Geylang Methodist School (Secondary)
End-of-Year Examination 2019

PHYSICS **6091/01**

Paper 1 **Sec 3 Express**

45 minutes

10 Oct 2019

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Write your name, index number and class on the Optical Answer Sheet (OAS) provided. Do not use staples, paper clips, highlighters, glue or correction fluid.

There are **thirty** questions in this paper. 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 OAS.

At the end of the examination, submit the OAS and the question paper separately.

INFORMATION FOR CANDIDATES

Each correct answer will score one mark.

Any rough work should be done in this paper.

Gravitational field strength is assumed to be 10 N/kg and acceleration due to gravity, *g*, is assumed to be 10 m/s^2, unless otherwise specified.

This document consists of **11** printed pages and **1** blank page.

[Turn over

1 A micrometer screw gauge was used to determine the diameter of a cylindrical rod. Fig. 1.1 shows the micrometer screw gauge when it was completely closed. When the anvil and spindle close around the rod, the reading is shown in Fig. 1.2.

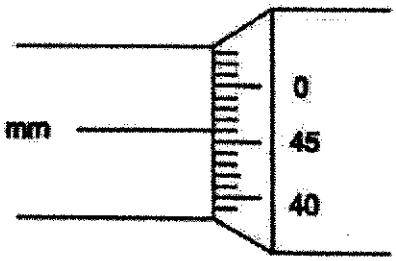


Fig. 1.1

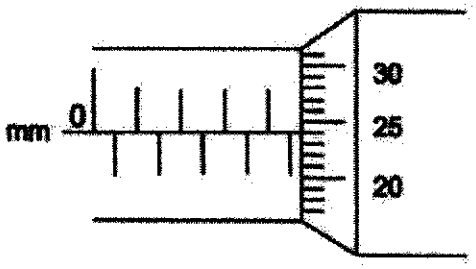


Fig. 1.2

Which is the correct diameter of the rod?

A 4.28 mm **B** 4.70 mm **C** 4.78 mm **D** 5.20 mm

2 A pendulum was swinging too quickly during an experiment.

Which of the following will increase the time taken for one complete oscillation?

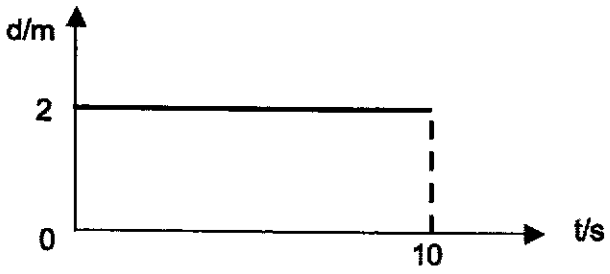
A Increase the mass of the bob.

B Increase the length of the pendulum.

C Increase the amplitude of the swing.

D Decrease the amplitude of the swing.

3 Which of the following best describes the motion of an object, represented by the displacement-time graph below?



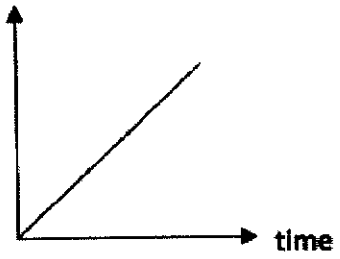
A The object is not moving.

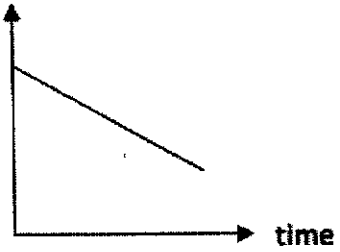
B The object travels a total distance of 20 m.

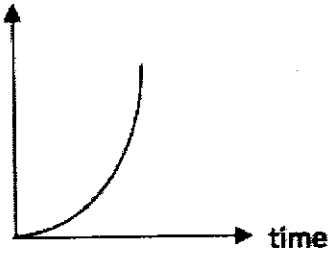
C The object travels at a constant speed of 2 m/s.

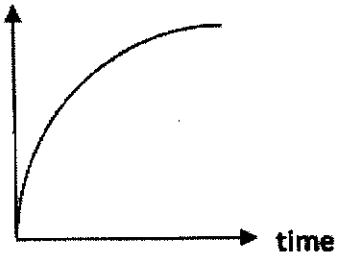
D The object travels at a constant acceleration of 0.2 m/s^2.

4 Which of the following distance-time graphs represents an object moving with decreasing speed?

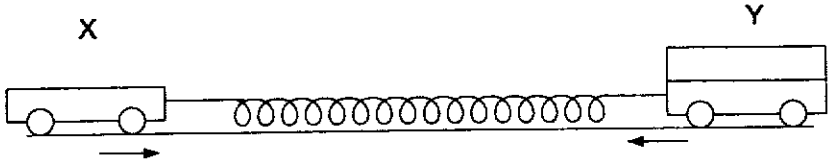
A


B


C


D


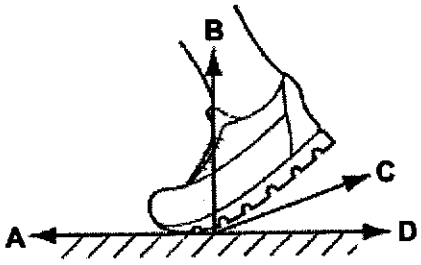
5 Two trolleys, X and Y, are joined by a stretched spring. Trolley X has half the mass of trolley Y. When the trolleys are released, the initial acceleration of trolley X is 2.0 m/s^2 to the right.



What is the initial acceleration of trolley Y to the left?

A 1.0 m/s^2 **B** 2.0 m/s^2 **C** 3.0 m/s^2 **D** 4.0 m/s^2

6 The diagram shows a runner's shoe at the start of a race.



Which arrow indicates the direction of the frictional force acting on the runner's shoe?

7 A deep-sea diver is sinking into deep water at a constant speed of 0.2 m/s.

What is the resultant force acting on the diver if he and his diving gear have a combined mass of 100 kg?

A 0 N **B** 100 N down **C** 1000 N up **D** 1000 N down

8 A bottle full of water has a mass of 200 g. Density of water is 1.0 g/cm^3. When the same bottle is completely filled with liquid **X**, the mass becomes 180 g.

What is the density of liquid **X**, if the mass of the empty bottle is 80 g?

A 0.8 g/cm^3 **B** 0.9 g/cm^3 **C** 1.2 g/cm^3 **D** 1.8 g/cm^3

9 Which of the following has the smallest inertia?

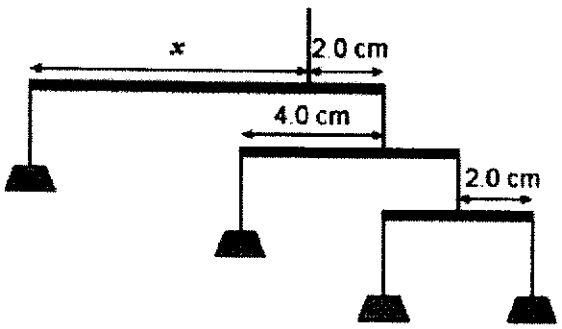
A a 30 kg girl running up a slope

B a 45 kg girl sliding on frictionless ice

C a block of weight 290 N rolling on rough ground

D a block of weight 500 N sliding on smooth ground

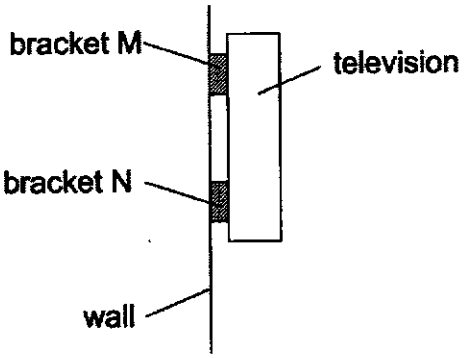
10 Four identical bells are balanced on light strings and horizontal bars of negligible mass as shown. The diagram is not drawn to scale.



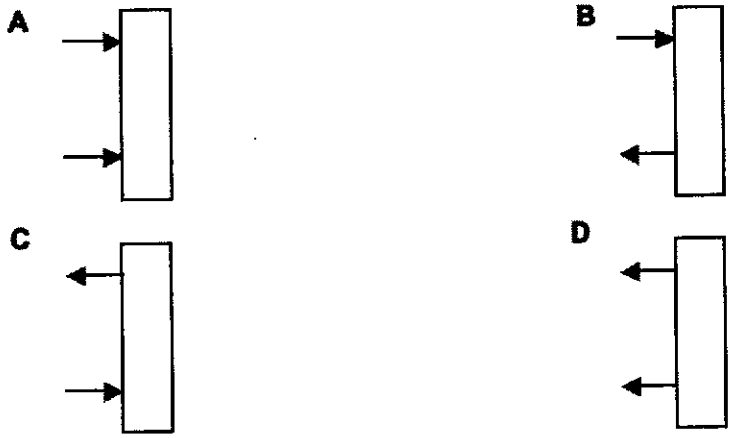
What is the distance x?

A 5.0 cm **B** 6.0 cm **C** 7.0 cm **D** 8.0 cm

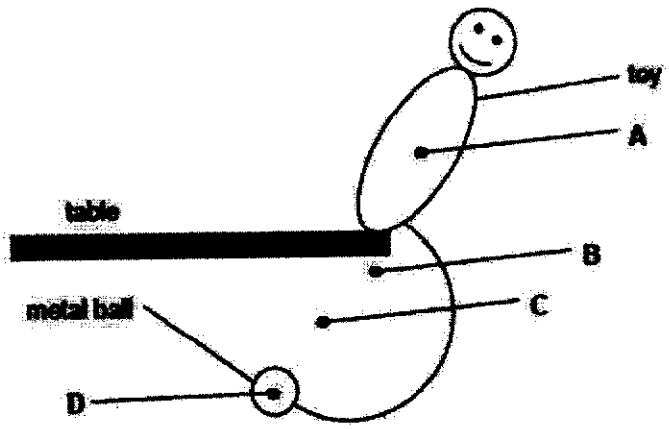
11 The diagram below shows a plasma television hung on the wall using bracket M and bracket N.



Which of the following diagrams shows the correct direction of the horizontal forces acting on the television by the two brackets?

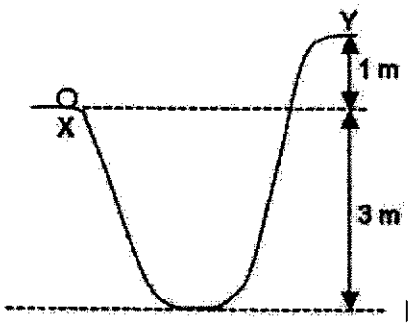


12 The diagram shows a toy balanced on the edge of a table and at rest. The toy has a metal ball attached to it.



Where is the likely centre of gravity of the toy?

13 The diagram below shows a marble of mass 25 g at the top of a slope at point X.



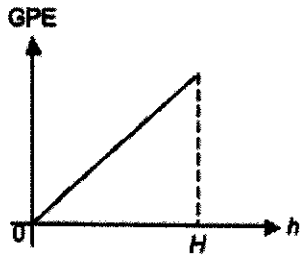
Assuming that friction is negligible, what is the minimum amount of kinetic energy that must be given to the marble at X such that it can reach point Y?

A 0.10 J **B** 0.25 J **C** 0.75 J **D** 1.00 J

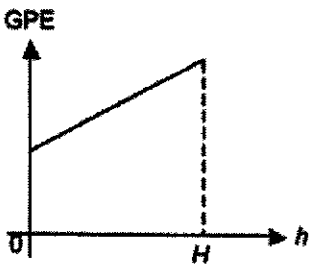
14 A stone drops from a height H.

