Name: ________________________ (   ) **CT Group: 25S0** ____

RAFFLES INSTITUTION

2024 YEAR 5 PROMOTION EXAMINATION

H2 PHYSICS

9749

2 h 30 min

Section B

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Name, Index Number and CT Group in the spaces at the top of this page.
Write in dark blue or black pen on both sides of the paper.
You may use a 2B pencil for any diagrams or graphs.

The use of an approved scientific calculator is expected, where appropriate.
Answer **all** questions.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	/ 15
16	/ 8
17	/ 9
18	/ 8
19	/ 10
20	/ 9
21	/ 17
22	/ 19
Deductions	
Total	/ 95

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16 To determine the Young modulus E of a metal, a student conducts an experiment on a wire made of the metal. Data collected from the experiment are shown below:

$F = (10.0 \pm 0.1)$ N

$L = (0.500 \pm 0.001)$ m

$d = (0.5 \pm 0.1)$ mm

$e = (0.21 \pm 0.01)$ mm

where F is the applied force
L is the original length of the wire
d is the diameter of the wire
e is the extension of the wire.

The Young modulus E is given by the equation:

$$E = \frac{FL}{Ae}$$

where A is the cross-sectional area of the wire.

(a) (i) Show that the unit of E is equivalent to Pa.

[1]

(ii) Determine the Young modulus E of this wire, to three significant figures.

E = ... Pa [2]

(iii) Use your answer in **(a)(ii)** to determine the actual uncertainty in the value of E.

Hence give a statement of E, with its uncertainty, to an appropriate number of significant figures.

E = ... ± ..... Pa [3]

(b) State the quantity that contributes most significantly to the uncertainty in E and suggest an improvement that can be made to reduce the uncertainty in E.

.....

.....

.....

..... [2]

[Total: 8]

17 During a basketball game, a player tries to shoot the ball into the hoop when he is 4.0 m away from the hoop. The hoop is 3.0 m above the ground. The ball leaves the player's hands at a height of 2.0 m above the ground and at angle of 60° from the horizontal and enters the centre of the hoop as shown in Fig. 17.1.

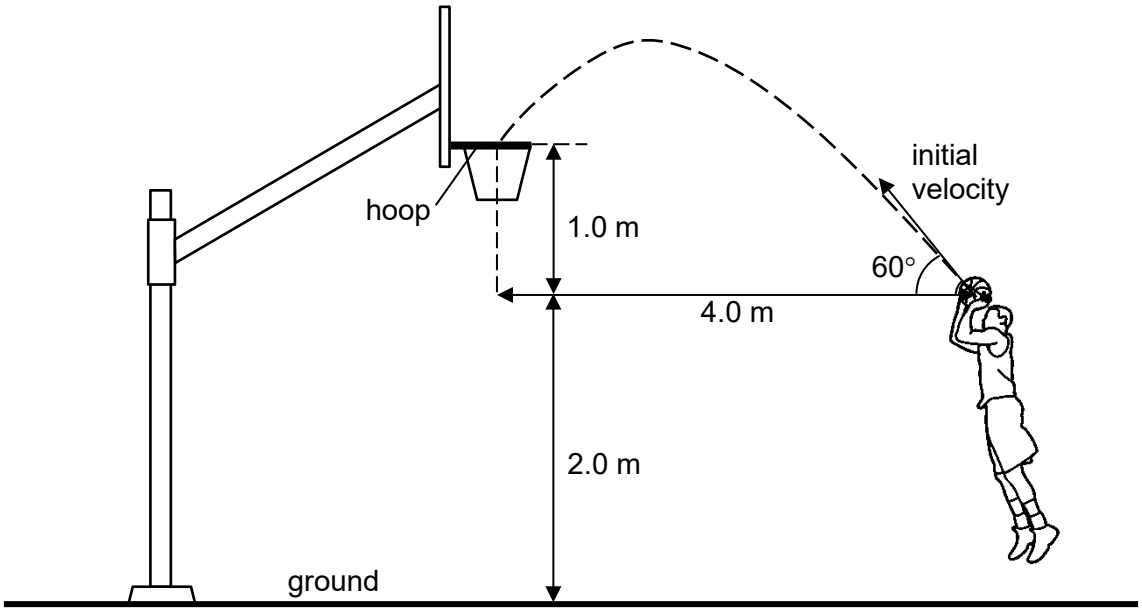

Fig. 17.1 (not to scale)

