S4 PHYSICS EXAMINATION MARKING GUIDE (THEORY) -2024.

Do not write in this margin

SECTION A: / 55 marks

1. $u = 8cm$, $f = +10cm$;

The image distance v: $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ ✓ 1

$\Rightarrow \frac{1}{10} = \frac{1}{8} + \frac{1}{v} \Rightarrow \frac{1}{v} = \frac{1}{10} - \frac{1}{8} \Rightarrow v = -40cm$. ✓ 1

The minus sign indicates that the image is formed is virtual.

The magnification: $m = \left|\frac{v}{u}\right| = \left|\frac{-40cm}{8cm}\right| = 5$. ✓ ✓ 1+1

This means that the image is five times larger than the object

4marks

2. a) iv ✓ 1

b) ii ✓ 1

c) iv ✓ 1

3marks

3 a) The far point of an eye is the farthest distance from the eye at which objects can be seen clearly without straining the eye muscles to focus. ✓ 1

b) $v = -2.5m$ and $u = \infty$; $f = ?$

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \Rightarrow$ ✓ $\frac{1}{f} = \frac{1}{\infty} + \frac{1}{-2.5}$ ✓ $\Rightarrow \frac{1}{f} = \frac{1}{-2.5}$ 1+1

$\Rightarrow f = -2.5m$. ✓ (This is a diverging lens) 1

4marks

NESA

CamScanner

2 Do not write in this margin 2 marks

④ b ✓

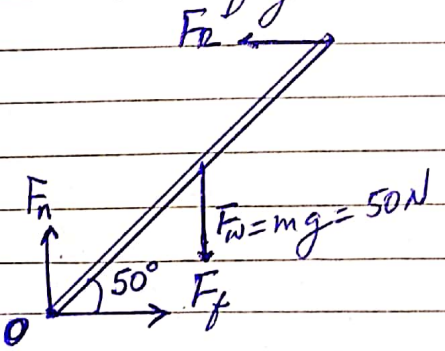
⑤ a) Condition 1:

The resultant force acting on the object must be equal to zero. ✓ ie the sum of all forces in the x-direction must be equal to zero ($\Sigma F_x = 0$) and the sum of all forces in the y-direction must be equal to zero ($\Sigma F_y = 0$). 1

Condition 2:

The resultant external torque about any axis must be equal to zero ie ✓ The sum of clockwise moments about any point must be equal to the sum of anticlockwise moments about the same point. 1

b) The free body diagram of the beam is shown in the figure below:



From the 1st condition of equilibrium:

$\Sigma F_x = 0 \Rightarrow F_f - F_R = 0 \Rightarrow F_f = F_R$. ✓ 1

$\Sigma F_y = 0$. $F_N - mg = 0 \Rightarrow F_N = 50N$ ✓ 1

From the 2nd condition of equilibrium.

$\Sigma \tau = 0$ (About point O).

CamScanner

$\Rightarrow 0 + 0 - (50N) \times (\frac{10m}{2}) \sin 40° + 10m \sin 50° F_R = 0$ ✓ 1

Do not write in this margin

$\Rightarrow F_R = 21N$. ie $F_f = F_R = 21N$. ✓ 1

The coefficient of static friction: $\mu = \frac{F_f}{F_N} = \frac{21N}{50N}$.

ie $\mu = 0.42$. ✓ 1

7marks

(6) a) The work done is equal to the area under F versus S graph = 55J ✓ 2

b). From the work-energy theorem; $W = \Delta ke$

ie $W = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$ ✓ $\Rightarrow W = \frac{1}{2}mv^2$ since $u = 0 m/s$. 1

$\Rightarrow 55 = \frac{1}{2} \times 3 \times v^2 \Rightarrow v = 6 m/s$. ✓ 1

4marks

(7) a) The momentum of an object is defined as the product of its mass and its velocity ✓ 1
It is a vector quantity and is measured in kg m/s.

b) (i) From the principle of conservation of linear momentum in x-direction and y-direction;

