Name: _____ ( ) Class : Sec 4 / ( )

南华中学

NAN HUA HIGH SCHOOL

PRELIMINARY EXAMINATION 2025

Subject : Physics

Paper : 6091/1

Level : Secondary Four

Date : 3 September 2025

Duration : 1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, class and index number on the separate Answer Sheet in the spaces provided.

There are **forty** questions in this paper. Answer **all** questions. For each question, there are four possible answers, **A**, **B**, **C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer sheet.

INFORMATION FOR CANDIDATES

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

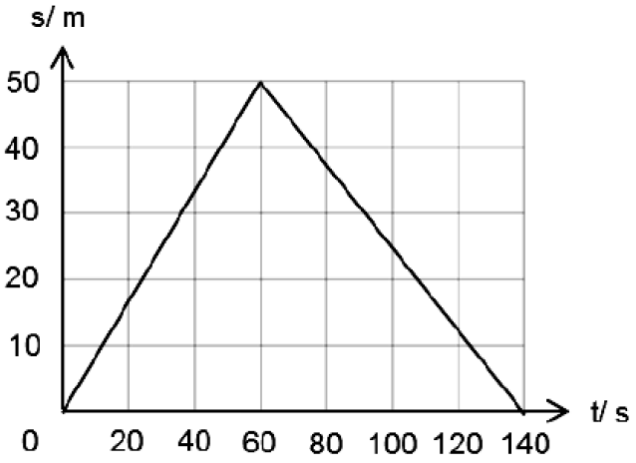
Any rough working should be done in this booklet.

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

1 What is the estimate of the radius of planet earth?

A 6.4 km **B** 6.4 Mm **C** 6.4 Gm **D** 6.4 Tm

2 The graph shows how the displacement of a girl changes as she walks on a pavement.



What is the total distance travelled by the girl?

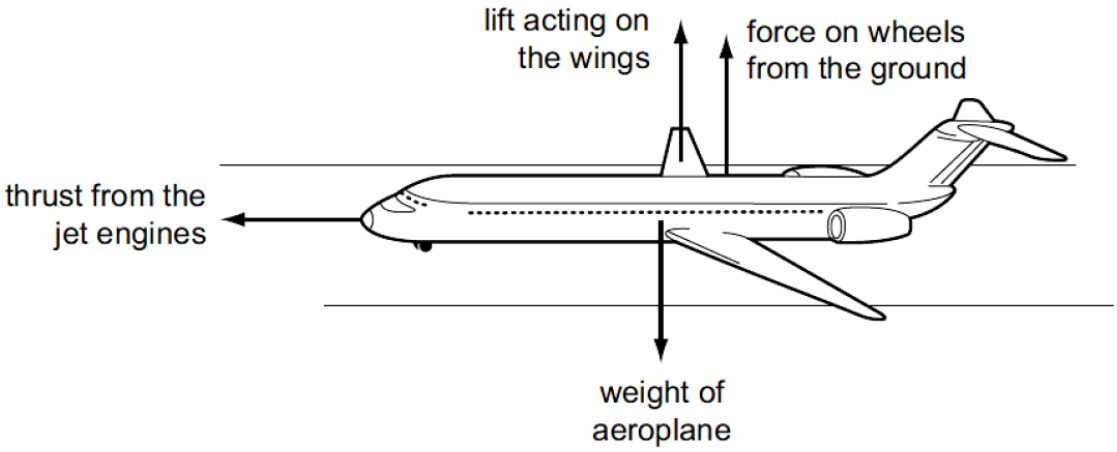
A 0 m **B** 50 m **C** 100 m **D** 3 500 m

3 At t = 0 s, a stone is thrown vertically up into the air at 20 m/s.

Which of the following best describes the motion of the stone in the air at t = 2.0 s?

	speed / m/s	acceleration / m/s^2
A	10	0
B	10	10
C	0	0
D	0	10

4 An aeroplane is half way along a runway before it takes off.

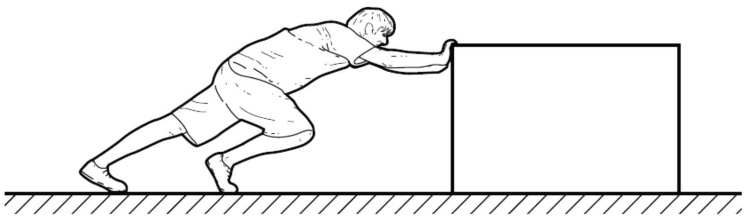


The arrows show the directions of four forces acting on the aeroplane.
The drag forces on the aeroplane are negligible.
The gravitational field strength, g, is 10 N / kg.
The acceleration of the aeroplane is 2 m / s^2.

What is the largest force?

A the force on the wheels from the ground
B the lift acting on the wings
C the thrust from the jet engines
D the weight of the aeroplane

5 A man pushes a heavy box along the ground.

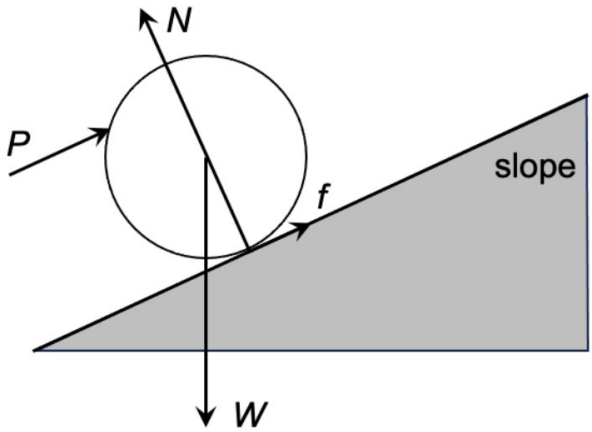


A force acts between the man's hands and the box. Another force acts between the man's feet and the floor.

In which directions do these forces act on the man?

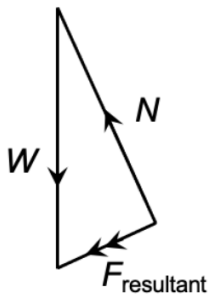
	force on man's hands	force on man's feet
A	towards the left	towards the left
B	towards the left	towards the right
C	towards the right	towards the left
D	towards the right	towards the right

6 A fully loaded barrel of weight W is being rolled up a slope before coming to a stop. The image below shows the force P required to hold the barrel at rest on the slope, the frictional force f between the barrel and the slope, and the normal contact force N on the barrel by the slope.

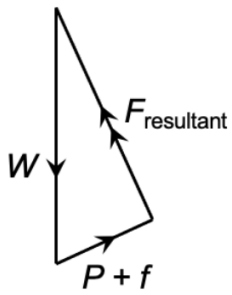


Which diagram represents the forces exerted by the slope on the barrel and their resultant force?

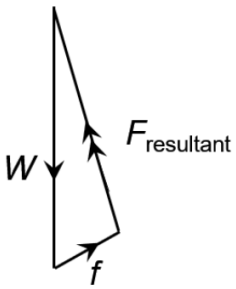
A



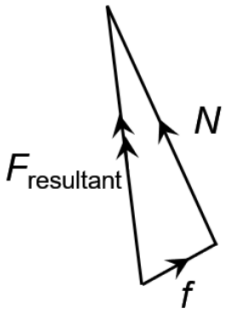
B



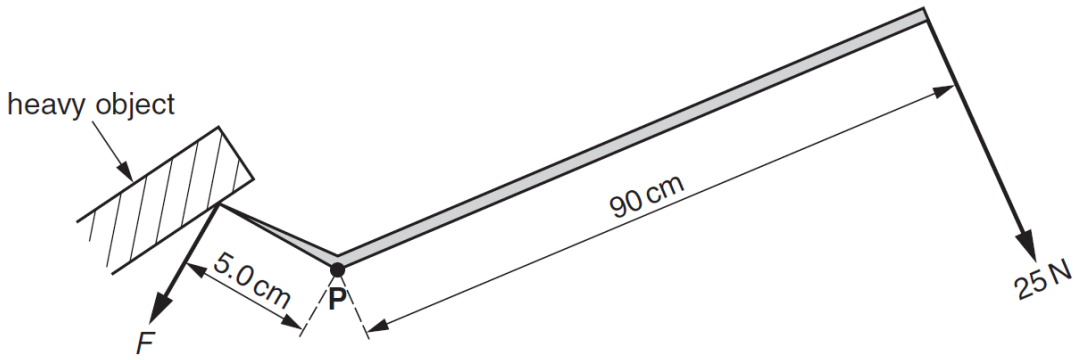
C



D



7 A lever is used to lift a heavy object.



A force of 25 N is applied at a distance of 90 cm from the pivot P. The load F exerted by the heavy object on the lever is 5.0 cm from pivot P. The directions of the 25 N force and of the load F are both at right-angles to the lever. Assume the mass of the lever is negligible.

What is the resultant moment about pivot P if load F is 500 N?

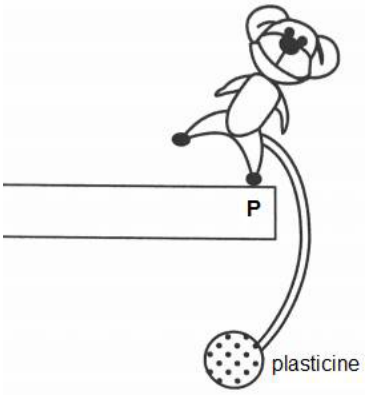
A 0 Nm

B 2.5 Nm anticlockwise

C 22.5 Nm clockwise

D 250 Nm anticlockwise

8 A toy monkey is placed at the edge of a table at point P as shown. The toy can be balanced on the table by adding a lump of plasticine at the end of the tail.



In which position is the toy's centre of gravity?

A directly above P

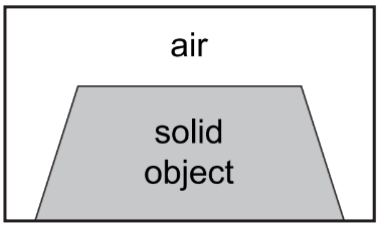
B directly below P

C directly above the plasticine

D directly below the plasticine

9 A box has an internal volume of 1000 cm^3. When a solid object is placed in the closed box, the volume occupied by the air in the box is 520 cm^3.

The density of the object is 8.00 g / cm^3.



What is the mass of the object?

A 60.0 g **B** 3840 g **C** 4160 g **D** 8000 g

10 Which statement about hydraulic machines is **not** true?

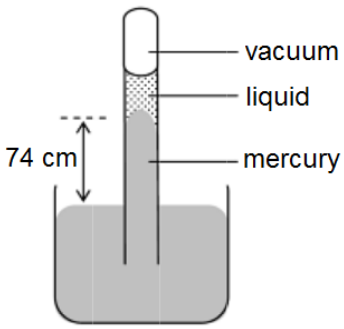
A Liquids are used because they are almost incompressible.

B Hydraulic machines can multiply the effects of the effort force.

C Hydraulic machines can give larger energy outputs than the actual work done.

D Changes in liquid pressure are transmitted equally to all parts of the liquid.

11 The diagram shows a barometer containing a liquid of density 1200 kg / m^3 above the mercury column. The density of mercury is 13 600 kg / m^3 and the atmospheric pressure is 76 cm Hg.



What is the height of the liquid?

A 2.0 cm **B** 22.7 cm **C** 26.0 cm **D** 76.0 cm

12 A car with a total mass 850 kg is travelling along a road at a constant speed of 25 m/s. The driver applies the brakes to slow down the car to 12 m/s with a constant deceleration in 5.0 s.

What is the work done against the braking force?

A 2.21 kJ **B** 11 kJ **C** 110 kJ **D** 204 kJ

13 A 12 kg bucket of sand was moved 8.0 m vertically in 4.0 s by a 0.40 kW motor.

What is the efficiency of the motor?

A 41.6 % **B** 60.0 % **C** 96.0 % **D** 167 %

14 Some gas is trapped in a closed container. The gas is cooled and the volume of the container is kept constant.

What happens to the gas molecules?

A They collide with the walls more often.

B They contract.

C They get closer together.

