YUYING SECONDARY SCHOOL
END-OF-YEAR EXAMINATION
Secondary 3 Express

NAME

CLASS

REG. NO

PHYSICS

5059

14 October 2016

2 hour

Setter: Mr Alvin Peh

Candidates answer on the Question Paper.
Additional Materials: Multiple Choice Answer Sheet,
Plain Paper and Graph Paper

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on this question booklet and the separate Answer Sheet.
Write in dark blue or black pen on both sides of the paper.
You may use a pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
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 choice in **soft pencil** on the separate Answer Sheet.
Read the instructions on the Answer Sheet very carefully.
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Section B
Answer all questions in the spaces provided.

Section C
Answer **all** questions in the spaces provided.
Question 10 has a choice of parts to answer.

The number of marks is given in brackets [ ] at the end of each question or part question.
The use of an approved calculator is expected, where appropriate.

For Examiner's Use	
Total	100

This document consists of **30** printed pages.

J33

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Section A

Answer **all** the questions in this paper.
The total mark for this section is 30.

1. The dimensions of a rectangular block of wood are measured as 130 mm, 4.0 mm and 3.21 mm. What are the measuring instruments used to obtain such readings?

   (i) metre rule
   (ii) vernier calipers
   (iii) micrometer screw gauge

   A. (i) and (ii) only
   B. (i) and (iii) only
   C. (ii) and (iii) only
   D. (i), (ii) and (iii)

2. Newton's Law of Gravitation is given by $F = \frac{Gm_1m_2}{r^2}$ where m_1 is the mass of particle 1, m_2 is the mass of particle 2, F is the gravitational force, r is the distance between the two particles and G is the universal gravitational constant. Which of the following is the unit for G?

   A. $kg^3\,m^3\,s^2$
   B. $kg\,s^2 / m^3$
   C. $m^3 / kg\,s^2$
   D. $kg^3\,m^3 / s^2$

3. A cyclist, riding at a speed of 5 m/s, brakes with uniform deceleration and stops in 3 m. How long does the cyclist take to stop?

   A. 0.6 s
   B. 1.2 s
   C. 1.33 s
   D. 3.0 s

4. A stone is thrown vertically upwards from the top of a building with a speed of 10 m/s. The stone reaches the ground below after 3 s.
   What is the height of the building?

   A. 5 m
   B. 10 m
   C. 15 m
   D. 20 m

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   B. $kg\,s^2 / m^3$
   C. $m^3 / kg\,s^2$
   D. $kg^3\,m^3 / s^2$

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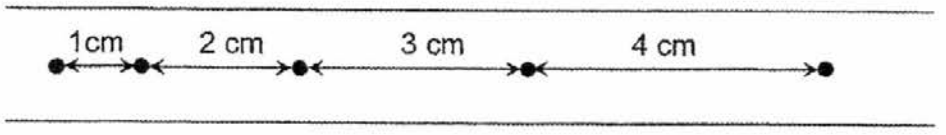
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   A. 5 m
   B. 10 m
   C. 15 m
   D. 20 m

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7. A ticker tape timer vibrates at 50 Hz. The tape in the figure shows the distance moved by a trolley.



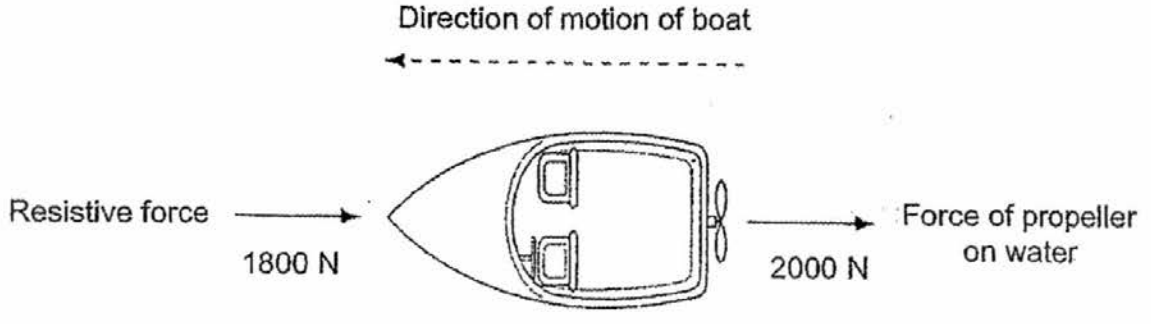
What is the average speed of the trolley for the interval shown?

A. 0.5 cm s^{-1}
B. 12 cm s^{-1}
C. 20 cm s^{-1}
D. 125 cm s^{-1}

8. A child of mass 20 kg slides down a rope which hangs vertically from a tree. If her acceleration is 2.0 ms^{-2}, what is the frictional force between the child and the rope? (Take the gravitational force on a mass of 1 kg to be 10 N.)

A. 40 N
B. 100 N
C. 160 N
D. 200 N

9. The propeller on a boat pushes water backwards with a force of 2000 N. The boat moves through the water against a total resistive force of 1800 N.



Using Newton's Third Law of Motion, what would be the forward force on the propeller due to the water?

A. 200 N
B. 1800 N
C. 2000 N
D. 3800 N

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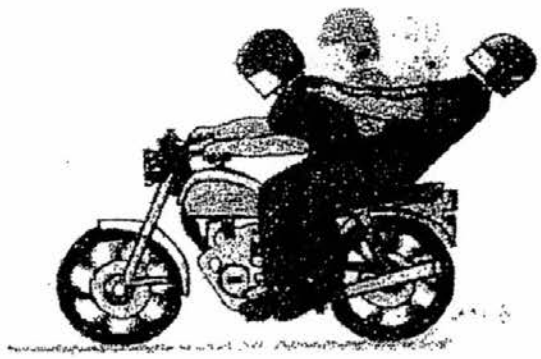
10. An object is moving under the influence of F_1 on a smooth surface. A while later, an opposing force F_2 of the same magnitude acts on it.



What will happen to the object?

A. It will slow down.
B. It will move in the opposite direction.
C. It will come to rest immediately after the opposing force acts on it.
D. It will continue to move but with a constant velocity.

11. The diagram shows a pillion rider moving backwards when the motorcycle accelerates. Which option correctly explains the backward movement of the pillion rider?



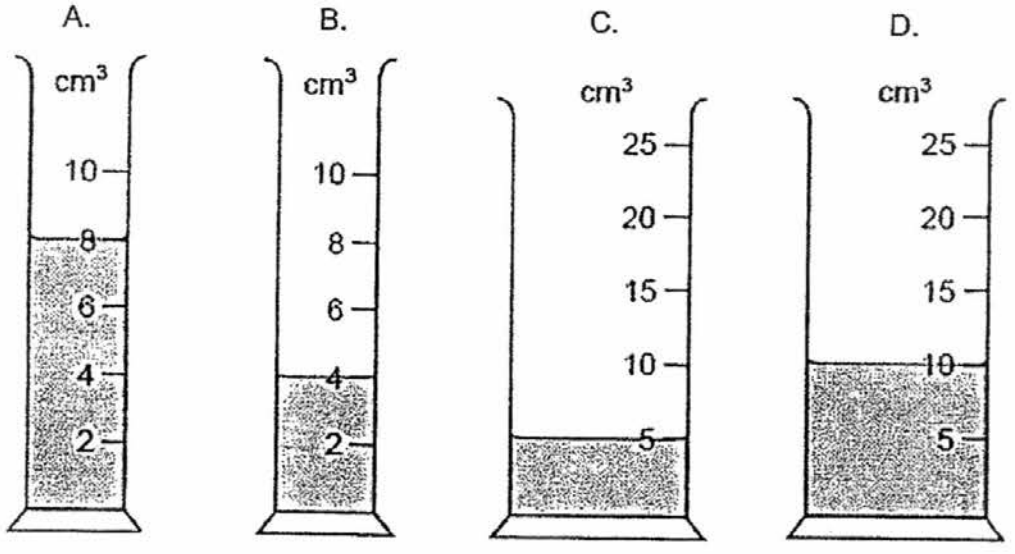
A. the pillion rider having an inertia
B. the forces on the riders being zero
C. the moment of the pillion rider
D. the conservation of total energy of the riders

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15. Which of the following statements about a bag of rice on the Earth is correct?

A. Its weight is measured in kilograms.
B. Its weight is one of the forces acting on it.
C. Its mass is inversely related to its inertia.
D. Its mass at the North Pole is different from its mass at the Equator.

16. The same mass of four different liquids is placed in some measuring cylinders.



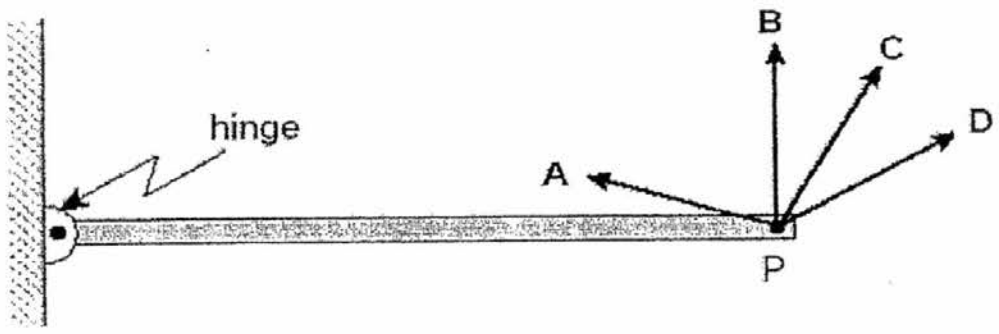
Which measuring cylinder contains the liquid with the greatest density?

17. The density of a silver bar, of volume 10 cm^3, is 10.0 gcm^{-3}. What will be the density of the silver bar when a hole of volume 1.0 cm^3 is drilled into the bar?

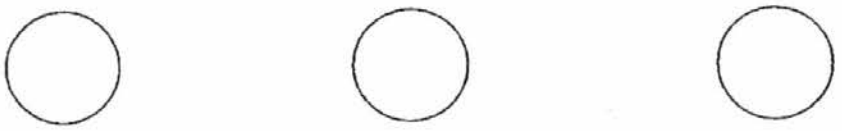
A. 9.0 g cm^{-3}
B. 10.0 g cm^{-3}
C. 10.5 g cm^{-3}
D. 11.0 g cm^{-3}

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18. The diagram below shows a force applied in several different directions at the point P on a hinged beam. In which direction will the force produce the largest moment about the hinge?



19. The diagram illustrates three uniform objects of the same external diameter.

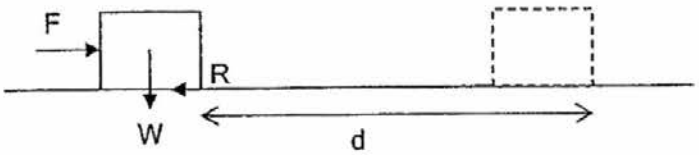


(1) hollow sphere	(2) solid sphere	(3) hollow sphere
mass 100 g	mass 100 g	mass 200 g

Which objects have the centre of gravity at a similar point?

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

20. The figure below shows a box being pushed using a constant force of F through a distance d. The box has a weight of W and there is a total resistive force R acting against the box.

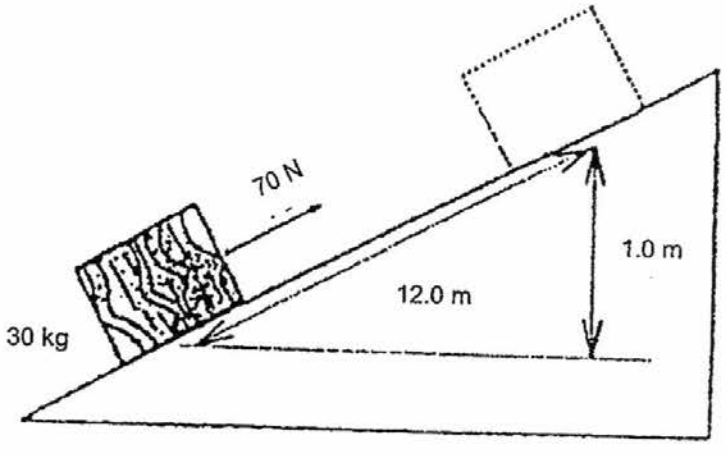


What is the useful work done on the box?

