Federal Board HSSC – I Examination
Physics – Mark Scheme

SECTION B

Q.2 **(2)**

$$\text{Power} = \frac{\text{Work done}}{\text{time taken}}$$

$P = \frac{\overline{F}.\overline{S}}{t}$ (as work done = $\overline{F}.\overline{S}$) (1 mark)

$P = \overline{F}.\frac{\overline{S}}{t}$

as $\frac{\overline{S}}{t} = \overline{V}$

then $P = \overline{F}.\overline{V}$ (1 mark)

Q.3 **(2)**

Yes, scalar product of two vectors be negative when the angle ‘θ’ between them is $90° < \theta \leq 180°$.

(also accept $\overline{A}.\overline{B} = AB \cos 180° = -AB$) (1 mark)

Example
i. work done by force of friction
ii. work done by gravity when an object is raised to a certain height. (1 mark)

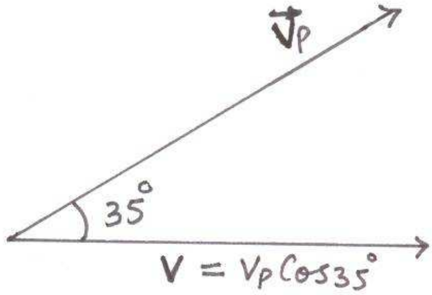
Q.4 **(2)**

Energy (PE) = 4.0×10^4J
m = 60kg
PE = mgh (1 mark)

$h = \frac{PE}{mg} = \frac{4.0\times10^4}{60\times9.8} = \frac{4.0\times10^4}{588} = 68\text{m}$ (1 mark)

Q.5 **(2)**

Speed of the car = V = 120kmh^{-1}
$\theta = 35°$



(1 mark)

Let V_p is the speed of the airplane
speed of the car = V = V_p Cos θ (as V_x = V Cos θ)

$$V_p = \frac{V}{Cos\theta} = \frac{120kmh^{-1}}{Cos35^\circ} = 146.5 \text{ km h}^{-1}$$

or $40.7ms^{-1}$ (1 mark)

Q.6 **(2)**

Body will be weightless i.e. T = 0
Equation of motion of a body of mass 'm' moving downward in an elevator with acceleration 'a' is

T = mg – ma (1 mark)

Where T is the apparent weight of the body
If the body is falling freely then a = g
therefore T = 0 (1 mark)

Q.7 **(2)**

$R = \frac{R_{max}}{2}$ (Given condition)

$$\frac{Vi^2 Sin2\theta}{g} = \frac{Vi^2/g}{2}$$ (1 mark)

$Sin2\theta = 0.5$

$2\theta = Sin^{-1}0.5 = 30°$
$\theta = 15°$ and 75° (because range is same for complementary angles) (1 mark)

Q.8 **(2)**

According to 1st law of thermodynamics
$Q = \Delta U + W$
∵ Q = 0 (for an adiabatic process)
∴ $W = -\Delta U$ (1 mark)

Since the gas expands and does external work at the cost of its internal energy so it cools down. (1 mark)

Q.9 **(2)**

a. Period of oscillation T = 20 ms = 20 $\times 10^{-3}$ s = 2 $\times 10^{-2}$ s (1 mark)

b. T = 20 ms = 20 $\times$ 10^{-3}s

λ = 600mm = 600 $\times$ 10^{-3}m

V = (as f =)

$\therefore$ V = $\frac{1}{T}\times$ λ = $\frac{1}{2\times10^{-2}}\times$ 600 $\times$ 10^{-3}

V = $30ms^{-1}$ (1 mark)

Q.10 **(2)**

L.H.S dimensions of v = $[LT^{-1}]$ (1 mark)

R.H.S dimensions of $\sqrt{\frac{T}{\mu}}$ = $\left[\frac{MLT^{-2}}{ML^{-1}}\right]^{1/2}$ = $\left[L^2T^{-2}\right]^{1/2}$ = $[LT^{-1}]$

L.H.S = R.H.S (1 mark)

also accept

Since v = $\sqrt{\frac{T}{\mu}}$

$[LT^{-1}]$ = $\left[\frac{MLT^{-2}}{ML^{-1}}\right]^{1/2}$ (1 mark)

$[LT^{-1}]$ = $\left[L^2T^{-2}\right]^{1/2}$

$[LT^{-1}]$ = $[LT^{-1}]$

L.H.S = R.H.S (1 mark)

