S4 PHYSICS MARKING GUIDE

1. a) -----iii) **(1mark)**
   b) -----ii) **(1mark)**

2. a) -----ii) **(1mark)**

   b)-----iv) **(1mark)**

3. a) -----ii) **(1mark)**

   b) -----iv) **(1mark)**

4. ----- i) **(1mark)**

5. Impulse is the product of force and the time for which it acts. **(1mark)**

   $F = ma$

   $F = m\left(\frac{v-u}{t}\right)$

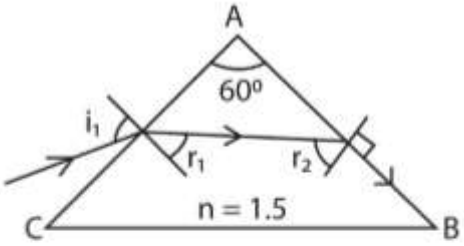
   $Ft = mv - mu$

   Hence impulse = change in momentum **(2marks)**

6. The algebraic sum of all the forces acting in one direction is equal to the algebraic sum of all the forces acting in the opposite direction. **(1mark)**

and - The algebraic sum of all moments of forces at any given point is equal to zero. **(1mark)**

7.



Using Snell's law on face AB

$1.5\sin r_2 = \sin 90^0$

$r_2 = 41.8^0$ **(1mark)**

Also applying Snell's law on face AC

$r_1 = 60 - 41.8 = 18.2^0$ **(1mark)**

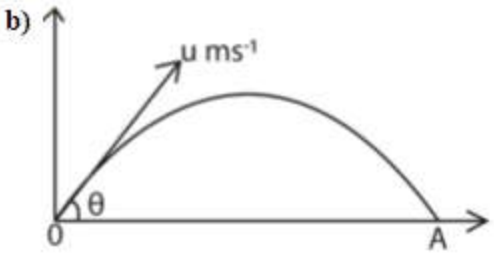
$\sin i = 1.5\sin 18.2$

$i = 27.9^0$ **(1mark)**

8. a) --Time of flight is the time taken by a projectile to move from the point of projection to where it lands **(1mark) nb**

-- Range is the horizontal distance between the point of projection and the v point where the projectile hits the ground **(1mark)**

b)



At point A, the vertical distance covered above the point of projection is zero **(1mark)**

From $s = ut + \frac{1}{2}at^2$

$0 = u\sin\theta \times t - \frac{1}{2}gt^2$

$t = \frac{2u\sin\theta}{g}$ **(1mark)**

therefore the time of flight of projectile is $\frac{2u\sin\theta}{g}$.

9. **(0.5 marks) each → 7.5 marks**

1.-------L	8. --------- A	15. -------J
2. ------F	9. --------- K	
3. ------B	10. -------- H	
4.-------M	11. -------- D	
5--------C	12. -------- P	
6.--------N	13. -------- G	
7.--------I	14. -------- E	

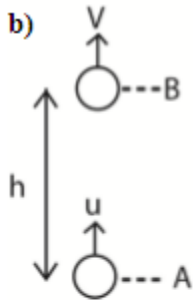
10. $r_1 = 10cm = 0.1m$, $r_2 = -15cm = -0.15m$

Using $\frac{1}{f} = (n-1)\left(\frac{1}{r_1} + \frac{1}{r_2}\right) = (1.5-1)\left(\frac{1}{0.1} + \frac{1}{0.15}\right) = 1.67D$

(1mark) **(1mark)** **(1mark)**

11. a) The total mechanical energy (K.E + P.E) of a body in an isolated system is constant. **(1mark)**

b)



