ICSE Board
Class X Physics
Gold Series
Sample Paper – 5 Solution

Section 1

Answer 1

(a) On an atomic scale, the source of contact forces is the electromagnetic force between the particles of an atom which include electrons, protons and neutrons.

(b) Given that:
Force with which the engine pulls the train, F = 6000 N
Distance covered by the train, s = 200 m
Work done, W = F × s
= 6000 × 200
= 1.2×10^6 joule
= 1.2×10^{13} erg

(c) Two characteristics of the third class lever:
1. The effort arm is always smaller than the load arm.
2. Mechanical advantage is always lesser than 1.

(d) Taking moments about the pivot (fulcrum)
Effort × Effort arm = Load × Load arm
Effort arm = 2 – 0.1 = 1.9 m
E × 1.9 = 100 × 0.1
E = 100 × 0.1/1.9
E = 5.26 kgf

(e) A ray of light does not refract or deviate when the refractive index of the block remains the same as that outside it or when the ray strikes normal to the surface of the glass block.

Answer 2

(a) The distance of the corridor, d = 86 m

To hear the echo, sound has to travel twice the total distance of the corridor, i.e. = 2d = 172 m

Because the fifth echo was heard at 2.5 s, time of the first echo = 2.5/5 = 0.5 s

Speed of sound = total distance travelled/time taken

= 172/0.5 = 344 m/s

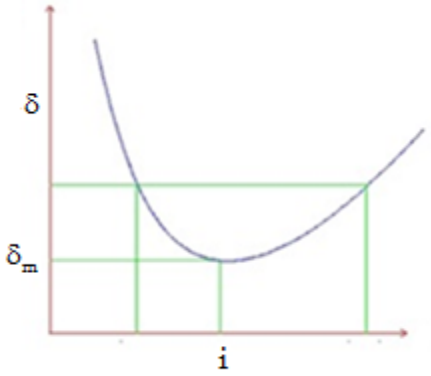
(b)

Real image	Virtual image
1. A real image is formed due to actual intersection of the refracted (or reflected) rays. 2. A real image can be obtained on a screen. 3. A real image is inverted with respect to the object. 4. Example: The image of the distant object formed by a convex lens.	1. A virtual image is formed when the refracted (or reflected) rays meet if they are produced backwards. 2. A virtual image cannot be obtained on a screen. 3. A virtual image is erect with respect to the object. 4. Example: The image of an object formed by a concave lens.

(c) To a fish under water, the man will look taller than he actually is.

(d) If the central portion of the convex lens is wrapped by a black paper, then there will be no effect on the image formed.

(e) The graph representing the variation of angle of deviation for various angles of incidence is as shown below:



Answer 3

(a) Ultraviolet spectrum and infra-red spectrum

Application:

Ultraviolet: It is used to sterilise water.

Infra-red: It is used for photography at night or when it is misty and foggy.

(b) A vibrating string having a small surface area does not produce much sound and transfers very little of its vibrational energy into the air and therefore produces only a feeble sound. If vibrations are transferred to a larger surface, such as a board, the air will be disturbed more effectively and a louder sound will therefore be produced.

(c) Let 'm' kg of steam be required.

Heat given out by steam to condense into water at 100°C

$= mL$

$= m (2268 \times 10^3)$ J

Heat given out by 'm' kg of water to cool from 100°C to 0°C

$= m\ c\ \Delta T$

$= m \times 4200$ J/Kg °C $\times (100 - 0)$°C

$= m \times 42 \times 10^4$ J

Total heat lost $= m (2268 \times 10^3) + m (42 \times 10^4)$

$= m \times 2688 \times 10^3$ J

Heat gained by 2 kg of ice in melting at 0°C

$= 2 \times (336 \times 10^3)$ J

$= 672 \times 10^3$ J

Heat lost = Heat gained

$\therefore m \times 2688 \times 10^3 = 672 \times 10^3$

$$m = \frac{672 \times 10^3}{2688 \times 10^3} = 0.25 \text{ Kg}$$

(d) Heat supplied to a substance during its change of state increases the potential energy of its molecules and not the kinetic energy. Because a rise in temperature is dependent on the kinetic energy of the molecule, no rise in temperature occurs during its change of state.