A. Fd – Rd – Wd
B. Fd + Rd + Wd
C. Fd – Rd
D. Fd – Wd

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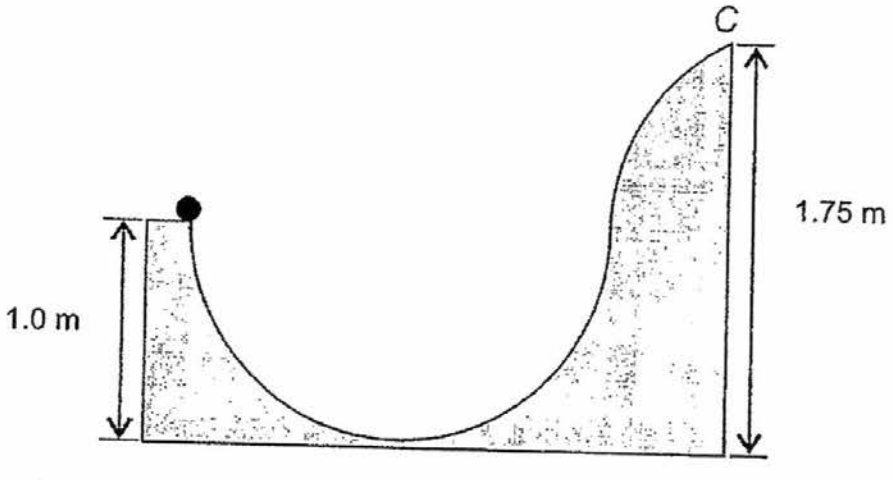
21. A wooden block of mass 30 kg is pulled up a rough inclined plane at a constant speed by a force of 70 N. When the distance moved along the plane is 12.0 m, the increase in height is 1.0 m.



What is the work done against friction for every 1.0 m increase in height?

A. 300 J
B. 360 J
C. 540 J
D. 840 J

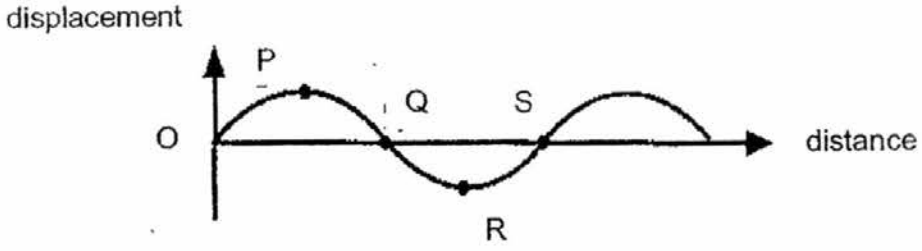
22. Assuming that there is no energy loss, calculate the minimum value of initial speed required for the ball to reach point C as shown in the figure.



A. 2.06 m s^{-1}
B. 3.87 m s^{-1}
C. 4.50 m s^{-1}
D. 5.21 m s^{-1}

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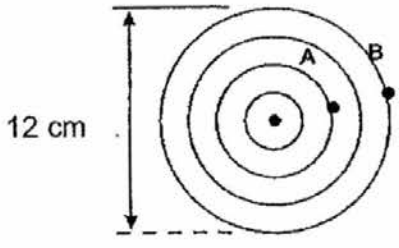
23. The diagram below shows the displacement-distance graph of a transverse wave traveling to the right at a certain instant.



Which of the following statements is correct?

A. Particle P is moving downwards.
B. Particle Q is momentarily at rest.
C. Particle R is moving to the right.
D. Particle S is moving downwards.

24. Circular water waves are produced by a dot vibrator. The wave pattern at a certain instant is as shown in the diagram below.



If the speed of the water waves is 0.6 ms^{-1}, what is the time taken for the wave to travel from A to B?

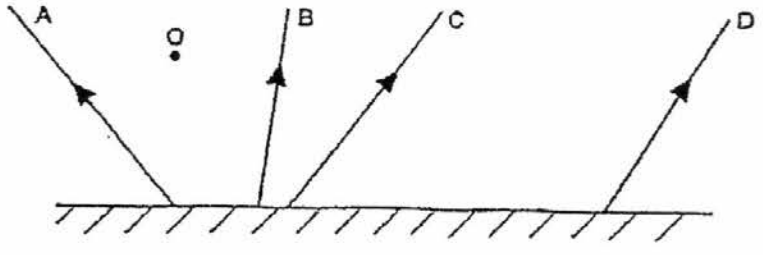
A. 0.05 s
B. 0.67 s
C. 5.0 s
D. 6.7 s

25. Which of the following devices does **not** make use of electromagnetic waves in its operation?

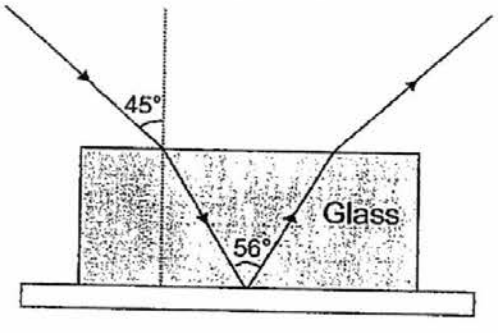
A. camera
B. loudspeaker
C. television remote control
D. sun-tanning machine

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26. The diagram below shows the plan view of an object O in front of a plane mirror. Which one of the reflected rays of light appears to come from the image of O?



27. A piece of glass was placed on top of a polished mirror surface as shown in the figure below. What is the critical angle of glass?



A. 28.1°
B. 41.6°
C. 45.0°
D. 58.5°

28. A pupil did an experiment on a thin converging lens. The distance between the illuminated object to the centre of the lens is recorded as the object distance. He measured and recorded the image height as shown in the table. All the images obtained are real and inverted.

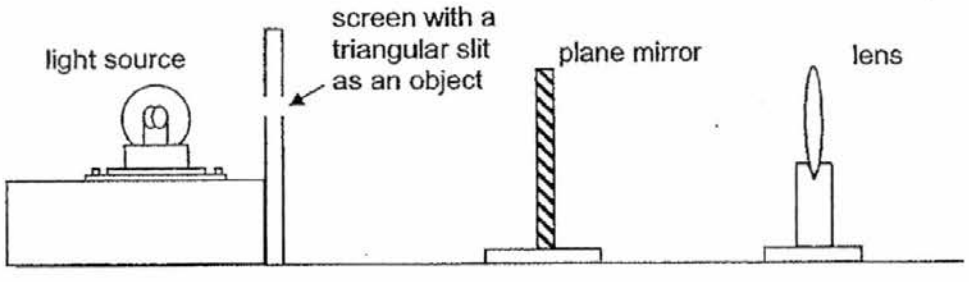
Object height / cm	3.0	3.0
Object distance / cm	9.0	11.0
Image height /cm	3.7	2.5

Which length is most probably the focal length of the lens?

A. 5.0 cm
B. 9.0 cm
C. 10.0 cm
D. 11.0 cm

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29. The diagram below shows some apparatus set up in a Physics Laboratory.



The following is a list of steps taken by a pupil to find the focal length of a convex lens.

(1) Move the object to and fro until a sharp image is formed side by side with it on the screen.
(2) Place a plane mirror behind the lens.
(3) Measure the distance between the lens and the screen.
(4) Measure the distance between the light source and the plane mirror.

Which is the correct order of steps for the pupil to take in order to find the focal length of a convex lens?

A. (1), (2), (3)
B. (2), (1), (3)
C. (2), (1), (4)
D. (4), (1), (3)

30. Which option correctly describes what happens when sound waves pass through a liquid?

A. A convection current is produced throughout the liquid.
B. Molecules vibrate faster about fixed points.
C. Molecules vibrate perpendicularly to the direction of travel of the waves.
D. Molecules vibrate parallel to the direction of travel of the waves.

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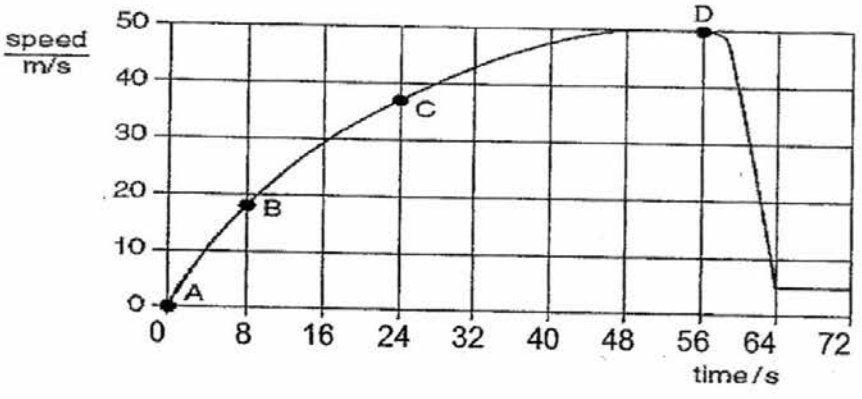
Section B

Answer **all** the questions in this section.
The total mark for this section is 40.

1. During the National Day Parade, parachutists from the Red Lions free fall vertically downwards from a height of 10 000 ft (3 048 m). The figure below shows a parachutist during his descent after his parachute has opened.



The graph shows how the speed of the parachutist varies with time for a section of the flight in the air.



a. State the value of the terminal velocity before and after the opening of the parachute.

i. before opening of the parachute, terminal velocity = ... [1]

ii. after opening of the parachute, terminal velocity = ... [1]

b. Describe the motion of the parachutist between points A and D.

[2]

_____

_____

_____

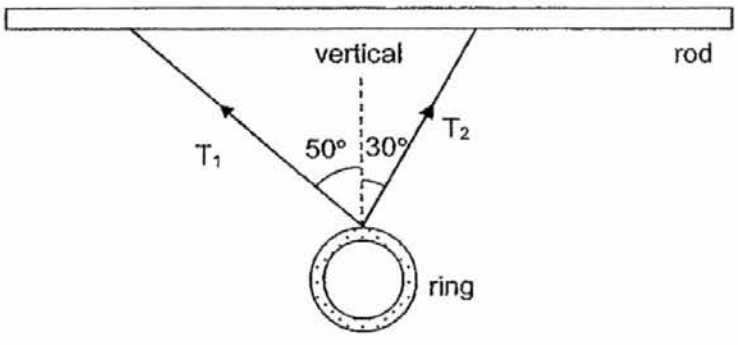
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c. Explain how the velocity changes from the point the parachutist began his descent till just before the parachute was opened.

[3]

2. A ring is supported by two strings that hang from a rod as shown below.



The ring has a weight of 3.0 N

a. State the direction and the size of the resultant force of the two tensions T_1 and T_2.

[2]

angle between resultant force and T_2 = _____ °

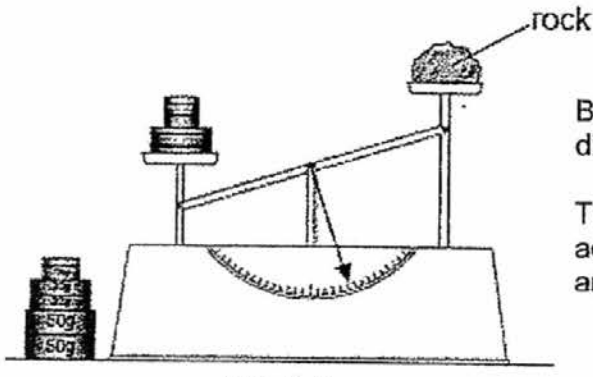
size of the resultant force = _____ N

b. On the plain paper provided, draw a labelled scaled diagram to determine the size of the two tensions T_1 and T_2 in the strings.

