Name ____________________________ (   )   Class _______

PRELIMINARY EXAMINATION
GENERAL CERTIFICATE OF EDUCATION ORDINARY LEVEL

PHYSICS **6091/03**
Paper 3 Practical Test **15 August 2025**
1 hour 50 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS

Write your name and index number on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue, correction fluid, correction tape or highlighters.

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 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 [ ] at the end of each question or part question.

Shift
Laboratory

For Examiner's Use	
1	/10
2	/10
3	/20
Total	/40

This document consists of **13** printed pages.

圣尼各拉女校
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[Turn Over

Section A

1 *In this experiment you will determine the length of a wire used in the experiment.*

You are provided with:

- a power supply
- a switch
- a variable resistor
- a 3V voltmeter
- a 1A ammeter
- a half-metre rule
- a nichrome resistance wire
- connecting leads.

The nichrome resistance wire is partially hidden inside an envelope and the remainder is held onto a piece of cardboard by pieces of clear tape.

You must **not** remove the wire from the cardboard, or interfere with the envelope in any way.

You must **not** write on, or mark, the cardboard in any way.

Set up the circuit as shown in Fig. 1.1.

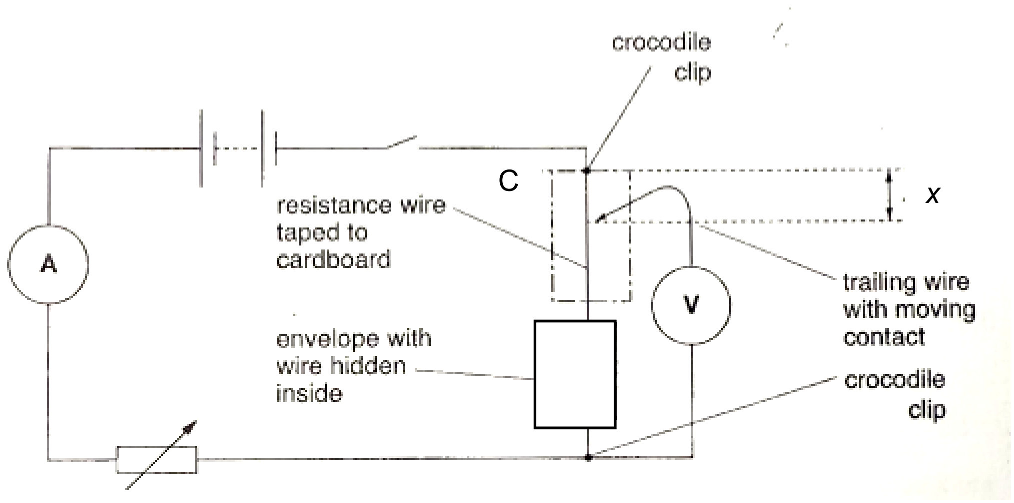

Fig. 1.1

Place your ruler along the resistance wire on the cardboard so that the zero mark on the ruler is at point C, where the wire leaves the crocodile clip. You are going to place the moving contact on the resistance wire at different distances, *x*, from point C and measure the current through the circuit.

(a) Place the moving contact on the resistance wire at a point approximately 40 cm from C. Measure and record the value of x.

Length reported to 1 dp in cm with unit clearly stated, range between 38 to 42 cm.

x = **40.0 cm** .... [1]

(b) **(i)** Close the switch and adjust the variable resistor until the voltmeter shows the maximum possible value. Measure and record the voltage V and the current in the circuit, I.

V precision is 0.05 V
I precision is 0.01 A
V value should exceed 2.00 V (push variable resistor to min)

V = **2.40 V** ....

I = **0.34 A** ....

[2]

(ii) Hence calculate the resistance of the nichrome resistance wire, R.

