East Spring Secondary School

Towards Excellence and Success

Name: ..... ( )

Class: .....

First Semestral Assessment 2019
Secondary 4 Express

PHYSICS **6091**

Thursday **2 hours**
16 MAY 2019 **0830 – 1030**

Additional materials:
OTAS

INSTRUCTIONS TO CANDIDATES

Write your name, class and register number in the spaces provided above, and on all the work you hand in.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams, graphs, tables or rough working.

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

Calculators are allowed.

Section A [20 marks]
Answer **all** questions in soft pencil on the OTAS.

Section B [50 marks]
Answer **all** questions on the question paper.

Section C [20 marks]
Answer **any two** questions on the question paper.

At the end of the examination, hand in the OTAS separately.

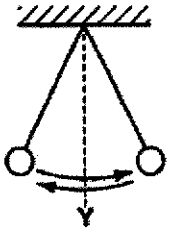
The number of marks is given in brackets [ ] at the end of each question or part question. Staple any used graph paper with the question paper.

Section	Marks
A	/20
B	/50
C	/20
Total	/90

This question booklet consists of **23** printed pages including the cover page.

Section A [20 Marks]
Answer **ALL** questions in soft pencil on the OTAS.

A1 A pendulum swings backwards and forwards passing through **Y**, the middle point of the oscillation.

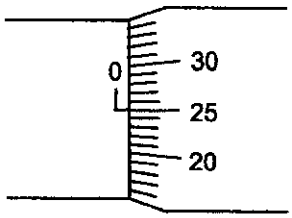


The first time the pendulum passes through **Y**, a stopwatch is started. The twenty-first time the pendulum passes through **Y**, the stopwatch is stopped. The reading is T.

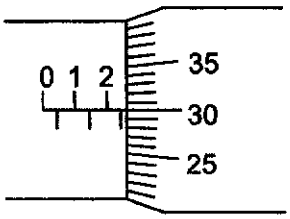
What is the period of the pendulum?

A T/10 **B** T/20 **C** T/21 **D** T/40

A2 A micrometer screw gauge is used to measure the thickness of a sheet of glass. The readings on the micrometer screw gauge are shown below.



Zero Error

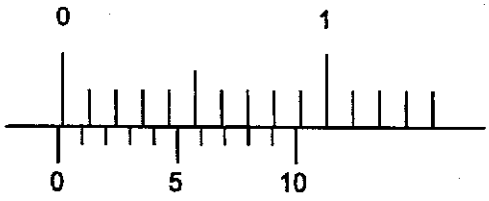


Actual Reading

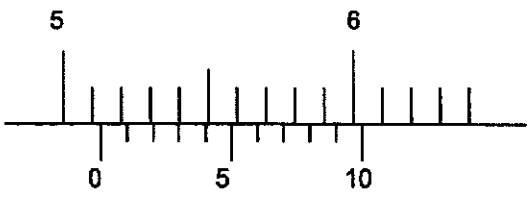
What is the thickness of the sheet of glass?

A 2.05 mm **B** 2.55 mm **C** 2.80 mm **D** 3.05 mm

A3 A vernier calliper is used to measure the thickness of a stack of paper. The readings on the vernier calliper are shown below.



Zero Error



Actual Reading

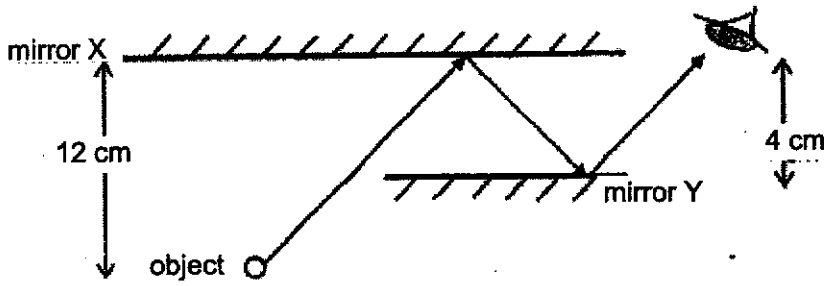
What is the thickness of the stack of paper?

A 5.05 mm **B** 5.11 mm **C** 5.15 mm **D** 5.21 mm

A4 Which of the following unit conversions is correct?

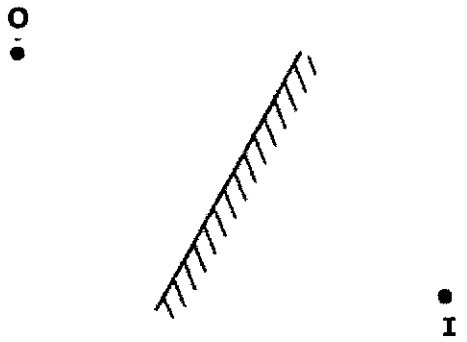
A	4 ng = 4000 μg	**C**	500 mm = 5 m
B	6000 μs = 6 ms	**D**	9000 Ms = 9 ks

A5 The diagram below shows how a ray of light from an object **O** enters the eye after being reflected twice. Using the data given in the diagram, find the distance of the final image of **O** from the mirror **X**.

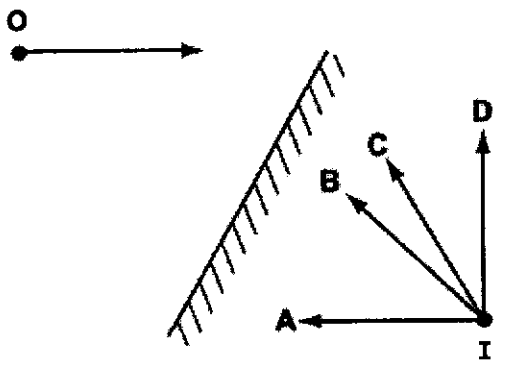


A 8 cm **B** 12 cm **C** 16 cm **D** 20 cm

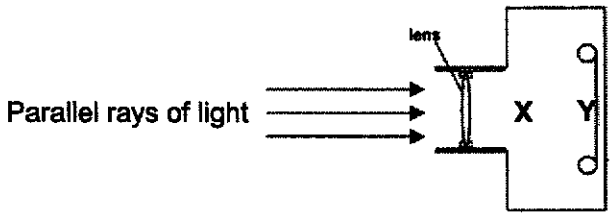
A6 An object placed in front of a plane mirror at **O** produces an image at **I**.



