Candidate Name	Class	Register Number
_____		

PEIRCE SECONDARY SCHOOL

Department of Science

Second Semestral Examination for Secondary Three Express

PHYSICS **5059**

Wednesday **12 October 2016** **0800 – 1000**
Additional Material:
OTAS Answer Sheet

Time: 2 hours

INSTRUCTIONS TO CANDIDATES
Write your name, class and register number in the spaces provided at the top of this page and on the separate OTAS Answer Sheet.

Section A: Multiple Choice (30 marks)
There are thirty multiple choice questions in this section.
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 answer in the OTAS provided.
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Section B: Structured Questions (40 marks)
Answer **all** questions. Write your answers in the spaces provided on the Question Paper.

Section C: Free Response Questions (30 marks)
Answer **all** questions. Write your answers in the spaces provided on the Question Paper.
The number of marks is given in brackets [ ] at the end of each question or part question.

FOR EXAMINER'S USE	
Section A	/ 30
Section B	/ 40
Section C	/ 30
TOTAL	/ 100

PARENT'S SIGNATURE

This paper consists of **25** printed pages.

Setter: Miss Chua Soh Ann

Section A: Multiple Choice (30 marks)

Answer **all** the questions in the OTAS Answer Sheet provided.

1 Which of the following is a suitable estimate for the radius of the Earth?

A 6 nm **B** 6 μm **C** 6 Mm **D** 6 Gm

2 Fig. 2.1 shows the reading of a pair of vernier calipers when its jaws are totally closed. Fig. 2.2 shows the reading on the same pair of vernier calipers when it measures the diameter of a rod.

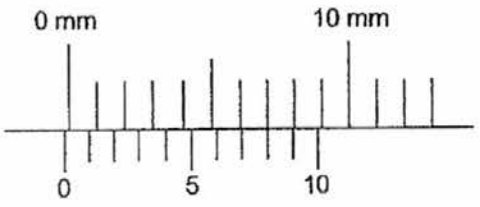


Fig. 2.1

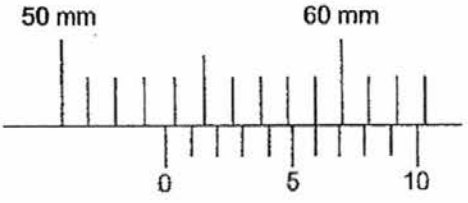


Fig. 2.2

What is the diameter of the rod?

A 5.34 cm **B** 5.38 cm **C** 50.34 cm **D** 50.38 cm

3 Brownian motion can be observed in illuminated smoke particles contained in a sealed transparent cell using a low power microscope. Which of the following statements is **incorrect**?

A The speed of the observed motion is affected by temperature.

B The observed motion is caused by random motion of the smoke particles moving by themselves.

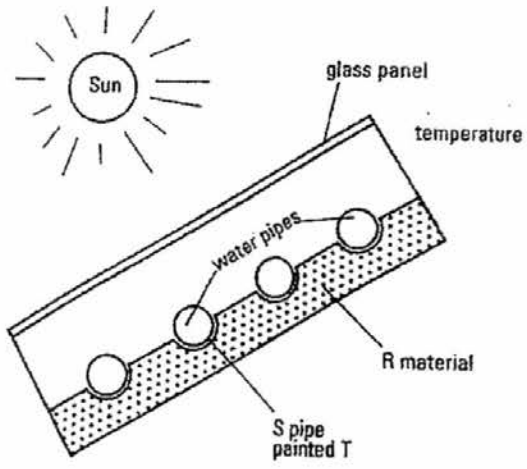
C The observed motion is caused by random motion of the air molecules hitting the smoke particles.

D Air molecules are too tiny to be observed through the microscope.

4 A mercury column is 5.0 cm long at 0 °C and 30.0 cm long at 100 °C. When it is placed in a convection oven, the mercury column was measured to be 40.0 cm long. What is the temperature in the convection oven?

A 100 °C **B** 140 °C **C** 133 °C **D** 167 °C

5 A cross-section of a solar panel is shown below. In the labelling, three key words have been replaced by the letters, R, S and T.



Which of the following best describes R, S and T?

	R	S	T
A	conducting	lead	black
B	insulating	iron	white
C	insulating	copper	black
D	conducting	zinc	silver

6 Thermal energy is supplied at the same rate to 100 g of paraffin and 100 g of water in similar containers. Why does the temperature of the paraffin rise more quickly?

A The paraffin is less dense than water.

B The paraffin is more dense than water.

C The paraffin has a larger specific heat capacity than water.

D The paraffin has a smaller specific heat capacity than water.

7 A vibrating source moves up and down in a ripple tank. What will happen if the vibrating frequency is increased?

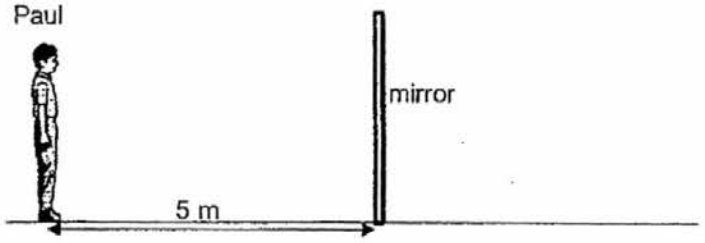
A The wave peaks will be higher and the troughs lower.

B The waves will be closer together.

C The waves will be further apart.

D The waves will move faster across the tank.

8 The diagram shows Paul standing in front of a plane mirror at a distance of 5 m.



What is the distance between Paul's initial position and his final image if Paul moves backwards by another 5 m?

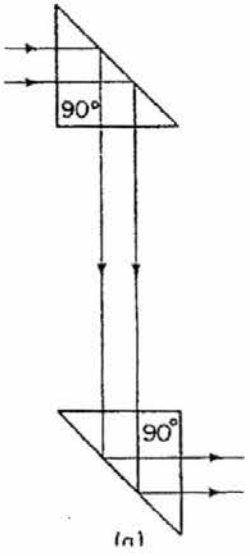
A 5 m

B 10 m

C 15 m

D 20 m

9 A periscope uses two 45° prisms to reflect the light ray into the observer's eye. Which of the following is a possible refractive index of the prism's material?



A 1.00

B 1.39

C 1.41

D 1.44

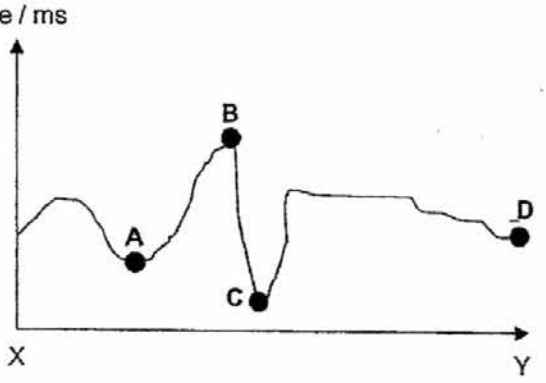
10 Below are four statements about the applications of the components in the electromagnetic spectrum.

- Gamma rays are used to treat cancer.
- Infrared radiation is used in intruder alarms.
- Microwaves are used in satellite televisions.
- X-rays are used in medical imaging.

How many of these statements are **correct**?

A 1 **B** 2 **C** 3 **D** 4

11 The diagram below shows the duration for ultrasound to return back to the receiver on a ship. The ship travelled from point X to point Y along the surface of the water. At which position is the water deepest?



12 What is the approximate range of audible frequencies for a healthy adult?

A 20 Hz to 100 Hz

B 2 Hz to 20 000 Hz

C 20 Hz to 20 000 Hz

D 200 Hz to 2000 Hz

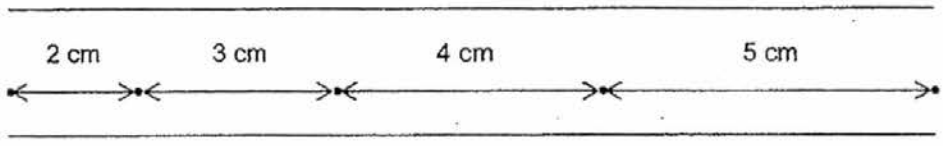
13 A tuning fork produces a sound wave with a frequency of 1 kHz. If the speed of sound is 340 m/s in air, what is the distance between the centre of a rarefaction and the centre of an adjacent compression on the wave?

A 0.085 m **B** 0.17 m **C** 0.34 m **D** 0.68 m

14 A circular disc has 100 holes. It rotates at 300 revolutions per minute and air is blown across the holes. What is the frequency of the sound produced?

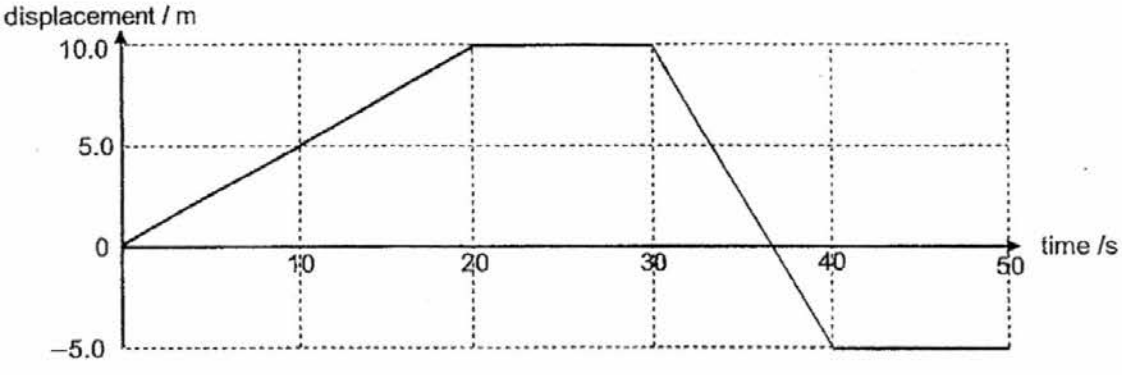
A 5 Hz **B** 180 Hz **C** 300 Hz **D** 500 Hz

15 A ticker tape timer vibrates at 100 Hz. The tape in the diagram below shows the distance moved by a trolley. What is the average speed of the trolley for the whole interval?



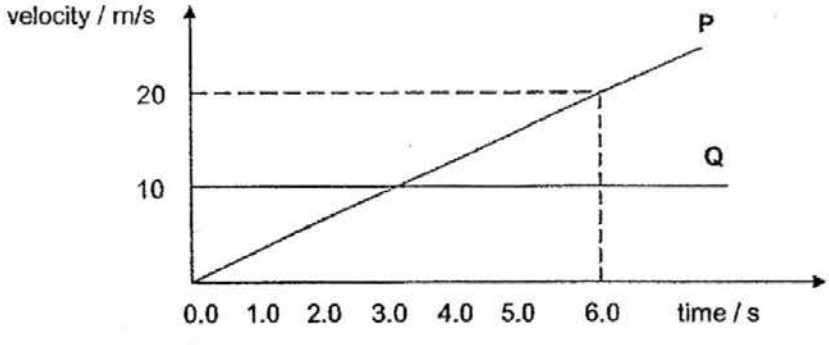
A 0.14 cm/s
B 0.56 cm/s
C 25 cm/s
D 350 cm/s

16 The displacement-time graph of a man travelling along a straight, horizontal road is shown below. What is the total distance travelled by the man in 50 s?