(e)

i. A heating wire must have a high resistance so that it can produce intense heat. Hence, it is made of nichrome.

ii. A fuse wire must have a low melting point in order to save the appliance from burning.

Answer 4

(a) This means that the power of the bulb is 500 watt and its potential is 240 volts.

$P = 500\ W, V = 240\ V$

$P = V^2/R$

$R = V^2/P = (240)^2/500 = 115.2\ \Omega$

$R = 115.2\ \Omega$

$V = IR$

$I = V/R = 240/115.2 = 2.08\ A$

Thus, the current in the bulb is 2.08 ampere and the resistance of the bulb is 115.2 Ω.

(b) The first two resistances are in series (across BC and CD).

Their effective resistance is $2 + 2 = 4\ \Omega$.

Now, this combination is in parallel with another resistance of $2\ \Omega$ (across BD).

$$\frac{1}{R} = \frac{1}{4} + \frac{1}{2}$$

$$\frac{1}{R} = \frac{3}{4}$$

$$\Rightarrow R = \frac{4}{3}$$

Now, this R is in series with the other two $2\ \Omega$ resistances (across AB and DE)

$$\Rightarrow \text{Effective resistance} = \frac{4}{3} + 2 + 2$$

$$= \frac{16}{3}$$

Thus, the effective resistance of the network= $\frac{16}{3}$

(c) Magnetic field lines due to a straight current-carrying conductor are in the form of concentric circles.

(d) Uranium found in nature has two isotopes. They are $^{238}_{92}U$ and $^{235}_{92}U$. The isotope $^{235}_{92}U$ is fissionable easily.

(e) When an electron is emitted from a nucleus, there will be no change in the n/p ratio, but when a positron is emitted, the ratio increases (number of protons decreases).

Section 2

Answer 5

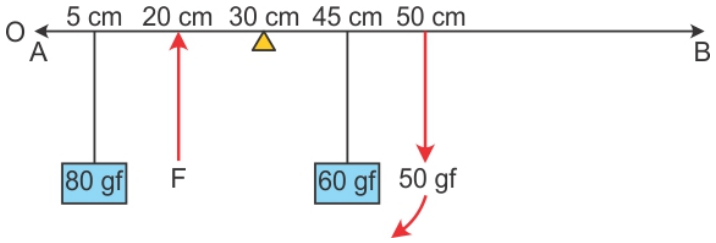
(a) When it reaches the ground, all its initial potential energy is converted to kinetic energy.

Hence, the kinetic energy when it reaches ground is

$\frac{1}{2}mv^2$ = mgh = 50 ×9.8×10 = 4900 J

Velocity just before it hits the ground $= \sqrt{\frac{2 \times 4900}{50}} = 14\ m/s$

(b)



If we take the moment about the 30 cm mark,

Anticlockwise moment = 80 g f × 25 cm

= 2000 g f cm

Clockwise moment = 60 g f × 15 cm + 50 g f ×20 cm

= 1900 g f cm

Here, anticlockwise moment > clockwise moment

Therefore, force at the 20 cm mark must act in an upward direction in order to keep the scale in equilibrium.

Now, taking moment about the 30 cm mark.

Sum of anticlockwise moments = Sum of clockwise moments

80 g f × 25 cm = 60 g f ×15 cm + F × 10 cm + 50 g f × 20 cm

2000 g f cm = 1900 g f cm + F × 10 cm

F = 100 g f cm/10 cm = 10 g f

(c)

i. According to the principle of lever:

Load × Load arm = Effort × Effort arm

ii.