At A, K.E $=\frac{1}{2}mu^2$, P.E = 0 **(1mark)**

Total energy at A = K.E + P.E $=\frac{1}{2}mu^2 + 0 = \frac{1}{2}mu^2$

At B, K.E $=\frac{1}{2}mv^2$; P.E = mgh **(1mark)**

Total energy at B, $=\frac{1}{2}mv^2$ + mgh

But $v^2 = u^2 - 2gh$

Total energy at B $=\frac{1}{2}m(u^2 - 2gh) + mgh = \frac{1}{2}mu^2$ **(1mark)**

Total energy at A = total energy at B

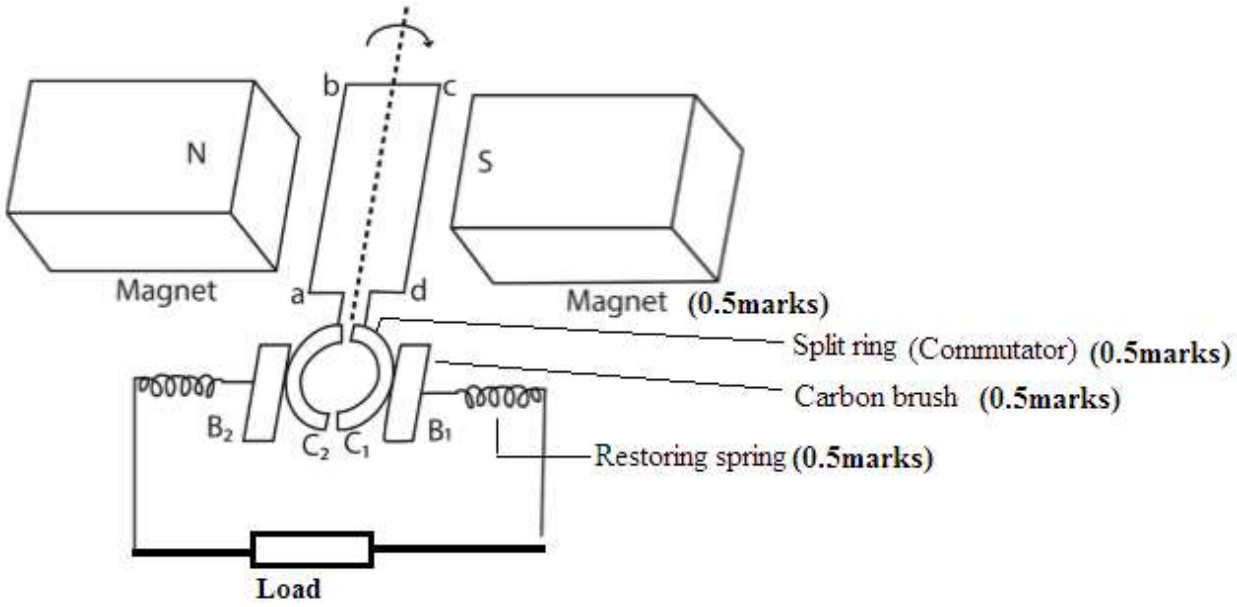
12. a) Definition of energy degradation **(1mark)**

Process by which energy becomes less available for doing useful work.

(b) The major difference between a d.c. motor and a.c. generator (2marks)

In a d.c. motor, electrical energy is converted into mechanical energy while for a d.c. generator mechanical energy is converted into electrical energy. **(2marks)**

(c) Description with the aid of a diagram the mode of action of a simple d.c. generator.



B_1 and B_2 are carbon brushes, C_1 and C_2 are split ring commutators and abcd is a rectangular coil

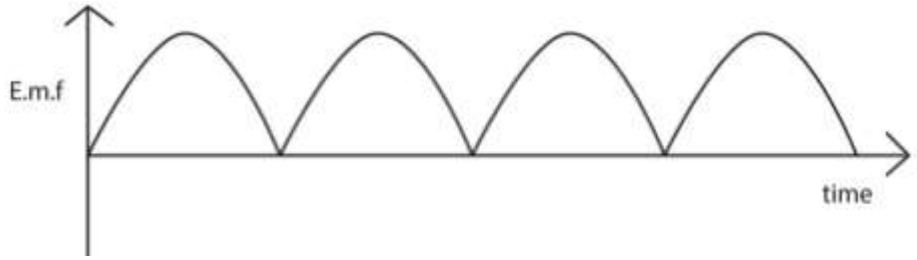
When the coil rotates at uniform velocity in magnetic field, e.m.f is induced in it. **(2marks)**

When the coil is in vertical position, the commutators change brushes C_1 to B_2 and C_2 to B_1.

