  |
| --- | --- |
| INTO THE PAGE. | 1 mark |

1. Derive an expression showing the relationship between the electric field strength ‘E’; the magnetic field strength ‘B’, and the speed of the H-2+ ions ‘v’.

(2 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |

1. (i) Based on the diagram, state the direction of the magnetic field in the chamber.

(1 mark)

|  |  |
| --- | --- |
| Out of the page. | 1 mark |

1. Explain why the chamber is filled with a vacuum. As part of your answer, describe how the path of the beam of H-2+ ions would change if the chamber was filled with a low-pressure gas.

(3 marks)

|  |  |
| --- | --- |
| If the chamber was filled with a low-pressure gas, the H-2+ ions would collide with these atoms reducing their EK and speed ‘v’. | 1 mark |
| The radius ‘r’ of the circular path taken by the ions is given by:  , so, if ‘v’ decreases, ‘r’ decreases and a spiral path will result. | 1 mark |
| Therefore, a vacuum ensures a constant speed ‘v’ and radius ‘r’. | 1 mark |

1. (i) Use the appropriate formulae in your data booklet to derive the following expression for the frequency ‘f’ of the charged particle’s rotation in the field:

to show that the following expression can be derived for the frequency ‘f’ of the charged particle’s rotation in the field:

where B = magnetic field strength (T);

q = electric charge on the particle (C); and

m = mass of the particle (kg).

(4 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
|  | 1. mark |

(ii) Hence, calculate the frequency of circular rotation of the H-2+ ions if the magnetic field strength in the vacuum chamber is 1.20 T.

(2 marks)

|  |  |
| --- | --- |
|  |  |
|  | 1 mark |
|  | 1 mark |

**Question 16 (13 marks)**

1. Calculate the transmission current in the line between the AC generator and the substation.

(2 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |

1. Hence, calculate the power lost in the transmission line between the AC generator and the substation.

(2 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |

1. Calculate the electric power generated at the AC generator.

(2 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |

1. Determine the voltage at which electric power is generated at the AC generator.

(2 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |

1. Calculate the ideal turns ratio in the transformer at the substation.

(2 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |

1. If all other factors were kept equal, would an increase in AC frequency from 50 Hz to 60 Hz increase or decrease the power loss in a transformer due to eddy currents? Explain.

(3 marks)

|  |  |
| --- | --- |
| Increasing the AC power frequency will also increase the rate of change of flux due to the alternating currents in the transformer coils. | 1 mark |
| Increasing the rate of change of flux will increase the size of the eddy currents generated in the iron cores. | 1 mark |
| Hence, power losses due to eddy currents will also increase. | 1 mark |

**END OF SECTION TWO**

**Section Three: Comprehension 20% (36 marks)**

This section has two (2) questions. Answer **both** questions. Answer the questions in the spaces provided.

Suggested working time: 40 minutes.

**Question 17 (18 marks)**

1. Using information from the article - and data from your Formulae and Data Booklet – calculate the centripetal force acting on the James Webb Telescope while it is in orbit at L2 La Grange Point. [Note, the distance between the Earth’s centre of mass and L2 is 1.5 million kilometres].

(3 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

1. (i) State the orbital period (T) of the James Webb Telescope around the Sun in seconds.

(2 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |

(ii) Hence (or otherwise) calculate the average orbital speed of the James Webb Telescope around the Sun.

(3 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
| OR |  |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

1. The James Webb Telescope is tuned to infrared radiation that is emitted by extremely distant luminous objects (eg – galaxies). To be able to detect this faint IR radiation, the telescope needs to be cooled to a very low operating temperature of 50 K. Suggest a reason for this.

(3 marks)

|  |  |
| --- | --- |
| The infrared radiation from different galaxies will be very low intensity. | 1 mark |
| At greater than 50 K, the JWT will emit black body radiation in the infrared region. This will overwhelm the faint incoming infrared signals from distant objects. | 1 mark |
| By cooling the JWT to 50 K or less, the JWT will emit body radiation in the radio waves region and not interfere with the faint incoming infrared signals. | 1 mark |

1. The James Webb Telescope’s four instruments collect radiation in the 0.5 to 28 micron range. Calculate the corresponding frequency range for these instruments.

