MARKING GUIDE 2024

SUBJECT: PHYSICS

S4 PCM, MPG, MPC & PCB)

Section A (70marks)

1) 1-a ,2-c,3-d,4-b,5-e /5marks

2a) Normal adjustment of an astronomical telescope is a condition for which produces a final image which is at infinity. At this condition the eye is relaxed. **(1mark)**

b) Let fo and fe be the —— *focal lengths of the objective and eyepiece respectively*

i)magnification M=fo/fe 120/5=24 (2marks)

ii) the separation = fo+fe=120+24=124cm (2marks

3a) Fossil fuels is non-renewable energy source that began to form millions of years ago from the remains of the living plants and animals.
Renewable energy source can be recycled or replaced at a rate faster than they are consumed. **(2marks)**

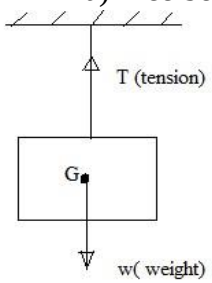
b) Nuclear energy**(1mark)**

c)Solar energy, wind energy, hydroelectric energy, (any one example) **(1mark)**

d)Petroleum, coal and natural gas. (any one example) **(1mark)**

4.Equilibrium of an object suspended

a) Free body diagram of forces



(1mark)

b) An object is in equilibrium if
$\Sigma F_x = 0$, and $\Sigma F_y = o$**(1mark)**
$\Sigma F_y = w - T = o$, or $T = w$**(1mark)**

$T = mg$

$= 1 \times 10 = 10N$ **(1mark)**

5. Let the throwing point be (0,0). Horizontal be x-direction and vertical be y direction.

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To find t we can use the equation $y_f = y_i + u_y t - \frac{1}{2}gt^2$ (vertically)

Or $y_f = y_i + (u\sin\theta)t - \frac{1}{2}gt^2$ **(1mark)**

On the ground $y_f = 0$

$y_i + (u\sin\theta)t - \frac{1}{2}gt^2 = 0$ **(1mark)**

$gt^2 - (2u\sin\theta)t - 2y_i = 0$ or $t = \frac{u\sin\theta \pm \sqrt{u^2\sin^2\theta + 2gy_i)}}{g}$ **(1mark)**

$t = \frac{50\sin 30^0 \pm \sqrt{50^2\sin^2 30^0 + 2(10)(70)}}{10}$ **(1mark)**

$t = 7$ or $t = -2$ (ignored)

The correct value of time is 7sec. **(1mark)**

6. The height $H = 200m$

Mass of the stone $m = 2000kg$

a)At the height $h = \frac{H}{2}$, we have $h = \frac{200}{2} = 100m$

$P.E = mgh = mg\frac{H}{2}$

$= 2000(10)(100) = 2\times10^6 J$ **(1mark)**

$K.E = \frac{1}{2}mv^2 = \frac{1}{2}m\left(\sqrt{2gh}\right)^2$

$= \frac{1}{2}m\left(\sqrt{2g\frac{H}{2}}\right)^2 = \frac{1}{2}m\left(\sqrt{gH}\right)^2$

$= \frac{1}{2}\times2000\left(\sqrt{10\times200}\right)^2 = 2\times10^6 J$ **(1mark)**

b) Total mechanical energy $M.E = K.E + P.E$ **(1mark)**

$= 2\times10^6 J + 2\times10^6 J = 4\times10^6 J$ **(1mark)**

7. a) The work-energy theorem states that the work done on an object is equal to the change in its kinetic energy.**(2marks)**

b) *Mass m=1000kg*

Speed v=16.7m/s

Frictional force F=-8000N

7. a) The work-energy theorem states that the work done on an object is equal to the change in its kinetic energy. **(2marks)** b) *Mass m=1000kg*
Speed v=16.7m/s
Frictional force F=-8000N

The negative sign indicates that this force opposes the motion of the car.

$K.E = \frac{1}{2}mv^2 = \frac{1}{2}(1000)(16.7)^2 = 139445J$ **(1mark)**

Assume the stopping distance is d

$W = F.d = (-8000)d$ **(1mark)**

$\Delta K.E = W$

$K.E_f - K.E_i = (-8000)d$ **(1mark)**

$0J - 139445\,J = (-8000)d$

$d = 17.4m$ **(1mark)**

8. a)A linear momentum of a particle or object is the product of the mass and its velocity.**(1mark)**
b) Momentum formula in terms of kinetic energy(K) and mass (m) is
$P = \sqrt{2mK}$ **(1mark)**
The baseball has greatest magnitudeof momentum since it has a heavy mass.**(1mark)**
c)Momentum $P = mv$ (1)
Kinetic energy $K.E = \frac{1}{2}mv^2$ (2)
Using (1) into (2) we get $K.E = \frac{1}{2m}P^2$
Divide by g both sides $\frac{K.E}{g} = \frac{1}{2mg}P^2$
$\frac{K.E}{g} = \frac{1}{2w}P^2$, $\frac{K.E}{g} = \frac{1}{2w}P^2$ **(1mark)**
$K.E = \frac{g}{2w}P^2$ where $w = mg$ =weight
If the man of weight 700N and woman of 450N have same momentum, the woman has greatest kinetic energy. **(1mark)**

9. a) The principle of conservation of momentum states that whenever two or more particles in an isolated system interact, the total momentum of the system remains constant".**(2marks)**

b)Let m=400kg is the mass of a car

M=4000kg is the mass of the track

$u = 72km/h = 20m/s$ is the initial velocity of the car

$V = 9km/h = 2.5m/s$ Initial velocity of the track

$u' = 18km/h = 5m/s$ =final velocity of the car

V' = final velocity of the track.