E.m.f reverses direction but the current does not change direction. Hence current flows in the same direction in a resistor.

(d) Sketch of the output (graph of voltage with time) of a d.c. generator.

(1mark)



13. a)

Renewable Resources	Non-renewable Resources	
It can be used again and again throughout its life.	It cannot be used again and again as it is limited which can be depleted one day.	**(1mark)**
They are the energy resources which cannot be exhausted.	They are the energy resources which can be exhausted one day.	**(1mark)**
It is environment-friendly as the amount of carbon emission is low.	It is not environment-friendly as the amount of carbon emission is high.	**(1mark)**
These resources are present in unlimited quantity.	These resources are present in a limited quantity only.	
The total cost of these resources is low.	The total cost of these resources is comparatively high.	
These resources are pollution free.	These resources are not pollution free.	
The maintenance cost of the renewable resources is very high.	The maintenance cost of the renewable resources is low.	
Requires large land area for the installation of the power plant.	Requires less land area for the installation of the power plant.	
It is sustainable	It is exhaustible	

Note: Award marks to any other correct answers

b) The primary fossil fuel energy sources are petroleum (oil), **natural gas**, and coal. **(1.5marks)**

c) The main advantage of fossil fuels is that they are relatively **abundant**, and therefore, relatively **inexpensive. (1mark)**

d) Fossil fuels are more **polluting** than renewable energy sources as they e mit carbon dioxide when burnt. **(1mark)**

14. a) Amount of sound energy transferred $\frac{150\ x\ 2}{15} = 20J$ **(1 mark)**

Amount of sound energy transferred $\frac{150\ x\ 3}{15} = 30J$ **(1 mark)**

b) Amount of sound energy transferred $\frac{100\ x\ 100}{150}$ % = 66.7% **(2marks)**

15.a) $I=\frac{E}{R+r}=\frac{12v}{3.05}$=3.93A

And the terminal voltage:

ΔV=IR=E-Ir=12V-(3.93A)(0.05Ω)=11.8V

To check this result, we calculate the voltage across the load resistance R:

ΔV=IR=(3.93A)(0.05Ω)=11.8V

The power delivered to the load resistor is

$P_{R=Ir}^2$=(3.93A)^2(0.05Ω)=46.3W

The power delivered to the internal resistance is

Pr=I^{2}r=(3.93A)^2(0.05Ω)=0.772W

Let us connect the same 3.00Ω load resistor to the battery. The current in the battery now is

$I=\frac{E}{R+r}=\frac{12v}{(3\Omega+2\Omega)} = 2.4A$, and the terminal voltage is

ΔV=E-Ir=12V-92.4A)(2Ω)=7.2V

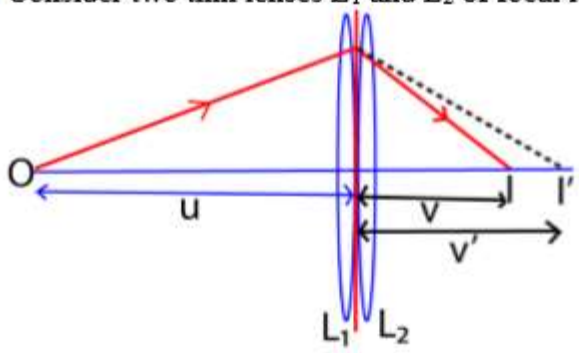
Notice that the terminal voltage is only 60%of the e.m.f .The power delivered to the load resistor and internal resistance is

$P_{R=I}^2$R=(2.4A)^2(3Ω)=17.3W

Pr=I^{2}r=(2.4A)^2(2Ω)=11.5W

Section B: Attempt any three questions of your choice

16. a) Consider two thin lenses L_1 and L_2 of focal length f_1 and f_2.