[4]

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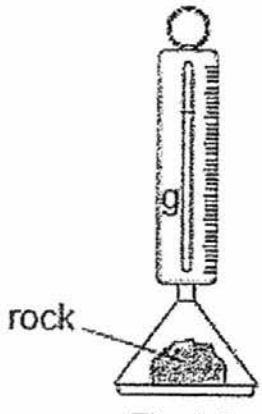
3. A space research organisation plans to send astronauts to Mars to examine rocks on its surface. The organisation will produce a report containing information about conditions on Mars. The gravitational field strength on the surface of Mars is 3.7 Nkg^{-1}.
While still on the surface of Mars, the astronauts will measure the mass of each rock collected. Fig. 3.1 and Fig. 3.2 show two instruments that the astronauts will use.



Balance X and a set of brass discs.

The mass of each disc is accurately determined on Earth and the value is marked on it.

Fig. 3.1



Balance **Y** which is accurately calibrated on Earth and the mass values are marked on the vertical scale.

Fig. 3.2

a. A rock of mass 0.50 kg is dropped on Mars and it falls to the surface. State the acceleration of the falling rock. Assume that there is no air resistance on Mars.

[1]

241

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b. When the two instruments are used on Mars, they will give different readings for the mass of the same rock.

i. Explain the difference in readings by the two instruments.

[2]

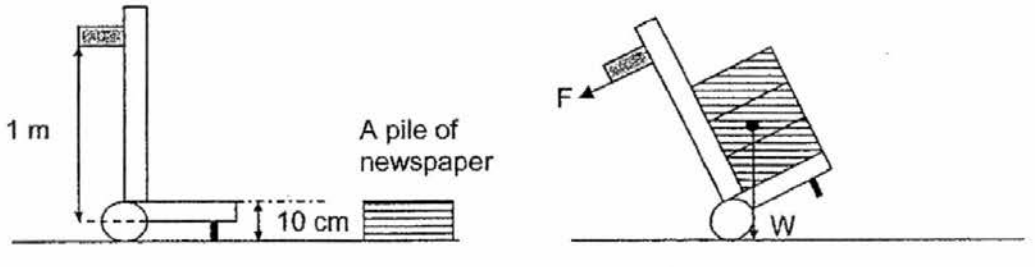
ii. Which instrument, balance X or Y, will give the correct reading of the mass of the rock? Name this instrument.

[1]

c. The astronauts will also determine the density of each rock. Explain if the density of the rock found on Mars differs from its density when brought back to Earth.

[2]

4. A newspaper collector uses a trolley to move his newspaper with ease.



a. Each pile of newspaper has a mass of 5 kg. Calculate the amount of work needed to vertically lift 3 piles of newspaper onto the trolley a pile at the same time.

[2]

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b. Will it be more efficient to lift the piles of newspaper together as shown in Fig 4.1 instead of lifting 1 pile at a time as shown in Fig 4.2? Explain your answer.

[2]

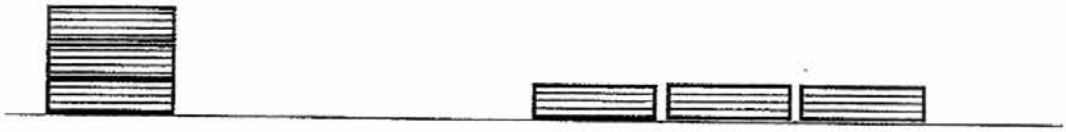


Fig 4.1 Fig 4.2

c. The trolley is then tilted before being moved. The radius of the wheel of the trolley is 5 cm and W is the weight of the papers and trolley.
Calculate F, the minimum amount of force, needed to ready the papers for movement as shown above. The mass of trolley is given as 1 kg.

[2]

d. Should the trolley be tilted more or less to move the paper more efficiently? Explain your answer.

[3]

242

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5. Fig. 5.1 shows a cross-section of a piece of glass which has a refractive index of 1.60. A ray of light is incident normally at the top surface as shown.

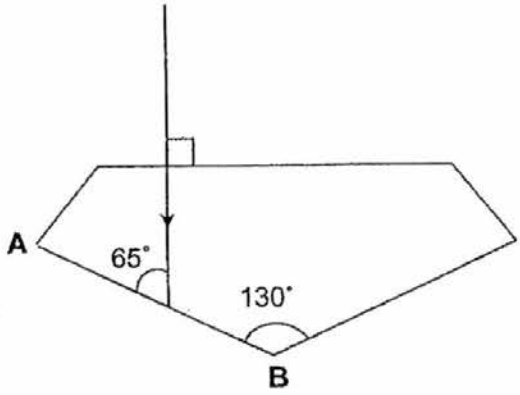


Fig. 5.1

a. Find the angle of refraction of the ray at the boundary AB.

[2]

b. A piece of diamond of refractive index 2.40 is cut to have the same shape as the glass in Fig. 5.1. Explain briefly why the diamond seems to 'glow' whereas the glass piece does not when light falls on it.

[2]

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6. Microwaves are waves in the electromagnetic spectrum.

   a. State the name of the waves in the part of the electromagnetic spectrum that have wavelengths longer than microwaves.

   [1]

   _____

   b. Explain why the frequency of these waves is lower than the frequency of microwaves.

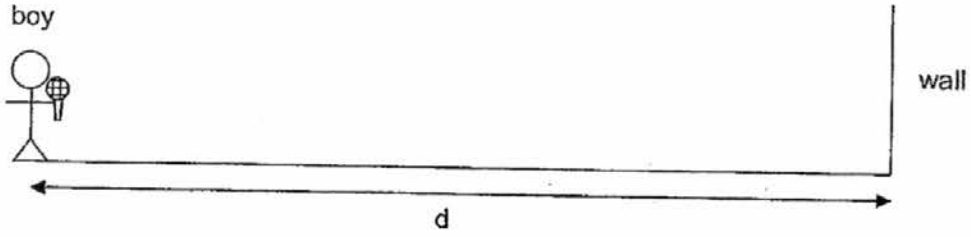
   [1]

   _____

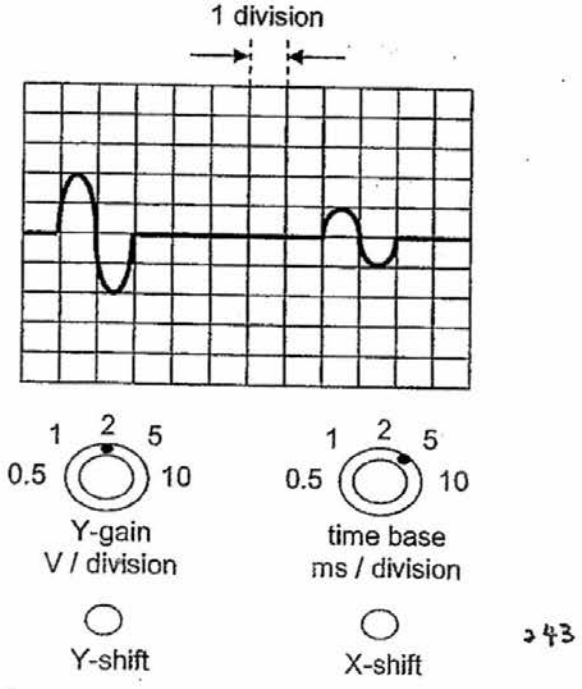
   _____

   _____

7. A boy, holding a microphone, is standing a distance d from a wall.



The microphone is connected to a cathode ray oscilloscope (C.R.O.) with four controls. When the boy claps once, the sound is received by the microphone and the audio signal is displayed on the C.R.O. as shown below.



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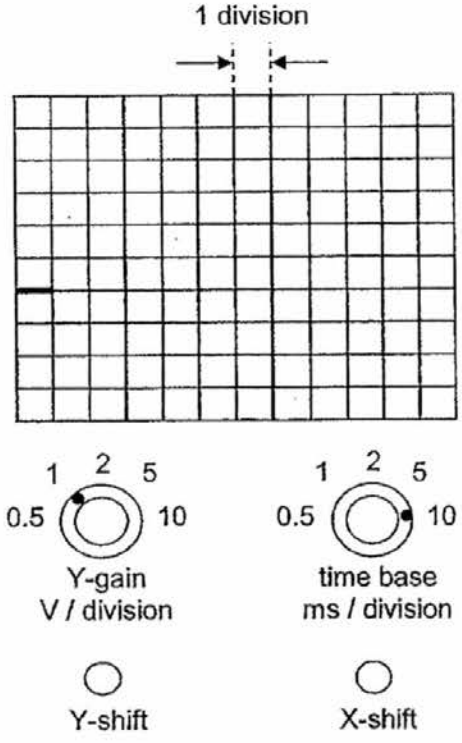
a. Determine the frequency of the sound due to the clap.

[2]

b. If the speed of sound in air is 330 ms^{-1}, determine the distance, d, between the boy and the wall.

[2]

c. Another student then adjusts the display controls of the C.R.O. Part of the signal is given as shown below.



In the display above, complete the signal with the new settings.

[2]

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Section C

Answer **all** the questions in this section in the spaces provided.
Question 10 is in the form either/or
and only **one** of the alternatives should be attempted.
The total mark for this section is 30.

8. Fig. 8.1 shows a 1.2 kg trolley being pulled along a rough horizontal bench by means of tension, T, in the thread fastened to the trolley. The other end of the thread is attached to a mass-hanger of mass 200 g.

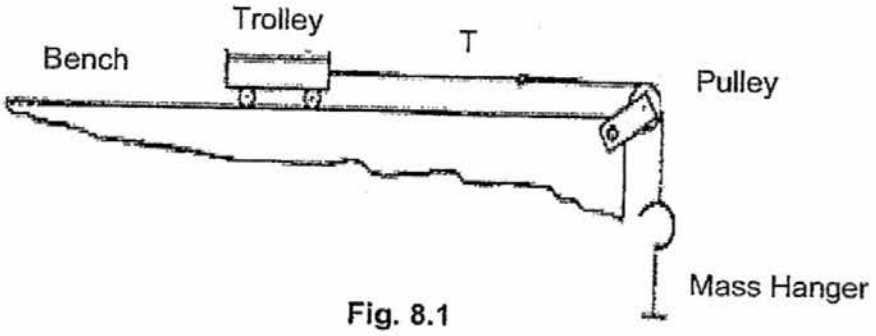


Fig. 8.1

a. Draw the free body diagram illustrating all the forces acting on the trolley.

[2]

b. The frictional force between the wheels of the trolley and the surface of the bench is 0.5 N. Calculate the acceleration of the trolley.

[3]

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c. From your answer in (a) and (b), describe in detail, the motion of the trolley.

[2]

d. Suggest a way in which the friction between the wheels and the bench can be reduced.

[1]

e. If the trolley is loaded with sand, compare the change in speed of the loaded and unloaded trolley.

[2]

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9. Ultrasound is a type of high frequency sound used in medical diagnosis. Important information about the internal structures of the body can be obtained by using a detector to analyse the reflections from the internal structures.

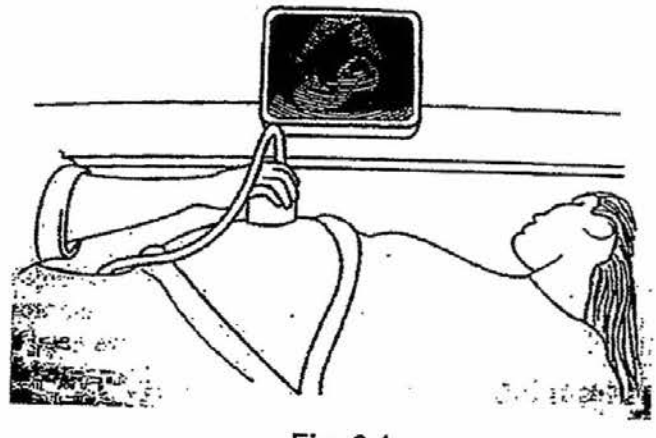


Fig. 9.1

Fig. 9.1 shows an ultrasonic scanner used to monitor the development of the baby of a pregnant woman. As an ultrasonic wave travel through the body tissues, energy is lost (attenuated) and the amplitude and intensity of the ultrasonic wave reduces.

