REPUBLIC OF RWANDA

EASTRERN PROVINCE

RWAMAGANA DISTRICT

ADVENCED LEVEL DISTRICT COMPREHENSIVE

ASSESSMENT FOR THE SECOND TERM,2023-2024.

SUBJECT: PHYSICS LEVEL: SENIOR FOUR (S4)

MARKING GUIDE

COMBINATIONS:

PHYSICS-CHEMISTRY-MATHEMATICS (PCM)

MATHEMATICS- PHYSICS- COMPUTER SCIENCE (MPC)

PHYSICS –CHEMISTRY- BIOLOGY (PCB)

MATHEMATICS –PHYSICS- GEOGRAPHY (MPG)

ASSOCIATED NURSING PROGRAM (ANP)

INSTRUCTIONS:

1) Do not open this question paper until you are told to do so.

2) This paper consists of TWO sections: **A** and **B**

SECTION A: Attempt all questions **(70marks)**

SECTION B: Attempt any three questions **(30marks)**

3) Use only a blue or black pen**.**

SECTION A: Attempt all questions **(70marks)**

Qn1. Most generators have a wired loop or coil that is rotated in a magnetic field to produce a current, this is called **electromagnetic induction**. **(2marks)**

Qn2. (a) The power of the lens is

$$P = \frac{1}{f} = \frac{1}{0.205m} = 4.88D \qquad (\boldsymbol{2marks})$$

(b)We find the focal length of the lens from

$$P = \frac{1}{f};$$

$-6.25D = \frac{1}{f}$ which gives $f = -0.160m = -16.0cm$ **(2marks)**

(c) For (a) The lens was Converging **(1mark)** and for **(b)** the lens was diverging **(1mark)**

Qn3. spherical aberration occurs when a lens can't focus a single color of light, so in spherical aberration, rays of light from a point on the optical axis of a spherical lens do not all meet at the same image point **(1mark).** while **chromatic aberration** occurs when a lens can't focus the various colors (wavelengths) at a single point so, the failure of a lens to focus all colours in the same plane is known as chromatic aberration. **(1mark)**

Qn4. (a) True **(1mark)**

(b) True **(1mark)**

(c) False (**1mark)**

Qn5. Sun for solar energy **(1mark)**

Water falls for hydroelectric power **(1mark)**

Coal **(1mark)**

Methane gas **(1mark)**

Biomass

Biogas

Etc

Qn6. a. **Energy degradation** is the process by which energy becomes less available for doing work. **(1mark)**

(b) Electric energy is transformed into heat **(1mark)** and light **(1mark)**

Qn7. (a) Angular Velocity: The speed at which the angular location of a rotating body changes is known as angular velocity. The angular velocity of a particle is along the axis of a circle when an object moves in a circular motion. The angular velocity does not change**.** **(1mark)** While

Linear velocity: When an object moves along a straight route, linear velocity is defined as the rate of change of displacement with respect to time. A particle's linear velocity is along the circumference of a circle when an object moves in a circular motion. **(1mark)**

(b) $\theta = 5 + 4t - t^2$, R= 0.05m

(i) since $\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$ or $\omega = \frac{d\theta}{dt} = 4 - 2t$ at t=2, $\omega = 0$ rad/s **(1mark)**

(ii) α =-2 rad/s^2 **(1mark)**

(iii) a = r^2 ω (**½mark**) at t=0, a = (0.05)^2×4 = 0.01 m/s^2 (**½mark**)

(iv) v = r ω (**½mark**) at t=0, v = 0.05x4 = 0.2m/s (**½mark**)

Qn8. (a) The equivalent resistance is found by combining the 820Ω and 680Ω resistors in parallel, and then adding the 470Ω resistor in series with that parallel combination.

$$R_{eq} = \left(\frac{1}{820\,\Omega} + \frac{1}{680\,\Omega}\right)^{-1} + 470\,\Omega = 372\,\Omega + 470\,\Omega = 842\,\Omega \approx \boxed{840\,\Omega}$$ **(2marks)**

(b) The current delivered by the battery is

$$I = \frac{V}{R_{eq}} = \frac{12.0\,\text{V}}{842\,\Omega} = 1.425\times10^{-2}\,\text{A}.$$ **(1mark)**

This is the current in the 470Ω resistor. The voltage across that resistor can be found by Ohm's law.

$$V_{470} = IR = (1.425\times10^{-2}\,\text{A})(470\,\Omega) = \boxed{6.7\,\text{V}}$$ **(1mark)**

Thus, the voltage across the parallel combination must be 12.0V – 6.7V= 5.3V. **(1mark)**

This is the voltage across both the 820 Ω and 680Ω resistors, since parallel resistors have the same voltage across them.

