Name :	Class	Index no.

DEYI SECONDARY SCHOOL

End-of-Year Examination 2021
Secondary Three Express

SCIENCE(PHYSICS) **5076/5077**

7 Oct 2021
1115 – 1300 h
1 hours 45 minutes

Additional Materials: OTAS

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.
Write your **name** and **class/register number** in the spaces above.

1. There are **three** sections in this paper: Section **A** (20 marks), Section **B** (45 marks) and Section **C** (20 marks).
2. Answer **ALL** questions in Section **A** on the **OTAS** provided.
3. Answer **ALL** questions in Sections **B** and **C** in the spaces provided.
4. Hand in the **OTAS** separately from the answers to Sections **B** and **C**.
5. Take acceleration due to gravity, ***g***, to be 10 m/s^2 whenever necessary.

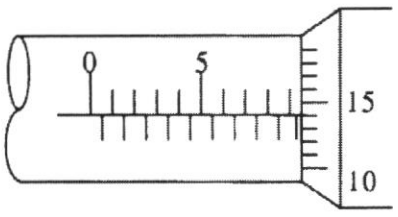
Section	Marks
Section A	/ 20
Section B	/ 45
Section C	/ 20
Total	/ 85

This question paper consists of 19 printed pages, including the cover page. **[Turn over**

Section A (20 marks)

Answer all questions on the OTAS provided.

1 The diagram shows the reading on a micrometer screw gauge.



What is the reading shown?

A 5.14 mm
B 5.54 mm
C 9.14 mm
D 9.64 mm

2 A pendulum clock is found to be too fast by 10 minutes per day. This clock can be corrected by

A decreasing the amplitude of oscillation.
B decreasing the length of pendulum.
C increasing the amplitude of oscillation.
D increasing the length of pendulum.

3 What must change when a body is accelerating?

A the force acting on the body
B the mass of the body
C the speed of the body
D the velocity of the body

4 A car driver drove 80 km in 1 hour before making a stop for lunch for 30 minutes. She drove another 100 km in the next 1.5 hour in heavy traffic.
What was her average speed for the whole journey?

A 60 km/h
B 72 km/h
C 80 km/h
D 103 km/h

5 A stone is falling through the air. The acceleration of free fall is 10 m/s^2.
Ignoring air resistance, what happens to the stone each second during its fall?

A The acceleration of the stone increases by 10 m/s^2.
B The speed of the stone increases by 10 m/s.
C The stone travels a distance of 10 m.
D The stone travels at a speed of 10 m/s.

6 Which of the following is not an example of inertia?

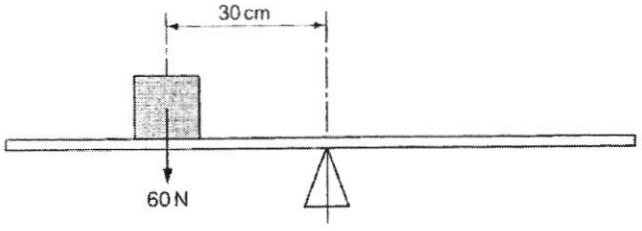
A A coin remains at its original position when the card, which the coin is resting on, is pulled away suddenly.
B A person in a bus is thrown backwards, when the bus suddenly moves from rest.
C Coffee spills from the cup when a car is brought to a stop suddenly.
D When a few drops of blue ink are added to a beaker of water, the ink spreads evenly in the beaker after a while.

7 On Earth, the gravitational field strength is 10 N/kg. On the moon, the gravitational field strength is 1.6 N/kg.

If an object has a weight of 50 N on Earth, what is its weight on the moon?

A 1.6 N **B** 5.0 N
C 8.0 N **D** 80 N

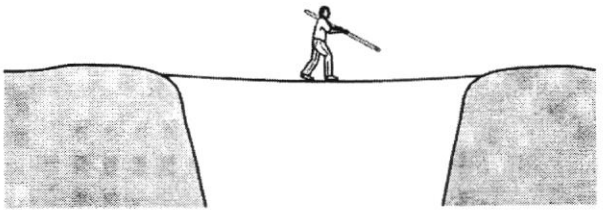
8 A uniform beam is balanced at its midpoint. An object is placed on the beam as shown in the diagram.