(2 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |

1. Explain why conducting astronomy in the infrared region of the electromagnetic spectrum will allow the James Webb telescope to view the Universe as it was 100 million to 250 million years after the Big Bang.

(3 marks)

|  |  |
| --- | --- |
| Ever since the Big Bang 13.7 billion years ago, the Universe has been expanding. | 1 mark |
| Stars and galaxies formed about 100 million to 250 million years after the Big Bang. | 1 mark |
| The light emitted by these first stars and galaxies is still travelling to us and has been redshifted into the infrared region. | 1 mark |

1. The first light emitted in the Universe – the Cosmic Microwave Background Radiation – is evidence supporting Big Bang Theory. Explain.

(2 marks)

|  |  |
| --- | --- |
| According to Big Bang Theory, the Universe was filled with plasma which absorbed and scattered any radiation travelling through it. | 1 mark |
| About 380 000 years after the Big Bang, atoms began to form, and radiation was no longer absorbed or scattered – the CMB is a remnant of this radiation. | 1 mark |

**Question 18 (18 marks)**

1. In their famous experiment, Michelson and Morley used the rotation of the Earth on its axis and its revolution around the Sun to measure the speed of sunlight. They took measurements of the speed of sunlight six (6) months part.

One measurement was taken when the observers were travelling AWAY from the Sun. The next measurement was taken so that they were travelling TOWARDS the Sun (see below).

TRAVELLING TOWARDS SUN

TRAVELLING AWAY FROM SUN

In accordance with Newton’s Laws, Michelson and Morley incorrectly hypothesised that the speed of light should be measured to be different values at these two locations. State their hypothesis and explain why they made this prediction.

|  |  |
| --- | --- |
| Travelling towards the Sun: SPEED OF LIGHT > c | 1 mark |
| Travelling away from the Sun: SPEED OF LIGHT < c | 1 mark |
| According to Newtonian Physics, all velocities (including the speed of light) are relative. | 1 mark |
| TOWARDS SUN: speed of light = c + vEARTH; AWAY FROM SUN: speed of light = c + vEARTH | 1 mark |

1. In his famous train experiment, Einstein imagined a train travelling at speed ‘v’ that was a significant proportion of the speed of light ‘c’. At particular instant of time, the train was situated equidistant between two trees – an observer (X) on the moving train was also positioned at the midpoint between the two trees (see below).

Another observer (Y) is standing in a stationary position on the side of the tracks directly opposite the train. At the same instant, this stationary observer is standing directly opposite the observer in the train and is also equidistant between the two trees (see below).

At this instant in time, the stationary observer sees two bolts of lightning strike the two trees at exactly the same time.

**v**

**TREE 1**

**TREE 2**

**X**

**Y**

State the order in which the observer on the train (X) sees the lightning bolts. Explain your answer.

(3 marks)

|  |  |
| --- | --- |
| Observer ‘X’ sees TREE 2 first; TREE 1 second. | 1 mark |
| Light travels form both lightning bolts towards observer ‘X’ at the same speed ‘c’. | 1 mark |
| Observer ‘X’ is travelling towards TREE 2 so the light from this tree reaches him before that of TREE 1. | 1 mark |

1. (i) Using appropriate formulae from your Data Booklet, explain why objects cannot travel at the speed of light, ‘c’.

(3 marks)

|  |  |
| --- | --- |
| Relativistic energy of an object is given by: | 1 mark |
| Hence, as v → ∞, E→ ∞ | 1 mark |
| To reach ‘c’, the energy required would become infinitely large. | 1 mark |

(ii) On the axes below, sketch a graph showing how the relativistic momentum of an object changes as its speed approaches ‘c’.

(2 marks)

Relativistic momentum

Speed

c

|  |  |
| --- | --- |
| Asymptote at ‘c’ indicated. | 1 mark |
| Shape of the graph is correct. | 1 mark |

1. The following questions relate to the examples of time dilation mentioned in the article. Consider only the effects of **special** relativity

(i) A spaceship travels to a distant galaxy at 99.5% of the speed of light. The astronaut ages 5.00 years by the time they arrive. Calculate how much time would have passed on Earth during this time.

(3 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

(ii) Calculate the average orbital speed of a GPS satellite if it ticks seven (7) microseconds longer in the course of one day than a stationary clock on earth.

(3 marks)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

**END OF EXAMINATION**