D They move more slowly.

15 Four bars, all of exactly the same size, are each placed with one end in boiling water.

The times taken for the temperature of the other end to increase by 2 °C are measured.

material of bar	time for 2 °C rise / s
aluminium	10
copper	5
cork	800
styrofoam	1200

To make a large metal tank with the least heat loss, which materials should be used for the walls of the tank and its insulation?

	tank	insulation
A	aluminium	cork
B	aluminium	styrofoam
C	copper	cork
D	copper	styrofoam

16 The outer surface of an electric kettle is always kept polish and shiny.

What is the purpose of this?

A To stop energy loss by radiation and conduction.

B To reflect any radiation incident on its outer surface.

C To reduce energy loss by thermal conduction.

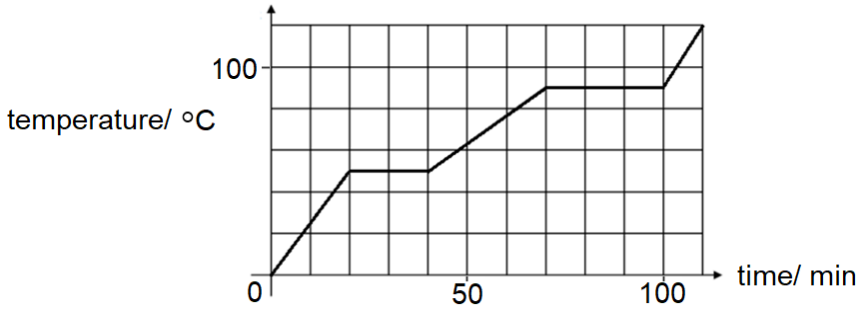
D To be a poor emitter so as to reduce energy loss.

17 24 000 J of energy is required to increase the temperature of 2.0 kg of water by 3.0 K.

What is the heat capacity of the water?

A 4000 J / K **B** 6000 J / K **C** 8000 J / K **D** 12 000 J / K

18 The graph shows the change in temperature when heat is supplied at 200 W to 1.0 kg of the substance.



What is the specific latent heat of vaporization of the substance?

A 4000 J / kg **B** 6000 J / kg **C** 240 000 J / kg **D** 360 000 J / kg

19 Which statement about water is correct?

A Evaporation does not take place when water is at 100 °C.
B Boiling only takes place on the surface of the water
C Steam causes less severe burn than boiling water
D Solidified water has less internal energy than water.

20 Springs and ropes can both be used to illustrate wave motion.

Which statement is correct?

A Ropes are only suitable for illustrating longitudinal waves.
B Ropes are suitable for illustrating both transverse and longitudinal waves.
C Springs are only suitable for illustrating longitudinal waves.
D Springs are suitable for illustrating both transverse and longitudinal waves.

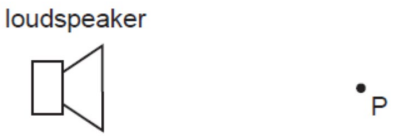
21 A sound wave of frequency 400 Hz travels through a gas with velocity 980 m/s.

The frequency of the wave is doubled to 800 Hz.

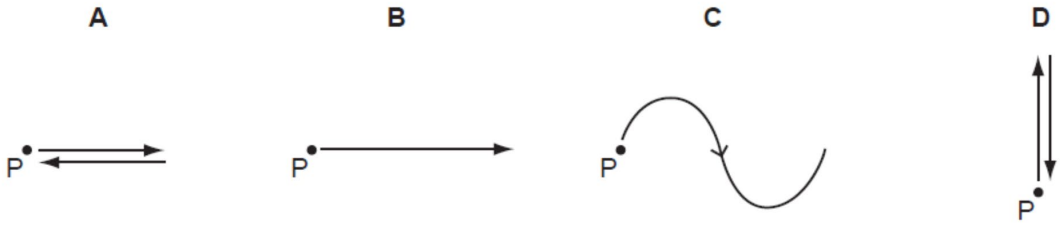
Which row is correct for the 800 Hz wave?

	velocity in m/s	wavelength in m
A	980	1.2
B	980	2.5
C	1960	1.2
D	1960	2.5

22 The diagram shows a loudspeaker that is producing a continuous sound wave of frequency 200 Hz in air.



Which diagram best shows how the sound causes a molecule at P to move during $\frac{1}{200}$ s ?

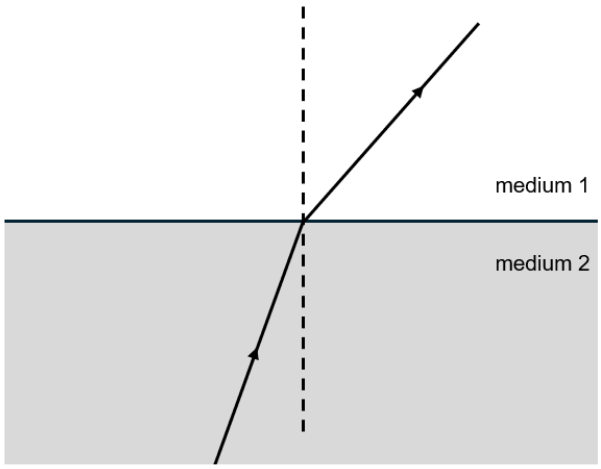


23 The main components of the electromagnetic spectrum have many well-known uses.

What is a use of infra-red radiation?

A Checking metal castings for cracks.
B Alarms to detect intruders.
C Transmitting satellite television signals.
D Detecting forgery in counterfeit notes.

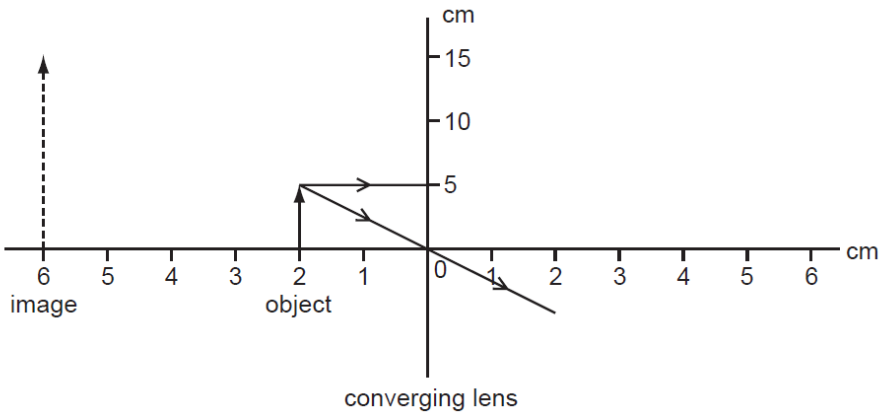
24 The diagram shows a ray of light moving from medium 2 to medium 1.



Which row compares medium 2 with medium 1?

	medium 2	medium 1
A	light travels faster	higher refractive index
B	light travels faster	lower refractive index
C	light travels slower	higher refractive index
D	light travels slower	lower refractive index

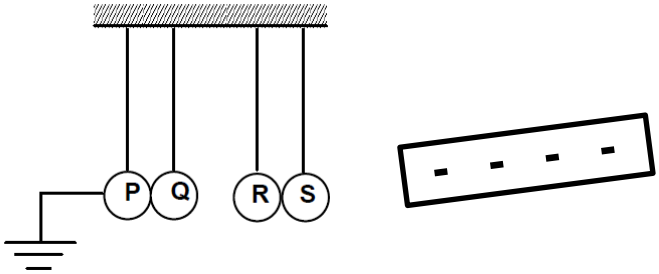
25 An object 5.0 cm high is placed 2.0 cm from a converging (convex) lens which is being used as a magnifying glass. The image produced is 6.0 cm from the lens and is 15 cm high.



What is the focal length of the lens?

A 2.0 cm **B** 3.0 cm **C** 4.0 cm **D** 5.0 cm

26 Four metal spheres, P, Q, R and S are suspended by cotton threads with P touching Q and R touching S. A negatively charged rod is brought near S and then P is earthed, as shown in the diagram below.

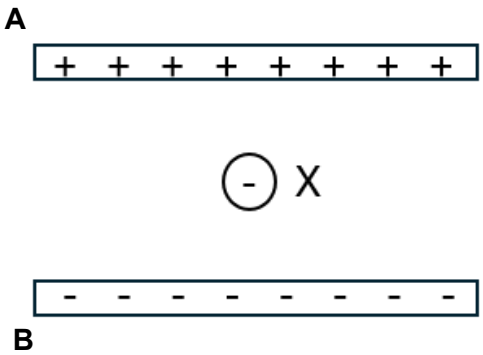


The earth connection is first removed, followed by the rod.

What are the charges on the spheres?

	P	Q	R	S
A	positive	positive	neutral	neutral
B	positive	positive	negative	positive
C	negative	positive	neutral	positive
D	neutral	negative	positive	positive

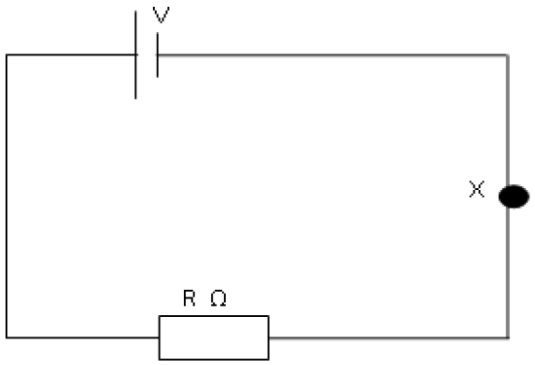
27 Two metal plates A and B are charged positively and negatively respectively. A negative charge X is put into the electric field between the plates as shown.



Which of the following pairs of arrows show the direction of the electric field between the metal plates and the direction of the electric force on X?

	direction of the electric field between metal plates	direction of electric force on X
A	↓	↓
B	↓	↑
C	↑	↑
D	↑	↓

28 The circuit in the diagram shows a fixed resistor of resistance R Ω connected to a power supply of V volts. Assuming each electron has a charge of e coulomb, how many electrons pass through point X in 1 minute?



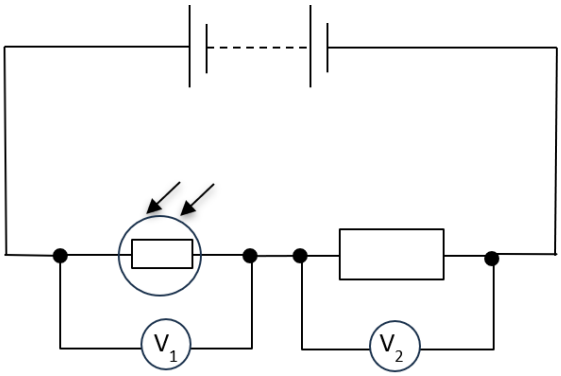
A $\frac{60V}{Re}$ **B** $\frac{60Re}{V}$ **C** $\frac{60Ve}{R}$ **D** $\frac{V}{60Re}$

29 A 0.40 m length of resistance wire with a cross-sectional area of 0.20 mm^2 has a resistance of 2.0 Ω.

Which wire of the same material will also have a resistance of 2.0 Ω?

	length	area
A	0.20 m	0.20 mm^2
B	0.20 m	0.40 mm^2
C	0.80 m	0.10 mm^2
D	0.80 m	0.40 mm^2

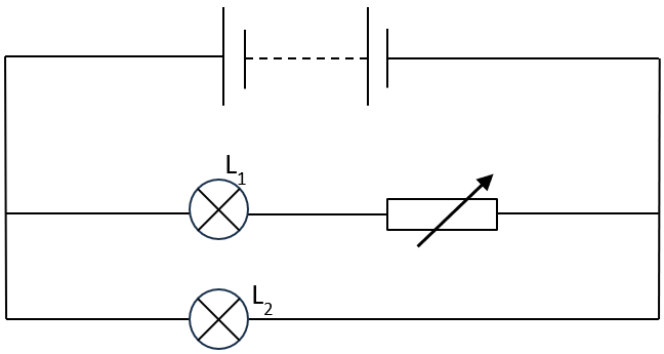
30 A circuit is set up as shown. The initial reading on both voltmeters is 2.5 V. The light intensity shining on the LDR is increased.