Which graph shows correctly the variation of the gravitational potential energy (GPE) of the stone with the height *h* of the stone above the ground?

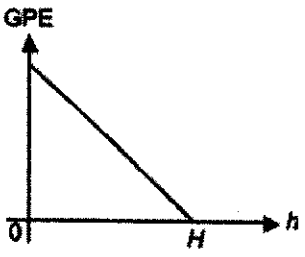
A



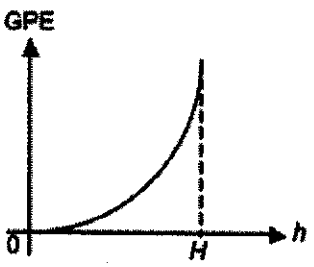
B



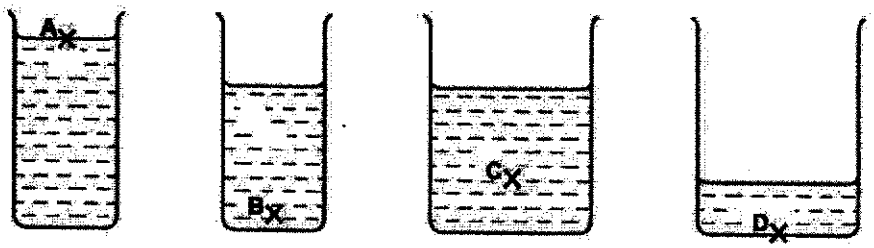
C



D

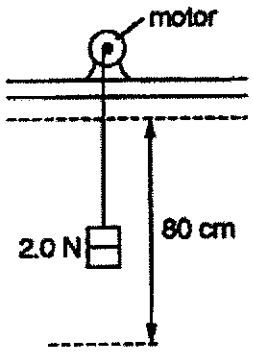


15 Four beakers contain the same liquid.



At which point is the pressure the greatest?

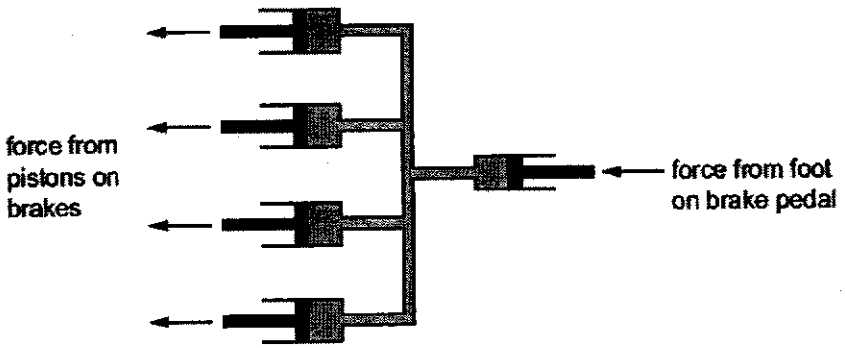
16 The diagram below shows an electric motor used to raise a weight of 2.0 N through a vertical height of 80 cm with a constant speed of 20 cm/s.



Assuming that there are no energy losses to the surroundings, what is the electrical power supplied by the motor?

A 0.16 W **B** 0.40 W **C** 16 W **D** 40 W

17 The diagram shows the brake system of a car.

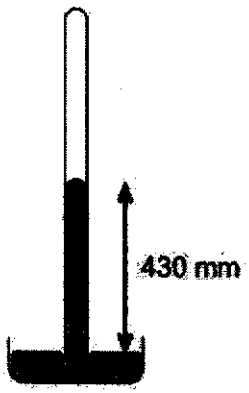


The pipes are filled with incompressible liquid. The area of the piston connected to the brake pedal is 8 cm^2. The area of each piston connected to the brakes is 12 cm^2. A force of 800 N is applied by the foot to the brake pedal.

What is the force applied to each brake?

A 300 N **B** 400 N **C** 800 N **D** 1200 N

18 A barometer is incorrectly set up such that some air is trapped above the mercury column.



Given that the atmospheric pressure is equivalent to 760 mmHg, and the density of mercury is 13560 kg/m^3. What is the pressure of the trapped air?

A 13.6 kPa **B** 44.7 kPa **C** 58.3 kPa **D** 103 kPa

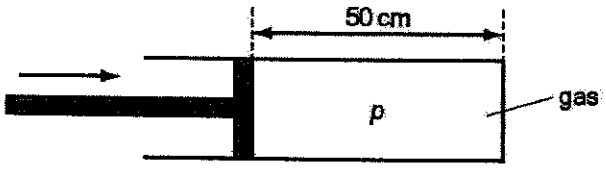
19 The mercury-in-glass thermometer shown has a linear scale.

At a temperature of 100°C, *h* has a value of 28 cm.
At a temperature of 80°C, *h* has a value of 24 cm.

What is the value of *h* when the temperature is 0°C?

A 0.0 cm **B** 4.0 cm **C** 8.0 cm **D** 10.0 cm

20 A gas is trapped inside a cylinder by a movable piston. The length of the gas column is 50 cm and the pressure inside the cylinder is *p*.



The piston is pushed in a distance of 20 cm, so that the length of the gas column is now 30 cm. The temperature of the gas does not change.

What is the new pressure of the gas?

A 0.4 *p* **B** 0.6 *p* **C** 1.7 *p* **D** 2.5 *p*

21 Which of the following statements about Brownian motion is correct?

A Brownian motion applies to gases only.

B Smoke particles in air can be observed to move in convection currents.

C Smoke particles in air move slower when temperature is lowered.

D The motion of smoke particles is due to smoke particles colliding with each other.

22 If two substances A and B are of the same temperature, which statement is true?

A No net thermal energy transfer between them even when they are placed together.

B They have the same amount of thermal energy.

C They are of the same state of matter.

D They have the same amount of internal energy.

23 Container P and container Q are each filled with equal amounts of hot water of the same temperature. Both containers are of the same size.

The temperatures of the water in the containers are measured with identical thermometers some time later. It is observed that container P has a much lower temperature than container Q.

What of the reasons below are possible?

1 Container P is painted black and container Q is painted silver.
2 Container P has a lid and container Q is not covered.
3 Container P is made of steel and container Q is made of clay.

A 1 and 2 only **B** 1 and 3 only **C** 2 and 3 only **D** 1, 2 and 3

24 A cup of hot water is allowed to cool on a cork mat at room temperature. Which of the following statements about the process by which the cup of hot water loses thermal energy is **incorrect**?

A Loss of thermal energy through radiation is the most effective when the temperature difference is small.

B The rate at which thermal energy is lost via conduction is low as the cork mat is a poor conductor.

C The rate at which thermal energy is lost via radiation depends on the colour and texture of the cup's surface.

D The processes of conduction, convection and radiation are in operation.

25 Which statement about thermal radiation is **incorrect**?

A A good absorber is also a good emitter.

B A piece of ice at 0 °C does not radiate thermal energy.

C The rate of emission of radiant energy from a body depends on temperature.

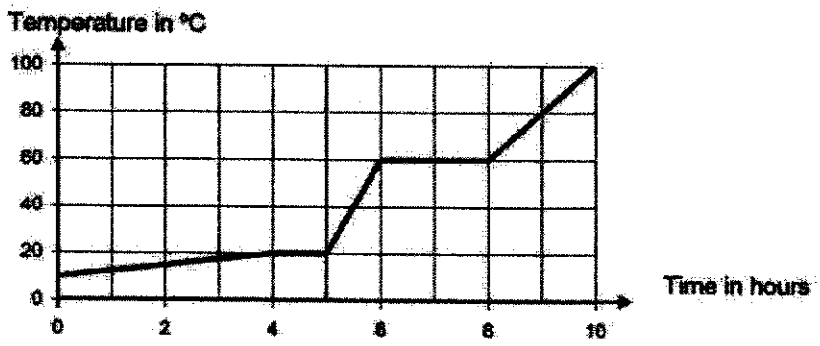
D The rate of emission of radiant energy from a body depends on its surface area.

26 An immersion heater heats a 2 kg block of aluminium which has a specific heat capacity of 840 J kg^{-1} $°C^{-1}$. The temperature of the block rises at a constant rate of 5 °C per minute.

What is the power of the heater, assuming no loss of thermal energy to the surroundings?

A 14 W **B** 70 W **C** 140 W **D** 8400 W

27 A solid sample of a material is heated at a constant rate until it reaches its gaseous state. The graph of its temperature against time is shown below.



Which of the following statement is true?

A The specific heat capacity of the material is smallest when in the liquid state.

B The heat capacity of the material increases with temperature.

C The specific latent heat of fusion is twice the specific latent heat of vaporisation.

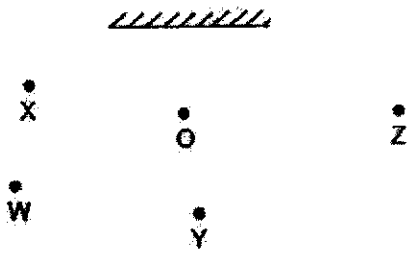
D The specific latent heat of fusion is smaller than the specific heat capacity of ice.

28 A 2 kg stone moving at a constant velocity of 10 cm/s collides with a wall. Upon collision, 30 % of the kinetic energy of the stone is converted to heat inside the stone. The specific heat capacity of the stone is c J kg^{-1} $°C^{-1}$.

What is the increase in temperature of the stone in °C?

A $\frac{3}{2000c}$ **B** $\frac{1}{200c}$ **C** $\frac{30}{20c}$ **D** $\frac{15}{c}$

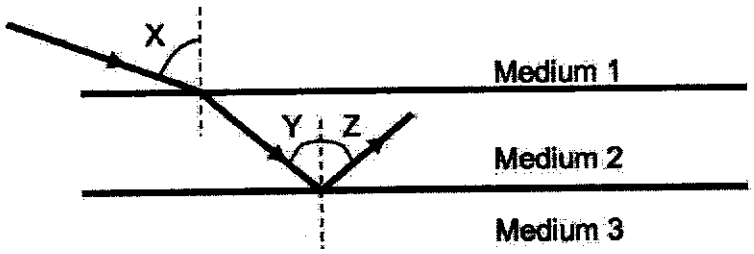
29 Four students standing at positions W, X, Y, and Z, try to view the reflection of the object O through a plane mirror.



How many students can see the image of object O in the mirror?

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

30 A ray of light travels from Medium 1 to Medium 2 and then undergoes total internal reflection as shown in the figure below.



Which of the following statements is true?

A Angle X is the critical angle of Medium 1.

B Angle Y is the critical angle of Medium 2.

C Medium 1 is optically denser than Medium 2.

D Medium 2 is optically denser than Medium 3.

End of paper

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Geylang Methodist School (Secondary)
End-of-Year Examination 2019

Candidate Name

Class

Index Number

PHYSICS

6091/02

Paper 2 Physics

Sec 3 Express

Additional materials : Nil

1 hour 30 minutes

9 Oct 2019

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions. Write your answers in the spaces provided on the question paper.

Section B
Answer **all** questions. Write your answers in the spaces provided on the question paper.

Candidates are reminded that all quantitative answers should include appropriate units. You are advised to show all your working in a clear, orderly manner.

Gravitational field strength is assumed to be 10 N/kg and acceleration due to gravity, *g*, is assumed to be 10 m/s^2, unless otherwise specified.

