

**MUHANGA DISTRICT**

**PHYSICS EXAMINATION/100marks**

**Class: S4 All science combinations**

**Name of student:.....**

**Instruction: Attempt all questions in section A**

**Attempt any three questions in section B**

**SECTION A: ATTEMPT ALL QUESTIONS/55MARKS**

- a) A transparent medium bound by one or two curved surfaces
- b) An opaque object that reflects light
- c) A device that only produces virtual images
- d) A curved mirror made of glass

2. Which type of lens is thicker at the centre than at the edges?

- a) Concave lens
- b) Diverging lens
- c) Convex lens
- d) Meniscus lens

3. What is the principal focus of a convex lens?

- a) The point from which rays appear to diverge
- b) The point to which all parallel rays converge after refraction
- c) The centre of the lens
- d) The point where the lens is thickest

4. The near point of a normal human eye is approximately:

- a) 10 cm
- b) 15 cm
- c) 25 cm
- d) 50 cm

5. The far point of a normal human eye is:

- a) 25 cm
- b) 1 m

c) 5 m

d) Infinity

6. A body is in equilibrium when:

a) Net force is zero only

b) Net torque is zero only

c) Both net force and net torque are zero

d) Velocity is zero

7. An object is in stable equilibrium if:

a) Its centre of gravity is above the base of support

b) When displaced, it returns to its original position

c) When displaced, it moves further away

d) It remains in any position

8. Lam's theorem applies to:

a) Two forces in equilibrium

b) Three concurrent forces in equilibrium

c) Parallel forces

d) Non-co-planar forces

9. A machine does 600 J of work in 30 seconds. Its power is:

a) 20 W

b) 180 W

c) 600 W

d) 18000 W

10. An object of mass 2 kg moving at 4 m/s collides with a stationary object of mass 2 kg and they stick together. The common velocity after collision is:

a) 0 m/s

b) 2 m/s

c) 4 m/s

d) 8 m/s

11. Three resistors  $2\ \Omega$ ,  $3\ \Omega$ , and  $6\ \Omega$  are connected in parallel. The equivalent resistance is:

a)  $11\ \Omega$

b)  $1\ \Omega$

c)  $36\ \Omega$

d)  $0.5\ \Omega$

12. Kirchhoff's junction rule is based on the conservation of:

- a) Energy
- b) Charge
- c) Momentum
- d) Power

13. Kirchhoff's loop rule is based on the conservation of:

- a) Charge
- b) Mass
- c) Energy
- d) Current

14. A cell of emf 1.5 V and internal resistance  $0.5 \Omega$  is connected to a  $2.5 \Omega$  resistor.

The current in the circuit is:

- a) 0.3 A
- b) 0.5 A
- c) 1.0 A
- d) 1.5 A

15. Rwanda's main fossil fuel resource is:

- a) Coal
- b) Petroleum
- c) Methane gas from Lake Kivu
- d) Natural gas

16. Geothermal energy originates from:

- a) The sun
- b) The moon
- c) Heat within the earth
- d) Wind

17. The main advantage of renewable energy sources over non-renewable sources is:

- a) They are cheaper
- b) They are more efficient
- c) They are environmentally friendly and sustainable
- d) They produce more energy

18. A Sankey diagram is used to show:

- a) Electrical circuits
- b) Energy flow and transformations

c) Forces on a body

d) Motion of projectiles

19. A projectile is launched at an angle of  $30^\circ$  with initial velocity 20 m/s. The horizontal component of velocity is:

a) 10 m/s

b) 17.3 m/s

c) 20 m/s

d) 11.5 m/s

20. An object moves in a circle of radius 2 m with constant speed 4 m/s. Its centripetal acceleration is:

a)  $2 \text{ m/s}^2$

b)  $4 \text{ m/s}^2$

c)  $8 \text{ m/s}^2$

d) 16

$\text{m/s}^2$

21. Match the following from column A to column B /7marks

Column A	Column B
Solar energy	a. Uses turbines to convert kinetic energy of moving water into electricity
Hydroelectric power	b. Energy from organic materials like wood, crops, and animal wastes
Geothermal energy	c. Converts sunlight directly into electricity using photo-voltaic cells
Wind energy	Harnesses heat from radioactive decay within the Earth
Biomass energy	e. Uses air currents to rotate turbines for electricity generation
Tidal energy	Breaking of nuclear bomb

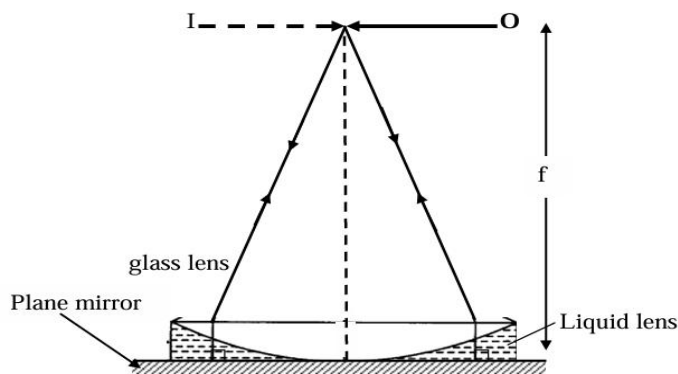
Nuclear energy

g. Energy from ocean waves and tides

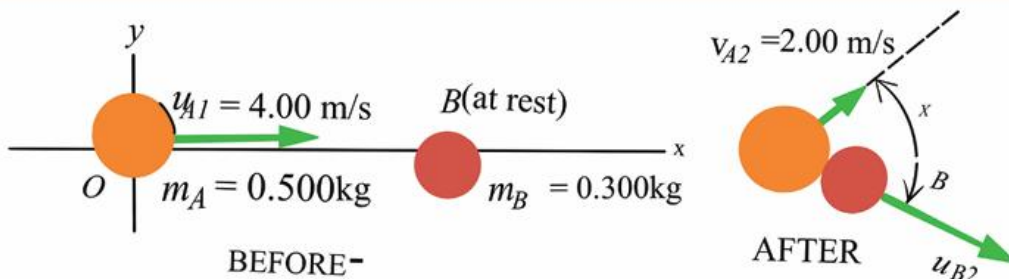
22. A ball is thrown from the top of a building 45 m high with an initial velocity of 20 m/s at an angle of  $30^\circ$  above the horizontal.

