# Answers

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## Chapter 1 Measurement

**Performance Evaluation**

**1.** (a)

| Base quantity | S.I. unit |
|---|---|
| Length | metre |
| Mass | kilogram |
| Time | second |
| Thermodynamic temperature | kelvin |
| Electric current | ampere |
| Luminous intensity | candela |
| Amount of substance | mole |

(b) kg $m^2$ $s^{-3}$

**2.** (a) 1 m $s^{-2}$
(b) 15 m $s^{-1}$
(c) $v$ increases linearly with $t$

**3.** (a)

| $T$ / s | 1.30 | 1.80 | 2.22 | 2.55 | 2.86 |
|---|---|---|---|---|---|
| $T^2$ / $s^2$ | 1.69 | 3.24 | 4.93 | 6.50 | 8.18 |

(c) 0.0817 $s^2$ $g^{-1}$
(d) Unchanged because the period of oscillation of a loaded spring does not depend on the value of the gravitational acceleration.
(e) From the graph of $T^2$ against $m$, use the method of extrapolation to determine the value of $m$ when $T^2$ = 1.0 s, so $T$ is equal to 1.0 s. Substitute the slotted weights with plasticine of mass $m$, about 12 g.

**4.** (a)

| Pupil | Time, $t$ / s | Speed, $v$ / m $s^{-1}$ |
|---|---|---|
| *A* | 58.79 | 6.80 |
| *B* | 60.06 | 6.66 |
| *C* | 57.68 | 6.93 |
| *D* | 59.87 | 6.68 |
| *E* | 57.99 | 6.90 |

(b) You use an electronic stopwatch to measure the time of their motion.
(c) Pupil *C* is the fastest.
(d) Use an electronic sensor to prevent errors in measurement caused by the reaction time of humans when starting and stopping the stopwatch.

**5.** (a) In the old system, $F = mlt^{-2}$
$m = Ft^2l^{-1}$
Therefore, in *FAT* system
$l = A^{½}$, and
$m = FT^2l^{-1}$
$= FT^2A^{-\frac{1}{2}}$
(b) – No measuring instrument can measure force and area accurately.
– No instrument or object is used as standards for force and area
– Units for derived quantity become very complex and hinder effective communication among physicists

**6.** (a) – Straight line that does not pass through the origin and has a negative gradient.
– $p$ decreases linearly with $q$
(b) – Curve that does not pass through the origin and has a negative gradient.
– $p$ decreases with $q$
(c) – Horizontal straight line with zero gradient
– $p$ constant or $p$ does not depend on $q$

## Chapter 2 Force and Motion I

**Performance Evaluation**

**1.** (a) 10.0 m $s^{-1}$
(b) 25.0 m
(c) 9.0 m

**2.** (a) –2.0 m $s^{-2}$
(b) 5 s

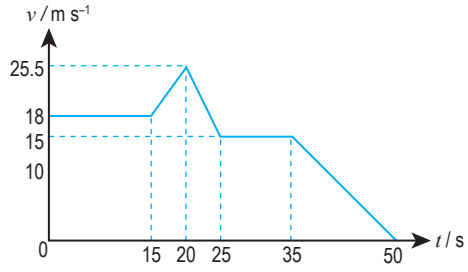
**3.** When Swee Lan paddles a boat on the river backwards, a force of action $F$ is applied on the river water and simultaneously a force of reaction of the same magnitude but in the opposite direction to the direction of $F$ acts on the boat. Therefore, the boat moves forward.

**4.** 12 s

**5.** 12 N

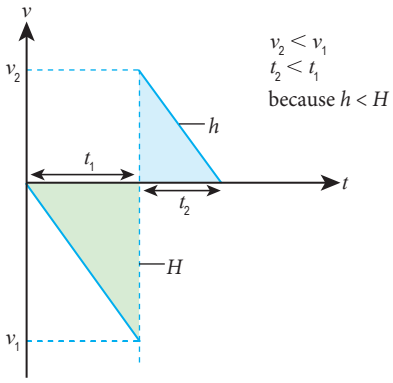
**6.** 100 m $s^{-1}$

**7.**




$v = 25.5 \text{ m s}^{-1}$

**8.**




$v_2 < v_1$
$t_2 < t_1$
because $h < H$

**9.** (a) 7.5 s
(b) 56.25 m
(c) For the car, $x_c = 900$ m
For the bus, $x_b = 750$ m
(d) $x_c$ is longer than $x_b$, therefore the car is in front of the bus

**10.** (a) Before the launch, the rocket carries a spacecraft at rest at the launch pad with zero momentum. During the launch, a large amount of fast moving hot gases is released through the exhaust. This creates/cause high downward momentum. According to the principle of conservation of momentum, an equally high but opposite momentum is produced. Hence, an upthrust gives an acceleration to the rocket.
(b) Acceleration of the rocket can be increased by reducing the mass of the rocket.

