Section A: MCQ (5 marks)

Answer **all** questions. Write your answers in the spaces provided on the cover page.

1. The height of a square-based wooden pyramid block of wood is 38.7 mm.

The base area of the pyramid is 25 cm^2.

The volume of a pyramid is given by

$$V = \frac{1}{3} \times \text{base area} \times \text{height}$$

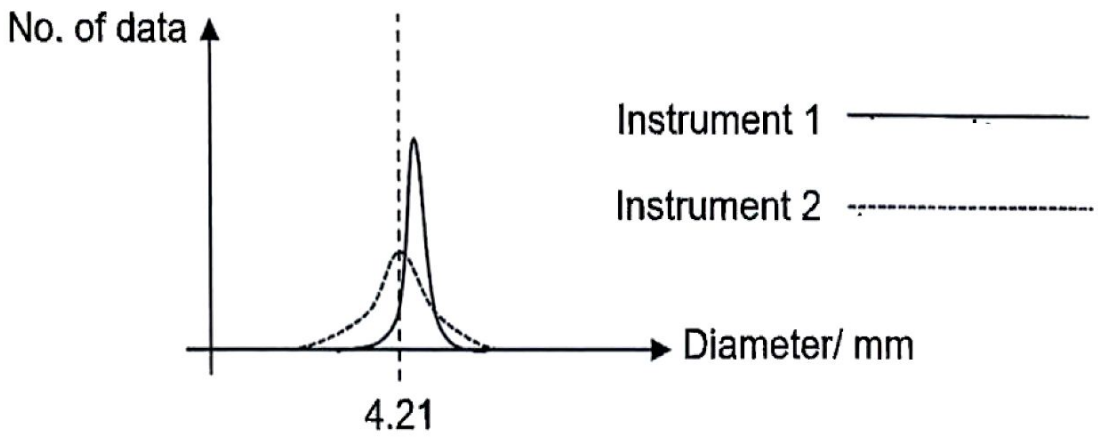
Which of the following is the **correctly recorded value** of the volume of the wooden pyramid?

A 32 cm^3 **B** 32.0 cm^3 **C** 32.2 cm^3 ✗ **D** 322.5 cm^3 ✗

2. A machinist was told to manufacture a piston head with a diameter of 4.21 mm so that it can fit and operate in an engine cylinder.

He took repeated measurements of the diameter using two instruments and plotted the results.

The instruments were properly calibrated and used correctly.



Which of the following statements best describes the precision of the instruments?

A Instrument 1 is more precise. ✗

B Instrument 2 is more precise. ✓

C Both instruments have the same precision. ✗

D Both instruments are equally accurate. ✗

3. Which of the following contains only vector quantities?

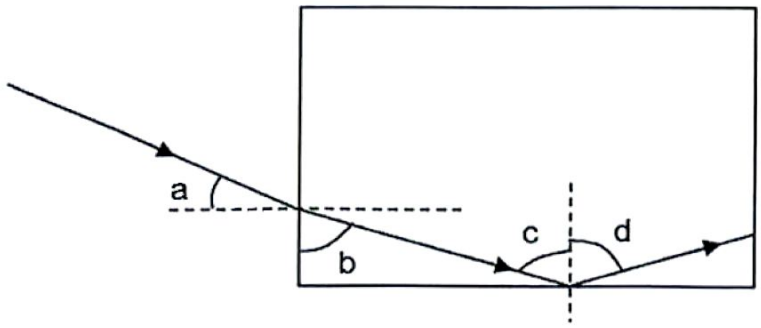
A distance, force, speed

B displacement, acceleration, force

C distance, mass, time

D displacement, temperature, time

4. The diagram shows the path of a ray of light as it enters a transparent block and is reflected at the lower surface. Angles a, b, c, and d are labelled in the diagram.