$mv_1 \sin 30° - mv_2 \sin 30° = 0$ ✓ $\Rightarrow v_1 = v_2$. 1

and $mv_0 = mv_1 \cos 30° + mv_2 \cos 30°$ ✓ $\Rightarrow v_0 = 2v_1 \cos 30°$ 1

$\Rightarrow v_0 = \sqrt{3}\, v_1 \Rightarrow v_1 = v_2 = \frac{v_0}{\sqrt{3}} = \frac{9}{\sqrt{3}} m/s = 5.19 m/s$ ✓ 1

(ii) The total kinetic energy of the two balls before collision:

$K_0 = \frac{1}{2}mv_0^2 + 0 = \frac{1}{2}mv_0^2$ ✓ - (1) 0 5

NESA NATIONAL EXAMINATION AND SCHOOL INSPECTION AUTHORITY

CamScanner

The total kinetic energy after collision:

$$K = \frac{1}{2}mv_1^2 + \frac{1}{2}mv_2^2 = mv_1^2 \quad \checkmark \quad (2)$$

By comparing eq (1) and (2), we conclude that the kinetic energy is not conserved. ✓

Do not write in this margin

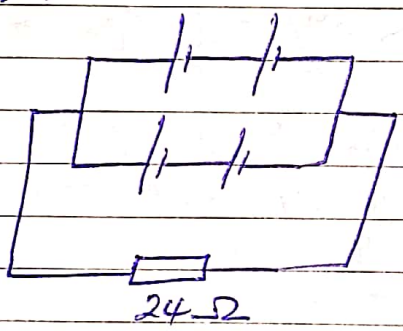
0

6 marks

(8) a) $I = \frac{nE}{R+nr} \checkmark = \frac{4\times4.5}{24+(4\times2)} A = 0.56\,A$ ✓ 1+1

b) $I = \frac{E}{R+\frac{r}{n}} \checkmark = \frac{4.5}{24+\frac{2}{4}} A = 0.18\,A$ ✓ 1+1

c) This combination is shown in the figure below:



$I = \frac{E_t}{R+r_t} \checkmark = \frac{9}{24+2} = 0.3A$ ✓ 1 1

6 marks

(9) a) Kirchhoff's junction rule states that the sum of all currents entering the junction is equal to the sum of all currents leaving the the junction. ✓ 2

b) From junction rule: $I_1 = I_2 + I_3$. ✓ 1

From the upper loop: $24 - 2I_1 + 4I_1 - 3I_3 = 0$ ✓ 1

From the lower loop: $12 + 3I_3 - I_2 - 5I_2 = 0$ ✓ 1

By solving the above three equations, we get: $I_1 = 3.5A$; $I_2 = 2.5A$ and $I_3 = 1A$. 1+1+1

8 marks

CamScanner

(10) $R = 20.3\,m$; $V_o = 20\,m/s$; $g = 10\,m/s^2$; $H_{max} = ?$

$R = \frac{V_o^2 \sin 2\theta}{g}$ ✓ $\Rightarrow 20.3 = \frac{20^2 \sin 2\theta}{10} \Rightarrow \theta = 15.24°$ ✓ 1+1

$H_{max} = \frac{V_o^2 \sin^2\theta}{2g}$ ✓ $= \frac{20^2 \cdot \sin^2 15.24°}{2\times 10}\,m = 1.339\,m$. ✓ 1+1

4marks

(11) a) $\theta = 30°$; $H_{max} = 50\,m$; $V_o = ?$

$H_{max} = \frac{V_o^2 \sin^2\theta}{2g}$ ✓ $\Rightarrow V_o^2 = \frac{2gH_{max}}{\sin^2\theta}$ 1

$\Rightarrow V_o = \sqrt{\frac{2\times 9.81\times 50}{\sin^2(30°)}}$ ✓ $= 1820\,m/s$ ✓ 1 1

b) Applications of projectile motion:
- In playing foot ball, basket ball, ✓ etc 1
- Rocket launch. ✓ 1
- etc.