(1mark)

For lens L_1,

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

$$\frac{1}{f_1} = \frac{1}{u} + \frac{1}{v'} \quad \text{.....(i)} \qquad \textbf{(1mark)}$$

For L_2, I' acts as the object

$$\frac{1}{f_2} = \frac{1}{-v'} + \frac{1}{v} \quad \text{.....(ii)} \qquad \textbf{(1mark)}$$

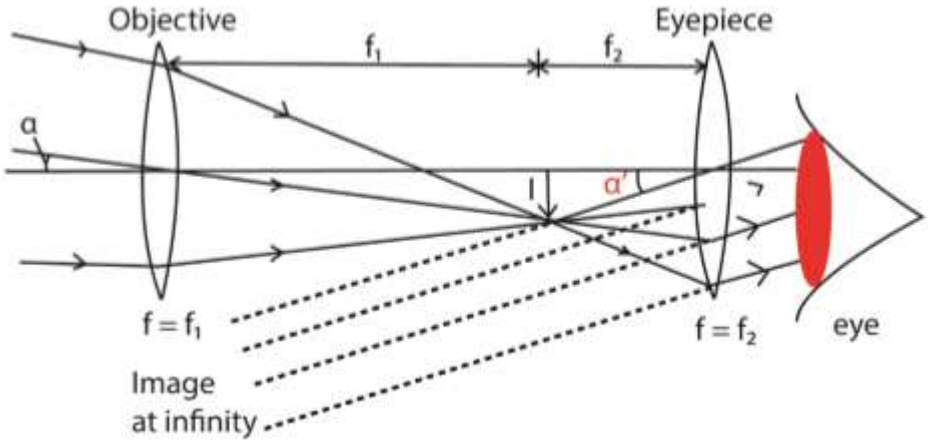
Eqn. (i) + Eqn. (ii)

$$\frac{1}{f_2} + \frac{1}{f_2} = \frac{1}{u} + \frac{1}{v} = \frac{1}{F}$$

$$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} \qquad \textbf{(1mark)}$$

Where F is the focal length of combined lens,

b) A ray diagram of astronomical telescope in normal adjustment.
(3marks)



c) The expression (Formula) for the magnifying power of the telescope in this setting.
(3marks)

For an aided eye (using the instrument)

For small angle, tanα' ≈ α' for small angle in radians

$\alpha' = \frac{h}{f_e}$ ..... (i)

Where, h, is the height of image I, f_e is the focal length of eye piece

For unaided eye

$\alpha = \frac{h}{f_o}$ ..... (ii)

f_0 is the focal length of objective lens

Combining equations (i) and (ii)

Magnifying power, $m = \frac{\alpha'}{\alpha} = \frac{h}{f_e} \div \frac{h}{f_o} = \frac{f_o}{f_e}$

d) The distance between the objective and the eyepiece. **(3marks)**

From $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

Action of eyepiece

$\frac{1}{5} = \frac{1}{u} - \frac{1}{25}$, u = 4.2cm

Action of objective

$\frac{1}{2} = \frac{1}{2.5} + \frac{1}{v}$, v = 10.0cm

Separation = u + v= 10.0 + 4.2 = 14.2cm

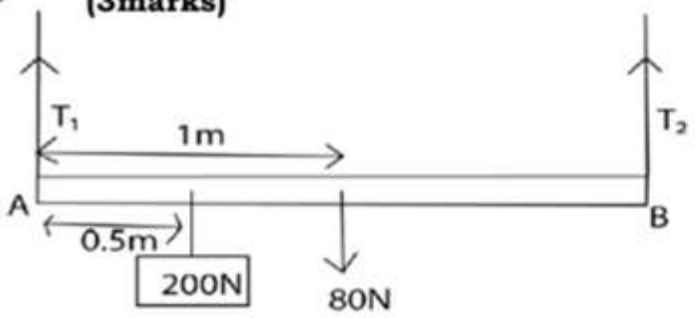
e) Two differences between compound microscopes and telescopes. **(2marks)**

Compound microscope	Astronomical telescope
- View near objects - Objective lens has smaller focal length - In normal adjustment the final image is at near point - Has greater resolving power	- View distant object - Objective lens has longer focal length - In normal adjustment, final image at infinity - Has lower resolving power