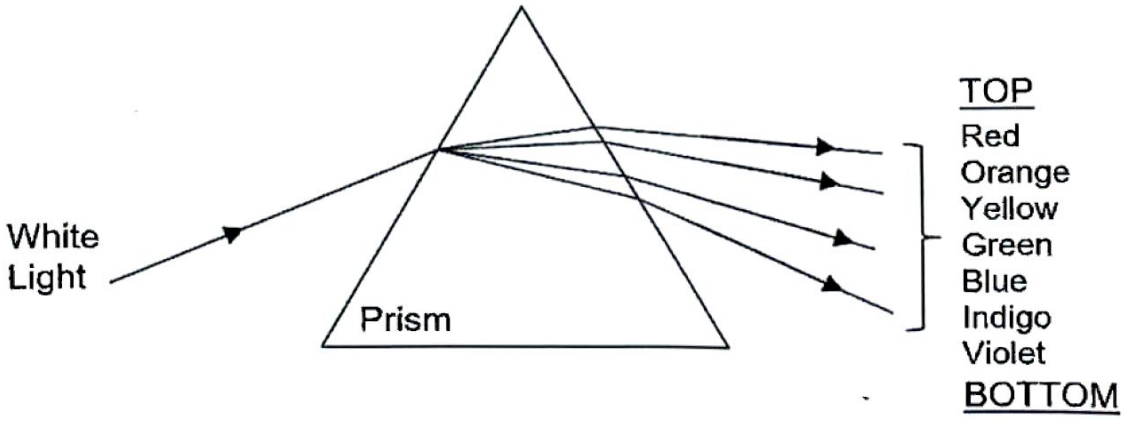
Which pair of angles represents the angle of incidence and the angle of reflection respectively?

	Angle of incidence	Angle of reflection
A	a	c
B	b	c
C	c	b
D	c	d

5. The table shows how frequency relates to the different colours of visible light.

← High frequency						Low frequency →
Violet	Indigo	Blue	Green	Yellow	Orange	Red

When white light passes through a glass prism, it splits into its component colours as shown.



Which statement can be inferred from the table and the observation?

A Refractive index of a medium is high when using light with low frequency.

B Refractive index of a medium is based on refraction of green light.✗

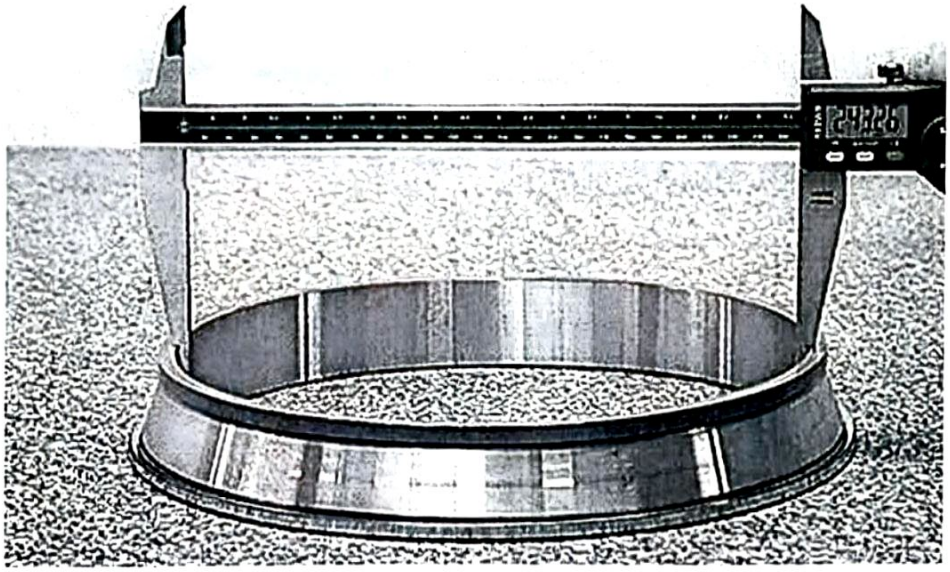
C Refractive index of medium depends on the frequency of light used.✓

D Refractive index of medium is defined as a range of values.

Section B: Structured Question (25 Marks)

Answer all the questions in the spaces provided.

1. An engineer uses the digital calipers shown below to determine the internal diameter of a metal ring of about 25 cm.



(a) **(i)** State what is meant by random errors.

.....

.....[1]

(ii) Describe how random errors may be reduced

.....

.....[1]

(b) Explain why a 30 cm ruler is less suitable than the digital calipers for measuring the internal diameter of the ring.

.....

.....[1]

2.

The diagram shows a plane landing at an angle to the runway. The angle between the centreline of the runway and the nose of the aircraft is called the **crab angle**.

During landing, an aircraft must maintain a **normal landing velocity** of 120 knots* directed towards the runway from the south.

On one occasion, the pilot overhears a message from the ground controller.