Q.11 **(2)**

Wavelength of the waves = λ = 4m

Path difference = $S_2P - S_1P$ = 5m – 3m = 2m (1 mark)

$S_2P - S_1P$ = 2m = $\frac{2}{2}\times 2m$ = $\frac{4m}{2}$ =

$\therefore$ Path difference = (This is the condition of destructive interference)

Therefore amplitude = 0 (1 mark)

Q.12 **(2)**

a. For greater resolving power. (1 mark)

b. For brighter image. (1 mark)

Q.13 **(2)**

a. Acceleration at A = max ≈ g = 9.8 ms^{-2} (1 mark)

b. From B to C sky diver moves with uniform velocity i.e. with terminal velocity therefore acceleration is zero. (1 mark)

Q.14 **(3)**

m = 25kg
d = 10m
h = 3.0m
F = 200N
v at the top = 2 ms^{-1} (1 mark)
using work energy principle
work done = ΔKE + ΔPE + work done against friction

Fd = $\frac{1}{2}mv^2$ + mgh + work done against friction (1 mark)

200 10 = 50 + 25 9.8 3 + work done against friction
Work done against friction = 2000 – 785 = 1215J (1 mark)

(OR)

Speed of the wave = v = 330 ms^{-1}
Length of the pipe = = 12cm = 0.12m
Wavelength of 3rd harmonic = λ_3 = ?
Frequency of 5th harmonic = f_5 = ? (1 mark)

a. $\frac{\lambda_3}{4} + \frac{\lambda_3}{2} + \frac{\lambda_3}{2} =$

$\frac{5\lambda_3}{4} =$ $\lambda_3 = \frac{4l}{5}$ = 0.096m = 9.6cm (1 mark)

b. $v = f_5 \lambda_5$

as $\frac{9\lambda_5}{4} =$ $\lambda_5 = \frac{4l}{9}$

$v = f_5$ $\frac{4l}{9}$

$f_5 = \frac{9V}{4l} = \frac{9 \times 330}{4 \times 0.12}$ = 6187.5 HZ (1 mark)

Q.15 **(3)**

N = 250 lines/mm
for 1st order n = 1
screen distance L = 200cm

$\sin\theta = \frac{(107.3 - 72.7)cm}{200cm}$

$\sin\theta = 0.173$ (1 mark)

$d = \frac{1}{N} = \frac{1}{250}mm = \frac{1}{250}\times10^{-3}m = 4 \times 10^{-6}m$ (1 mark)

since $d \sin\theta = n\lambda$

$\lambda = \frac{d\sin\theta}{n} = \frac{4\times10^{-6}\times0.173}{1}$

$\lambda = 6.92 \times 10^{-7}m$

$\lambda = 692nm$ (1 mark)

(OR)

$d_1 = 1$ cm $= 0.01m$

$v_1 = 1ms^{-1}$

$d_2 = ?$

$v_2 = 21ms^{-1}$

Since $A_1v_1 = A_2v_2$ $(\because A = \pi r^2)$ (1 mark)

$r_1^2 v_1 = r_2^2 v_2$

$d_1^2 v_1 = d_2^2 v_2 \Rightarrow d_2 = \sqrt{\frac{V_1}{V_2}}\, d_1$ $(\because r = \frac{d}{2})$ (1 mark)

$d_2 = \sqrt{\frac{1}{21}}\times0.01 = 2.18 \times 10^{-3}m \approx 0.22$ cm (1 mark)