For Examiner's Use	
Section A	/ 40
Section B	/ 30
Total	/ 70

This document consists of **14** printed pages.

[Turn over

SECTION A

Answer **ALL** questions in this section in the spaces provided.

1 A sky-diver falls vertically starting from rest at time t = 0 s.
His acceleration is non-uniform until he reaches a steady speed of 40 m / s at t = 15 s.
He opens his parachute at t = 20 s and decelerates at a decreasing rate until t = 25 s.
From t = 25 s, he falls at a steady speed of 5 m/s.

(a) Draw the speed-time graph for the sky-diver from t = 0 s to t = 30 s on Fig.1.1 below. [4]

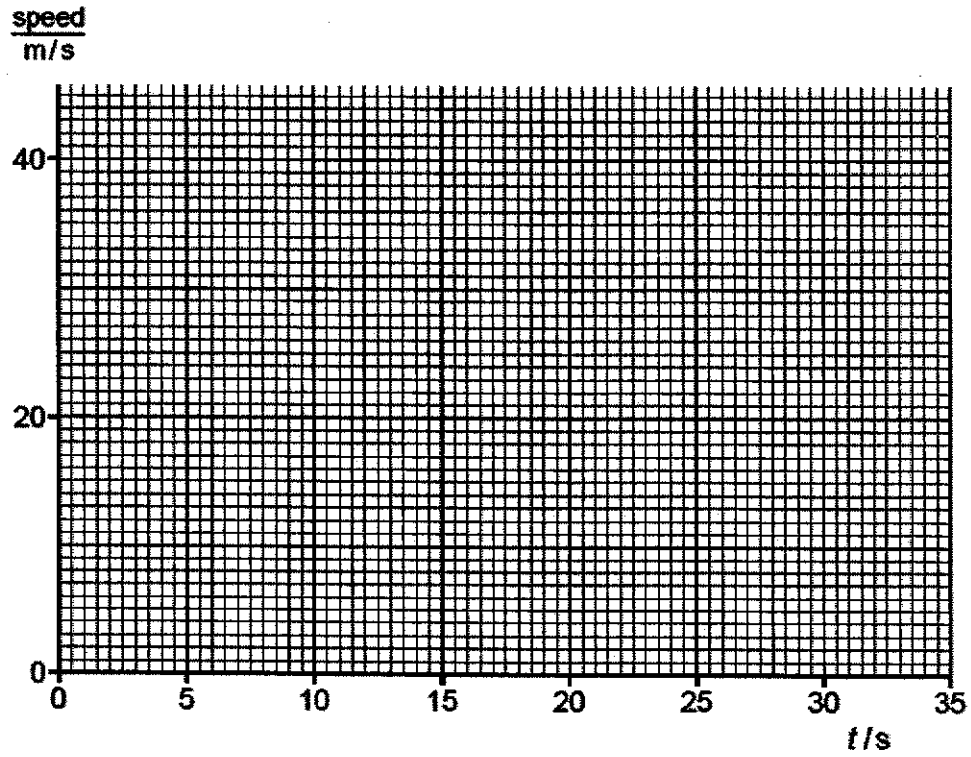

Fig. 1.1

(b) State how your graph in Fig. 1.1 can be used to obtain the distance that the sky-diver falls.

..... [1]

(c) Explain, in terms of forces, why the sky-diver decelerates and finally reaches a steady speed, **after** he opens his parachute.

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.....

..... [3]

2 Fig. 2.1 shows a sealed container filled fully with water, and a droplet of oil in the middle.

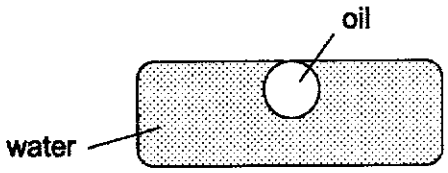


Fig. 2.1

When the container is pulled to the right, the oil droplet moves to the right as shown in Fig. 2.2.

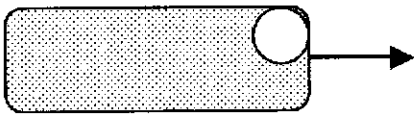


Fig. 2.2

(a) Explain how Fig. 2.1 shows that the oil is less dense than the water.

.....

..... [1]

(b) Explain, using ideas about inertia, why the oil droplet moves to the right when the container is pulled to the right in Fig. 2.2.

.....

.....

.....

..... [2]

3 A uniform plank of length 4.0 m and weight 500 N is suspended by two strings at X and Y. A box of mass 3.5 kg is placed as shown in Fig. 3.1.

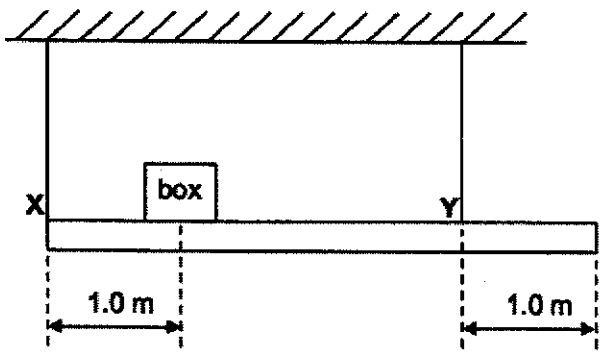


Fig. 3.1

(a) On Fig. 3.1, draw arrows to represent **all** the forces acting on the plank. [2]

(b) The plank is balanced. Calculate the force in the string at X by taking moments about Y.

force at X = ... [2]

(c) Hence or otherwise, calculate the force in the string at Y.

force at Y = ... [1]

(d) An additional weight is suspended from the plank directly below point Y.

State and explain how this will affect the force in the string at X.

.....

.....

.....

..... [2]

4 Fig. 4.1 shows a house-martin has a mass of 0.12 kg. When it returns to its nest, it is travelling horizontally at **P** with a speed of 13.0 m/s and is at a distance of 7.5 m below its nest. It then glides upwards to the nest as shown in the diagram.

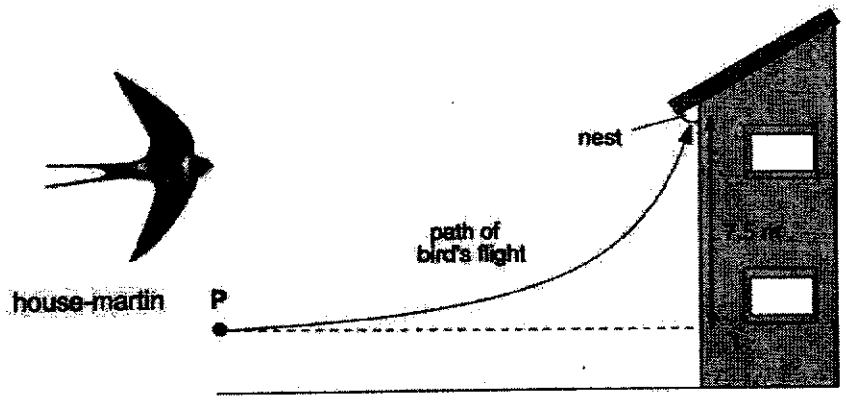


Fig. 4.1

Neglecting air resistance, calculate

(a) the kinetic energy of the house-martin at **P**,

kinetic energy = ... [2]

(b) the work done against gravity as the house-martin glides upwards to its nest,

work done = ... [2]

(c) the speed of the house-martin as it reaches its nest.

speed = ... [3]

5 The stainless steel Hydro Flask has become a trendy item among young people, but do you know the Physics concepts behind the making of these excellent water bottles? Fig. 5.1 shows part of a brochure for a Hydro Flask.

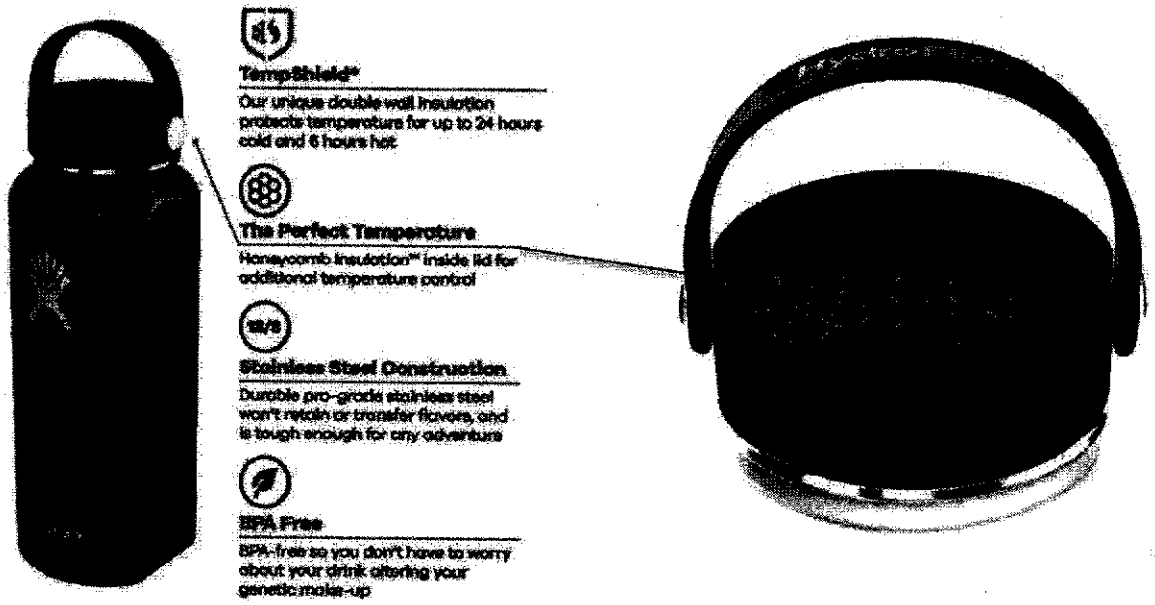


Fig. 5.1

(a) Another part of the brochure further elaborates the TempShield technology.

"Used in every product we make, TempShield™ is our double wall, vacuum insulated technology that guards the temperature of your drink."

Explain how TempShield™ keeps cold drinks cold for a long time.

.....

.....

.....

..... [2]

(b) "Honeycomb Insulation™ inside lid for additional temperature control"

Explain, how using a honeycomb design in the lid instead of a solid piece of plastic, helps to keep the cold drinks cold.

.....

.....

.....

..... [2]

(c) The manufacturer also makes this claim in part of the brochure.

"We also guarantee no condensation outside of the bottle, ever."

Explain why there is no condensation on the outside even if we fill the Hydro Flask with ice water.

.....

.....

..... [1]

6 A ray of light from an underwater laser pointer, is incident upon a spherical air bubble as shown in Fig. 6.1. The refractive index of water is 1.33.

