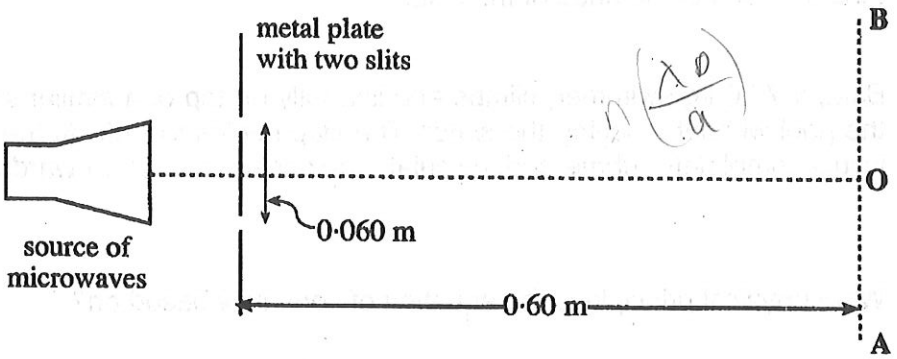
Candidate Name Tan Zhi Yong **Registration Number** 0352624

*Write your name and registration number. Write your answers on a **new sheet** of writing paper. Detach and staple this question on top of your answers to **this** question.*

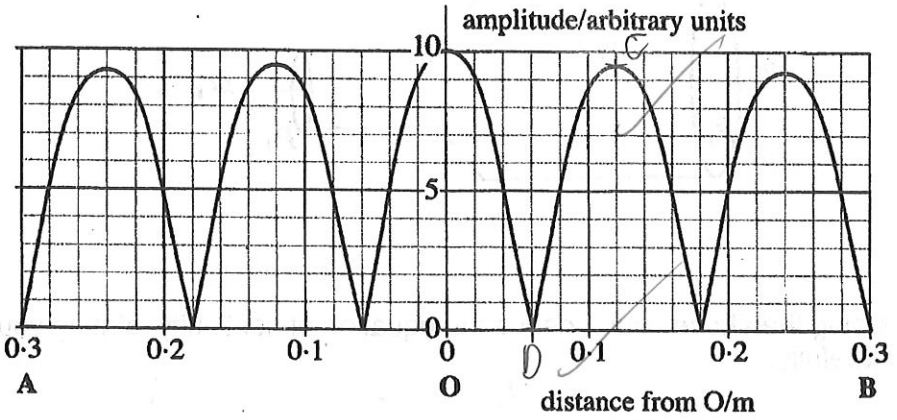
29(a) (i) Describing a wave as *transverse* implies that the directions of motion associated with the wave (at any point in its path) must be at right angles to each other. What are these directions of motion? [2]

(ii) What is a *polarised* transverse wave? [1]

(b) Apparatus is set up as shown to demonstrate the interference of microwaves.



A microwave sensor is moved along the line **AOB**, enabling a graph to be plotted of microwave amplitude against distance from **O** along the line **AOB**.



(i) Write down the amplitude at **O** and the amplitude at a point 0.040 m from **O**. Hence calculate the ratio of the intensities at these points. [3]

(ii) Mark one point on the above graph corresponding to constructive interference and another corresponding to destructive interference. Label these points "**C**" and "**D**" respectively on the graph above. [1]

(iii) Explain the parts played by *diffraction and interference* in the formation of the interference pattern. [2]

(iv) Use the concepts of *phase difference* and *path difference* to explain how *destructive* interference comes about. Assume that the slits act as in-phase sources. [3]

(v) Find the wavelength of the microwaves. [3]

Section C [30 marks]

*Write your answers on the **writing paper** provided.*

28(a) Rahmat, a 60.0 kg lifeguard of a swimming pool, is inspecting the pool on a large rubber dinghy. On board the dinghy, there is a rectangular styrofoam slab of thickness 10.0 cm and density 300 kgm^{-3}, which is used as a float.

(i) Rahmat accidentally threw the styrofoam slab into the pool. What will happen to the water level of the pool? Explain your answer.

[3]

(ii) Rahmat jumps into the water, climbs and rests fully on the styrofoam slab without touching the water. The floating slab is just completely submerged below the water. Find the area of the base of the slab.