5marks

(12) a) (ii) ✓ 1
b) (i) ✓ 1
c) (iv) ✓ 1
d) (ii) ✓ 1

4marks

(13) $V = 9\,m/s$; $a_c = 3\,m/s^2$, $R = 2m$;

$a_c = \frac{V^2}{R}$ ✓ $\Rightarrow R = \frac{V^2}{a_c} = \frac{g^2}{3}$ ✓ $= 6m$. ✓ 1+1+1

3marks

(14) $D = 4m$; $R = 2m$; $f = 90\,rpm\,(rev/min)$.

a) $f = \frac{90\,rev}{60\,sec} = 1.5\,rev/s\,(Hz)$.

$V = 2\pi f R$ ✓ $= (2\times 3.14\times 2\times 1.5)\,m/s = 0.84\,m/s$. ✓ 1+1

Do not write in this margin

NESA

CamScanner

b) $\omega = \frac{2\pi}{T} = 2\pi f = 2 \times 3.14 \times 1.5 \text{ rad/s} = 9.42 \text{ rad/s}$ 1+1

c) $a_c = \frac{v^2}{r} = \frac{(0.84)^2}{2} \text{ m/s}^2 = 0.35 \text{ m/s}^2$. 1+1

6marks

Do not write in this margin

(15) a) True 1

b) True 1

c) True 1

d) False. 1

4marks

SECTION B: /30 marks

(16) a) The X-component of each force:

For F: $F_x = F\cos 60° \Rightarrow F_x = 0.5F$ 1

For P: $P_x = -P\cos 30° \Rightarrow P_x = -0.886P$ 1

For $F_1 = 200N$: $F_{1x} = 200N \cos 45° = 141.4N$. 1

For $F_2 = 300N$: $F_{2x} = -300N$ 1

b) The Y-component of each force:

For F: $F_y = F\sin 60° = 0.866F$ 1

For P: $P_y = -P\sin 30° = -0.5P$ 1

For $F_1 = 200N$: $F_{1y} = -200N \sin 45° = -141.4N$ 1

For $F_2 = 300N$: $F_{2y} = 0$ 1

c) Condition: $\Sigma F_x = 0$ and $\Sigma F_y = 0$

i.e. $0.5F + (-0.886P) + 141.4 - 300 = 0$.

$\Rightarrow 0.5F - 0.886P = 158.6$ ... eq(1) 5

$0.866F + (-0.5P) + (-141.4) + 0 = 0$ 0

CamScanner

$\Rightarrow 0.866F = 0.5P + 141.4$ --- eq(2) ✓

Do not write in this margin

By solving the above two equations we get: $F = 86.4N$ ✓ and $P = -134N$ ✓

5 5 0+0

10 marks

(17) $V_0 = 600\ m/s$; $\theta = 60°$

a) $R = \frac{V_0^2 \sin 2\theta}{g}$ ✓ $= \frac{600^2 \sin(2\times 60°)}{9.81}\ m = 31780.74\ m$ ✓ 1+1

b) $H_{max} = \frac{V_0^2 \sin^2\theta}{2g}$ ✓ $= \frac{600^2 \sin^2 60°}{2\times 9.81}\ m = 13,781.46\ m$ ✓ 1+1

c) $V = \sqrt{V_0^2 - 2V_0 g \sin\theta t + g^2 t^2}$ ✓ 1

$V = \sqrt{600^2 - 2\times 600\times 9.81\times \sin 60°\times 30 + (9.81)^2 \times 30^2}$

$= 378\ m/s$ ✓ 1

d) From the principle of conservation of mechanical energy,

$mgh + \frac{1}{2}mv^2 = \frac{1}{2}mV_0^2$ ✓ $\Rightarrow V = \sqrt{V_0^2 - 2gh}$ 1

ie $V = \sqrt{600^2 - 2\times 9.81\times 10000} = 404.72\ m/s$ ✓ 1

e) $t = \frac{V_0 \sin\theta}{g}$ ✓ $= \frac{600\times \sin 60°}{9.81} = 52.96\ Sec.$ ✓ 1+1

10 marks

(18) a) (i). Nearsightedness / Shortsightedness ✓ or myopia 1

(ii) Wearing concave / diverging lenses ✓ 1

b) Angular magnification; M

$= \frac{\text{Angle subtended by the image at the aided eye}}{\text{Angle subtended by the object at the naked eye.}}$ ✓ 1

