Name: _____ Index Number: _____ Class: _____

TEMASEK SECONDARY SCHOOL
O Level Preliminary Examination 2024
Secondary 4 Express

PHYSICS **6091 / 03**
Paper 3 Practical

1 hour 50 minutes

Additional Material: NIL

READ THESE INSTRUCTIONS FIRST

Do not open the booklet until you are told to do so.

You are required to submit this booklet at the end of the paper.

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.

Answer **all** questions.
All of your answers should be written in this Question Paper: scrap paper must not be used. Graph paper is provided in this Question Paper. Additional sheets of graph paper should be used only if it is necessary to do so.

You will be allowed to work with the apparatus for a maximum of **55 minutes** for each section. You are expected to record all your observations as soon as they are made. An account of the method of carrying out the experiments is **not** required.

The use of an approved scientific calculator is expected, where appropriate.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] as the end of each question or part question.

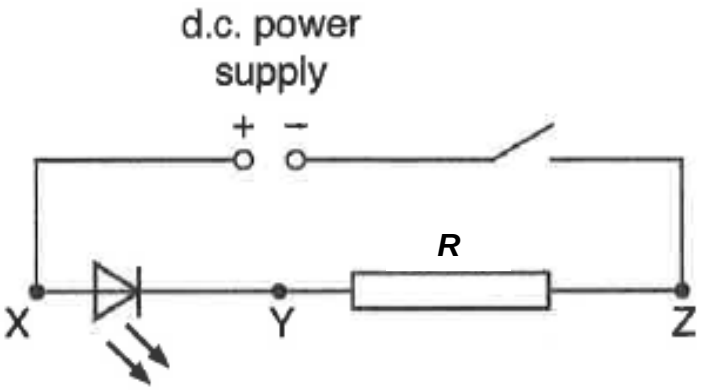
Shift
Laboratory

For Official Use	
1	
2	
3	
Total	**40**

This document consists of **XX** printed pages.

	Section A
1	*In this experiment, you will investigate an electrical circuit containing a light-emitting diode (LED).* You are provided with • a power supply (consists of two 1.5 V batteries with battery holders), • a switch, • a light-emitting diode (LED), • 1500 Ω and 6200 Ω resistors, • a voltmeter, • 6 connecting leads, • a digital micrometer.

	(a)	The LED has two legs, one labelled positive, and the other labelled negative. Measure and record the diameter of any one leg.
		diameter = ... [1]
		Record to 2 dp in mm Acceptable range

	Assemble the circuit shown in Fig. 1.1, where R = 1500 Ω.  **Fig. 1.1**

	(b)	**(i)**	Connect the voltmeter across junctions Y and Z to measure the potential difference (p.d.) V_R across R. Close the switch and record V_R.
			V_R = ... [1]
			1.20 V (2 dp with correct unit)
		(ii)	Open the switch and disconnect the voltmeter.

			Calculate the current I in the circuit using the relationship $$I = \frac{V_R}{R}$$ where R is the resistance of the resistor that is in the circuit.
			I = ... [1]
			I = 1.20 / 1500 = 8.00×10^{-4} A (correct sf, unit)
		(iii)	Connect the voltmeter across junctions X and Y to measure the p.d. V across the LED. Close the switch and record V.
			V = ... [1]
			1.80 V (2 dp with correct unit)
		(iv)	Calculate the power P dissipated in the LED using the relationship $$P = I\,V$$
			P = ... [1]
			P = $(8.00 \times 10^{-4})(1.80)$ = 1.44×10^{-3} W (correct sf, unit)

	(c)	Disconnect the 1500 Ω resistor and replace it with the 6200 Ω resistor.		
		(i)	Repeat **(b)** and record the new values of V_R and V.	
				V_R = ...
				V = ... [1]
			1.30 V; 1.00 V (2 dp with correct unit)	
		(ii)	Calculate new values of I and P.	
				I = ...
				P = ... [1]
			I = 1.30 / 6200 = 2.10×10^{-4} A P = 2.10×10^{-4} W Both correct to get 1 mark (correct sf, unit)	
		(iii)	R is increased from 1500 Ω to 6200 Ω.	

			Compare the increase in *R* with the change in I and with the change in *P*.
			…… …… [1]
			When R increases, I decreases and P decreases. [1]

	(d)	Describe how modifications can be made to the circuit in Fig. 1.1 to measure I directly and for a range of values of *R*.
		…… …… …… [2]
		Connect an ammeter in series. [1] Replace fixed resistor with a variable resistor / rheostat. [1]

[Total: 10]

