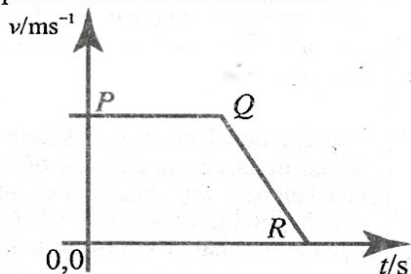


2024 WASSCE PHYSICS

OBJECTIVE TEST QUESTIONS

- The vacuum and silvered surfaces of a vacuum flask walls are to **respectively**
A. minimize conduction and convection and prevent radiation. B. prevent conduction and convection and minimize radiation. C. prevent conduction and minimize convection and radiation. D. minimize conduction and prevent conduction and radiation.
- The magnitude of the acceleration of a moving object is equal to the A. gradient of a displacement-time graph. B. gradient of a velocity-time graph. C. area below a force-time graph. D. area below a velocity-time graph.
- In which of the following states is **maximum** pressure exerted on a person? A. Standing on two feet B. Standing on one foot C. Lying on the floor D. Kneeling on the floor
- What are cathode rays? A. Stream of electrons B. Beam of neutrons C. Beam of protons D. Stream of alpha particles
- The capacitance of a parallel plate capacitor A. decreases when the separation between the plates decreases. B. increases when the potential difference between the plates is increased. C. is greater without a dielectric between the plates than with dielectric. D. is greater with dielectric between the plates than without dielectric.



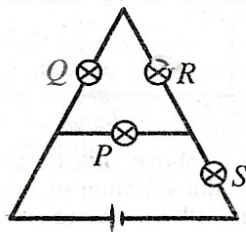
- The diagram above illustrates the motion of a cyclist from P to R. The distance travelled is determined by the A. area under QR. B. area under PQR. C. gradient of PQR. D. gradient of QR.
- A ray of light travels from a less dense medium denser medium. How are the speed and frequency of the light affected? The speed A. increases and the frequency increases. B. decreases and the frequency decreases. C. increases and the frequency remains the same. D. decreases and the frequency remains the same.
- The function of a fuse in an electric circuit is to A. break the circuit when the current exceeds a certain value. B. save energy by reducing the voltage. C. ensure that the current in the circuit exceeds a certain value. D. save energy by reducing the current.
- A body moves with uniform velocity when the resultant force on it is A. greater than the frictional force acting on it. B. less than the frictional force acting on it. C. equal to zero. D. equal

to unity.

- The law of conservation of momentum is stated for closed and isolated system. What are the **two** conditions for a system to be closed and isolated? A. No external force acts on the system and there is no change in mass of the system. B. No external force acts on the system and there is a gain in mass. C. No external force acts on the system and there is a loss in mass. D. An external force acts on the system and there is no change in mass.
- A stone of mass 200 g attached to a string is made to revolve in a horizontal circle of radius 1.5 m at a steady speed of 5 ms⁻¹. Calculate the tension in the string at the bottom of the circle. [$g = 10 \text{ ms}^{-2}$] A. 5.3 N B. 3.3 N C. 2.0 N D. 1.3 N
- To convert a milli-ammeter to an ammeter, it is necessary to connect a resistor of A. low value in series with it. B. high value in series with it. C. low value in parallel with it. D. high value in parallel with it.
- An object is placed 1.5 m from a plane mirror. How far is the image from the object? A. 3.0 m B. 1.3 m C. 1.0 m D. 0.3 m
- Chromatic aberration in lenses can be **corrected** by using a combination of A. diverging and converging lenses. B. an opaque material to cover the rims of lenses. C. wide parallel beams on the lens's surface. D. a thin convex lens.
- A cube of wood of side 10.0 cm floats vertically in water with 4.5 cm of its length submerged. Calculate the density of the wood. [Density of water = 1 gcm⁻³] A. 0.450 gcm⁻³ B. 0.203 gcm⁻³ C. 0.090 gcm⁻³ D. 0.045 gcm⁻³
- A temperature of 60 °C is equivalent to A. 25 °F. B. 50 °F. C. 108 °F. D. 140 °F.
- All of the following uses are practical applications of x-ray **except** A. the treatment of tumours. B. determining the depth of a mine. C. dental operation. D. detecting fracture in bones.
- Two isolated charged spheres **each** of magnitude + 1.0 × 10⁻⁶ C are separated by a distance of 2.0 × 10⁻¹ m. Calculate the magnitude of the electrostatic force between them.

