Section A: MCQ (5 marks)

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

1. A rectangular block of wood has dimensions:

12.0 cm, 5.0 mm and 3.22 mm.

Which value should be recorded for the volume of the block?

A 193.2 mm^3 **B** 1900 mm^3 **C** 1930 mm^3 **D** 1932 mm^3

2. A wood planer is set to plane wood to a thickness of 2.5 cm.

A carpenter uses two instruments to measure the thickness of the plank after passing it through a planer. The results are shown below.

Instrument 1
2.5 cm
2.5 cm
2.6 cm

Instrument 2
2.51 cm
2.55 cm
2.52 cm

Which of the following statement best describes the measurements from the instruments?

A Measurements from both instruments are equally accurate.

B Measurements from both instruments are equally precise.

C Measurements from instrument 1 are more accurate than those from instrument 2.

D Measurements from instrument 1 are more precise than those from instrument 2.

3. Which of the following contains only scalar quantities?

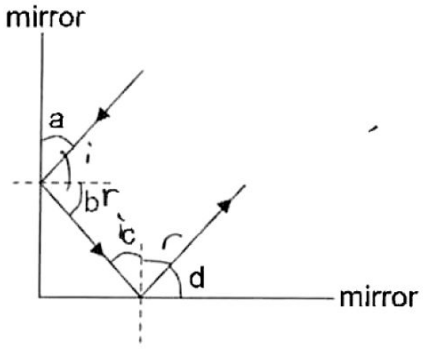
A distance, force, speed

B distance, mass, time

C acceleration, energy, force

D displacement, temperature, time

4. The diagram shows a ray of light striking two mirrors placed at right angle to each other. The ray undergoes two reflections.



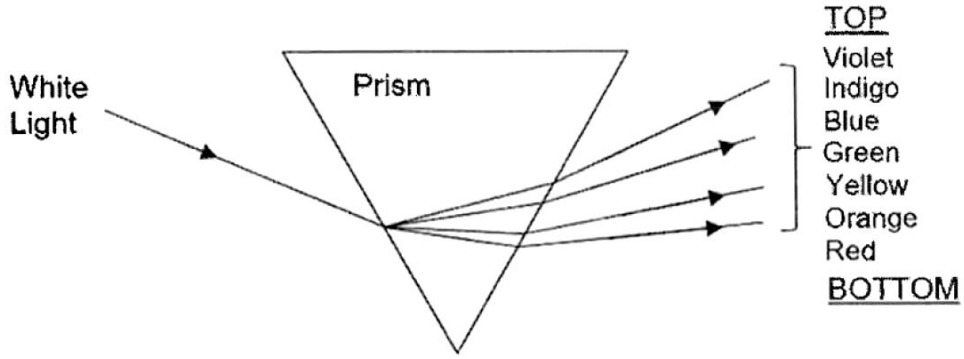
Which angles represent the angle of incidence and the angle of reflection respectively?

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

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

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

When white light passes through a glass prism, it splits into a spectrum as shown.



Using the information above, which statement about the refractive index of the glass for different colours of light can be inferred?

A The refractive index measured with white light is the most accurate.

B The refractive index measured with green light is the most accurate.

C The refractive index measured with any coloured light can never be accurate.

D The refractive index measured with low frequency light is lower than that of high frequency light.

Section B: Structured Question (25 Marks)

Answer all the questions in the spaces provided.

1. A fruit vendor uses the instrument as shown in Fig. 1.1, to determine the mass of a durian that is approximately 2 kg.

Fig. 1.1

(a) **(i)** State what are systematic errors.

.....

.....[1]

(ii) Describe how a systematic error might arise when using the instrument.

.....

.....[1]

(b) Study the instrument in Fig 1.2 carefully and explain why it is not suitable for the fruit vendor.

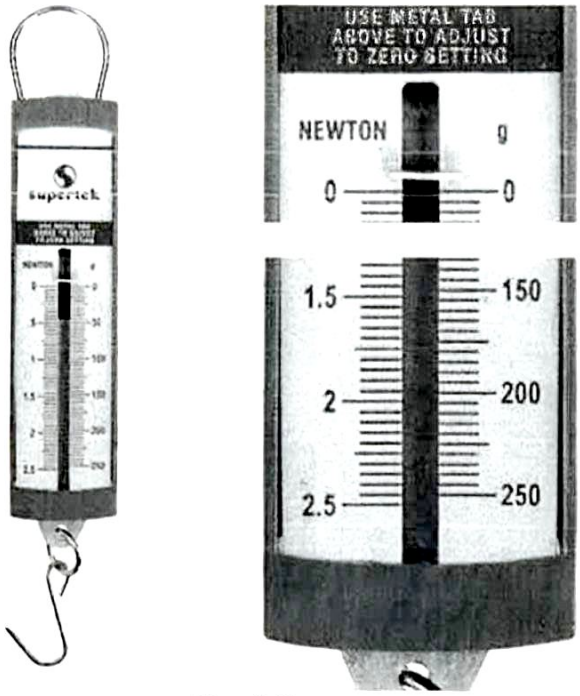


Fig. 1.2

.....