What are the possible new readings on voltmeters V_1 and V_2?

	reading on V_1	reading on V_2
A	2.0	3.0
B	2.5	2.0
C	2.5	3.0
D	3.0	2.0

31 A rheostat and two identical light bulbs are connected as shown.



What happens to the brightness of the light bulbs as the resistance of the rheostat increased gradually?

	L_1	L_2
A	decrease	no change
B	decrease	increase
C	increase	decrease
D	no change	decrease

32 An electric kettle should always be fitted with an earth connection as a protective device.

What is being “protected” by the earth connection?

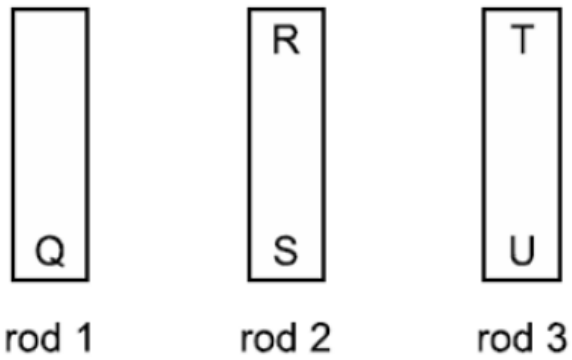
A The person using the kettle.
B The fuse in the circuit.
C The heating element of the kettle.
D The cable connecting the kettle.

33 An electric bulb has a rating of 120 V, 50 W.

If the bulb is connected to a voltage supply of 60 V, what is the power dissipated by the bulb?

A 13 W **B** 15 W **C** 25 W **D** 50 W

34 A student was given three metal rods as shown in the diagram below and was tasked to determine which one(s) is a/are magnet(s). The ends of the 3 metal rods are tested by holding end Q close to the others one by one.



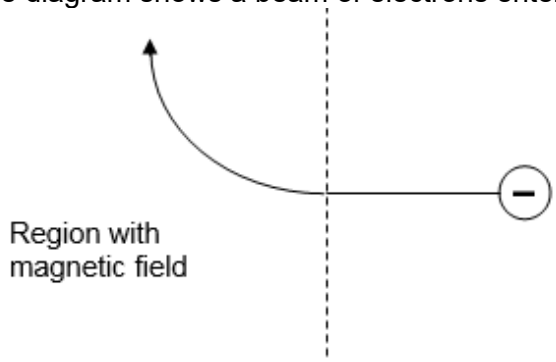
The results show that end Q

1) attracts end R
2) attracts end S
3) attracts end T
4) repels end U

Which of the metal rod(s) is a/are magnet(s)?

A rod 1 only
B rod 1 and rod 2
C rod 1 and rod 3
D rod 3 only

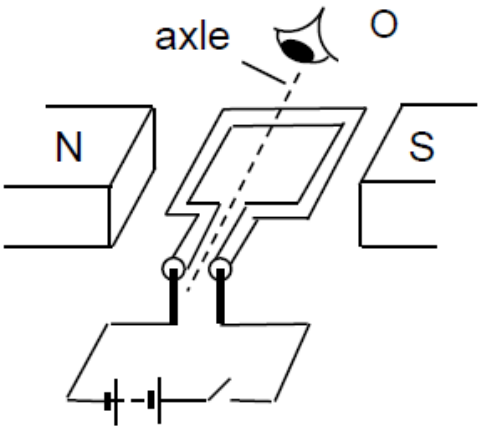
35 The diagram shows a beam of electrons entering a magnetic field.



What will be the direction of the magnetic field?

A into the page
B out of the page
C towards the bottom of the page
D towards the top of the page

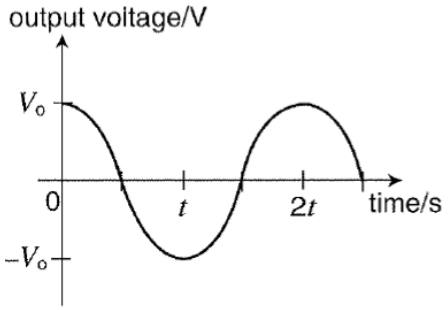
36 A coil of wire that can spin on an axle is placed between the poles of two magnets.



When the switch is closed, as seen by the observer, the coil will

A oscillate about the axle but finally rest in a position with its plane parallel to the magnetic field.
B oscillate about the axle but finally rest in a position with its plane perpendicular to the magnetic field.
C rotate anti-clockwise direction.
D rotate clockwise direction.

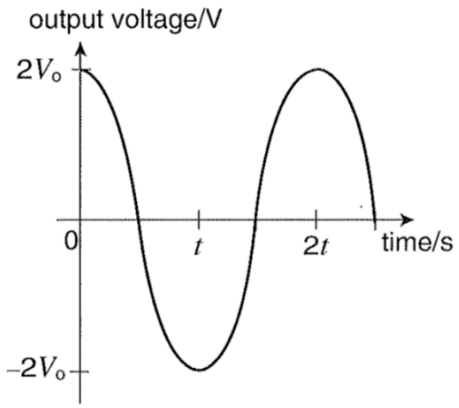
37 Graph 1 shows the output voltage-time graph of an a.c. generator.



graph 1

The output voltage can be changed by the following methods:

1) Increase the frequency of rotation of the coil.
2) Increase the number of turns of the coil.
3) Increase the strength of the magnet.



graph 2

Which of the method(s) listed above is / are possible to obtain the output voltage shown in graph 2?

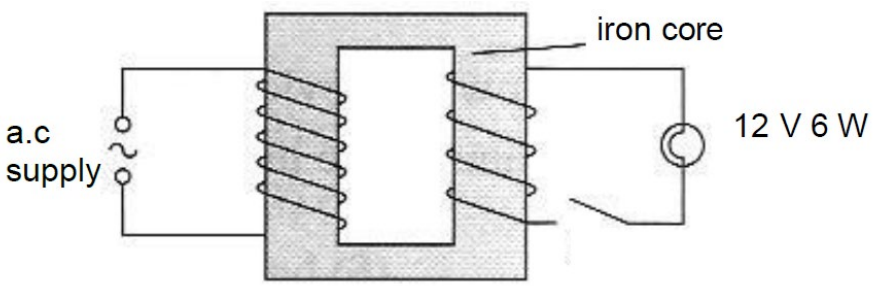
A 1 and 2

B 1 and 3

C 2 and 3

D 1, 2 and 3

38 What is the likely voltage and current from an a.c. supply to the ideal transformer shown below?



	voltage/ V	current/ A
A	18	0.34
B	18	0.75
C	220	0.34
D	220	0.75

39 A factory produces thin aluminium sheets. A radioactive isotope and a detector are used to continuously check the thickness of the aluminium sheets.

What is the most suitable source to use?

A an alpha source with a half-life of a few years

B a beta source with a half-life of a few years

C an alpha source with a half-life of a few minutes

D a beta source with a half-life of a few minutes

40 Three different radioactive nuclides P, Q and R each decay by three different successive emissions.

- P emits α, α, β
- Q emits α, β, β
- R emits β, β, β

Which nuclide produces a final nucleus that has the same proton number as its starting nucleus, and which nuclide produces the same nucleon number as its starting nucleus?

	same proton number	same nucleon number
A	P	Q
B	P	R
C	Q	P
D	Q	R

Name: _____ ( ) **Class: Sec 4 / ( )**

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NAN HUA HIGH SCHOOL

PRELIMINARY EXAMINATION 2025

Subject : Physics

Paper : 6091/02

Level : Secondary Four

Date : 1 September 2025

Duration : 1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number in the spaces at the top of this page.

Write in dark blue or black pen.

You may use HB pencil for any diagrams or graphs.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.
Write your answers in the spaces provided.

Section B
Answer **one** question.
Write your answers in the spaces provided.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

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

For Examiners' Use	
Section A	
Section B	
Total	

This document consists of **21** printed pages.

Section A

Answer **all** the questions in this section.

1 **(a)** A 7.0 kg picture frame is being suspended from a nail by a string. The string forms two segments exerting tensions T_1 and T_2 as shown in the Fig. 1.1. The strings also make an angle of 35° and 60° with the vertical respectively.

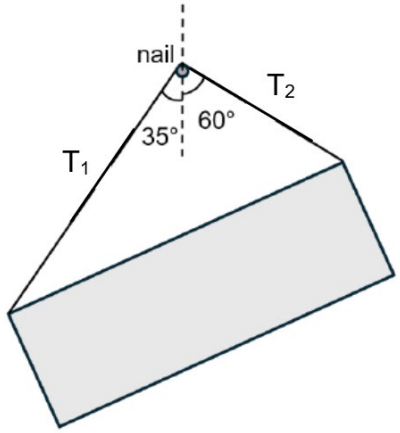


Fig. 1.1

In the space below, draw a vector diagram to determine the tensions T_1 and T_2. Specify the scale used.

T_1 = _____

T_2 = _____ [4]

(b) **(i)** Explain what is meant by the precision of a measuring instrument.

.....

..... [1]

(ii) Hence, state the precision of a digital caliper.

..... [1]

(c) Currently nuclear power provides approximately 9% of the world's electricity. This translates to about 2600 terawatt-hours (TWh) of electricity generated annually by nuclear reactors.

Calculate the energy generated by nuclear reactors annually in joules.

energy = ……... [2]

2 **(a)** State the principle of moments.

_____

_____ [1]

(b) Fig. 2.1 shows a decoration that hangs by string from the ceiling in a toyshop. Four objects, P, Q, R and S hang by string from rods 1 and 3. These two rods hang by string from rod 2. The decoration is completely stationary and the rods are horizontal. The weights of the rods and the strings may be neglected.

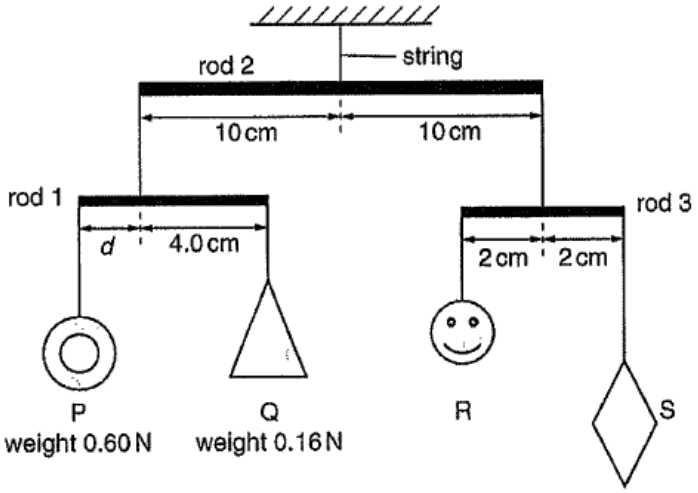


Fig. 2.1 (not to scale)

Object P weighs 0.60 N and object Q weighs 0.16 N.

(i) Calculate the value of the distance *d* on Fig. 2.1.

d = _____ [2]

(ii) Determine the weight of object R and of object S.

weight of R = _____

weight of S = _____ [2]

(iii) Object P falls off. Using moments, state and explain what happens to rod 1 and rod 2.

rod 1: _____

_____

rod 2: _____

_____ [2]

3 Fig. 3.1 shows a U-shaped tube, containing mercury, is used as a manometer to measure pressure from a cylinder of gas.

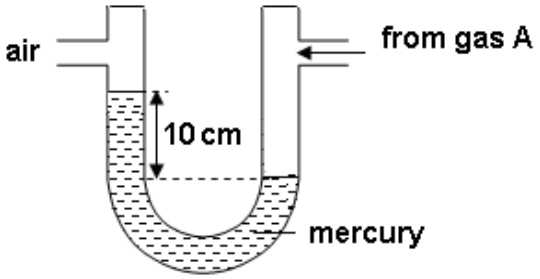


Fig. 3.1

When one side of the cylinder is connected to an unknown gas A, the difference in mercury levels is 10.0 cm. (Density of mercury = 13 600 kg / m^3, g = 10 m / s^2)

(a) If atmospheric pressure is 76 cm Hg, calculate, in units of Pascal,

(i) the pressure difference between gas **A** and air,

pressure difference = _____ [2]

(ii) the pressure of gas A.

pressure of gas A = _____ [2]

(b) The setup in Fig. 3.1, which was on the surface of the Earth, is now transported to the top of a mountain with gas A still connected to the right of the manometer.