A 3.5 m B 5.0 m C 13.5 m D 25.0 m

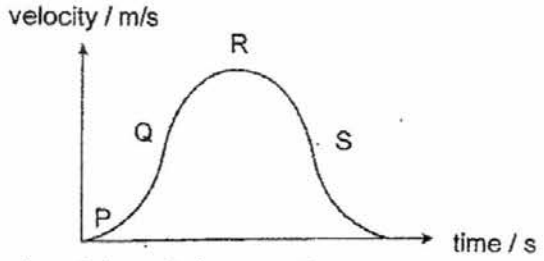
17 Two cars **P** and **Q** started from the same point on a level road at different velocities. Their velocities are shown in the graph below.



What is the time that the two cars meet?

A 3.0 s B 4.0 s C 5.0 s D 6.0 s

18 The diagram below shows the velocity-time graph of a truck travelling along a straight road.



Which of the following statements is correct?

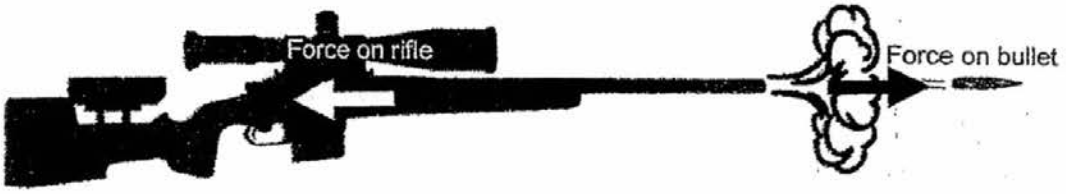
A The truck is moving backwards from R to S.

B The truck moved back to the original position.

C The truck accelerated uniformly throughout.

D The truck moved at zero acceleration at R.

19 When the trigger of a rifle is pulled, the force exerted on the recoiling rifle is just as great as the force that drives the bullet along the barrel.



Why does the bullet undergo more acceleration than the rifle?

A The bullet is smaller in size.

B The bullet has a smaller mass.

C The bullet is free to move while the rifle is held down.

D The bullet explodes before it leaves the rifle.

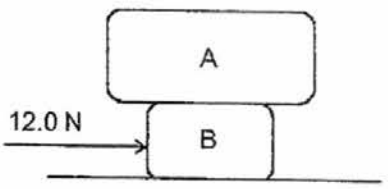
20 Box A of mass 4.0 kg is stacked on top of box B of mass 2.0 kg. A force of 12.0 N is applied on box B. Assume that the surface between the boxes and the table top are both frictionless. What will happen to the motion of boxes?

A Box A accelerates to the right at 3.0 m/s^2 while box B accelerates at 6.0 m/s^2.

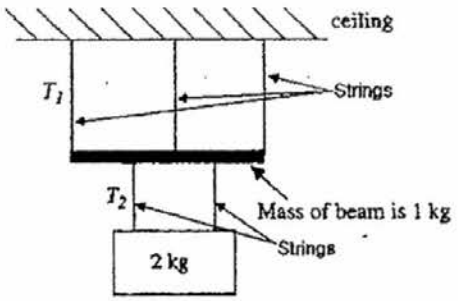
B Box B accelerates to the right at 6.0 m/s^2 while box A drops down vertically.

C Both box A and box B accelerate to the right at 2.0 m/s^2.

D Both box A and box B accelerate to the right at 6.0 m/s^2.

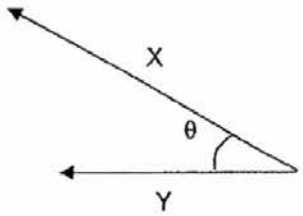


21 The diagram below shows a system of 5 strings and a beam of mass 1 kg holding a 2 kg mass. What are the tensions T_1 and T_2 in the two strings shown below?
[Take g = 10 N/kg]



	T_1 / N	T_2 / N
A	6.7	10
B	6.7	20
C	10	10
D	10	20

22 Two forces X and Y of constant magnitudes act at the same point as shown below.



When the angle θ between the forces X and Y increases from 0° to 180°, the magnitude of the resultant force

A increases and then decreases.

B decreases.

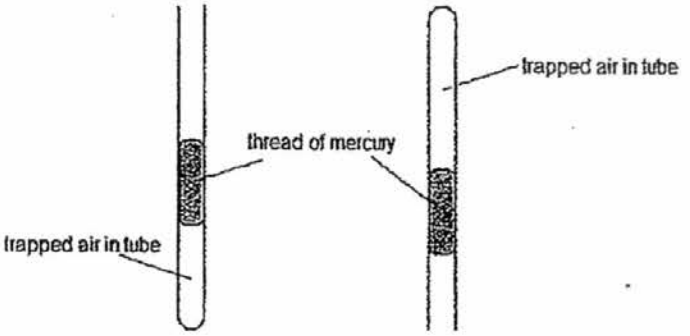
C increases.

D decreases and then increases.

23 The pressure on the tyres of a sedan car is P. The contact surface of each tyre with the floor is A. Calculate the new contact surface of each tyre when air is released from the tyre and the pressure of the car is reduced to 0.75 P.

A 0.333 A B 1.33 A C 4 A D 6 A

24 A thin tube contains a thread of mercury which traps air at the end of the tube. The other end of the tube is open to atmospheric pressure.



When the tube is turned upside down, the volume of the trapped air increases. Which of the following statements explains this?

A The pressure in the trapped air is reduced.

B The air gets hotter when the tube is turned upside down.

C The atmospheric pressure is less when it acts upwards on the mercury.

D The trapped air molecules hit the mercury harder when travelling downwards.

25 Fig. 25a and Fig. 25b show an open-ended and a closed tube manometer respectively connected to the same gas cylinder.

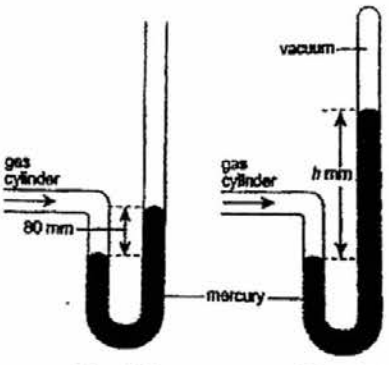


Fig. 25a Fig. 25b

The atmospheric pressure is 760 mmHg. What is the height, *h*, of the mercury in Fig. 25b?

A 80 mmHg

B 760 mmHg

C 800 mmHg

D 840 mmHg

26 A glass, full of water, is covered with a card and then inverted. When the glass is held in the air, the card will not fall off and the water will not escape. What is the reason for this?

A The atmospheric pressure prevents the card from falling off.

B The card makes a water tight seal to prevent the water from escaping.

C The pressure in the glass is raised because it is filled with water.

D The water remains in its position because of inertia.

27 Which of the following statements is incorrect?

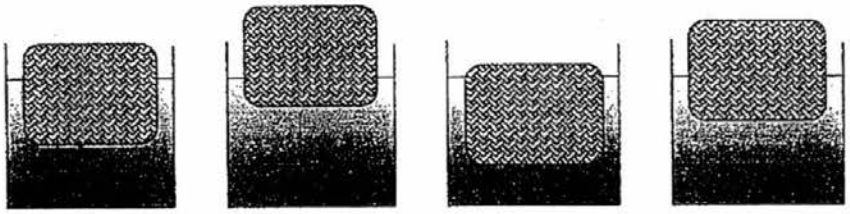
A A 2 kg iron block has twice as much inertia as a 1 kg block of iron.

B A 2 kg iron block has twice as much volume as a 1 kg block of iron.

C A 2 kg bunch of bananas has twice as much volume as a 1 kg loaf of bread.

D A 2 kg bunch of bananas has twice as much mass as a 1 kg loaf of bread.

28 Identical pieces of wood are placed in four different liquids, P, Q, R and S.



Which liquid has the largest density?

A P B Q C R D S

29 A mass of liquid of density ρ is thoroughly mixed with an equal mass of another liquid of density 2ρ. The two mixtures are immiscible (they do not mix). What is the density of the composite liquid?

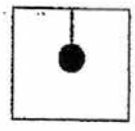
A $\frac{4}{3}\rho$

B $\frac{3}{2}\rho$

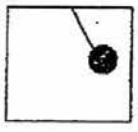
C $\frac{5}{3}\rho$

D ρ

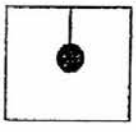
30 A pendulum hangs from the ceiling of a stationary bus.

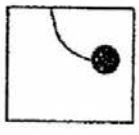


The bus suddenly starts to move towards the left. Which of the following diagrams show the position of the pendulum immediately after the bus starts to move?

A 

B 

C 

D 

End of Section A

Class | Register Number

Candidate Name _____

Section B: Structured Questions (40 marks)

Answer **all** the questions in the spaces provided.

1 A student has an open tank for storing water outside her house. The tank is painted black and is in direct sunlight.

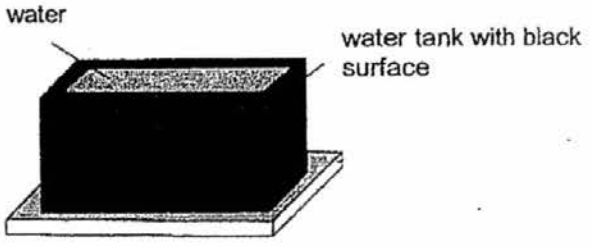
The cross-sectional area of the tank is 3.0 m^2.

The density of the water is 1000 kg/m.

The specific heat capacity of water is 4.2 kJ/kg°C.

The specific latent heat of vaporization of water is 2.2×10^6 J/kg.

The specific heat capacity of the metal cup is 462 J/kg°C.



(a) State how the thermal energy is transferred from the sun to the water.

_____ [1]

(b) If the water tank was used to store heated water instead, state two changes you would make to reduce heat loss.

_____

_____

_____ [2]

(c) The student notices that the water level in the tank falls by 0.50 cm in 11 hours.

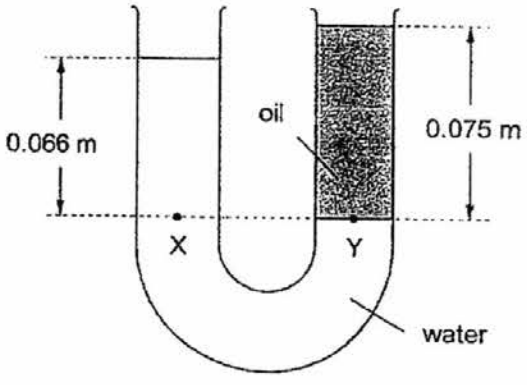
(i) Calculate the energy used to evaporate the water.

energy = ... [2]

(ii) A 1200 W microwave is used to heat 0.7 kg of water at 30 °C in a 13 g cup. The final temperature of the water and the cup is 82 °C. Find the time required to heat the water to this temperature.

time required = ... [3]

2 A U-shaped tube, with a constant cross-sectional area, contains some water of density 1000 kg/m^3. Oil is then poured into the right-hand side of the tube and does not mix with the water. The diagram below shows the levels of the water and the oil when equilibrium is reached.