Attenuation is measured in decibels per centimetre ($dBcm^{-1}$) of tissue and is represented by the attenuation coefficient of the specific tissue type. The higher the attenuation coefficient, the more attenuated the ultrasonic wave is affected by the specified tissue.

Attenuation is an important concept as it limits the depth of the image that can be obtained via ultrasound.

The table below shows the attenuation coefficients and speeds of ultrasonic waves, transmitted at 1 MHz, through different body tissues.

body tissue	**attenuation coefficient / $dBcm^{-1}$**	**speed / ms^{-1}**
water	0.002	1484
fat	0.63	1450
liver	0.5 - 0.94	1570
bone	5.0	4080

Sources: http://usra.ca/tissue.php & https://wiki.engr.illinois.edu

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a. Describe how ultrasonic waves are transmitted from the scanner, through the body tissues, to the baby of the pregnant woman.

[2]

b. Describe one difference between an ultrasound and electromagnetic waves.

[1]

c. By studying the values in table, estimate the attenuation coefficient of human blood for an ultrasonic wave transmitted at 1 MHz.

[1]

d. Describe **two** properties of sound waves that contribute to the attenuation of ultrasonic waves in body tissues.

[2]

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e. Explain why ultrasound is often **not** used in the medical diagnosis of bones in the body.

[2]

f. Calculate the wavelength of ultrasonic waves in the fat of the body of the pregnant woman.

[2]

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Either

10a. State what is meant by the moment of a force and state how it can be calculated. [2]

10b. Fig. 10.1 shows a non-uniform rod PQ of length 35 cm attached to two strings A and B of equal length. The tension in string A is 5 N and that in string B is 2 N.

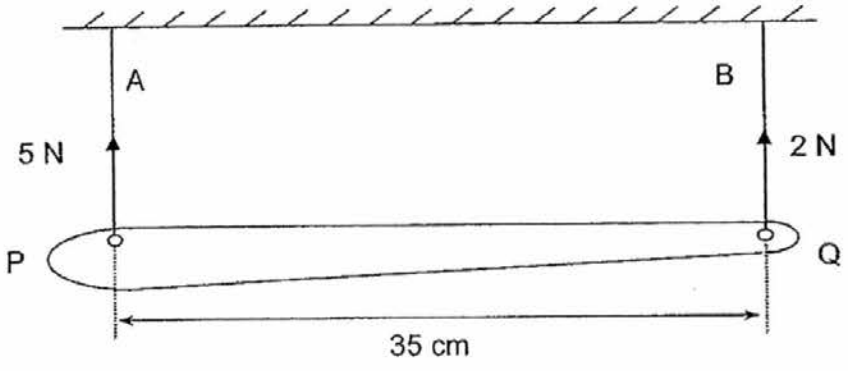


Fig. 10.1

Determine the following:

i. the weight of PQ, [1]

ii. the position of the centre of gravity of PQ from the end P. [2]

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10c. Fig. 10.2 shows a sheet of metal suspended from a hole in one corner at A. The weight of the metal is 0.10 N and the centre of gravity is at G. The metal sheet swings freely and comes to rest.

i. In the space next to the given figure, sketch a diagram of the sheet in its final rest position. Mark points A and G on your diagram.

[1]

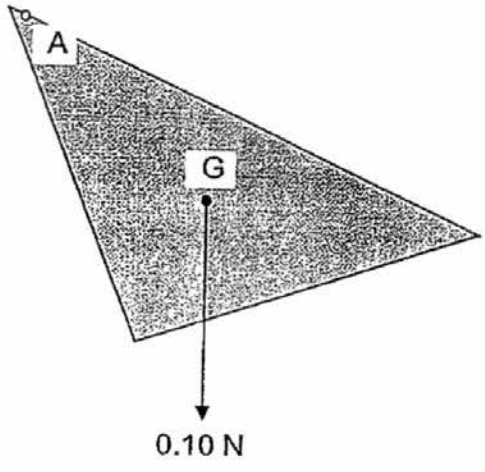


Fig. 10.2

ii. Explain why the sheet remains at rest in this position.

[2]

10d. The metal sheet is placed on a table. State two reasons why it is more stable when it is placed flat on the table than when it is placed on the table in a vertical position.

[2]

247

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Or

10a. In an experiment to find the focal length of a convex lens, the following readings were obtained.

distance of object from lens, u/cm	40.0	31.5	27.0	23.0	17.5	15.5	12.0
distance of image from lens, v/cm	10.0	12.5	15.0	17.5	22.5	25.0	30.0

i. Using a scale of 1.0 cm to 2.5 cm for both axes, plot a graph of u/cm against v/cm on the graph paper provided.

[3]

ii. Use the graph to find the value of u and v when they are equal by drawing the line u= v.

[1]

value of u = _____ cm

value of v = _____ cm

iii. Using the relationship,

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

determine the focal length of the lens.

[2]

10b. In what way(s) are the images formed by a camera and a slide projector similar and in what way(s) are they different?

[2]

_____

_____

_____

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Section A

Answer **all** the questions in this paper.
The total mark for this section is 30.

1. The dimension of a rectangular block of wood is measure as 130 mm, 4.0 mm and 3.21 mm. What are the measuring instruments used to obtain such readings?

   (i) *metre rule*
   (ii) *vernier calipers*
   (iii) *micrometer screw gauge*

   A. (i) and (ii) only
   B. (i) and (iii) only
   C. (ii) and (iii) only
   D. (i), (ii) and (iii)

2. Newton's Law of Gravitation is given by $F = \frac{Gm_1m_2}{r^2}$ where m_1 is the mass of particle 1, m_2 is the mass of particle 2, F is the gravitational force, r is the distance between the two particles and G is the universal gravitational constant.

   Which of the following is the unit for G?

   A. $kg^3\,m^3\,s^2$
   B. $kg\,s^2 / m^3$
   C. $m^3 / kg\,s^2$
   D. $kg^3\,m^3 / s^2$

3. A cyclist, riding at a speed of 5 m/s, brakes with uniform deceleration and stops in 3 m. How long does the cyclist take to stop?

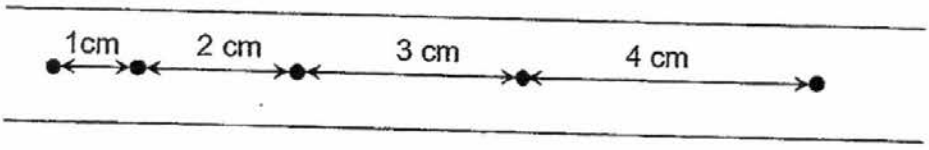
   A. 0.6 s
   B. 1.2 s
   C. 1.33 s
   D. 3.0 s

4. A stone is thrown vertically upwards from the top of a building with a speed of 10 m/s. The stone reaches the ground below after 3 s. What is the height of the building?

   A. 5 m
   B. 10 m
   C. 15 m
   D. 20 m

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7. A ticker tape timer vibrates at 50 Hz. The tape in the figure shows the distance moved by a trolley.



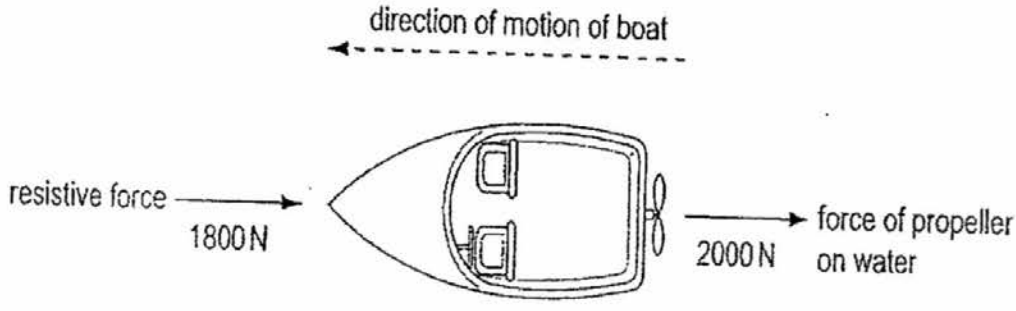
What is the average speed of the trolley for the interval shown?

A. 0.50 cm s^{-1}
B. 12 cm s^{-1}
C. 20 cm s^{-1}
D. 125 cm s^{-1}

8. A child of mass 20 kg slides down a rope which hangs vertically from a tree. If her acceleration is 2.0 m s^{-2}, what is the frictional force between the child and the rope? (Take the gravitational force on a mass of 1 kg to be 10 N.)

A. 40 N
B. 100 N
C. 160 N
D. 200 N

9. The propeller on a boat pushes water backwards with a force of 2000 N. The boat moves through the water against a total resistive force of 1800 N.



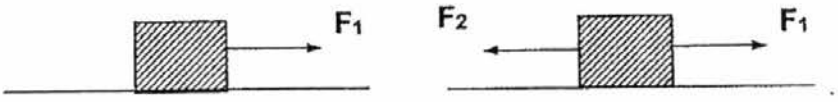
Using Newton's Third Law of Motion, what would be the forward force on the propeller due to the water?

A. 200 N
B. 1800 N
C. 2000 N
D. 3800 N

250

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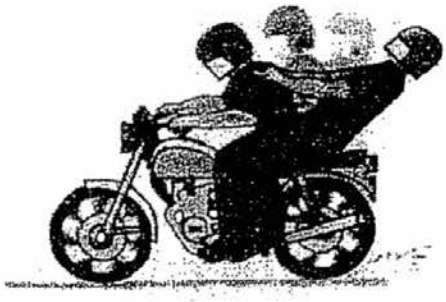
10. An object is moving under the influence of F_1 on a smooth surface. A while later, an opposing force F_2 of the same magnitude acts on it.



What will happen to the object?

A. The object will slow down.
B. The object will move in the opposite direction.
C. The object will come to rest immediately after the opposing force acts on it.
D. The object will continue to move but with a constant velocity.

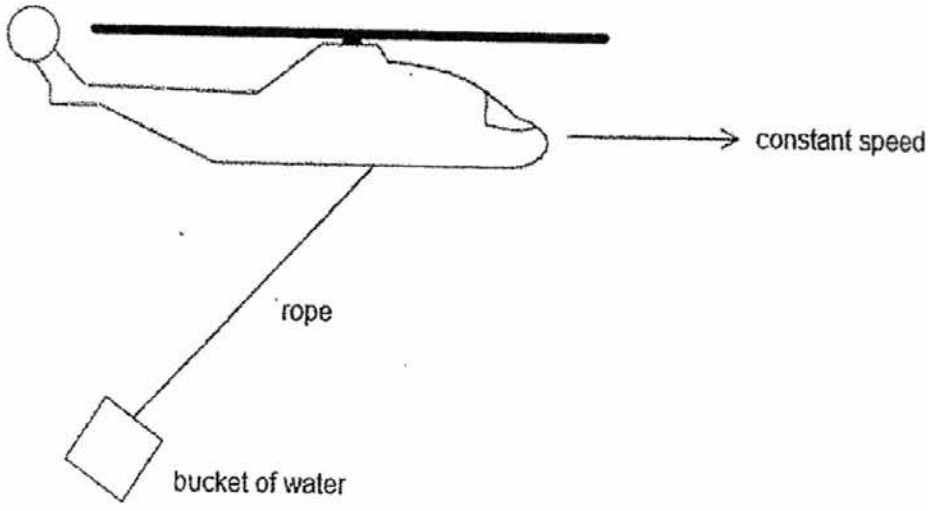
11. The diagram shows a pillion rider moving backwards when the motorcycle accelerates. Which option correctly explains the backward movement of the pillion rider?