State and explain the changes (if any) in the mercury levels in the tube.

_____

_____

_____

_____ [2]

4 Fig. 4.1 shows a semi-circular glass prism with a light ray directed towards O, the midpoint between A and B. The refractive index of the glass prism is 1.8.

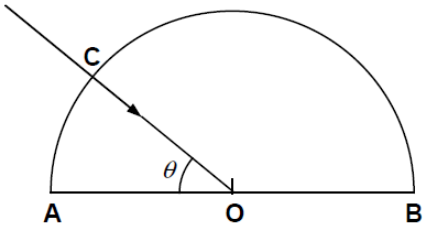


Fig. 4.1

(a) Explain why there is no refraction when the light ray enters the glass prism at C.

.....

..... [1]

(b) What is the maximum angle θ, such that the emergent ray will occur along the edge AB.

maximum angle = ... [2]

(c) Fig. 4.2 shows the same glass prism with another light ray directed towards O at the same angle θ.

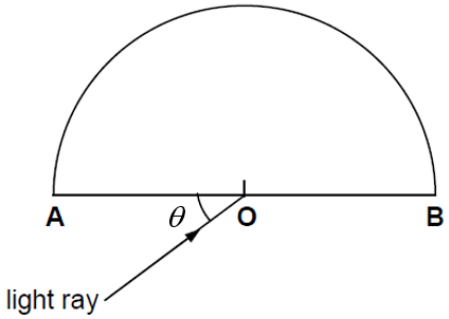


Fig. 4.2

(i) On Fig. 4.2, draw a possible path of the light ray as it enters and exits the glass prism. [1]

(ii) Explain if total internal reflection will occur in Fig. 4.1 or Fig. 4.2 if angle θ can be varied.

.....

..... [1]

(d) Fig. 4.3 shows a simple optical fibre of the same glass material in Fig. 4.1. A light ray **PQ** enters the fibre and strikes the curved surface at an angle 60°. [2]

Complete the path of the light ray until it reaches the end surface labeled **XY**. Label all relevant angles values within the optical fibre.

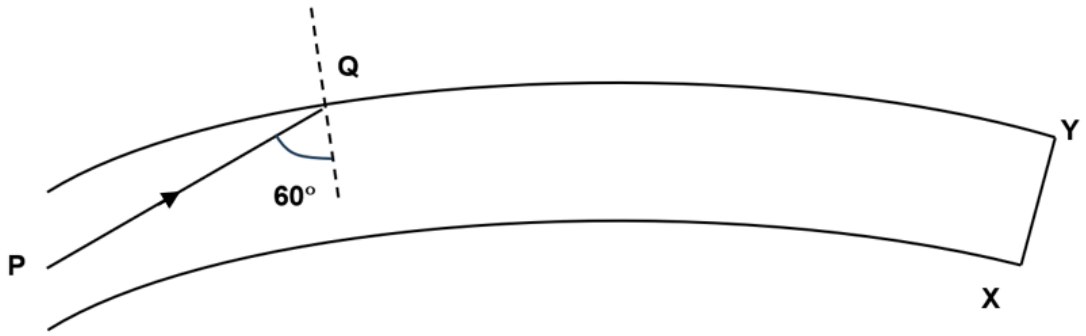


Fig. 4.3 (not to scale)

5 In a tsunami created by an earthquake, it was observed that a ship took 20 min to move from its highest point to its lowest point. The distance between the highest point and the lowest point was 20 m.

(a) **(i)** Define the period of a wave.

_____

_____ [1]

(ii) Determine the frequency of the tsunami wave.

frequency = _____ [2]

(b) When the ship was at its highest point, another ship that was 300 km away was also at its highest point. There were two crests between the two ships. Fig. 5.1 shows the displacement-distance graph of the wave.

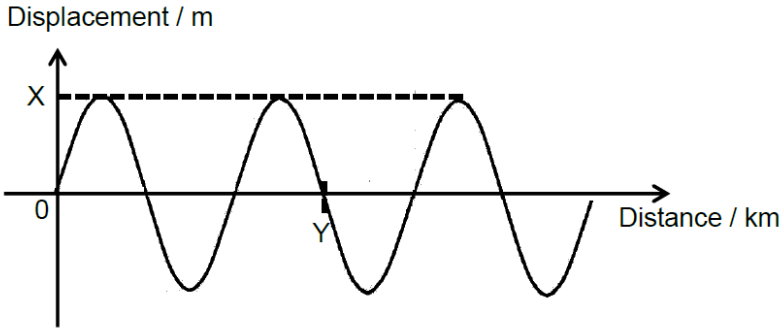


Fig. 5.1

(i) Determine the magnitudes of X and Y.

magnitude of X = _____ [1]

magnitude of Y = _____ [1]

(ii) Show that the speed of the wave is about 42 m / s . [1]

(iii) The tsunami wave was detected at 0800 hrs and the distance between the tsunami wave and the shore was 200 km.

Determine the time that the tsunami wave will reach the shore.

time of arrival = _____ [2]

(c) Describe the motion of the ship as the first waves arrive at the ship.

_____

_____ [1]

6 Fig. 6.1 shows a light plastic sphere coated with silver conductive paint being suspended by a length of insulating thread.

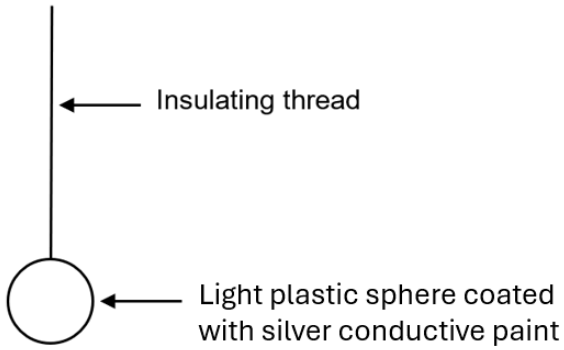


Fig. 6.1

(a) A positively charged rod is placed near to the sphere as shown in Fig 6.2.

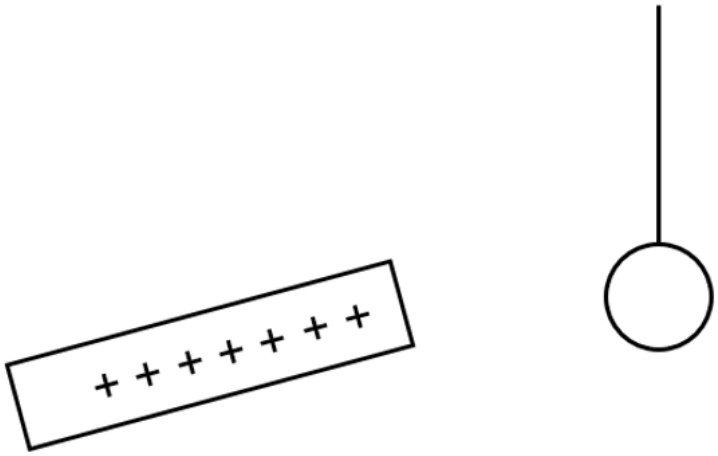


Fig. 6.2

(i) On Fig. 6.2,

1. draw the charges on the sphere, [1]

2. draw the electric field set up between the charged rod and the sphere. [1]

(ii) The rod touches the sphere for a moment before being separated again.

Describe and explain what happens to the distribution of charges in the rod and sphere.

--- [2]

(b) In another experiment, a negatively charged rod was brought close to a **solid** metal conducting sphere as shown in Fig 6.3 below. The metal conducting sphere was *earthed* on the left-hand side as shown.

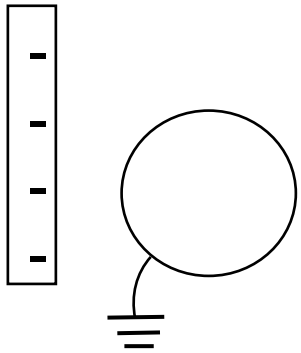


Fig. 6.3

(i) Explain what the phrase *'was earthed'* means. [1]

(ii) On Fig. 6.3, draw the charges on the metal sphere. [1]

7 **(a)** Thorium-234 has a half-life of 24 days. A sample of radioactive material contains 40 mg of thorium-234.

Calculate the mass of thorium-234 remaining after 72 days.

mass of thorium-234 remaining = _____ [2]

(b) Thorium-234 (Th-234) undergoes decay to form Protactinium-234 (Pa-234).

The proton number for Thorium and Protactinium is 90 and 91 respectively.

Write a nuclear equation using nuclide notation to represent the change in the composition of Thorium-234 when it decays.

_____ [1]

(c) A sample contains a large number of radioactive nuclei that emit beta-particles. The sample is placed near to a radiation detector in a laboratory and the count rate is recorded over a long period of time.

Fig. 7.1 shows the count rate recorded by the detector during this period.

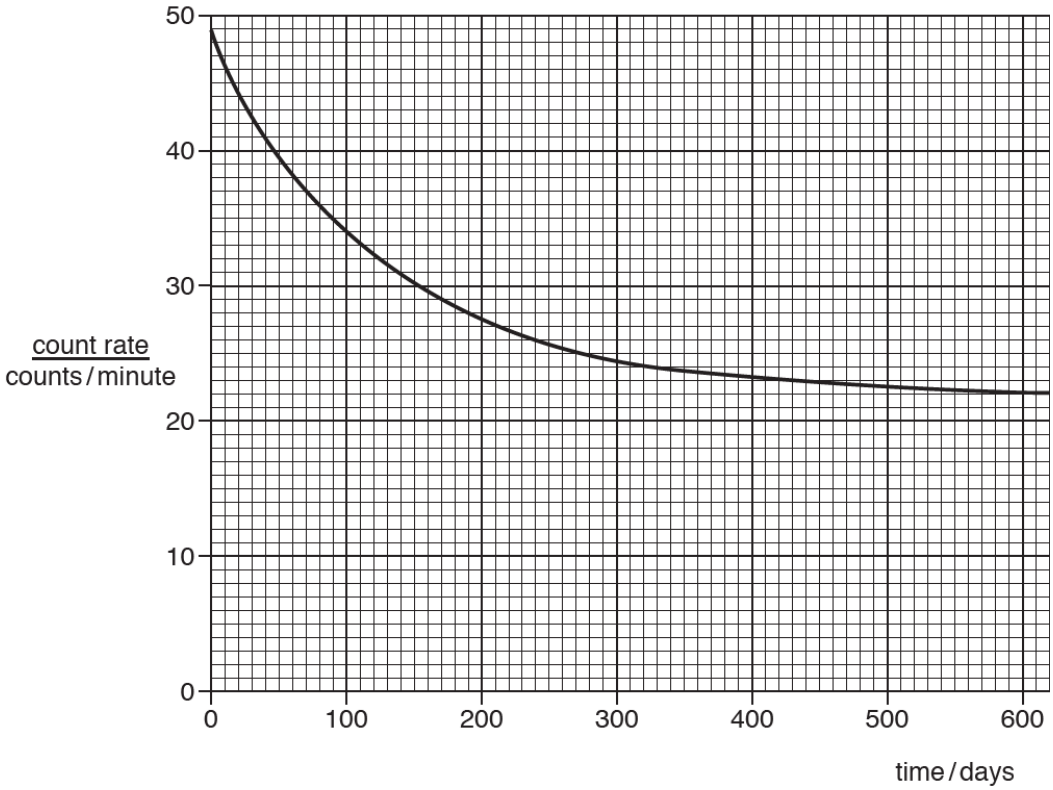


Fig. 7.1

Using Fig. 7.1,

(i) determine the background count in the laboratory in counts per min (cpm)

background count = ……. [1]

(ii) determine the count rate at time t = 0, due to the sample on its own in counts per min (cpm)

count rate due to sample = ..……. [1]

(iii) estimate the half-life of the radioactive atoms in the sample.

half-life = ……. [2]

8 **(a)** A student investigates the behaviour of a light dependent resistor (LDR) by setting up the circuit connected to a source with an electromotive force of 6.0 V as shown in Fig 8.1 below.