Equation of conservation of momentum

$mu + MV = mu' + MV'$ or $V' = \dfrac{mu + MV - mu'}{M}$ **(2marks)**

$V' = \dfrac{(400)(20) + (4000)(2.5) - (400)(-5)}{4000} = 5m/s = 18km/h$ **(2marks)**

10. Electromotive force $E = I(R + r)$

The electric current

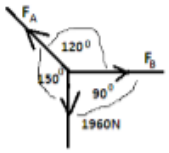
$I = \dfrac{E}{(R + r)} = \dfrac{8.5}{(81 + 0.9)} = 0.104A$ **(1mark)**

$E = IR + Ir$

$E = V + Ir$ **(1mark)**

The terminal voltage $V = E - Ir = 8.5 - (0.104)(0.9) = 8.406V$ **(2marks)**

11. Force diagram



(2marks)

Using Lami's formula

$\dfrac{F_A}{\sin 90^0} = \dfrac{1960}{\sin 120^0} = \dfrac{F_B}{\sin 150^0}$ **(1mark)**

Then

$\dfrac{F_A}{\sin 90^0} = \dfrac{1960}{\sin 120^0}$ **(1mark)**

$F_A = \dfrac{1960}{\sin 120^0} = 2263N$ **(1mark)**

And also $\dfrac{1960}{\sin 120^0} = \dfrac{F_B}{\sin 150^0}$

$F_B = 1131.6N$ **(1mark)**

a) The lami's theorem state that if three forces acting at a point are in equilibrium then each of the force is directly proportional to the sine of the angle between the remaining two forces/2marks

$T_B = 1151.8N$ **(1mark)**

12. (a) Energy degradation is the process by which energy is transformed into forms that are less available for doing work. **(2marks)**

b)i) Wasted energy =2000 joules-600 joules=1400joules**(2marks)**

ii)Efficiency $E = \frac{Useful\ energy}{In\ put\ energy} = \frac{600}{2000} = 30\%$ **(2marks)**

13. Let V be a common velocity

By law of conservation of linear momentum

$m_A u_A + m_B u_B = (m_A + m_B)V$ **(1mark)**

$(0.01)u_A + (5\times 0) = (0.01+5)V$ **(1mark)**

$V = \frac{u_A}{501}$ (1)**(1mark)**

Equation defining conservation of kinetic energy

Kinetic energy of combined mass =potential energy at the highest point

(1mark)

$\frac{1}{2}(m_A + m_B)V^2 = (m_1 + m_2)gh$

$\frac{1}{2}V^2 = gh$

$\frac{1}{2}V^2 = 10\times 0.05$ (2)**(1mark)**

Using (1) in (2) we get $v_A = 501 m/\sec$ **(1mark)**

14. a) Moment of force is the product of a force and the lever arm, where the lever arm is the perpendicular distance from the axis to the line of application of the force.**(1mark)**

b)Using the conditions of equilibrium

$\sum \vec{F_y} = 0$, $X + Y - 3 = 0$ **(0.5mark)**

Or $X + Y = 3$ (1)

$\sum \vec{\tau}_{ext} = 0$ (about the fixed point)

Taking the fixed point A

$X(AB) - 3(AG) + Y(AB) = 0$ **(0.5mark)**

$0 - 3(0.4) + Y(0.6) = 0$ (2)

$Y(0.6) = 3(0.4)$ $Y = 2N$ **(1mark)**

Eq (1) becomes $X + 2 = 3$

Where $X = 1N$ **(1mark)**

Section B (30 marks)

15.a) Any one difference

Compound microscope	Astronomical telescope
In normal adjustment, the final image is at near point. **(1mark)**	The final image is at infinity**(1mark)**
The objective lens has a short focal length.	The objective has a long focal length.
The object is near (it is used to view near and small objects)	The object is at infinity (used to see distant objects).

b) i)If the final image is at infinity, the objective forms an intermediate image at the focalpoint of the eye piece.**(1mark)**
Let f_e be the focal length of the eye piece and f_o of the objective
The position of an intermediate image V_o = separation – focal length of eye piece **(1mark)**
= (22.1 – 2.50) cm**(1mark)**
v_o= 19.5cm.