NESA NATIONAL EXAMINATION AND SCHOOL INSPECTION AUTHORITY

CamScanner

While;

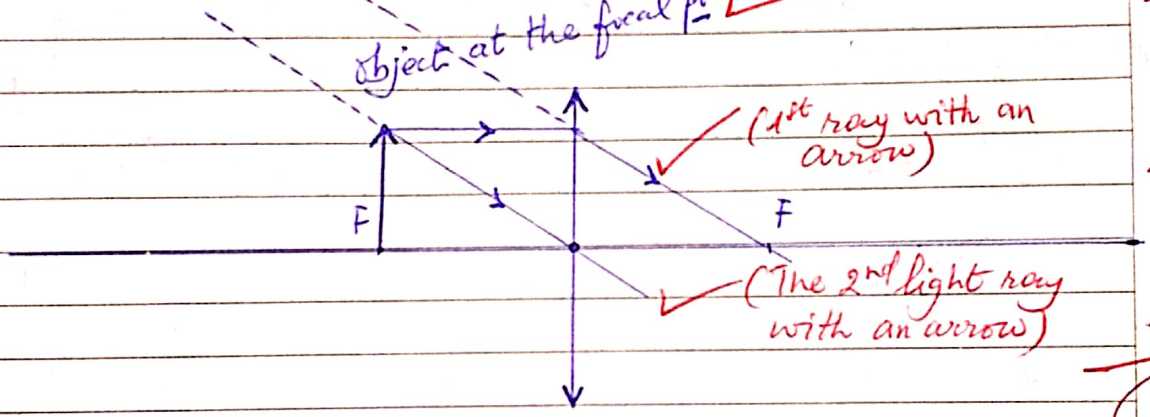
The linear magnification; $m = \frac{\text{Image height}}{\text{Object height}}$ ✓ 1

c) (i) Objective ✓ lens and eyepiece ✓ lens. 5+0 5

(ii) Eyepiece lens ✓ 1

(iii) objective lens ✓ 1

(iv) A ray diagram of simple microscope which is not in normal use:



1 1 1

10 marks

(19) a) Condition for minimum deviation to take place:

The angle of incidence must be equal to the angle of emergence ✓ 1

(or) The internal angles of refraction of refraction must be equal

(or) The light ray must pass symmetrically through the prism.

b) Dispersion takes place. ✓ 1

c) Refraction does not take place. ✓ 1

Do not write in this margin

CamScanner

d) i) $A = 60°$; $n_2 = 1.5$; $i_1 = 45°$; $n_1 = 1$.

Do not write in this margin

$n_1 \sin i_1 = n_2 \sin r_1 \Rightarrow \sin r_1 = \frac{n_1}{n_2} \sin i_1$ ✓ 1

$\Rightarrow r_1 = \sin^{-1}\left(\frac{n_1}{n_2} \sin i_1\right) = \sin^{-1}\left(\frac{1}{1.5} \sin 45°\right)$

$\Rightarrow r_1 = 28.125° \simeq 28°$ ✓ 1

$A = r_1 + r_2 \Rightarrow r_2 = A - r_1 = 60° - 28.125° = 31.875°$ ✓ 1

$n_2 \sin r_2 = n_1 \sin i_2 \Rightarrow i_2 = \sin^{-1}\left(\frac{n_2}{n_1} \sin r_2\right) = \sin^{-1}(1.5 \sin 32°)$