Which force will rebalance the system?

A 30 N acting upwards, 60 cm to the right of the midpoint
B 30 N acting upwards, 60 cm to the left of the midpoint
C 45 N acting downwards, 45 cm to the right of the midpoint
D 90 N acting downwards, 20 cm to the left of the midpoint

9 A man walks along a tightrope, carrying a long pole.

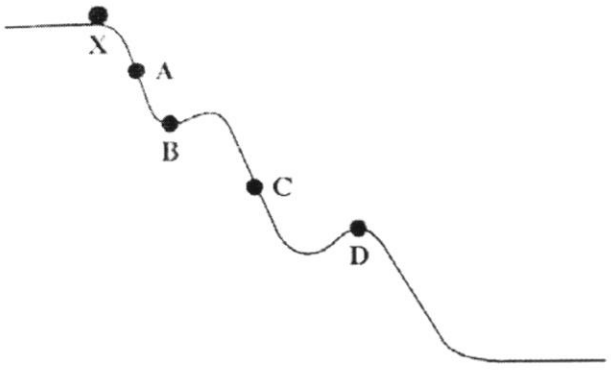


Why does he carry the pole?

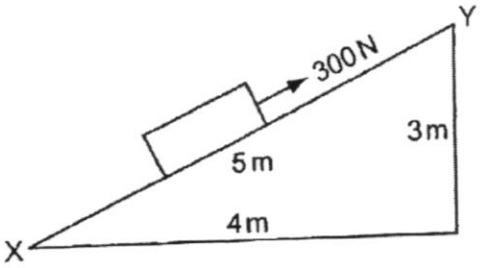
A to make it easier to keep his centre of gravity over the rope
B to raise his centre of gravity
C to reduce his pressure on the rope
D to spread out his weight

[Turn over

10 A ball, starting at point X, rolls down the hill shown in the diagram.
At which point does the ball have half of its maximum kinetic energy? Ignore friction.



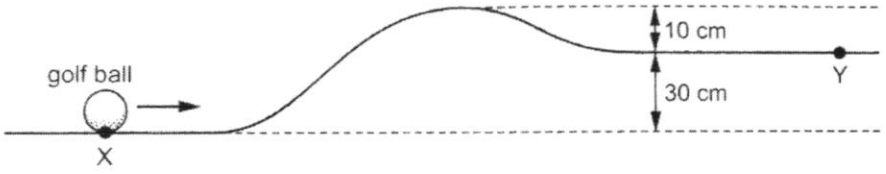
11 A 300 N force is applied to a box in the direction XY in order to move it up a ramp of the dimensions shown.



How much work is done when moving the box from X to Y?

A 900 J
B 1200 J
C 1500 J
D 3000 J

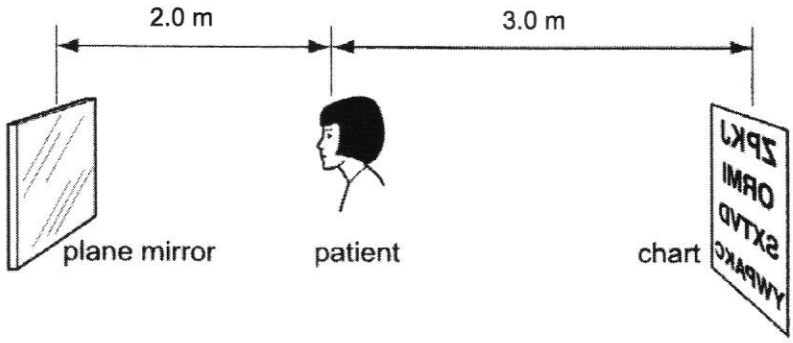
12 A golf ball, of mass 0.10 kg, is travelling horizontally in the direction shown.



Assume that no kinetic energy is transferred to thermal energy or sound energy, and the gravitational field strength is 10 N/kg.
What is the minimum speed the golf ball must have at X, to enable it to reach point Y?

