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About A Level

(PURE) PHYSICS

(YEARLY)

About Thinking Process

When solving problems, we first analyse the questions and then gather relevant information until we are able to determine the answers. But for presentation reason, we need to organise, rearrange and then present ONLY the required workings and solutions.

Thinking process reveals the extra but relevant information which is not required as part of the solutions.

About MCQ with HELPs

Explanations are given so that students know exactly why the answer is the right one.

period	2013 to 2024
contents	June & November, Paper 1 & 2, Worked Solutions
form	Year By Year
compiled for	O Levels
special features	Thinking Process, MCQ with HELPs

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'O' Level (Pure) Physics 5054 (Yearly)

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JUNE 2024 PAPER 1

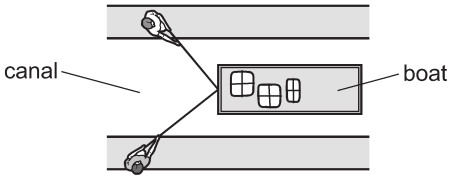
MCQ Section

1. What is measured using a micrometer?

A area **B** current
C length **D** mass

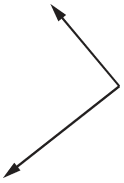
[Topic 1]

2. Two people pull on ropes to move a boat along a canal.

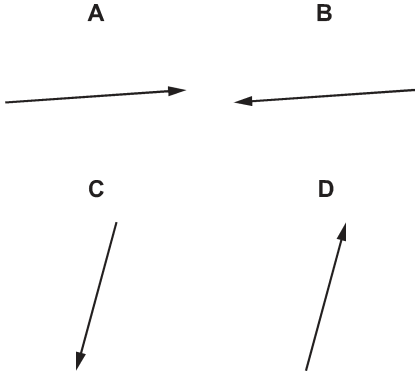


The boat moves at a constant velocity.

The vector diagram for the tension in the ropes is shown.



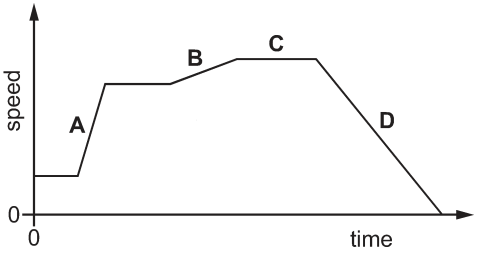
Which vector is the drag acting on the boat?



[Topic 1]

3. The graph shows how the speed of a car travelling in a straight line changes with time.

Which section shows the largest acceleration?



[Topic 2]

4. A man walks along a path from X to Y. The diagram shows the path from above.

The man measures the distance he walks and the time taken.

Which quantity can be calculated using this data only?

A acceleration
B average speed
C average velocity
D power

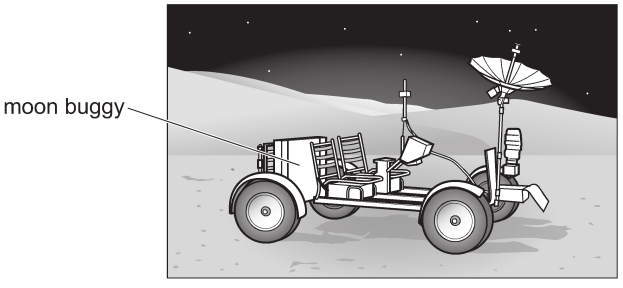
[Topic 2]

5. Which property of an object determines its resistance to a change from its state of rest or motion?

A its mass
B its shape
C its surface area
D its volume

[Topic 3]

6. The diagram shows a moon buggy used by astronauts.



1. C A standard type of a micrometer is used for making precise linear measurements of dimensions such as diameter, thickness and lengths of very small objects under one inch length.

2. A The resultant force on the boat due to the pull on the two ropes will be directed to the left as shown in the option **B**. So, the drag force on the boat will be to the right as shown in option **A**.

3. A The slope (gradient) of a speed-time graph represents the magnitude of acceleration. The steeper the slope, the greater the acceleration. Thus, the option **A** shows the largest acceleration.

4. B The average speed of an object is the total distance travelled by the object divided by the elapsed time to cover that distance.

5. A The resistance to change the state of an object's rest or motion is called inertia, while inertia depends on the mass of an object. The heavier the object the greater its resistance to change its state of rest or motion.

The mass of the moon buggy on the Earth is 210 kg. The gravitational field strength on the Moon is $\frac{1}{6}$ of that on the Earth.