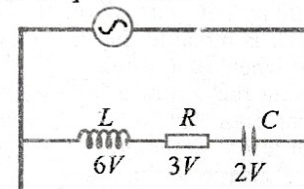
$$\left[K = \frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ Nm}^2\text{C}^{-2} \right]$$

- A. 2.25 × 10⁻¹ N B. 4.50 × 10⁻¹ N
C. 2.25 × 10¹ N D. 4.50 × 10¹ N



- In the circuit diagram above, which lamp causes the other to go off? A. P B. Q C. R D. S
- A particle of mass 3.6 × 10⁻⁶ kg revolving around the earth has a radial acceleration of 4.3 × 10⁷ ms⁻². Calculate the centripetal force of the particle. A. 6.25 × 10⁻¹⁴ N B. 1.55 × 10² N C. 1.00 × 10² N D. 2.00 × 10⁻² N
- For a convex lens to form a real image, the distance between the object and the screen will be A. equal to the focal length of the lens. B. less than the focal length of the lens. C. twice the focal length of the lens. D. four times the focal length of the lens.

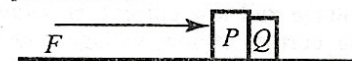
Use the circuit diagram below to answer question 22



A Constant voltage source supplies a sinusoidal alternating *e.m.f.* The voltage marked against the components are their peak values.

- Determine the peak value of the applied *e.m.f.* A. 1 V B. 4 V C. 5 V D. 1 V
- A 2 μF capacitor is connected **directly** across a 150 V_{rms}, 60 Hz A.C source. Calculate the *rms* value of the current. A. 0.113 A B. 0.160 A C. 150 A D. 1324 A
- A body of mass, m is projected vertically upward with a velocity, y. At what position will the potential energy be **maximum**?
A. $\frac{y^2}{g}$ B. $\frac{2y^2}{g}$ C. $\frac{y^2}{2g}$ D. $\frac{y^2}{4g}$
- Light of energy 1.12 × 10⁻¹⁸ J is incident on a metal of ejected electrons with **maximum** energy of 8.0 × 10⁻¹⁹ J. Calculate the threshold frequency of the metal. [$h = 6.626 \times 10^{-34} \text{ Js}$] A. 4.8 × 10¹⁴ Hz B. 1.2 × 10¹⁵ Hz C. 1.7 × 10¹⁵ Hz D. 2.8 × 10¹⁵ Hz
- An object 2.0 cm high is placed at the radius of curvature of a concave mirror such that it is perpendicular to the principal axis of the mirror. Determine the height of the image. A. 0.5 cm B. 1.0 cm C. 1.5 cm D. 2.0 cm

Use the diagram below to answer question 27.



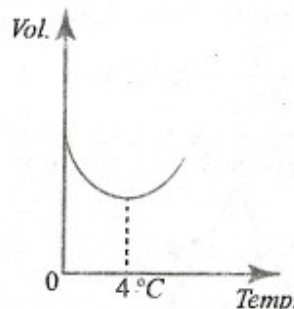
- The diagram above illustrates two boxes P and Q of masses 27.3 kg and 6.2 kg **respectively** on a smooth horizontal surface. If a force of F of 150 N is applied to the combined forces, calculate the acceleration. A. 4.5 ms⁻² B.

33.5 ms⁻² C. 70 ms⁻² D. 150 ms⁻²

28. A boy of mass 40 kg jumps off a stationary skateboard and moves horizontally with a speed of 1.5 ms⁻¹ while the skateboard moves in the opposite direction with a speed of 20 ms⁻¹. Calculate the mass of the skateboard. A. 60 kg B. 40 kg C. 3 kg D. 2 kg
29. The depolarizing agent in a *Leclanché* cell is A. powdered carbon. B. manganese (IV) oxide. C. carbon rod. D. ammonium.
30. Which of the following terms has different dimension from the other? A. Stress×strain B. Stress/strain C. Pressure D. Torque
31. A capacitor described as a mica capacitor has A. both plates made of mica. B. one of its plates made of mica. C. a dielectric made of mica. D. the same capacitance as that of mica.
32. In which of the following devices is the thermal expansion considered a disadvantage? A. Fire alarm B. Thermostat C. Bimetallic thermometer D. Balance wheel of a watch
33. The inside portion of a hollow metal sphere of diameter 20 cm is polished. The portion will therefore form a A. Concave mirror of focal length 5 cm. B. concave mirror of focal length 10 cm. C. convex mirror of focal length 5 cm. D. convex mirror of focal length 10 cm.
34. Which of the following statements about a projectile is not correct? A. A projectile motion is a two-dimensional motion. B. A projectile is an object launched into air and allowed to move freely due to gravity. C. The range of the projectile is independent of the acceleration due to gravity. D. The time of flight is dependent of the acceleration due to gravity.
35. Atmospheric pressure decreases with an increase in altitude because A. acceleration due to gravity increases with altitude. B. temperature increases with altitude. C. internal energy increases with altitude. D. interaction among air molecules decreases due to less quantity of air.
36. The main difference between *x-rays* and *gamma rays* is in their A. ionizing ability. B. absorbing rate. C. mode of propagation. D. mode of production.
37. The phenomenon used for explaining the formation of a rainbow in the sky is A. interference. B. refraction. C. reflection. D. dispersion.
38. Which of the following modes is the most economical method of transmitting electrical power over a long distance? A. Alternating current at high voltage and low current. B. Alternating current at low voltage and high current. C. Direct current at high voltage and high current. D. Direct current at low voltage and low current.
39. The correct sequence of ionization power of alpha particle, gamma ray and beta particle respectively is A. low, medium, high. B. high, medium, low. C. medium, low, high. D. high,

low, medium.