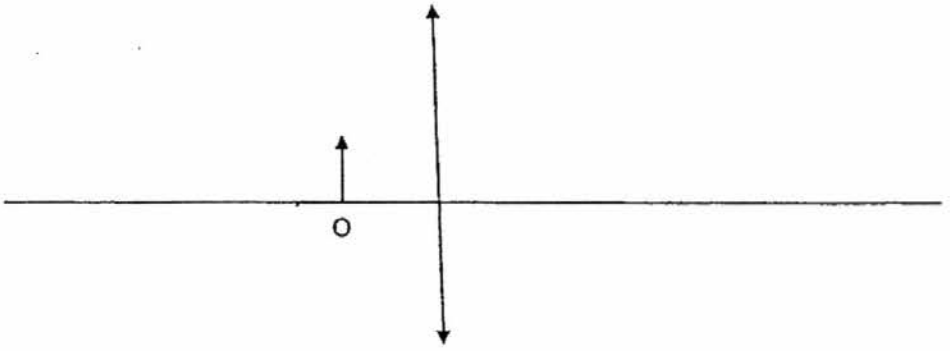
(a) Points X and Y are at the same horizontal level. X is 0.066 m below the top surface of the water and Y is 0.075 m below the top surface of the oil. Calculate the pressure at point Y due to the liquid above it.

pressure = ... [2]

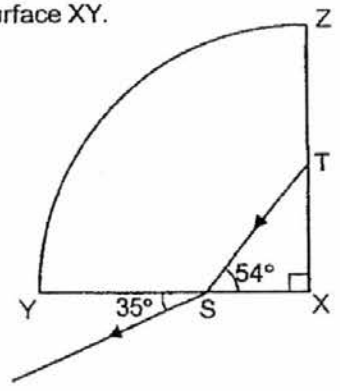
(b) Hence, calculate the density of the oil.

density = ... [2]

3 The diagram below shows a ray diagram with an object, O, in front of a converging lens, drawn to scale. Given that the image formed is virtual, upright and double in height, complete the ray diagram to find the focal point of the lens. Label the image I and the focal point of the lens with an F. [2]



4 The figure below shows a glass block XYZ in the shape of a quadrant with centre at X. A ray of light is incident at T on side XZ and travels through the glass block before hitting side XY at S and emerging from surface XY.



(a) Calculate the refractive index of the glass.

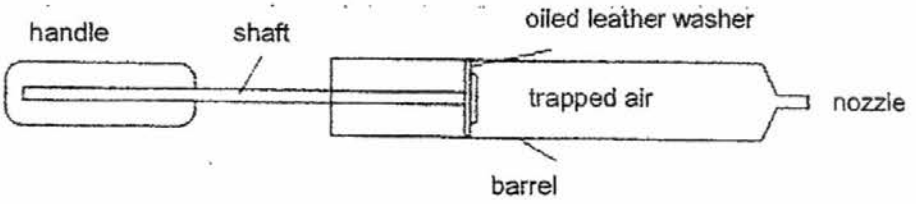
refractive index = ... [2]

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

critical angle = ... [2]

(c) On the diagram above, complete the path of the light ray on XZ before it hits T. [1]

5 The diagram below shows a bicycle pump.



(a) Explain in terms of molecular motion, how trapped air creates a pressure on the oiled leather washer.

_____

_____

_____ [2]

(b) When the nozzle is blocked and the handle is slowly pushed in, the pressure of the trapped air increases. Explain why the pressure increases if the temperature of the air in the barrel remains constant and there is no leakage of air.

_____

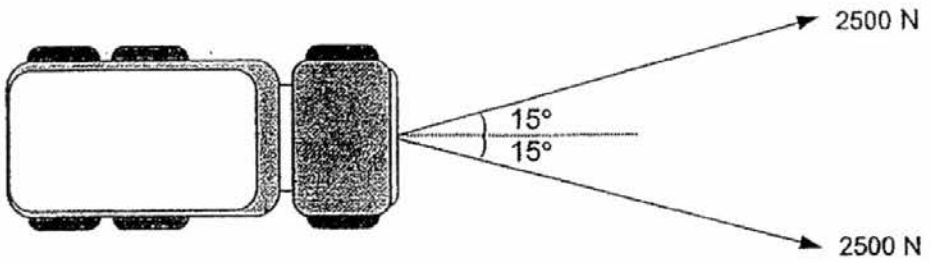
_____

_____ [2]

(c) A force of 75 N is applied on the pump handle when it is pushed into the barrel. What is the pressure of the trapped air if the cross sectional area of the barrel is 250 mm^2 and the atmospheric pressure is 1.0×10^5 Pa?

pressure = ... [2]

6 The diagram below shows a lorry of mass 6500 kg. It is stuck in soft ground. Two jeeps are used to pull the lorry forward. Each jeep exerts a force of 2500 N at an angle of 15° in the direction in which the lorry is supposed to move.



Draw a suitable scaled diagram, stating the scale used, to determine the magnitude and direction of the resultant force that is pulling the lorry forward.

scale = ...

magnitude of resultant force = ...

direction of resultant force = ...

[4]

7 For safety reasons, the minimum separation between two moving cars is determined by the reaction time of the drivers, the speed and deceleration produced by the braking systems of the cars.

Car B is moving at a constant speed of 12 m/s. The driver notices that car A stops suddenly. Car B travels 18 m before the driver applies the brake and decelerates uniformly for a further 30 m before it stops.

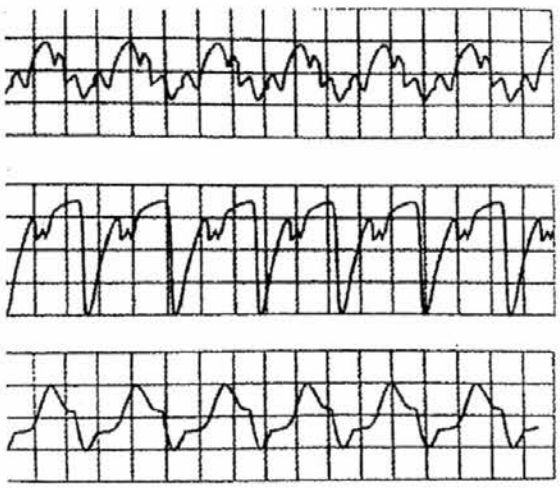
(a) Calculate the reaction time of the driver of car B.

reaction time = ... [2]

(b) Calculate the total time taken for car B to stop from the moment he saw the car A stops suddenly.

total time taken = ... [2]

8 **(a)** The following waveforms are produced when different instruments are played in front of the microphone. Each instrument is played in the same place each time.



(i) Which instrument is producing the loudest sound? Explain your answer.

_____ [1]

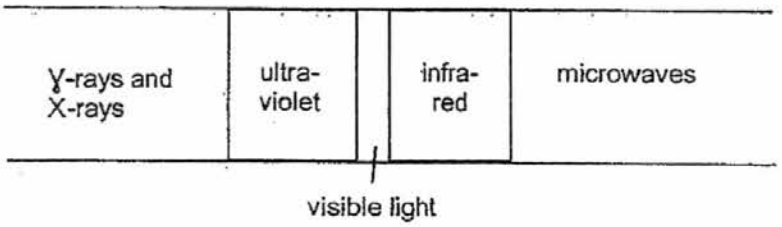
(ii) From the waveforms produced, how do we know that all instruments are producing a note of the same pitch?

_____ [1]

(b) There are two walls X and Y which are 120 m apart from each other. A boy standing at 40 m away from wall X claps his hands once. If the speed of sound in air is 330 m/s, what is the time interval between the first and the second echo that he hears?

time interval = ... [2]

9 The diagram below shows part of the electromagnetic spectrum.



(a) Name one type of radiation that has a lower frequency than visible light.

_____ [1]

(b) The speed of the radiation is halved as it enters a medium of different density. State if the medium is denser or less dense, and explain how the wavelength is affected.

_____

_____

_____ [2]

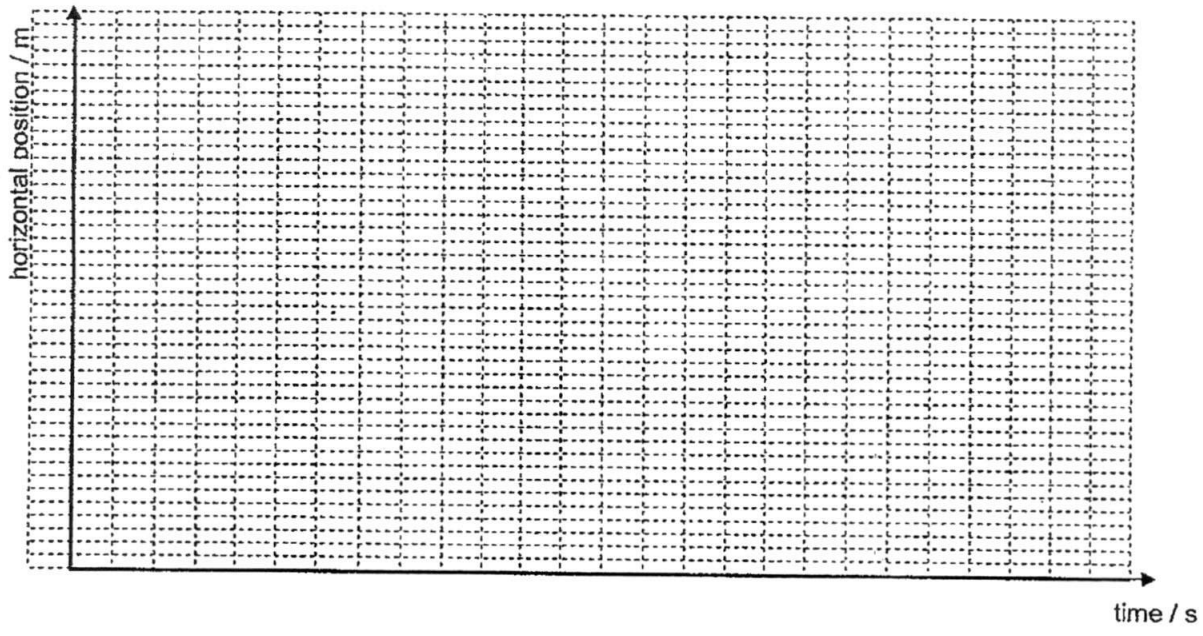
Section C: Free Response Questions (30 marks)

Answer **all** the questions in the spaces provided.

10 The position-time information shown below is for a trip on a very small roller coaster. The position information describes horizontal movement parallel to the ground and vertical movement up in the air.

time / s	horizontal position / m	vertical position / m
1	0	11
2	1	11
3	2	11
4	4	8
5	7	5
6	11	1
7	17	0
8	21	2
9	22	5
10	21	8
11	17	10
12	13	8
13	12	5
14	13	2
15	17	0
16	21	0
17	24	0
18	27	3
19	29	5
20	31	7
21	33	7
22	35	5
23	38	2
24	40	0

(a) Plot the horizontal position-time graph in the space below. [2]



(b) Describe the horizontal velocity of the rollercoaster during the 24 s.