The position of the intermediate image is at 19.5cm.**(1mark)**

ii)Magnification

$$M_\infty = \left(\frac{v_o}{f_0} - 1\right)\frac{D}{f_e}$$ **(1mark)**

$$M_\infty = \left(\frac{19.5}{1.6} - 1\right)\frac{25}{2.5} = 111.8$$ **(1mark)**

c)Uses of a compound microscope

-It is used in pathology labs so as to identify diseases.**(1mark)**

- It is used in biology labs so as to identify the plant cells and microorganisms

(1mark)

16. a)Conditions of equilibrium:

*-The resultant external force acting on a body must be equal zero.***(1mark)**

*-The resultant external torque about any axis must be zero (The sum of clockwise moments about any point equals the sum of the anticlockwise moments about the same point)***(1mark)**

b)Using the conditions of equilibrium

$\sum \vec{F}_y = 0 \quad , \quad F_A - 1500\,g - 15000\,g + F_B = 0$ **(2marks)**

Or $F_A - 1500 \times 10 - 15000 \times 10 + F_B = 0$

Or $F_A + F_B = 165000 \quad (1)$**(1mark)**

$\sum \vec{\tau}_{ext} = 0$ (about the fixed point)

Taking the fixed point P

$F_A(0) - 1500\,g(10) - 15000\,g(15) + F_B(20) = 0$ **(2marks)**

Or $0 - 1500(10)(10) - 15000(10)(15) + F_B(20) = 0$

Taking the fixed point P

$F_A(0) - 1500\,g(10) - 15000\,g(15) + F_B(20) = 0$ **(2marks)**

Or $0 - 1500(10)(10) - 15000(10)(15) + F_B(20) = 0$

$F_B = 120000\,N$ **(1mark)**

Eq (1) becomes $F_A + 120000 = 165000$ **(1mark)**

Where $F_A = 45000\,N$ **(1mark)**

17. (a)A Biogas plant is an airtight tank in which organic wastes mixed with water can be digested/ fermented through anaerobic bacteria action. **(1mark)**

b) Advantages and disadvantages of using biogas energy

Advantages

- Biogas does not contribute to the atmospheric pollution, less air pollution**(1mark)**
- Available source; it replaces the deforestation (wood energy) **(1mark)**
- Production of fertilizers It is not expensive It is renewable.
- The biogas is a type of fuels which can be burnt to produce heat energy for cooking and other uses.

Disadvantages:

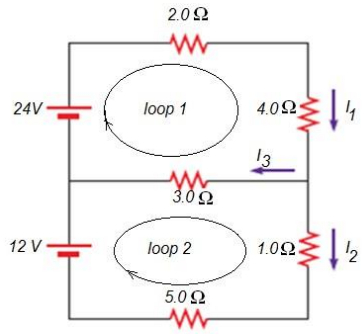
-when it is not well installed it can cause many problems (breathing diseases) because of gas rejected. **(1mark)**
-It causes air pollution**(1mark)**

(c)The environmental problems associated with the recovery of fossil fuels and their use in power stations
-Pollution (i.e. carbon dioxide, acid rain, smog, heavy metals, volatile organic compounds, radioactive material) **(1mark)**
-Carbon monoxide released from power plants is capable of poisoning people (hemoglobin cells begin reacting with carbon monoxide instead of oxygen**(1mark)**
-Coal mining causes release of flammable gases, there is a risk of collapse and underground fires, gases are a threat to the lungs of miners**(1mark)**
-Crude oil and gas retrieval can lead to explosions, oil spills and leakages that pollute the environment and harm life. **(1mark)**

18. (a)Kirchhoff's rules state that:

1. The sum of the currents entering any junction must equal the sum of the currents leaving that junction. (This rule is often referred to as the junction rule.) **(1mark)**

2. The sum of the potential differences across all the elements around any closed-circuit loop must be zero. (This rule is usually called the loop rule.) **(1mark)** b)



(2marks)

Current rule

$I_1 = I_2 + I_3$ (1)**(1mark)**

From the loop 1

$24 - 2I_1 - 4I_1 - 3I_3 = 0$

$6I_1 + 3I_3 = 24$ (2)**(1mark)**

From the loop 2

$12 + 3I_3 - I_2 - 5I_2 = 0$

$3I_3 - 6I_2 = -12$ (3)**(1mark)**

Solving Eq. (1), (2) and (3) simultaneously we get

$I_1 = 3.5A$, **(1mark)**

$I_2 = 2.5A$ **(1mark)**and

$I_3 = 1A$ **(1mark)**

19. Equation of motion on the hoop

$y_f = y_i + (u\sin\theta)t - \frac{1}{2}gt^2$ (vertically) **(1mark)**

$3.05 = 2 + (u\sin 40^0)t - \frac{1}{2}(10)t^2 \Rightarrow (5)t^2 - (u\sin 40^0)t + 1.05 = 0$ (1)**(2marks)**

Equation of the horizontal motion

$x = u(\cos 40^0)t$ **(1mark)**

$t = \frac{x}{u(\cos 40^0)} = \frac{10}{u(\cos 40^0)}$ (2) **(1mark)**

Using (2) into (1)**(4mark)**

We get $u = 10.72m/s$ **(1mark)**