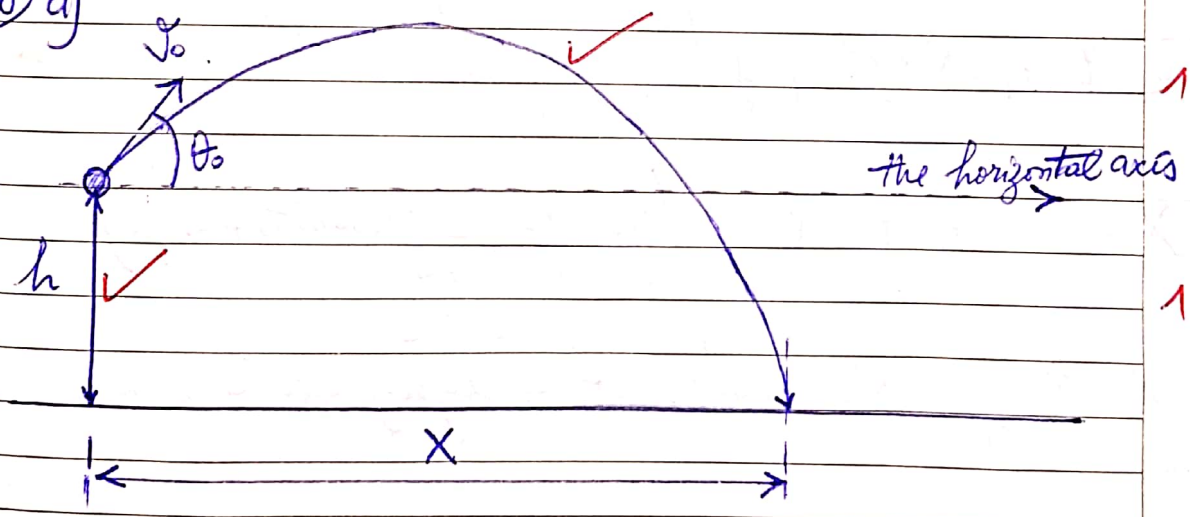
$\Rightarrow i_2 = 52.38°$ ✓ 1

ii) $D = (i_1 + i_2) - A \Rightarrow D = (45° + 52.38°) - 60° = 37.38°$ ✓ 1+1+1

10 marks

---

20 a)



✓ 1

✓ 1

$v_{0y} = v_0 \sin\theta_0$ ✓

$v_{0x} = v_0 \cos\theta_0$ ✓

0.5 or 0.5

$X = (v_0 \cos\theta) \times t$ ✓ and 1

$y = y_0 + v_{0y} t - \frac{1}{2} g t^2 \Rightarrow y = h + v_{0y} t - \frac{1}{2} g t^2$.

$0 = h + v_0 \sin\theta\, t - \frac{1}{2} g t^2$ ✓ 1

NESA

CamScanner

$\frac{g}{2}t^2 - V_0\sin\theta_0 . t - h = 0 \Rightarrow t^2 - \frac{2V_0\sin\theta_0}{g}.t - \frac{2h}{g} = 0$

Do not write in this margin

Let's solve for t:

$a = 1$; $b = -\frac{2V_0\sin\theta_0}{g}$ and $c = -\frac{2h}{g}$.

$\Delta = b^2 - 4ac = \frac{4V_0^2\sin^2\theta_0}{g^2} + \frac{8h}{g}$.

$\Rightarrow \Delta = \frac{4V_0^2\sin^2\theta_0 + 8gh}{g^2}$

$t = \frac{-b \pm \sqrt{\Delta}}{2a}$

$t_1 = \frac{V_0\sin\theta_0}{g} + \frac{1}{g}\sqrt{V_0^2\sin^2\theta_0 + 2gh}$

t_2 = -ve (rejected).

So, $t = t_1 = \frac{V_0\sin\theta_0}{g} + \frac{1}{g}\sqrt{V_0^2\sin^2\theta_0 + 2gh}$ ✓ 1

$X = V_0\cos\theta_0 . t = V_0\cos\theta . \left(\frac{V_0\sin\theta_0}{g} + \frac{1}{g}\sqrt{V_0^2\sin^2\theta_0 + 2hg}\right)$

$\therefore X = \frac{V_0\cos\theta_0}{g}\left(V_0\sin\theta_0 + \sqrt{V_0^2\sin^2\theta_0^2 + 2gh}\right)$ Hence proved.

b) Substituting $h = 0$ into the above expression, we obtain:

$X = \frac{V_0^2\sin 2\theta_0}{g}$ ✓ 4

END

10 marks

NESA NATIONAL EXAMINATION AND SCHOOL INSPECTION AUTHORITY

CamScanner