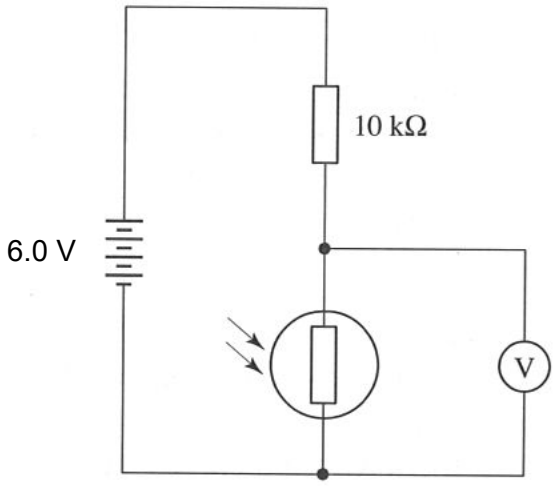


Fig. 8.1

(i) Explain what is meant by an *electromotive force* of 6.0 V.

.....

..... [1]

(ii) The p.d. across the LDR in bright daylight is 0.23 V.

Determine the resistance of the LDR in bright daylight.

resistance = ... [2]

(iii) State and explain how the voltmeter reading changes when the light intensity surrounding the LDR decreases.

.....

.....

..... [2]

(b) The LDR is now connected across another circuit as shown in Fig 8.2 below. During a certain instance, the resistance of the LDR is 10 kΩ and the value of the variable resistor was set at 3.8 kΩ.

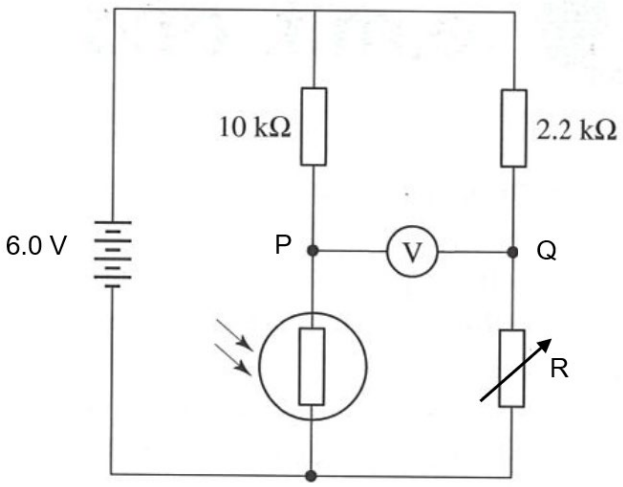


Fig. 8.2

(i) Calculate the total resistance of this circuit at that instant.

total resistance = _____ [2]

(ii) State why the p.d. across the LDR is 3.0 V.

_____

_____ [1]

(iii) **(1)** determine the p.d. across the variable resistor.

p.d. = _____ [1]

(2) determine the p.d. between points P and Q

p.d. = _____ [1]

9 A simulation of a roller coaster is done to investigate how the speed of the carriage is affected by the shape of the track as shown in Fig. 9.1. Track **X** is frictionless.

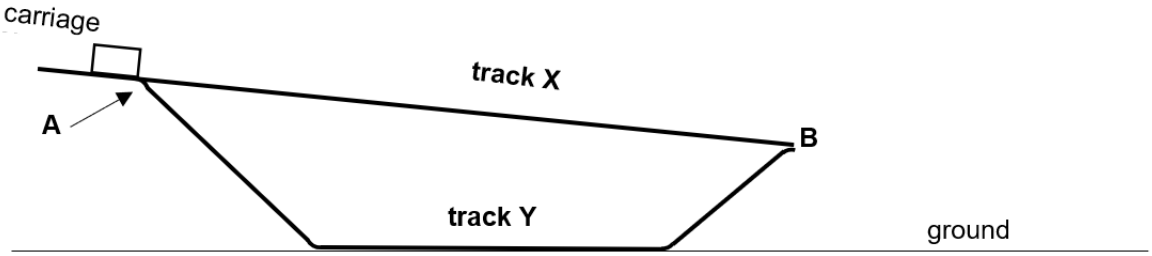


Fig. 9.1

The carriage is released at point A. The speed of the carriage along each track is measured at various times until the carriage reaches point B.

Table 9.2 shows the readings obtained.

	data 1	**data 2**
time / s	speed / m/s	speed / m/s
0	0	0
0.20	0.90	0.25
0.40	1.80	0.50
0.60	2.70	0.75
0.80	2.70	1.00
1.00	2.70	1.25
1.20	2.70	1.50
1.40	2.60	1.75
1.60	2.50	2.00
1.80	-	2.25
2.00	-	2.50

Table 9.2

(a) **(i)** Explain how data 2 in Table 9.2 shows it corresponds to the motion of the carriage traveling along track X.

--- [1]

(ii) Calculate the length of track X.

length of track X = ____ [2]

(iii) Fig 9.3 shows an instant when the carriage was travelling along the horizontal section of track Y.

Fig. 9.3

Describe a Newton's third law action-reaction pair of forces acting in the vertical direction.

[2]

(iv) The mass of the carriage used for the simulation is increased.

State and explain the difference in the final speed of the carriage on track X.

[2]

(b) Using **data 1:**

(i) determine the deceleration of the carriage during a certain section of its motion

deceleration = [1]

(ii) explain, using an appropriate Newton's law, how it can be deduced that track Y is also frictionless.

[2]

Section B

Answer **one** question from this section.
Answer either **Question 10** or **Question 11**

10 An air cooler works by taking in warm air from the surrounding and blows it over a cooling pad. This causes the water on the cooling pad to evaporate and the air passing through it is cooled as shown in Fig. 10.1.

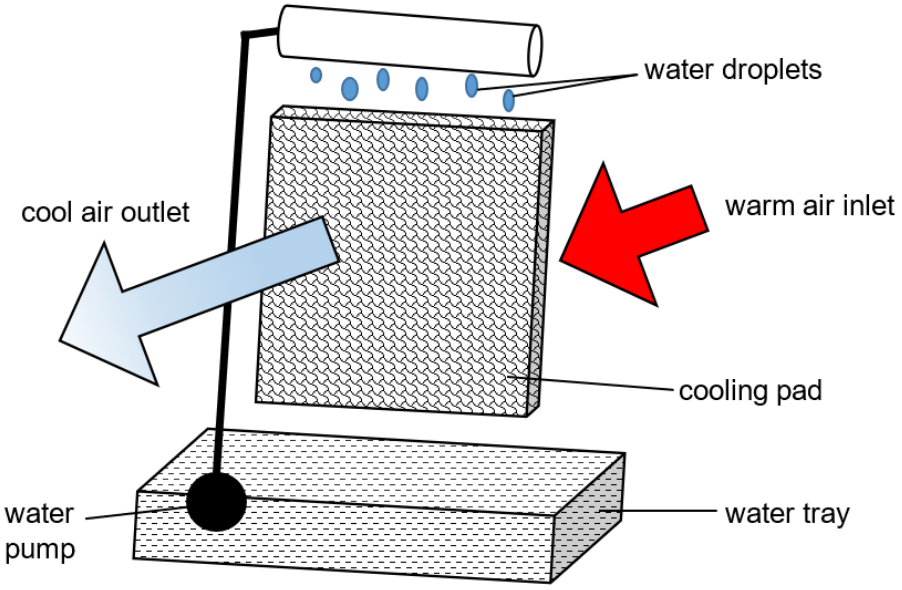


Fig. 10.1

(a) Define *specific heat capacity*.

.....

.....

..... [1]

(b) Explain why the specific latent heat of fusion of water is smaller than the specific latent heat of vaporization of water.

.....

.....

.....

..... [2]

(c) The volume of the room is 90 m^3. The air cooler cools the room by 5 °C after a period of time. Given that the density of air is 1200 g / m^3 and its specific heat capacity of air is 1.0 kJ / (kg °C):

(i) Calculate the amount of thermal energy removed by the air cooler.

thermal energy removed = _____ [2]

(ii) Determine the time taken (in min) for the air cooler to decrease the temperature of the room by 5 °C if the rate of heat removal is 270 J/s.

time taken = _____ [2]

(d) It takes a longer time than the value calculated in **(c)(ii)** to cool the room.

Suggest one modification to the air cooler to reduce the time taken to cool the room.

_____

_____

_____ [1]

(e) The air cooler is rated at '120 V, 50 W' and was turned on for 180 mins.

Calculate the cost of electricity for this usage if one kWh costs 30 cents.

cost of electricity = _____ [2]

11 Fig. 11.1 shows a rotating permanent magnet in an alternating current generator ("dynamo"). The dynamo is used to power a lamp.

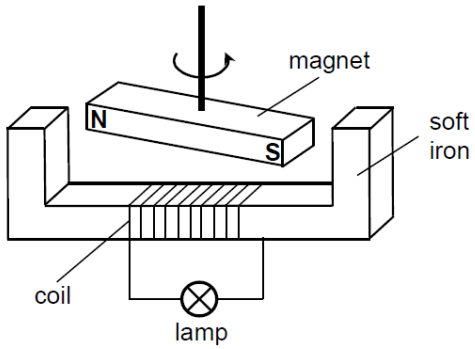


Fig. 11.1

(a) Explain, in detail, how an induced current is produced by the apparatus shown in Fig 11.1.

.....

.....

.....

.....

..... [3]

(b) Explain why the current induced in the coil of the dynamo is alternating.

.....

.....

.....

..... [2]

(c) State two ways that the induced current in the lamp might be increased.

1. .....

2. ..... [2]

(d) Describe what happens to the period and amplitude of the alternating current when the magnet is spun at twice the speed.

period: .....

amplitude: ..... [2]

(e) Suggest one advantage of this dynamo as compared to the conventional alternating current generators which require the use of slip rings and carbon brushes.

_____

_____ [1]

Answer for Preliminary Examination Physics P1

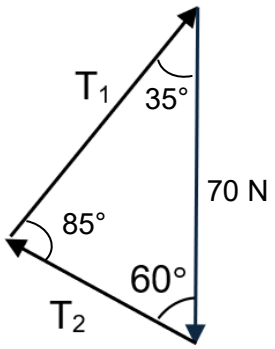
1	2	3	4	5	6	7	8	9	10
B	C	D	D	B	D	B	B	B	C

11	12	13	14	15	16	17	18	19	20
B	D	B	D	B	D	C	D	D	D

21	22	23	24	25	26	27	28	29	30
A	A	B	D	B	A	B	A	D	A

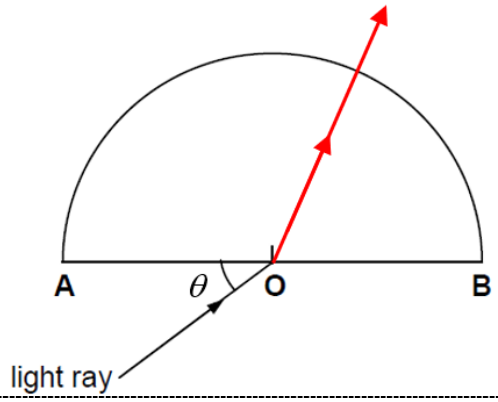
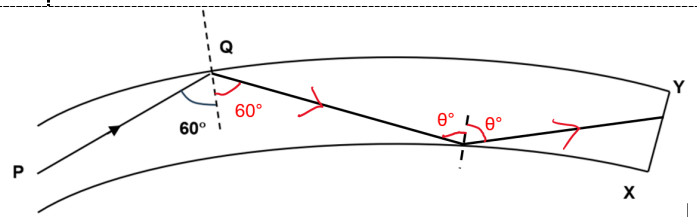
31	32	33	34	35	36	37	38	39	40
A	A	A	C	A	B	C	A	B	D