If the object moves towards the mirror in the direction shown by the arrow, in which direction does the image move?



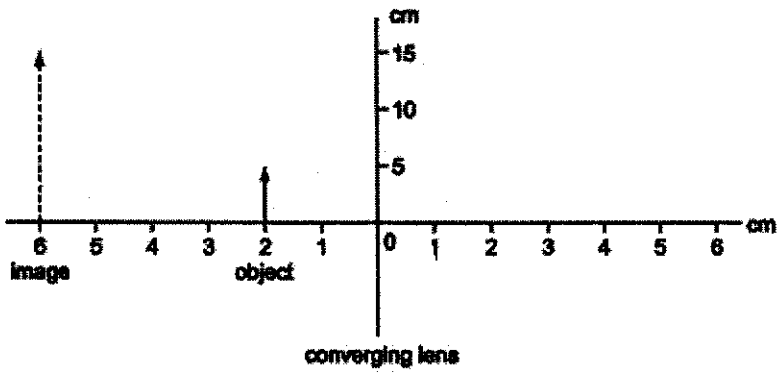
A7 A camera has a lens that causes parallel rays of light to converge at point **X** as shown.



Which of the following would allow the light to converge at point **Y**?

A Replacing the lens with another one with lower refractive index.
B Replacing the lens with another one with higher refractive index.
C Moving the entire camera forward.
D Moving the entire camera backward.

A8 An object of 5.0 cm high is placed 2.0 cm from a converging lens. The image produced is 6.0 cm from the lens and is 15 cm high.

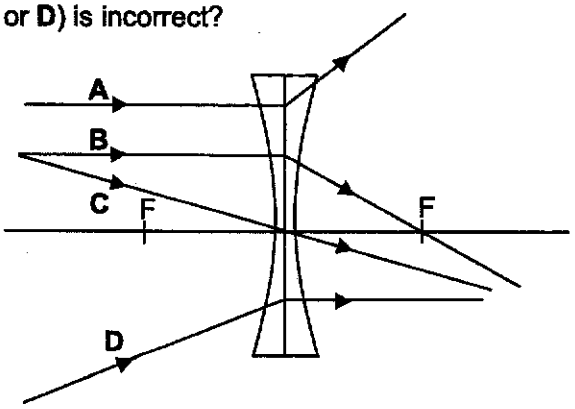


What is the focal length of the lens?

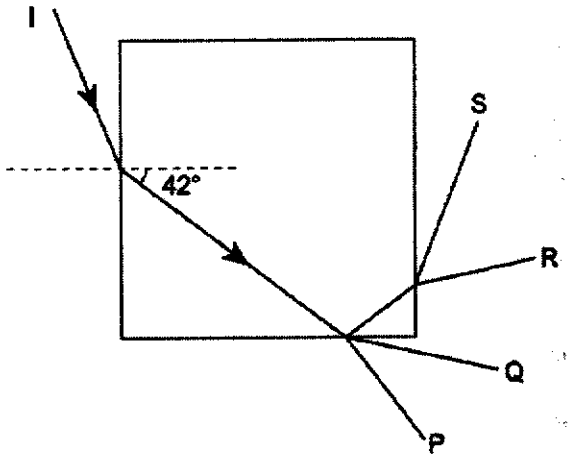
A 2.0 cm **B** 3.0 cm **C** 4.0 cm **D** 6.0 cm

A9 Four different rays are passing through a diverging lens as shown in the diagram below.

Which ray (**A**, **B**, **C** or **D**) is incorrect?

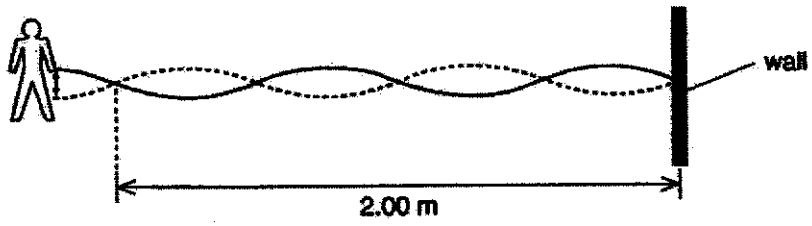


A10 Which of the following rays correctly shows the path of I through a glass block with critical angle 45°?



A P B Q C R D S

A11 The diagram shows waves set up in a rope by a student moving the free end up and down at a steady rate.



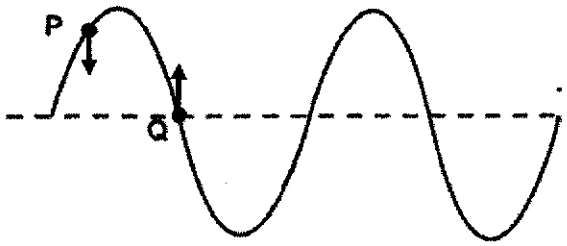
What is the wavelength of the waves shown, and what will be the wavelength when the student doubles the frequency at which the free end is moved up and down?

	wavelength as shown	wavelength when frequency doubled
A	0.50 m	1.00 m
B	0.50 m	0.50 m
C	1.00 m	1.00 m
D	1.00 m	0.50 m

A12 How do the speed and the wavelength of red light in vacuum compare with the speed and wavelength of violet light in vacuum?

	speed of red light	wavelength of red light
A	greater than violet light	greater than violet light
B	greater than violet light	less than violet light
C	same as violet light	greater than violet light
D	same as violet light	less than violet light

A13 The diagram shows the direction of two particles on a wave at P and Q at this instant.



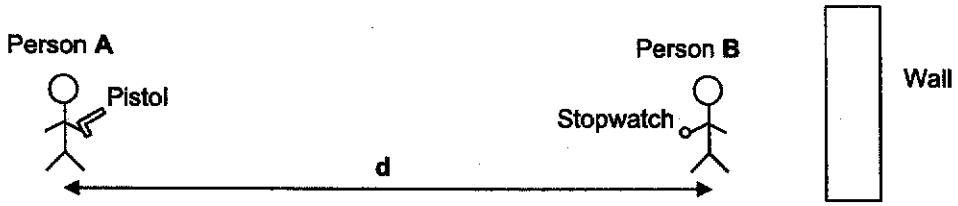
In which direction is the wave moving?

