ICSE Board
Class X Physics
Board Paper – 2015 Solution

SECTION - I

1.

(a)

(i) Normal reaction force is exerted by the table top.

(ii) The force is in the upward direction.

(b)

(i) The thickness of the glass block, angle of incidence and refractive index of glass (any one) are the factors which affect the lateral displacement of light as it passes through a rectangular glass slab.

(ii) On reversing the direction of the current in a wire, the magnetic field produced by it gets **reversed**.

(c)

(i) The position of the centre of gravity of a body depends on its shape, that is, on the distribution of mass.

(ii) The SI unit of moment of force is newton × metre (Nm).

(d) The following are the factors which affect the turning effect of a body:

- Magnitude of the force applied
- Distance of line of action of the force from the axis of rotation

(e)

(i) When several forces acting on a body produce no change in its state of rest or motion, the body is said to be in equilibrium.

(ii) In a beam balance, when the beam is balanced in a horizontal position, it is in **static** equilibrium.

2.

(a)

(i) When force is in the direction of displacement $\theta = 0°$, then $\cos 0 = 1$.
Hence, the work done by a force measured in the direction of displacement is
$W = F \times S$
The work done is maximum and positive.

(ii) When the displacement is in the direction making an angle θ with the direction of force,
Work done = Component of force in the direction of displacement × displacement
$\therefore W = F \cos\theta \times S$

(b)

(i) Burning of a candle: Conversion of chemical energy to light energy.
When a candle burns, it gives light.

(ii) A steam engine: Conversion of heat energy into mechanical energy.
In a steam engine, chemical energy of coal first changes to heat energy of steam, and then heat energy changes to mechanical energy.

(c)

(i) A scissor is a force multiplier because the effort applied is less than the load.

(ii) 1 kWh = 1 kilowatt × 1 hour
$= 1000 \text{ J s}^{-1} \times 3600 \text{ s}$
$= 3.6 \times 10^6 \text{ J}$

(d) A planet moves around the Sun in a nearly circular path for which the gravitational force of attraction on the planet by the Sun provides the necessary centripetal force required for circular motion.

(e) Given that
Force = 150 N
Velocity = 10 m s^{-1}
$\therefore$ Power = F × v
$= 150 \text{ N} \times 10 \text{ m s}^{-1}$
$= 1500 \text{ W}$

3.

(a)

(i) M.A. = $\frac{1}{\sin\theta} = \frac{1}{\frac{h}{l}} = \frac{l}{h}$

(ii) A clock is a common device where a gear train is used. In a clock, the gear system is used to obtain gain in torque.

(b) Given:

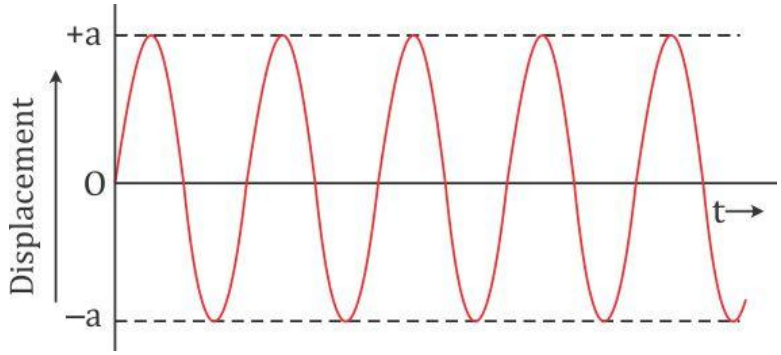
Speed of light in glass = 2×10^5 km/s = 2×10^8 m/s

Refractive index of glass is

$$\mu_{glass} = \frac{3\times10^8}{2\times10^8} = 1.5$$

(c)

(i) The displacement–time graph for a body executing free vibrations is given below:



(ii) The free vibrations of a body actually occur only in vacuum because the presence of a medium offers some resistance due to which the amplitude of vibration does not remain constant and decreases continuously.

Thus, we define free vibrations as the periodic vibrations of a body of constant amplitude in the absence of any external force on it.

(d)

(i) The resistivity of a semiconductor decreases with increase in temperature.

(ii) For a fuse, higher the current rating, thicker is the fuse wire.

(e)

(i) X-rays are used in the study of structure of crystals.

(ii) X-rays are used in the detection of fracture in bones and teeth.

4.

(a) The water boils at the higher temperature because of the reasons given below:

- The water used by Rishi might be impure. The boiling of a liquid increases with the addition of impurities.
- Rishi might have used a container which creates a pressure within. The boiling point of a liquid increases with an increase in pressure.