R =V/I = 2.40 / 0.34 = 7.1 Ω

R = **7.1 Ω** .... [2]

(c) Given that the resistivity of nichrome is 1.00×10^{-6} Ω m, and the cross-sectional area of the wire is 6.2×10^{-8} m^2, calculate the length of the resistance wire across the voltmeter and hence estimate the length of resistance wire hidden in the envelope.

$$l = \frac{R \times A}{\rho} = \frac{7.1 \times 6.2 \times 10^{-8}}{1.00 \times 10^{-6}} = 0.44\, m$$ **[B1]**

Length of wire from crocodile clip to end of cardboard = 3.5 cm

Length of wire extending out from envelope on the other side = 1.0cm (if not explicitly written BOD)

Length of wire in envelope = 44 – 3.5 – 1.0 [M1]
= 39.5
= 40 cm [A1, correct precision and unit]

***Note common error is student subtracting x from l, rather than the remnant from length of cardboard minus x.Such students will only get 1 mark from finding l.**

length of resistance wire across voltmeter = **40 cm** ....

length of resistance wire in envelope = **37 cm** ....

[3]

(d) Suggest how the cross-sectional area of the resistance wire may be determined accurately and reliably.

Measure the diameter of the resistance wire with a digital micrometer screw gauge [1]. Calculate the area using $\pi(d^2/4)$.

<u>Make repeated measurement</u> of diameter at different points (BOD) along the length of wire and <u>take average</u> [1] [2]

.

[Total: 10]

For loops method

20 loops [1] with ruler, and calculate [1]

can use micrometer screw gauge (non-digital)

2 *In this experiment you will determine the mass of a half-metre rule.*

You are provided with:

- a half-metre rule with holes near both ends
- a length of string attached to the half-metre rule at the 49.0 cm mark
- a pivot in the form of a pin mounted on cork on a retort stand
- a 50 g mass hanger labelled P and five 20 g masses
- a pulley
- a retort stand with boss and clamp
- a metre rule
- a protractor
- two bricks.

The supervisor has set up the apparatus as shown in Fig. 2.1.

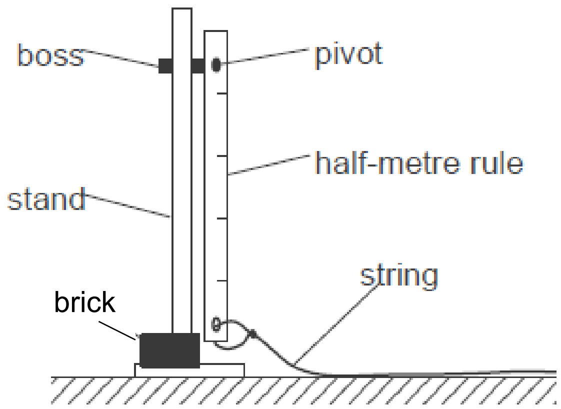

Fig. 2.1

Pass the string through the pulley and hang the mass hanger from the loop at the free end of the string. Set up the apparatus as shown in Fig. 2.2, with the pulley held up by the second retort stand (not shown in diagram).

The mass hanger must be above the benchtop when the string is horizontal.

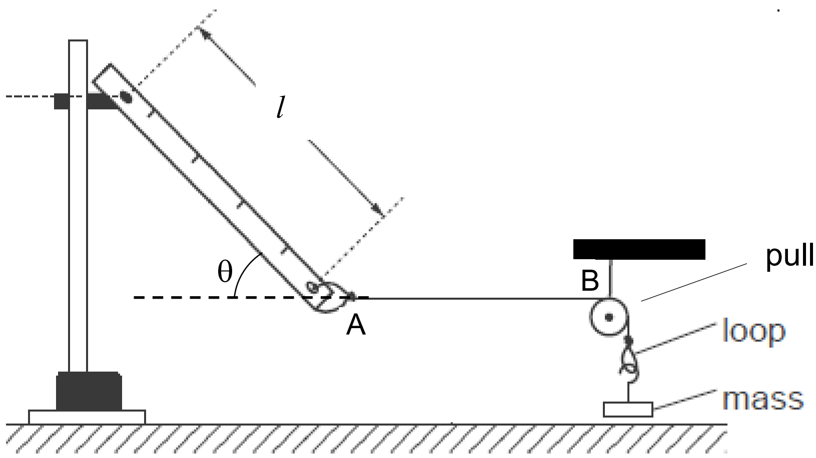

Fig. 2.2

(a) Explain how you ensured that AB was horizontal.