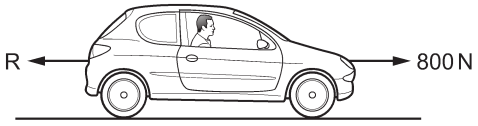
What is the weight of the moon buggy on the Moon?

A zero **B** 35 N
C 210 N **D** 340 N

[Topic 3]

7. A car travels along a road. The force on the car due to the engine is 800 N.

The motion of the car depends on the value of the total resistive force R.



Which row shows the motion of the car for the given value of R?

	value of resistive force R / N	motion
A	500	deceleration
B	800	acceleration
C	900	deceleration
D	1000	acceleration

[Topic 4]

8. Four of the gravitational forces that act between objects in the Solar System are listed.

P the force on the Moon due to the Earth
Q the force on the Earth due to the Sun
R the force on the Earth due to the Moon
S the force on the Moon due to the Sun

Which two forces are a Newton's third law pair?

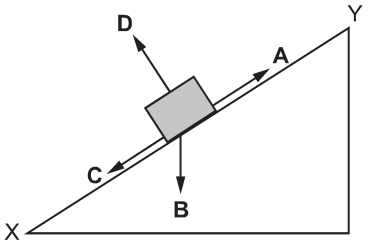
A P and Q
B P and R
C Q and S
D R and S

[Topic 4]

9. A box is moved up a rough slope from X to Y.

The diagram shows four forces acting on the box.

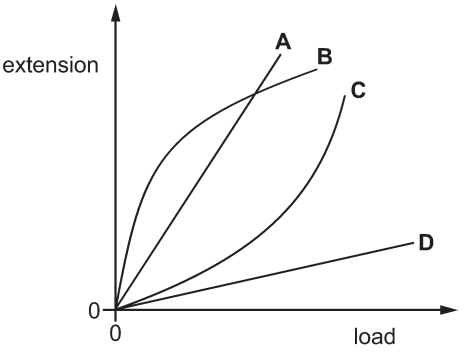
Which force is the force due to friction on the box?



[Topic 4]

10. The graph shows how the extension of four different threads depends on the load attached.

Which thread is the most difficult to stretch over the range of loads shown?

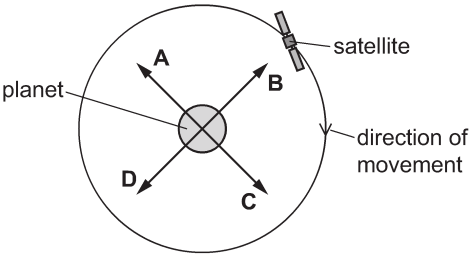


[Topic 6]

11. A satellite orbits a planet in a circular path as shown. It has constant speed.

There is a force on the satellite due to the planet.

In which direction is the force on the satellite when it is in the position shown?



[Topic 4]

MCQ Answers

6. D Gravitational field strength on Earth $= 9.8$ N/Kg

Gravitational field strength on Moon $= \frac{1}{6}(9.8)$ N/Kg

Thus, weight of the buggy on Moon is, $W = m \times g$

$= 210 \times \frac{1}{6}(9.8) = 343$ N

≈ 340 N

7. C The car decelerates if the resultant force acts in the opposite direction of the car's motion, causing the car to slow down.

8. B According to Newton's third law, for every action in nature there is an equal and opposite reaction, which means that when one object exerts a force on another object the second object exerts an equal and opposite force on the first object.

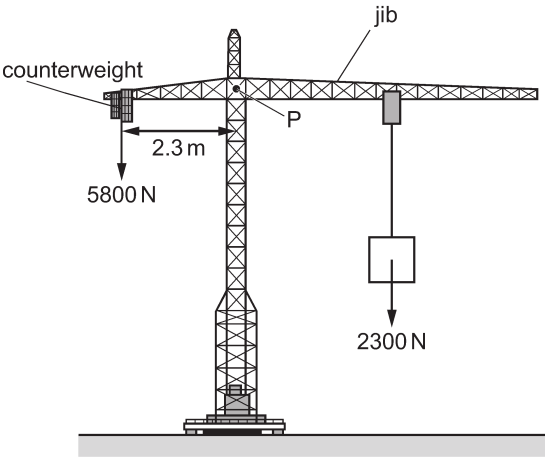
9. C A frictional force always acts in a direction opposite to the direction of motion of an object, causing the object to slow down.

10. D On applying the same force to all the four threads. The thread which shows the least extension, is the thread which is most difficult to stretch.

