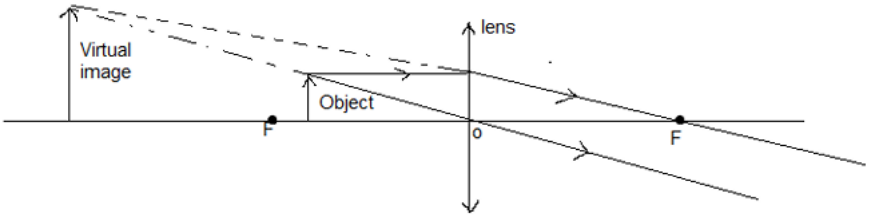
PHYSICS MARKING GUIDE 2023-2024 **PROGRAM S4**

SECTION A

1.	**1. a**.An image of an object is a virtual image when the rays of the light do not actually pass through it; they only seem to come from it. A virtual image would not be obtained on a cinema screen. **b**. The formation of a virtual image by a thin converging lens occurs for a real object placed inside its principal focus.  **c.** This lens can be used as a single microscope because it forms an upright and magnified image.	**2pts** **2pts** **2pts**
2.	2. a) Power of a lens is defined as its ability to converge or diverge the rays of light falling on it. Or Power of a lens is defined as the reciprocal of the focal length of the lens.SI unit of power is dioptre (D) b) P=1/f Given $f_1 = 50cm$ $f_2 = -40cm$ $$\frac{1}{f_{com}} = \frac{1}{f_1} + \frac{1}{f_2}$$ $$\frac{1}{f_{com}} = \frac{1}{50} + \frac{1}{-40}$$ $$\mathbf{f_{com} = -200cm}$$ As $P_{com} = \frac{1}{f_{com}}$ $P_{com} = \frac{1}{-2}$ $P_{com} = -0.5D$ c) The combination will act as diverging lens since f_{com} is negative **3.** **Advantages** 1. Solar power is pollution free and causes no greenhouse	**2pts** **3pts** **1pt** **(4marks)**

	gases to be emitted after installation 2. Reduced dependence on foreign oil and fossil fuels 3. **Low Operating Costs:** Once installed, solar panels have relatively low operating and maintenance costs. They have no fuel or ongoing operational expenses. 4. **Renewable Energy Source:** Solar energy is a renewable resource, meaning it is inexhaustible as long as the sun continues to shine. 5. **Reduced Electricity Bills:** Solar power systems can generate electricity for your home or business, reducing your dependence on the grid and leading to lower electricity bills. 6. **Long Lifespan:** Solar panels typically have a long lifespan, often lasting 25 years or more, with minimal degradation in performance over time **Etc. accept student ideas according to what have been discussed in class** Disadvantages 1. High initial costs for material and installation and long ROI (return on investment) 2. **Intermittent Energy Production:** Solar power generation is dependent on sunlight, and energy production is intermittent. Weather conditions, time of day, and seasonal variations can affect the amount of energy produced. 3. **Space Requirements:** Solar panels require a significant amount of space for installation, especially for larger systems. This can be a limitation for residential and commercial installations with limited available space. 4. **Weather Dependence:** Solar panels are less effective on cloudy days or during the night when there is no sunlight. Energy storage solutions (such as batteries) can address this issue to some extent. ***Etc. accept various ideas of students accordingly***	**1pt for each correct point**
	4. a) The defect is myopia or short-sightedness b) This defect should be corrected by a suitable diverging spectacles 5.	**1.5pts** **1.5pts**

5marks

Let
u_1 , v_1 , f_1 *and* $m_1 = -\frac{v_1}{u_1}$ be respective object distance, image distance, focal length and linear magnification of convex lens.
And u_2 , v_2 , f_2 *and* $m_2 = -\frac{v_2}{u_1}$ be respective object distance, image distance, focal length and linear magnification of diverging lens with $f_1 = -f_2$ *and* $h_1 = h_0$

$m_1 = \frac{h_1}{h_0} = -\frac{v_1}{u_1}$ for $h_1 = 2h_0$

$\frac{2h_0}{h_0} = -\frac{v_1}{u_1} \Leftrightarrow v_1 = -2u_1$

Since $\frac{1}{f_1} = \frac{1}{u_1} + \frac{1}{v_1} \Leftrightarrow \frac{1}{f_1} = \frac{2-1}{2u_1}$