## Chapter 3 Gravitation

**Performance Evaluation**

**1.** (a) (i) $F = \frac{GMm}{r^2}$
(ii) $F = \frac{mv^2}{r}$
(iii) $v = \frac{2\pi r}{T}$
(b) $M = \frac{4\pi^2 r^3}{GT^2}$
(c) $1.99 \times 10^{30}$ kg

**2.** (a) $v = \frac{2\pi r}{T}$
(b) $v = \sqrt{\frac{GM}{r}}$
(c) A free falling satellite orbits around Earth with a centripetal acceleration that equals to the gravitational acceleration. The gravitational acceleration does not depend on the mass of the object.

**3.** Kepler's Second Law states that a line that connects a planet to the Sun sweeps out equal areas in equal times. The shorter the distance of the plant from the Sun, the faster the velocity of the planet. From *A* to *B*, the speed of planet Uranus increases to a maximum value and then decreases.

**4.** (a) Satellite and the Moon as a pair
(b) $7.71 \times 10^3$ N

**5.** (a) – Mass of the Earth
– Distance from the centre of the Earth
(b) 0.23 m s$^{-2}$

**6.** (a) $\frac{T_1^2}{T_2^2} = \frac{r_1^3}{r_2^3}$
(b) $4.49 \times 10^{12}$ m

**7.** 29.44 years

**8.** 9 996 m s$^{-1}$

**9.** (a) $3.54 \times 10^4$ m s$^{-1}$
(b) Small particles are unlikely to escape because of the very high escape velocity.

**10.** (i) $F_{BC} = 2P$
(ii) $F_{AC} = 0.5P$

## Chapter 4 Heat

**Performance Evaluation**

**1.** (a) Heat is absorbed or released during changes in phase without any change in temperature.
(b) When steam is condensed into water, latent heat is released to heat up the water.
(c) – Rapid heating.
– Direct heating of water, that is without wasting heat to heat up the container.

**2.** (c) ✓

**3.** (a) Block *A*.
(b) Block *B*. Block with a low specific heat capacity experiences higher increase in temperature.

**4.** (a) Specific latent heat is the quantity of heat absorbed or released by 1 kg of substance during a change in its phase without any change in its temperature.
(b) $2.27 \times 10^5$ J

**5.** (a) Specific latent heat of vaporisation, $l_v$, of a substance is the quantity of heat absorbed by 1 kg of the substance when boiling or the quantity of heat released by 1 kg of the substance when condensing without any change in its temperature.

(b) (i) 0.28 kg
(ii) $2.25 \times 10^6$ J kg$^{-1}$

**6.** 4.95 J

**7.** (a) 2 200 W
(b) 513.6 s

**8.** (a) 264 kPa
(b) Volume of tyre remains unchanged

**9.** (a) 3.82 cm$^3$
(b) – Mass of the trapped air remains unchanged
– Pressure of the trapped air is constant
– Trapped air and water are in thermal equilibrium. The temperatures of water and air are the same.

**10.** (a) Specific latent heat of fusion, $l_f$, of a substance is the quantity of heat absorbed by 1 kg of the substance when melting or the quantity of heat released by 1 kg of the substance when freezing without any change in its temperature.
(b) Heat absorbed does not increase the average kinetic energy of the molecules. This heat is used to weaken the bonds between the molecules of ice.
(c) (i) 40 000 J (ii) 0.12 kg
(d) – All the heat absorbed by the ice is supplied by the immersion heater. No heat is lost to the surroundings.
– The ice does not absorb heat from the surroundings.

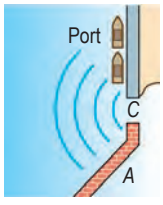
**11.** (a) (i) 147 000 J (ii) 183.75 s
(b) Plastics have high specific heat capacities and are good heat insulators.
(c) Metals have low specific heat capacities and are good heat conductors.
(d) Water rises when heated and cold water sinks through convection. So, all the water is heated. Therefore, the heating element of a kettle is fitted at the base of the kettle.

**12.** (a) Aluminium
(b) Aluminium has a low specific heat capacity and is a good conductor of heat. Therefore, aluminium is suitable for making cooking utensils.

## Chapter 5 Waves

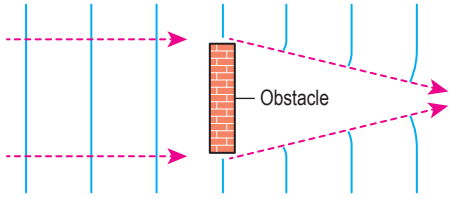
### Performance Evaluation

**1.** (a) (i) Reflection
(ii) Refraction
(iii) Diffraction
(b)




(c) Less diffraction and higher amplitude compare to diffraction through a narrow entrance.