11. D The planet's gravitational force on a satellite keeps it revolving in its orbit around the planet. This force is always directed towards the centre of the planet.

12. A crane has a 5800 N counterweight positioned 2.3 m from the tower along a horizontal jib.

The centre of gravity P of the crane jib is marked.



What is the horizontal distance between the 2300 N load and P so that there is no moment about P?

A 0.91 m **B** 3.5 m
C 5.8 m **D** 8.1 m

[Topic 5]

13. A car of mass 750 kg travels 400 m at 25 m / s. It then accelerates to 35 m / s and travels a further 400 m.

What is the change in the momentum of the car due to acceleration?

A 7500 kg m / s
B 24 000 kg m / s
C 45 000 kg m / s
D 75 000 kg m / s

[Topic 7]

14. A ball is dropped from rest at the top of a building. Air resistance is negligible.

The velocity of the ball is 14 m / s when it hits the ground.

What is the height of the building?

A 2.9 m **B** 10 m
C 20 m **D** 40 m

[Topic 8]

15. Which energy source is available constantly over a 24-hour period?

A natural gas **B** solar cells
C tidal **D** wind

[Topic 8]

16. A 15 W lamp is turned on for 30 minutes. It wastes 7000 J of energy.

What is the efficiency of the lamp?

A 0.26 **B** 0.35
C 0.59 **D** 0.74

[Topic 8]

17. Which quantity is **not** measured in joules (J)?

A gravitational potential energy
B latent heat
C power
D work

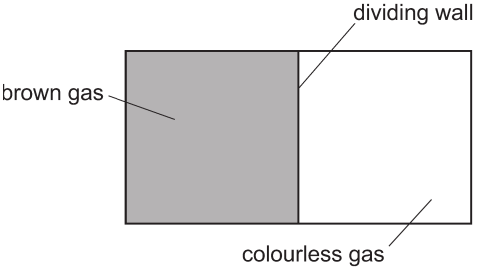
[Topic 1]

18. Which description of a liquid is correct?

A fixed shape, fixed volume
B fixed shape, variable volume
C variable shape, fixed volume
D variable shape, variable volume

[Topic 10]

19. A transparent box has a dividing wall in its middle. It contains two different gases, one in each half, as shown.



The dividing wall is removed. The box is left for a long time. The gases do not react.

What is then seen in the box?

A brown gas on the right and colourless gas on the left
B pale brown gas throughout
C several distinct clouds of colourless and brown gas throughout
D colourless gas on the right and brown gas on the left

[Topic 10]

MCQ Answers

12. C Anticlockwise moment = Clockwise moment

$\Rightarrow F_1 \times d_1 = F_2 \times d_2$

$5800 \times 2.3 = 2300 \times d_2$

$d_2 = \dfrac{5800 \times 2.3}{2300}$

$= 5.8$ m

13. A Change in momentum,

$\Delta P = m(v - u)$

$= 750(35 - 25)$

$= 7500$ kg m/s

14. B Loss in P.E. of ball = Gain in K.E. of ball

$\Rightarrow mgh = \dfrac{1}{2} \times m v^2$

$\Rightarrow h = \dfrac{v^2}{2g}$

$\Rightarrow h = \dfrac{(14)^2}{2 \times 9.8} = 10$ m

15. A It is a fact that among the given four energy sources, natural gas is the only energy source that is available constantly over a 24-hour period.

16. D Energy produced, $E = P \times t$

$\Rightarrow E = 15 \times (30 \times 60)$

$= 27\,000$ J

Net useful energy = energy produced − energy wasted

$= 27\,000 - 7000$

$= 20\,000$ J

Thus, Efficiency $= \dfrac{\text{useful energy}}{\text{total energy}}$

$= \dfrac{20\,000}{27\,000} = 0.74$

17. C Gravitational potential energy, latent heat and work are measured in Joules whereas power is measured in watts (W).

20. A bottle containing a cold liquid is placed on a table on a warm day. Drops of water form on the outside of the bottle.

Which process causes the drops to form?

A condensation
B conduction
C convection
D evaporation

[Topic 10]

21. What is the specific heat capacity of a liquid?

A the difference between the boiling temperature and the melting temperature of the liquid
B the energy required to change the state of 1 kg of the liquid
C the energy required to heat 1 kg of the liquid through 1 °C
D the increase in temperature of the liquid when it is heated

[Topic 11]

22. Which statement about infrared radiation is correct?

A In a vacuum, infrared radiation travels at the speed of light.
B Infrared radiation is a longitudinal wave.
C Infrared radiation has a higher frequency than ultraviolet radiation.
D White surfaces are better emitters of infrared radiation than black surfaces.