$\frac{1}{f_1} = \frac{1}{u_1} - \frac{1}{2u_1}$ $f_1 = 2u_1$

For $f_1 = f_2$, then $f_2 = -2u_1$

Diverging lens $\frac{1}{f_2} = \frac{1}{u_2} + \frac{1}{v_2}$ for $u_1 = u_2$

$-\frac{1}{2u_1} = \frac{1}{u_1} + \frac{1}{v_2}$

$-\frac{1}{2u_1} - \frac{1}{u_1} = \frac{1}{v_2} \Leftrightarrow v_2 = -\frac{2}{3}u_1$

With $m_2 = -\frac{v_2}{u_2} \Leftrightarrow m_2 = \frac{+2}{3}\frac{u_1}{u_1}$

$m_2 = \frac{2}{3}$

6.

a) The law of conservation of momentum states "*that in an isolated system the total momentum of two or more bodies acting upon each other remains constant unless an external force is applied*". **2marks**

b) Momentum before collision = Momentum after collision **4marks**

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$(0.16\text{kg})(0.50\text{m/s}) + (0.10\text{kg})(0\text{m/s}) = (0.16\text{kg})v_1 + (0.10\text{kg})(0.50\text{m/s})$

$0.08\ \text{kg m/s} = (0.16\text{kg})v_1 + 0.05\ \text{kg m/s}$

$0.03\ \text{kg m/s} = (0.16\ \text{kg})v_1$

$v_1 = 0.19\text{m/s}$

7.

a) Critical angle is defined as incident angle for which an angle of refraction is equal to 90^0. **1mark**

Or is defined as an angle of incident for which light grazes over the interface

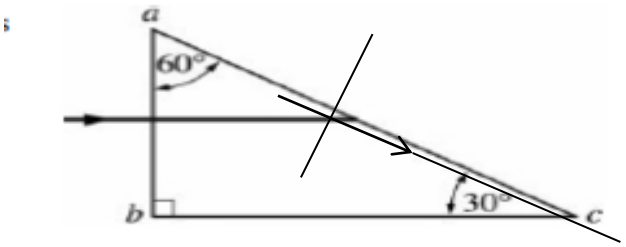
b) The index of refraction of prism is 1.5, means, the speed of light in that prism is 1.5 times slower than the speed of light in air/vacuum **2marks**

c) let n_p , θ_c , be respective index of refraction of prism and critical angle

Assume prism to be surrounded by air $n_{air} = 1$

Finally $sin\theta_c = \frac{n_{air}}{n_p}$ so $n_p = \frac{n_{air}}{sin\theta_c}$ $n_p = \frac{1}{sin60}$ $n_p = 1.15$ **2marks**

d)



1mark

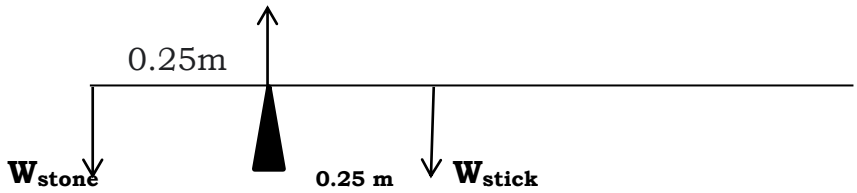
8.

a) Two conditions must be simultaneously satisfied in equilibrium. **2marks**

-the sum of all external forces acting on the body is

-the sum of all external torques from external forces is zero

b)

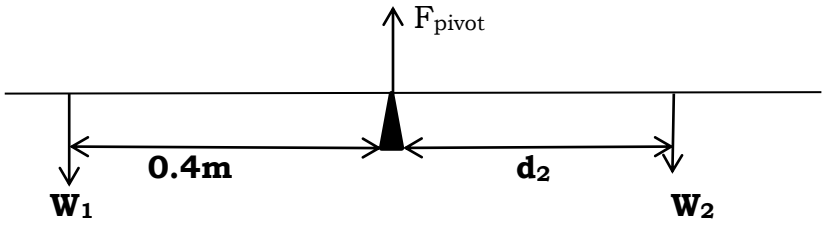


Since the stick is uniform, its weight must be at a half of its length. Then, consider pivot as axis of rotation and counterclockwise moment must be equal to clockwise moment **4marks**