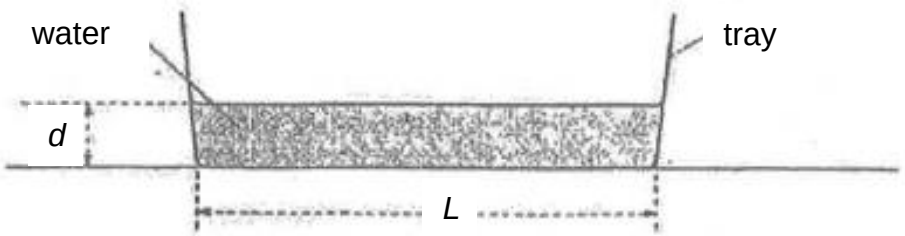
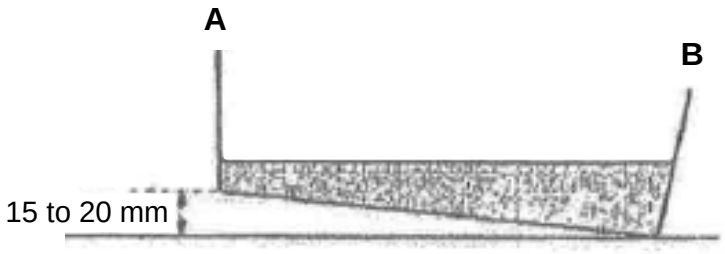
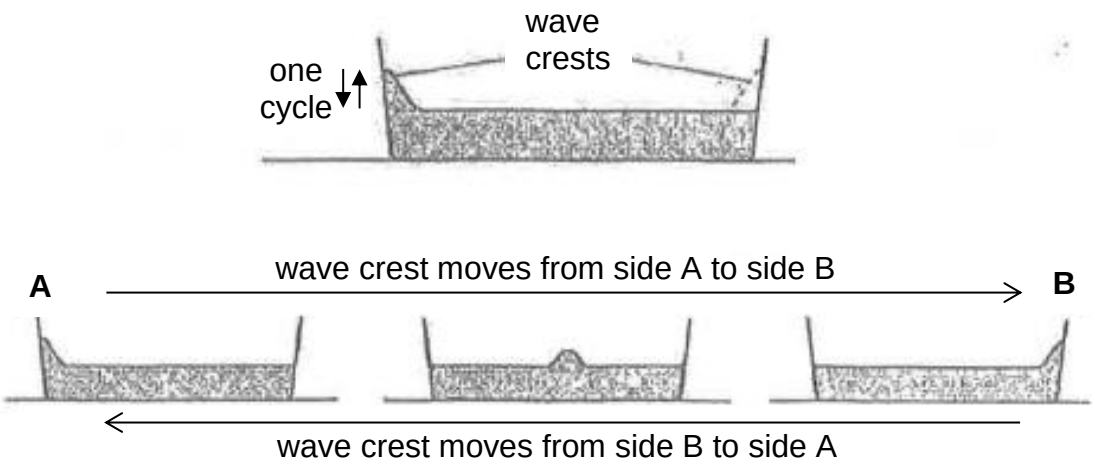
2	*In this experiment, you will investigate how the speed of a water wave changes as the depth of the water is altered.* You are provided with • a tray, • a beaker • a marked stick, • a stopwatch, • a half-metre rule. Set up the apparatus shown in Fig. 2.1. With the tray flat on the bench, carefully pour water into it so that the depth, *d*, is 10 mm. Use the marked stick provided to help you measure this depth. 

		Fig. 2.1
	(a)	Measure and record the length *L* of the tray.
		L = ... [1]
		Acceptable range with unit [1]

		Raise one side of the tray, A, by about 15 to 20 mm, as shown in Fig. 2.2 and then let it drop back to the bench.  **Fig. 2.2** You should see a wave move forward and backward across the surface of the water several times, as shown in Fig. 2.3.  **Fig. 2.3** One cycle consists of a wave crest traveling from side **A** of the tray to side **B** and back again to side **A**.
	(b)	Determine an accurate time *t* taken for a wave crest to complete 3 cycles.
		t = ... [2]
		evidence of average taken [1] accuracy of value and to correct dp [1] e.g. *t* = (3.9 + 4.1 + 3.9) / 3 = 4.0 s

	(c)	Calculate the average speed of the wave, *c*, using the formula $$c = \frac{6L}{t}$$
		c = ... [1]
		c = 6(165 mm) / 4.0 s = 250 mm/s [1]

	(d)	**Plan** It is suggested that the average speed *c* and depth *d* are related by the expression: $$c = A\sqrt{d} + B$$ where *A* and *B* are constants. Using the same apparatus given in this experiment, plan an experiment to investigate this relationship. In your plan, you should: • state **one** key variable to control. • explain briefly how to do the experiment. • describe how to vary *d*. • draw a table, with column headings, to show how to display the range of readings. • write a statement of the graph to plot to test this relationship. • explain how to determine *A* and *B* if the relationship is valid.
		…… …… …… …… …… …… …… …… ……

[6]

[Total: 10]

EITHER

IV: depth of water in tray, *d*

DV: average speed of wave, *c* (OR time *t* taken for the wave crest to complete 3 cycles) [0]

Control: Release height of side A fixed at 15 mm. [1]

Pour water into tray until *d* = 10 mm with the aid of the marked stick.

Drop side A of tray from a fixed height of 15 mm, measured using the ruler.

Using stopwatch, measure time t_1 taken for 3 cycles of wave. Repeat to find t_2, and calculate average time *t*. [1]

Calculate *c* using $c = 6L / t$.

Calculate $\sqrt{d}$.