A up **B** down **C** left **D** right

A14 Which of the following frequency of sound cannot be heard by humans?

A 19 Hz **B** 190 Hz
C 1900 Hz **D** 19,000 Hz

A15 In an experiment to determine the speed of sound, person **B** wants to measure the time taken for the sound to travel a distance d.



When should person **B** start and stop the stopwatch?

	Start the stopwatch when he	Stop the stopwatch when he
A	sees the light from the pistol	hears the echo from the wall
B	sees the light from the pistol	hears the sound from the pistol
C	hears the sound from the pistol	hears the echo from the wall
D	hears the sound from the pistol	sees the light from the pistol

A16 A man stands between 2 upright, vertical walls with smooth surface. When he claps his hands once, he hears the first two echoes 0.4 s and 0.8 s later.

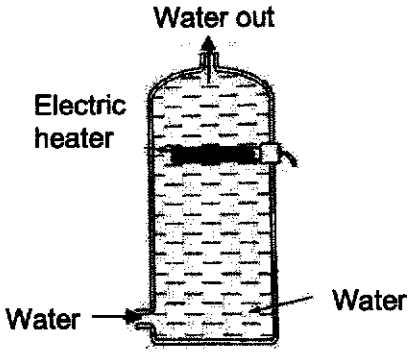
If the speed of sound in air is 340 m/s, what is the distance between the walls?

A 68 m **B** 136 m **C** 204 m **D** 408 m

A17 The temperature of a fixed mass of gas increases while the volume is kept at constant. How do the properties of the gas particles change?

	Average speed	Frequency of collision with walls of container	Average distance between particles
A	constant	increases	decreases
B	increases	constant	decreases
C	increases	increases	constant
D	increases	increases	increases

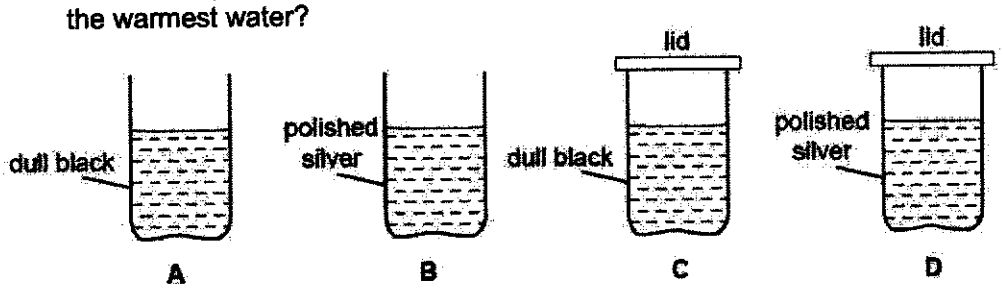
A18 An electric heater is placed in a water tank in a position as shown below.



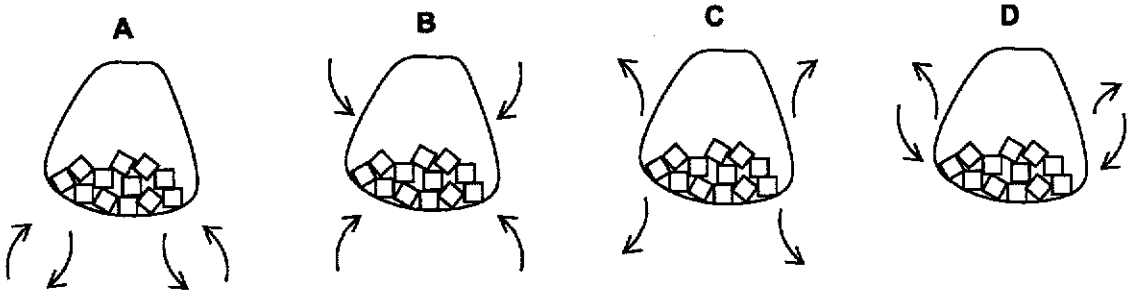
Water at the bottom of the tank stays cold for some time. Why is this so?

A Heat transfers slowly from the heater to bottom by radiation.
B Heat transfers slowly from the heater to bottom by conduction.
C During convection, cold water sinks to the bottom.
D Heat is unable to transfer from the heater to the bottom.

A19 The diagram shows four similar cans. Each can contains the same volume of water initially at 80 °C. After five minutes, which can (**A**, **B**, **C** or **D**) will contain the warmest water?



A20 Which of the following shows the movement of air caused by the bag of ice?



- End of Section A -

Section B [50 marks]

Answer all questions.

Write your answers in the spaces provided on the question paper.

B1 A student measures the time taken for a pendulum to complete 20 oscillations and records it as t_1. He repeats the experiment twice and records the time taken as t_2 and t_3.

The student then measures t_1, t_2 and t_3 using different lengths of pendulum. The results are shown in Fig. B1.1.

Length / cm	t_1 /s	t_2 /s	t_3 /s
20.0	10.92	10.82	11.00
30.0	11.31	11.60	11.44
40.0	12.11	11.90	12.05

Fig. B1.1

(a) Calculate the period of the pendulum for the length 30.0 cm.

Period = ... [2]

(b) The student changes the pendulum to another one with twice the mass and adjust the length to be 40.0 cm. He sets the pendulum in oscillation and measures the time taken for 20 oscillation.

Estimate the time taken for the pendulum to complete 20 oscillation.

..... [1]

(c) Explain why it is not advisable to determine the period of the pendulum by measuring the time taken for

(i) 2 oscillations.

.....

..... [1]

(ii) 40 oscillations.

.....

..... [1]

[Total: 5 marks]

B2 Fig. B2.1 shows a ray of light **PQRS** as it enters and leaves a semi-circular glass block which has a refractive index of 1.54.