Note that this voltage value could also be found as follows.

$$V_{\text{parallel}} = IR_{\text{parallel}} = (1.425\times10^{-2}\,\text{A})(372\,\Omega) = 5.3\,\text{V}$$

Qn9.

For the refraction at the first surface, we have

$n_{air}\sin\theta_1 = n\sin\theta_2$;

$(1.00)\sin 45.0° = (1.58)\sin\theta_2$, which gives $\theta_2 = 26.6°$.

We find the angle of incidence at the second surface from

$(90° - \theta_2) + (90° - \theta_3) + A = 180°$, which gives

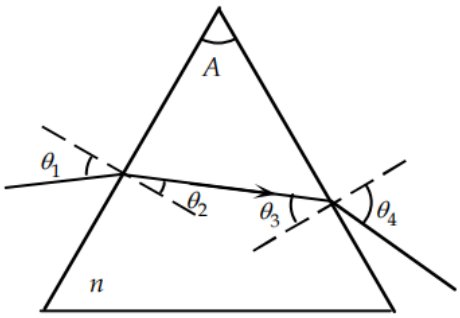
$\theta_3 = A - \theta_2 = 60° - 26.6° = 33.4°$.

For the refraction at the second surface, we have

$n\sin\theta_3 = n_{air}\sin\theta_4$;

$(1.58)\sin 33.4° = (1.00)\sin\theta_4$, which gives

$\theta_4 = \boxed{60.4° \text{ from the normal.}}$



(4marks)

Qn10. (a) The table below shows the differences between a compound microscope and an astronomical telescope. **(2marks)**

Compound microscope	**Astronomical telescope**
In normal adjustment, the final image is at near point.	The final image is at infinity
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).
The distance between the objective lens and eye piece is greater than $f_o + f_e$.	Distance between the objective and the eye piece is $f_o + f_e$.

(a) (i) The total magnification is

$M = M_o M_e = (59.0)(12.0) = \boxed{708\times.}$ **(2marks)**

(ii) With the final image at infinity, we find the focal length of the eyepiece from

$$M_e = \frac{N}{f_e};$$

$$12.0 = \frac{(25.0\,\text{cm})}{f_e}, \text{ which gives } f_e = \boxed{2.08\,\text{cm.}}$$

Because the image from the objective is at the focal point of the eyepiece, the image distance for the objective is

$$d_i = l - f_e = 20.0\,\text{cm} - 2.08\,\text{cm} = 17.9\,\text{cm.}$$

We find the object distance from the magnification:

$$M_o = \frac{d_i}{d_o};$$

$$59.0 = \frac{(17.9\,\text{cm})}{d_o}, \text{ which gives } d_o = 0.303\,\text{cm.}$$

We find the focal length of the objective from the lens equation:

$$\left(\frac{1}{d_o}\right) + \left(\frac{1}{d_i}\right) = \frac{1}{f_o};$$

$$\left(\frac{1}{0.289\,\text{cm}}\right) + \left(\frac{1}{17.9\,\text{cm}}\right) = \frac{1}{f_o}, \text{ which gives } f_o = \boxed{0.298\,\text{cm.}}$$

(2marks)

(ii) We find the object distance from the magnification:

$$M_o = \frac{d_i}{d_o};$$

$$59.0 = \frac{(17.9\,\text{cm})}{d_o}, \text{ which gives } d_o = 0.303\,\text{cm.}$$

(2marks)

Qn11. (a) – Stable equilibrium (1*mark*) When object in stable equilibrium is moved, it has a tendency to fall back to its original position. **(1*mark*)**

–**Unstable (1*mark*)** When such object is moved, it cannot return to its original position without some exertion of energy. **(1*mark*)**
–**Neutral** (**1*mark***) an object is said to be in neutral equilibrium if it moves to a new position when it is disturbed. Let us consider a cone to understand these states **(1*mark*)**
(***b***) For an object to be in static equilibrium, it must be experiencing no acceleration. This means that **(1)** The net force exert on the object in all directions must be zero **(1mark)**
Or $\sum F_{ext} = 0$ it implies that $\sum F_x = 0$ and $\sum F_y = 0$
(2) The net torque on the object in all directions must be zero**. (1mark)**
Or $\sum \tau_{ext} = 0$ it implies that $\sum \tau_x = 0$ and $\sum \tau_y = 0$

Qn12. i) projector **(1mark)**

ii) magnified **(1 mark)**

Qn13. The sign of f determines whether the lens is converging or diverging. 16.0 cm s = . 36.0 cm s′ = +. Use

$m = -\frac{s'}{s}$ to find the size and orientation of the image.