A. the pillion rider having an inertia
B. the forces on the riders being zero
C. the moment of the pillion rider
D. the conservation of total energy of the riders

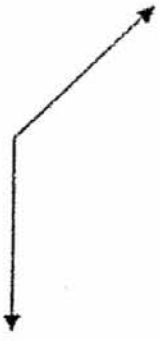
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12. A fire-fighting helicopter is flying at constant speed along a horizontal straight-line carrying a bucket of water as shown in the diagram below. The rope to the bucket makes a fixed angle with the vertical.

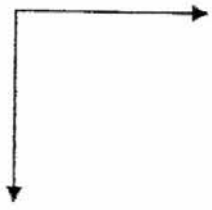


Which of the following diagrams is the correct free body diagram of the forces acting on the bucket?

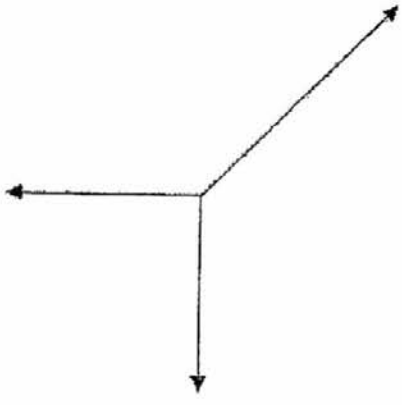
A.



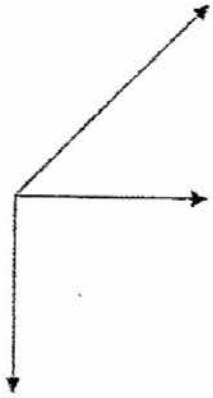
B.



C.



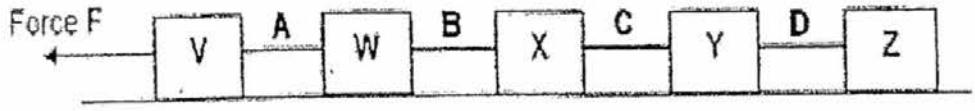
D.



251

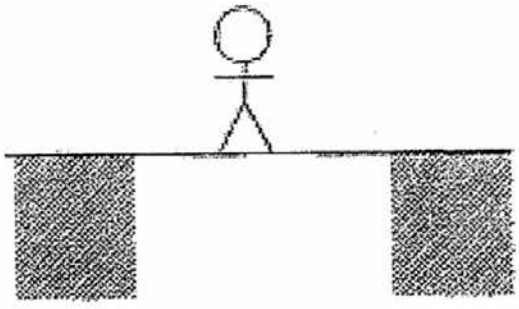
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13. Five blocks of equal masses V, W, X, Y and Z are connected by four identical strings as shown in the diagram. They are pulled by a steadily increasing force F.



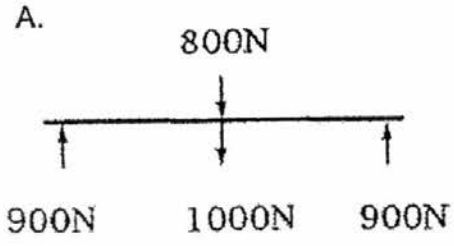
Which of the strings A, B, C or D is most likely to break first?

14. The diagram below shows a man of weight 800 N standing in the middle of a uniform, rigid, horizontal plank. The plank weighs 1000 N.

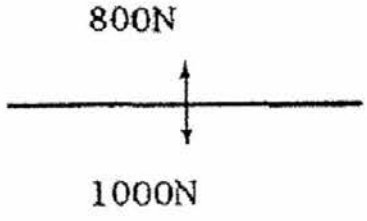


Which of the following diagrams show the forces on the plank?

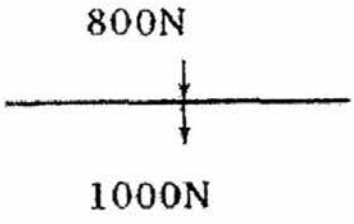
A.



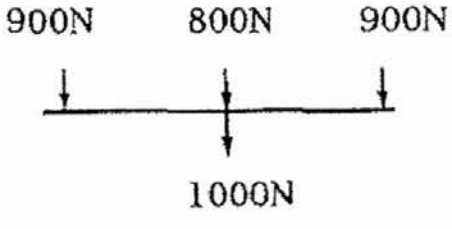
B.



C.



D.

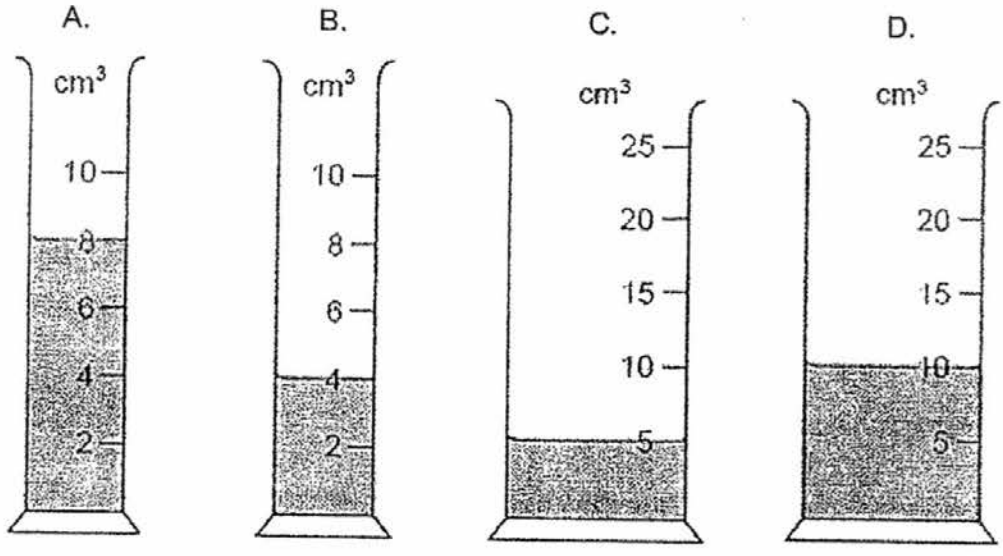


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15. Which of the following statement about a bag of rice on the Earth is correct?

A. The weight of a bag of rice is measured in kilograms.
B. The weight of a bag of rice is one of the forces acting on it.
C. The mass of a bag of rice is inversely related to its inertia.
D. The mass of a bag of rice at the North Pole is different from its mass at the Equator.

16. The same mass of four different liquids is placed in some measuring cylinders.



Which measuring cylinder contains the liquid with the greatest density?

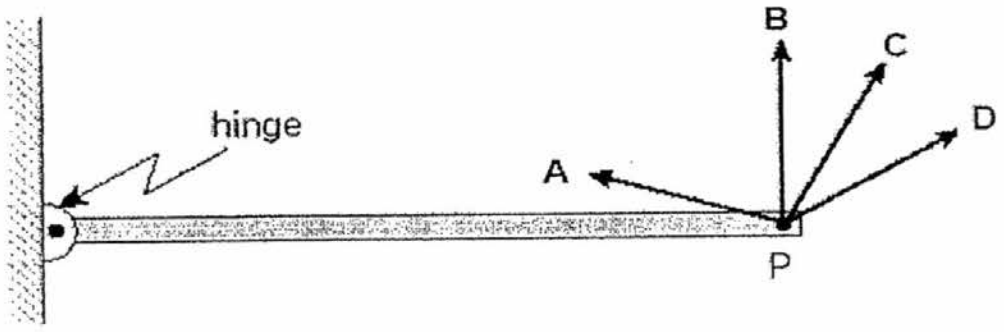
17. The density of a silver bar, of volume 10 cm^3, is 10.0 g cm^{-3}. What will be the density of the silver bar when a hole of volume 1.0 cm^3 is drilled into the bar?

A. 9.0 g cm^{-3}
B. 10.0 g cm^{-3}
C. 10.5 g cm^{-3}
D. 11.0 g cm^{-3}

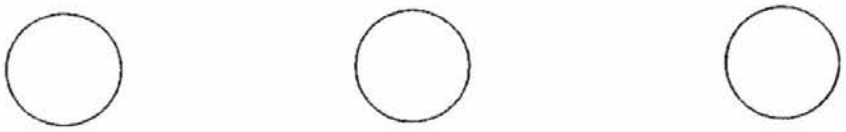
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18. The diagram below shows a force applied in several different directions at the point P on a hinged beam. In which direction will the force produce the largest moment about the hinge?



19. The diagram illustrates three uniform objects of the same external diameter.



(1) hollow sphere
mass 100 g

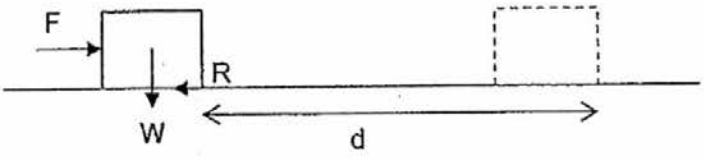
(2) solid sphere
mass 100 g

(3) hollow sphere
mass 200 g

Which objects have the centre of gravity at a similar point?

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

20. The figure below shows a box being pushed using a constant force of F through a distance d. The box has a weight of W and there is a total resistive force R acting against the box.

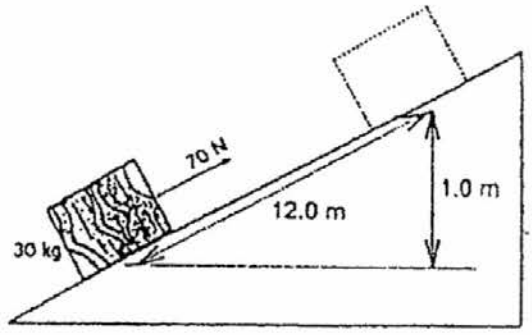


What is the useful work done on the box?

A. Fd – Rd – Wd
B. Fd + Rd + Wd
C. Fd – Rd
D. Fd – Wd

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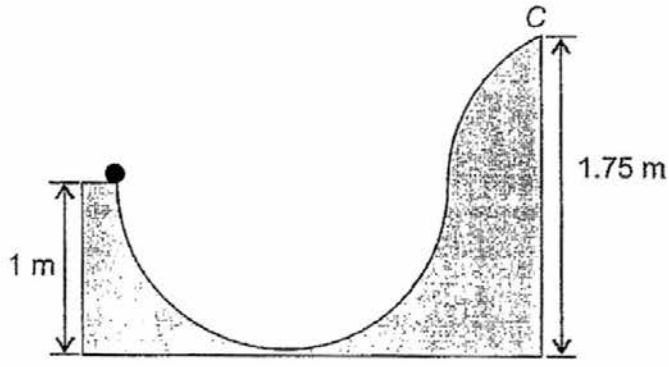
21. A wooden block of mass 30 kg is pulled up a rough inclined plane at a constant speed by a force of 70 N. When the distance moved along the plane is 12.0 m, the increase in height is 1.0 m.



What is the work done against friction for every 1.0 m increase in height?

A. 300 J
B. 360 J
C. 540 J
D. 840 J

22. Assuming that there is no energy loss, calculate the minimum value of initial speed required for the ball to reach point C as shown in the figure.

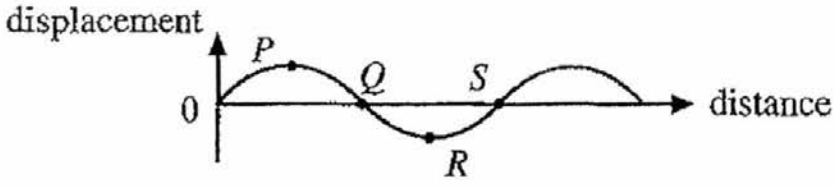


A. 2.06 m s–1
B. 3.87 m s^{-1}
C. 4.50 m s^{-1}
D. 5.21 m s^{-1}

>53

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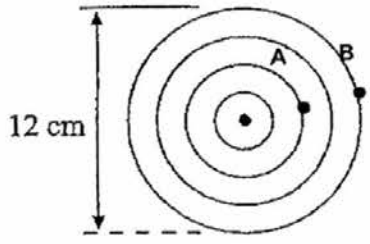
23. The diagram below shows the displacement-distance graph of a transverse wave traveling to the right at a certain instant.