(1) MA has no unit.

(2) VR has no unit.

(3) The unit of weight is kgf.

(4) The unit of mass is kg.

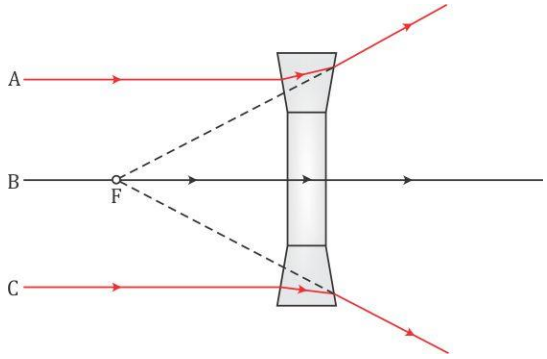
iii. Velocity ratio = $\frac{\text{distance moved by the effort}}{\text{distance moved by the load}}$

Velocity ratio = Total number of pulleys in the system

Answer 6

(a) In the early morning, the sun is near the horizon. Light has to travel through a thicker layer of air and also cover a longer distance in the earth's atmosphere. Hence, most of the blue light and shorter wavelengths are scattered away by the particles in the earth's atmosphere before they reach our eyes. Thus, light of longer wavelengths only reach our eyes and give rise to the reddish appearance of the sun.

(b) In a concave lens, the upper part behaves like a prism with its base upwards and the lower part behaves like a prism with its base downwards as shown below. The prism portion in the upper part of the lens bends the incident ray upwards and the prism block of the concave lens in the lower part bends the incident ray downwards. The central part of the lens which is a parallel sided glass block passes the incident ray undeviated. Thus, a concave lens diverges the parallel rays incident on it. Hence, it is known as a diverging lens.



(c)

i. A prism with an angle of 90° between its two refracting surfaces and the other two angles of 45° each is known as a total reflecting prism.
ii. The ozone layer protects us from harmful UV rays of the sun.
iii. When the rays from the sun (which is at infinity) are brought to focus on a piece of paper with the help of a converging lens, the paper burns due to the heat of the sun rays. Hence, a converging lens behaves as a burning glass.

Answer 7

(a)

i. Tone is the quality or character of sound, while note is a sign or character used to represent a tone. A note's position and form indicate the pitch and duration of the tone.

ii. A violin and sitar note can be distinguished by a characteristic called timbre. Its objective measure is the wave form.

(b) A stretched string on being set into vibrations sends sound waves through the medium in the form of compressions and rarefactions which are received by the ear in the form of sound.

(c) Sound heard on reflection from a distant obstacle (such as a cliff, a hillside etc.), after the original sound has ceased, is called an echo.

The three conditions necessary for the formation of an echo are

1. The minimum distance in air between the source of sound and the reflector must be 17 m. It is different in different media depending on the speed of the sound in that medium.
2. The size of the reflector must be large enough in comparison to the wavelength of the sound wave so that the reflection of sound can take place.
3. The intensity of the sound should be sufficient enough so that the related sound reaching the ear is audible.

Answer 8

(a) Mass of calorimeter, $m_1 = 50$ g

Mass of water, $m_2 = 100$ g

Mass of ice, $m_3 = 15$ g

Temperature, $t_1 = 288$ K = 15°C

Temperature, $t_2 = 276$ K = 3°C

Latent heat of fusion of ice is given by

$$L = \frac{[m_1 C_c + m_2 C_w] \times (t_1 - t_2)}{m_3} - 4.2 \times 3$$

$$L = \frac{(50 \times 0.42 + 100 + 4.2) \times (15 - 3)}{15} - 4.2 \times 3$$

$$L = 340.2 \text{ Jg}^{-1}$$

(b) Angle of deviation, $\theta = 120°$

Now, as $\theta = i_1 + i_2 - A$

where $A = 60°$

and $i_2 = 90°$

$\Rightarrow i_1 = 120 + 60 - 90$

$i_1 = 90°$

So, the angle of incidence will be 90°.