(a) $f = \frac{ss'}{s+s'} = \frac{(16.0\text{ cm})(36.0\text{ cm})}{16.0\text{ cm}+36.0\text{ cm}} = 11.1\text{ cm}$. $f > 0$ and the lens is converging.

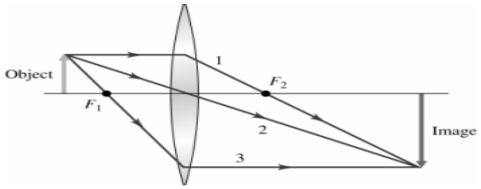
(3marks)

(b) The image height is calculated as;

$m = -\frac{s'}{s} = -\frac{36.0\text{ cm}}{16.0\text{ cm}} = -2.25$. $|y'| = |m|y = (2.25)(8.00\text{ mm}) = 18.0\text{ mm}$. $m < 0$ so the image is inverted.

(3marks)

(c) The principal-ray diagram is sketched in Figure below;



(2marks)

Qn14. (a) Algebraic sum of all currents entering and leaving the junction/node of an electric circuit is zero. **(1mark)**

(b) The algebraic sum of all potential differences and electromotive forces in a loop (closed path) of electrical network is zero. **(1mark)**

(c) Kirchhoff's voltage law or loop rule **(1mark)**

(d) Kirchhoff's current law or junction/node rule **(1mark)**

Qn15. (a) (i) work energy theorem states that the net work done on an object is equal to its change in kinetic energy". **(1mark)**

(ii) Let point 1 be just before the box reaches the end of the spring and let point 2 be where the spring has maximum compression and the box has momentarily come to rest.

$W_{tot} = K_2 - K_1$

$K_1 = \frac{1}{2}mv_0^2$, $K_2 = 0$

Work is done by the spring force. $W_{tot} = -\frac{1}{2}kx_2^2$, where x_2 is the amount the spring is compressed.

$-\frac{1}{2}kx_2^2 = -\frac{1}{2}mv_0^2$ and $x_2 = v_0\sqrt{m/k} = (3.0\text{ m/s})\sqrt{(6.0\text{ kg})/(7500\text{ N/m})} = 8.5\text{ cm}$

(2marks)

(b) The difference between elastic and inelastic collisions is

- **Elastic collisions** involve the conservation of both momentum and kinetic energy (**$\frac{1}{2}$ *mark***) while **inelastic collisions** conserve only momentum. (**$\frac{1}{2}$ *mark***)
- In an elastic collision, objects rebound after impact, whereas objects may stick together or deform in an inelastic collision.
- In an inelastic collision, kinetic energy is not conserved, and will change forms into sound, heat, radiation, or some other form.
- In an elastic collision, kinetic energy is conserved and does not change forms

(b) Given that;

Mass of bullet, $m_1 = 20g$ its initial velocity, $\boldsymbol{u_1 = 200m/s}$

Mass of wooden block, $m_2 = 380g$ its initial velocity $\boldsymbol{u_2 = 0m/s}$

So, the momentum is conserved

$m_1u_1 + m_2u_2 = V(m_1 + m_2)$ **(1mark)**

$V = \frac{m_1u_1+m_2u_2}{m_1+m_2} = \frac{(20g\times 200\ m/s)+(380g\times 0\ m/s)}{20g+380g} = \frac{4000\ g\ m/s}{400g} = 10m/s$ **(1mark)**

SECTION B: ATTEMPT ANY THREE QUESTIONS (45MARKS)

Qn16.Introduction (1mark)

Development of the topic (main body)

List of at least 4 the different strategies of reducing global warning **(1mark each fact $1 \times 4 = 4$*marks*)**

Explanation given to each fact **(1 mark each fact $1 \times 4 = 4$*marks*)**

<u>Example</u>

Global warming is the persistent increase in temperature of the earth's surface (both land and water) as well as its atmosphere**. (1mark)**

The following are some strategies of reducing Global warming to support my point view main body

ANY 4 STRATEGIES+EXPLANATIONS (8marks)

1. Replacing coal and oil with natural gas
2. Use of renewable energy sources and nuclear power

3. Carbon dioxide capture and storage
4. Use of hybrid vehicles
5. Discouraging deforestation (stop cutting the tree)
6. Plant more trees 9afforestation)
7. Phasing out fossil fuels
8. High efficiency during power production
9. Combined heating and power systems

Global warming is damaging the earth's climates as well as the physical environment. One of the most visible effects of global warming can be seen in the Arctic region where glaciers, permafrost and sea ice are melting rapidly.