[Topic 19]

23. The speed of sound in air is 330 m / s.

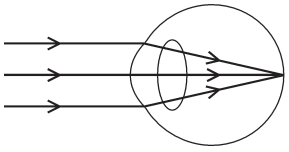
Which sound is classed as ultrasound?

A a sound with a wavelength of 250 cm
B a sound with a wavelength of 25 cm
C a sound with a wavelength of 2.5 cm
D none of the above

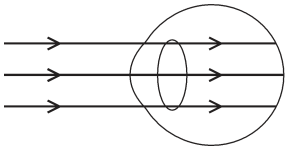
[Topic 13]

24. Which diagram shows how light from a distant object forms an image in a normal eye?

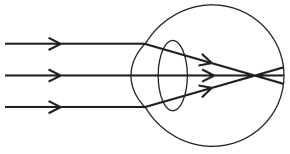
A



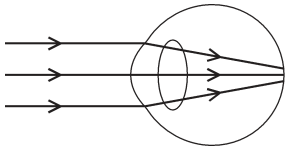
B



C



D



[Topic 17]

25. The colour of visible light is related to the wavelength of the light.

Which list of colours is in order of increasing wavelength?

A blue → green → yellow → red
B blue → green → red → yellow
C green → red → yellow → blue
D red → yellow → green → blue

[Topic 15]

MCQ Answers

18. C It is a fact that a liquid has a variable shape and a fixed volume.

19. B The brown gas diffuses into the colourless gas. As a result, a pale-brown (light-brown) gas is seen spread throughout the transparent box.

20. A Water droplets form on the outer surface of the bottle containing a cold liquid due to condensation. The temperature of the bottle is cold enough to cool down the water vapour in the surrounding air, so it turns from gaseous to liquid state.

21. C It is a fact that specific heat capacity is the heat energy required to raise the temperature of 1 kg of a substance through 1°C.

22. A It is a fact that all e.m. waves including infra-red radiation travel in vacuum at the speed of light i.e. 3.0×10^8 m/s.

23. D The wavelength of ultrasound in air at atmospheric pressure is 1.9 cm or less.

24. A The lens system of the human eye refracts the rays of light from the distant object and converge them to form an image of the object on light-sensitive (membrane) screen called the retina at the back of the eye.

25. A Fact.

NOVEMBER 2024 PAPER 2

THEORY Section

Question 1

A jet ski is a type of boat that carries one or two people and travels at high speed on water.

Fig. 1.1 shows a student riding on a jet ski.

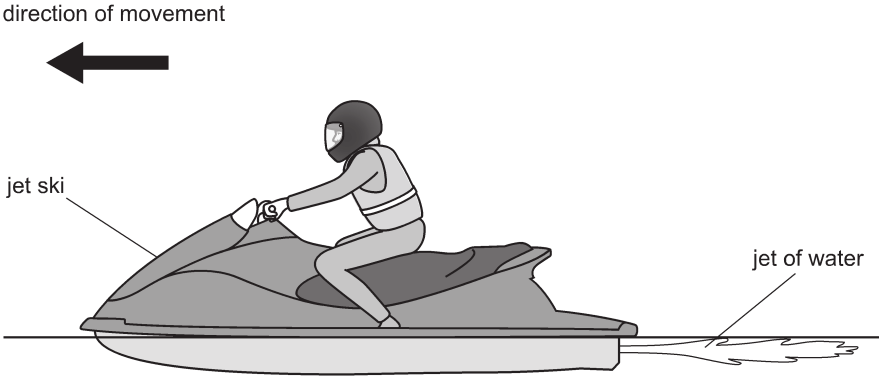


Fig. 1.1

A high-speed jet of water is forced backwards out of the back of the jet ski by a pump inside the jet ski.

(a) The pump increases the momentum of the water that is forced backwards out of the back of the jet ski.

(i) Complete the word equation to show the relationship between the resultant force on an object and the change in momentum of the object

. resultant force =

[1]

(ii) In 2.0 s, the pump increases the backwards speed of 180 kg of water by 30 m / s.

Calculate the backwards force exerted on the water. [2]

(b) (i) Using Newton's third law of motion, explain why there is a forwards force on the jet ski. [2]

(ii) The student has a mass of 70 kg and the jet ski has a mass of 280 kg.