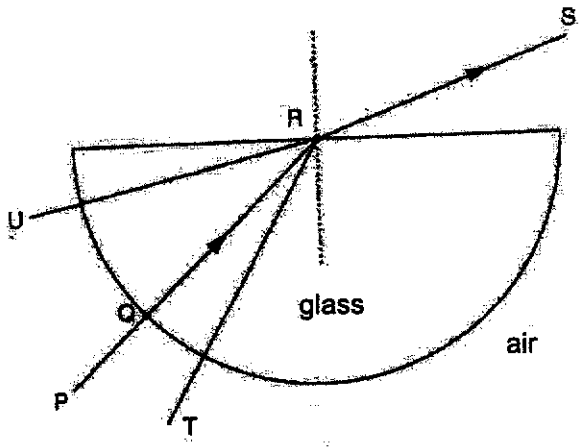


Fig. B2.1

The speed of light in air is assumed to be the same as the speed of light in vacuum.

(a) Explain why there is no change in the direction of the ray as it enters the block at **Q**.

.....

..... [1]

(b) Calculate the critical angle of the glass block.

Critical angle = ... [2]

(c) The ray **UR** is incident at point **R** with an angle equals to the critical angle. On Fig. B2.1, label the critical angle with the letter C. [1]

(d) Another ray passes along **TR**. On Fig. B2.1, draw this ray as it leaves the block at **R**. [1]

[Total: 5 marks]

B3 Fig. B3.1 shows a girl standing in front of a shop window made of thick glass. She sees the reflection of her shoes in surface **A**.

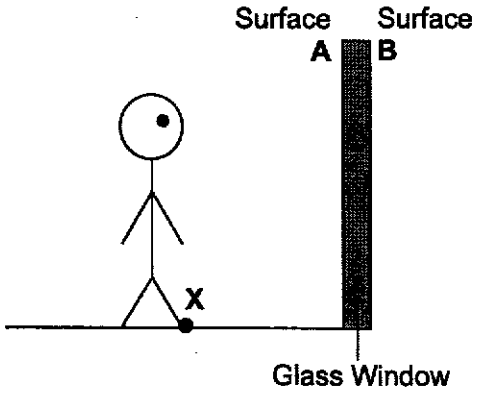


Fig. B3.1

(a) On Fig. B3.1, show how the girl sees the image of her shoes on surface **A** by drawing a ray of light from point **X**. [2]

(b) Fig. B3.2 shows a ray of light in air that is incident on surface **A** of the glass window. Some of the light is reflected by surface **A**. Most of the light refracts into the glass.

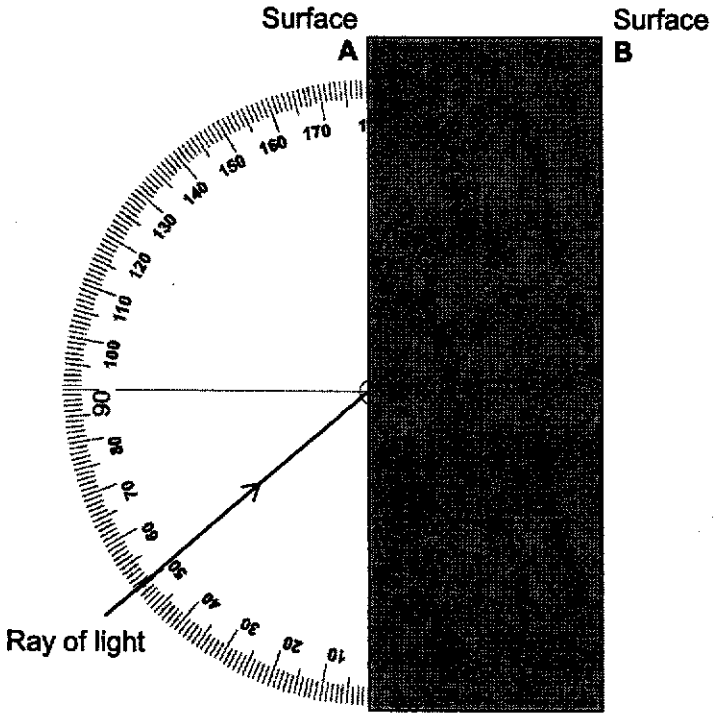


Fig. B3.2

Complete the path of the light ray in Fig. B3.2 until it emerges on the other side of the glass window. [1]

(c) The ray in Fig. B3.2 refracts at surface **A** with an angle of refraction of 25.4°.

(i) Define the term *angle of refraction*.

..... [1]

(ii) Calculate the refractive index of the glass.

Refractive Index = ... [2]

(d) It is not possible for the ray of light to undergo total internal reflection at either surface **A** or surface **B**.

(i) Explain why the ray of light cannot be totally internally reflected at surface **A**.

.....

..... [1]

(ii) Explain why the ray of light that enters the glass through surface **A** cannot be totally internally reflected at surface **B**.

.....

..... [1]

[Total: 8 marks]

B4 Fig. B4.1 shows a converging lens and an object. Three rays are shown from the top of the object and one of the rays crosses the focal point.

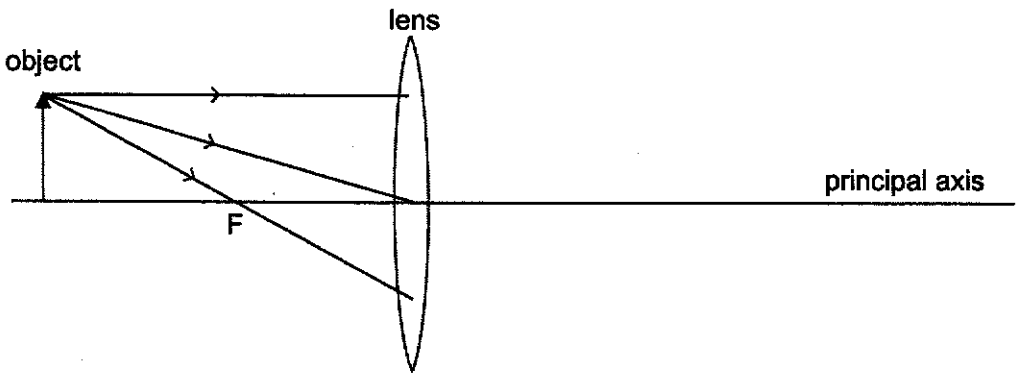


Fig. B4.1

(a) Complete Fig. B4.1 and show how the three rays produces an image. [2]

(b) Define the term *focal length* of a converging lens.