"Winds at 20 knots"

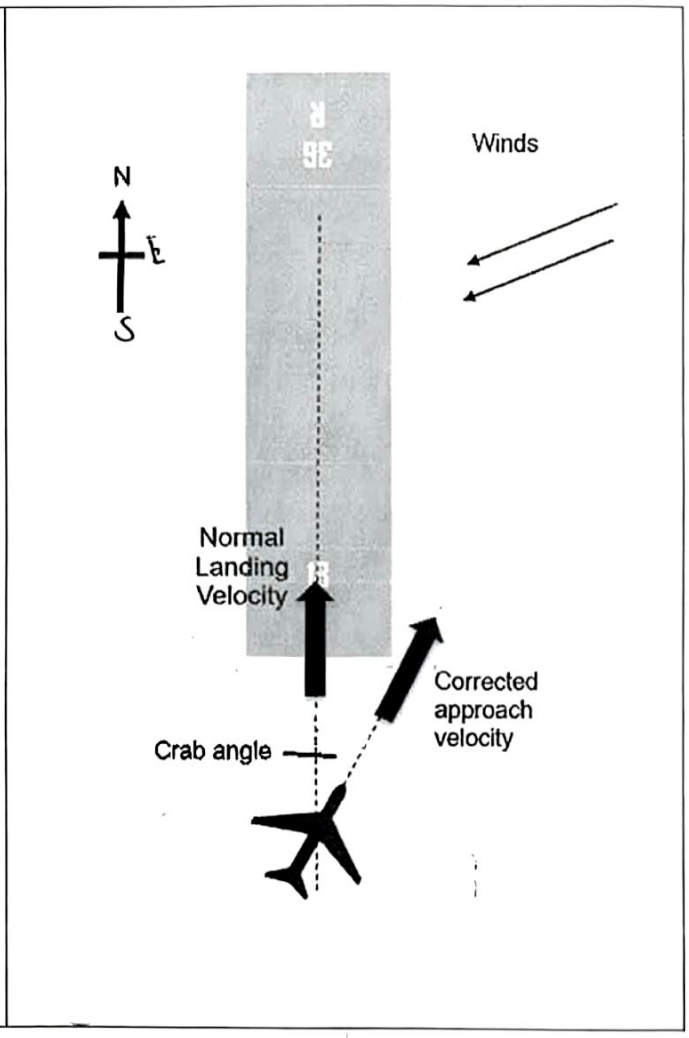
The pilot needed more information to adjust the aircraft to the **corrected approach velocity** in order to land safely.

After clarification, a clearer message came in.

"Winds 060 at 20 knots"

This means the wind is blowing from a bearing of 060 at a speed of 20 knots. (60 degrees east of north)

*The unit for speed in the aviation industry



(a) Identify the difference between the two messages "*Winds at 20 knots*" and "*Winds 060 at 20 knots*".

.....

.....[1]

(b) Using either calculations or a scale vector diagram (use the scale: 1 cm represents 10 knots), determine the magnitude and direction of the corrected approach velocity.

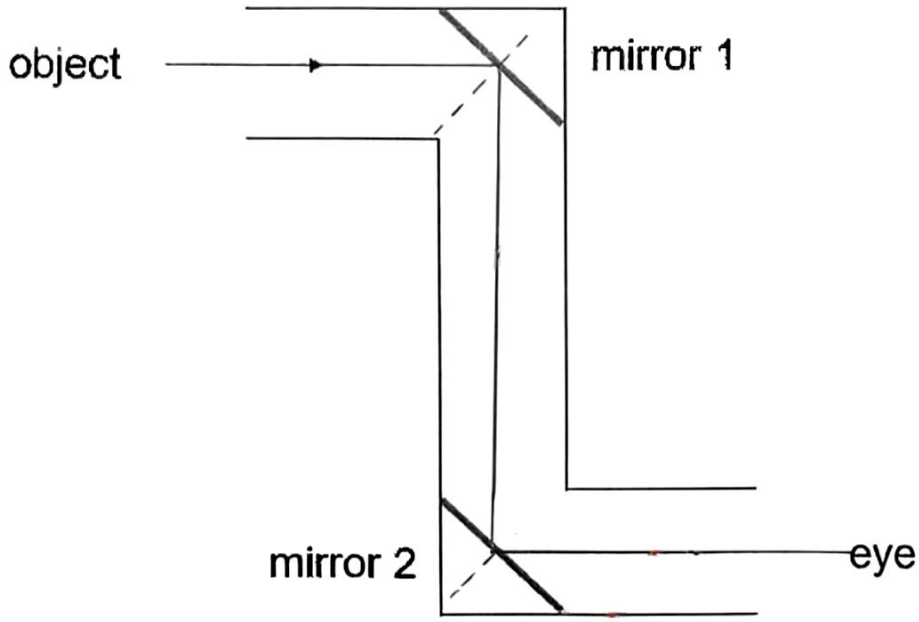
[4]

magnitude. .....

direction: .....