A 1.4 m/s
B 2.0 m/s
C 2.4 m/s
D 2.8 m/s

13 The diagram shows a patient having her eyes tested. A chart with letters on it is placed behind her and she sees the chart reflected in a plane mirror.



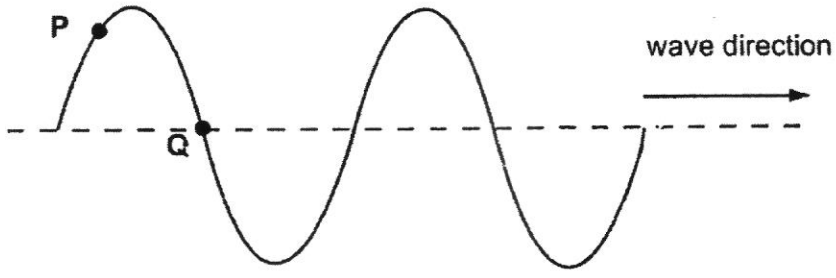
How far away from the patient is the image of the chart?

A 3.0 m
B 5.0 m
C 7.0 m
D 10.0 m

14 A student uses a converging lens to produce an enlarged virtual image of an insect she wishes to scrutinize carefully. The focal length of the lens is 10 cm.
What is a suitable distance between the insect and the lens?

A 8 cm
B 10 cm
C 15 cm
D 20 cm

15 The diagram shows a wave on a string with two points **P** and **Q** marked. The wave is moving in the direction shown.

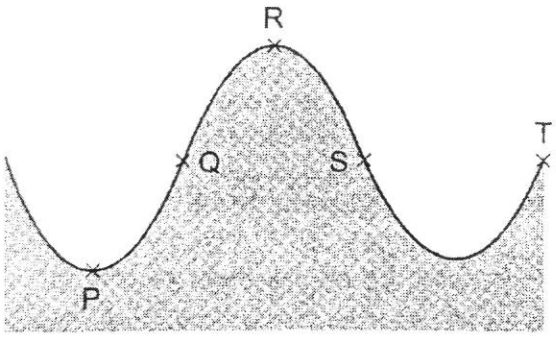


What will happen next?

A **P** will move to the right.
B **P** will move up.
C **Q** will move up.
D **Q** will not move.

[Turn over

16 The diagram shows waves travelling on the sea.



Which points are one wavelength apart?

A P and R
B Q and T
C R and T
D S and T

17 Which type of electromagnetic wave is deliberately used in some circumstances to cause damage to living cells in the human body?

A infra-red
B gamma rays
C microwaves
D radio waves

18 What is a property of all electromagnetic waves?

A They are deflected by magnets.
B They are positively charged.
C They travel at the speed of sound.
D They travel through a vacuum.

19 To find the depth of water beneath a ship, a pulse of sound is sent into the water and the time taken to receive the echo is 0.4 s.

How far beneath the ship is the sea bed?
(The speed of sound in water is 1500 m/s.)

A 300 m
B 600 m
C 1200 m
D 3750 m

20 A man who is standing at a point **X** between two parallel walls (as shown in the diagram) fires a starting pistol.

He hears the first echo after 0.6 s and another one after 0.8 s.
How long after firing the pistol will he hear the next echo?

A 1.2 s
B 1.4 s
C 1.6 s
D 2.4 s

[Turn over

Section B (45 marks)

Answer all questions in the spaces provided.

21 A pair of vernier calipers is used to measure the thickness of a stack of 400 pieces of paper. The position of the vernier scale is shown in Fig. 21.1.

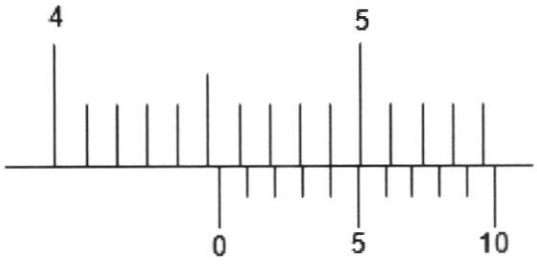


Fig. 21.1

(a) **(i)** State the reading of the vernier calipers.

reading = ... cm [1]

(ii) Hence, determine the thickness of one piece of paper.

thickness = ... cm [1]

(b) Describe briefly how a more accurate measurement of the thickness of the stack of papers can be obtained.