..... [1]

(c) The object is shifted to a new position such that the image formed becomes real and larger than the object.

Describe the new position of the object, in terms of the focal length of the lens.

..... [1]

(d) The object is shifted until it is at a distance lesser than a focal length away from the lens.

State three characteristics of the image formed by the lens.

1. .....

2. .....

3. ..... [1]

[Total: 5 marks]

B5 A vibrating dipper is generating some water waves in a tank as shown in Fig. B5.1.

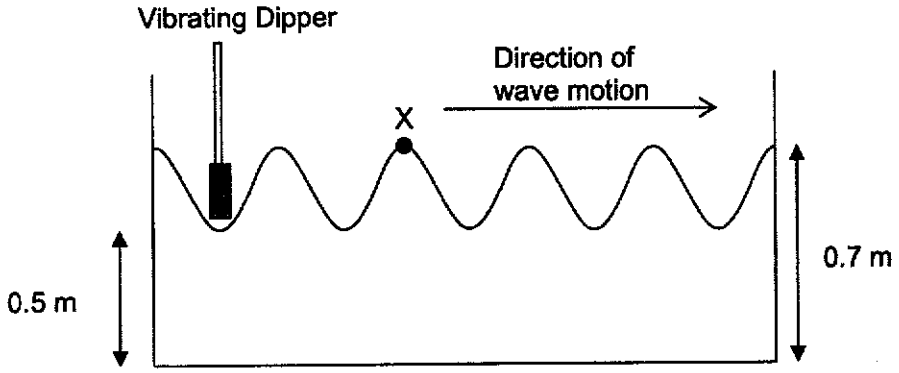


Fig. B5.1

(a) Define the term *transverse wave*.

.....

..... [1]

(b) Describe the movement of point **X** during the next half cycle of the wave.

.....

..... [1]

(c) Calculate the amplitude of the wave.

Amplitude = ... [1]

(d) Fig. B5.2 shows the tank when viewed from above.

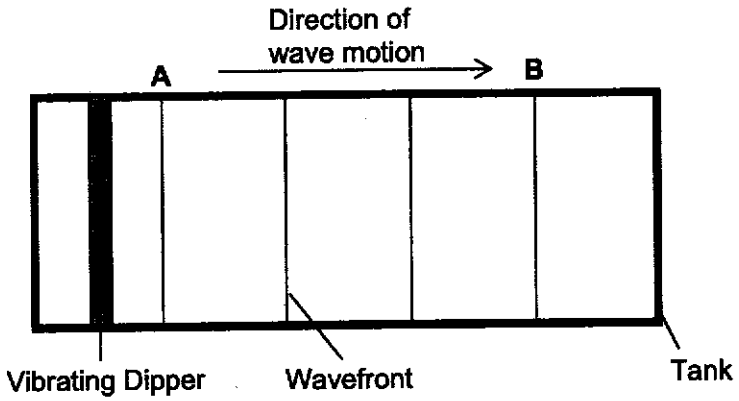


Fig. B5.2

(i) Define the term *wavefront*.

.....

..... [1]

(ii) In Fig. B5.2, the distance between **A** to **B** is 9 cm.

1. Calculate the wavelength of the wave.

Wavelength = ... [1]

2. Calculate the frequency of the wave given that the speed is 0.3 m/s.

Frequency = ... [2]

(e) A triangular metal block is lowered into the water tank to create a region of shallow water. This results in a wavefront pattern as shown in Fig. B5.3.

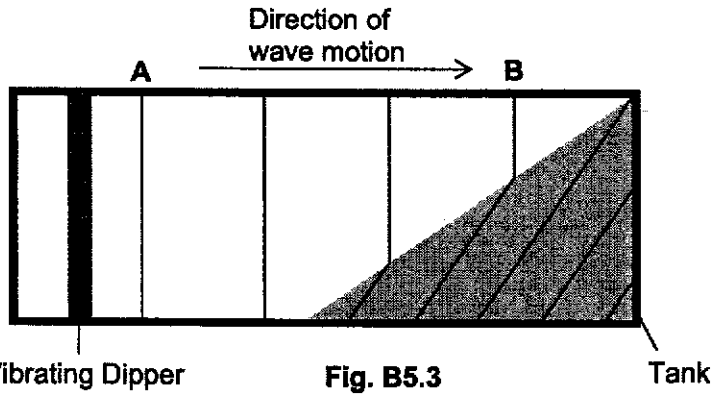


Fig. B5.3

Describe how the speed, frequency and wavelength of the wave changes when it enters the shallow water.

speed: .....

frequency:.....

wavelength: ..... [1]

[Total: 8 marks]

B6 Light, microwaves, ultraviolet and infra-red are different types of radiation in the electromagnetic spectrum.

(a) Write down the names of these types of radiation in each of the boxes, placing them in order of increasing frequency in Fig. B6.1. [1]

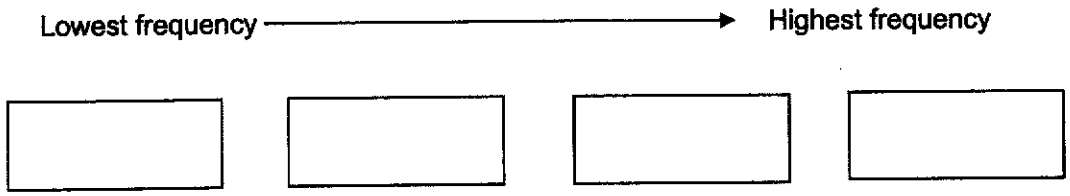


Fig. B6.1

(b) State one use for the following;

mircowaves, ... [1]

infra-red waves, ... [1]

ultraviolet waves. ..... [1]

(c) Both light and sound are waves.

(i) State one difference, other than their speeds, between sound and light.

.....

..... [1]

(ii) Light travels faster in air than in glass, but sound travels faster in glass than in air.