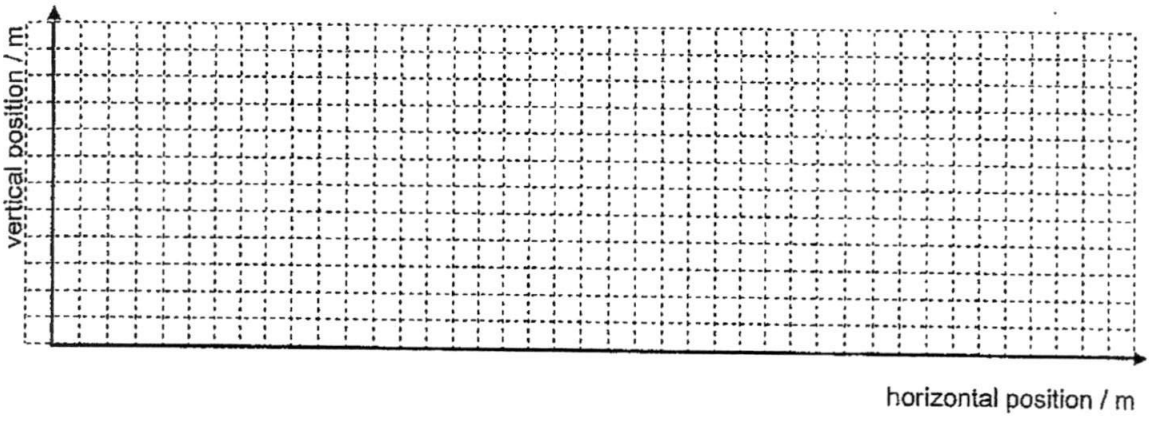
_____

_____

_____

_____ [3]

(c) Plot the vertical position – horizontal position graph in the space below. [2]



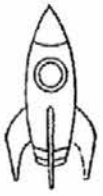
(i) What does the shape of this graph represent?

_____ [1]

(ii) At t = 24 s, a constant braking force was applied to the rollercoaster that brought it to a stop in 4 s. Given that the deceleration is 10.79 m/s^2, calculate the braking force given that the rollercoaster has a mass of 3500 kg.

braking force = ... [2]

11 During lift off, a rocket produces 7 x 10^6 N of thrust. The rocket has a mass of 3.2 X 10^4 kg. The gravitational field strength on Earth is taken as 10 N/kg.



(a) On the diagram above, draw and label the forces acting on the rocket upon lift off.[2]

(b) Determine the weight of the rocket.

weight = ... [2]

(c) Calculate the initial acceleration of the rocket upon lift off.

initial acceleration = ... [3]

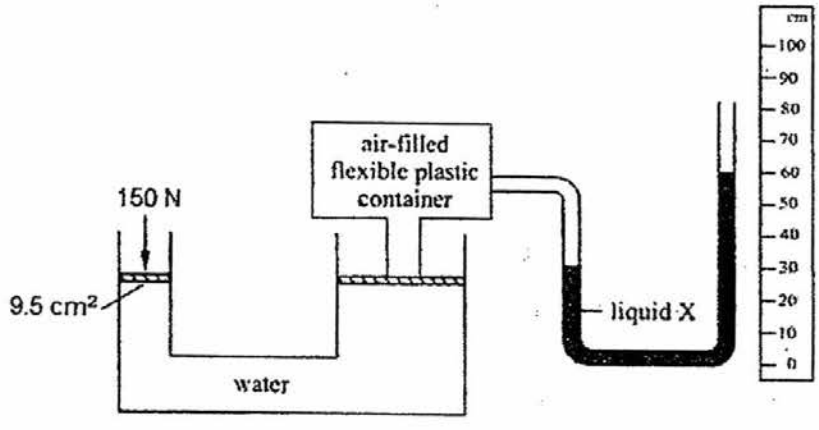
(d) The rocket descends vertically toward the surface of planet X with a constant speed of 2.0 m/s. Assume that the gravitational strength on planet X is 0.7 N/kg. Calculate the upward thrust on the rocket as it descends.

upward thrust = ... [2]

(e) The rocket has landed on the surface of planet X. State the reaction force of the planet X on the rocket.

reaction force = ... [1]

12 (a) The diagram shows a hydraulic press with a force of 150 N being exerted on a smaller piston with a cross-sectional area of 9.5 cm^2.



As the smaller piston is depressed downwards, the larger piston moves up and compresses an air-filled flexible plastic container attached to it. A manometer filled with liquid X is connected to the plastic container to measure the pressure difference between the air inside and the atmospheric pressure outside.

(i) Explain how pressure is transmitted in the hydraulic press above.

[1]

(ii) Calculate the pressure in Pa exerted on the air-filled flexible plastic container.

pressure = ... [2]

(iii) If the atmospheric pressure is 10^5 Pa, calculate the density of liquid X in the manometer.

density of liquid X = ... [3]

(b) The full scale diagram on the next page shows how the positions of particles in a medium changes with time while a longitudinal wave, travelling from left to right, passes through the medium. At time t = 0 s, before the arrival of the wave, all the particles are at their original undisturbed positions.

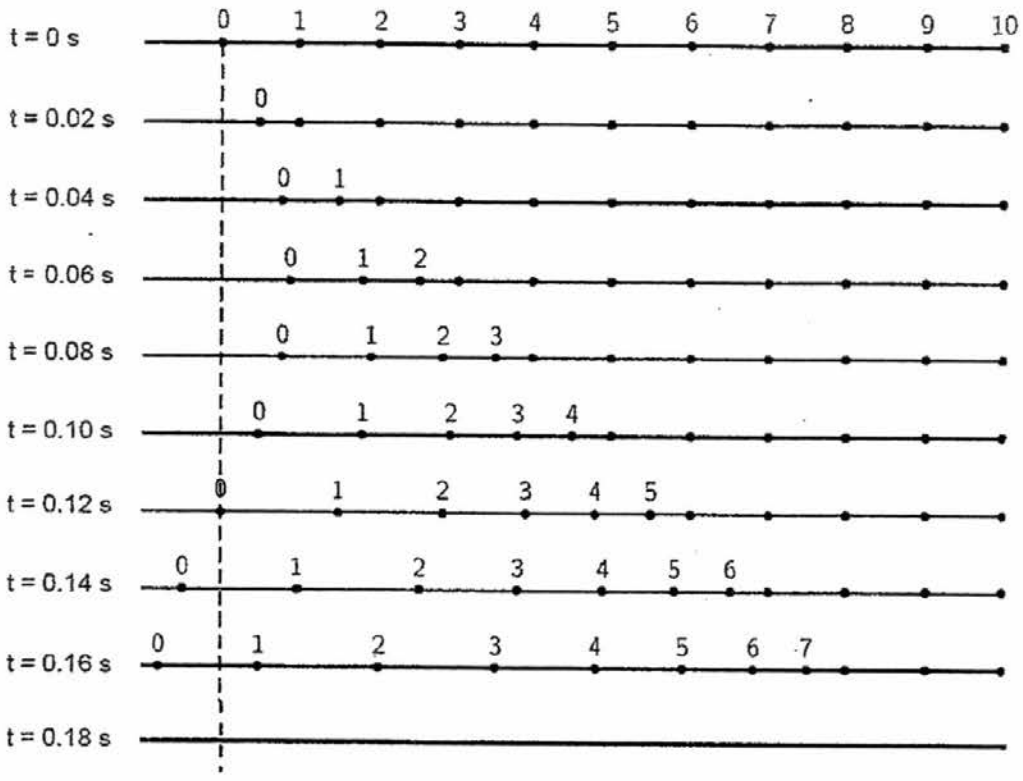
(i) State the amplitude of the wave.

amplitude = ...[1]

(ii) On the diagram on the next page, indicate the position of particle 2 at t = 0.18 s. [1]

(iii) Determine the period of the wave.

period = ...[2]


t = 0 s
0 1 2 3 4 5 6 7 8 9 10
t = 0.02 s
0
t = 0.04 s
0 1
t = 0.06 s
0 1 2
t = 0.08 s
0 1 2 3
t = 0.10 s
0 1 2 3 4
t = 0.12 s
0 1 2 3 4 5
t = 0.14 s
0 1 2 3 4 5 6
t = 0.16 s
0 1 2 3 4 5 6 7
t = 0.18 s

End of Paper

Candidate Name _____ Class | Register Number

PEIRCE SECONDARY SCHOOL

Department of Science

Second Semestral Examination for Secondary Three Express

PHYSICS **5059**

Monday **12 Oct 2016** **0800 – 1000**
Additional Material:
OTAS Answer Sheet

Time: **2 hours**

INSTRUCTIONS TO CANDIDATES

Section A: Multiple Choice (30 marks)
There are thirty multiple choice questions in this section.
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 answer in the OAS provided.
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Section B: Structured Questions (40 marks)
Answer **all** questions. Write your answers in the spaces provided on the Question Paper.

Section C: Free Response Questions (30 marks)
Answer **all** questions. Write your answers in the spaces provided on the Question Paper.
The number of marks is given in brackets [ ] at the end of each question or part question.

This paper consists of **22** printed pages.

Setter: Miss Chua Soh Ann

Section A: [30 marks]

Answer **all** the questions in the OTAS Answer Sheet provided.

1 Which of the following is a suitable estimate for the radius of the Earth?

A 6 nm **B** 6 μm **C** 6 Mm **(D)** 6 Gm

2 **Fig. 2.1** shows the reading of a pair of Vernier Calipers when its jaws are totally closed. **Fig. 2.2** shows the reading on the same pair of Vernier Calipers when it measures the diameter of a rod.

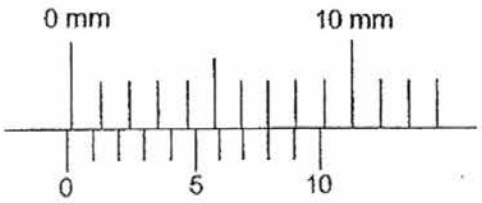


Fig. 2.1

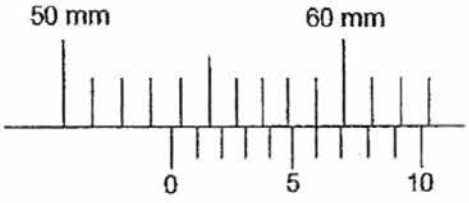


Fig. 2.2

What is the diameter of the rod?

(A) 5.34 cm **B** 5.38 cm **C** 50.34 cm **D** 50.38 cm

3 Brownian motion can be observed in illuminated smoke particles contained in a sealed transparent cell using a low power microscope. Which of the following statements is **incorrect**?

A The speed of the observed motion is affected by temperature.

(B) The observed motion is caused by random motion of the smoke particles moving by themselves.