Repeat experiment, varying *d*, from 10 mm to 60 mm, by using pre-marked stick at intervals of 10 mm. [1]

Tabulate all data into table as follow.

d/mm	t_1/s	t_2/s	t/s	c/mms^{-1}	$\sqrt{d}$/mm^{½}
10					
20					
30					
40					
50					
60					

[1]

Plot graph of *c* against $\sqrt{d}$ and draw line of best fit. [1]

If relationship is valid, graph will be a straight line. *A* is the gradient of graph and *B* is the vertical intercept. [1]

Section B

3 *In this experiment, you will investigate how the energy transferred to the surroundings from a beaker of hot water depends on the insulation of the beaker.*

You have been provided with

- a thermometer,
- two 250 ml beakers,
- a folded sheet of newspaper,
- two rubber bands,
- a square piece of card,
- a stopwatch.

(a) Measure room temperature θ_0.

θ_0 = …… [1]

30.0 °C (1 d.p)

(b) Pour hot water into one of the beakers until it reaches the 200 ml mark.

(c) **(i)** Place the thermometer in the water.

(ii) When the thermometer reads 65.0 °C, start the stopwatch.

Measure and record the temperature θ_1 and the time t at appropriate intervals for six minutes.

(iii) Describe the process and techniques used to ensure the temperature is measured accurately with time.

……

……

……

…… [2]

Any two

- Stopwatch is held beside thermometer so that temperature can be read promptly.
- Bulb of thermometer is positioned centrally without touching the sides/ bottom of the beaker.
- Read off thermometer scale at eye level to prevent parallax error.
- Read off to the nearest half smallest division on the thermometer scale.

(d) (i) Insulate the empty beaker by wrapping the folded newspaper around the **sides** of the beaker. Secure the newspaper to the beaker using one or two rubber bands as shown in Fig. 3.1.

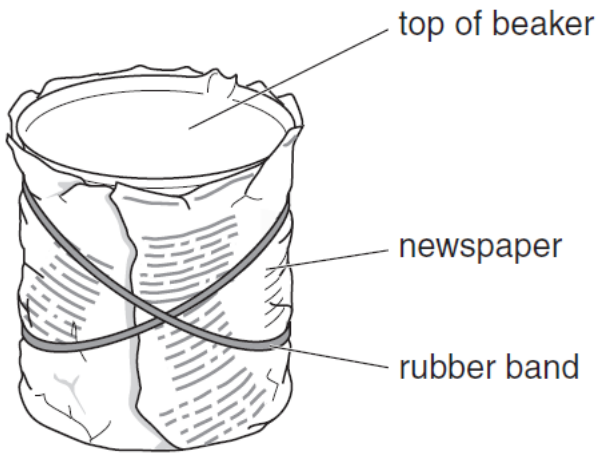


Fig. 3.1

(ii) Pour the hot water into the beaker until it reaches the 200 ml mark.

Place the cardboard lid on the beaker and gently insert the thermometer through the hole in the lid so that the thermometer is in the water.

(iii) Repeat **(c)(ii)**, recording the temperature θ_2 at the same time intervals for six minutes.

(e) Record all values of θ_1 and θ_2 for the corresponding times in a table. Include a column for $(\theta_2 - \theta_1)$.

t / min	θ_1 / °C	θ_2 / °C	$(\theta_2 - \theta_1)$ / °C
1	63.0	64.5	1.5
2	61.5	63.5	2.0
3	60.0	63.0	3.0
4	58.5	62.0	3.5
5	57.0	61.5	4.5
6	55.5	60.5	5.0

[5]

At least 6 sets of t, θ. [1]

Correct column headings with quantity/unit [1]

Range of t covering 6 minutes [1]

θ_1 and θ_2 recorded to nearest 0.5 °C consistently. [1]

Correct calculation for $(\theta_2 - \theta_1)$ and correct d.p for θ. [1]

	(f)	It is suggested that θ_1 and θ_2 are related by the expression $(\theta_2 - \theta_1) = k\theta_1 + c$ where k and c are constants. Using the grid provided, plot a graph of $(\theta_2 - \theta_1)$ against θ_1. Draw the line of best fit.
		A: Axis S: Scale P: Plot L: Best fit line [4]

	(g)	From your graph, determine the values of k and c.
		k = ...
		c = ... [3]
		[1 – gradient coordinates and triangle] [1 – correct c calculated with unit]
	(h)	Use your values from **(a)** and **(g)** to determine the value of θ_2 when θ_1 reaches room temperature.
		θ_2 = ... [1]
		[1 – correct θ_2 calculated with unit]
	(i)	State **two** significant sources of error.
		1. .... 2. .... [2]
		Relevant points might include: • Temperature differences are small compared to the precision of the instrument • Heat escaping from bottom of beaker • Reading stopwatch and thermometer simultaneously • Deformation of lid
	(j)	Suggest **two** improvements that could be made to the experiment to address the errors identified in **(i)**. You may suggest the use of other apparatus or different procedures.
		1. .... 2. .... [2]
		Relevant points might include: • Use thermometer with greater precision • Insulate bottom or stand on insulating surface/not metallic surface • Use a temperature probe and data logger • Use a stiffer lid

[Total: 20]

END OF PAPER