(b)

(i) A current-carrying freely suspended solenoid acts as a bar magnet, and thus, due to the Earth's magnetic field, it rests along a particular direction.

(ii) It rests in the North–South direction.

(c) Let R_P be the equivalent resistance of the resistors 12 Ω, 6 Ω and 4 Ω connected in parallel. Hence, we have

$$\frac{1}{R_P} = \frac{1}{12} + \frac{1}{6} + \frac{1}{4}$$

$$= \frac{1+2+3}{12} = \frac{1}{2}$$

$$R_P = 2\Omega$$

Therefore, the equivalent resistance of the circuit is

$$2\Omega + R_P + 5\Omega = 2\Omega + 2\Omega + 5\Omega = 9\Omega$$

Thus, the equivalent resistance between points A and B is 9 Ω.

(d) Two similarities between an AC generator and a DC motor are

a. A coil rotates in a magnetic field between the pole pieces of a powerful electromagnet.

b. The external circuit is connected to two carbon brushes B_1 and B_2.

(e)

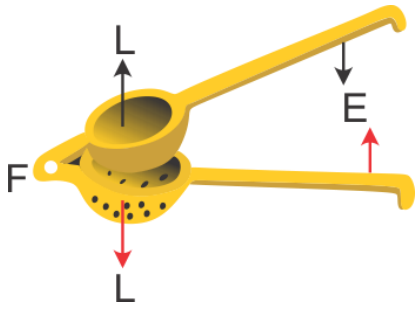
(i) The cathode ray tube is evacuated to a low pressure to avoid collisions of electrons with air molecules.

(ii) If the negative potential on the grid is changed, then the number of electrons reaching the anode and striking the screen changes which ultimately changes the brightness of the pattern of the screen.

SECTION - II

5.

(a) The diagram below shows a lemon crusher indicating the direction of effort (E) and load (L).



(b)

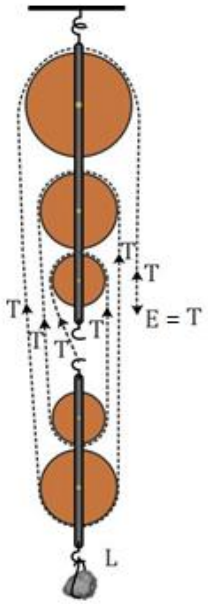
(i) Power is measured in horse power. 1 HP = 746 W

(ii) According to the principle of moments, we have
Moment of load about the fulcrum = Moment of effort about the fulcrum
Load × Load arm = Effort × Effort arm
Given that the effort arm = 20 cm = 0.2 m, the minimum force E = 2 N
Therefore, the moment of load or the moment of force = 0.2 × 2 = 0.4 Nm
The moment of force needed to loosen the nut = 0.4 Nm

(iii) The work done by a fielder when he takes a catch in a cricket match is negative because the force applied by the fielder is in the direction opposite to the displacement of the ball. The angle between the force applied and the displacement of the ball is 180°. We know that work done = F.s cosθ
Therefore, work done = −F.s

(c)

(i) A block and tackle system whose velocity ratio is 5 is as shown below:



(ii) Given that

Velocity ratio, VR = 5

Effort = 150 kgf

Efficiency = 75%

$$\text{We know that efficiency, } \eta = \frac{\text{Mechanical Advantage}}{\text{Velocity Ratio}}$$

$$\frac{75}{100} = \frac{MA}{5}$$

$$MA = 5 \times \frac{75}{100}$$

$\therefore$ Mechanical advantage = 3.75

$$\text{But, Mechanical advantage} = \frac{\text{Load(L)}}{\text{Effort(E)}}$$

$$\therefore \text{Load} = \text{Mechanical advantage} \times \text{Effort}$$

$$= 3.75 \times 150 \text{ Kgf}$$

$$= 562.5 \text{ Kgf}$$

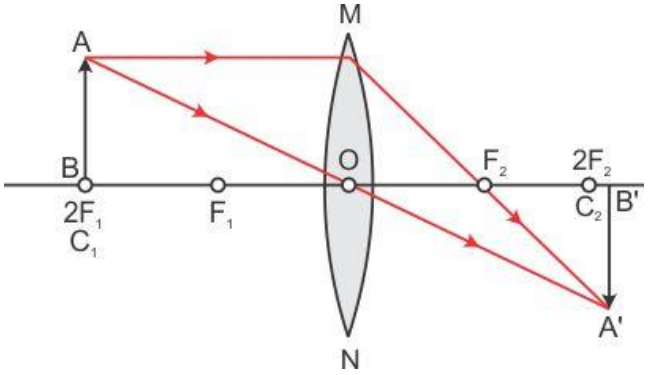
Therefore, Rohan can raise a maximum load of 562.5 kgf with this pulley system.