Which of the following statements is correct?

A. Particle P is moving downwards.
B. Particle Q is momentarily at rest.
C. Particle R is moving to the right.
D. Particle S is moving downwards.

24. Circular water waves are produced by a dot vibrator. The wave pattern at a certain instant is as shown in the diagram below.



If the speed of the water waves is 0.6 m s^{-1}, what is the time taken for the wave to travel from A to B?

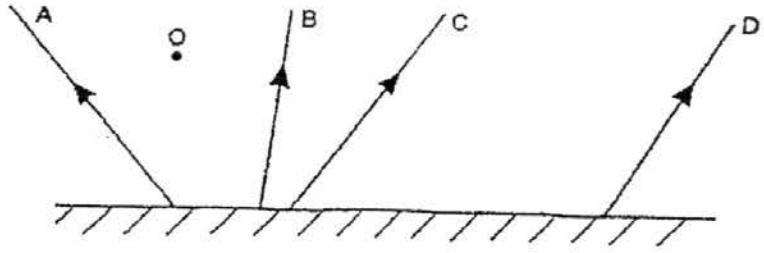
A. 0.050 s
B. 0.67 s
C. 5.0 s
D. 6.7 s

25. Which of the following devices does **NOT** make use of electromagnetic waves in its operation?

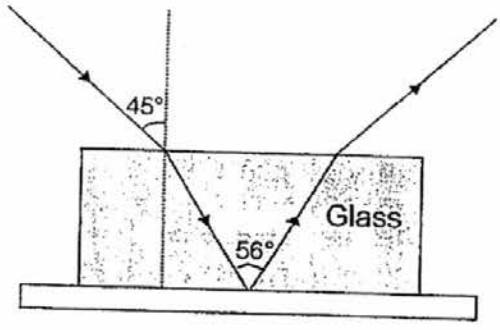
A. camera
B. loudspeaker
C. television remote control
D. sun-tanning machine

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26. The diagram below shows the plan view of an object O in front of a plane mirror. Which one of the reflected rays of light appears to come from the image of O?



27. A piece of glass was placed on top of a polished mirror surface as shown in the figure below. What is the critical angle of glass?



A. 28.1°
B. 41.6°
C. 45.0°
D. 58.5°

28. A pupil did an experiment on a thin converging lens. The distance between the illuminated object to the centre of the lens is recorded as the object distance. He measured and recorded the image height as shown in the table. All the images obtained are real and inverted.

Object height / cm	3.0	3.0
Object distance / cm	9.0	11.0
Image height /cm	3.7	2.5

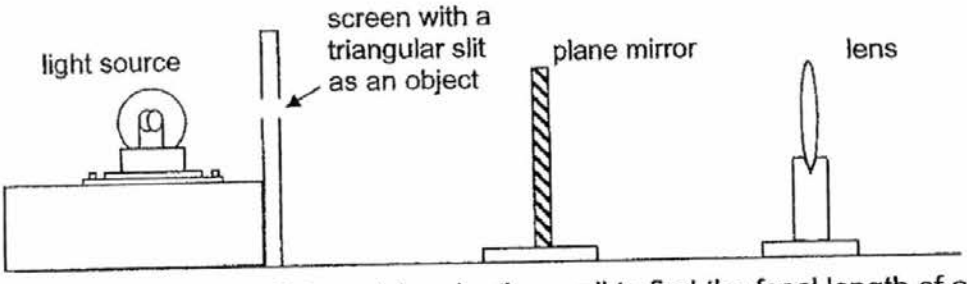
Which length is most probably the focal length of the lens?

A. 5.0 cm
B. 9.0 cm
C. 10.0 cm
D. 11.0 cm

254

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29. The diagram below shows some apparatus setup in a Physics Lab.



The following is a list of steps taken by the pupil to find the focal length of a convex lens.

(1) Move the object to and fro until a sharp image is formed side by side with it on the screen.
(2) Place a plane mirror behind the lens.
(3) Measure the distance between the lens and the screen.
(4) Measure the distance between the light source and the plane mirror.

Which is the correct order of steps for the pupil to take in order to find the focal length of a convex lens?

A. (1), (2), (3)
B. (2), (1), (3)
C. (2), (1), (4)
D. (4), (1), (3)

30. Which option correctly describes what happens when sound waves pass through liquid?

A. a convection current is produced throughout the liquid
B. molecules vibrate faster about fixed points
C. molecules vibrate perpendicularly to the direction of travel of the waves
D. molecules vibrate parallel to the direction of travel of the waves

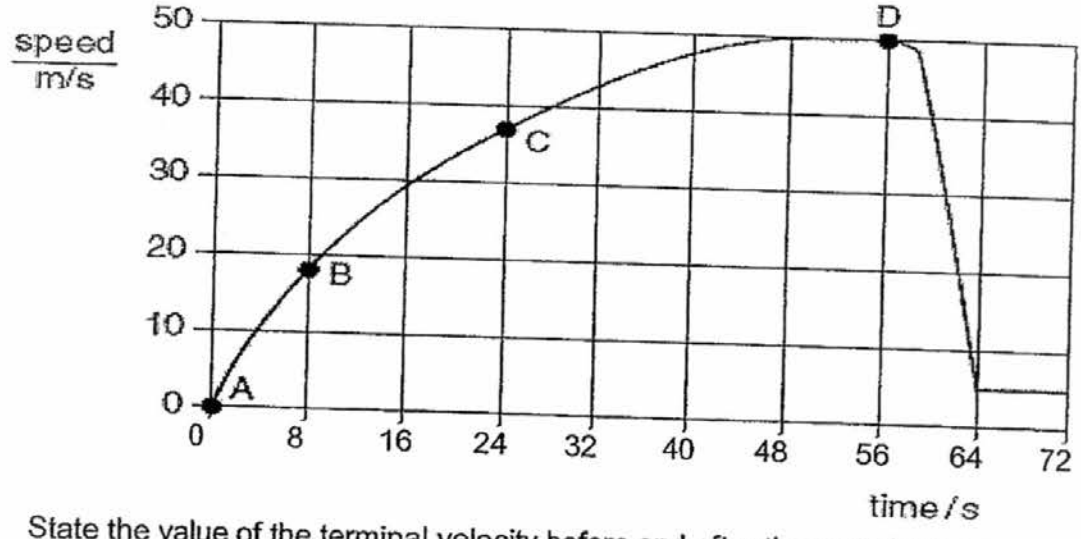
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Section B

Answer **all** the questions in this section.
The total mark for this section is 40.

1. During the National Day Parade, parachutists from the Red Lions free-fall vertically downwards from a height of 10 000 ft (3 048 m). The figure below shows a parachutist during his descend after his parachute has opened. The graph shows how the speed of the parachutist varies with time for a section of the flight in the air.





a. State the value of the terminal velocity before and after the parachute opens.

i. before parachute opens, terminal velocity = ... [1]

ii. after parachute opens, terminal velocity = ... [1]

before parachute opens, terminal velocity = 50 m/s	A[1]
after parachute opens, terminal velocity = 5 m/s	A[1]

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b. Describe the motion of the parachutist between A and D.

[2]

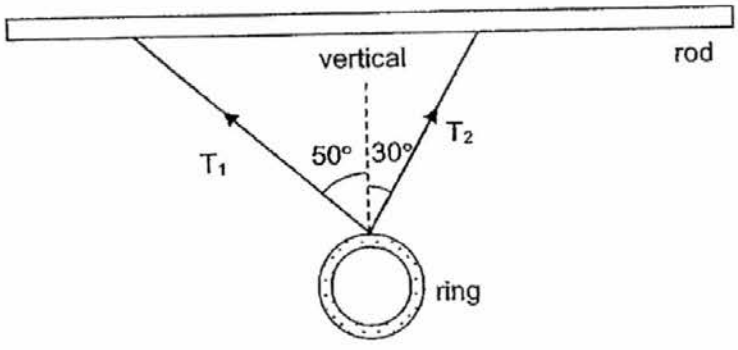
The speed is ***increasing*** at a ***decreasing*** rate.	A[1] for each ***bold*** word

c. Explain how the velocity changes from the point the parachutist begin his descend till just before the parachute is opened.

[3]

Initially, the amount of air resistance experienced by the parachutist is zero. Thus the resultant force experienced by him is due to his weight.	A[1]
Thus will create him to experience a large value of acceleration since F = ma	A[1/2]
As the amount of air resistance increases over time, the resultant force experienced by him gradually decreased.	A[1]
Thus the acceleration experienced by the parachutist is reduced over time.	A[1/2]

2. A ring is supported by two strings that hang from a rod as shown below.



The ring has a weight of 3.0 N

a. State the direction and the size of the resultant force of the two tensions T_1 and T_2.

[2]

angle between resultant force and T_2 = _____ °

size of the resultant force = _____ N

angle between resultant force and T_2 = 30 °	A[1]
size of the resultant force = 3 N	A[1]

b. In the plain paper provided, draw a labelled scaled diagram to determine the size of the two tensions T_1 and T_2 in the strings.

[4]

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3. A space research organisation plans to send astronauts to Mars to examine rocks on its surface. The organisation will produce a report containing information about conditions on Mars. The gravitational field strength on the surface of Mars is 3.7 N kg^{-1}.

While still on the surface of Mars, the astronauts will measure the mass of each rock collected. Fig. 3.1 and Fig. 3.2 show two instruments that the astronauts will use:

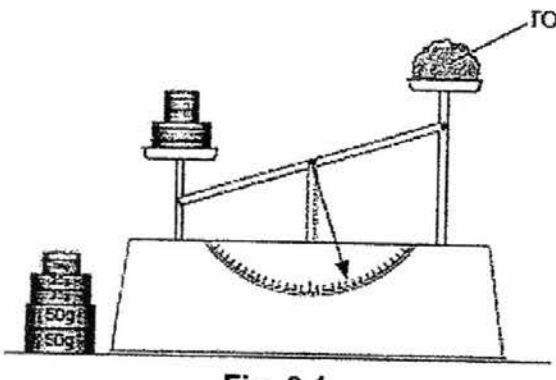


Fig. 3.1

Balance X and a set of brass discs;

The mass of each disc is accurately determined on Earth and the value is marked on it.

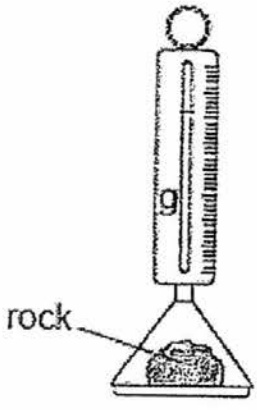


Fig. 3.2

Balance **Y** which is accurately calibrated on Earth and the mass values are marked on the vertical scale.

a. A rock of mass 0.50 kg is dropped on Mars and it falls to the surface. State the acceleration of the falling rock. Assume that there is no air resistance on Mars.

[1]

acceleration = 3.7 ms^{-2}	A[1]

256

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b. When the two instruments are used on Mars, they will give different readings for the mass of the same rock.

i. Explain the difference in readings by the two instruments.

[2]

Mass remains the same when it is being measured on Mars.	A[1]
Weight is dependent on the gravitational field strength and will be different when measured on Mars.	A[1]

ii. Which instrument, balance X or Y, will give the correct reading of the mass of the rock? Name this instrument.