Measure the height of the string at 2 points along AB using a metre rule. If the height is the same at these two points, the string is horizontal. [Also accept horizontal reference with distant object] [1]

(b) **(i)** Record the mass m of the load that is suspended from the loop.

m = **50 g**

(ii) Measure and record the distance l between the centre of the holes on the half-metre rule.

l = **48.0 cm** [1]

(iii) Measure and record the angle θ that the half-meter rule makes with the horizontal, and calculate the value of tan θ.

Angle given to nearest whole number, tan θ reported to 2sf

θ = **26°**

tan θ = **0.48**

[2]

(c) Add a 20 g mass to the mass hanger. Record the new value of m.
Do not accept 2 d.p. as mass balance is not an apparatus for this experiment and hence they should not have measured its mass.

m = **70 g** [1]

(d) Adjust your setup such that AB is horizontal again.

Measure and record the new value of θ, and calculate the new value of tan θ.

New value of angle should be smaller than in b) (iii).

θ = **20°**

tan θ = **0.36**

[1]

(e) Plan

A student claims that $\tan\theta = \frac{M}{2}\left(\frac{1}{m}\right)$, where *M* is the mass of the half-metre rule and a constant.

Plan an experiment to investigate the student's claim.
In your plan, you should

- state **one** key variable to control,
- describe how you would perform the experiment,
- sketch the graph that you would obtain, assuming that the student's claim is correct
- explain how you would determine *M* from your graph.

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....[4]

[Total: 10]

[1] control: keep the position of the pivot along the ruler the same, such that the value of *l* remains constant.

[1] repeat steps a) and b), then provide method to <u>vary m by adding 20g masses</u> and <u>measure θ with protractor</u> to eventually obtain 6 sets of data

[1] plot a graph of tan θ against 1/m. the graph obtained will be a straight line with positive gradient, and passing through the origin.

[1] M can be found by multiplying the gradient of the graph obtained by 2.

Section B

3 *In this experiment, you will investigate the true minimum temperature of an endothermic process.*

You are provided with:

- a measuring cylinder
- two Styrofoam cups
- a retort stand
- two bosses and clamps
- a thermometer
- a glass rod
- a stopwatch
- a container containing sample P
- labelled card
- paper towels
- a mass balance (shared)

You are provided with a sample of solid P in a container. When sample P is added to water, it dissolves. As this is an endothermic process, energy is transferred from the water to the dissolving sample and the temperature of the solution falls.

(a) The mass of the container for sample P is given on the labelled card.

Determine the mass, *m*, of your sample P.

Mass of sample in container measured and recorded to 2 d.p. in grams
Mass of container subtracted from measured mass to obtain an answer in 2 d.p.

m = **4.95 g** .... [1]

(b) Use the measuring cylinder to measure approximately 50 cm^3 of water. Record the volume of water V.
Volume of water measured to half the smallest division of the measuring cylinder. Range of values between 48 to 52 cm^3.
ml is accepted

V = **50.0 cm^3** .... [1]

(c) Pour the water into the Styrofoam cup as shown in Fig. 3.1.

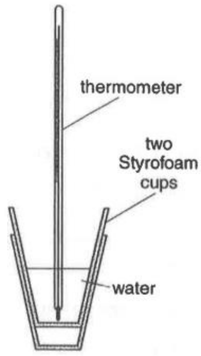


Fig. 3.1

Measure and record the temperature of the water in the Styrofoam cup, T.
Temperature of water measure to half the smallest division of thermometer, which is 1 d.p. in degree celsius

T = ...**29.5 °C**.............. [1]

(d) Add the entire sample of P into the water and start the stopwatch at the same time. Stir the mixture but do not measure the temperature, until the first 30-second interval is reached. Record the corresponding time t and temperature T at the first 30-second interval.

Continue to measure and record the temperature of the mixture at 30-second intervals over a duration of at least 6 minutes in a table in the space provided below. Continue to stir the mixture during the process.

t/s	T/°C
30.0	22.5
60.0	21.5
90.0	21.5
120.0	21.5
150.0	22.0
180.0	22.0
210.0	22.5
240.0	22.5
270.0	23.0
300.0	23.5
330.0	23.5
360.0	24.0

[1] correct column header with units

[1] correct precision given for time and temperature. If time is presented in minutes, the correct dp in minutes should still be preserved (given that their stopwatch reads to 1 dp. In seconds)

[1] 12 sets of data as per instructions with the correct trend (positive gradient) [only ignore t=0s] allow up to 90s dropping temperature or no temperature change.