17. a) i) A couple of forces is a combination of two forces that are equal in magnitude but opposite in direction (and acting along parallel lines), thus creating the turning effect of a torque or moment. **(1mark)**

ii) Principle of moment: For an object to be in equilibrium (with no movements about a turning point), the sum of anticlockwise moments is equal to the sum of clockwise moments. **(2marks)**

b) **(3marks)**



The sum of moments of initial at A = 0

$0 = 0.5 \times 200 + 1 \times 80 - T_2 \times 2$

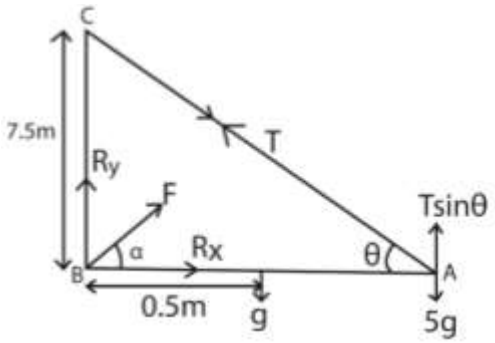
$T_2 = 90\ N$

But $T_1+T_2 = 200+80$

$T_1 + 90 = 280$

$T_1 = 190N$

c. i) A sketch diagram to show the forces acting on the beam. **(2marks)**



ii) Calculate the tension in the rope. **(2 marks)**

Moments At B: $T \times 1\sin\theta = 1.0 \times 0.5 + 5g \times 1$

But $\tan\theta = 36.9^0$

$T = \frac{5.5 \times 9.8}{\sin 36.9} = 89.9N$

iii) Calculate the force exerted by the hinge on the beam? **(3marks)**

Rx = 0.8T = 0.8 x 89.9 = 71.9N

Ry = 6 x 9.81 – 0.6 x 89.9 = 4.9N

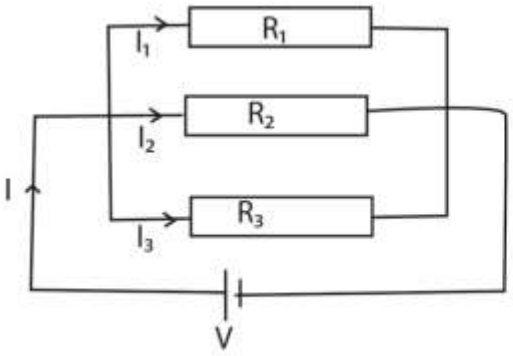
Resultant, R = $\sqrt{R_x^2 + R_y^2} = \sqrt{71.9^2 + 4.9^2}$ = 72.1N

iv)The direction of the force exerted by the hinge on the beam **(2 marks)**

Direction: tan α = $\frac{R_y}{R_x} = \frac{4.9}{71.9}$; α = 3.89^0

18. a) i) A volt is the potential difference between two points if work done to transfer1C of charge from one of the point to the other is 1J **(1mark)**

ii)



(1mark)

The p.d across each resistor is the same and equal to V

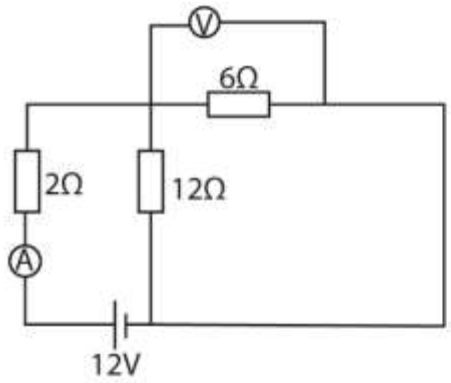
By conservation of current at the junction, I = $I_1 + I_2 + I_3$ **(1mark)**

From Ohm's law: $\frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$ where R is the equivalent resistance in the circuit

Dividing throughout by V

$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ **(2marks)**

iii)



In the circuit above, has negligible internal resistance. Find the ammeter and voltmeter readings (04marks)

Effective resistance R = $2 + \frac{6 \times 12}{6+12} = 6\Omega$ **(1mark)**

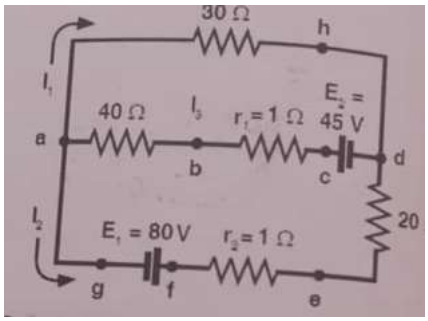
Current through 2Ω resistor = $\frac{V}{R} = \frac{12}{6} = 2A$ **(1mark)**