3. A student designs a periscope to observe over the wall of a playground. Two plane mirrors are placed at 45 ° to the vertical walls of the periscope.

The diagram below shows a narrow beam of light from a distant object strikes the first mirror.



(a) On the diagram, draw the path of the light ray after it reflects from mirror 1, then mirror 2, and finally reaches the eye. [1]

(b) Explain why the angle of incidence must be equal to the angle of reflection on a plane mirror.

.....

.....[1]

(c) **(i)** Identify the object for mirror 2.

..... [1]

(ii) State how the distance between the two mirrors affects the distance between the observer and the final image.

.....

..... [1]

4. A narrow beam of monochromatic light travels from air into water at the surface. The angle of incidence in air is 45 °, and the angle of refraction in water is 32 °.

(a) Describe the speed of light in water relative to its speed in air.

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.....[1]

(b) Using the definition of refractive index and the law of refraction, explain why the angle of refraction in water is smaller than the angle of incidence in air.

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.....[1]

A student claims:

"If the angle of incidence is increased, the angle of refraction will increase by the same amount."

(c) Comment on the student's claim.

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.....[2]

5. A student designs a small projector for a science exhibition using a thin converging lens of focal length 15 cm.

She uses it to project the image of a small slide onto a screen placed 60 cm from the lens.

(a) State what is meant by a *focal length* of 15 cm.

.....

..... [1]

(b) The lens equation is given by:

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

Where
u is the object distance
v is the image distance from the lens
(negative value when the image is virtual)
f is the focal length of the lens.

(i) Calculate the position of the slide so that a sharp image can be projected on the screen.

position of slide: .....[1]

(ii) Determine whether the setup produces an enlarged image on the screen.

Explain your answer.

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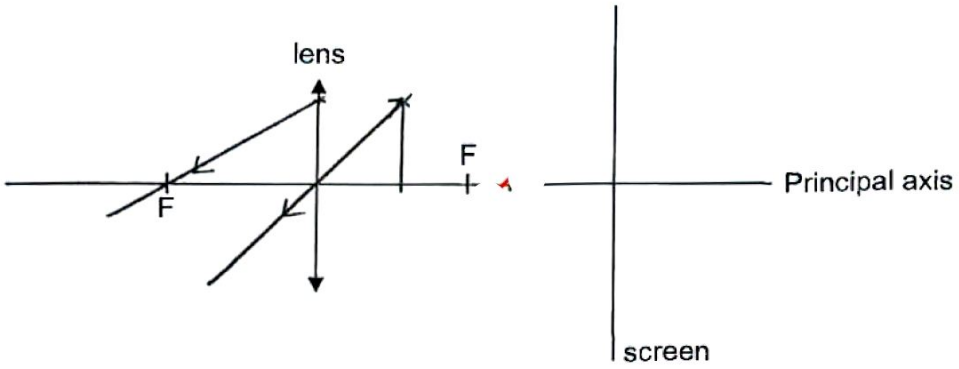
..... [2]

(c) Complete the diagram below to show how the student's set up would prevent a real image from forming on the screen. [1]



6. The table below shows the refractive indices, n, for various materials used in optical experiments and telecommunications.

Material	Refractive Index (n)
Vacuum	1
Air	1.0003 ($\approx$ 1.00)
Water	1.33
Silica Glass (Standard)	1.50
Optical Fiber Core	1.65
Optical Fiber Cladding	1.52

(a) Explain why total internal reflection can occur when light travels from the core to the cladding, but **not** from the cladding to the core.

.....

.....[1]

(b) Calculate the critical angle for the boundary between the core and the cladding.

critical angle: .....[2]

(c) Theoretically, if the diameter of the core is uniform and maintained the same throughout the length of the fibre, light signals can be transmitted through a fibre in air. No cladding of lower optical density is needed.

Explain one disadvantage of using this design.

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.....[1]

-- End of Test --