Use your answer from **(a)(ii)** to determine the acceleration of the student and jet ski when no resistive forces are acting. [2]

(c) The jet ski reaches a speed of 20 m / s.

Calculate the total kinetic energy of the student and jet ski at this speed. [3]

[Topic 7]

Solution

(a) (i) $\text{Resultant force} = \dfrac{\text{increase in momentum}}{\text{unit time}}$

(ii) $F = ma$

$= m \times \dfrac{\Delta v}{t}$

$= 180 \times \dfrac{30}{2} = 2700\ \text{N}$

(b) (i) As the pump of the jet ski exerts a force on the water. In return, the water exerts an equal and opposite force on the pump of the jet ski.

(ii) $F = m \times a$

$a = \dfrac{F}{m}$

$= \dfrac{2700}{70 + 280} \approx 7.7\ \text{m/s}^2$

(c) $\text{K.E.} = \dfrac{1}{2} \times m \times v^2$

$= \dfrac{1}{2}(70 + 280) \times (20)^2$

$= 70,000\ \text{J}$

COMMENT on **ANSWER**

"**(a) (i)** ***Alternatively:***
Resultant force
= rate of increase in momentum

(ii) ***Alternatively:***

$F = \dfrac{\text{increase in momentum}}{\text{unit time}}$

$= \dfrac{mv}{t}$

$= \dfrac{180 \times 30}{2} = 2700\ \text{N}$"

Question 2

A glass beaker of mass m is at rest on a horizontal surface.
The base of the beaker is a circle with a radius r.

(a) The beaker exerts a pressure on the horizontal surface.
Determine an expression for the pressure in terms of the gravitational field strength g, m and r.

pressure =

[2]

(b) Fig. 2.1 shows the beaker being filled with a liquid from container X.

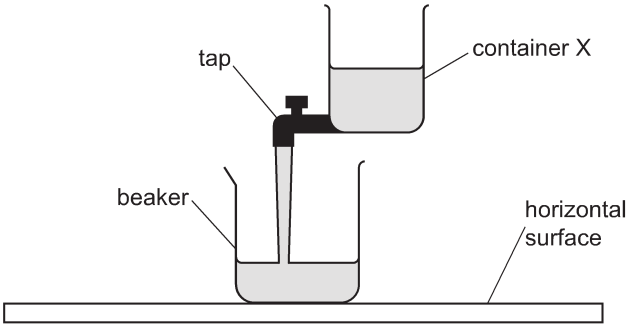


Fig. 2.1

Initially, the beaker is empty.

At time $t = 0$, the tap is opened and liquid from container X flows slowly into the beaker at a constant rate.

At time $t = T$, the liquid stops flowing into the beaker.

Sketch on Fig. 2.2 to show how the pressure exerted on the horizontal surface varies between $t = 0$ and $t = 2T$. [3]

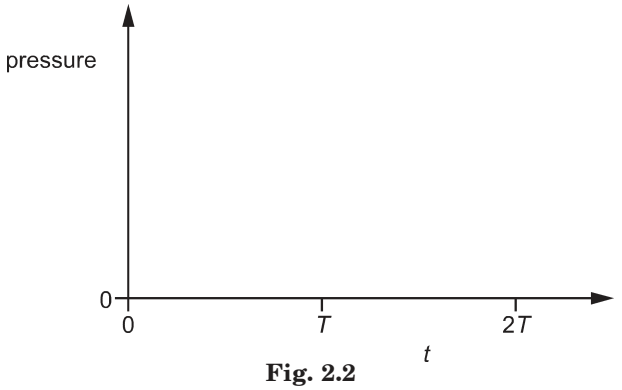


Fig. 2.2

[Topic 9]

Solution

(a) Pressure, $P = \dfrac{F}{A}$

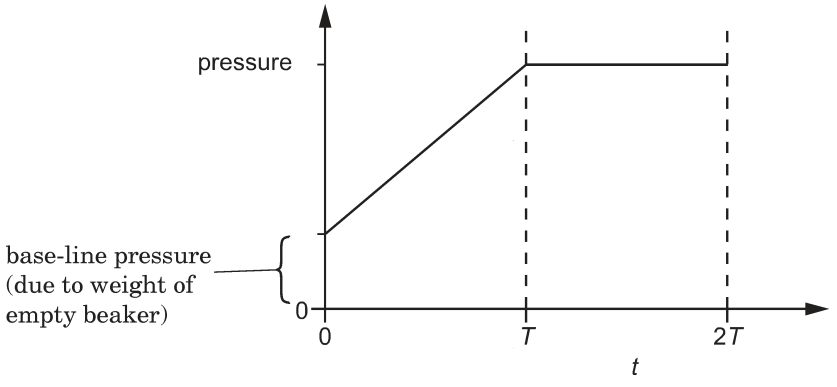
Where, F = weight of beaker $\Rightarrow$ F = mg

A = area of circular base of the beaker with radius r.