Hence ammeter reading = 2A **(1mark)**

Effective resistance of 6Ω and 12Ω = $\frac{6 \times 12}{6+12} = 4\Omega$

V = IR = 2 x 4 = 8V **(1mark)**

b) $I_3 = I_1 + I_2$



Using loop rule in loop ahdcba

I3(40+1)30I_1=45

(I_1+I_2)(40+1)+30I1=45

71I_1+41I_2=45 equation (1)

In a loop agfedcba

I3(40+1)+I_2(20+1)=80+45

(I_1+I_2)(40+1)+I_2(20+1)=80+45

41I_1+62I_2=125 equation (2)

Solving equations 1 and2 simultaneously gives

I_1=-0.87A I_2=2.6A I_3=1.7A

19. (a) **(3marks)**

Perfectly elastic collision	**Inelastic collision**	**Perfectly inelastic collision**
After collision, the bodies separate and retake their original shapes	After collision, the bodies separate but don't retake their original shapes (they are deformed)	After collision, the bodies stick together and move as one body with a common velocity
The linear momentum is conserved	The linear momentum is conserved	The linear momentum is conserved
The kinetic energy is conserved	The kinetic energy is not conserved	The kinetic energy is not conserved
The coefficient of restitution is equal to one (e=1)	The coefficient of restitution lies between zero and one (0< e <1)	The coefficient of restitution is equal to one (e = 0)

b) (i) Momentum is defined by $p = mv$. Taking the right as positive, the initial momentum of the ball is

$$p_i = (0.5 \text{ kg})(-15 \text{ m/s}) = -7.5 \text{ kg-m/s}. \quad \textbf{(2 marks)}$$

(ii) The final momentum is

$$p_f = (0.5 \text{ kg})(10.5 \text{ m/s}) = 5.25 \text{ kg-m/s}. \quad \textbf{(2 marks)}$$

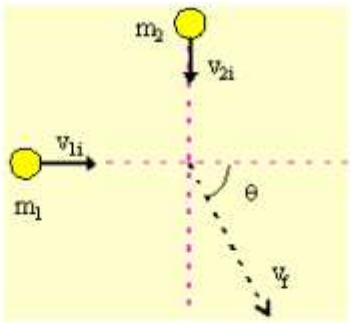
(iii) Impulse is defined as the change in momentum

$$I = p_f - p_i = 12.75 \text{ kg-m/s}. \quad \textbf{(2marks)}$$

(iv) Average force is related to impulse by $I = F_{average}t$, and the wall would exert this force on the ball to the right. Therefore

$$t = I / F_{average} = 12.75 \text{ kg-m/s} / +1000 = 0.013 \text{ s}. \quad \textbf{(2marks)}$$

(c)



In any kind of collision, momentum is conserved so

$$(m_1 + m_2)v_f = m_1v_{1i} + m_2v_{2i}. \quad (1) \qquad \textbf{(1 mark)}$$

Now momentum and velocity are vector quantities and the *i* and *j* components must be handled separately

$$(m_1 + m_2)v_{fx} = m_1v_{1ix} + m_2v_{2ix}, \quad (1a)$$

$$(m_1 + m_2)v_{fy} = m_1v_{1iy} + m_2v_{2iy}. \quad (1b)$$

So we can rearrange these equations to find the components of the final velocity

$$v_{fx} = (m_1v_{1ix} + m_2v_{2ix}) / (m_1 + m_2), \quad (2a)$$

$$v_{fy} = (m_1v_{1iy} + m_2v_{2iy}) / (m_1 + m_2). \quad (2b) \qquad \textbf{(1mark)}$$

