Comparison between NEW and OLD syllabuses

In the NEW Physics syllabus, some topics are removed and some are newly added. Moreover, the syllabus is divided into two parts: **core** and **extension**. Some difficult topics are grouped under the extension part and they will only be asked in Section B of both Papers 1 and 2.

(a) Topics removed from and added to the syllabus

The following table shows the topics that are removed from and added to the syllabus. Questions involving the removed topics in past examination papers are now out of the syllabus, while the newly added topics are allocated in both the core and extension parts. Students should pay more attention to the new topics during revision.

Section	Topics removed	Topics added
Optics	• Reflection by curved mirrors • Optical instruments: magnifying glass, microscope, telescope, human eye, camera	—
Heat	• Gas laws, Kinetic Theory	• Transfer process of heat (conduction, convection and radiation)
Mechanics	• Pressure as force per unit area • Moment produced by a force • Machine	• Effect of air resistance of object falling under gravity
Waves	• Standing (stationary) waves • Viewing water wavefront by stroboscope	• Using the unit decibel to represent the sound intensity level • Noise pollution and acoustic protection
Electricity and Magnetism	• CRO, electronic devices, logic gates • Charging by using of an E.H.T power supply	—
Atomic Physics	• α-particle scattering experiment	• X-ray: property and emission • Using sievert as a unit to measure radiation dosage • Prevention of radiation dosage • Nuclear fission and chain reaction • Nuclear fusion and solar energy

1.1 Temperature, heat and internal energy

Learning Focus

- Understand the meaning of temperature.
- Interpret temperature as a quantity associated with average kinetic energy due to the random motion of the molecules in a system. **Extension**
- Define the Celsius scale and fixed points on the Celsius scale.
- Use temperature-dependent properties to measure temperature.
- Distinguish between different types of thermometers.
- Define 'heat' as the energy transferred resulting from the temperature difference between two objects.
- Define 'internal energy' and 'power', and also distinguish between heat and internal energy.
- Interpret internal energy as the mechanical energy of molecules in a system. **Extension**
- Define heat capacity and specific heat capacity and determine specific heat capacity by experiment.
- Apply the formula $Q = mc\Delta T$.
- Understand the practical importance of the high specific heat capacity of water.

A. Temperature and thermometers

(a) Temperature

- Temperature（溫度）is an objective measurement because our feelings are not reliable.
- Temperature is a quantity to measure how hot an object is, i.e. the degree of hotness.
  - The molecules in an object are in *constant random motion*. **Extension**
  - The hotter the object, the more vigorously the molecules move, i.e. they have a higher average kinetic energy. **Extension**
  - The temperature of an object is therefore associated with the average kinetic energy due to the random motion of molecules in an object. **Extension**

> **Reminder**
> A question on the concept of molecules in constant random motion is usually asked in the multiple-choice questions.

(b) Temperature scale（溫標）

- A scale is needed to measure temperature and this is obtained by choosing two temperatures which are called *fixed points*.
- Lower fixed point（低定點）– it is the melting point（熔點）of pure ice under normal atmospheric pressure.
- Upper fixed point（高定點）– it is the boiling point（沸點）of pure water under normal atmospheric pressure.
- The temperature at the lower fixed point is taken to be 0°C.

> **Reminder**
> A fixed point is a specific temperature that can be reproduced easily.

Glossary

bimetallic strip	雙層金屬片
boiling point	沸點
Celsius scale	攝氏溫標
clinical thermometer	體溫計
condensation point	凝結點
conduction	傳導
convection	對流
emission	發射
evaporation	蒸發
freezing point	凝固點
greenhouse effect	溫室效應
heat	熱（量）
heat capacity	熱容量
infra-red radiation	紅外輻射
internal energy	內能
latent heat	潛熱
liquid-in-glass thermometer	液體玻璃溫度計
lower fixed point	低定點
melting point	熔點
power	功率
radiation	輻射
resistance thermometer	電阻溫度計
rotary thermometer	轉動式溫度計
specific heat capacity	比熱容量
specific latent heat of fusion	熔解比潛熱
specific latent heat of vaporization	汽化比潛熱
temperature	溫度
temperature scale	溫標
thermistor thermometer	熱敏電阻溫度計
thermocouple	溫差電偶
thermometer	溫度計
upper fixed point	高定點

Important Formulae

- $\theta = \dfrac{X - X_0}{X_{100} - X_0} \times 100°\text{C}$
- Heat transferred by an electric heater = Power × Time
- Heat Q required to heat a substance of mass m, specific heat capacity c with a temperature change ΔT:
  $Q = mc\Delta T$
- Energy Q required to melt a substance of mass m, specific latent heat L at its melting point:
  $Q = mL$

Demonstration

Paper I Conventional Questions

Section A

1.