$\Rightarrow$ $A = \pi r^2$

Thus, Pressure, $P = \dfrac{mg}{\pi r^2}$

(b)



Question 3

Fig. 3.1 shows a laboratory freezer.

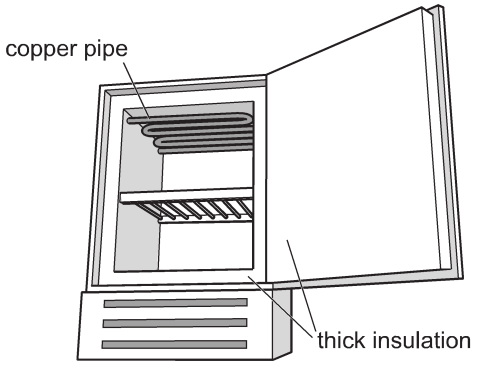


Fig. 3.1

The door is closed and the freezer is switched on.

A cold liquid is pumped through the copper pipe at the top of the freezer.

The temperature of the air next to the copper pipe decreases quickly.

(a) Explain how the temperature of the rest of the air in the freezer decreases. [3]

(b) The thick insulation shown in Fig. 3.1 is made from a plastic material.

(i) The plastic material in the insulation is a poor thermal conductor.
Describe how thermal energy is transferred through a plastic material. [2]

(ii) The plastic material also contains a large number of small air bubbles.
Explain how the air bubbles reduce the transfer of thermal energy through the insulation. [3]

[Topic 12]

Solution

(a) As the cold liquid is pumped through the copper pipe at the top of the freezer, it cools down the pipe. The cold pipe then absorbs the heat from the surrounding air through conduction. This lowers the temperature of the air **near** the pipe. Consequently, the cooler air becomes denser and sinks while the warmer air at the bottom of the freezer rises. This sets up convection current which helps in spreading the cooler air gradually in the freezer until a lower uniform temperature in the entire freezing compartment is reached.

(b) (i) Heat energy is transferred through an insulating material such as a plastic material by conduction. The particles of plastic material on the warmer side gain thermal energy and start vibrating more. They, in turn, collide with the neighbouring particles and pass on the vibrations and hence the thermal energy to the particles on the cooler side of the plastic material.

(ii) The air trapped in air bubbles is a very bad conductor of heat. So, this trapped air in the tiny pockets or bubbles not only reduces the heat transfer by conduction but also minimises the heat transfer by convection as the air trapped in the bubbles is less able to move or circulate. Hence, the presence of air bubbles increases the thermal insulation of the plastic material.

Question 4

Fig. 4.1 shows a large syringe that is sealed at the nozzle by wax. There is a piston inside the syringe.

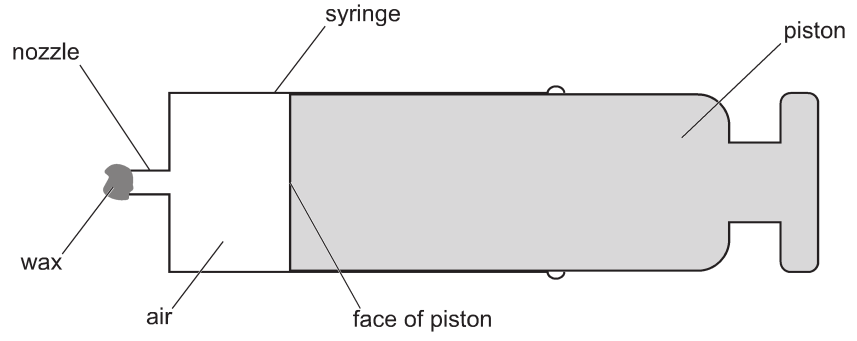


Fig. 4.1

The pressure of the air inside the syringe is equal to atmospheric pressure, 1.0×10^5 Pa.

The volume of the air inside the syringe is 1.2×10^{-4} m^3.

The area of the end of the piston that is in contact with the air is 3.5×10^{-3} m^2.

The friction between the piston and the syringe is negligible.

(a) (i) Calculate the force on the piston due to the pressure of the air inside the syringe. [2]

(ii) The force on the piston in **(a)(i)** acts to the right.