Using idea about molecules, explain why sound travels faster in glass than in air.

.....

.....

.....

..... [2]

[Total: 7 marks]

B7 A sound wave in air is shown in Fig. B7.1. **A**, **B**, **C** and **D** are at the centres of regions of compression of the wave. The wave is moving to the right.

Fig. B7.1

(a) Describe how the distance between the air layers at **B** will change when the sound wave passes through them.

.....

..... [1]

(b) The sound wave in Fig. B7.1 has a frequency 2000 Hz and a wavelength of 0.3 m.

(i) Calculate the distance between **A** and **D**.

distance = ... [1]

(ii) Calculate the period of the wave in ms.

period = ... ms [2]

(c) When t = 0 s, the position of the compression is at **A**. On Fig. B7.1, mark, with a cross, the new position of the compression at **A** after 1.0 ms. [1]

(d) The sound wave enters a microphone that is connected to a cathode ray oscilloscope. The waveform displayed is shown in Fig. B7.2.

On Fig. B7.3, draw the waveform for a sound that is softer and high pitched. [2]

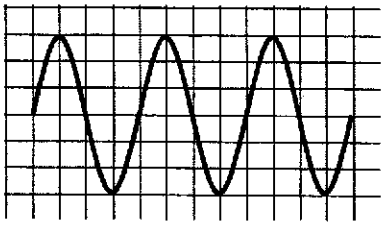


Fig. B7.2

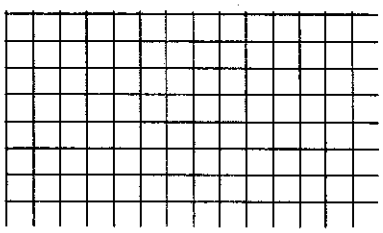


Fig. B7.3

[Total: 7 marks]

B8 In a Brownian motion experiment, particles of smoke are introduced into a container of air. A microscope is used to view the smoke particles. Fig. B8.1 shows the path of a smoke particle.

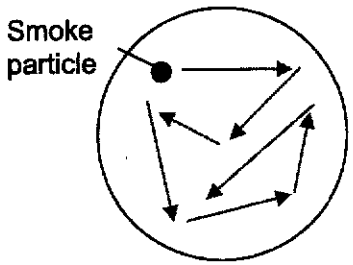


Fig. B8.1

(a) Explain, in terms of movement of molecules, why the smoke particle moves in a manner shown in Fig. B8.1.

.....

.....

.....

..... [2]

(b) The mass of an air molecule is very small. The pressure created inside the container is very high.

Explain, in terms of movement of molecules,

(i) how the air molecules create a pressure inside the container.

.....

.....

.....

..... [2]

(ii) why the pressure inside the container increases if volume of the container is reduced at constant temperature.

.....

..... [1]

- End of Section B – [Total: 5 marks]

Section C [20 marks]

Answer **all** the questions in this section.
Answer only one of the two alternative questions in C2.

C1 Fig. C1.1 shows an optical fibre with a glass of uniform refractive index.

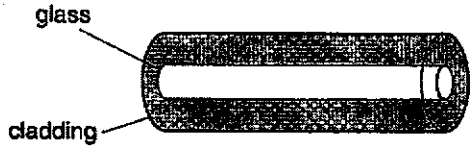


Fig. C1.1

Fig. C1.2 shows three rays of light entering the fibre from air. Each of these rays follows one of the three possible paths through the fibre.

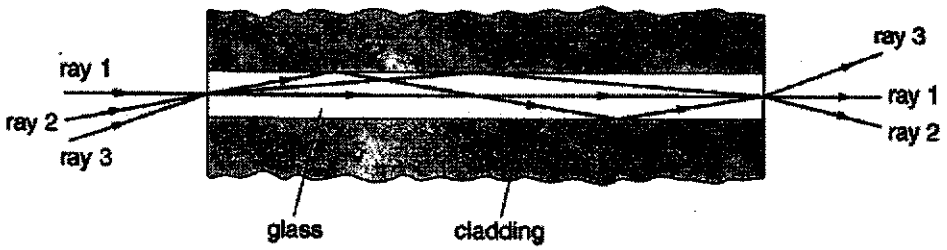


Fig. C1.2

The three rays travel different distances and take different times to pass through the fibre. Fig. C1.3 gives information about the three rays and their paths in two cables of lengths 5 km and 10 km.

	angle of incidence on entry/^{0}	angle of refraction on entry/^{0}	distance covered in 5 km cable/m	time spent in 5 km cable/μs	distance covered in 10 km cable/m	time spent in 10 km cable/μs
ray 1	0	0	5000	25.0	10000	50.0
ray 2	20	13	5135	25.5	10270	51.5
ray 3	α	22.5	5140	27.0	10820	54.0

Fig. C1.3

(a) Using data for ray 1 from Fig. C1.3, calculate the refractive index of the glass. The speed of light in air is assumed to be the same as the speed in vacuum.

Refractive Index = ... [3]

(b) Calculate the angle of incidence α for ray 3.

Angle of incidence = ... [2]

(c) Explain why ray 3 spend the longest time in the 10 km optical fibre among the 3 rays.

.....

..... [1]

(d) State whether the refractive index of the cladding in Fig. C1.2 should be higher or lower than the refractive index of glass. Explain your answer.

.....

.....

..... [2]

(e) At time t = 0 μs, ray 1, 2 and 3 enters the optical fibre.

Fig. C1.4 shows the brightness of the rays when they leave the 10 km optical fibre.

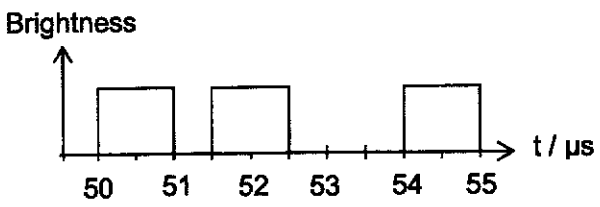


Fig. C1.4

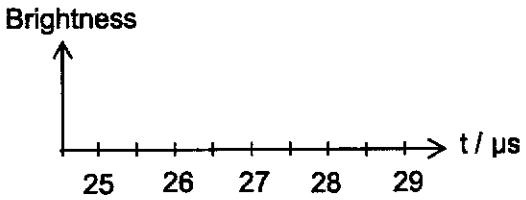


Fig. C1.5

On Fig. C1.5, sketch the graph to show the brightness of the rays when they leave the 5 km optical fibre. [1]

(f) State an advantage of using light in optical fibres to transmit data as compared to using electricity in copper wires.