Q.16 **(3)**

$F_H = 5N$

$F_v = 4N$

$T = ?$

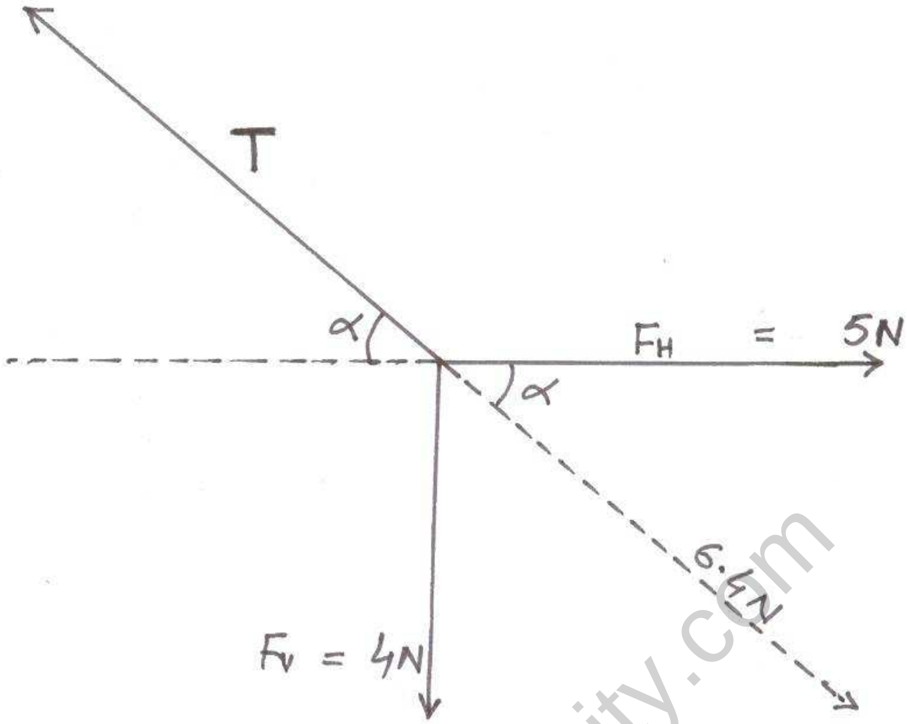
$T = \sqrt{F_H^2 + F_v^2}$ (1 mark)

$T = \sqrt{5^2 + 4^2}$ N

$T = \sqrt{41}$ N

$T = 6.4N$ (1 mark)

<u>**Direction of T**</u>



$\tan\alpha$ = = 0.8 α = $\tan^{-1}0.8$

α = 38.7^0 (1 mark)

(OR)

$v = 1.1 \times 10^4 ms^{-1}$
$m = 6.6 \times 10^{-27} kg$
$k = 1.38 \times 10^{-23} JK^{-1}$ (1 mark)

$T = \frac{2}{3k} < \frac{1}{2}mv^2 >$ (1 mark)

$T = \frac{6.6\times10^{-27}\times(1.1\times10^4)^2}{3\times1.38\times10^{-23}}$

$T = 1.9 \times 10^4 K$ (1 mark)

Q.17 **(3)**

Position / **Variable**	**B**	**A**	**C**
Displacement	max	0	max
Velocity	0	max	0
Acceleration	max	0	max
Kinetic Energy	0	max	0
Potential Energy	max	0	max

Column B, all correct answers (1 mark)

Column A, all correct answers (1 mark)
Column C, all correct answers (1 mark)

(OR)

T = 2000N
m = 1000kg
$\theta = 10°$
$T - mg \sin\theta = F$ (1 mark)
$T - mg \sin\theta = ma$

$a = \frac{T - mg\sin\theta}{m} = \frac{T}{m} - g\sin\theta$

$a = \frac{2000}{1000} - 9.8\sin 10°$

$a = 2 - 9.8 \times 0.1736$ (as $\sin 10° = 0.1736$)
$a = 2 - 1.7017$
$a = 0.298\ ms^{-2}$
$a \approx 0.3\ ms^{-2}$ correct answer with correct units (2 marks)

Q.18 **(3)**

Output = 1000MJ
Efficiency = η (%) = 40%

$\eta = \frac{40}{100} = 0.4$

input = ?
waste energy = ?

$\eta = \frac{output}{input}$ (1 mark)

$input = \frac{output}{\eta}$

$input = \frac{1000MJ}{0.4} = 2500MJ$ (1 mark)

waste energy = input – output
= 25000MJ – 1000MJ
= 1500MJ or 1.5×10^{9}J (1 mark)

(OR)

output power = P = 15KW = 15×10^{3}W
mass of loaded elevator = m = 1000kg
height of the building = h = 30m
time taken = t = ?

$Power = \frac{work}{time\ taken} = \frac{mgh}{t}$ (1 mark)

$t = \frac{mgh}{P}$

$t = \frac{1000 \times 9.8 \times 30}{15 \times 10^3}$ $= 19.6$ s

correct answer with correct units (2 marks)

Q.19 **(3)**

a. From A to B object moves with uniform speed of $2ms^{-1}$ (1 mark)
From B to C object moves with uniform deceleration (1 mark)

b. Distance covered = area under v – t graph
Distance covered = $2 \times 2 = 4m$ (1 mark)

also accept:

$d = V_{av}\, t = \left(\frac{Vi + Vf}{2}\right)t = \left(\frac{2+2}{2}\right) \times 2 = 4$ m

(OR)