.....

..... [1]

(c) Explain why the micrometer screw gauge is not a suitable instrument to measure the length of a pen.

.....

..... [1]

22 Two small tugboats are pulling a large ship in a harbour.

Fig. 22.1 represents the view from above and shows the directions of the forces on the ship.

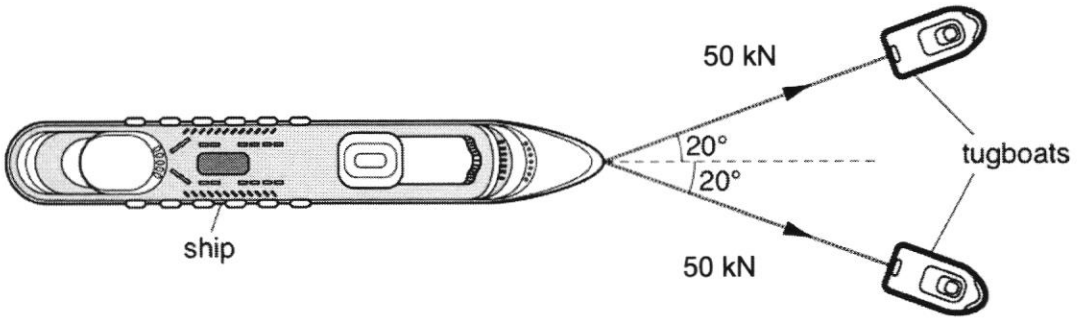


Fig. 22.1

Each of the tugboats exerts a force of 50 kN on the ship.

By drawing a vector diagram in the space below, determine the resultant of these two forces. State the scale used clearly.

scale = ...

resultant force = ... kN [4]

[Turn over

23 A vertical uniform tube of area of cross-section 0.25 cm^2 contains a column of liquid of length 12.4 cm as shown in Fig. 23.1.

The density of the liquid is 0.80 g/cm^3.

Calculate

(a) the mass of liquid in the tube,

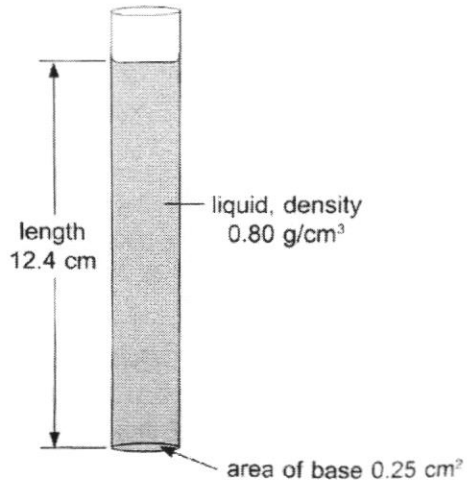


Fig. 23.1

mass = ... g [3]

(b) the weight of liquid in the tube (g = 10 N/kg)

weight = ... N [2]

(c) the pressure on the base of the tube due to the column of liquid.

pressure = ... N/cm^2 [2]

24 A uniform metre rule is pivoted at the 35 cm mark, as shown in Fig. 24.1.

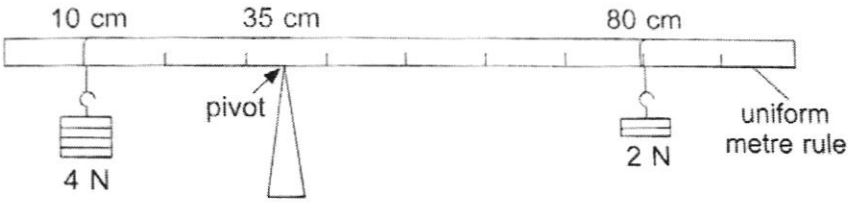


Fig 24.1

A weight of 4 N is suspended from the 10 cm mark. A weight of 2 N is suspended from the 80 cm mark so that the rule is balanced horizontally.