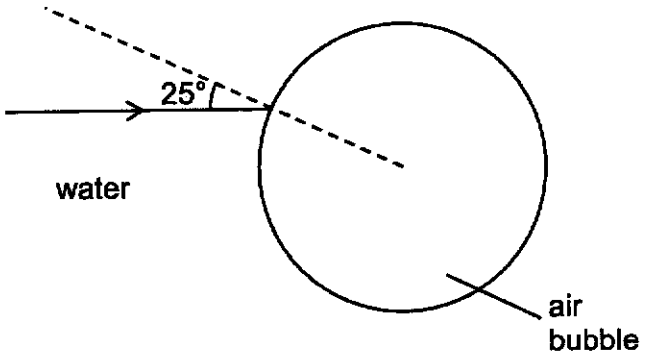


Fig. 6.1

(a) Complete the path of the ray until it exits the air bubble, showing clearly all angles at the boundaries. Show the workings to calculate these angles in the space below. [4]

7 Fig. 7.1 shows a light ray from the top of an object passing through a converging lens.

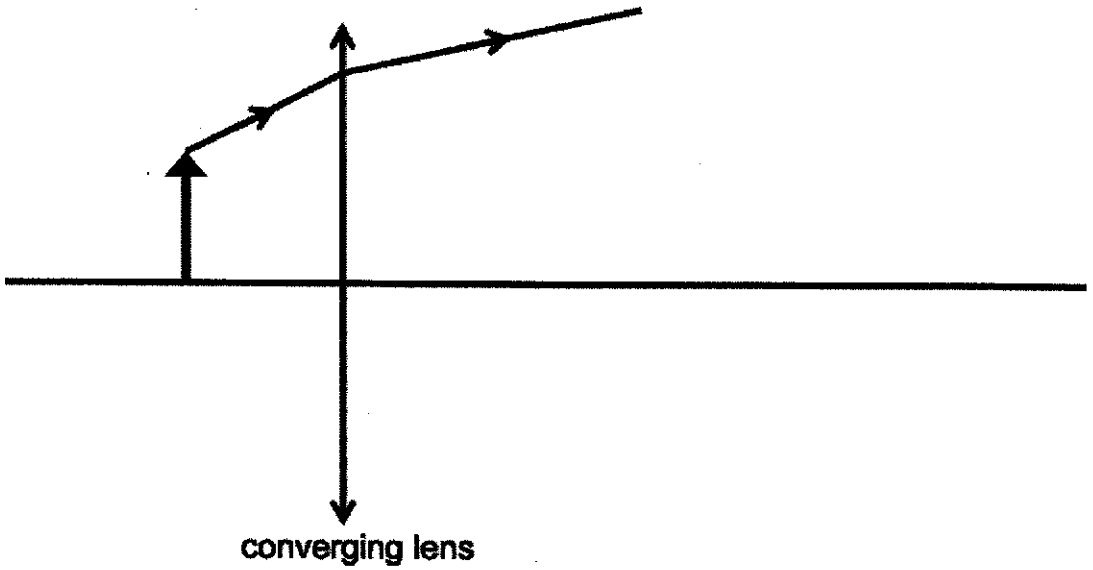


Fig. 7.1

(a) Draw appropriate light rays and construction lines to locate

(i) the image and label the image **I**, and [2]

(ii) the principal focus and label it **F**. [1]

(b) Describe the changes in the characteristics of the image formed (in three stages) as the object is gradually moved to the left, further away from the lens, until the object is slightly more than 2 focal lengths away.

.....

.....

.....

.....

.....

..... [3]

End of Section A

SECTION B

Answer **all** the questions in this section

8 Fig. 8.1 shows a small jet plane on a runway before taking off.

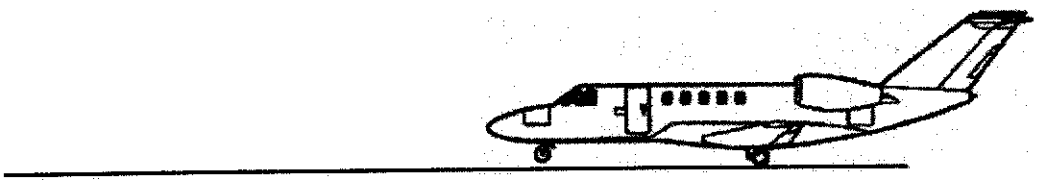


Fig. 8.1

When the plane just begins to move along the runway, the engines produce a constant thrust force of 21020 N and the plane experiences a constant frictional force of 688 N. The mass of the fully-loaded plane is 6800 kg. The plane is initially at rest.

(a) Calculate the acceleration of the plane as it just begins to move along the runway.

acceleration = ... [2]

(b) Besides the frictional force, the plane experiences another resistive force as it moves along the runway.

(i) State the name of this resistive force.

..... [1]

(ii) This resistive force changes as the speed increases.
Predict and explain how the acceleration in **(a)** changes due to the changing resistive force.

.....

.....

.....

..... [2]

(c) The average acceleration of the plane along the runway is 2.2 m/s^2.

(i) Determine the time taken for the plane to reach a final speed of 55 m/s on the runway before it takes off.

time taken = ... [2]

(ii) Determine the minimum length of the runway that is required for the plane to take off.

minimum length = ... [2]

(d) After take-off, the wheels of the plane are folded into the body of the plane as shown in Fig. 8.2.

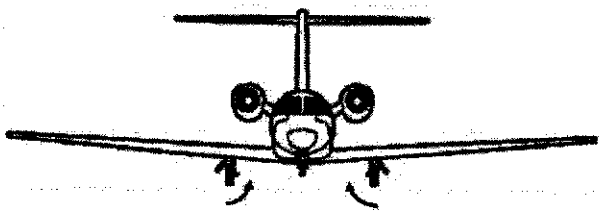


Fig. 8.2

Explain why the wheels are folded into the body of the plane.

.....

..... [1]

9 **(a)** Fig. 9.1 shows a manometer being used to measure the pressure of some gas in a container. The container is connected to the manometer by a length of rubber tubing.

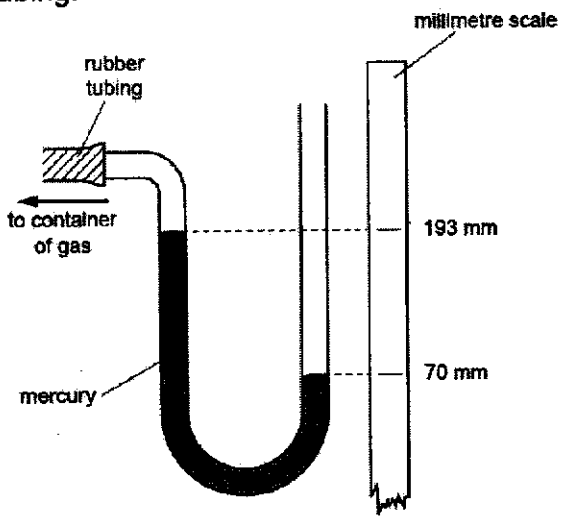


Fig. 9.1

The atmospheric pressure is 752 mm of mercury and the density of mercury is 1.36×10^4 kg/m^3.

Calculate the actual pressure of the gas in the container in

(i) mm Hg, and

pressure = ... [1]

(ii) Pa.

pressure = ... [2]

(iii) State how the vertical height difference of the two mercury surfaces changes, if at all, when a narrower tube is used instead.

.....

..... [1]

(b) Fig. 9.2 shows a diver working below the surface of a lake. The density of the water in the lake is 1000 kg/m^3, the atmospheric pressure at the surface is 1.0×10^5 Pa.

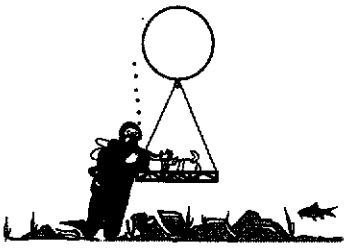


Fig. 9.2

The diver inflates a balloon with air at a depth of 15 m and attaches the balloon to a tray of objects.

(i) Calculate the total pressure acting on the balloon, at 15 m below the surface of the lake.

pressure = ... [2]

(ii) The diver releases the tray and the balloon, and they begin to rise. The temperature of the air in the balloon does not change. The volume of the balloon is 0.3 m^3 at 15 m depth.

Calculate the volume of the balloon when it reaches the surface.

volume = ... [2]

(iii) Explain, in terms of the air molecules inside the balloon, why the air pressure in the balloon is less at the surface.

.....

.....

.....

..... [2]

10 An experimental setup is shown in Fig. 10.1 below.

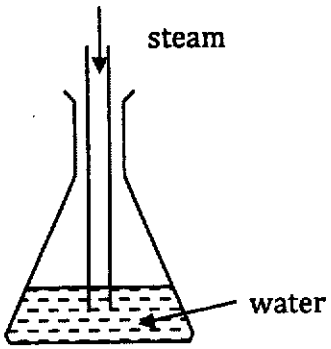


Fig. 10.1

Steam at 100 °C is pumped through a tube into a conical flask containing 500 g water at a room temperature of 25 °C.
After some time, the temperature of the water in the flask rises to 90 °C.
The specific heat capacity of water is 4200 J/kg/K and the specific latent heat of vaporization of water is 2250 kJ/kg.

(a) State what is meant by the specific latent heat of vaporization.

.....

..... [1]

(b) Explain why the mass of water in the jug increases.

..... [1]

(c) Calculate the energy needed to warm the water from 25 °C to 90 °C.

energy = ... [2]

(d) Calculate the final mass, m, of water in the jug when its temperature has reached 90 °C.

m = ... [3]

(e) Is the value of **m** obtained in **(d)** above higher or lower than the actual value obtained in the experiment? Explain your answer clearly.

.....

.....

.....

..... [2]

(f) State one way to improve the results of the experiment.

.....

..... [1]

END OF PAPER

Geylang Methodist School (Secondary)
End-of-Year Examination 2019

PHYSICS **6091/01**

Paper 1 **Sec 3 Express**

45 minutes

10 Oct 2019

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Write your name, index number and class on the Optical Answer Sheet (OAS) provided. Do not use staples, paper clips, highlighters, glue or correction fluid.

There are **thirty** questions in this paper. 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 OAS.

At the end of the examination, submit the OAS and the question paper separately.

INFORMATION FOR CANDIDATES

Each correct answer will score one mark.

Any rough work should be done in this paper.

Gravitational field strength is assumed to be 10 N/kg and acceleration due to gravity, *g*, is assumed to be 10 m/s^2, unless otherwise specified.

This document consists of **11** printed pages and **1** blank page.

[Turn over

1 A micrometer screw gauge was used to determine the diameter of a cylindrical rod. Fig. 1.1 shows the micrometer screw gauge when it was completely closed. When the anvil and spindle close around the rod, the reading is shown in Fig. 1.2.

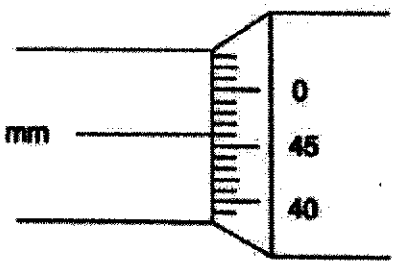


Fig. 1.1

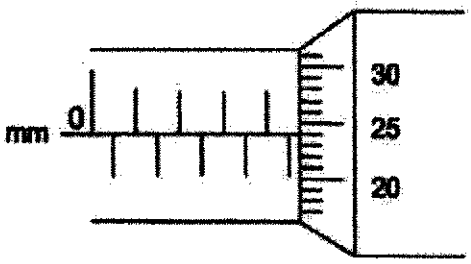


Fig. 1.2

Which is the correct diameter of the rod?

A 4.28 mm **B** 4.70 mm **C** 4.78 mm **D** 5.20 mm

2 A pendulum was swinging too quickly during an experiment.

Which of the following will increase the time taken for one complete oscillation?

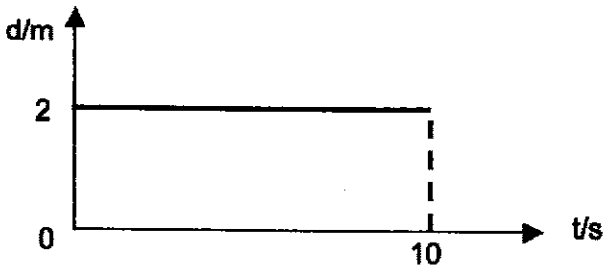
A Increase the mass of the bob.