For core and cladding

Using $n_1 \sin \theta_1 = n_2 \sin \theta_2$

$n_1 = 1.5$

$n_2 = 1.4$

$\theta_2 = 90°$

$\theta_1 = \theta_c$

$\sin \theta_c = \frac{n_2 \sin \theta_2}{n_1} = \frac{1.4 \times \sin 90°}{1.5}$

$\sin \theta_c = 0.9333$

$\theta_c = \sin^{-1}(0.933) \approx 69°$ (1 mark)

For air and core

$n \sin \theta = n_1 \sin \theta'$

$n = 1.0$

$\theta = ?$

$\theta' = 90° - 69° = 21°$

$n_1 = 1.5$ (1 mark)

$\sin \theta = \frac{n_1 \sin \theta'}{n} = \frac{1.5 \sin 21°}{1} = 0.53$

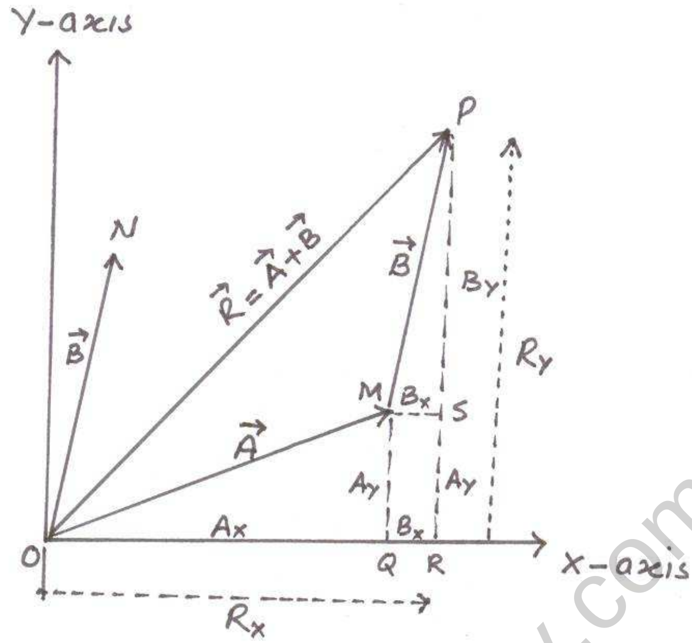
$\theta = \sin^{-1}(0.53)$

$\theta = 32.5°$ (1 mark)

SECTION C

Q.20 **(8)**

a.



Properly labeled figure and rectangular components of individual vectors (explanation required) (2 marks)

Expression of magnitude of the resultant vector (2 marks)

Direction of the resultant vector (1 mark)

b. $\vec{A} = 3\hat{i} + 4\hat{j}$ and $\vec{B} = 5\hat{i} - 3\hat{k}$

$\vec{A}.\vec{B} = (3\hat{i} + 4\hat{j}).(5\hat{i} - 3\hat{k})$

$= 15$

$|\vec{A}.\vec{B}|^2 = 15^2 = 225$ (1 mark)

$$\vec{A}\times\vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 4 & 0 \\ 5 & 0 & -3 \end{vmatrix}$$

$= \hat{i}(-12) - \hat{j}(-9) + \hat{k}(-20)$

$= -12\hat{i} + 9\hat{j} - 20\hat{k}$

$|\vec{A}\times\vec{B}|^2 = (-12)^2 + (9)^2 + (-20)^2$

$= 144 + 81 + 400 = 625$ (1 mark)