[1]

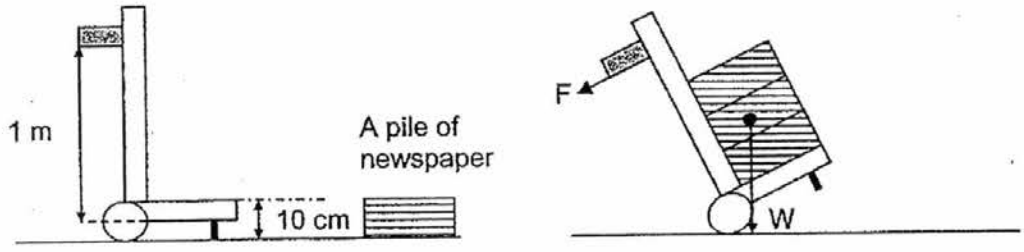
Balance X	A[1/2]
Beam Balance	A[1/2]

c. The astronauts will also determine the density of each rock. Explain if the density of the rock found on Mars differs from its density when brought back to Earth.

[2]

Density will remain the same.	A[1]
It is dependent on the ***mass*** and the ***volume*** if the rock and not the weight.	A[1]

4. A newspaper collector uses a trolley to move his newspaper with ease.



a. Each pile of newspaper has a mass of 5 kg. Calculate the amount of work needed to vertically lift 3 piles of newspaper onto the trolley a pile at the same time.

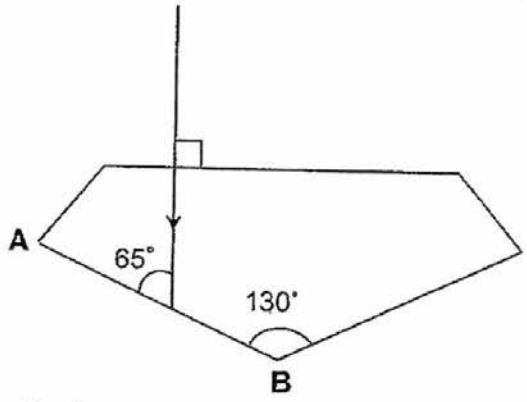
[2]

Work done = F x d	
Work done = 3 x (50 x 0.1)	A[1]
Work done = 15 J	A[1]

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5. The figure below shows a cross-section of a piece of glass which has a refractive index of 1.60. A ray of light is incident normally at the top surface as shown.



a. Find the angle of refraction of the ray at the boundary AB

[2]

$n_i \sin i = n_r \sin r$	
$1.6 \times \sin 25 = 1.00 \times \sin r$	A[1]
$\sin r = 0.6762$	
$r = 42.5°$	A[1]

b. A piece of diamond of refractive index 2.40 is cut to have the same shape as the glass in the figure. Explain briefly why the diamond seems to 'glow' whereas the glass piece does not when light falls on it.

[2]

When the refractive index is higher, the critical angle will be reduced as shown in the calculation.	A[1/2]
$\sin c = 1 \div n$ $\sin c = 1 \div 2.4$ $c = 24.6°$	A[1/2]
With a smaller critical angle, it is more likely for the light rays to undergo total internal reflection and be refracted back into air at the top surface of the diamond.	A[1]

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6. Microwaves are waves in the electromagnetic spectrum.

a. State the name of the waves in the part of the electromagnetic spectrum that have wavelengths longer than microwaves.

[1]

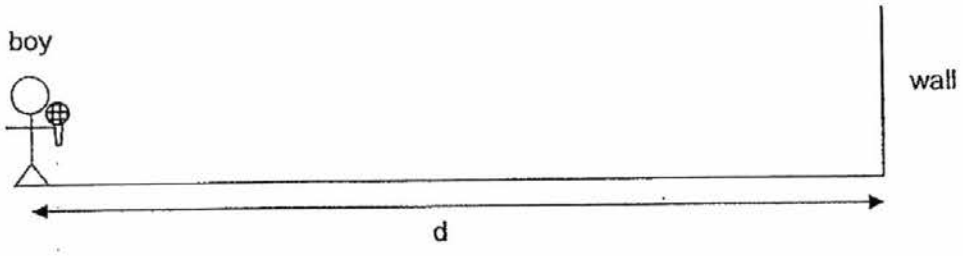
Radiowaves	A[1]

b. Explain why the frequency of these waves is lower than the frequency of microwaves.

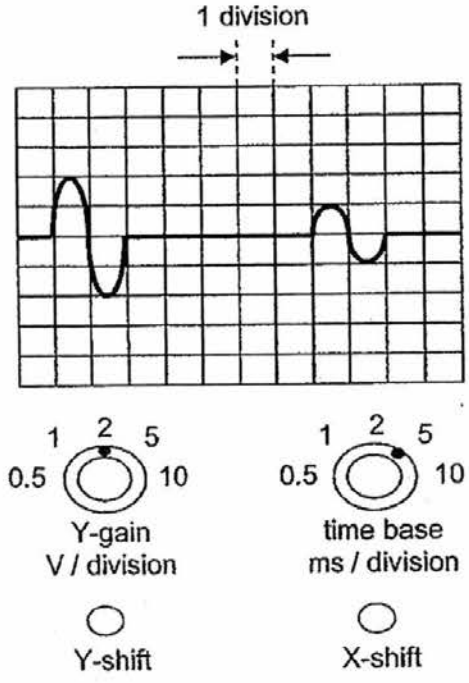
[1]

As all the waves in the electromagnetic spectrum travel at the same speed in vacuum,	A[1/2]
The frequency is lower when the wavelength is larger according to the relationship $v = f\lambda$	A[1/2]

7. A boy, holding a microphone, is standing a distance d from a wall.



The microphone is connected to a cathode ray oscilloscope (C.R.O.) with four controls. When the boy claps once, the sound is received by the microphone and the audio signal is displayed on the C.R.O. as shown below.

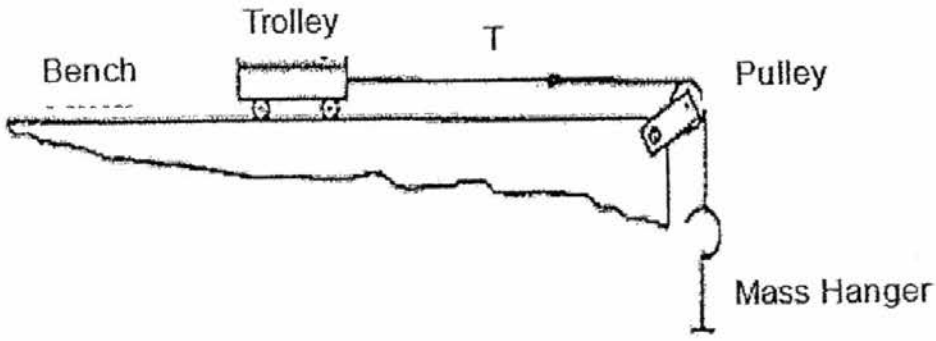


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Section C

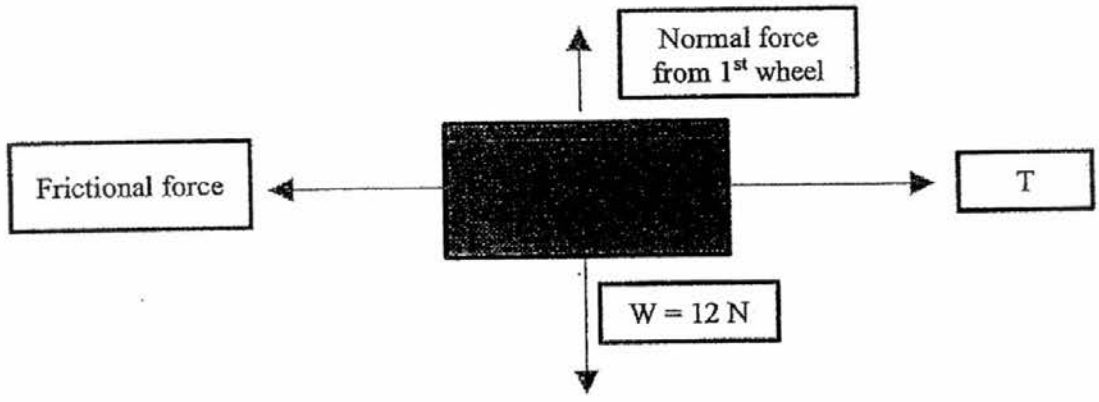
Answer **all** the questions in this section in the spaces provided.
Question 10 is in the form either/or
and only **one** of the alternatives should be attempted.
The total mark for this section is 30.

8. The figure shows a 1.2 kg trolley being pulled along a rough horizontal bench by means of tension T in the thread fastened to the trolley. The other end of the thread is attached to a mass-hanger of mass 200 g.



a. Draw in the space below, the free body diagram illustrating all the forces acting on the trolley.

[2]



A[1/2] for each correct force drawn
-½ m if no label of force
-½ m if no value for weight

b. The frictional force between the wheels of the trolley and the surface of the bench is 0.5 N. Calculate the acceleration of the trolley.

[3]

F – frictional force = ma	
0.2 x 10 – 0.5 = 1.2 x a	A[1]
a = 1.25 m/s^2	A[1]

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c. From your answer in (a) and (b), describe in detail, the motion of the trolley.

[2]

Since there is a resultant force acting on the trolley, the system is not balanced.	A[1/2]
In accordance to Newton's 2nd law, the trolley will experience an acceleration.	A[1/2]
The speed of the trolley will increase at 1.25 m/s for each second.	A[1]

d. Suggest a way in which the friction between the wheels and the bench can be reduced.

[1]

Use lubricants or oil	Any 1 of thee suggested answers.
Use material of lower friction for the wheel and the ground	
Use roller, ball bearings or wheels – not accepted	

e. The trolley is loaded with sand. Compare the change in speed of the loaded and unloaded trolley.

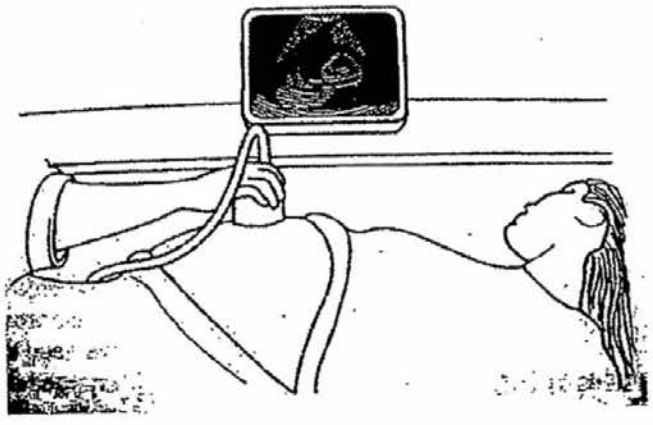
[2]

The mass of the trolley is now increased.	A[1/2]
With the same resultant force experienced by the trolley, the value of the acceleration will be reduced for the loaded trolley	A[1/2]
This is in accordance to the relationship, F = ma	A[1/2]
Thus the velocity of the loaded trolley will be lower than that of the unloaded trolley.	A[1/2]

260

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9. Ultrasound is a type of high frequency sound used in medical diagnosis. Important information about the internal structures of the body can be obtained by using a detector to analyse the reflections from the internal structures.



The figure above shows an ultrasonic scanner used to monitor the development of the baby of a pregnant woman. As an ultrasonic wave travel through the body tissues, energy is lost (attenuated) and the amplitude and intensity of the ultrasonic wave reduces.

Attenuation is measured in decibels per centimetre (dBcm-1) of tissue and is represented by the attenuation coefficient of the specific tissue type. The higher the attenuation coefficient, the more attenuated the ultrasonic wave is by the specified tissue.

Attenuation is an important concept as it limits the depth of the image that can be obtained via ultrasound.