B Increase the length of the pendulum.

C Increase the amplitude of the swing.

D Decrease the amplitude of the swing.

3 Which of the following best describes the motion of an object, represented by the displacement-time graph below?



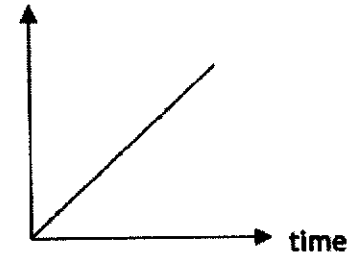
A The object is not moving.

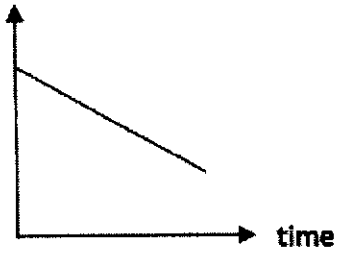
B The object travels a total distance of 20 m.

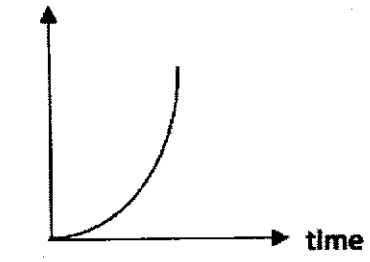
C The object travels at a constant speed of 2 m/s.

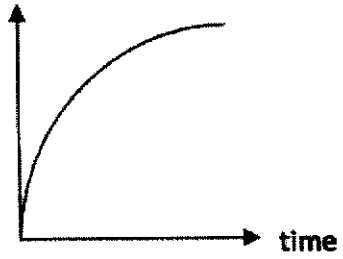
D The object travels at a constant acceleration of 0.2 m/s^2.

4 Which of the following distance-time graphs represents an object moving with decreasing speed?

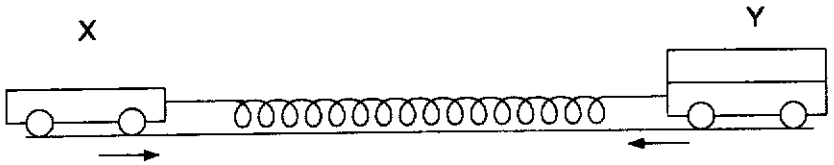
A


B


C


D


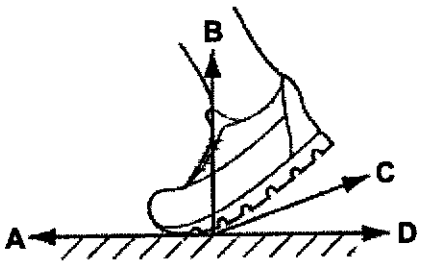
5 Two trolleys, X and Y, are joined by a stretched spring. Trolley X has half the mass of trolley Y. When the trolleys are released, the initial acceleration of trolley X is 2.0 m/s^2 to the right.



What is the initial acceleration of trolley Y to the left?

A 1.0 m/s^2 **B** 2.0 m/s^2 **C** 3.0 m/s^2 **D** 4.0 m/s^2

6 The diagram shows a runner's shoe at the start of a race.



Which arrow indicates the direction of the frictional force acting on the runner's shoe?

7 A deep-sea diver is sinking into deep water at a constant speed of 0.2 m/s.

What is the resultant force acting on the diver if he and his diving gear have a combined mass of 100 kg?

A 0 N **B** 100 N down **C** 1000 N up **D** 1000 N down

8 A bottle full of water has a mass of 200 g. Density of water is 1.0 g/cm^3. When the same bottle is completely filled with liquid **X**, the mass becomes 180 g.

What is the density of liquid **X**, if the mass of the empty bottle is 80 g?

A 0.8 g/cm^3 **B** 0.9 g/cm^3 **C** 1.2 g/cm^3 **D** 1.8 g/cm^3

9 Which of the following has the smallest inertia?

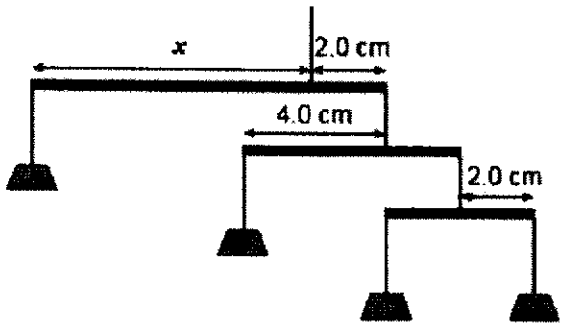
A a 30 kg girl running up a slope

B a 45 kg girl sliding on frictionless ice

C a block of weight 290 N rolling on rough ground

D a block of weight 500 N sliding on smooth ground

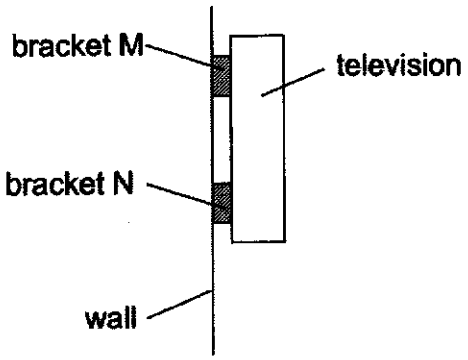
10 Four identical bells are balanced on light strings and horizontal bars of negligible mass as shown. The diagram is not drawn to scale.



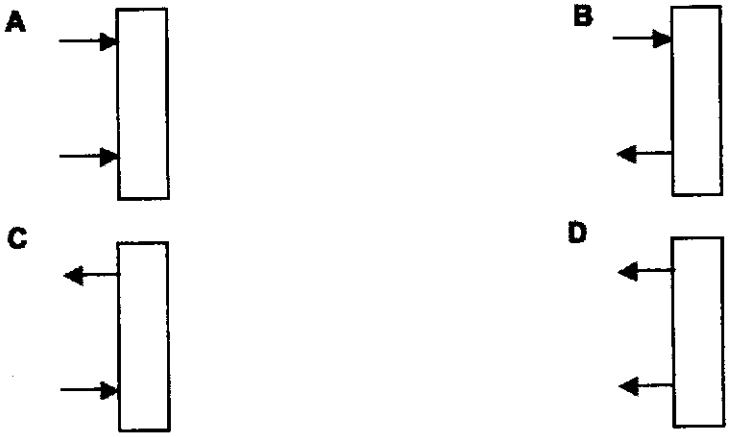
What is the distance x?

A 5.0 cm **B** 6.0 cm **C** 7.0 cm **D** 8.0 cm

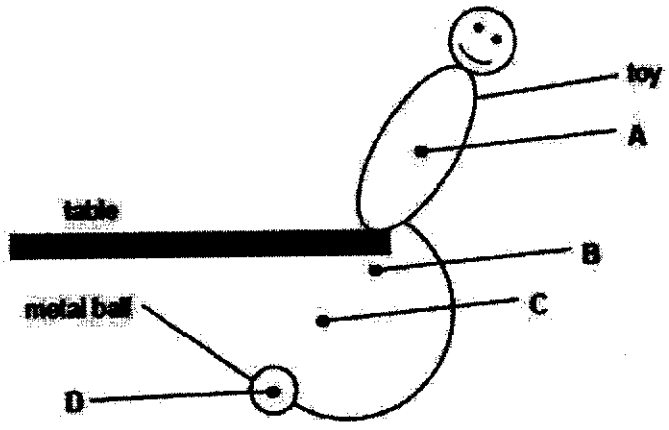
11 The diagram below shows a plasma television hung on the wall using bracket M and bracket N.



Which of the following diagrams shows the correct direction of the horizontal forces acting on the television by the two brackets?

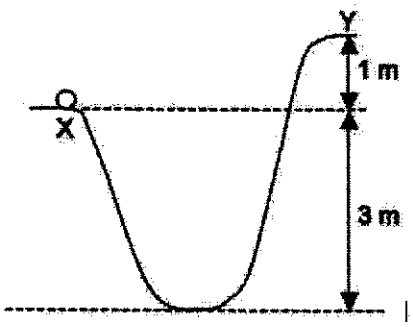


12 The diagram shows a toy balanced on the edge of a table and at rest. The toy has a metal ball attached to it.



Where is the likely centre of gravity of the toy?

13 The diagram below shows a marble of mass 25 g at the top of a slope at point X.



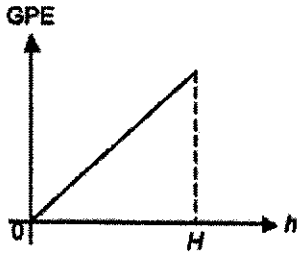
Assuming that friction is negligible, what is the minimum amount of kinetic energy that must be given to the marble at X such that it can reach point Y?

A 0.10 J **B** 0.25 J **C** 0.75 J **D** 1.00 J

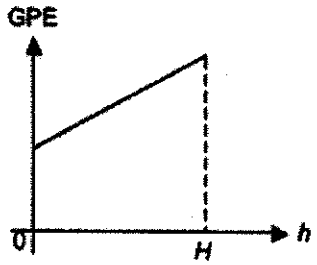
14 A stone drops from a height H.

Which graph shows correctly the variation of the gravitational potential energy (GPE) of the stone with the height *h* of the stone above the ground?

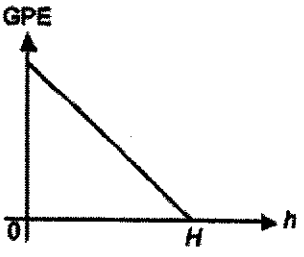
A



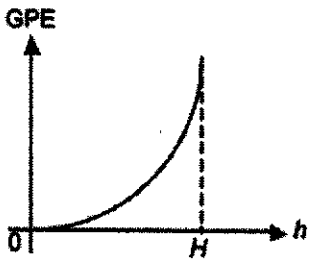
B



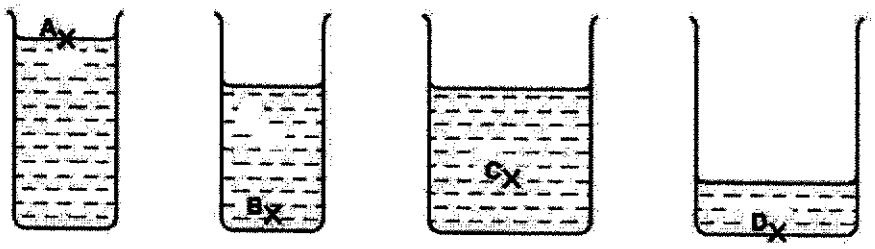
C



D

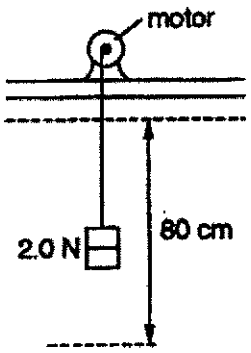


15 Four beakers contain the same liquid.



At which point is the pressure the greatest?