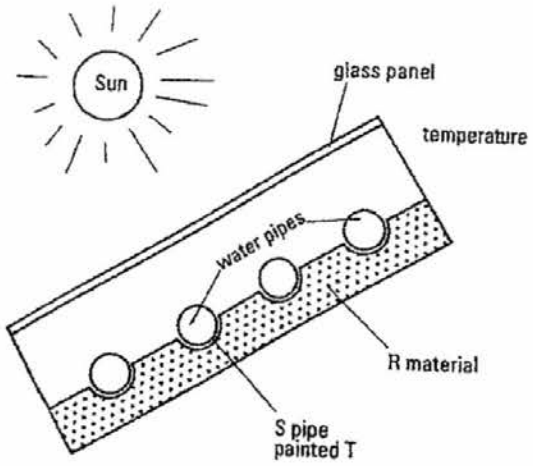
C Air molecules are observed to be moving about in random motion.

D Air molecules are too tiny to be observed through the microscope.

4 A mercury column is 5.0 cm long at 0 °C and 30.0 cm long at 100 °C. When it is placed in a convection oven, the mercury column was measured to be 40.0 cm long. What is the temperature in the convection oven?

A 125 °C **(B)** 140 °C **C** 150 °C **D** 167 °C

5 A cross-section of a solar panel is shown below. In the labelling, three key words have been replaced by the letters, **R**, **S** and **T**.



What are the best words to replace these letters?

	R	S	T
A	conducting	lead	black
B	insulating	iron	white
(C)	insulating	copper	black
D	conducting	zinc	silver

6 Thermal energy is supplied at the same rate to 100 g of paraffin and 100 g of water in similar containers. Why does the temperature of the paraffin rise more quickly?

A The paraffin is less dense than water.

B The paraffin is more dense than water.

C The paraffin has a larger specific heat capacity than water.

(D) The paraffin has a smaller specific heat capacity than water.

7 A vibrating source moves up and down in a ripple tank. What will happen if the vibrating frequency is increased?

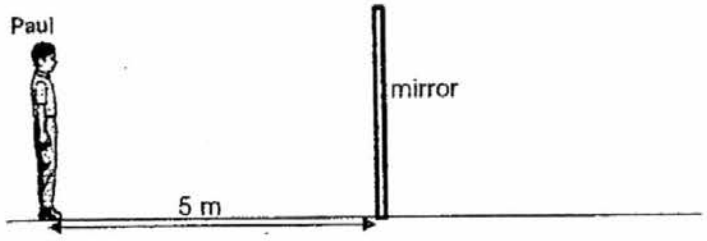
A The wave peaks will be higher and the troughs lower.

(B) The waves will be closer together.

C The waves will move slower across the tank.

D The waves will move quicker across the tank.

8 The diagram shows Paul standing in front of a plane mirror at a distance of 5 m.



What is the distance between Paul's initial position and his final image if Paul moves backwards by another 5 m?

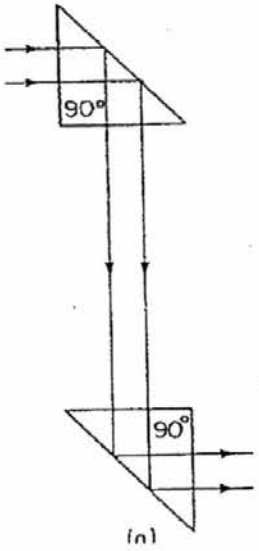
A 5 m

B 10 m

C 15 m

D 20 m

9 A periscope uses two 45° prisms to reflect the light ray into the observer's eye. What is/are the possible refractive index of the prism's material?



A 1.00

B 1.39

C 1.41

D 1.44

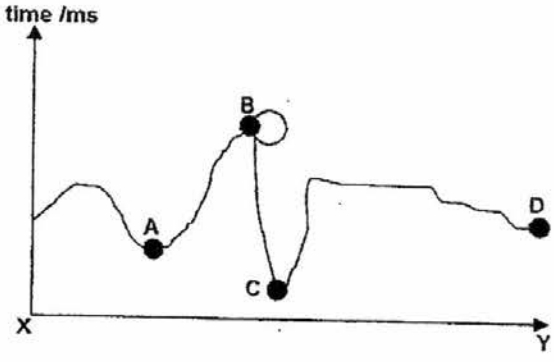
10 Below are four statements about the uses of electromagnetic radiation.

- Gamma rays are used to treat cancer.
- Infrared are used in intruder alarms.
- Microwaves are used in satellite televisions.
- X-rays are used in medical imaging.

How many of these statements are **correct**?

A 1 B 2 C 3 (D) 4

11 The diagram below shows the duration for ultrasound to return back to the receiver on a ship. The ship travelled from point X to point Y along the surface of the water. At which position is the water deepest?



12 What is the approximate range of audible frequencies for a healthy adult?

A 20 Hz to 100 Hz
B 2 Hz to 20 000 Hz
(C) 20 Hz to 20 000 Hz
D 200 Hz to 2000 Hz

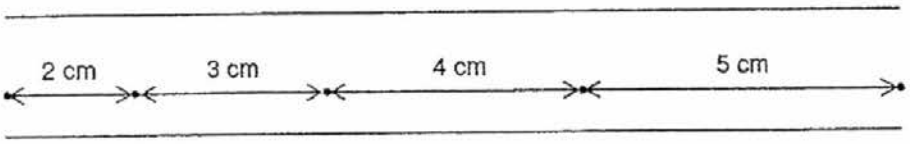
13 A tuning fork produces a sound wave with a frequency of 1000 Hz. If the speed of sound is 340 ms^{-1} in air, what is the distance between the centre of a rarefaction and the centre of an adjacent compression on the wave?

A 0.085 m (B) 0.17 m C 0.34 m D 2.9 m

14 A circular disc has 100 holes. It rotates at 300 revolutions per minute and air is blown across the holes. What is the frequency of the sound produced?

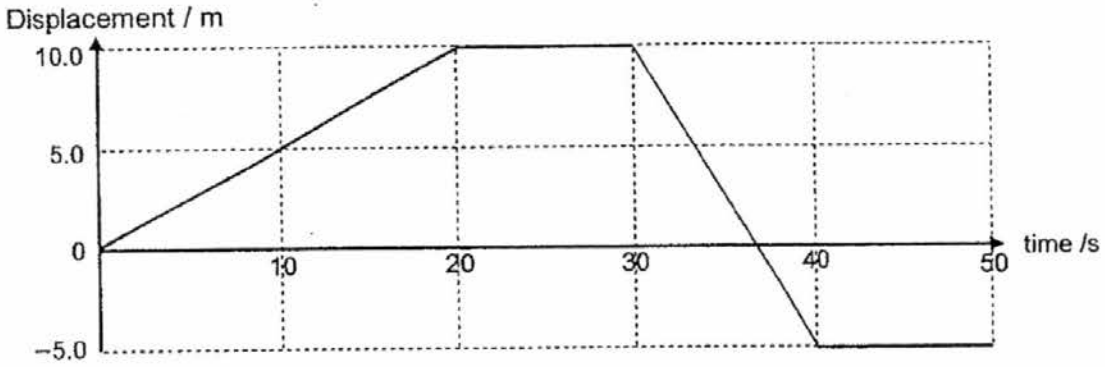
A 20 Hz B 180 Hz C 300 Hz (D) 500 Hz

15 A ticker tape timer vibrates at 100 Hz. The tape in the diagram below shows the distance moved by a trolley. What is the average speed of the trolley for the whole interval?



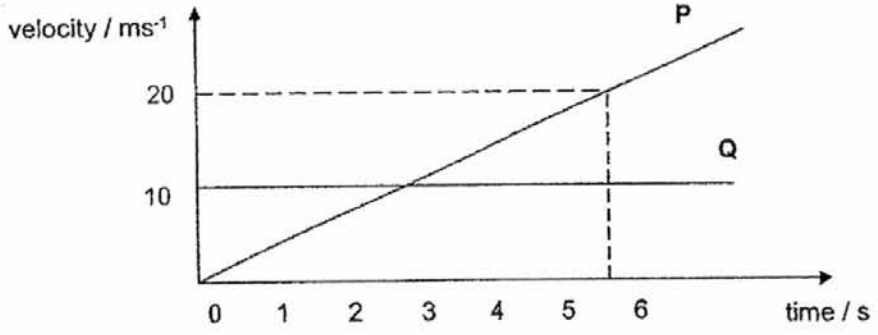
A 0.14 cm/s
B 0.56 cm/s
C 25 cm/s
(D) 350 cm/s

16 The displacement-time graph of a man travelling along a straight, horizontal road is shown below. What is the total distance travelled by the man in 50 s?



A 3.5 m B 5.0 m C 13.5 m (D) 25.0 m

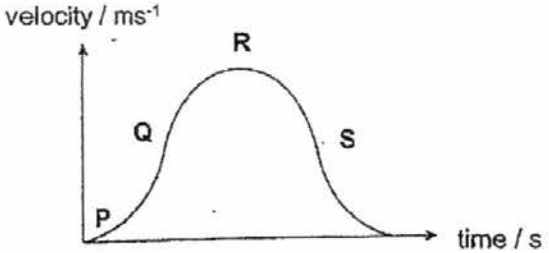
17 Two cars **P** and **Q** started from the same point on a level road at different speeds. Their speeds are shown in the graph below.



What is the time that the two cars meet?

A 3.0 s B 4.0 s C 5.0 s (D) 6.0 s

18 The figure below shows the velocity-time graph of a truck travelling along a straight road.



Which of the following statement is correct?

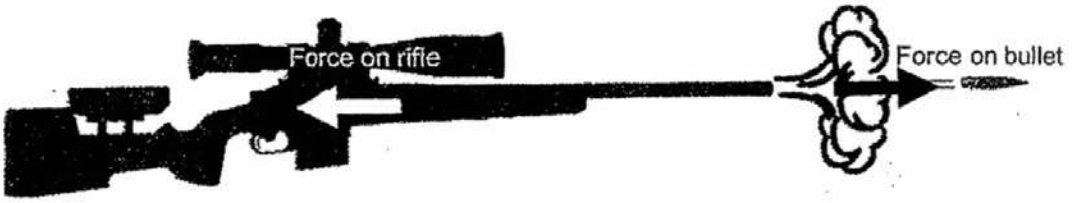
A The truck is moving backwards from **R** to **S**.

B The truck moved back to the original position.

C The truck accelerated uniformly throughout.

(D) The truck moved at zero acceleration at **R**.

19 When the trigger of a rifle is pulled, the force exerted on the recoiling rifle is just as great as the force that drives the bullet along the barrel.



Why does the bullet undergo more acceleration than the rifle?

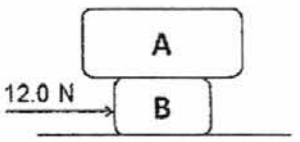
A The bullet is smaller in size.

(B) The bullet has a smaller mass.

C The bullet is free to move while the rifle is held down.

D The bullet explodes before it leaves the rifle.

20 A 4.0 kg box **A** is stacked on top of a 2.0 kg box **B**. A force of 12.0 N is applied on box **B**. Assume that the surface that the surfaces between the boxes and the table top are both frictionless. What will happen to the motion of boxes?