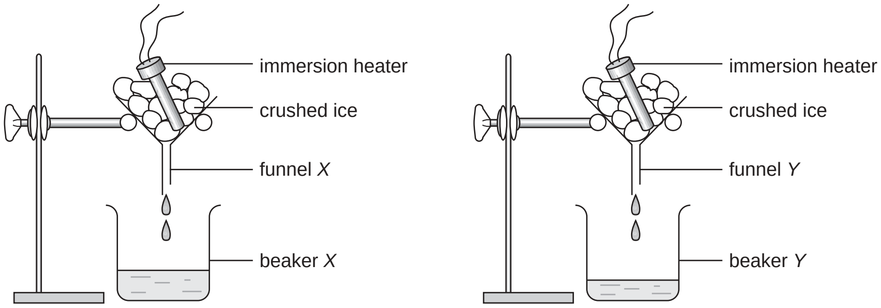


Figure 1.14

The above experiment set-up is used to determine the specific latent heat of fusion of ice. Equal mass of crushed ice is put into two funnels *X* and *Y*. Two identical immersion heaters are completely immersed into the ice. The heater in *Y* is unconnected while that in *X* is connected to a joulemeter which is connected to an electric power supply.

(a) Why does the ice have to be crushed? (2 marks)

(b) When the heater is turned on, funnel *X* starts to drip about one minute later than *Y*. Suggest one possible reason. (2 marks)

> **Guidelines**
> The experiment should be started at the melting point for the purpose of accuracy.

(c) When both funnels *X* and *Y* are dripping at the same rate, the following procedures are done:

1. The beakers are replaced by two dry beakers.
2. The heater in funnel *X* is turned on.
3. A stop watch is started.

After 15 minutes, the following readings are recorded:

Initial reading of joulemeter = 3362 J
Final reading of joulemeter = 6874 J
Mass of water in beaker *Y* = 11.6 g
Mass of water in beaker *X* = 22.4 g

(i) Find the heat supplied by the heater.

(ii) What is the mass of ice melted by absorbing heat from the heater?

(iii) Find the specific latent heat of fusion of the ice.

2 Position and Movement

Concept Map

Position and

Physical quantities about motion

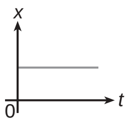
Scalar: Only possesses magnitude
- Distance: Length along the path
- Average speed: Distance travelled per unit time
- Instantaneous speed: How fast an object moves at an instant **Extension**

Vector: Possesses both magnitude and direction
- Displacement: How far and in which direction an object is from the reference point
- Average velocity: Displacement per unit time
- Instantaneous velocity: The velocity of the object at an instant **Extension**
- Acceleration: Rate of change of velocity, $a = \frac{v - u}{t}$

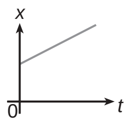
Physical quantities in motion change with time

Displacement-time graph
Slope of graph = Velocity

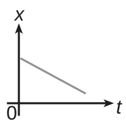
(a) Object is at rest (slope = 0)



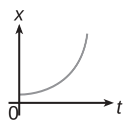
(b) Object is moving forward with uniform velocity (positive slope)



(c) Object is moving backward with uniform velocity (negative slope)

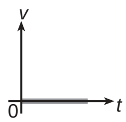


(d) Object is accelerating (increasing slope)

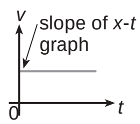


Velocity-time graph
Area under graph = Displacement
Slope of graph = Acceleration

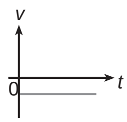
(a) Object is at rest (slope = 0)



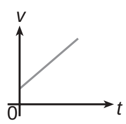
(b) Object is moving forward (positive value)



(c) Object is moving backward (negative value)

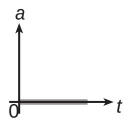


(d) Object is accelerating (positive slope)