Explain why the piston does not move to the right. [2]

(b) The piston is now pulled to the right by an additional force.

The temperature of the air in the syringe does not change.

(i) Explain, in terms of particles, why the pressure of the air in the syringe decreases. [3]

(ii) Calculate the pressure of the air inside the syringe when the volume of the air is 1.5×10^{-4} m^3. [2]

[Topic 10]

Solution

(a) (i) Force, $F = \text{Pressure } (P) \times \text{Area } (A)$

$= (1.0 \times 10^5) \times (3.5 \times 10^{-3})$

$= 350 \text{ N}$

(ii) Since the air pressure outside the syringe is equal to the air pressure inside the syringe and they are acting on the piston in the opposite directions. Hence, the force pushing the piston to the right (350 N) is equal to the force pushing the piston to the left (350 N). As a result, there is no unbalanced force to cause a motion in the piston to the right.

(b) (i) On pulling the piston to the right, the volume of the air in the syringe increases but the speed of the particles remains the same as the temperature remains constant. As a result, the particles are now spread out over a larger space and collide with the walls of the syringe less frequently. Since, pressure is a result of these collisions, hence, fewer collisions lead to a decrease in pressure.

(ii) $P_1 \times V_1 = P_2 \times V_2$

$\Rightarrow \quad P_2 = \dfrac{P_1 \times V_1}{V_2}$

$= \dfrac{(1.0 \times 10^5) \times (1.2 \times 10^{-4})}{(1.5 \times 10^{-4})} = 8.0 \times 10^4 \text{ Pa}$

Question 5

Some glass lenses are converging lenses, and others are diverging lenses.

(a) Draw the cross-section of a diverging lens. [1]

(b) Fig. 5.1 shows the cross-section of a converging lens, the principal axis and the two principal focuses (focal points) F_1 and F_2 on a full-scale grid.

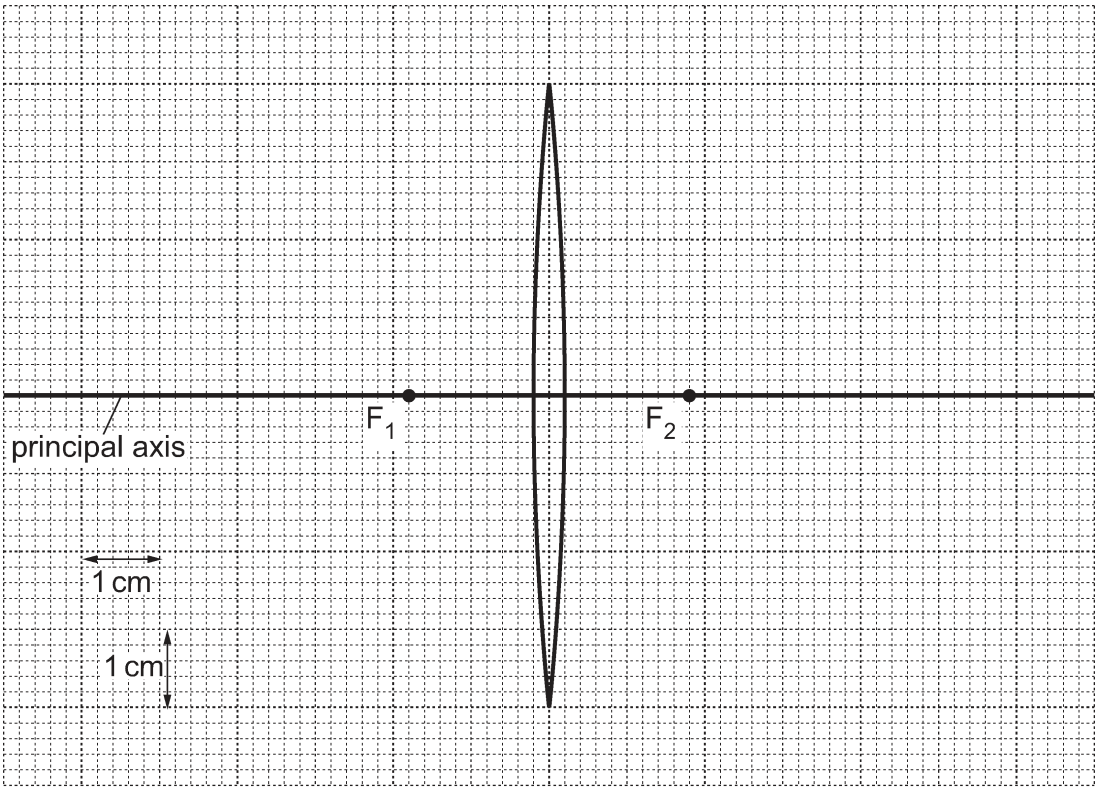


Fig. 5.1

A student places an object of height 2.1 cm at a distance of 3.0 cm from the centre of the lens.