Section A (70 marks)

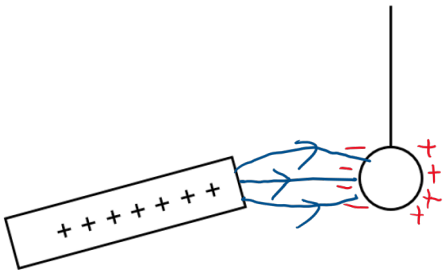
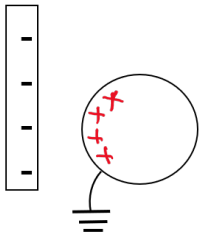
1	(a)		1 – suitable vector diagram 1 – Tensions labeled with correct arrows indicated. 1 – T_1 = **57 N to 63 N** 1 – T_2 = **38 N to 42 N**	
	(b)	(i)	precision is the smallest unit/division an instrument can measure	1
		(ii)	0.001 cm (or 0.01 mm)	1
	(c)	E = (2600 x 10^{12}) x 60 x 60 = **9.4 x 10^{18} J**		1 1

2	(a)	For an object in *equilibrium,* the sum of clockwise moments about *a pivot* is equal to the sum of anticlockwise moments about the *same pivot.*		1
	(b)	(i)	anti-clockwise moments = clockwise moments 0.60 x d = 0.16 X 0.40 d = **1.1 cm**	1 1
		(ii)	0.16 + 0.60 = W_R + W_S Since W_R = W_S (by inspection of symmetry), therefore W_R = W_S = ½ (0.16 + 0.60) = **0.38 N**	1 1
		(iii)	Rod 1 <u>rises</u> and at the same time <u>rotates clockwise</u> (both must be stated) due to the net clockwise moment. Rod 2 <u>rotates clockwise</u> as the sum of clockwise moments is now larger than the sum of anticlockwise moments. (or net clockwise moments)	1 1

3	(a)	(i)	difference in pressure = hρg = 0.10 x 13600 x 10 = **13 600 Pa**	 1 1
		(ii)	Pressure of gas A = (0.76 x 13600 x 10) + 13 600 Pressure of gas A = 116 960 = 117 000 Pa (3sf) or 120 000 Pa (2sf)	1 1
	(b)	Pressure difference more than 10 cm/ left hand side mercury level is higher. At higher altitude, atmospheric pressure decreases while gas A pressure remains constant, leading to a greater pressure difference between the two sides.		1 1

4	(a)	The angle of incidence of the light ray at C is zero (i = 0°)			1
	(b)	sin c = 1/1.8 c = 33.7° max angle θ = 90 – 33.7 = **56.3°**			1 1
	(c)	(i)		Light ray leaves without bending	1
		(ii)	Fig. 4.1. Light is going from an optically denser medium in the glass block to optically less dense medium air at boundary AB.		1
	(d)			1 – correct ray path with arrows 1 – first TIR angle labeled	

5	(a)	(i)	Period of a wave is the time taken for the wave to complete one oscillation.	1
		(ii)	Frequency = 1 / (2x20x60) = **4.2×10^{-4} Hz** (2sf)	1 1
	(b)	(i)	magnitude of X = 20/2 = **10 m** magnitude of Y = **150 km** {units important in physics}	1 1
		(ii)	v = fλ = $4.2 \times 10^{-4} \times 100\,000$ = **42 m/s** (correct f and λ needs to be substituted)	1
		(iii)	t = distance / speed = 200 000 / 42 = 1 hr 19 mins Time = 0800 + 1 hr 19 mins = **09 19 Hrs** (rounding off errors accepted)	1 1
	(c)	The ship will move up and down perpendicular to the direction of the wave.		1

6	(a)	(i)		1 – charges drawn correctly in sphere. 1 – electric field drawn correctly with arrows.	
		(ii)	When the rod touches the sphere, some of the electrons in the sphere flows into the rod and neutralize some of the positive charges in the sphere. When the rod separates from the sphere, the rod has positive charges and the sphere also has net positive charges.		1 1
	(b)	(i)	providing a **conducting path** for charges to flow.		1
		(ii)			1

7	(a)	suitable working mass remaining = **5.0 mg**			1 1
	(b)	$^{234}_{90}\text{Th} \rightarrow {}^{234}_{91}\text{Pa} + {}^{0}_{-1}\beta$			1
	(c)	(i)	1.	22 cpm	1
			2.	49 – 22 = **27** c**pm**	1
			3.	Use of 27/2 = 13.5 13.5 + 22 = 35.5 85 or 90 days (evidence shown on graph)	 1 1

8	(a)	(i)	**6.0 J** of work is done by the source in driving a unit charge around a complete circuit.		1
		(ii)	$\frac{R_{LDR}}{(R_{LDR}+10\,000)}\times 6=0.23$		1
			R_{LDR} = **399 Ω** (3sf) or **400 Ω** (2sf)		1
		(iii)	When light falling on LDR decreases, resistance and p.d. across it increases. Voltmeter reading increases.		1 1
	(b)	(i)	10kΩ + 10kΩ = 20 000Ω 2.2 kΩ + 3.8 kΩ = 6000 Ω $\frac{1}{R}=\frac{1}{20\,000}+\frac{1}{6000}$ R = **4620 Ω** (3sf) or **4600 Ω** (2sf)		1 1
		(ii)	the source voltage is shared equally by the two equal resistors		1
		(iii)	(1)	p.d = $\frac{3.8\ k\Omega}{(3.8\ k\Omega\ 1+2.2\ k\Omega\ )}\times 6$ p.d. = **3.8 V**	1
			(2)	p.d. = 3.8 – 3.0 = **0.80 V**	1

9	(a)	(i)	acceleration is constant / the speed of the carriage increases throughout the motion / the speed of the carriage increase at a slower rate as compared to data 1.		1
		(ii)	distance = ½ x 2.00 x 2.50 distance = **2.5 m**		1 1
		(iii)	earth's gravitational force of attraction on carriage and carriage's gravitational force of attraction on the earth **or** Normal force of track pushing carriage and Normal force from carriage pushing track. Both forces equal in size but opposite in direction		1 1
		iv)	no difference in mass. by conservation of energy, k.e. = p.e the mass cancels out and does not play a part.		1 1
	(b)	(i)	a= (v – u)/t a = (2.7 - 2.6) / 0.20 a = - 0.50 m / s^2 deceleration = **0.50 m / s^2**		1
		(ii)	from t = 0.6 s to t = 1.20 s the speed is constant. Net Force is equal to zero and based on newtons' second law there is no friction acting.		1 1

Section B (10 marks)

10	(a)	Specific heat capacity c is defined as the amount of thermal energy required to raise the temperature of a unit mass (e.g. 1 kg) of a substance by 1 K (or 1˚C).	1
	(b)	There is a greater increase in the internal potential energy of a substance when vaporising than melting/ more thermal energy needed to break bonds during vaporising <u>there is also work done against the surrounding air pressure</u> in order for the molecules to escape into the atmosphere.	1 1
	(c)	(i) Thermal energy = 90 m^3 × 1.2 kg/m^3 × 1.0 kJ/(kg K) × 5 K = **540 kJ**	1 1
		(ii) Time taken = 540 kJ ÷ 270 J/s = 2000 s or **33.3 mins**	1 1
	(d)	Increase the surface area of the cooling pad for the air to pass through. Increase the rate of airflow through the cooling pad. Or Increase the rate of water flow down the cooling pad.	1
	(e)	Energy used = 0.050 x 3 = 0.15 kwh Cost = 0.15 x 0.30 = **$0.045**	1 1

11	(a)	As magnet rotates, the number of magnetic field lines cutting the coil changes / the magnetic flux linking the coil changes/ rate of change of magnetic field changes. By **Faraday's Law,** this causes an induced e.m.f., and hence an induced current in the complete circuit.	1 1,1
	(b)	The poles of the magnet will alternate in approaching and leaving the two ends of the soft iron. According to **Lenz's law**, the current induced will oppose the motion thus need to change direction of flow to repel and attract the magnet.	1 1
	(c)	Any two of: Increase the number of turns (per unit length) of the coil Increase the speed of rotation of the magnet Use a stronger magnet	1,1
	(d)	period: halves amplitude: doubles	1 1
	(e)	Less wear and tear energy loss as heat in the slip rings and carbon brushes reduced small **and** compact.	1

Name: _____ ( ) Class: Sec 4 / ( )

南华中学

NAN HUA HIGH SCHOOL

PRELIMINARY EXAMINATIONS 2025

Subject : Physics

Paper : 6091/3

Level : Secondary Four

Date : 12 August 2025

Duration : 1 hour 50 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, class and register number in the spaces at the top of this page and on any separate answer paper used.

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 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 these observations are made.
An account of the method of carrying out the experiment is **not** required.
The use of 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	
2	
3	
Total	

This paper consists of **15** printed pages.

Section A

1 *In this experiment you will investigate the deviation of a ray of light that is reflected internally from the surface of a rectangular transparent block.*

You are provided with:

- a transparent block
- Light source with slit,
- 30-cm ruler,
- protractor,
- an A4 paper

(a) **(i)** Measure the length (L), width (W) and height (H) of the transparent block using the 30 cm ruler.

L = _____

W = _____

H = _____ [1]

(ii) Given that the mass of the glass block is 416 g.

Calculate the density of the glass block.

density = _____ [2]

(b)

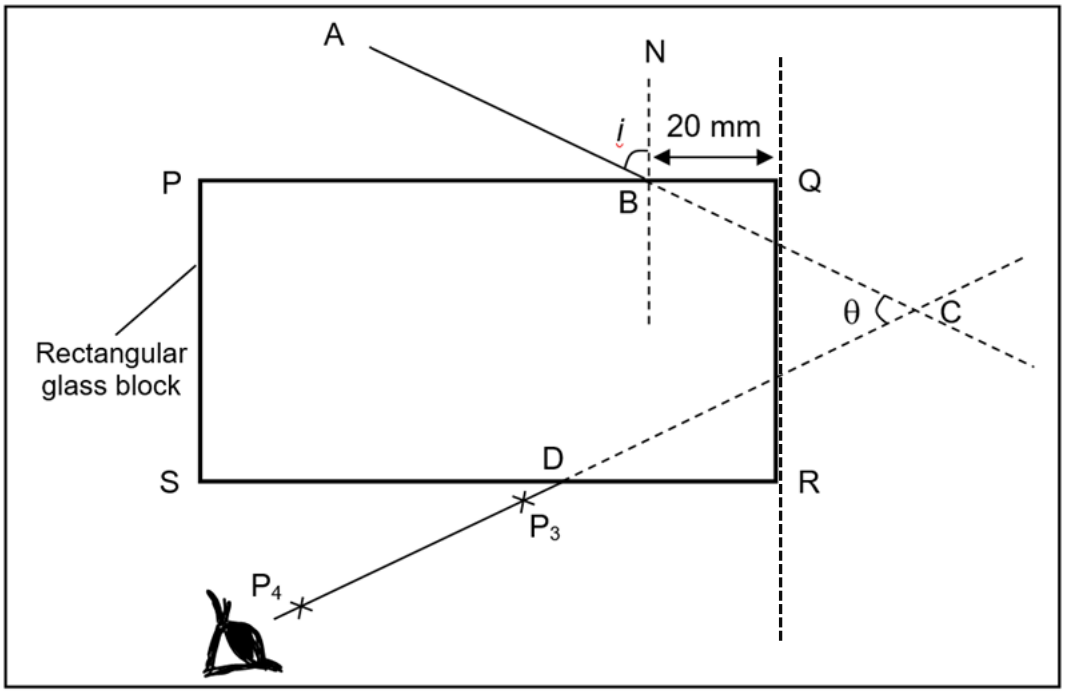


Fig. 1.1

On Fig. 1.2 on page 5 of your question paper,

Trace the outline of your glass block and label it **PQRS** as above. Align the short side QR along the dotted line.

Mark a point **B** on edge **PQ** at 20 mm from **Q**. Draw a dotted line at **B** perpendicular to **PQ** and label it **N** to represent the normal.