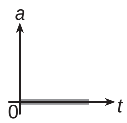


Acceleration-time graph
Area under graph = Change in velocity

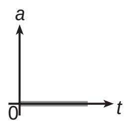
(a) Object is at rest



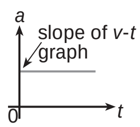
(b) Object is moving forward with uniform velocity



(c) Object is moving backward with uniform velocity



(d) Object is accelerating (positive value)

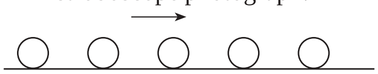


Movement

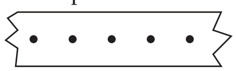
Motion along a straight line

Uniform motion

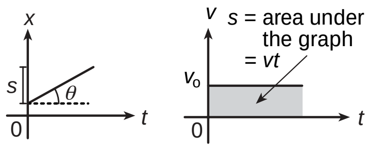
- Appearance
  - stroboscope photograph:



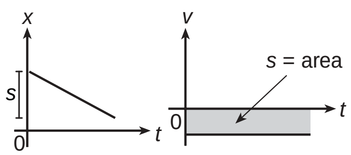
  - ticker-tape



- Definition - motion with constant velocity
- Formula - Displacement is given by $s = vt$.
- Graphs
  - forward uniform motion:

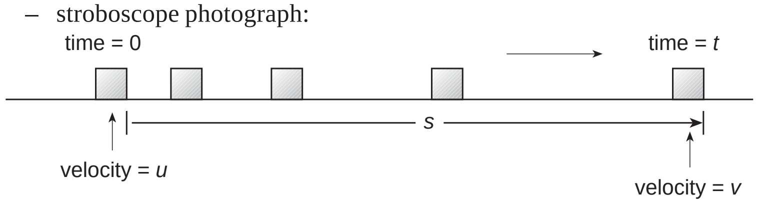


  - backward uniform motion:

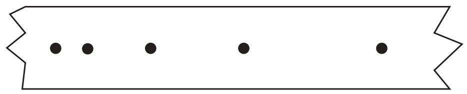


Uniformly accelerated motion

- Appearance
  - stroboscope photograph:



  - ticker-tape:



  - data logging system
- Definition: motion with constant acceleration
- Equations of motion:

$$v = u + at$$
$$v^2 = u^2 + 2as$$
$$s = \frac{1}{2}(u + v)t$$
$$s = ut + \frac{1}{2}at^2$$

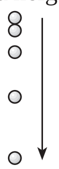
where

u: initial velocity
v: final velocity
a: acceleration
s: displacement t: time taken

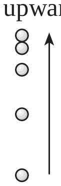
Vertical motion under gravity

- Motion in one direction:

Case 1 (Object dropped from a height)

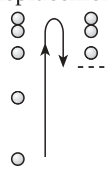


Case 2 (Object projected upward)

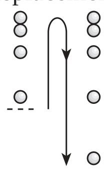


- Motion with a change in direction: Object projected upward **Extension**

Case 1 (Upward displacement)



Case 2 (Downward displacement)



Important Formulae

- Average speed = $\frac{\text{Distance travelled}}{\text{Time}}$
- Average velocity = $\frac{\text{Total Displacement}}{\text{Time}}$
- Acceleration = $a = \frac{v - u}{t}$
- In a uniform motion, displacement s is equal to the product of velocity v and time t taken: $s = vt$
- In a uniformly accelerated motion, initial velocity u, final velocity v, acceleration a, displacement s and time t are related by the equations:

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$s = \frac{1}{2}(v + u)t$$

$$v^2 = u^2 + 2as$$

Examination Question Analysis

Topics	Conventional Questions (Year)	Multiple-choice Questions (Year)
Scalars and vectors	—	97(4), 00(1)
Distance / displacement and average speed / velocity	96(2aii), 01(8a)	92(2), 94(3), 96(2), 97(2), 99(1), 01(2)
Distance / displacement and velocity-time graph	92(1b, c), 93(1bii, iii), 97(1d), 99(7c), 01(8bii)	92(4), 95(8), 98(5), 00(4)
Average velocity and stroboscope picture or ticker-tape	97(3ai)	94(2)
Relation among the shapes of *x-t*, *v-t* and *a-t* graphs	92(1d), 95(1ci), 96(2b), 97(1a, c), 98(1a), 99(7a), 01(8bi)	92(1), 93(5), 95(4), 96(4), 98(4), 99(3), 01(1)
Acceleration and *v-t* graph	97(1b), 99(7b)	—
Acceleration and strobe picture or ticker tape	95(1cii)	92(3), 93(2)
Quantities of motion in free fall	93(1biv)	93(3), 94(42), 95(3,5), 96(6), 99(2), 00(2), 01(3)
Free fall (calculation)	00(7a)	97(6)
Equations of uniformly accelerated motion	93(1ai), 96(2ai, d),97(3aii, 1), 98(1ci, ii),00(7bi, ii)	98(2), 00(3)