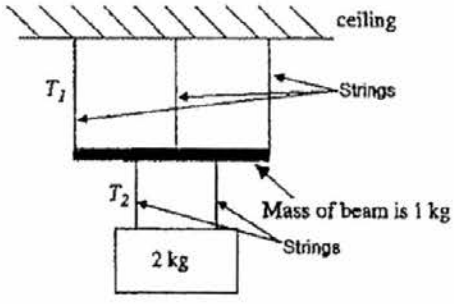
A Box **A** accelerates to the right at 3.0 ms^{-2} while box **B** accelerates at 6.0 ms^{-2}.

(B) Box **B** accelerates to the right at 6.0 ms^{-2} while box **A** drops down vertically.

C Both box **A** and box **B** accelerate to the right at 2.0 ms^{-2}.

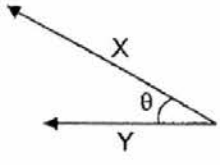
D Both box **A** and box **B** accelerate to the right at 6.0 ms^{-2}.

21 The diagram below shows a system of 5 strings and a beam of mass 1 kg holding a 2 kg mass. What are the tensions T_1 and T_2 in the two strings shown below? Take g = 10 N/kg



	T_1 / N	T_2 / N
A	6.7	5
(B)	6.7	10
C	10	5
D	10	10

22 Two forces X and Y of constant magnitudes act at the same point as shown below.



When the angle θ between the forces X and Y increases from 0° to 180°, the magnitude of the resultant force

A increases and then decreases.

(B) decreases.

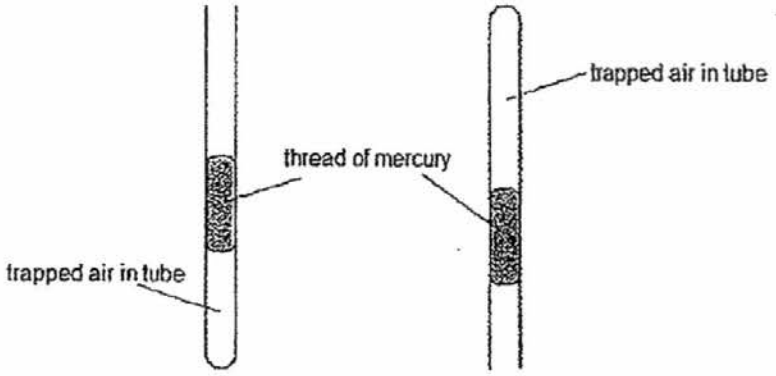
C increases.

D decreases and then increases.

23 The pressure on the tyres of a sedan car is P. The contact surface of each tyre with the floor is A. Calculate the new contact surface of each tyre when air is released from the tyre and the pressure of the car is reduced to 0.75 P.

A 1.25 A (B) 4.0 s C 5.0 s D 6.0 s

24 A thin tube contains a thread of mercury which traps air at the end of the tube. The other end of the tube is open to the atmosphere.



When the tube is turned upside down, the volume of the trapped air increases. Which statement explains this?

(A) The pressure in the trapped air is reduced.

B The air gets hotter when the tube is turned upside down.

C The atmosphere pushes less when it acts upwards on the mercury.

D The trapped air molecules hit the mercury harder when travelling downwards.

25 Fig. 25a and Fig. 25b show an open-ended and a closed tube manometer respectively connected to the same gas cylinder.

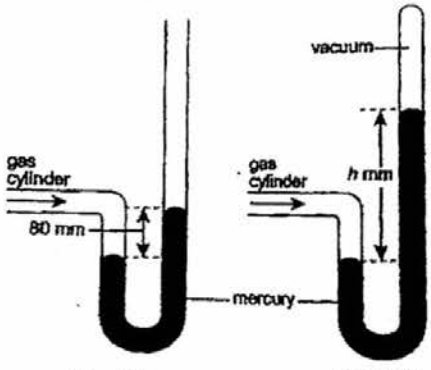


Fig. 25a Fig. 25b

The atmospheric pressure is 760 mmHg. What is the height, *h*, of the mercury in Fig. 23b?

A 60 mmHg

B 760 mmHg

C 800 mmHg

(D) 820 mmHg

26 A glass full of water is covered with a card and then inverted. When the glass is held in the air, the card will not fall off and the water will not escape. What is the reason for this?

(A) The atmospheric pressure prevents the card from falling off.

B The card makes a water tight seal to prevent the water from escaping.

C The pressure in the glass is raised because it is filled with water.

D The water remains in its position because of inertia.

27 Which of the following statements is **incorrect**?

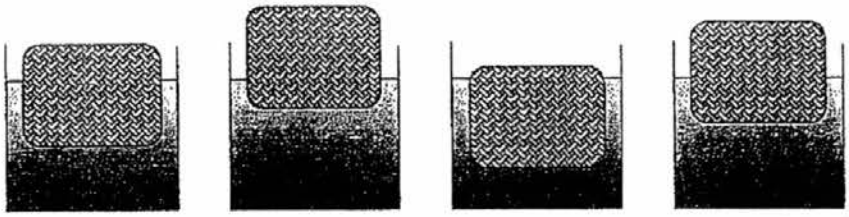
A A 2 kg iron block has twice as much inertia as a 1 kg block of iron.

B A 2 kg iron block has twice as much volume as a 1 kg block of iron.

(C) A 2 kg bunch of bananas has twice as much volume as a 1 kg loaf of bread.

D A 2 kg bunch of bananas has twice as much mass as a 1 kg loaf of bread.

28 Identical pieces of wood are placed in four different liquids, P, Q, R and S.



Which liquid has the biggest density?

A P B Q C R D S

29 A mass of liquid of density ρ is thoroughly mixed with an equal mass of another liquid of density 2ρ. No change of the total volume occurs. What is the density of the liquid mixture?

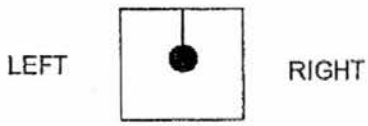
(A) $\frac{4}{3}\rho$

B $\frac{3}{2}\rho$

C $\frac{5}{3}\rho$

D ρ

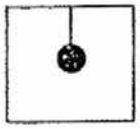
30 A pendulum hangs from the ceiling of a stationary bus.

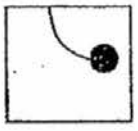


The bus suddenly starts to move towards the **left**. Which of the following diagrams show how the pendulum will be hanging immediately after the bus starts to move?

(A)


B

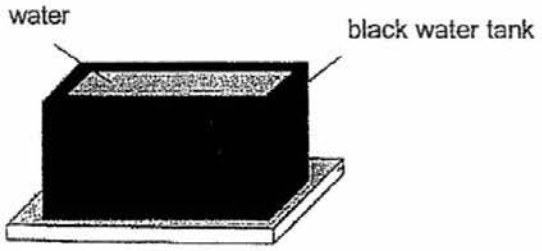

C


D


Section B [40 marks]

Answer **all** the questions in the spaces provided.

1 A student has an open tank for storing water outside her house. The tank is painted black and is in direct sunlight



(a) State and explain how the water is transferred from the sun to the water. [1]

Radiation

f the water tank was used to store heated water instead, state two changes you would make to reduce heat loss. [2]

Paint tank white – white/ silver is a bad emitter of radiation
Lid – reduce evaporation
Use Styrofoam – bad conductor of heat (any two answers with principle)

(b) The student notices that the water level in the tank falls by 0.0050 m in 11 hours.

The cross-sectional area of the tank is 3.0 m^2.

The density of the water is 1000 kgm^{-3}.

The specific heat capacity of water is 4.2 $kJ\ kg^{-1}\ °C^{-1}$.

The specific latent heat of vaporization of water is $2.2 \times 10^6\ Jkg^{-1}$.

The specific heat capacity of the metal cup is 462 $J\ kg^{-1}\ °C^{-1}$.

(i) Calculate the average rate at which the energy is used to evaporate the water. [2]

Volume = $0.005 \times 3 = 0.015 m^3$ (1/2m)
Mass = density x volume = $1000 \times 0.015 = 15$ kg (1/2m)
Energy = ml = $15 \times 2.2 \times 10^6 = 33\ 000\ 000$J (1m)

(ii) A 1200 W microwave is used to heat 0.7 kg of water at 30 °C in a13 g metal cup. The final temperature of the water is 82 °C. Find the time taken to reach this temperature. [3]

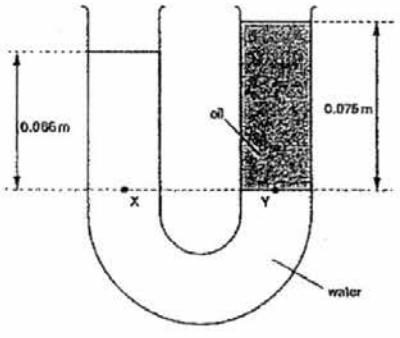
Heat provided by the microwave = Heat absorbed by the water + heat absorbed by the metal cup

$Px\ t = mc\Delta\theta + mc\Delta\theta$

$1200 \times t\ (1m) = (0.7 \times 4.2 \times 1000 \times 32) + (0.013 \times 462 \times 32)\ (1m)$

$t =$ (1m)

2 A U-shaped tube, with a constant cross-sectional area, contains some water of density 1000 kg/m^3. Oil is then poured into the right-hand side of the tube and does not mix with the water. The figure below shows the levels of the water and the oil when equilibrium is reached.



Points **X** and **Y** are at the same horizontal level. **X** is 0.066 m below the top surface of the water and **Y** is 0.075 m below the top surface of the oil.

a) Calculate the pressure at point **Y** due to the liquid above it. [2]

Pressure at Y = Pressure at X
= hρg
= 0.066 x 1000 x 10
= 660 Pa (accept 660 N/m^2)

(students can write 660 Pa above atmospheric pressure. However, not to guess the value of atmospheric pressure)

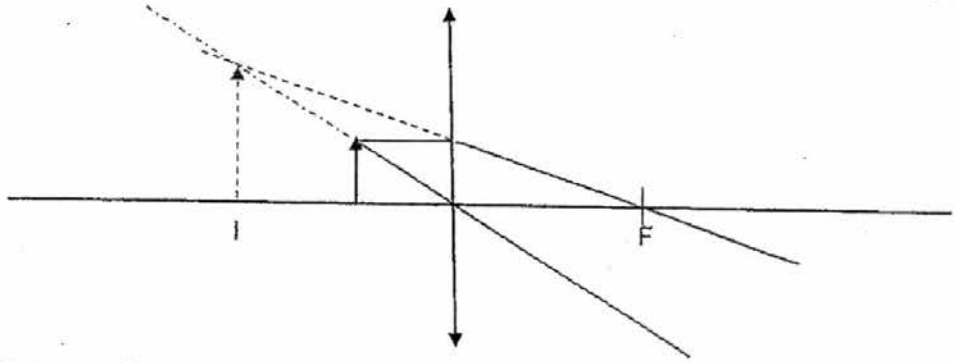
b) Hence, calculate the density of the oil. [2]

$p_y = h\rho g$

$660 = (0.075)\rho(10)$

$\rho_{oil} = \dfrac{660}{(0.075)(10)} = 880\ \text{kg/m}^3$

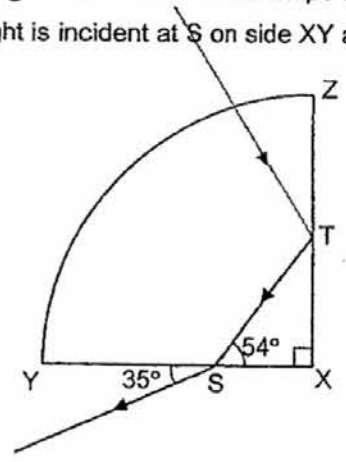
3 (a) The diagram below shows a ray diagram with an object, O, in front of a converging lens, drawn to scale. Given that the image formed is virtual, upright and double in height, complete the ray diagram to find the focal point of the lens. Label the image I and the focal point of the lens with an F. [3]



(b) State two changes to the image if the object is placed beyond the focal point of the lens.