.....

..... [1]

[Total: 10 marks]

C2 Either

A filament lamp is shown in Fig. C2.1.

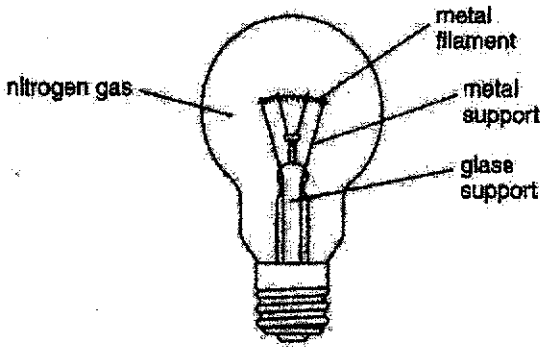


Fig. C2.1

The filament lamp emits electromagnetic radiation with a range of wavelengths. Fig. C2.2 shows the energy emitted per second at each wavelength.

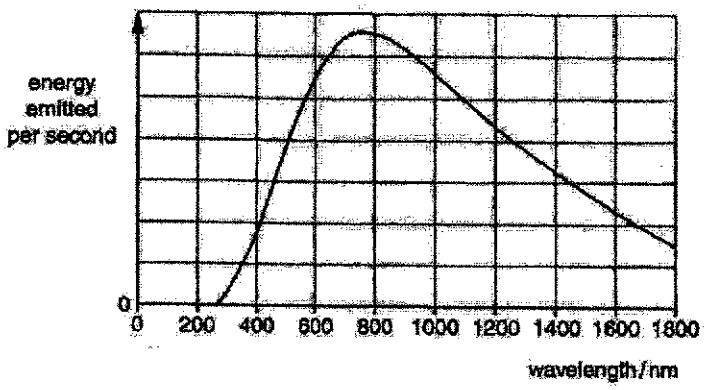


Fig. C2.2

The wavelength of visible light is between 400 nm to 700 nm.

(a) Using information from Fig. C2.2, state the two other electromagnetic waves which are emitted by the filament other than visible light.

1. .....

2. ..... [2]

(b) The current in the lamp is reduced. The colour of the filament changes from white to red. Describe the changes in the total energy and the average wavelength of radiation emitted by the lamp.

.....

.....

..... [2]

(c) The filament lamp loses thermal energy by conduction, convection and radiation.

(i) Describe how energy is lost quickly from the metal filament to the metal support.

.....

.....

.....

.....

..... [3]

(ii) Describe how the nitrogen gas is heated inside the lamp.

.....

.....

.....

.....

..... [3]

[Total: 10 marks]

C2 OR

Fig. C2.3 shows the inside of a refrigerator.

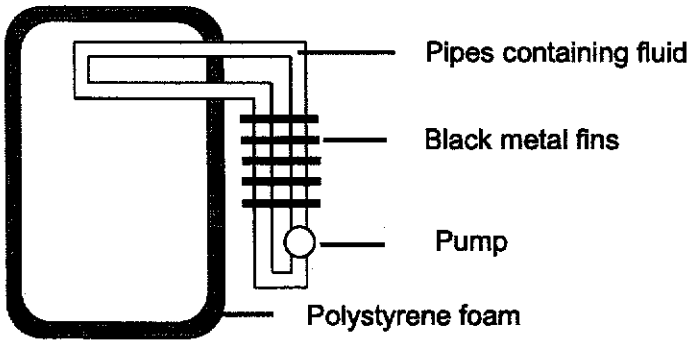


Fig. C2.3

A fluid pumped through the pipes takes thermal energy (heat) away from the top part of the refrigerator. The energy is passed into the air at the back of the refrigerator through the black metal fins.

(a) Explain how the air inside the refrigerator is kept cool by the pipes at the top of the refrigerator

.....

.....

.....

.....

..... [3]

(b) Explain three features of the fins that allow thermal energy to be transferred easily to the air at the back of the refrigerator.

.....

.....

.....

.....

.....

..... [3]

(c) Explain how the layer of polystyrene foam helps to keep the contents of the refrigerator cool.

.....

..... [1]

(d) The fluid inside the pipe is in a liquid state.

(i) Describe the motion of the molecules in a liquid.

.....

.....

..... [2]

(ii) Describe an experiment to provide evidence that the molecules in a liquid are moving.

.....

..... [1]

[Total: 10 marks]

- End of Paper -

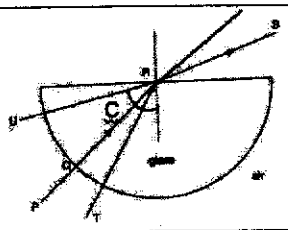
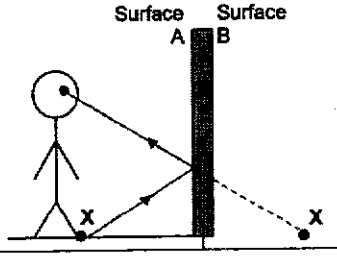
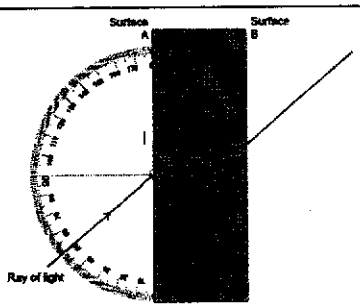
2019 Sec 3 Exp Physics 1SE

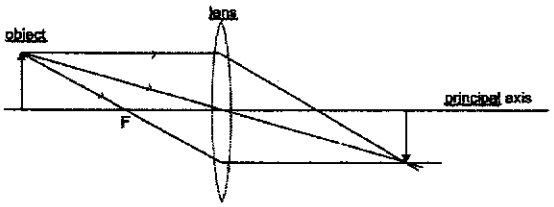
Section A [1 mark each; 20 marks in total]