3.2 Newton's First Law of motion

Learning Focus

- Understand Newton's First Law of motion and apply Newton's First Law to explain situations in which objects are at rest or in uniform motion.

A. Definition of Newton's First Law of motion

- Newton's First Law of motion（牛頓運動第一定律）states that:
  A stationary object at rest tends to stay at rest, and a moving object in motion tends to keep moving with the same speed and in the same direction unless acted upon by an *unbalanced force*（不平衡力）or net force（淨力）.
- When the velocity of an object is found to be constant, we may apply Newton's First Law to conclude that the unbalanced force acting on the object is zero.
- **NO** unbalanced force is required to keep an object in uniform motion. It keeps going by its own inertia. Inertia is **NOT** a force.
- Draw a free-body diagram and set up equations using the above vector sum relation.

Reasoning step: An object is at rest, or in uniform motion → Resultant of **ALL** external forces = 0

Reminder
No matter in which direction an object goes, the unbalanced force is still zero.

B. Friction-compensated inclined plane

- When friction acting on an object is just balanced by the component of its weight on an inclined plane, the plane is said to be 'friction-compensated'（補償摩擦作用）.
- In Figure 3.16, the weight W is resolved into two components, one is parallel to the plane while the other is perpendicular to the plane.

Reminder
The forces to be resolved in Figure 3.16 must be the hypotenuse of a right-angled triangle.

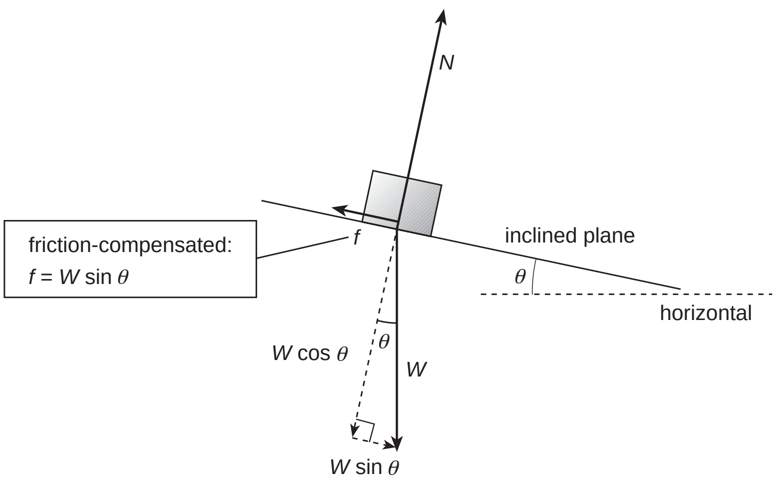


Figure 3.16

Guided Example 2

A 2 kg block is pushed by a force of 8 N on a horizontal table surface. The friction between the block and the table surface is 3 N.

(a) Find the acceleration of the block.

(b) What is the *normal reaction* acting on the block by the table surface?

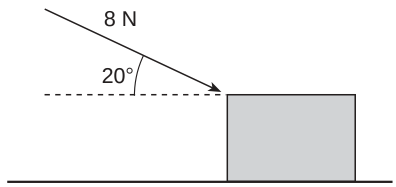


Figure 3.36

Reminder
From the direction of motion / acceleration, determine the direction of unbalanced force and find the normal reaction.

Suggested Answer

(a) Unbalanced force is a horizontal force because the block moves only on the table surface.

Unbalanced force = 8 cos 20° – 3
= 4.52 N

By Newton's Second law: $a = \frac{F}{m}$
$= \frac{4.52}{2}$
$= 2.26\ \text{m s}^{-2}$ (to right)

(b) As the unbalanced force is a horizontal force,

Magnitude of Upward force = Magnitude of downward force
R = 8 sin 20° + W
= 8 sin 20° + 2 × 10
= 22.7 N (upward)

Guided Example 3

A man of mass 50 kg is standing in a lift. The lift accelerates downwards from rest and acquires a speed of 6 m s^{-1} after 4 seconds.