Draw a line which makes an angle of incidence (***i***) of 40 ° with the normal.

(i) Measure and record ***i***.

i = _____ [1]

Place the glass block onto the outline marked **PQRS**.

Turn on the light source to illuminate the slit.

Position the illuminated slit so that a single ray of light is along the line.

The light ray will emerge from the edge **SR** of the glass block as shown in the diagram.

You may use the A4 paper provided shade the diagram (to block the ambient light in the room) if the emergent ray is not clear enough.

Mark two points $\mathbf{P_3}$ and $\mathbf{P_4}$ on the emergent ray.

Remove the glass block and draw a straight line passing through $\mathbf{P_3}$ and $\mathbf{P_4}$ till it intersects with side SR at point D. Extend this line with dotted line. (See diagram)

Extend the line AB with a dotted line until it intersects with the dotted line you have drawn earlier.

(ii) Measure and record the angle θ between BC and DC and the perpendicular distance (x) between C and face QR

θ = _____ [1]

x = _____ [1]

(c) State two precautions which you took to ensure the experiment was performed as accurately as possible.

---

[2]

(d) Identify two sources of error which make the measurements taken to be inaccurate.

---

[2]

[Total: 10]

Fig. 1.2

Blank Page

2 *In this experiment, you will investigate an electric circuit containing a light-dependent resistor (LDR).*

You are provided with:

- a lamp,
- a light-dependent resistor with blue tack,
- a power supply,
- a fixed resistor of resistance 470 Ω,
- a ruler,
- a stand and boss,
- a switch,
- a voltmeter and two connecting leads
- 6 connecting leads.

(a) Set up the circuit as shown in Fig. 1.1.

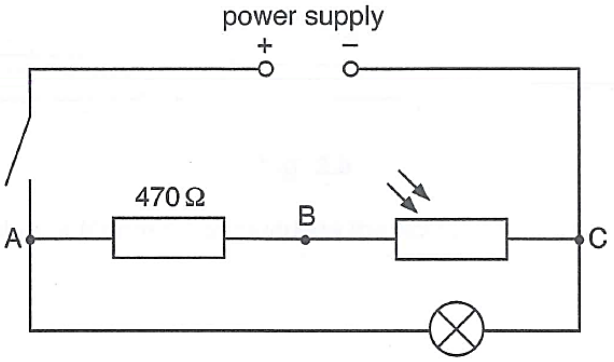


Fig. 2.1

(b) Set up the light-dependent resistor (LDR) and lamp as shown in Fig. 2.2. Secure the light bulb to the boss above the LDR. The boss can be moved up and down to change the distance between the LDR and the lamp. Set distance *d* to approximately 2.0 cm.

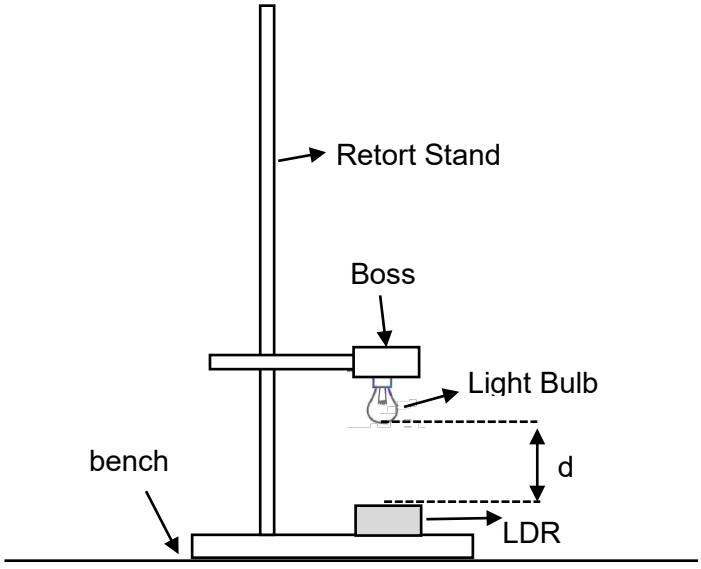


Fig. 2.2

(i) Measure the distance *d*.

d = _____ [1]

(ii) State one difficulty when making this measurement.

_____

_____ [1]

(c) **(i)** Connect the voltmeter across the terminals of the power supply. Close the switch.

Record the voltmeter reading V_S.

V_S = _____

(ii) Connect the voltmeter across points A and B. Close the switch.

Record the voltmeter reading V_{AB}.

V_{AB} = _____ [1]

(iii) Open the switch.

The current I in the fixed resistor is given by the equation

$$I = \frac{V_{AB}}{R}$$

Where R = 470 Ω.

Calculate I.

I = _____ [1]

(iv) Calculate the resistance R_L of the LDR using the equation

$$R_L = \frac{V_L}{I}$$

Where the potential difference (p.d.) V_L across the LDR is given by $V_L = (V_S - V_{AB})$.

R_L = _____ [1]

(d) A student who is investigating the relationship between the resistance of the LDR and the distance from the LDR to the light source, claims that the relationship should be

$$R_{LDR} = 2\gamma d + k$$

where R_{LDR} *is the resistance of the LDR, d is* the distance from the light source, *k* and γ are constants.

Plan an experiment using the above relationship to determine the constant γ using a graphical method.

Your plan should include

- the quantities that you should keep constant,
- a detailed description of how you would perform the experiment,
- a statement of the graph that you would plot to test the relationship,
- a sketch of the graph that you would obtain if the suggested relationship is correct,
- an explanation of how you would obtain a value for the constant γ from your graph.

[5]

[Total: 10]

Section B

3 *In this experiment, you will investigate the oscillation of a mass on a spring.*

You are provided with:

- two stands, bosses and weights
- a piece of adhesive putty moulded to a spring
- a rod
- a small piece of adhesive putty
- a stop-watch
- a rule

The supervisor has set up the apparatus, as shown in Fig. 3.1.

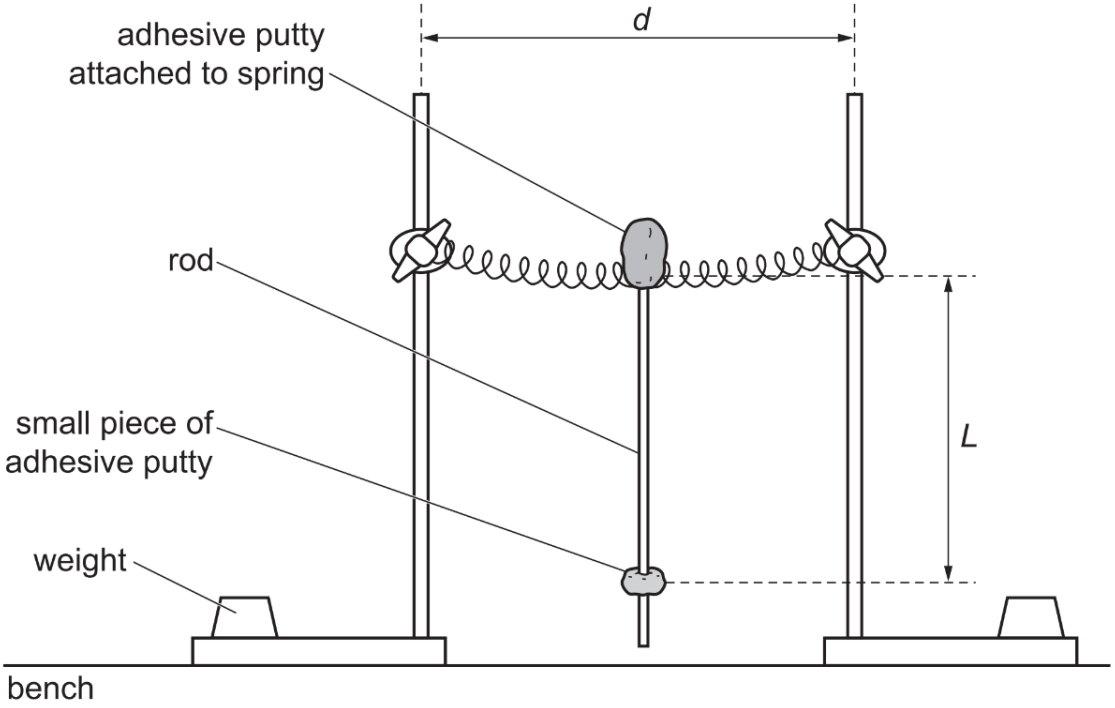


Fig. 3.1

(a) Describe two ways that the apparatus is arranged to reduce the risk of the stands toppling over.

1. .....

.....

2. .....

..... [2]

(b) **(i)** Adjust the position of the stands so that d = 26 cm. While moving the stands, take care that the spring does not become loose.

Adjust the position of the small piece of adhesive putty so that it is approximately 3.0 cm from the lower end of the rod. Press it firmly to the rod to ensure that it does not slip off.

Measure and record the distance, L in cm, from the centre of the spring to the centre of the small piece of adhesive putty.

L = _____ [1]

(ii) Calculate $\frac{L^2}{100}$.

$\frac{L^2}{100}$ = _____ [1]

(c) **(i)** Pull the bottom tip of the rod towards you by approximately 20.0 cm. Release the rod so that it swings freely.

Describe a technique for determining an accurate time T for one oscillation.

_____

_____ [1]

(ii) Determine an accurate value for the period T of the rod.

T = _____ [2]

(iii) Calculate T^2.

T^2 = _____ [1]

(d) Repeat steps **(b)** and **(c)** for further values of *L*.
Record your results for *L*, $\frac{L^2}{100}$, *T* and T^2. Include all of your results. [4]

(e) Using the grid provided, plot a graph of T^2 against $\frac{L^2}{100}$. [4]

Draw a straight line of best fit.

(f) Determine the gradient G of your line.

G = _____ [2]

(g) A student suggests that the best fit of line should be a curve.

State and explain whether the points on your graph support this suggestion.

_____

_____

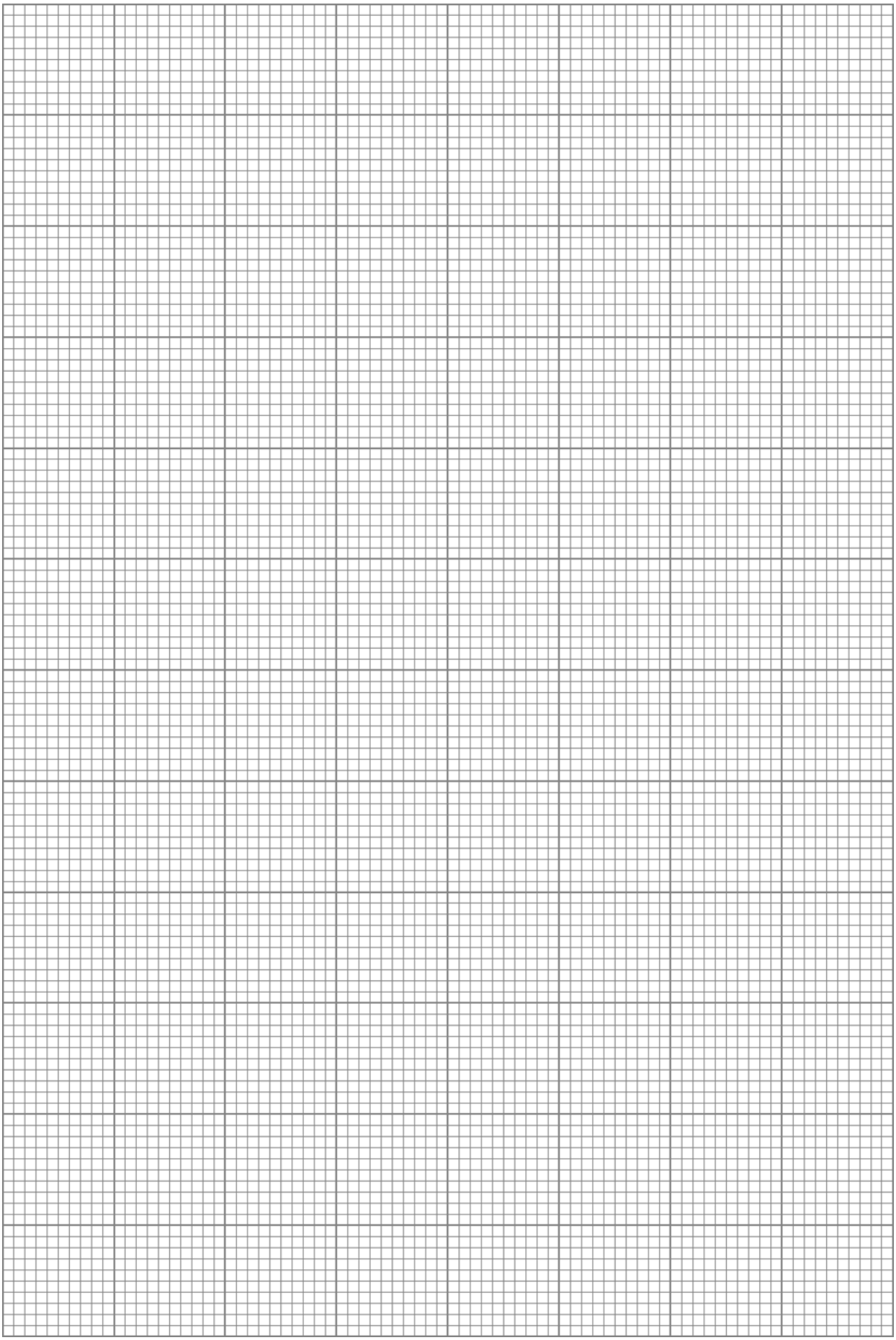
_____ [1]

(h) Another student suggests that the measurement of T when L is large is more accurate than when L is small.