0.25xWstone=0.25Wstick

Wstick= Wstone=10N
Mass of stick is 1kg

9.

a) 

2marks

b) The sum of parallel forces in one direction balances sum of parallel forces in opposite direction. Hence F_{pivot}= **W_1 + W_2**

2marks

F_{pivot}=3N+6N

F_{pivot}=9N

3marks

c) To maintain static equilibrium , counterclockwise moment must be equal to clockwise moment

$0.4x3=6d_2$ $d_2=0.2m$

10.

a)

i. light

ii. kinetic

b)

i. $Power = \frac{Energy\ transferred}{time}$

ii. $Energy\ transferred = Powerxtime$

$$Energy\ transferred = 78Wx10s$$

$$Energy\ transferred = 780J$$

c)

Input energy=220J

Wasted energy=176J

Output=Useful energy

=220J-176J

=24J

$$\text{Efficiency} = \frac{Output\ energy}{Input\ energy}$$

$$\text{Efficiency} = \frac{44}{200}x\ 100\%$$

$$\text{Efficiency} = 12\%$$

11.

i.

ii. Work done by net force=Fnet x s

From second Newton's law Fnet=ma

Fnet=Fapp-Ff

$$F_f = \mu mg$$

$$F_f = 0.1x2x10 \quad \rightarrow \quad F_f = 2N$$

$$Fnet = 7N - 2N$$

$$= 5N$$

Thus

$$a = \frac{Fnet}{m}$$

$$a = \frac{5}{2}$$

a=2.5ms^{-1}

$$S = \frac{1}{2}at^2 + v_0t$$

$$S = \frac{1}{2}x2.5x10^2 + 0$$

$$S = 125m$$

Work done by net force=5Nx125

=625J

iii. Work done by net force=change in kinetic energy(work-energy theorem)

=625J

12.

a. Is defined as the property of a conductor to resist/oppose the flow of current through it

.10=5+R that is R=5Ω

c.$I_1 = \frac{15}{10}$=1.5 hence $I_1 = I_2 = 1.5A$ $I_3 = I_1 + I_2 = 3A$

SECTION B

13.

a. **The angular magnification or magnifying power** of an optical instruction is defined by the equation M=$\frac{\beta}{\alpha}$

Where β is angle subtend at the eye by the image formed when using the instrument and α is angle subtended at the unpaid eye i.e without the instrument.

Linear (a lateral or transverse) magnification is the ratio of the image distance to the object distance That is m=$\frac{v}{u}$

b. Angular magnification m=$\frac{25}{6}$ =4.18

Distance v is given by: $\frac{1}{v}=\frac{1}{f}-\frac{1}{u} \Rightarrow: \frac{1}{v}=\frac{1}{6}-\frac{1}{5}$ then v=-30cm

Linear magnification m=$\frac{-30}{5}=-6$

c.

$$\frac{1}{u_2}+\frac{1}{V_2}=\frac{1}{f_2}$$

$$\frac{1}{u_2}=\frac{1}{f_2}-\frac{1}{V_2}=\frac{V_2-f_2}{f_2V_2}$$

$$u_2=\frac{f_2V_2}{V_2-f_2}=\frac{5(-25)}{-25-5}=\frac{125}{30}=4.17cm$$

For the objective, image I_1 is real image and is placed at distance $v_1=\frac{125}{6}$ for the objective

Hence $u_1=\frac{V_1f_1}{V_1-f_1}=\frac{2(65/6)}{\frac{65}{6}-2}=2.453cm$

The object O is about 2.453cm from the objective

14.