$|\vec{A}.\vec{B}|^2 + |\vec{A}\times\vec{B}|^2 = 225 + 625 = 850$

$A^2 = (3)^2 + (4)^2 = 9 + 16 = 25$

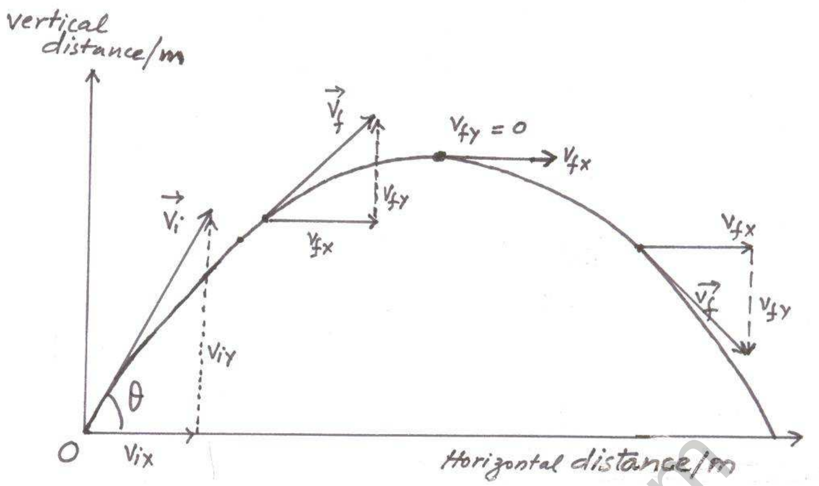
$B^2 = 5^2 + (-3)^2 = 25 + 9 = 34$

$A^2B^2 = 25 \times 34 = 850$

$|\vec{A}.\vec{B}|^2 + |\vec{A}\times\vec{B}|^2 = A^2B^2$ (Proved) (1 mark)

Q.21 **(8)**

a.



Figure, definition, examples and explanation (2 marks)
Time of flight (2 marks)
Range of the Projectile (2 marks)

b. Angle of inclination = θ = 20°
Initial velocity = v_i = 20 m/s
Maximum vertical distance = H = ?
Maximum horizontal distance = R = ?

$H = \frac{V_i^2 \sin^2\theta}{2g} = \frac{(50)^2(\sin 20^0)^2}{2\times 9.8} = \frac{2500\times 0.117}{2\times 9.8} = 14.9 \approx 15\text{m}$ (1 mark)

$R = \frac{Vi^2}{g}\sin 2\theta = \frac{(50)^2}{9.8}\sin(2\times 20°) = 163.9 \approx 164\text{m}$ (1 mark)

Q.22 **(10)**

a. Statement of 1st law of thermodynamics with mathematical relation (1 mark)
Explanation of the law (2 marks)

b. Explanation of isothermal process with P–V graph (2 marks)
Explanation of adiabatic process with P–V graph (2 marks)

c. Temperature difference between the source and the sink = $T_1 - T_2$ = 100°C = 100K
Heat absorbed from the source = Q_1 = 746J
Heat rejected to the sink = Q_2 = 546J

First Method:

$\eta = \frac{Q_1 - Q_2}{Q_1} = \frac{746 - 546}{746}$

∴ $\eta = 0.268$ (1 mark)

Now $\eta = \frac{T_1 - T_2}{T_1}$

Since $T_1 - T_2 = 100k$

∴ $\eta = \frac{100}{T_1}$ ∴ $T_1 = \frac{100}{0.268} = 373k = 100°C$ (1 mark)

and $T_2 = T_1 - 100 = 273k = 0°C$ (1 mark)

Second Method:

$\frac{Q_1}{Q_2} = \frac{T_1}{T_2}$ ∴ $T_2 = T_1 \frac{Q_2}{Q_1} = (T_2 + 100) \frac{\theta_2}{\theta_1}$ (1 mark)

$T_2 = T_2 \frac{Q_2}{Q_1} + 100 \frac{Q_2}{Q_1}$

$T_2 = T_2 \frac{546}{746} + 100 \times \frac{546}{746}$

$T_2 = 0.73T_2 + 73.2$

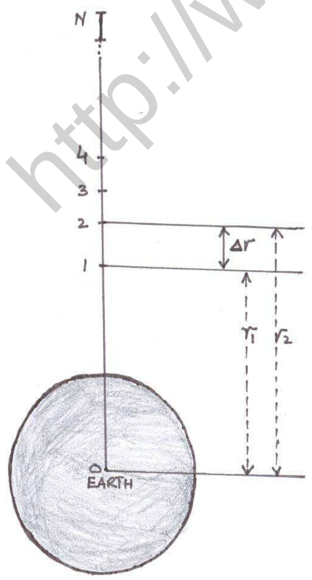
∴ $T_2 (1-0.73) = 73.2$ (1 mark)

∴ $T_2 = \frac{73.2}{0.27}$ ∴ $T_2 = 271.1 \approx 271k = -2°C$

$T_1 = T_2 + 100 = 371k = 98°C$ (1 mark)

(OR)

a. Definition of absolute potential energy (1 mark)



Figure, assumptions and explanation (1 mark)
Derivation steps (3 marks)
Absolute potential energy on the surface of the earth (1 mark)

b.	Explanation and derivation of relation for velocity	(1 mark)
	Derivation for orbital radius	(2 marks)
	Relationship between orbital radius and the time period (i.e. r $\propto t^{2/3}$)	(1 mark)