Now, if $r_1 = 19°$

Then as $r_1 + r_2 = A$

$\Rightarrow r_2 = A - r_1$

$\therefore r_2 = 60 - 19$

$= 41°$

Hence, the angle of incidence at the face AC is 41°.

It is known as critical angle.

(c) **Basic principle of heat transfer:** Heat always flows from hot bodies to cold bodies when they are in contact or are connected by some conducting medium.

Answer 9

(a)

i. Given - The equivalent resistance between A and B is $2\,\Omega$.

All the three resistances (12Ω, RΩ and 4Ω) are in parallel.

So, $\frac{1}{2} = \frac{1}{12} + \frac{1}{R} + \frac{1}{4}$

$\frac{1}{R} = \frac{2}{12}$

$\Rightarrow R = 6\Omega$

ii. The resistance across PQ and RS are connected in series, i.e. $2 + 2 = 4\,\Omega$

This combination is connected in parallel with the 2Ω resistance across QR.

$\frac{1}{R} = \frac{1}{4} + \frac{1}{2} = \frac{3}{4}$

$R = \frac{4}{3}$

This combination is connected in series with the resistances 2Ω and 2Ω across AQ and RB, respectively. So, the equivalent resistance across AB is

$R = 2 + \frac{4}{3} + 2 = \frac{16}{3}$

(b) Power consumed by 20 lamps, P = VI:

P = 20 × 60

P = 1200 W

Power consumed by 10 fans, P = VI:

P = 220 V × 0.5A × 10

P = 1100 W

Power consumed by electric kettle, $P = V^2/R$:

$P = (220)^2/110 = 44W$

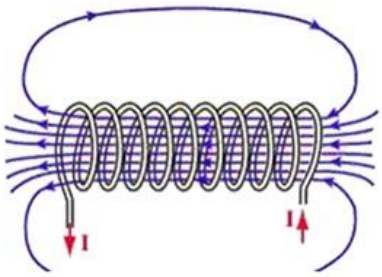
Total power consumed = 1200 W + 1100 W + 44 W

= 2344 W = 2.344 kW

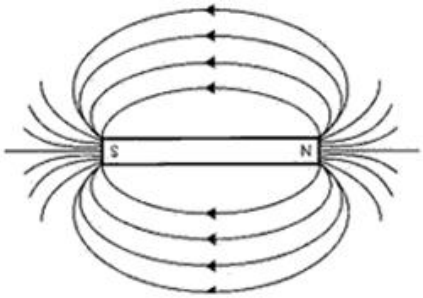
Total power consumed in a month = 2.344 × 6 × 30 = 421.92

Total cost of the bill = 3.25 × 421.92 = Rs 1371.24

(c) Magnetic field lines for a solenoid



Magnetic field lines of a bar magnet



Answer 10

(a) Three properties of nuclear forces:

1. They are independent of charge.
2. They form the strongest force in nature.
3. They are of very short range.

(b)

Isotopes	Isobars
Atoms of the same element having the same atomic number Z but different mass number A are called isotopes.	Atoms of the same element having the same mass number A but different atomic number Z are called isobars.

(c) Tracer techniques in the classical sense comprise a set of methods based on the application of stable or unstable (radioactive) isotopes of an element as makers of naturally occurring forms of the elements. The tracer isotope may occur as a free element or as incorporated into chemical compounds. The technique of using radioactive tracers to study certain phenomena is called tracer technique.

When working with radioactive isotopes as tracers, the ionising radiation emitted during radioactive decay forms the basis for identification and quantification. Methods for the detection of ionising radiation are extremely sensitive, and a radiotracer therefore requires only very small amounts of radioactively labelled compounds.

Application: Tracers are used to detect suspected brain tumours and blood clots before they become dangerous.