(a) Draw a diagram to show all the forces acting on the man.

(b) Find the *man's acceleration*.

(c) What is the normal force exerted by the floor of the lift on the man?

Reminder
As the man is moving together with the lift, his acceleration is same as that of the lift.

Suggested Answer

(a)

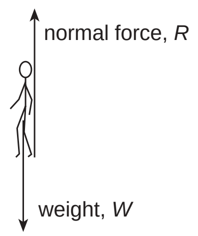


Figure 3.37

6. Read the following passage about the High Jump and answer the questions that follow:

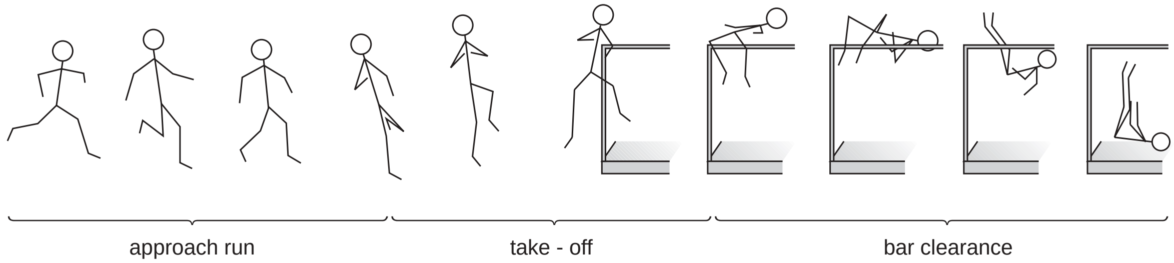


Figure 4.33

In the Olympic Games, the High Jump（跳高）is the most fascinating event in the field as it combines ballistic strength with speed, expressed through rhythm and body control. The falling of the crossbar is always followed by the audience's sigh and disappointment.

The key to success is the efficient transfer of speed into vertical lift off the ground. Rhythm and technique determine how well the athlete achieves this transfer of speed.

The method of high jumping discussed here is known as the Fosbury Flop（背越式）(named after its originator, the 1968 Olympic champion, Dick Fosbury). The Flop has become the universal method of high jumping. Figure 4.33 shows the complete process of this method.

After the jumper leaves the ground, his centre of mass follows a projectile motion. No matter how hard he stretches his body, he can no longer change his own mechanical energy. The maximum height reached by his centre of mass is already determined.

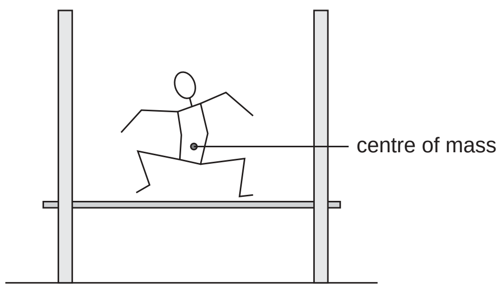


Figure 4.34

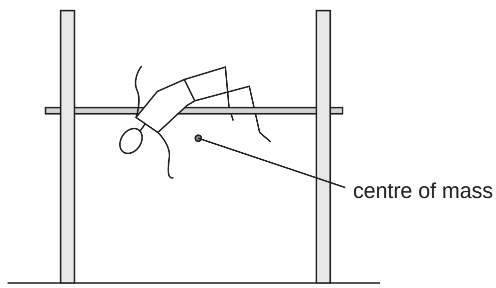


Figure 4.35

Figure 4.34 and figure 4.35 show two ways of clearing the crossbar. In the traditional method, the jumper's centre of mass is much higher than the bar. However, in the Fosbury Flop, the jumper curves his body so that he can clear the crossbar with his centre of mass well below the bar. The record was raised from 2.18 m to 2.24 m in 1968 Olympic. Now, the record using this method is 2.43 m!

(a) Describe the energy change in different phases shown in Figure 4.33. Hint 6 (3 marks)

(b) Explain why 'the efficient transfer of speed into vertical lift off' is so important in high jump event. Hint 7 (3 marks)

(c) After the jumper leaves the ground, he cannot change his own mechanical energy. Explain why. (2 marks)

Practice

Paper I Conventional Questions

Section B

1.