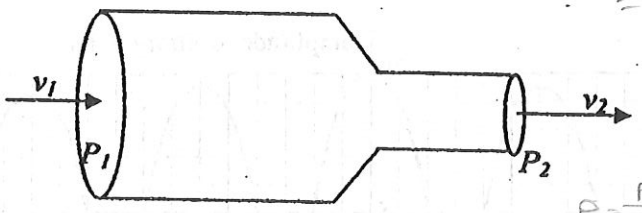
[4]

(iii) Bala, a 75.0 kg swimmer, climbs and lies fully on top of a similar styrofoam slab in the pool without touching the water. The slap begins to sink. At the instant the slab is just completely submerged, calculate the acceleration downwards.

[3]

(b) (i) What physical principle is the equation of continuity based on?

[1]



(ii) Using the above figure, derive the equation of continuity, stating your assumption(s) carefully.

[4]

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28(i) The water level remains the same. The principle of floatation states that the ~~weight~~ mass of water displaced by a floating object is ~~to~~ equal to the ~~weight~~ mass of the object. Since the styrofoam slab floats on water, it will displace the same ~~weight~~ mass of water regardless of ~~what~~ whether it is ~~in contact~~ directly in contact with the water or on the dinghy. 3

28(ii) ~~Mass of float =~~

Let the area be $A\ m^2$

Mass of float $= 0.1m \times 300 \times A$

$= 30A\ kg$

Volume of float $= 0.1A\ m^3$

Mass of Rahmat + float $= (30A + 60)\ kg$

$\frac{30A + 60}{0.1A} = 1000$

$30A + 60 = 100A$

$70A = 60$

$A = 0.857\ m^2$ 4

28(iii) Upthrust ~~$0.1(A\ 0.1(0.8571)(1000)(9.80)$~~

$= 0.1(0.8571)(1000)g$

$= 85.71g\ N$

Force exerted on water $= [30(0.8571) + 75]g$

$= 100.7g\ N$

Resultant force $= 100.7g - 85.71g$

$= 15.00g\ N$

Acceleration $= \frac{15.00g}{30(0.8571) + 75}$

$= 1.46\ ms^{-2}$ (3 s.f.) 3

28bi) Principle of conservation of mass.

28bii) ~~$P = \frac{F}{A}$~~

~~$F_1 = P_1$~~

~~$A_1 = \frac{F_1}{P_1}$~~

Assumption:

The mass of water flowing from the left side is equal to the mass of water flowing out of the right side at any time.

$$\Delta m_1 = \Delta m_2$$

$$\rho \Delta V_1 = \rho \Delta V_2$$

$$\rho A_1 V_1 = \rho A_2 V_2$$

$$\therefore A_1 V_1 = A_2 V_2$$

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29(a)(i) ~~Horizontal~~ They are perpendicular to the direction of propagation of the wave.

29(a)(ii) A polarised transverse wave is one where ~~the~~ there ~~directions of motion~~ are only two directions of motion of the wave.

29(b)(i) Amplitude at O = 10 units
Amplitude at point = 5 units
$\text{Intensity} \propto (\text{Amplitude})^2$
$\text{Ratio of intensities} = \frac{(10)^2}{(5)^2}$
$= 4 : 1$

29(b)(ii) When the microwaves passed through the two slits, they diffracted about them. These waves interfered with each other. When the waves are in phase, constructive interference occurs and ~~the~~ the amplitude is maximum. When the waves are π radians out of phase, destructive interference occurs and ~~they~~ the amplitude is at a ~~minimal~~ minimum.

29(a)(iv) The waves interfere with each other when they come into contact. The path difference refers to the difference in the distance each wave travelled upon striking a point on the screen. This path difference ~~may~~ causes a phase difference in the two waves. When the waves interfere in such a manner

that the amplitudes of one wave is positive and the other is negative, the phase difference is π radians. This causes destructive interference as the waves superimpose to result in a minimum amplitude.

29a)

$$d \sin\theta = n\lambda$$

$$\lambda = \frac{d \sin\theta}{n}$$

Assume that $\sin\theta \approx \tan\theta$ since d is small compared to distance from the slits to the screen

$$\sin\theta \approx \frac{0.060}{0.60}$$

$$= 0.10$$

$$\lambda = \frac{(0.060)(0.10)}{1}$$

$$\frac{\Delta D}{a} = 0.12$$

$$\lambda = \frac{0.12(0.060)}{0.60}$$

$$= 0.012 \text{ m}$$