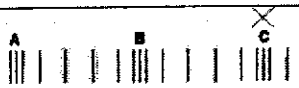
Qn	1	2	3	4	5	6	7	8	9	10
Ans	A	B	C	B	D	C	A	B	B	D

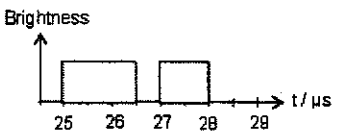
Qn	11	12	13	14	15	16	17	18	19	20
Ans	D	C	D	A	B	C	C	B	D	A

Section B [50 marks in total]

Qn	Answer	Mark
B1a	t_{ave} = (11.31 + 11.6 + 11.44) / 3 = 11.45 s T = 11.45 / 20 = 0.573 s	1 1
B1b	Accept any answer betweeen 11.90 s to 12.11 s	1
B1ci	The **human reaction time would be not be reduced** significantly as the average is for 2 oscillations.	1
B1cii	The **pendulum would lose energy as it swings** and the oscillation would become smaller, causing the time measured to be inaccurate.	1
B2a	The light is travelling along the normal OR The angle of incidence is 0°	1
B2b	c = $\sin^{-1}(\frac{1}{1.54})$ = 40.5°	1 1
B2c **B2d**		1 1
B3a **B3b**	Image of X is drawn [1 mark] Reflected ray drawn. [1 mark]   [1 mark]	3

B3ci	It is the angle between the normal and refracted ray	1
B3cii	$n = \frac{\sin(40)}{\sin(25.4)}$ = 1.50	1 1
B3di	The light is travelling from an optically less dense to a denser medium.	1
B3dii	The angle of incidence at surface B is smaller than the critical angle.	1
B4a	3 rays drawn [1 mark] image drawn. [1 mark] 	2
B4b	It is the distance between the focal point and the optical centre.	1
B4c	The object should be between the focal length and two times the focal length.	1
B4d	Virtual, Upright, Bigger than object	1
B5a	The wave move in a direction which is **perpendicular** to the direction of vibration of the particles in the wave.	1
B5b	Point X will move down to the lowest point OR trough of the wave.	1
B5c	Amplitude = (0.7-0.5)/2 = 0.1 m	1
B5di	It is an imaginary line which joins all the points that are in phase.	1
B5dii	1. 9/3 = 3 cm 2. f = v/λ = 0.3 / 0.03 = 10 Hz	1 1 1
B5e	Speed decrease Frequency remain the same Wavelength decrease	1
B6a	Microwaves, Infra-red, Light, Ultraviolet	1
B6b	Microwaves: Satellite communications Infra-red: Remote controls Ultra-violet: Sunbed	1 1 1
B6ci	Sound is a longitudinal wave but light is a transverse wave.	1

B6cii	The **molecules in glass are more closely packed** than molecules in air. Hence sound travel faster in glass because it is **easier to transfer the energy from one particle to another through vibrations**.	1 1
B7a	The distance between the air layers will increase and decrease continuously.	1
B7bi	0.3 x 3 = 0.9 m	1
B7bii	T = 1 / f = 1 / 2000 = 0.0005 s = 0.5 ms	 1 1
B7c		1
B7d	lower amplitude [1 mark] higher frequency [1 mark] 	2
B8a	The **air particles** are moving in a **constant and random motion**. The air particles will **collide with the smoke particle at different directions and with different force**, causing the smoke to move in a random manner.	1 1
B8bi	The air particles which are moving randomly will **collides with the walls of container and exert a force**. The **force exerted by the air particles per unit area** will give rise to pressure in the container.	1 1
B8bii	When the volume is reduced, the air particles will **collide more frequently with the walls of the container**.	1
C1a	Speed in glass = 10000/ (50×10^{-6}) = 2×10^{8} m/s Refractive index = $3 \times 10^{8} / 2 \times 10^{8}$ = 1.5	1 1 1
C1b	1.5 = sin α / sin 22.5 sin α = 1.5 x sin 22.5 α = $\sin^{-1}$(1.5 x sin 22.5) = 35.0°	1 1
C1c	Ray 3 spends the longest time because travels a longer distance since it **undergoes the most number of total internal reflection**.	1

C1d	Lower. This will **allow total internal reflection to occur as the light will travel from an optically denser to less dense medium.**	1 1
C1e		1
C1f	There is less signal interference when using light as compared to electricity.	1
EITHER		
C2a	Infra-red and Ultraviolet	2
C2b	The total energy will decrease. The average wavelength will increase.	1 1
C2ci	Energy is transferred from the metal filament to the metal support by **conduction**. When the **particles** in the metal filament are heated, they **vibrate and collide with their neighbours**, transferring energy from one particle to another until the cooler ends of the metal. When the **free electrons** in the filament are heated, they will **spread to the cooler ends of the metal and collide with the particles** there, transfering energy to them.	1 1 1
C2cii	When the nitrogen gas near the metal filamet is heated up, it **expands**, becomes **less dense and rises**. The cooler nitrogen gas at the top is **denser and sinks** to replace the nitrogen gas that rose. The cycle repeats and a **convection current is formed** to heat the gas.	1 1 1
OR		
C2a	When the air near the pipes at the top is cooled, it **contracts**, becomes **denser and sinks**. The warmer air at the bottom is **less dense and rises** to replace the air that sank. The cycle repeats and a **convection current is formed** to cool the air in the refrigerator.	1 1 1
C2b	The fins are made of metal which is a **good conductor of heat**. This helps to **conduct heat quickly** to the air outside. The fins are painted black which is a **good emitter of heat**. This helps to **radiate heat quickly** to the air outside. The fins are spaced apart to **increase surface area**. This helps to **radiate heat quickly** to the air outside.	3

C2c	It is a **poor conductor of heat** and **slows down** the **heat conducted** from **outside** the refrigerator **to** the air **inside**.	1
C2di	The liquid molecules are **sliding past each other.** The liquid molecules are in a **constant and random motion.**	1 1
C2dii	Sprinkle some **pollen grains on the water enclosed** in a glass **container.**	1