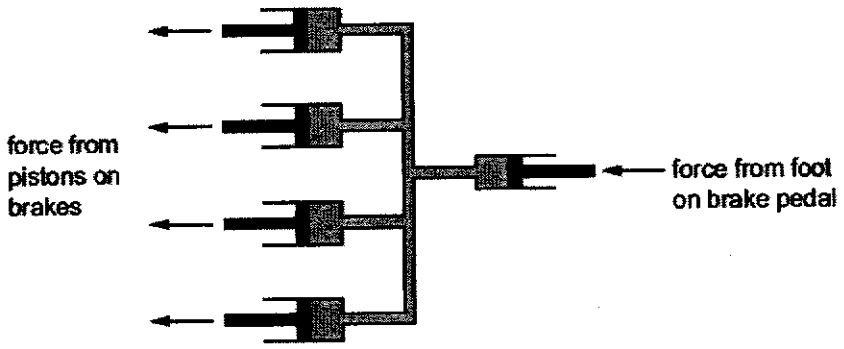
16 The diagram below shows an electric motor used to raise a weight of 2.0 N through a vertical height of 80 cm with a constant speed of 20 cm/s.



Assuming that there are no energy losses to the surroundings, what is the electrical power supplied by the motor?

A 0.16 W **B** 0.40 W **C** 16 W **D** 40 W

17 The diagram shows the brake system of a car.

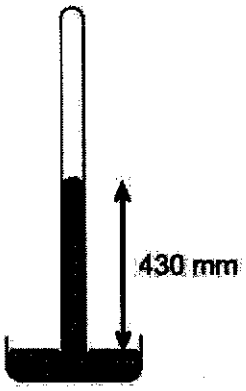


The pipes are filled with incompressible liquid. The area of the piston connected to the brake pedal is 8 cm^2. The area of each piston connected to the brakes is 12 cm^2. A force of 800 N is applied by the foot to the brake pedal.

What is the force applied to each brake?

A 300 N **B** 400 N **C** 800 N **D** 1200 N

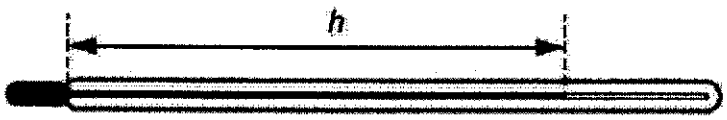
18 A barometer is incorrectly set up such that some air is trapped above the mercury column.



Given that the atmospheric pressure is equivalent to 760 mmHg, and the density of mercury is 13560 kg/m^3. What is the pressure of the trapped air?

A 13.6 kPa **B** 44.7 kPa **C** 58.3 kPa **D** 103 kPa

19 The mercury-in-glass thermometer shown has a linear scale.

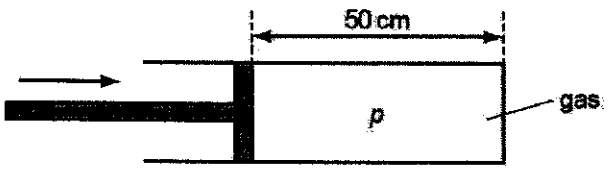


At a temperature of 100°C, *h* has a value of 28 cm.
At a temperature of 80°C, *h* has a value of 24 cm.

What is the value of *h* when the temperature is 0°C?

A 0.0 cm **B** 4.0 cm **C** 8.0 cm **D** 10.0 cm

20 A gas is trapped inside a cylinder by a movable piston. The length of the gas column is 50 cm and the pressure inside the cylinder is *p*.



The piston is pushed in a distance of 20 cm, so that the length of the gas column is now 30 cm. The temperature of the gas does not change.

What is the new pressure of the gas?

A 0.4 *p* **B** 0.6 *p* **C** 1.7 *p* **D** 2.5 *p*

21 Which of the following statements about Brownian motion is correct?

A Brownian motion applies to gases only.

B Smoke particles in air can be observed to move in convection currents.

C Smoke particles in air move slower when temperature is lowered.

D The motion of smoke particles is due to smoke particles colliding with each other.

22 If two substances A and B are of the same temperature, which statement is true?

A No net thermal energy transfer between them even when they are placed together.

B They have the same amount of thermal energy.

C They are of the same state of matter.

D They have the same amount of internal energy.

23 Container P and container Q are each filled with equal amounts of hot water of the same temperature. Both containers are of the same size.

The temperatures of the water in the containers are measured with identical thermometers some time later. It is observed that container P has a much lower temperature than container Q.

What of the reasons below are possible?

1 Container P is painted black and container Q is painted silver.
2 Container P has a lid and container Q is not covered.
3 Container P is made of steel and container Q is made of clay.

A 1 and 2 only **B** 1 and 3 only **C** 2 and 3 only **D** 1, 2 and 3

24 A cup of hot water is allowed to cool on a cork mat at room temperature. Which of the following statements about the process by which the cup of hot water loses thermal energy is **incorrect**?

A Loss of thermal energy through radiation is the most effective when the temperature difference is small.

B The rate at which thermal energy is lost via conduction is low as the cork mat is a poor conductor.

C The rate at which thermal energy is lost via radiation depends on the colour and texture of the cup's surface.

D The processes of conduction, convection and radiation are in operation.

25 Which statement about thermal radiation is **incorrect**?

A A good absorber is also a good emitter.

B A piece of ice at 0 °C does not radiate thermal energy.

C The rate of emission of radiant energy from a body depends on temperature.

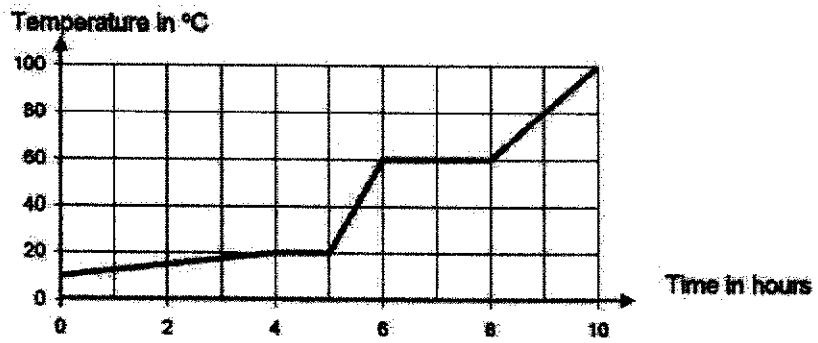
D The rate of emission of radiant energy from a body depends on its surface area.

26 An immersion heater heats a 2 kg block of aluminium which has a specific heat capacity of 840 J kg^{-1} $°C^{-1}$. The temperature of the block rises at a constant rate of 5 °C per minute.

What is the power of the heater, assuming no loss of thermal energy to the surroundings?

A 14 W **B** 70 W **C** 140 W **D** 8400 W

27 A solid sample of a material is heated at a constant rate until it reaches its gaseous state. The graph of its temperature against time is shown below.



Which of the following statement is true?

A The specific heat capacity of the material is smallest when in the liquid state.

B The heat capacity of the material increases with temperature.

C The specific latent heat of fusion is twice the specific latent heat of vaporisation.

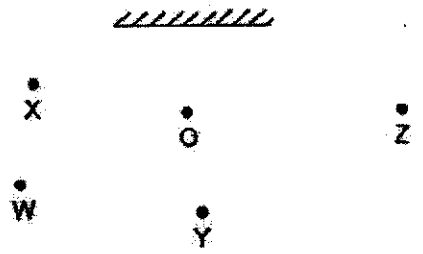
D The specific latent heat of fusion is smaller than the specific heat capacity of ice.

28 A 2 kg stone moving at a constant velocity of 10 cm/s collides with a wall. Upon collision, 30 % of the kinetic energy of the stone is converted to heat inside the stone. The specific heat capacity of the stone is c J kg^{-1} $°C^{-1}$.

What is the increase in temperature of the stone in °C?

A $\frac{3}{2000c}$ **B** $\frac{1}{200c}$ **C** $\frac{30}{20c}$ **D** $\frac{15}{c}$

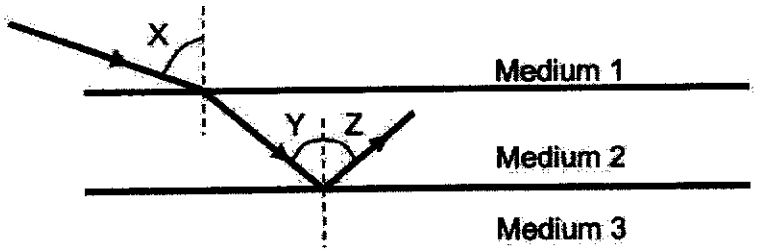
29 Four students standing at positions W, X, Y, and Z, try to view the reflection of the object O through a plane mirror.



How many students can see the image of object O in the mirror?

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

30 A ray of light travels from Medium 1 to Medium 2 and then undergoes total internal reflection as shown in the figure below.



Which of the following statements is true?

A Angle X is the critical angle of Medium 1.

B Angle Y is the critical angle of Medium 2.

C Medium 1 is optically denser than Medium 2.

D Medium 2 is optically denser than Medium 3.

End of paper

ANSWERS

1 C	2 B	3 A	4 D	5 A	6 A	7 A	8 A	9 C	10 B
11 C	12 B	13 B	14 A	15 B	16 B	17 D	18 B	19 C	20 C
21 C	22 A	23 B	24 A	25 B	26 C	27 A	28 A	29 B	30 D

Geylang Methodist School (Secondary)
End-of-Year Examination 2019

Candidate Name	ANSWERS		
Class		Index Number	

PHYSICS **6091/02**

Paper 2 Physics **Sec 3 Express**

Additional materials : Nil **1 hour 30 minutes**

Setter : Mr Sng Peng Hock **9 Oct 2019**

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions. Write your answers in the spaces provided on the question paper.

Section B
Answer **all** questions. Write your answers in the spaces provided on the question paper.

Candidates are reminded that all quantitative answers should include appropriate units. You are advised to show all your working in a clear, orderly manner.

Gravitational field strength is assumed to be 10 N/kg and acceleration due to gravity, *g*, is assumed to be 10 m/s^2, unless otherwise specified.

For Examiner's Use	
Section A	/ 40
Section B	/ 30
Total	/ 70

This document consists of **11** printed pages and **1** blank page.

[Turn over

SECTION A

Answer **ALL** questions in this section in the spaces provided.

1 A sky-diver falls vertically starting from rest at time t = 0 s.
His acceleration is non-uniform until he reaches a steady speed of 40 m / s at t = 15 s.
He opens his parachute at t = 20 s and decelerates at a decreasing rate until t = 25 s.
From t = 25 s, he falls at a steady speed of 5 m/s.

(a) Draw the speed-time graph for the sky-diver from t = 0 s to t = 30 s on Fig.1.1 below. [4]

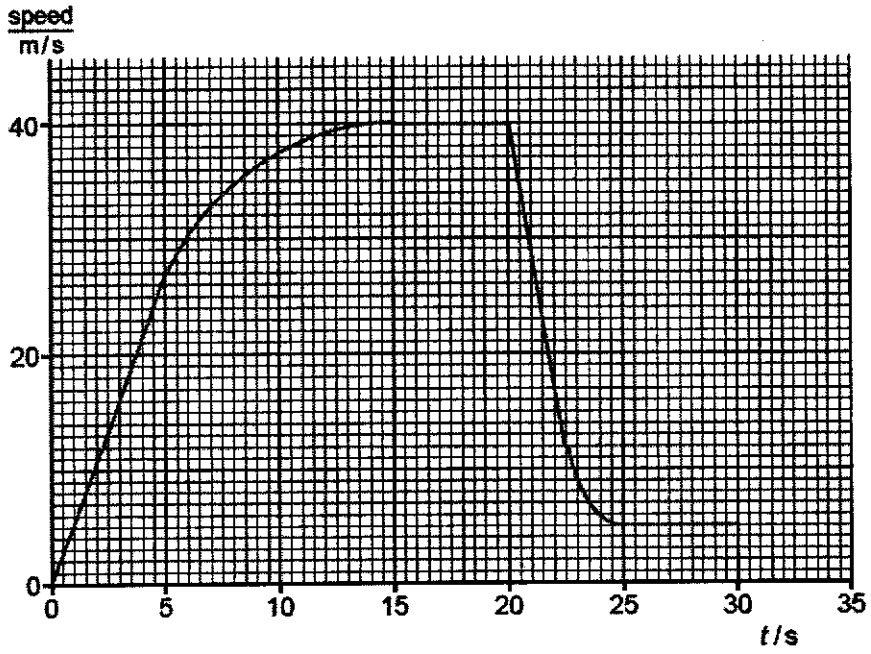


Fig. 1.1

[1]: For 0 to 15 sec, convex curve, end at 40 m / s
[1]: For 15 to 20 sec, horizontal straight line at 40 m / s
[1]: For 20 to 25 sec, concave curve, end at 5 m / s
[1]: From 25 sec, horizontal straight line till 30 sec.