**2.**




**3.** (a) – Same frequency
– Constant phase difference
(b) (i) *Q, S*
(ii) *P, R*
(c) (i) Before superposition

During superposition

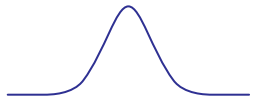
(ii) Before superposition

During superposition



(iii) Before superposition

During superposition



**4.** (a) Superposition of waves/Interference
(b) Bright fringes are formed when waves undergo constructive interference.
Dark fringes are formed when waves undergo destructive interference.
(c) $4.44 \times 10^{-7}$ m

**5.** (a) Amplitude = 15 cm, Period = $\frac{1}{f} = \frac{1}{5} = 0.2$ s
(b) 3.0 m s$^{-1}$

**6.** 335 m s$^{-1}$

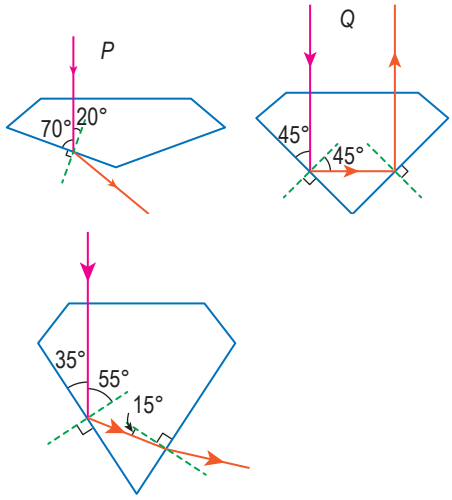
**7.** (a) 0.25 cm
(b) 75 cm
(c) 33 000 cm s$^{-1}$

**Performance Evaluation**

**1.** (a) (i) Critical angle is the angle of incidence when light travels from diamond into air at the angle of refraction of 90°.

(ii) 2.46

(b)




(c) Total internal reflection and refraction of light

**2.** 10 cm

**3.** (a) 38.02°

(b) $2.26 \times 10^8$ m $s^{-1}$

(c) Glass has a higher optical density because when light travels from water to glass, the light is refracted towards the normal.

**4.** (a) *RS* is the radius of a semi-circle and is the normal to the incident ray at point *R*, $i = 0$, so $r = 0$.

(b) 41.14°

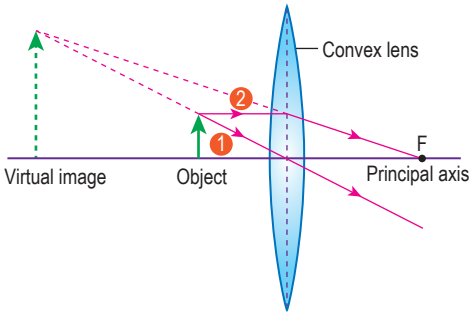
**5.** (a) (i) 1.0003

(ii) The value of the refractive index of air is almost equal to 1, that is the speeds of light in air and in vacuum are almost the same.

(b) The value $\Delta\theta$ on a hot night is different from that on a cold night because the optical density of air depends on temperature.

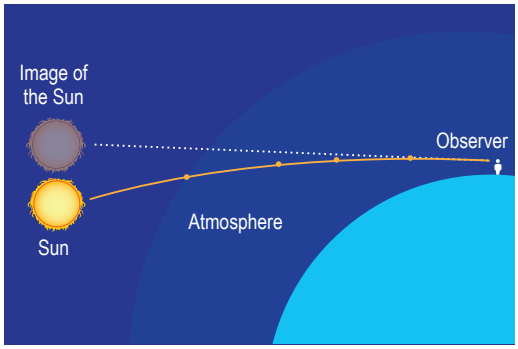
**6.** (a) Upright and magnified

(b)




(c) A real, inverted, diminished and formed on the opposite side of the object from the lens.

**7.** (a) The captain's statement is true. The light ray that enters the atmosphere is refracted by the layers of air having different optical densities. Therefore, a virtual image of the Sun is formed above the actual position of the Sun.




(b) The light rays from the object travel towards the side *AB* of the upper prism along the normal to *AB* through an opening in the periscope. The light rays reach the side *AC* without refraction. The angle of incidence is 45° and is larger than the critical angle of the prism, 42°. Therefore, total internal reflection happens at the side *AC* and the light is reflected downwards. The reflected light rays travel towards the side *DE* of the lower prism along the normal to *DE*. Once again, the light ray experiences total internal reflection at the side *DF*. In the end, the light rays emerge from side *EF* without refraction and enters the eye of the observer. The final image formed is upright and equal in size to the object.