[3]

(e) Using the grid provided, temperature T against time t. [4]

(e) A
S
P two slips allowed
L based on student's data

(f) Determine the gradient of your graph.

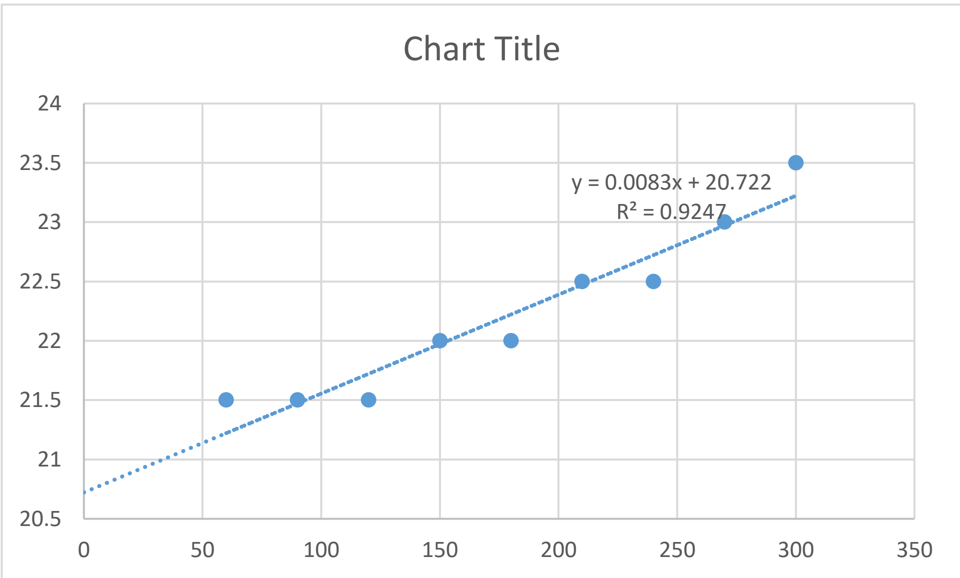
[1] gradient triangle drawn and coordinates labelled

[1] correct calculation of gradient (ignore units)

When there is no straight line, there is no single gradient of the graph, hence this part cannot be done [0]

gradient = ... [2]

(g) The minimum temperature, T_{min}, of the mixture can be determined from the y-intercept of your graph. Determine T_{min}.



Correct calculation of y-intercept or correct determination from graph given to precision of half small square.

Answer presented with the correct unit.

Get 1 m max if they really read T min for a curve, or they read y-intercept but it is non min.

T_{min} = **20.7 °C** [2]

(h) The amount of energy transferred from the water to sample P to dissolve it can be calculated using the equation

$$Q = m_{water} \times c \times \Delta T,$$

where m_{water} is the mass of water, c is the specific heat capacity of water, ΔT and is the maximum change of temperature of the water.

Given that c = 4200 J / (kg °C), calculate the value of Q for your experiment.

Q = (50/1000) x 4200 x (29.5 – 20.7) = 1800 J

[1] conversion of mass to kg
[1] ΔT is calculated from the difference between the starting temperature of the water and T_{min}.
[1] correct calculation of Q with unit and appropriate s.f.

Q = ...[3]

(i) Describe **one** significant source of error in this experiment.

Energy is transferred from the internal store of the surroundings to the water, and this could cause the calculated value of the energy transferred from water via heating to be lower than expected. (cannot energy transfer to surrounding)

.... [1]

(j) Suggest an improvement to the experiment that would reduce the error you identified in **(i)**.

Fit the double Styrofoam cups with a Styrofoam lid (providing a small hole for the thermometer).

.... [1]

(k) Describe one precaution taken to ensure reliability of the measured values of *T*. (ensuring consistency of results)

Ensure that the thermometer is clamped to the retort stand so that the readings of T can be made at eye level. [1]

Allow:

1. bulb of thermometer not touching the surfaces of the cup - but must state how, like by clamping, visually checking etc
2. Bulb Fully submerged by visually checking
3. Ensure that the thermometer is clamped to the retort stand so that thermometer doesn't touch the surface of cup

[Total: 20]

END