Explain whether your observations support this suggestion.

_____

_____ [1]



2025 Phy Prelim Practical P3_NHHS_suggested marking scheme

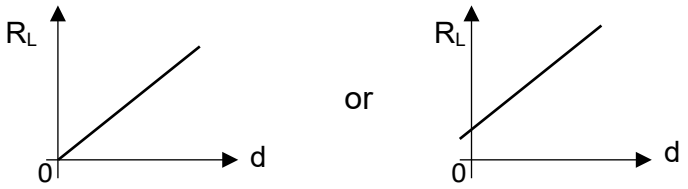
Question			suggested answer	marks
1	(a)	(i)	*L, W* and *H* recorded to 1 dp and correct units sample data : 12.5 cm x 6.6 cm x 2.0 cm (blocks differ)	1
		(ii)	Base on (ai) correct working, significant figures and units Volume = 12.5 x 6.6 x 2.0 = 165 cm^3 = 170 cm^3 (if 2 sf) Density = 416/170 = **2.5 g/cm^3 (2 sf)** {actual density of glass block is about 2.2 to 2.8 g/cm^3}	 1 1
	(b)	(i)	*i* recorded to the nearest degree 40 °	1
		(ii)	Recorded to the nearest degree with the correct units (eg. θ = 101°) Recorded to the nearest 0.1 cm with the correct units (eg. x = 1.0 cm)	1 1
	(c)		Points P_3 and P_4 marked as far away as possible Ensure the block is placed accurately on the given rectangle Ensure light source with slit is placed close to the glass block.	1,1
	(d)		Difficult to place the incident ray accurately on the line drawn (40°) Difficult to locate the exact centre of the emergent ray to draw the points Ambient light makes it difficult to locate emergent ray.	1,1

Question			suggested answer	marks
2	(b)	(i)	*d* value recorded with unit to nearest 0.1 cm	1
		(ii)	It is difficult to make ruler vertical It is difficult to access the centre of lamp / filament / judge where the filament is / ruler is too far from lamp	1
	(c)	(i)	Sensible value for V_S with 2 dp precision (range from 4.00 V to 4.45 V)	1
		(ii)	Sensible value for V_{AB} with 2 dp precision (eg V_{AB} = 2.20 V)	1
		(iii)	$I = \frac{V_{AB}}{R}$ $I = \frac{2.20}{470} = \mathbf{0.00468}\boldsymbol{A}$ (or 4.7mA)	1
		(iv)	$V_L = V_S - V_{AB} = 4.35 - 2.20 = 2.15V$ $R_L = \frac{V_L}{I}$ $R_L = \frac{2.15}{0.00468} = \mathbf{459\ \Omega\ (3\ sf)}$	1

	(c)	***Marking points***	

		• constant variables: (need 2)
		  • *surrounding light intensity*
		  • *value V_s* constant
		  • *R = 470 Ω*
		  • *Brightness of bulb*
			1

		• description of procedures:
		  • *d as* independent variable and record V_{AB}
		  • calculate I and calculate V_L
		  • *to calculate R_L (dependent variable)*
			1

		• vary *d* to get at least 5 sets of R_L	
		• plot a suitable graph: Plot R_L against d	1
			1
		• ϒ is ½ of the gradient of the graph	1

Question			suggested answer		marks
3	(a)	Any two from: - Weights placed on the base of each retort stand - Bosses are attached as low as possible - d is not too large / the spring is not too stretched - The orientation of the base of the retort stands (facing away)			1,1
	(b)	(i)	*38.0 cm ± 4.0 cm*		1
		(ii)	Correct calculation of $L^2 / 100$ using candidate's value **with unit** and **appropriate sf**	correct calculation unit & sf	1
	(c)	(i)	• Measure time for 10 oscillations and divide this by 10 • Wait for oscillations to stabilise before starting the timing • Count oscillations as the rod moves at its fastest in the same directions (through the resting point / centre of oscillation)		1
		(ii)	Correct calculation of an accurate value of T (need to show averaging)		1
			with **unit** and **appropriate sf**		1
		(iii)	Correct calculation of T^2 using candidate's value with unit and **appropriate sf**		1

(d)

- table with proper headers and unit (for L, $\frac{L^2}{100}$, T and T^2) — 1
- at least 5 sets of data with correct trend (L down, T down) — 1
- all values of L recorded to nearest 1dp in cm and T recorded to 1 or 2 dp in s. — 1
- correct calculation of $L^2/100$ and T^2 to **appropriate sf** — 1

sample data:

L/cm	$\frac{L^2}{100}/cm^2$	t_1 /s	t_2 / s	t_{ave} / s	T / s	T^2 / s^2
38.0	14.4	11.56	11.55	11.56	1.16	1.34
35.0	12.3	11.28	11.18	11.23	1.12	1.26
30.0	9.0	10.50	10.47	10.49	1.05	1.10
25.0	6.3	9.81	9.91	9.86	0.99	0.97
20.0	4.0	9.38	9.28	9.33	0.93	0.87
15.0	2.3	8.84	8.81	8.83	0.88	0.78
10.0	1.0	8.60	8.53	8.57	0.86	0.73
5.0	0.3	8.28	8.30	8.29	0.83	0.69

(e)

- axes labelled with headers + units and correct orientation — 1
- suitable scale, not based on 3, 6, 7 etc with plotted data occupying >= half the page in both directions — 1
- all points plotted correctly (points must be =< ½ small square from the correct position) — 1
- best fit line and fine crosses — 1

(f)

Constant G

- gradient:
  - use of *gradient triangle* that uses more than half the drawn line — G — 1
  - correct calculation of gradient — correct sf — 1

(g) — 1

Either:
(Yes, likely to be curved line)

- The best fit line is more likely a curved line than a straight line for my data - a smooth curve can be drawn for the plotted points

(No, more likely to be straight line)

- the increase in T^2 gets smaller;
- the points are all evenly spread about the best fit line
- the graph shows that T^2 increases by the same amount for equal increases in L^2 / 100 so the line should be straight

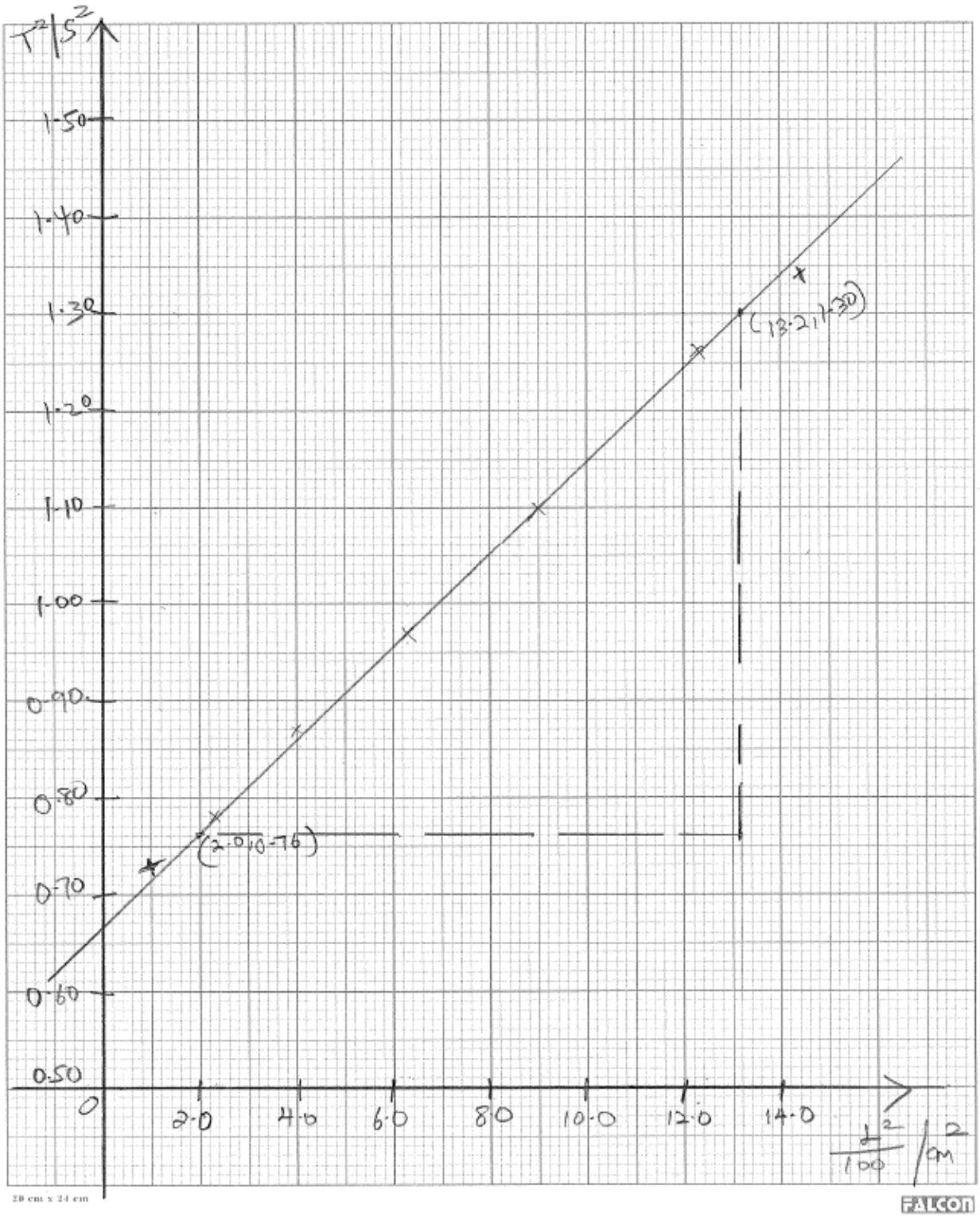
(h) — 1

Either
(Yes, measurement of L is more accurate when L is large)

- reaction time is a smaller proportion of the total time when L is large
- it's easier to judge the end of the swing when it is moving slower
- or points are closer to best fit line at large L;

or
(No measurement of L is more accurate when L is small)

- reaction time is the same
- points are closer to best fit line at smaller L;


T²/s²
1·50
1·40
1·30
1·20
1·10
1·00
0·90
0·80
0·70
0·60
0·50
0
2·0
4·0
6·0
8·0
10·0
12·0
14·0
(13·2, 1·30)
(2·0, 0·76)
L²/100 / m
20 cm x 24 cm
FALCON