Determine:

(a) the initial velocity of the ball

initial velocity = ... m s^{-1} [3]

(b) the time taken for the ball to move from the player to the hoop

time taken = ... s [1]

(c) the maximum height above the ground reached by the ball

maximum height = ... m [3]

(d) the magnitude of the change in velocity of the ball from the moment it leaves the player's hand to the moment it enters the hoop.

magnitude of change in velocity = ... $m\ s^{-1}$ [2]

[Total: 9]

18 Fig. 18.1 shows a swing ride carousel. The seats are suspended using light cables of length *L* from the circular top of diameter 14 m. When the period of rotation of the top is 8.7 s, the empty seats swing outwards, and the cables are inclined at an angle of 26° to the vertical.

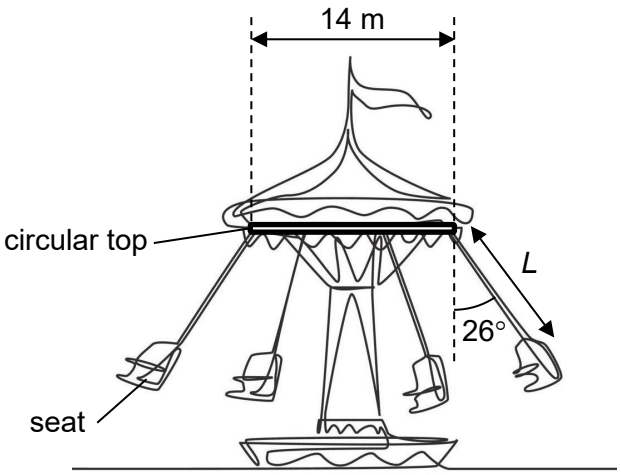

Fig. 18.1 (not to scale)

(a) Explain why the cables are inclined at an angle to the vertical when the top of the ride is rotating.

.....

.....

.....

.....

.....

..... [3]

(b) Show that the angular velocity of the top is 0.72 rad s^{-1}.

[1]

(c) Determine L.

L = ... m [3]

(d) A seat is occupied by a child of mass 30 kg and the top rotates with the same angular velocity in **(a)**.

State and explain whether the angle at which the cable inclines to the vertical increases, decreases or remains the same at 26°.

.....

..... [1]

[Total: 8]

19 **(a)** A planet of mass m is in a circular orbit of radius r around a star of mass M, as shown in Fig. 19.1.

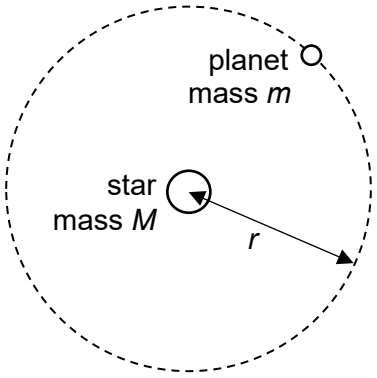

Fig. 19.1

The planet and the star may be considered to be point masses at their centres. The planet has an orbital period T.

Show that T and r are related by the equation:

$$T^2 = \frac{4\pi^2}{GM} r^3$$

where G is the gravitational constant.

[2]

(b) The star ρ–Cancri A has a planetary system like that of the Sun. It has five planets and data for these planets are given in Table 19.1.

Table 19.1

planet	orbital period / Earth days	radius of orbit / m
ρ–Cancri A b	14.7	
ρ–Cancri A c	44.4	
ρ–Cancri A d	5480	8.83×10^{11}
ρ–Cancri A e	2.80	5.69×10^{9}
ρ–Cancri A f	261	

(i) Use the equation in **(a)** and data from Table 19.1 to place the planets in order of orbital distance from ρ–Cancri A.

nearest to ρ–Cancri A ρ–Cancri A .....

ρ–Cancri A .....

ρ–Cancri A .....