Using the given values, we find

$$v_{fx} = [(50\text{ kg})(3\text{ m/s}) + (70\text{ kg})(0)] / (50\text{ kg} + 70\text{kg}) = 1.25\text{ m/s}, \quad (2a)$$

$$v_{fy} = [(50\text{ kg})(0) + (70\text{ kg})(-7\text{ m/s}) / (50\text{ kg} + 70\text{ kg}) = 4.083\text{ m/s}. \quad (2b)$$

To find the magnitude and direction of the final velocity, we use the Pythagorean Theorem and trigonometry,

$$v_f = [(v_{fx})^2 + (v_{fx})^2]^{1/2} = 4.27\text{ m/s, and} \qquad \textbf{(1mark)}$$

$$\theta = \textit{arctan}(|v_{fy}/v_{fx}|) = 72.98°. \qquad \textbf{(1mark)}$$

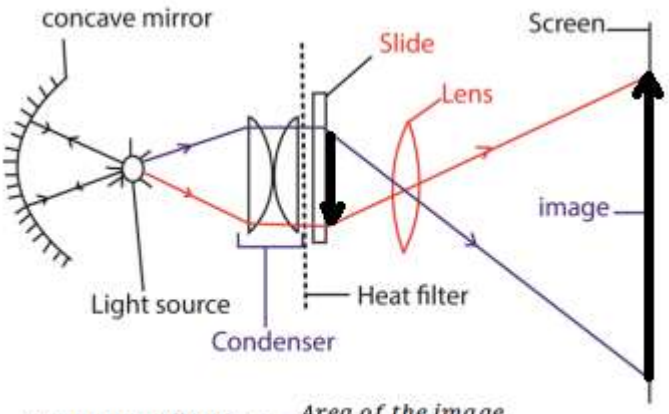
20. a) i) A projector is an instrument used to produce a large image of a small object.

(1mark)

- The slide, or film, is placed behind the projector lens outside its focal length and is illuminated buy a small but powerful source of light from concave reflector through condensing lenses.

(1mark)

- A magnified, real and inverted image on the screen **(1mark)**



Area magnification = $\frac{Area\ of\ the\ image}{Area\ of\ the\ object}$ **(2mark)**

ii) Area magnification = $\frac{Area\ of\ the\ image}{Area\ of\ the\ object} = \frac{2}{8\ x\ 10^{-4}} = 2500$ **(1mark)**

Linear magnification = $\sqrt{2500} = 50$

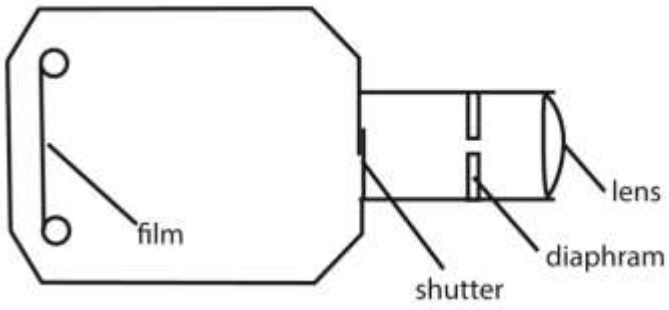
From $M = \frac{v}{f} - 1$

$50 = \frac{5}{f} - 1$

$f = \frac{5}{51} = 0.098m = 9.8cm$ **(2marks)**

b)

i) **Lens camera**



(1mark)

- The lens focused light from the object on to film **(0.5marks)**
- The diaphragm controls the amount of light reaching the film **(0.5marks)**
- The shutter controls the exposure time of light reaching the film**(0.5marks)**

- Film contain photosensitive chemicals and is where the image is stored. **(0.5marks)**

ii) **Correction of chromatic aberration**

- Use lenses made of low-dispersion glasses, especially those containing fluorite **(1mark)**

- By using combination of lenses of opposite nature (convex & concave) or chromatic doublet such that the dispersion produced by one lens is reversed by another. **(1mark)**

- Placing the eye close to the lens such that images due to different colours subtend the same angle at the eye.

Means of reduction of spherical aberration

- Using lenses with an aspheric surface **(1mark)**

- Using lens of small aperture. **(1mark)**

- Using a stopper such that only light incident on the middle of the lens pass, but this method reduces the brightness of the image since it reduces the amount of light energy passing through lens.