(a) On Fig. 24.1, draw an arrow to represent the weight of the metre rule. [1]

(b) Calculate the weight of the metre rule.

weight = ... N [2]

25 Fig. 25.1 shows two identical rectangular wooden blocks A and B. Block B has a layer of lead attached to its base.

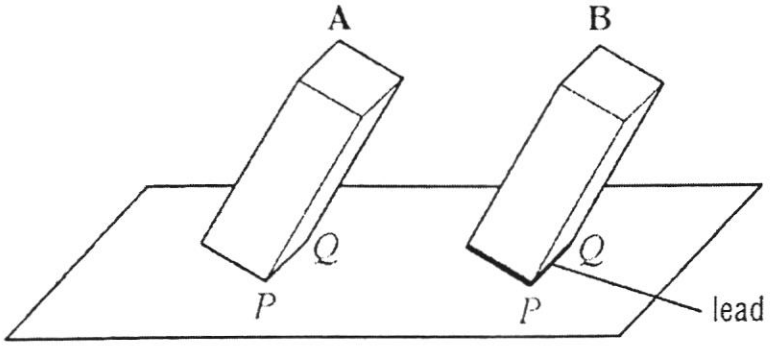


Fig. 25.1

[Turn over

The blocks were tilted about edges PQ as shown in Fig. 25.1. With the help of diagrams, explain why block A topples over at a smaller angle of tilt than block B.

.....

.....

.....

.....

..... [3]

26 A car of mass 1200 kg moves at 8 m/s.

(a) Calculate the kinetic energy of the car.

kinetic energy = ... J [2]

(b) The car's engine is switched off at the foot of a hill. Calculate the height the car could move up the hill before coming to rest, assuming there is no energy loss due to friction.

height = ... m [2]

(c) State the Principle of Conservation of Energy.

.....

.....

.....

..... [2]

27 A boy holds the loose end of a long rope which is fixed to a pole. He moves it up and down at a rate of 20 complete oscillations in every 50 seconds. Fig. 27.1 shows a section of the wave moving along the rope.

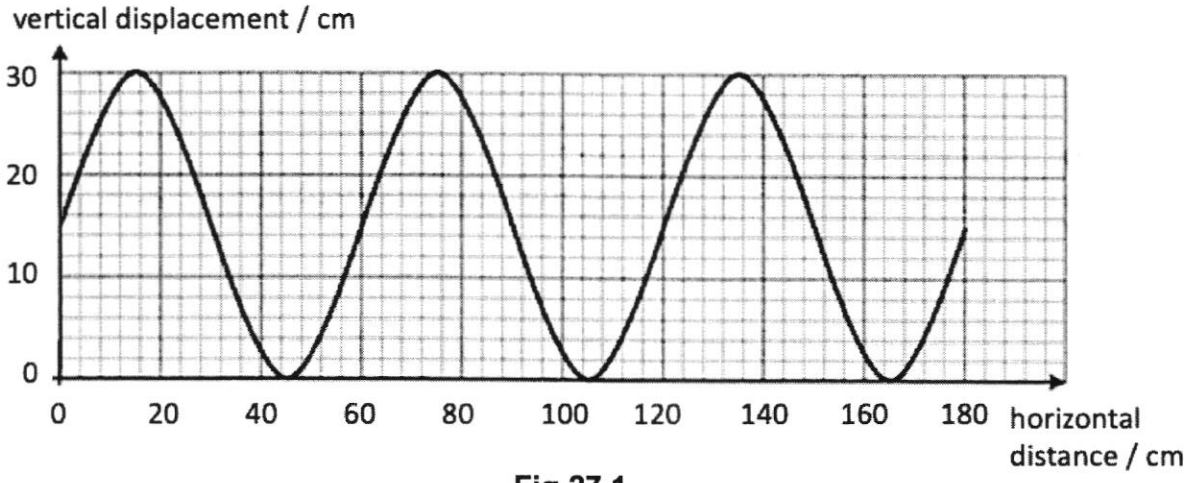


Fig 27.1

(a) Name the type of wave motion produced by the rope.

.....[1]

(b) State the amplitude of the wave.

amplitude = ... cm [1]

(c) Calculate the frequency of the wave.

frequency = ... Hz [1]

(d) Hence, calculate the speed of the wave in m/s.