- (a) How long does it take for the ball to reach the ground? (2 mark)
- (b) Calculate the horizontal distance from the base of the building where the ball strikes the ground. (2 mark)
- (c) Determine the magnitude and direction of the ball's velocity just before impact. (2mark)

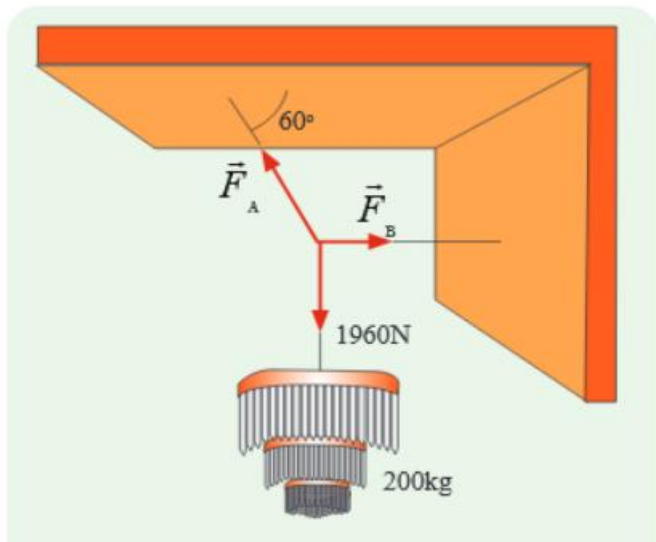
23. The curved face of a plano convex lens ( $n = 1.5$ ) is placed in contact with a plane mirror (fig. Below). An object at 10cm distance coincides with the image produced by the lens and reflection by the mirror. A flame of liquid is now placed between the lens and mirror and the coincident object and image are at 100cm distance. What is the refractive index of the liquid? /4marks



24. The figure shows an elastic collision of two pucks on a friction air hockey table. Puck A has mass  $m_A = 0.500\text{kg}$  and B has mass  $m_B = 0.300\text{kg}$ . Puck A has an initial velocity 4.00m/s in the positive direction and a final velocity of 2.00m/s in unknown direction. Puck B is initially at rest. Find the final velocity  $V_{B2}$  of puck B and the angle  $\alpha$  in the figure. /4marks

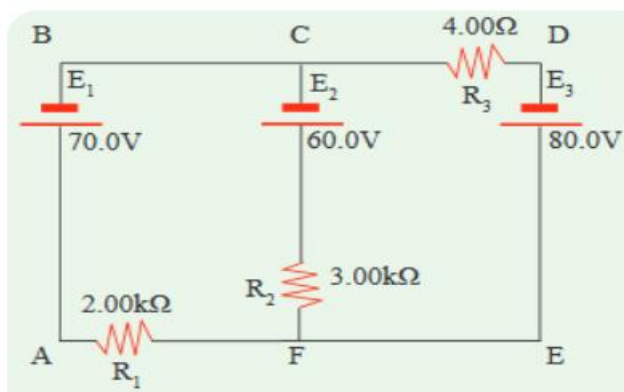


25. Calculate the magnitudes  $F_A$  and  $F_B$  of the tensions in the two cords that are connected to the vertical cord supporting the 200kg chandelier in the figure. /4marks



26. Using Kirchhoff's rules, /8marks

- (a) find the current in each resistor in the figure bellow.  
 (b) Find the potential difference between points C and F. Which point is at the higher potential?



**SECTION B: ATTEMPT ANY THREE QUESTIONS/45marks**

27. A rocket launches a satellite into circular orbit at 500 km altitude. The satellite mass is 2000 kg. Earth's radius is 6370 km, mass is  $5.98 \times 10^{24}$  kg, and  $G = 6.67 \times 10^{-11} \text{ N}\cdot\text{m}^2/\text{kg}^2$ . The launch vehicle must provide enough energy to reach orbital velocity and height. (a) Calculate the orbital velocity required for circular orbit at 500 km altitude. **(4 marks)**  
 (b) Determine the total mechanical energy (kinetic + potential) of the satellite in orbit. Compare this to the energy it would have on Earth's surface (taking potential energy as zero at infinity). **(4 marks)**  
 (c) Analyze the energy that must be provided by the rocket to place the satellite in orbit. Consider both the increase in potential energy and the kinetic energy required. Why is the required energy less than the sum of these quantities? **(3 marks)**  
 (d) If the rocket launches vertically to 500 km then turns horizontal, evaluate this trajectory versus a more efficient gravity turn trajectory. Explain the concept of energy degradation during launch and how trajectory optimization minimizes losses. **(4 marks)**

28. An archer participates in a competition where the target is 70 m away and placed at the same height as the release point. The archer uses a bow that launches arrows at 60 m/s. Air resistance is negligible for this