(i) Using Fig. 5.1, determine the focal length of the lens. [1]

(ii) On Fig. 5.1, draw a vertical arrow of height 2.1 cm that is 3.0 cm from the centre of the lens and label the arrow **O**. The arrow is the object. [1]

(iii) On Fig. 5.1, draw **two** rays from the tip of the object arrow to find the tip of the image.

Draw another arrow to show the image. [3]

(iv) Using the image marked on Fig. 5.1 in **(b)(iii)**, determine the linear magnification produced. [2]

(v) Explain whether the image of the object is real or virtual. [1]

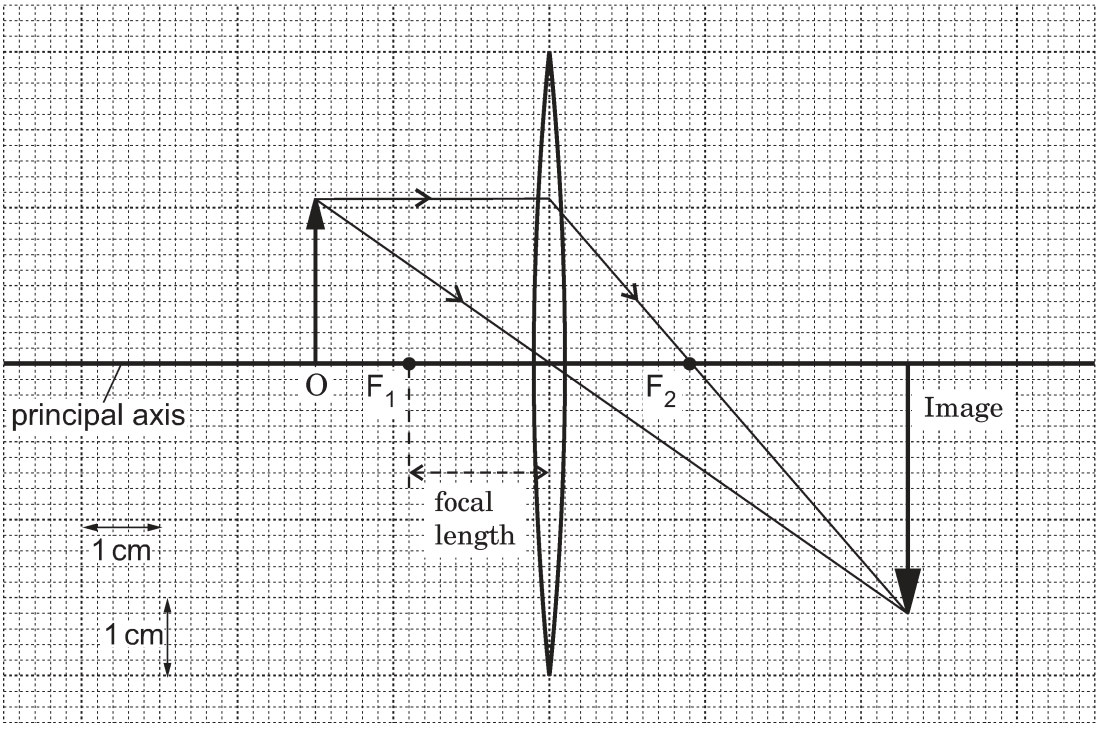
[Topic 16]

Solution

(a)

(b) (i) Focal length = 1.8 cm

(ii) & (iii)



(iv) Linear magnification $= \dfrac{\text{image height } (h_I)}{\text{object height } (h_O)}$

$= \dfrac{3.2\text{ cm}}{2.1\text{ cm}} \approx 1.5$

(v) Since the image is formed by converging light rays, so it is a real image.

COMMENT on **ANSWER**

"(b) (iv) ***Alternatively:***

Linear magnification $= \dfrac{\text{image distance}}{\text{object distance}}$

$= \dfrac{4.6\text{ cm}}{3.0\text{ cm}} \approx 1.5$

(v) ***Alternatively:***

— An inverted image formed by a converging lens is always a real image."