[Turn over

speed = ... m/s [3]

28 Fig. 28.1 shows components in the electromagnetic spectrum.

gamma-ray			visible light	infra-red radiation	microwaves	radio waves

Fig. 28.1

(a) Two components have not been named.

Complete Fig. 28.1 by adding the names of these components in the correct order. [2]

(b) State the speed of these waves in a vacuum.

speed = ... m/s [1]

(c) State which of the components

(i) has the lowest frequency.

..... [1]

(ii) is used in satellite communications.

..... [1]

(iii) is used in intruder alarms.

..... [1]

29 Fig. 29.1 shows a tuning fork, which produces a sound wave in air when the prongs of the fork are hit and they vibrate with a frequency of 500 Hz.

Fig. 29.1

(a) What is the frequency of the sound wave produced?

frequency = ... Hz [1]

(b) **(i)** How does the vibration of the fork change as the sound becomes softer?

.....

..... [1]

(ii) State one feature of this sound wave which remains constant as the sound becomes softer.

.....

..... [1]

(c) State the range of frequencies that a healthy teenage should be able to hear.

.....[1]

(d) The speed of sound in air is 340 m/s. Calculate the wavelength of the sound wave.

wavelength = ... m [2]

Section C (20 marks)

Answer all questions in the spaces provided.

[Turn over

30 An object falls through the air from rest until it hits the ground. Fig. 30.1 shows how the speed of the object changes with time.

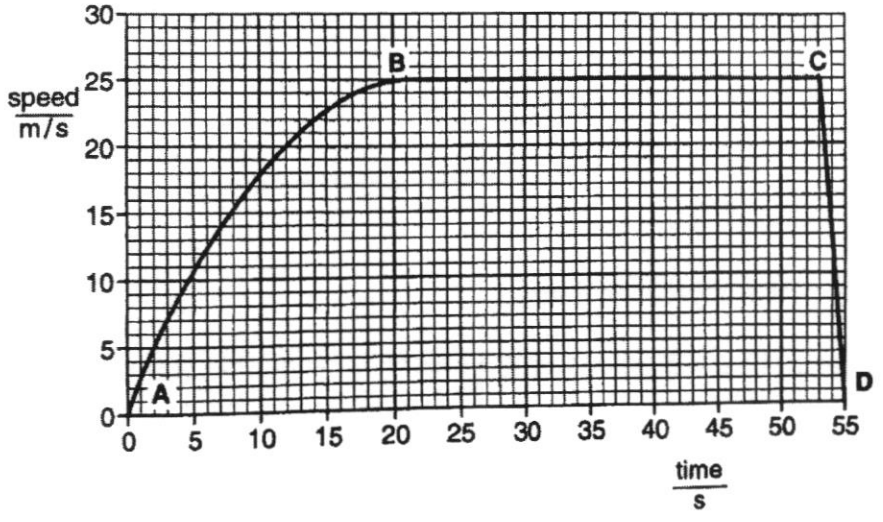


Fig. 30.1

(a) **(i)** State the magnitude of the acceleration of the object between points B and C.

acceleration = ... m/s^2 [1]

(ii) Describe the acceleration of the object as it falls between points A and B.

.....

..... [1]

(b) Use your answer to **(a)(i)** to explain how the weight of the object relates to the air resistance between points B and C.

.....

.....

..... [2]

(c) Use Fig. 30.1 to calculate the distance moved by the object between points B and C.

distance moved = ... m [2]

(d) The mass of the object is 5.0 kg.

(i) What is the acceleration of the object between points C and D?

acceleration = ... m/s^2 [2]

(ii) What is the braking force acting on the object between points C and D?

braking force = ... N [2]

31 Fig. 31.1 shows a light ray travelling in air, striking the curved surface of a semi-circular glass block at P. The light then travels in glass to Q. The refractive index of glass is 1.5.