Diminished/ inverted/ real (any two one mark) [1]

4 The figure below shows a glass block XYZ in the shape of a quadrant or a quarter of a circle, with centre X. A ray of light is incident at S on side XY and travels through the glass block, striking side ZX at T.



a) Calculate the refractive index of the glass. [2]

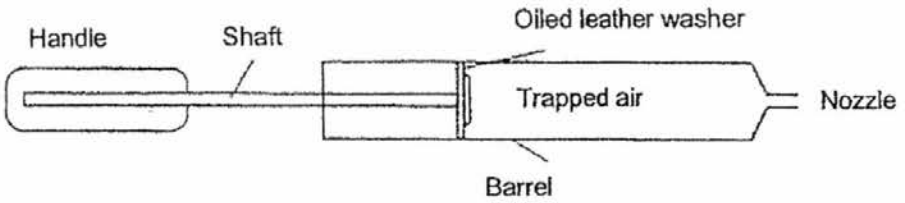
n = sin i / sin r
n = sin 55°/sin 36° [1]
n = 1.39 [1]

b) Calculate the critical angle of the glass block. [2]

sin c = 1/n
sin c = 1/1.4 [1]
c = 44.9° [1]

c) Draw the incident ray on TZ on the figure above. [1]

5 The diagram below shows a bicycle pump.



a) Explain in terms of molecular motion, how trapped air creates a pressure on the oiled leather washer. [2]

The trapped air molecules collide with the walls of the washer [1m] and the average forced exerted per unit area on the walls is pressure. [1m]

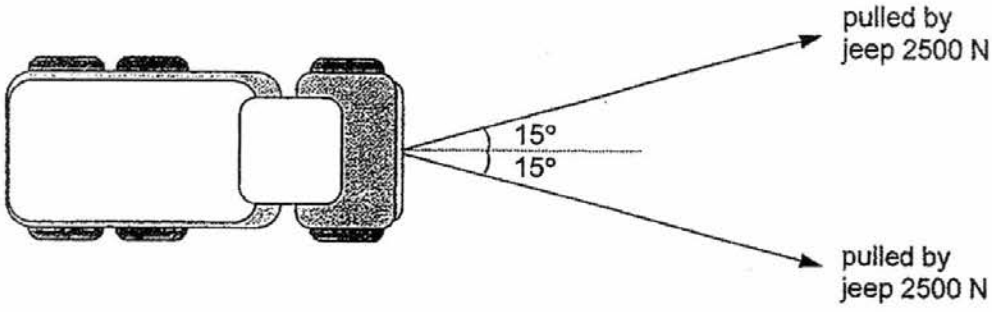
b) When the nozzle is blocked and the handle is slowly pushed in, the pressure of the trapped air increases. Explain why the pressure increases if the temperature of the air in the barrel remains constant and the there is no leakage of air. [2]

When the handle is pushed in, the volume of trapped air decreases. [1m] This increases the frequency of collisions of air molecules against the walls of the barrel, [1m] hence increasing the pressure.

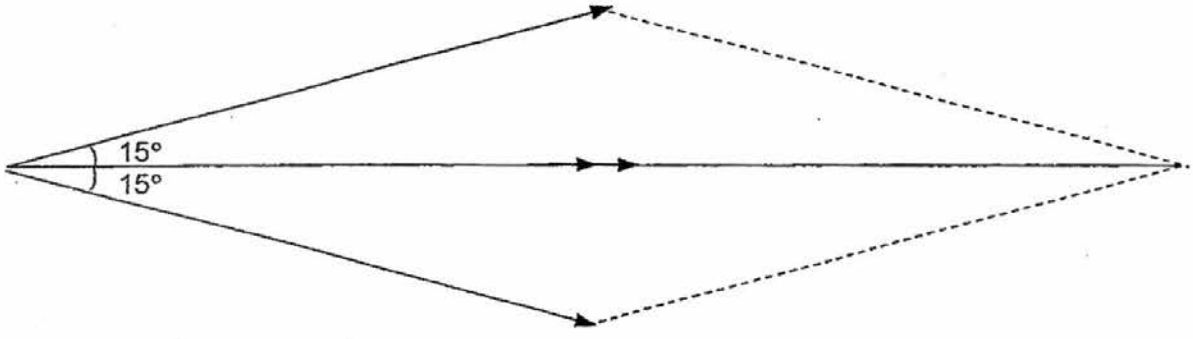
c) A force of 75 N is applied on the pump handle when it is pushed into the barrel. What is the pressure of the trapped air if the cross sectional area of the barrel is 250 mm^2 and the atmospheric pressure is 1.0×10^5 Pa? [2]

Pressure = Force / Area
Let trapped air pressure be P
$(P - 1.0 \times 10^5) = 75 / (250 \times 10^{-6})$
$P = 4.0 \times 10^5$ Pa

6 The figure below shows a lorry of mass 6500 kg. It is stuck in soft ground. Two jeeps are used to pull the lorry forward. Each jeep exerts a force of 2500 N at an angle of 15° in the direction in which the lorry is supposed to move.



Draw a suitable scaled diagram, stating the scale used, to determine the magnitude and direction of the resultant force that is pulling the lorry forward. [4]



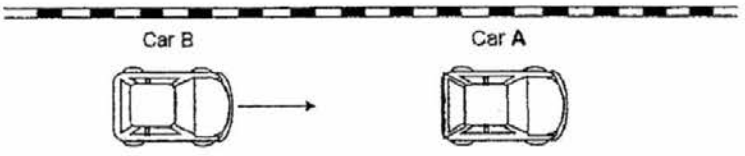
Scale 1cm:250 N (1m)
Shape/ arrows/ double arrows (1m)
All forces labelled with correct units (1m)
Answer + direction (1m) 4800 N

Scale = ...

Magnitude of resultant force = ...

Direction of resultant force = ...

7 For safety reasons, the minimum separation between two moving cars is determined by the reaction time of the drivers, the speed and deceleration produced by the braking systems of the cars.



Car **B** is moving at a constant speed of 12 ms^{-1}. The driver notices that car **A** stops suddenly. Car **B** travels 18 m before the driver applies the brake and decelerates uniformly for a further 30 m before it stops.

a) Calculate the reaction time of the driver of car B. [2]

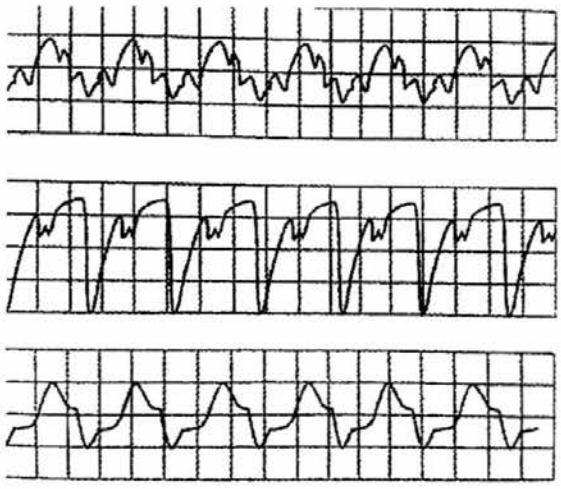
Reaction time = d / s
= 18 / 12
= 1.5 s

b) Calculate the time taken for car **B** to stop from the moment he saw the car **A** stops suddenly. [2]

½ (12) (t) = 30
t = 5 s
Total time taken = 1.5 + 5 = 6.5 s

8 a) The following wavefronts are produced when different instruments are played in front of the microphone. Each instrument is played in the same place each time.

The oscilloscope controls remain unaltered.



recorder

saxophone

clarinet

i) Which instrument is producing the loudest sound? How can you tell?

Saxophone, largest amplitude [1]

ii) How can you tell that all instruments are producing a note of the same pitch?

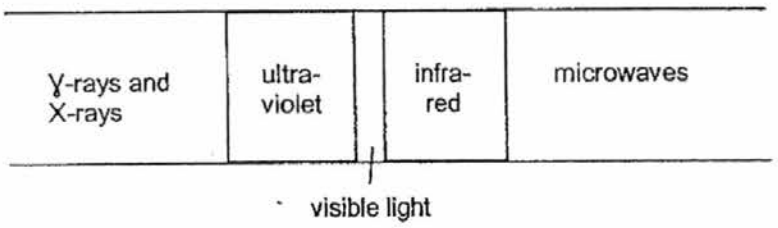
They have the same frequency of 2.5 squares.
The waveform is repeated every 2.5 squares. [1]

b) There are two walls **X** and **Y** which are 120 m apart from each other. A boy standing at 40 m away from wall **X** claps his hands once. If the speed of sound in air is 330 ms^{-1}, what is the time interval between the first and the second echo that he hears?

[2]

Time interval $= \frac{160}{330} - \frac{80}{330} = 0.242s(to\ 3s.f.)$

9 The diagram below shows part of the electromagnetic spectrum.



a) Name one type of radiation that has a lower frequency than visible light, and state an application for it.

Infrared – tv control / sunbeds
Microwave – cooking/ satellite communication

[2]

b) State a difference between the waves in the electromagnetic spectrum and sound waves.

Longitudinal/ transverse / Direction of vibration of particle/ speed in vacuum [1]

c) The speed of the radiation is halved as it enters a medium of different density. State if the medium is denser or less dense, and explain how the wavelength is affected.