ρ–Cancri A .....

furthest from ρ–Cancri A ρ–Cancri A ..... [1]

(ii) Use data from Table 19.1 for the planet ρ–Cancri A d and the planet ρ–Cancri A e to calculate an average value of the mass of the star ρ–Cancri A.

mass of star ρ–Cancri A = ... kg [3]

(c) The masses and radii of ρ–Cancri A and the Sun are related by the equations:

$$\frac{\text{mass of the star } \rho - \text{Cancri A}}{\text{mass of the Sun}} = 0.905$$

$$\frac{\text{radius of the star } \rho - \text{Cancri A}}{\text{radius of the Sun}} = 0.943 .$$

(i) Determine the ratio of the gravitational field strength on the surface of the star ρ–Cancri A to that on the surface of the Sun.

ratio = ... [2]

(ii) Use your answer in **(b)(ii)** to determine the orbital radius of the Earth around the Sun.

orbital radius = ... m [2]

[Total: 10]

20 An arrangement that uses a double slit to demonstrate the interference of light from a laser is shown in Fig. 20.1.

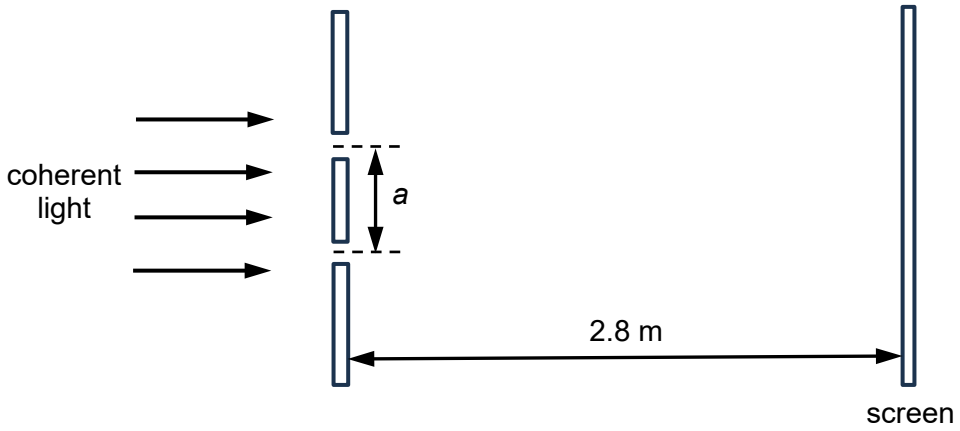

Fig. 20.1 (not to scale)

The light from the laser has a wavelength of 5.2×10^{-7} m and is incident normally on the slits. The separation of the two slits is *a*. The plane of the double slit and screen are parallel and separated by a distance of 2.8 m.

An interference pattern of bright fringes and dark fringes is formed on the screen as shown in Fig. 20.2. The distance between one particular dark fringe and one particular bright fringe is 18 mm.

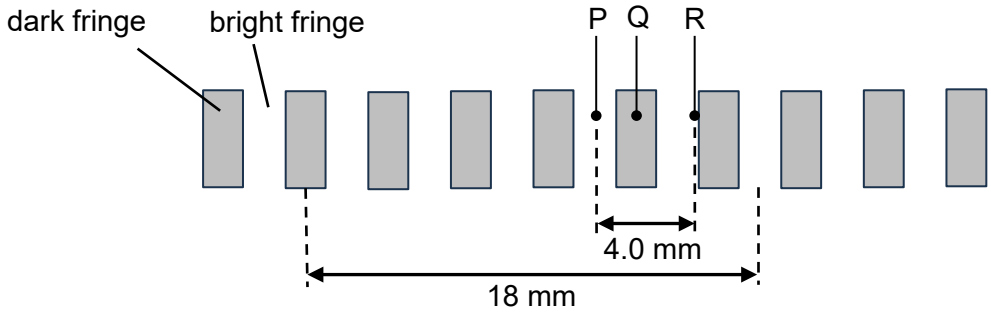

Fig. 20.2 (not to scale)

(a) The light waves emerging from the two slits are coherent.

State what is meant by coherent light waves.

.....

..... [1]

(b) Calculate the separation *a* of the slits.

a = ... m [2]

(c) Point P is at the middle of a bright fringe. Point Q is at the middle of a dark fringe. Point R is at a distance 4.0 mm from point P.

(i) State the phase difference between the light waves meeting at point Q.

phase difference = ... ° [1]

(ii) Calculate the phase difference between the light waves meeting at point R.

phase difference = ... ° [2]

(d) The width of one of the slits is decreased slightly. The separation of slits remains the same. State and explain the effect, if any, that this change has on:

(i) the fringe separation

.....

..... [1]

(ii) the intensity of bright fringes

.....

..... [1]

(iii) the intensity of dark fringes.

.....

..... [1]

[Total: 9]