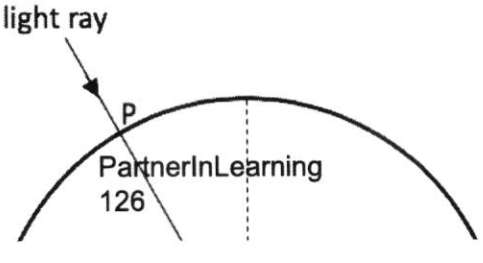


Fig. 31.1
(not drawn to scale)

(a) State why the light ray does not change direction when it enters the glass block at P.

.....

..... [1]

(b) The light ray strikes point Q at an angle of 60° as shown in Fig. 31.1.

(i) State the angle of incidence of the light ray at Q.

angle = ... ° [1]

(ii) Explain why and how the direction of light changes when the light ray emerges into the air at Q.

.....

.....

..... [2]

(iii) Determine the angle of refraction at Q of the emerging light ray.

angle = ... ° [2]

(iv) Hence, on Fig. 31.1, draw the emerging light ray at Q. [1]

(c) Another light ray strikes the semi-circular glass block at point R and travels to point Q at an angle of 30° as shown in Fig. 31.2.

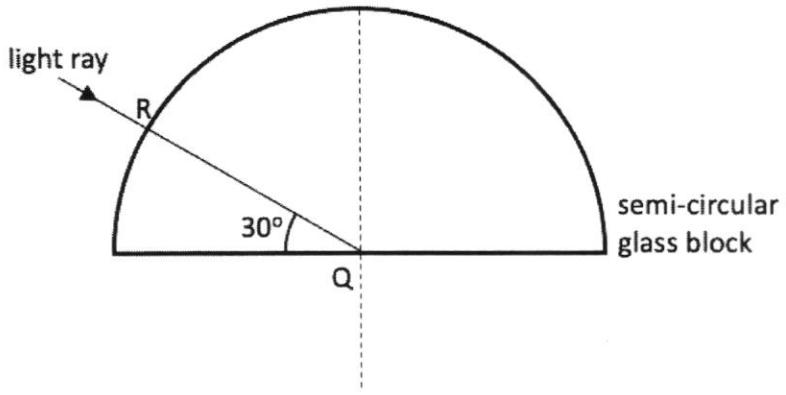


Fig. 31.2

Draw the path of the light ray as it emerges into the air.
Show your working clearly in the space given below. [3]

~ End of Paper ~

[Turn over

Deyi Sec End-of-Year Exam 2021
Sec 3E Sc(Physics) 5067/5077 – Answers

Section A MCQ

1	D	11	C
2	D	12	D
3	D	13	C
4	A	14	A
5	B	15	C
6	D	16	B
7	C	17	B
8	B	18	D
9	A	19	A
10	C	20	B

Section B

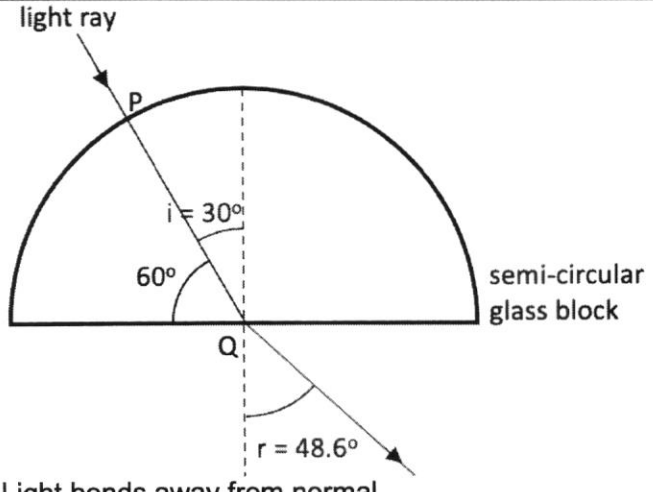
Note: -1 mark for sf error. Max of 1 mark.