(b) State how your graph in Fig. 1.1 can be used to obtain the distance that the sky-diver falls.

Area under the graph, from t = 0 to when the sky-diver reaches the ground. [1]

(c) Explain, in terms of forces, why the sky-diver decelerates and finally reaches a steady speed, **after** he opens his parachute.

When the parachute is first opened, upward force is much larger than downward force, hence speed decreases / sky diver decelerates. [1]
Air resistance decreases with decreasing speed [1]
Sky-diver will continue to decelerate until air resistance is equal to weight hence resultant force is zero and move at steady / constant speed. [1] [3]

2 Fig. 2.1 shows a sealed container filled fully with water, and a droplet of oil in the middle.

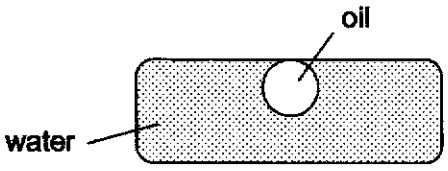


Fig. 2.1

When the container is pulled to the right, the oil droplet moves to the right as shown in Fig. 2.2.

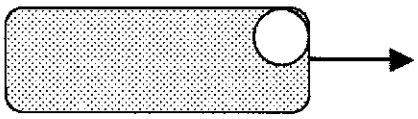


Fig. 2.2

(a) Explain how Fig. 2.1 shows that the oil is less dense than the water.

Less dense substance will float on a denser substance. Since the oil is floating on water, the oil must be less dense.

[1]

(b) Explain, using ideas about inertia, why the oil droplet moves to the right when the container is pulled to the right in Fig. 2.2.

Since oil is less dense, it has a lower mass per unit volume and thus less inertia than the surrounding water. [1]
When the container is moved to the right, the water has a higher reluctance to move compared to the oil droplet. [1]

[2]

3 A uniform plank of length 4.0 m and weight 500 N is suspended by two strings at X and Y. A box of mass 3.5 kg is placed as shown in Fig. 3.1.

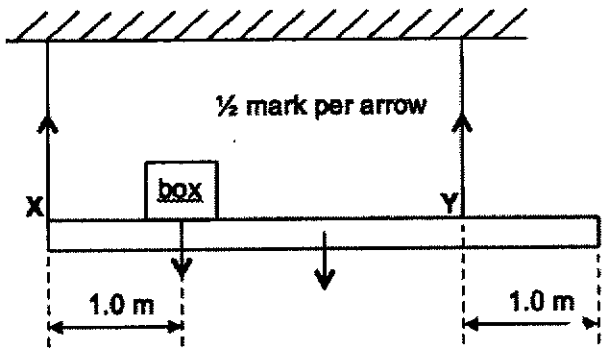


Fig. 3.1

(a) On Fig. 3.1, draw arrows to represent **all** the forces acting on the plank. [2]

(b) The plank is balanced. Calculate the force in the string at X by taking moments about Y.

Since the plank is balanced, taking moment about Y,
sum of clockwise moments = sum of anticlockwise moments.
$F_x \times 3 = 500 \times 1 + 35 \times 2$ [1]
$F_x = 190$ N [1]

force at X = ... [2]

(c) Hence or otherwise, calculate the force in the string at Y.

$500 + 35 = 190 + F_y$
$F_y = 345$ N [1]

force at Y = ... [1]

(d) An additional weight is suspended from the plank directly below point Y.

State and explain how this will affect the force in the string at X.

This will not affect the force at X. [1]
Taking moments about Y, the calculation of the force at X is the same as per part (b). [1]

[2]

4 Fig. 4.1 shows a house-martin has a mass of 0.12 kg. When it returns to its nest, it is travelling horizontally at **P** with a speed of 13.0 m/s and is at a distance of 7.5 m below its nest. It then glides upwards to the nest as shown in the diagram.

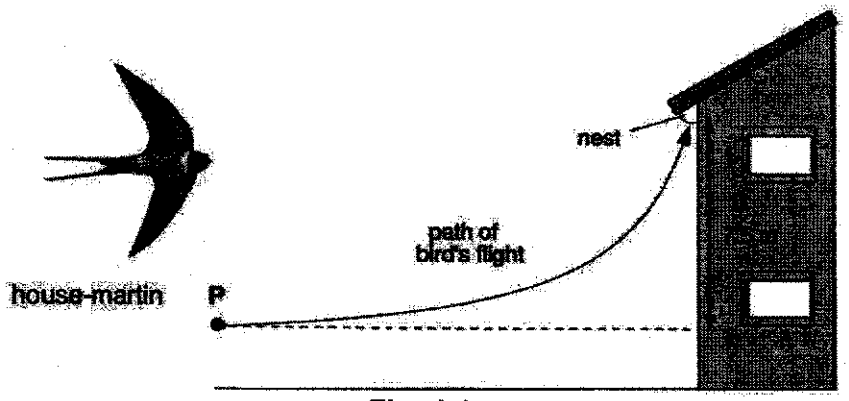


Fig. 4.1

Neglecting air resistance, calculate

(a) the kinetic energy of the house-martin at **P**,

KE = ½ mv^2
= ½ × 0.12 × 13.0^2 [1]
= 10.1 J (3sf) [1]

kinetic energy = ... [2]

(b) the work done against gravity as the house-martin glides upwards to its nest,

Work done against gravity
= mgh
= 0.12 × 10 × 7.5 [1]
= 9.00 J [1]

work done = ... [2]

(c) the speed of the house-martin as it reaches its nest.

Amount of KE left
= 10.14 – 9.00
= 1.14 J [1]
½ × 0.12 × v^2 = 1.14 [1]
v = 4.36 m/s [1]

(-[1] for 4.28 m/s if student use 10.1 J in the calculation)

speed = ... [3]

5 Mr Sng has been using the stainless steel Hydro Flask, long before the appearance of VSCO girls. There are some serious Physics concepts behind the making of these trendy water bottles. Fig. 5.1 shows part of a brochure for a Hydro Flask.

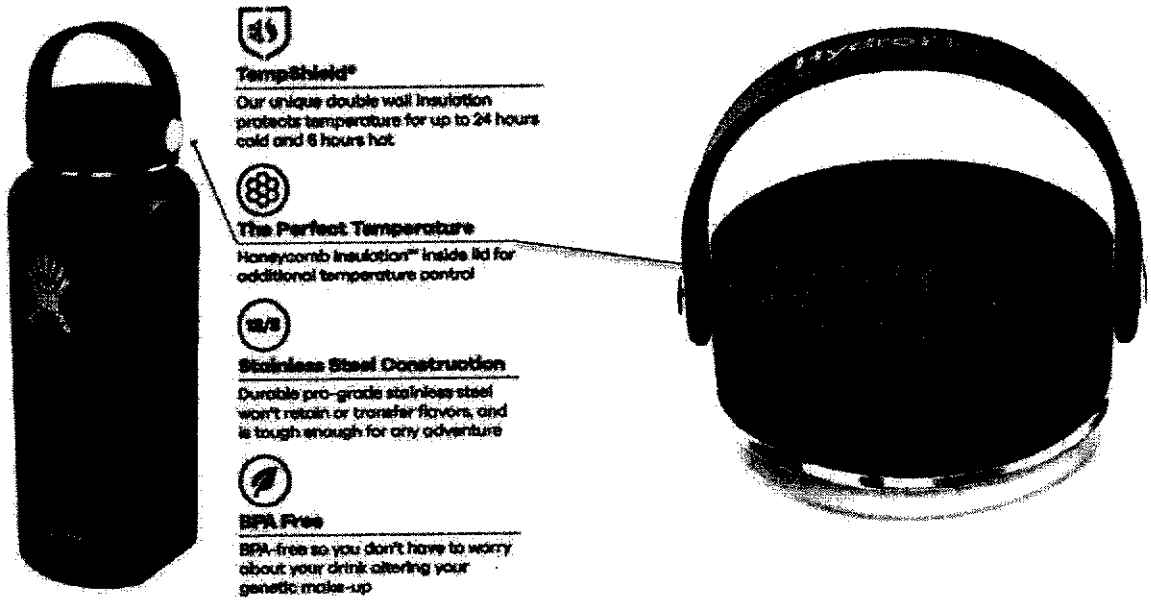


Fig. 5.1

(a) Another part of the brochure further elaborates the TempShield technology.

"Used in every product we make, TempShield™ is our double wall, vacuum insulated technology that guards the temperature of your drink."

Explain how TempShield™ keeps cold drinks cold for a long time.

There is a vacuum between the double walls, and this prevents/reduces heat gain by the cold drinks from the surrounding [1], through conduction and convection. [1]

[2]

(b) "Honeycomb Insulation™ inside lid for additional temperature control"

Explain, how using a honeycomb design in the lid instead of a solid piece of plastic, helps to keep the cold drinks cold.

Air pockets in the honeycomb design is a poor conductor of heat [1], this helps to reduce heat gain from the surrounding via conduction. [1] [2]

(c) The manufacturer also makes this claim in part of the brochure.

"We also guarantee no condensation outside of the bottle, ever."

Explain why there is no condensation on the outside even if we fill the Hydro Flask with ice water.

Due to the vacuum between the double walls, very little heat is transferred from the outside surface to the ice water. [1/2]
The outside surface will not reach a temperature low enough to cause water vapour to condense on it. [1/2]

[1]

6 A ray of light from an under water laser pointer, is incident upon a spherical air bubble as shown in Fig. 6.1. The refractive index of water is 1.33.