a) Given k= 10^3Nm x=0.02m

work done by spring $W_s=\frac{1}{2}kx_m^2$ Ws=0.20J

$$W_s=\Delta Ke \qquad W_s=\frac{1}{2}mv^2-\frac{1}{2}mv_0^2$$

$$v=0.5ms^{-1}$$

b. Work done by friction force

$$W_f=-F_fx\,d \qquad W_f=-4x0.02 \qquad W_f=-0.08J$$

$$W_s-W_f=\Delta Ke=\frac{1}{2}mv_f^2$$

So velocity of the block as it passes 0 is

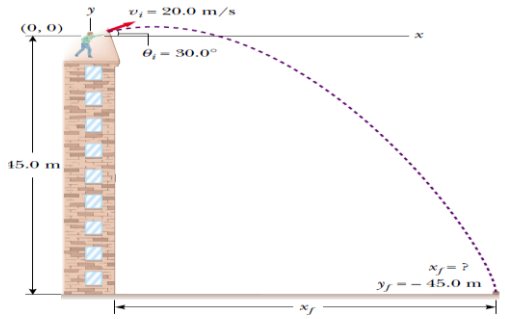
$v_f=\sqrt{2x\frac{w_s-w_f}{m}}$ $v_f=0.39ms^{-1}$

c. As the friction force increases to 10N, work done by friction force is $W_f = -F_f x\, d \qquad W_f = -10x0.02 \qquad W_f = -0.20J$ which is equal in magnitude to the kinetic energy at x =0 without the loss due to friction. Thus, all of the kinetic energy has been transformed by friction when the block arrives at x =0 and ***its speed at this point is v =0***.

15.

a.Time of flight is the total time taken by the projectile in air(from the point of projection to where it lands)

b.



$v_{ox} = v_x = v_0 \cos\theta \qquad 17.3\text{ms}^{-1}$

$v_{oy} = v_0 sin\theta \qquad 10\text{ms}^{-1}$

To find t let $Y_f = y_0 + \frac{1}{2}at^2 + v_{0y}t$ taking top as reference

$y_0 = 0\ , g = -10ms^{-2}\ and\ \ Y_f = -45m$ finally $\boldsymbol{t = 4.22s}$

c.

$v_y = v_{0y} - gt$

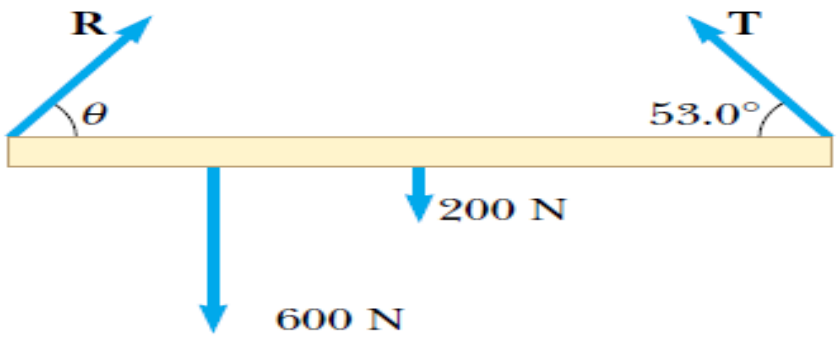
$$v_f = \sqrt{v_{x+}^2 v_y^2}$$

$$v_f = 35.9ms^{-1}$$

d. $R = v_X\, t_f \qquad$ R=17.3ms^{-1}x 4.22s $\qquad$ R=73m

16.

a) A free-body diagram" is a diagram showing all forces acting on a body" thus,



b) *Applying the two conditions of equilibrium, we have*

$\in F_x = 0 \qquad R\cos\theta - T\sin 53 = 0$

$\in F_y = 0 \quad R\sin\theta + T\sin 53 - 600 - 200 = 0$

choose at point R as axis of rotation, $\in \tau = 0 \quad T\sin 53 x8 - 600x2 - 200x4 = 0$

Finally $T = 313N \qquad \theta = 71 \qquad R = 580N$

17.

a. KCL: The Sum of current entering to the junction is equal to sum of current leaving the junction" Is based on the conservation of charge"

KVL: The sum of potential drops in a closed circuit is zero. So, it is based on the conservation of energy.

b.From the loop ***abcda*** and ***befcb*** we may apply KCL and KVL and we get**:**

KCL: $\qquad I_1 + I_2 = I_3$

KVL : $\qquad 10V - 6I_1 - 2I_3 = 0$

$-14V - 6I_1 - 10 - 4I_2 = 0$

Rearranging those equations we get **:** $\boldsymbol{I_1 = 2A \quad I_2 = -3A \quad I_3 = -1A}$