Global warming is harming the environment in several ways. Global warming has led to: desertification, increased melting of snow and ice, sea level rise, stronger hurricanes and cyclones it better to reach people though the community, school, the work place, public officials and the press(media), home, college and universities, professionals' different strategies of reducing global warming. **(1mark)**

Qn17. (a) (i) The emf of a cell is the energy provided by a cell or battery per unit electric charge passing through it. **(1mark)**

Or

The emf is the potential difference across the terminal of the cell when no current is flowing.

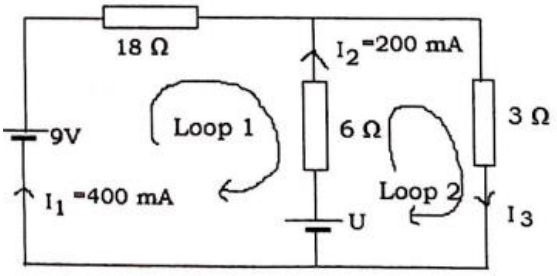
(ii)**Internal resistance of a cell** is refers to the opposition to the flow of current offered by the cells and batteries themselves resulting in the generation of heat. Internal resistance is measured in Ohms**. (1mark)**

(b)(i) The current through the circuit $I = \frac{E}{R+r} = \frac{1.52}{2.55+0.45} A = 0.51A$ **(1mark)**

The terminal potential difference$U = E - Ir = 1.52V - 0.45 \times 0.51V = 1.29V$ **(1mark)**

(ii) The power, $P = RI^2 = 2.55 \times (0.51)^2 W = 0.66W$ **(formula + correct answer 2marks)**

(c) The electrical circuit was given as;



(d) Applying junction rule;

$$I_3 = I_1 + I_2$$

$I_3 = 400mA + 200mA = 600mA$ **(2marks)**

(e) Loop2 gives us $U = 6 \times 0.2V + 3 \times 0.6 = 3V$ **(2marks)**

Or loop 1 gives us: $9 - 0.4 \times 18 + 0.2 \times 6 - U = 0$

$$U = 3V$$

Qn18. Given that projection angle is $\theta = 30^0$

Initial velocity, $u = 25m/s$

(a) The horizontal component $u_x = ucos\theta = 25cos30^0 = 21.65m/s$ **(1mark)**

vertical component $u_y = usin\theta = 25sin30^0 = 12.5m/s$ **(1mark)**

(b) At time $t = 3seconds$

Horizontal component $u_x = ucos\theta = 25cos30^0 = 21.65m/s$ **(1mark)**

Note: horizontal component of velocity is independent of time.

vertical component $u_y = usin\theta - gt = 25sin30^0 - 10 \times 3 = 7.5m/s$ **(1mark)**

(c) Displacement component at $t = 5s$

Horizontal displacement; $x = ucos\theta\ t = 25cos30^0 \times 5 = 108.25m$ **(1mark)**

Vertical displacement; $y = usin\theta t - \frac{1}{2}gt^2 = 25sin30 \quad \times 5 - \frac{1}{2} \times 10 \times 5^2 = -62.5m$ **(1mark)**

The negative sign means that the body moves down below the initial level of projection

(d)The maximum height attained, $h = \frac{u^2sin^2\theta}{2g} = \frac{25^2sin^230^0}{2\times10} = 7.81m$ **(formula+ correct answer 1mark)**

(e) The time of flight, $T = \frac{2usin\theta}{g} = \frac{2\times25sin30^0}{10} = 2.5s$ **(formula+ correct answer 1mark)**

(f) The time to reach the maximum height, $t = \frac{1}{2}T = 0.5 \times 2.5 = 1.25s$ **(1mark)**