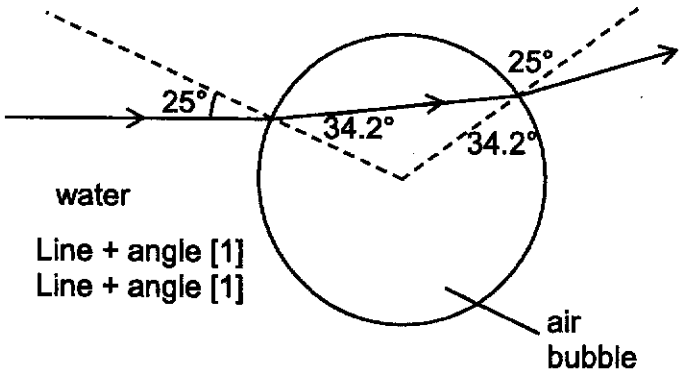


Fig. 6.1

(a) Complete the path of the ray until it exits the air bubble, showing clearly all angles at the boundaries. Show the workings to calculate these angles in the space below. [4]

(sin r) / (sin i) = n = 1.33

$r = \sin^{-1}(1.33 \times \sin 25)$ [1]

= 34.2° [1]

7 Fig. 7.1 shows a light ray from the top of an object passing through a converging lens.

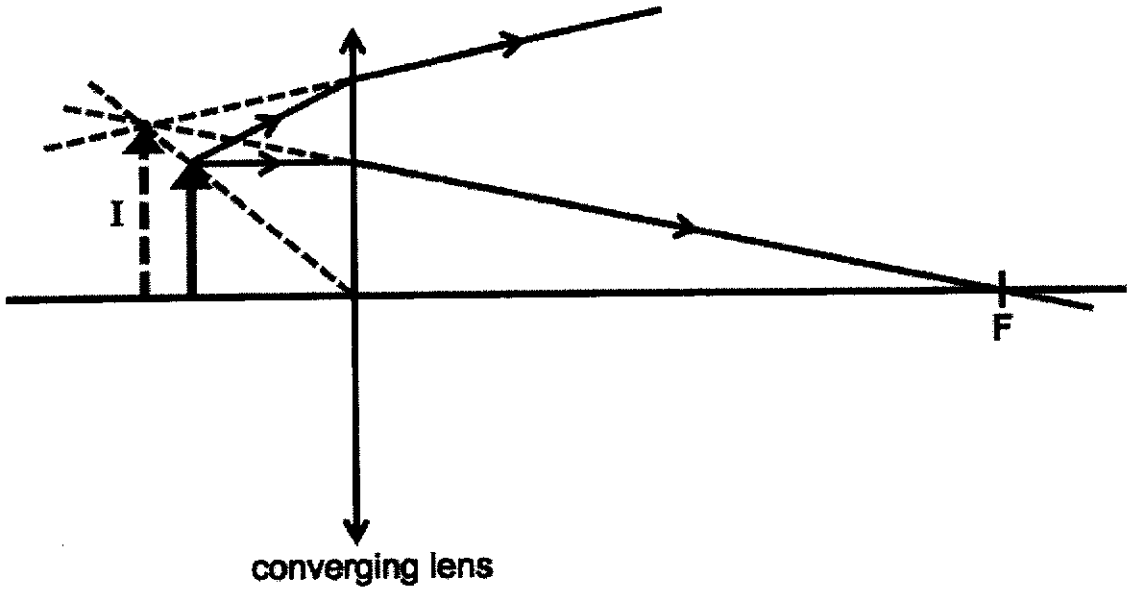


Fig. 7.1

(a) Draw appropriate light rays and construction lines to locate

(i) the image and label the image **I**, and [2]

(ii) the principal focus and label it **F**. [1]

(b) Describe the changes in the characteristics of the image formed (in three stages) as the object is gradually moved to the left, further away from the lens, until the object is slightly more than 2 focal lengths away.

As object moves to left (further away from lens), when object is at

1f: image is virtual, upright, enlarged [1]

between 1f and 2f: image is real, inverted, enlarged [1]

2f: image is real, inverted, same size as object [1]

more than 2f, image is real, inverted, diminished [1]

any 3 of the above. [3]

End of Section A

SECTION B

Answer **all** the questions in this section

8 Fig. 8.1 shows a small jet plane on a runway before taking off.

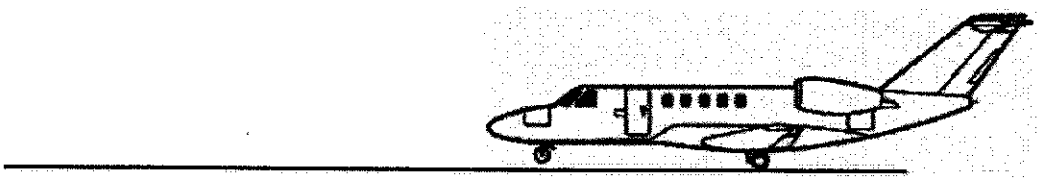


Fig. 8.1

When the plane just begins to move along the runway, the engines produce a constant thrust force of 21020 N and the plane experiences a constant frictional force of 688 N. The mass of the fully-loaded plane is 6800 kg. The plane is initially at rest.

(a) Calculate the acceleration of the plane as it just begins to move along the runway.

F_{net}
= 21020 - 688
= 20332 N [1]

$F_{net} = ma$
$a = 20332 / 6800$
$= 2.99\ m/s^2$ [1]

acceleration = ... [2]

(b) Besides the frictional force, the plane experiences another resistive force as it moves along the runway.

(i) State the name of this resistive force.

Air resistance / Drag force [1]

(ii) This resistive force changes as the speed increases.
Predict and explain how the acceleration in **(a)** changes due to the changing resistive force.

As the velocity of the plane increases, the air resistance it experiences increases. The net force acting on the plane decreases since the forward force is constant. [1]
This leads to a decrease in its acceleration. [1]

[2]

(c) The average acceleration of the plane along the runway is 2.2 m/s^2.

(i) Determine the time taken for the plane to reach a final speed of 55 m/s on the runway before it takes off.

$a = (v - u)/t$
$t = (55 - 0) / 2.2$ [1]
$= 25$ s [1]

time taken = ... [2]

(ii) Determine the minimum length of the runway that is required for the plane to take off.

Minimum length of runway = area under v-t graph

Length of runway
= ½ x 25 x 55 [1]
= 687.5
= 688 m (3 sf) [1]

[2]

minimum length = ...

(d) After take-off, the wheels of the plane are folded into the body of the plane as shown in Fig. 8.2.

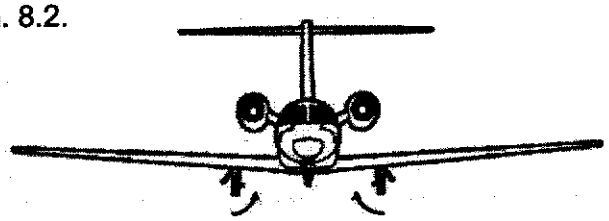


Fig. 8.2

Explain why the wheels are folded into the body of the plane.

The wheels are folded into the body of the plane to reduce air resistance during the flight as this provides a streamline shape for the plane. [1]

9 (a) Fig. 9.1 shows a manometer being used to measure the pressure of some gas in a container. The container is connected to the manometer by a length of rubber tubing.

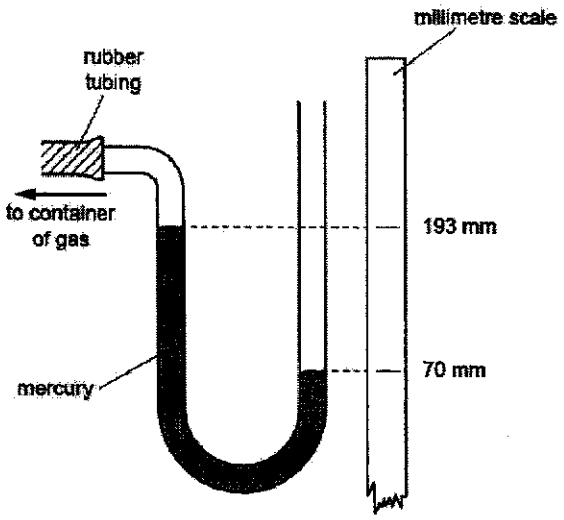


Fig. 9.1

The atmospheric pressure is 752 mm of mercury and the density of mercury is 1.36×10^4 kg/m^3.

Calculate the actual pressure of the gas in the container in

(i) mm Hg, and

pressure = 752 – (193 – 70) mmHg
= 629 mmHg

pressure = ... [1]

(ii) Pa.

pressure = h p g
= (0.629 x 13600 x 10) Pa [1]
= 8.55×10^4 Pa

pressure = ... [2]

(iii) State how the vertical height difference of the two mercury surfaces changes, if at all, when a narrower tube is used instead.

It will remain unchanged

[1]

(b) Fig. 9.2 shows a diver working below the surface of a lake. The density of the water in the lake is 1000 kg/m^3, the atmospheric pressure at the surface is 1.0×10^5 Pa.

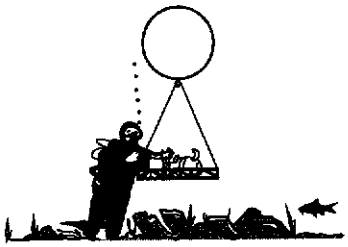


Fig. 9.2

The diver inflates a balloon with air at a depth of 15 m and attaches the balloon to a tray of objects.

(i) Calculate the total pressure acting on the balloon, at 15 m below the surface of the lake.

Total pressure = $1.0 \times 10^5 + 1000 \times 10 \times 15$ [1]
= 2.5×10^5 Pa [1]

pressure = ... [2]

(ii) The diver releases the tray and the balloon, and they begin to rise. The temperature of the air in the balloon does not change. The volume of the balloon is 0.3 m^3 at 15 m depth.

Calculate the volume of the balloon when it reaches the surface.

$P_1V_1 = P_2V_2$
$2.5 \times 10^5 \times 0.3 = 1.0 \times 10^5 \times V_2$ [1]
$V_2 = 0.75$ m^3 [1]

volume = ... [2]

(iii) Explain, in terms of the air molecules inside the balloon, why the air pressure in the balloon is less at the surface.

As the balloon rises, its volume increases. The frequency of air molecules colliding with the wall of the balloon is lower. [1]

This leads to a lower average force per unit area acting on the wall of the balloon, thus the pressure is reduced. [1]

[2]

10 An experimental setup is shown in Fig. 10.1 below.

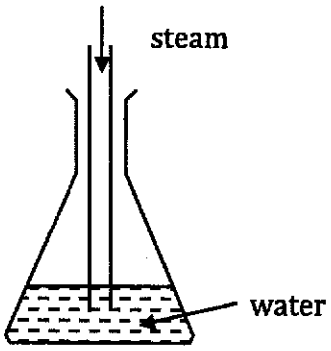


Fig. 10.1

Steam at 100 °C is pumped through a tube into a conical flask containing 500 g water at a room temperature of 25 °C.
After some time, the temperature of the water in the flask rises to 90 °C.
The specific heat capacity of water is 4200 J/kg/K and the specific latent heat of vaporization of water is 2250 kJ/kg.

(a) State what is meant by the specific latent heat of vaporization.

Energy required to convert 1 kg of a substance from liquid to vapour, without a change in temperature.

[1]

(b) Explain why the mass of water in the jug increases.

Steam condenses into water in the flask. [1]

(c) Calculate the energy needed to warm the water from 25 °C to 90 °C.

$Q = mc\Delta\theta$
$= 0.5 \times 4200 \times (90 - 25)$ [1]
$= 136\,500$ J [1]

energy = ... [2]

(d) Calculate the final mass, m, of water in the jug when its temperature has reached 90 °C.

Let m be total mass,
Heat lost by steam and condensed steam = Heat gained by water [1]
$(m - 0.5) \times 2250000 + (m - 0.5) \times 4200 \times (100 - 90) = 136\,500$ [1]
$m = 560$ g [1]

m = ...

[3]

(e) Is the value of **m** obtained in **(d)** above higher or lower than the actual value obtained in the experiment? Explain your answer clearly.

Lower. [1]
As heat is lost to the surroundings, more steam is needed to raise the temperature of the water. [1] [2]

(f) State one way to improve the results of the experiment.

Insulate the flask with wool or felt. [1] [1]

END OF PAPER