Denser (1m) $V = f\lambda$, wavelength halved

[2]

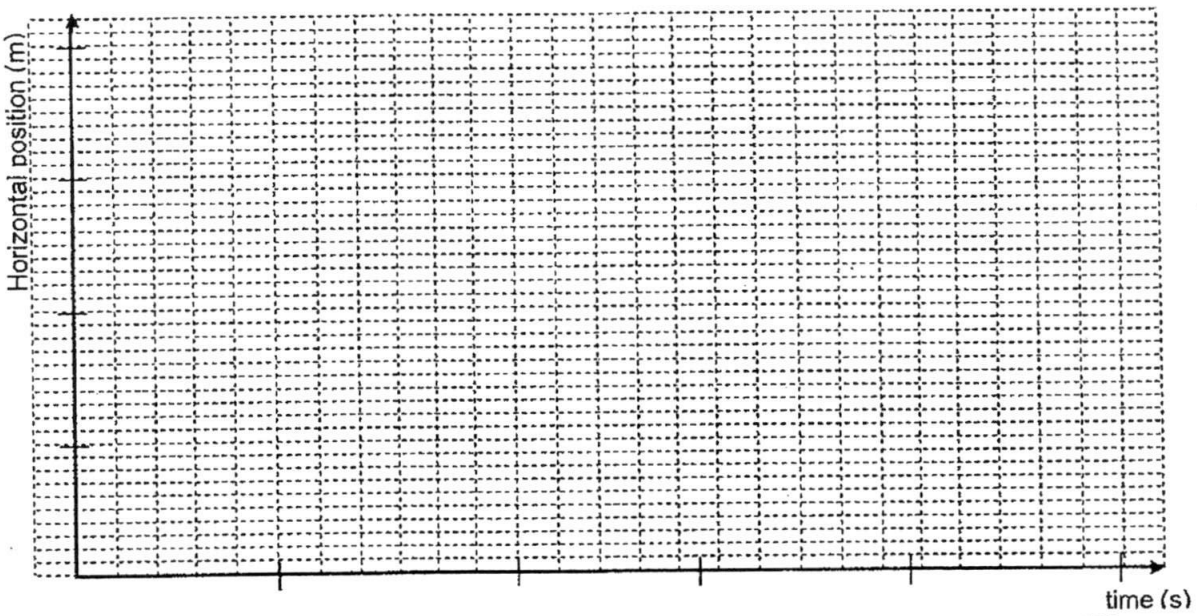
Section C [30 marks]

Answer **all** the questions in the spaces provided.

10 The position-time information shown is for a trip on a very small roller coaster. The position information describes horizontal movement parallel to the ground and vertical movement up in the air.

Time (s)	Horizontal position (m)	Vertical position (m)
1	0	11
2	1	11
3	2	11
4	4	8
5	7	5
6	11	1
7	17	0
8	21	2
9	22	5
10	21	8
11	17	10
12	13	8
13	12	5
14	13	2
15	17	0
16	21	0
17	24	0
18	27	3
19	29	5
20	31	7
21	33	7
22	35	5
23	38	2
24	40	0

a) Plot the horizontal position-time graph in the space below. [2]



(b) Describe the horizontal velocity of the rollercoaster. [3]

i) 0 s to 10 s:

_____

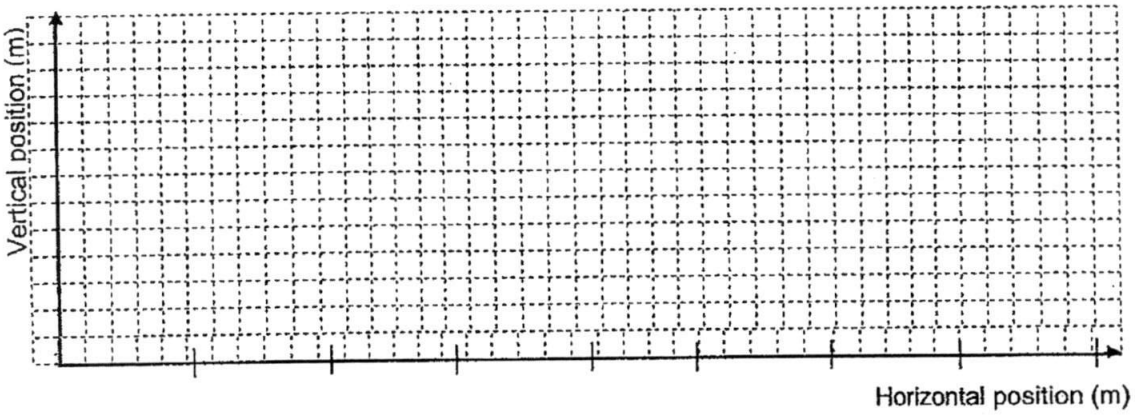
ii) 11 s to 14 s:

_____

iii) 15 s to 24 s:

_____

(c) Plot the vertical position – horizontal position graph in the space below. [2]



i) What does the shape of this graph represent? [1]

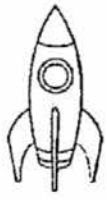
_____

_____

ii) At t = 24 s, a constant braking force was applied to the rollercoaster that brought it to a stop in 4 s. Given that the deceleration is 10.79 ms^{-2}, calculate the braking force. [2]

Weight = mg = (3.2 x 104)(10) = 3.2 x 10^5 N

11 During lift off, a rocket produces 7 x 10^6 N of thrust. The rocket has a mass of 3.2 X 10^4 kg. The gravitational field strength on Earth is taken as 10 Nkg^{-1}.



a) On the figure above, draw and label the forces acting on the rocket upon lift off. [2]

b) Determine the weight of the rocket.

Weight = mg = (3.2 x 104)(10) = 3.2 x 105 N

Weight = ... [2]

c) Calculate the initial acceleration of the rocket upon lift off. [3]

$F_R = 7 \times 10^6 - 3.2 \times 10^5 = 6.68 \times 10^6$ N

$F_R = ma$
$6.68 \times 10^6 = 3.2 \times 10^4 \times a$
$a = 209$ m/s² (3 s.f.)

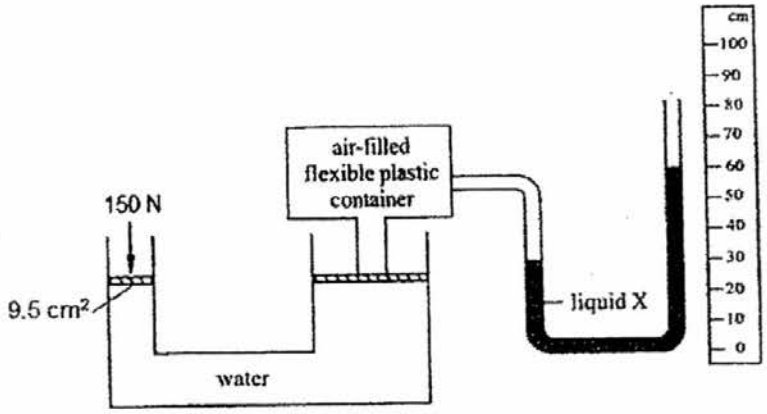
d) The rocket descends vertically toward the surface of Planet **X** with a constant speed of 2.0 ms^{-1}. Assume that the gravitational strength on Planet **X** is 0.7 Nkg^{-1}. Calculate the upward thrust on the rocket as it descends. [2]

Upward thrust = 3.2 x 10^4 x 0.7 = 22400 N

e) The rocket has landed on the surface of Planet **X**. State the reaction force of the Planet **X** on the rocket.

Reaction force ..... 22400 N ..... [1]

12 a) The diagram shows a hydraulic press with a force of 150 N being exerted on a smaller piston with a cross-sectional area of 9.5 cm^2.



As the smaller piston is depressed downwards, the larger piston moves up and compresses an air-filled flexible plastic container attached to it. A liquid X manometer is connected to the plastic container to measure the pressure difference between the air inside and the atmospheric pressure outside.

i) Explain how pressure is transmitted in the hydraulic press above. [1]

When the 150 N force is exerted on the small piston, a pressure is applied in the water. The pressure is then transmitted uniformly throughout the water to the larger piston.

ii) Calculate the pressure in **Pa** exerted on the air-filled flexible plastic container. [2]

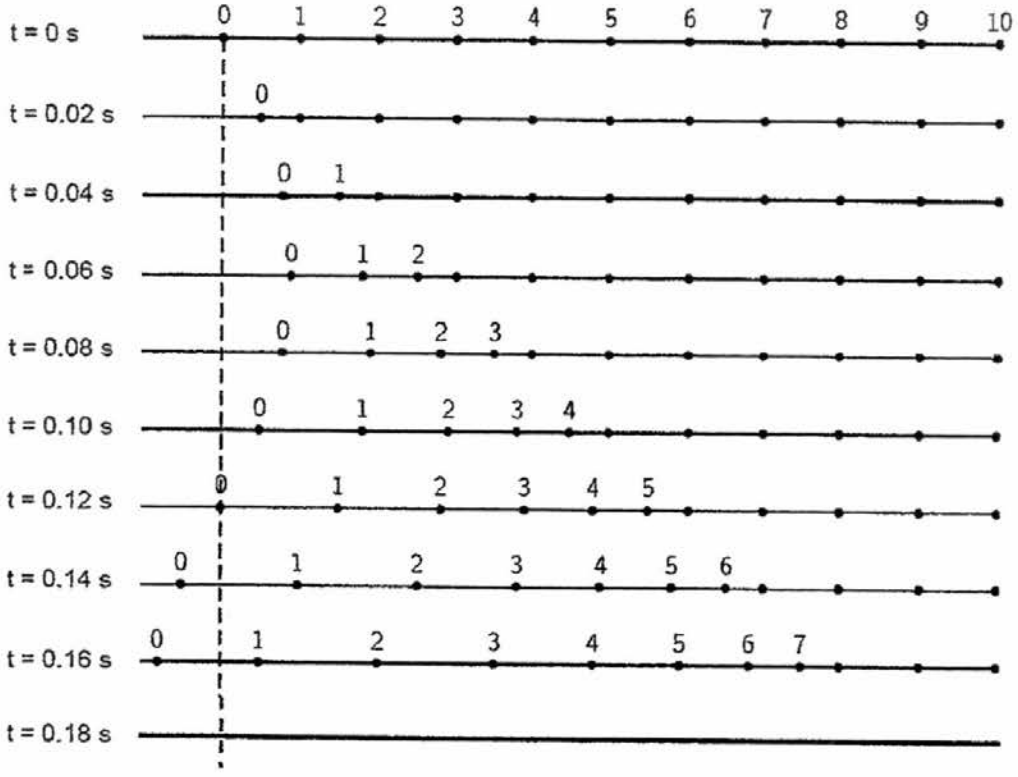
Pressure applied at the small piston = Pressure applied at the large piston (Pressure in the air-filled plastic container)
$P = F / A$
$= 150 / (9.5 \div 10\,000)$ [1]
$= 1.58 \times 10^5$ Pa [1]

iii) If the atmospheric pressure is 10^5 Pa, calculate the density of liquid X in the manometer.

[3]

Since pressure is transmitted uniformly, a pressure of 1.58×10^5 Pa is applied on the left side of the manometer.
Using $\mathbf{P = h\rho g}$,
$10^5 + (\rho \times 10 \times 0.30) = 1.58 \times 10^5$
$3\rho = 0.58 \times 10^5$
$\rho = 19\,333$ kg/m^3

b) The full scale diagram below shows how the positions of particles in a medium changes with time whilst a longitudinal wave, travelling from left to right, passes through the medium. At time t = 0 s, before the arrival of the wave, all



i) State the amplitude of the wave.

1.1 cm ± 0.1 cm

amplitude = ...[1]

ii) On the figure above, indicate the position of particle 2 at t = 0.18 s. [1]

iii) Determine the period of the wave.

Directly below particle 1 when particle 1 is at t = 0.12 s

half oscillation = 0.12 s

one oscillation
= 0.12 x 2 = 0.24 s

period = ...[2]

- End of Paper-