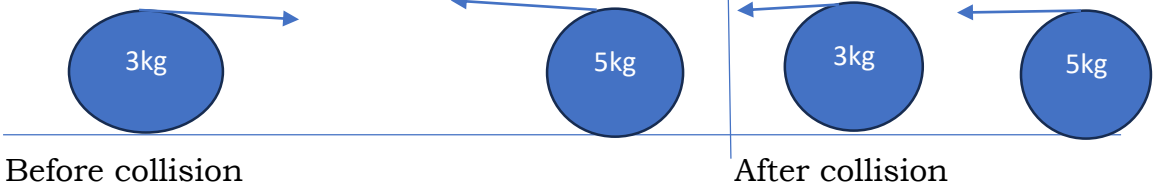
(g) Horizontal range, $R = \frac{u^2 sin2\theta}{g} = \frac{25^0 sin2(30)^0}{10} = 54.13m$ **(formula+ correct answer 1mark)**

Qn19. (a)Momentum is defined as the product of the mass of an object and its velocity. It is a vector quantity and its SI unit is kg m/s **(1mark)**

(b) From Newton's second law of motion. $f = m\,.\,a$ **(1/2 mark)** but $a = \frac{V_f - V_o}{\Delta t}$ **(1/2 mark)** then we can write that $f = m\frac{V_f - V_o}{\Delta t}$ and $f\Delta t = m(V_f - V_o)$ where $f\Delta t = I$ (Impulse) **(1/2 mark)**

$m(V_f - V_o) = \Delta p$ (change in momentum) (**1/2 mark)**

(c)



Before collision After collision

Given that: $m_1 = 3kg$ $u_1 = 6m/s$ and $V_1 = ?$

$m_2 = 5kg$ $u_2 = 5m/s$ and $V_2 = 1m/s$

From conservation of momentum, $m_1u_1 + m_2u_2 = m_1V_1 + m_2V_2$

Since momentum is a vector quantity, we have to take into account the directions of velocity given.

Considering all velocities to the right to be positive

$(3 \times 6) + (5 \times (-5)) = 3 \times (-V1) + 5 \times (-1)$ then, $V1 = \frac{2}{3}m/s$ **(formula+ correct answer 1mark)**

(***ii***) Kinetic energy before collision= $\frac{1}{2}m_1{u_1}^2 + \frac{1}{2}m_2{u_2}^2 = \frac{1}{2} \times 3 \times 6^2 + \frac{1}{2} \times 5 \times 5^2 = 116.5\,J$ **(1mark)**

Kinatic energy after collision= $\frac{1}{2}m_1{V_1}^2 + \frac{1}{2}m_2{V_2}^2 = \frac{1}{2} \times 3 \times (\frac{2}{3})^2 + \frac{1}{2} \times 5 \times (-1)^2 = 3.2\,\boldsymbol{J}$ **(1mark)**

Loss in energy = kinetic energy before collision – kinetic energy after collision **(1mark)**

$Loss$ in energy $= 116.5J - 3.2J = 113.3J$ **(1mark)**

(***iii***) **Coefficient of restitution**= $\frac{V_1 - V_2}{u_2 - u_1} = \frac{\frac{2}{3} - 1}{5 - 6} = \frac{1}{3}$**(formula+ correct answer 1mark)**

(d) If the resultant force acting on a body of constant mass is zero, the body's momentum is;

(d) constant (1mark)

Qn20. (a) (i) Renewable energy comes from the natural resources that can be replenished during an average human lifetime **(1mark)** while the fossil fuel can take thousands or even millions of years to replenish**. (1mark)**

(ii) Uranium **(2marks)** or others related to nuclear power plant

(iii) Solar energy **(1mark),** Geothermal energy **,** hydropower, power from ocean, wind energy, biomass etc.

(iv)Natural gas **(1mark),** Oil/ petroleum products **(1mark),** Coal

(b) Advantages of using solar cell

-The installation is not expensive **(1mark)**

-no pollution of atmosphere, etc **(1mark)**

(C) Causes of global warming are listed below:

- **The burning of fossil fuels,** which release greenhouse gases into the atmosphere. **(1mark)**
- **The reduction of ice**/snow cover due to global warming, which reduces albedo and increases the rate of heat absorption.
- **Reductions in the solubility of carbon dioxide in the sea due to increases in temperature**, which increase atmospheric carbon dioxide concentrations.
- **Deforestation** reduces carbon fixation by plans, which in turn increases carbon dioxide concentrations. Etc

.....END.....