The table below shows the attenuation coefficients and speeds of ultrasonic waves, transmitted at 1 MHz, through different body tissues.

body tissue	attenuation coefficient / $dBcm^{-1}$	speed / ms^{-1}
water	0.002	1484
fat	0.63	1450
liver	0.5 - 0.94	1570
bone	5.0	4080

Sources: http://usra.ca/tissue.php & https://wiki.engr.illinois.edu

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a. Describe how ultrasonic waves are transmitted from the scanner, through the body tissues, to the baby of the pregnant woman.

[2]

Waves are caused by vibration of the particles.	A[1/2]
Ultrasonic waves are longitudinal waves.	A[1/2]
As the ultrasonic waves travel through tissues, they will caused the tissue particles to vibrate parallel to the direction of the wave motion.	A[1]

b. Describe one difference between an ultrasound and electromagnetic waves.

[1]

Ultrasonic waves are longitudinal while electromagnetic waves are transverse.	A[1]

c. By studying the values in table, estimate the attenuation coefficient of human blood for an ultrasonic wave transmitted at 1 MHz

[1]

Since blood is thicker than water, the attenuation coefficient is between 0.002 and 0.63 $dBcm^{-1}$.	A[1]

d. Describe **two** properties of sound waves that contribute to the attenuation of ultrasonic waves in body tissues.

[2]

Ultrasonic waves can be reflected by the body tissues into the original medium upon incidence.	A[1]
Ultrasonic waves can undergo absorption as they travel through soft tissue. The particles vibrate and cause friction and a loss of sound energy occurs and heat is produced	A[1]

e. Explain why ultrasound is often not used in the medical diagnosis of bones in the body.

[2]

Ultrasonic waves may not be strong enough to penetrate the bones to give detailed images for diagnosis purposes.	A[1]
The reflected waves may be too weak to be detected.	A[1]

f. Calculate the wavelength of ultrasonic waves in the fat of the body of the pregnant woman.

[2]

$v = f\lambda$	
$1450 = (1/1\ 000\ 000) \times \lambda$	A[1]
$\lambda = 1.45 \times 10^{9}$ m	A[1]

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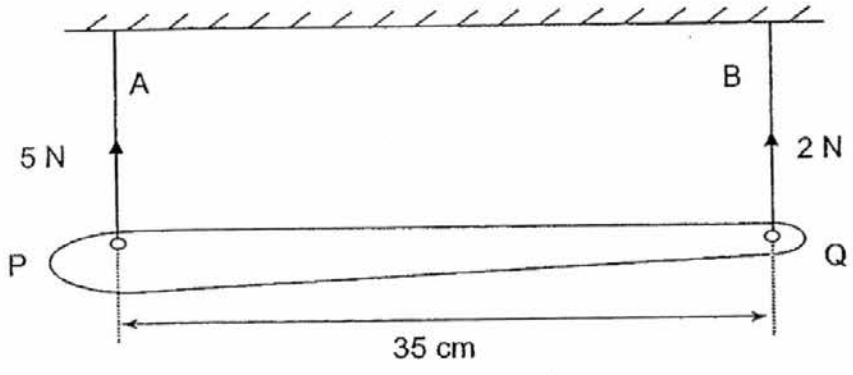
10. Either

a. State what is meant by the moment of a force and state how it can be calculated. [2]

Moment of a force refers to the product of the ***force*** and the ***perpendicular distance*** measured from ***the pivot to the line of application of the force.***	A[1]
M = F x d	A[1]

b. The figure shows a non-uniform rod PQ of length 35 cm attached to two strings A and B of equal length. The tension in string A is 5 N and that in string B is 2 N.

Determine the following:



i. the weight of PQ, [1]

Upward force = Downward force	
W = 5 + 2	
W = 7 N	A[1]

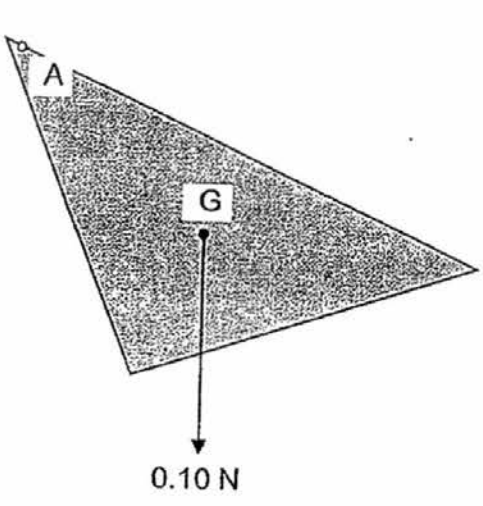
ii. the position of the centre of gravity of PQ from the end P. [2]

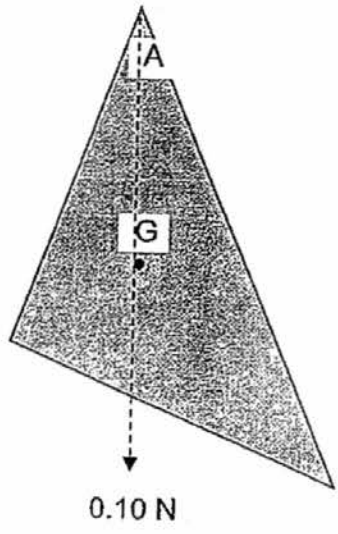
CW moments = anti-CW moments	
7 x dist = 2 x 35	A[1]
Dist = 10 cm away from P	A[1]

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c. The figure below shows a sheet of metal suspended from a hole in one corner at A. The weight of the metal is 0.10 N and the centre of gravity is at G. The metal sheet swings freely and comes to rest.

i. In the space next to given figure, sketch a diagram of the sheet in its final rest position. Mark points A and G on your diagram.





ii. Explain why the sheet remains at rest in this position.

[2]

At the rest position, the weight will act through the pivot.	A[1]
There is no perpendicular distance between the pivot and the force, thus no moment is created.	A[1]

d. The metal sheet is placed on a table. State **two** reasons why it is more stable when it is placed flat on the table than when it is placed on the table in a vertical position.

[2]

The CG will be lower.	A[1]
The base area will be wider.	A[1]

262

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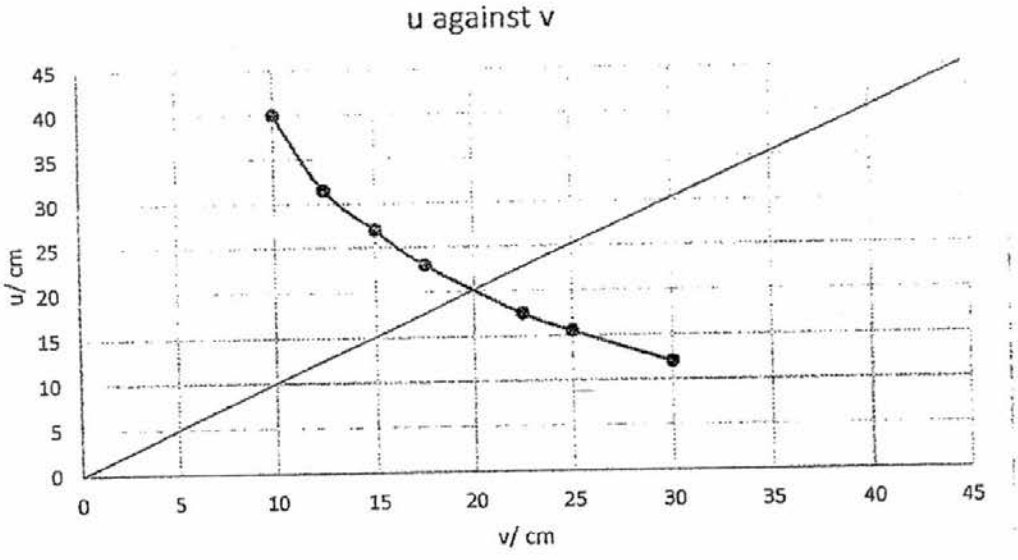
Or

a. In an experiment to find the focal length of a convex lens, the following readings were obtained.

Distance of object from lens, u/cm	40.0	31.5	27.0	23.0	17.5	15.5	12.0
Distance of image from lens, v/cm	10.0	12.5	15.0	17.5	22.5	25.0	30.0

i. Using a scale of 1.0 cm to 2.5 cm for both axes, plot a graph of u/cm against v/cm on the graph paper provided.

[3]



All points correctly plotted	A[1]
Smooth curve drawn	A[1]
Both axes labelled correctly	A[1]

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ii. Use the graph to find the value of u and v when they are equal by drawing the line u= v.

[1]

value of u = _____ cm

value of v = _____ cm

value of u = 20 cm	A[1/2]
value of v = 20 cm	A[1/2]

iii. Using the relationship,

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

hence determine the focal length of the lens

[2]

$\frac{1}{f}=\frac{1}{u}+\frac{1}{v}$	
$\frac{1}{f}=\frac{1}{20}+\frac{1}{20}$	A[1]
f = 10 cm	A[1]

b. In what way(s) are the images formed by a camera and a slide projector similar and in what way(s) are they different?

[2]

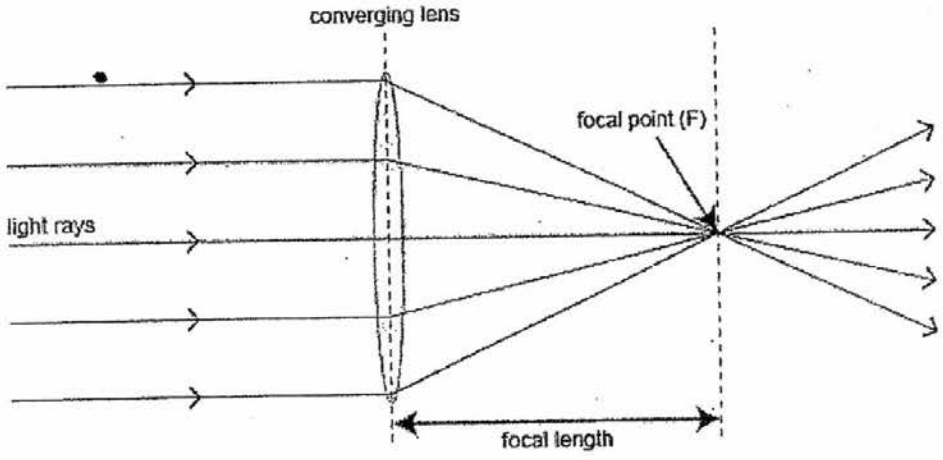
Similar – Real and Inverted	A[1/2] each
Difference – Size of image	A[1]

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c. It is possible for parallel incident rays to either converge to a point or appear to be diverging from a point by action of a piece of lens.

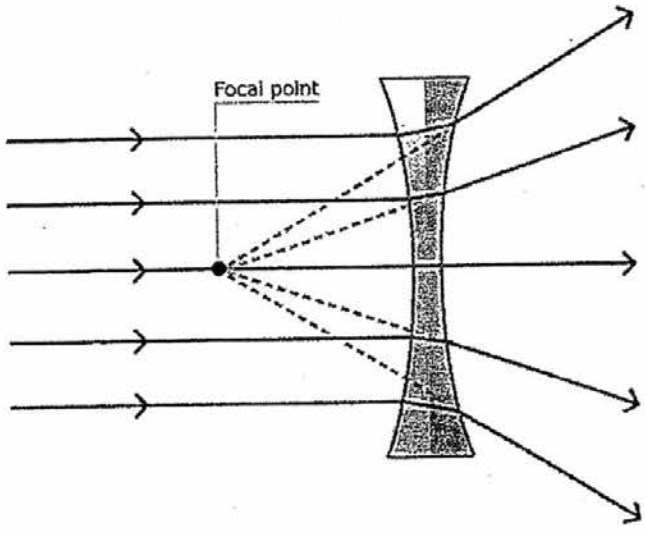
i. Draw ray diagram to illustrate the action on parallel incident rays by a converging lens.

[1]



ii. Draw ray diagram to illustrate the action on parallel incident rays by a diverging lens.

[1]



264

END OF PAPER END.

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