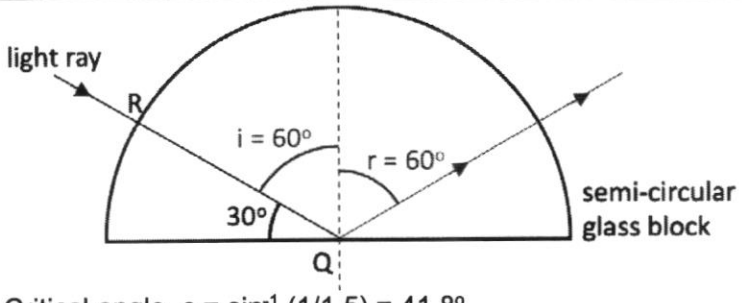
21a(i)	4.54 cm	1
(ii)	Thickness of one paper = 4.54 cm / 400 = 0.0114cm	1
b	Measure the thickness of the stack of papers at different positions and take average of the readings.	1
c	The measurement is out of range for a micrometer screw gauge.	1
22	Appropriate scale → 1 cm represent 10 kN Do not award mark if awkward scale used or diagram too small. Forces of 50kN and angle 20° are accurately drawn to scale and labelled Correct use of triangle or parallelogram method. Magnitude of ***R*** = 94 kN ± 1 kN (9.4 ± 0.1 cm)	1 1 1 1
23a	Volume = 12.4 x 0.25 = 3.1 Density = mass / volume 0.80 = mass / 3.1 mass = 2.48 g	1 1 1

b	W = mg = 0.00248 x 10 = 0.0248 N (allow ecf)	 1 1
c	Pressure = F/A = 0.0248 / 0.25 = 0.0992 g/cm^3 (allow ecf)	 1 1
24a	Correct arrow at the 50 cm mark.	1
b	By POM, Sum of anti-clockwise moments = sum of clockwise moments 4 x 25 = (W x 15) + (2 x 45) W = 0.667 N	 1 1
25	- Correct diagrams of blocks tilting (showing Block A at its toppling point) and with CGs at the approximate correct positions. - CG of Block B is lower. - A topples over at a smaller angle of tilt as <u>its CG falls outside its base</u> at a smaller angle.	1 1 1
26a	KE = ½ mv^2 = ½ x 1200 x 8^2 = 38 400 J	 1 1
b	KE = GPE 38400 = 1200 x 10 x h h = 3.2 m	 1 1
c	The Principle of Conservation of Energy states that energy cannot be created or destroyed, but can be converted from one form to another. (The total energy in an isolated system is constant.) – do we want to expect this statement?	 1 1
27a	Transverse wave	1
b	15 cm	1
c	Frequency = 20/50 = 0.40 Hz	 1
d	λ = 60 cm v = fλ = 0.4 x 0.6 = 0.24 m/s	1 1 1
28a	X-rays, ultraviolet (radiation)	1, 1
b	3 x 10^8 m/s	1
ci	radio waves	1
ii	microwaves	1
iii	infra-red (radiation)	1
29a	500 Hz	1
bi	The amplitude of the vibration decreases / the vibration become smaller.	1
ii	The pitch / frequency / speed / wavelength of the sound wave remains constant.	1
c	20 Hz to 20 kHz	1

d	$v = f\lambda$ $340 = 500\ \lambda$ $\lambda = 0.68$ m	 1 1

Section C

30ai	0	1
aii	The acceleration of the object is **decreasing**.	1
b	The weight and air resistance are equal. **Resultant force is zero** since acceleration is zero and **F= ma**.	1 1
c	distance = area under graph = (53 – 20) x 25 = 825 m	 1 1
di	acceleration b/w C and D = (25 – 0)/(53 – 55) = -12.5 m/s^2	1 1
ii	braking force = ma = 5 x 12.5 = 62.5 N (reject -62.5 N)	 1 1
31a	Angle of incidence at P = 0°	1
b(i)	Angle of incidence = 30°	1
(ii)	Change in optical medium / refractive index / speed of light Emerging light refracts / emerges at Q and bends away from the normal.	1 1
(iii)	n = sin r / sin i 1.5 = sin r / sin 30° r = 48.6°	 1 1
(iv)	 Light bends away from normal. Need not draw to scale. Angle 48.6° need not be stated.	1

c	 Critical angle, c = $\sin^{-1}$ (1/1.5) = 41.8° Total internal reflection at Q with r = i = 60° No change in direction as reflected ray emerges into air	 1 1 1

4