6.

(a)

(i) When an object is placed **at $2F_1$** of a convex lens, a real and inverted image of the same size as that of the object is formed at $2F_2$.

(ii) The ray diagram for the same is as shown below:



(b)

(i) The Sun appears red at sunrise because of the scattering of light by the atmospheric particles. During sunrise, the light from the Sun has to travel a longer distance through the atmosphere to reach the observer. During this, most of the shorter wavelengths present in it are scattered away from our line of sight by the molecules of air and other fine particles in the atmosphere. So, the light reaching us directly from the rising Sun consists mainly of longer wavelength red colour due to which the Sun appears red.

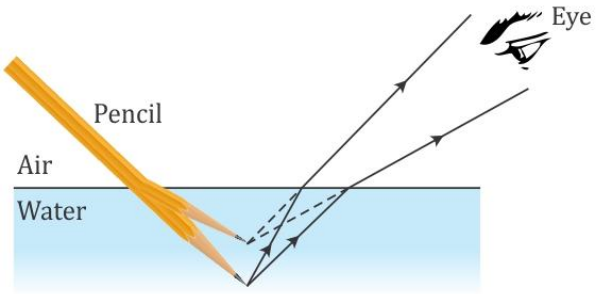
(ii) The subjective property of light related to its wavelength is colour.

(c)

(i) The immersed part of the pencil appears to be shortened and raised.

(ii) The phenomenon responsible for the above observation is the refraction of light in passing from water to air.

(iii) The ray diagram for the same is as shown below:



7.

(a)

(i) The safe limit of sound level for human hearing is 30 decibels (30 dB).

(ii) The characteristic of sound in relation to its waveform is quality or timbre.

(b)

(i) Let d_1 be the distance of the nearest cliff and d_2 be the distance of the farther cliff.

The time for the first echo is $t_1 = 3$ s

The first echo will be heard from the nearest cliff.

The total distance travelled by sound before reaching the person is $2d_1$.

We know that

$$\text{Speed of sound} = v = \frac{2d}{t} = \frac{2d_1}{t_1}$$

$$v = \frac{2 \times 480}{3} = 320 \text{ m/s}$$

Hence, the speed of sound is 320 m/s.

(ii) The second echo is heard 2 s after the first one.

Hence, $t_2 = 3 + 2 = 5$ s

Again the sound travels a total distance $2d_2$ before reaching the person.

So, we get

$$v = \frac{2d_2}{t_2}$$

$$\therefore d_2 = \frac{vt_2}{2} = \frac{320 \times 5}{2} = 800 \text{ m}$$

Hence, the distance between the other cliff and the person is 800 m.

(c)

(i) The vibrations which occur in pendulums B and D are called forced vibrations.

(ii) Pendulum C is in the state of resonance with pendulum A as it is of the same length.

(iii) The pendulums vibrate because the forced vibration from A is transferred due to string PQ.

Pendulum B is of a different length as compared to pendulum A. Hence, it will continuously vibrate with a frequency which is different from that of pendulum A. Its amplitude will also be very small.

Pendulum C is of the same length as compared to pendulum A. Hence, it will vibrate in phase with pendulum A. Its amplitude will be equal to that of pendulum A as it will attain resonance.

8.

(a)

(i) The device used to increase voltage at the generating station is the step-up transformer.

(ii) The residential houses are supplied with AC of frequency 50 Hz.

(iii) The switch is connected to the live (or phase) wire in a household electric circuit.

(b)

(i) The relationship between the potential difference and the current in a conductor is given by Ohm's law.

(ii) The slope of the V–I graph gives the resistance of the conductor.

$$\text{Slope} = \frac{V}{I} = R$$

(iii) The material used for making connecting wires is copper.

(c) Given that

$\varepsilon = 2$ V, r = 1.2 Ω, RA = 0.8 Ω, R1 = 4.5 Ω, R2 = 9 Ω

(i) We know that for the circuit

$$\varepsilon = IR_{total}$$

Now, the total resistance of the circuit is

$$R_{total} = r + R_A + R_p$$

$$\frac{1}{R_p} = \frac{1}{4.5} + \frac{1}{9} = \frac{3}{9}$$

$$\therefore R_p = 3\ \Omega$$

$$\Rightarrow R_{total} = 1.2 + 0.8 + 3 = 6\ \Omega$$

Hence, the current through the ammeter is

$$I = \frac{\varepsilon}{R_{total}} = \frac{2}{6} = 0.33\ A$$

(ii) The potential difference across the terminals of the cell is

$$V_{cell} = Ir = 0.33 \times 1.2 = 0.396 \text{ V}$$

9.