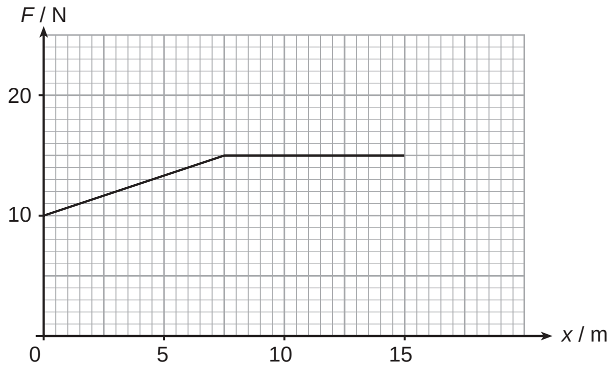


Figure 5.15

A block of mass 10 kg is pushed from rest along a level surface by a varying force F for a distance of 15 m. The above graph shows the variation of F against displacement x of the block. Meanwhile, the frictional force between the block and the surface is 6 N.

(a) Find the work done by F on the block. Hint 1 (3 marks)

(b) What is the final kinetic energy of the block? (3 marks)

(c) Find the final momentum of the block. (2 marks)

(d) If the first 7.5 m journey takes 7 s and the last 7.5 m journey takes 5 s, find the average unbalanced force acting on the block. (3 marks)

2.

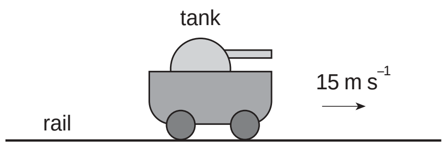


Figure 5.16

A tank of mass 30 tons is moving forward at a speed of 15 m s^{-1} on a smooth rail. It fires a cannon ball of mass 20 kg at a missile speed of 1400 m s^{-1} to a target in front of the tank.
(Given: 1 ton = 1000 kg)

(a) Find the final velocity of the tank just after the cannonball is fired. Hint 2 (3 marks)

(b) Estimate the minimum chemical energy released by the explosion. (3 marks)

(c) The explosion lasts for 0.4 s. Find the average pushing force experienced by the cannon ball in the firing tube. (3 marks)

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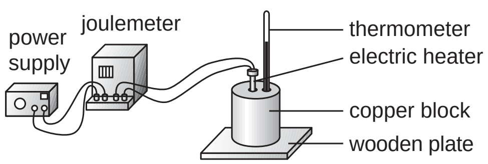
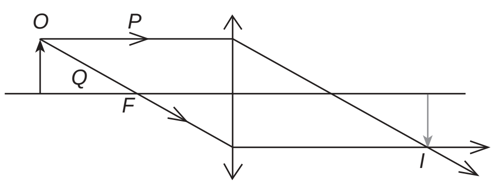
Question Commands

Paper I Conventional Questions

	Question command(s)	Example(s)	Tips
1.	Find the ...	1. Find the weight of a man of mass 65 kg. (1 mark) Ans: $W = mg = 65 \times 10 = 650$ N (1A) 2. A car of mass 1200 kg moving at 20 m s^{-1} is brought to stop uniformly by a 800 N friction. Find the braking distance. (3 marks) Ans: Work against friction = change in K.E. or $F \times s = \frac{1}{2}mv^2$ (1M) $800\, s = \frac{1}{2} \times 1200 \times 20^2$ (1M) $s = 300$ m (1A)	• The exact numerical answer is expected. • 1 mark question: a correct answer scores the mark • 2 marks question: 1 mark for the correct formula used and 1 mark for the answer* • 3 marks question: 1 mark for the correct formula or law applied, 1 mark for correct substitution of numerical values and 1 mark for the answer* * If the answer is correct, all the 'M' marks will be granted.
2.	Draw a diagram ...	Draw a diagram to show the experimental setup for the measurement of the specific heat capacity of copper. Ans: 	• The diagram should be labelled properly. Wrong spelling will score no mark. • If possible, use standard equipment/apparatus in the diagram.
3.	Complete the diagram ...	Complete the given diagram by adding the refracted rays of the incident rays *P* and *Q*. Hence locate the image formed. Ans: 	• Add lines, shapes or apparatus to the given diagram.