.....[1]

0 1

2.

The diagram on the right 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 needs a **normal landing velocity** of 120 knots* towards the north.

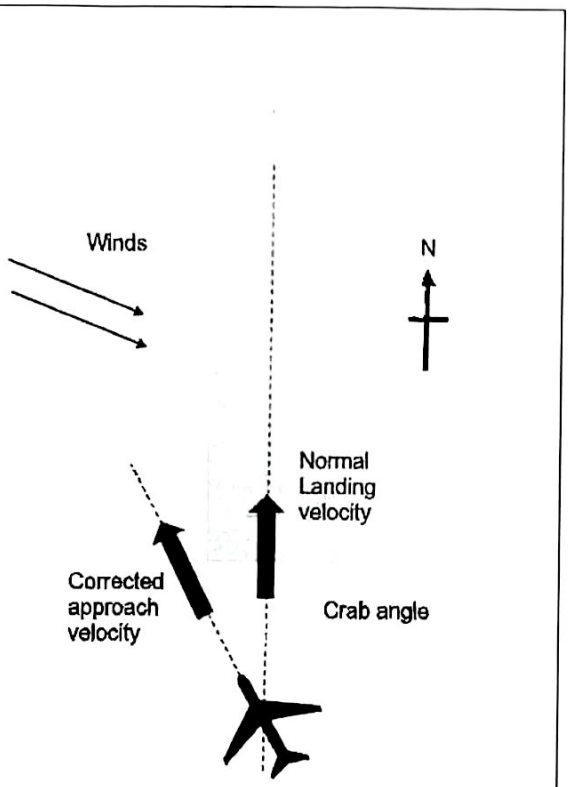
The ground controller reports.

"Winds 330 at 20 knots"

This means the wind is coming from a bearing of 330 (30° west of north) and the wind speed is 20 knots.

The pilot needs to adjust the aircraft to a **corrected approach velocity** to land safely

**The unit for speed in the aviation industry*



(a) Explain why the phrase *"winds 330 at 20 knots"* provides information for a vector quantity.

.....

.....[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 ray of light from a ray box strikes a plane mirror placed on a sheet of paper.

The angle between the incident ray and the normal is 40 °.

(a) Use the space below to construct a labelled diagram showing:

- the incident ray,
- the normal, and
- the reflected ray.

Clearly label the angle of incidence and the angle of reflection. The plane mirror has been drawn for you. [2]

(b) Calculate the angle between the incident ray and the reflected ray.

angle: .....[1]

(c) The mirror is rotated 5 ° clockwise while the incident ray remains fixed.

Calculate the angle between the reflected rays before and after the rotation.

angle: .....[1]

4. A fine beam of monochromatic light travels from air into water at a point on the water surface.

The angle of incidence in air is 45 °, and the angle of refraction in water is 32 °.

(a) By comparing the two angles, state how the direction of the ray changes as it enters the water.

.....

.....[1]

The water is then replaced by another transparent liquid X. For the same angle of incidence, the student observes that the angle of refraction in liquid X is 28 °.

(b) Compare the refractive index of the liquid X to that of water.

.....

.....[1]

(c) Using ideas about the speed of light, explain why the ray bends when it enters either water or liquid X from the air.

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.....

.....

.....[2]

(d) Calculate the refractive index of liquid X relative to that of water.

refractive index: .....[1]

5. A student designs a photography setup using a small converging lens.

- The lens has a *focal length of 10 cm*.
- She wants to take close-up photographs of small insects without damaging them.
- A screen is placed 12 cm from the lens.

She observes that if the insect is placed closer to the lens than the focal length, a real image cannot be formed.

(a) State what is meant by a *focal length of 10 cm* for the lens.

.....

.....[1]

(b) **(i)** The lens equation is given by

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

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

An insect is placed 15 cm from the lens.

Determine whether a sharp image of the insect can be formed on the screen.

.....

..... [2]

(ii) Suggest one modification to the setup that would allow the insect to be photographed sharply.

.....

.....[1]

6. The following table provides 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	1.62
Optical Fiber Cladding	1.52

(a) Explain briefly why total internal reflection can occur for light travelling from the core to the cladding, but **cannot** occur for light travelling from the cladding to the core.

.....

.....[1]

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

critical angle: .....[2]

(c) Explain why bending of the optic fibre may weaken the strength of the transmitted signals without the fibre being cut.

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-- End of Test --