(a)

(i) A gas caused by the greenhouse effect is carbon dioxide.

(ii) The high specific heat capacity of water makes it an effective coolant.

(b)

(i) The specific latent heat of fusion of ice is sufficiently high (=336 J g^{-1}), and so to freeze water, a large quantity of heat has to be withdrawn. Hence, it freezes slowly and thus keeps the surroundings moderate.

(ii) Principle of calorimetry: If no heat energy is exchanged with the surroundings, i.e. if the system is fully insulated, then the heat energy lost by the hot body is equal to the heat energy gained by the cold body.

(iii) The principle of calorimetry is based on the law of conservation of energy.

(iv) Increasing the impurities causes the melting point of ice to decrease.

(c) Given that

Mass of water converted to ice = m = 100 g

Temperature of water t_w = 20°C

Temperature of ice t_i = –10°C

Total time t = 35 min = 2100 s

Specific heat capacity of ice = 2.1 J $g^{-1}°C^{-1}$

Specific heat capacity of water = 4.2 J $g^{-1}°C^{-1}$

Specific latent heat of fusion of ice = 336 J g^{-1}

Amount of heat released when 100 g water cools from 20°C to 0°C is

$$Q_1 = mc\Delta T$$
$$= 100 \times 4.2 \times 20$$
$$= 8400 \text{ J}$$

Amount of heat released when 100 g water converts to ice at 0°C is

$$Q_2 = mL$$
$$= 100 \times 336$$
$$= 33600 \text{ J}$$

Amount of heat released when 100 g ice cools from 0°C to –10°C is

$$Q_3 = mc\Delta T$$
$$= 100 \times 2.1 \times 10$$
$$= 2100 \text{ J}$$

Hence, the total heat released is

$$Q = Q_1 + Q_2 + Q_3$$
$$Q = 8400 + 33600 + 2100$$
$$Q = 44100 \text{ J}$$

Therefore, the average rate of heat extraction is

$$P = \frac{Q}{t} = \frac{44100}{2100} = 21 \text{ W}$$

10.

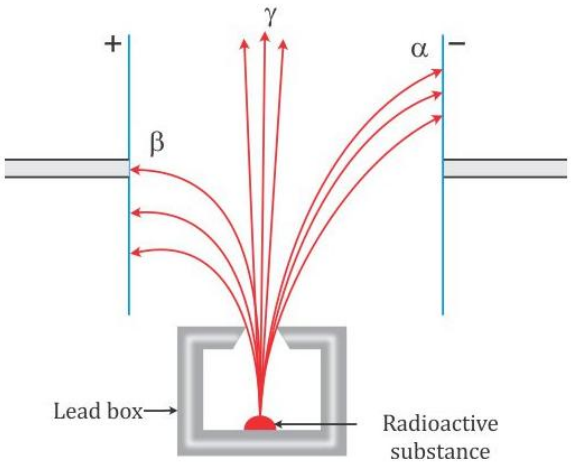
(a)

(i) The emission of electrons from a metal surface when heat energy is imparted to it is called thermionic emission.

(ii) Work function of a metal is expressed in terms of electron volt (eV).

(b)

(i) Deflection of radioactive radiations α, β and γ in an electric field is as shown below:



(ii) The two safety precautions to be taken while handling radioactive substances are (any two):

i. Radioactive substances should be kept in thick lead containers with a very narrow opening so as to restrict the radiations coming out from other directions.

ii. Radioactive materials should be handled with long lead tongs.

iii. People working with radioactive substances should put on special lead lined aprons and lead gloves.

(c) Given that the nucleus contains 84 protons and 128 neutrons, i.e. the atomic number of the nucleus is 84 and the mass number is 128 + 84 = 212.

The atomic nucleus A can be represented as $^{212}_{84}A$

(i) When the atomic nucleus A emits an alpha particle, the atomic number of the transformed nucleus B decreases by two and the mass number decreases by four. The transformation of nucleus A to B during alpha decay can be represented as

$$^{212}_{84}A \rightarrow {}^{4}_{2}He + {}^{208}_{82}B$$

(ii) When nucleus B emits a beta particle, the transformation can be shown as

$$^{208}_{82}B \rightarrow {}^{0}_{-1}e + {}^{208}_{83}C$$

During beta decay, the atomic number increases by 1, while the mass number remains the same.

(iii) There will not be any change in the mass number and atomic number of nucleus C if it undergoes gamma emission.

Gamma emission normally occurs along with alpha or beta decay.