40. Four pieces of constantan wire, marked E, F, G and H, each of length 1.0 m, are at the same temperature. Their respective diameters are 1 mm, 2 mm, 6 mm and 10 mm. Which wire has the highest resistance? A. E B. F C. G D. H
41. The maximum displacement of particles from equilibrium position in a wave motion is known as A. wavelength. B. amplitude. C. frequency. D. polarization.
42. A non-conducting vessel contains a liquid of mass 70.0 g at 25 °C. Another 70.0 g of the same liquid at 35 °C is quickly poured into the vessel. Determine the final temperature of the mixture. A. 15 °C. B. 20 °C. C. 30 °C. D. 40 °C
43. A galvanometer of full-scale deflection 10 mA has a resistance of 5 Ω. Calculate the shunt needed to convert it to measure a current of 2 A. A. 0.025 Ω B. 0.050 Ω C. 0.250 Ω D. 0.500 Ω
44. In storing magnets, the keepers are used to A. cancel the effect of the earth's magnetism. B. reduce self-demagnetization. C. protect the magnet from stray electric field. D. increase the strength of the magnet.
45. Which of the following factors does not affect the speed of sound? A. Loudness B. Wind direction C. Temperature D. Material medium
46. A convex mirror is used as a driving mirror; however, a disadvantage in this regard is that the image A. it produces is virtual. B. it produces is real. C. is not as bright as we would like. D. appears farther away from the driver.
47. The amount of heat energy that will be extracted when 0.02 kg of water vapor condenses to water at 97 °C is [Specific heat of vaporization of water = 2.26×10⁶ Jkg⁻¹, Specific heat capacity of water = 4200 Jkg⁻¹ K⁻¹] A. 45,452 J. B. 45,200 J. C. 25,200 J. D. 252 J.
48. Water is readily available, but it is not a thermometric liquid mainly because it A. clings to glass. B. does not expand uniformly. C. boils at low temperature. D. is colourless.
49. The constant temperature at which a liquid change into gaseous state is known A. evaporation point. B. melting point. C. dew point. D. boiling point.



50. The diagram above illustrates the graph for A. the variation of the volume of a gas with increasing temperature. B. expansion curve of mercury.

- C. expansion curve of liquid oxygen
D. anomalous expansion of water.

2024 WAEC PHYSICS

Paper 2

ESSAY

Part 1

- 1(a) Derive the dimension of surface tension.
(b) Name the instrument used to measure the force of gravity at a place.
- 2(a) State two uses of a polar satellite.
(b) What does the slope of a graph of tensile stress against tensile strain represent?
3. State the S.I. base units of the following quantities:
(b) A stress force constant;
(c) Planck's constant
4. An object projected at an angle to a level ground has a time of flight 4 s to move through still air. Calculate the maximum height attained by the object. [$g = 10 \text{ ms}^{-2}$]
5. State three uses of ferromagnetic materials.
6. An electron of mass, m and charge, e moves through the electric field of potential difference, V_0 with a speed, v . Show that the de Broglie wavelength associated with the electron is given as $\lambda = \frac{h}{\sqrt{2meV_0}}$, where h is the Planck's constant.
7. The fractional change in length produced in an elastic material of spring constant 680 Nm⁻¹ when a force of 306 N is applied to stretch it is 1.5. Calculate the original length of the material.

Part 2

- 8(a) State the effect of increasing temperature on the viscosity of a;
(i) liquid; (ii) gas
(b) State two factors that determine the magnitude of a moment of a force about a point.
(c) A uniform stick AB of length, L and mass, m , is balanced horizontally on a knife edge 10.0 cm from A when an object of mass 400 g is suspended at A. When the knife edge is moved 5 cm further, the object has to be moved to a point 9.00 cm from A for the stick to balance.
(i) Represent the balance system with a suitable diagram
(ii) Determine the:
I. mass, m of the stick;
II. length, L .
(d) Explain in terms of air molecules why the pressure at the top of a high mountain is less than that at sea level.
(e) Mercury of density 13.6×10³ kgm⁻³ is poured in a container of uniform cross-sectional area 40 cm² to a height

of 20 cm. The total pressure exerted on the base of the container is $1.42 \times 10^5 \text{ Pa}$. Calculate the

- mass of mercury in the container
- pressure exerted at the surface of the mercury. [$g = 10 \text{ m/s}^2$]

9a(i) What is a *thermometric liquid*?

(ii) State the reason for the following design features of a clinical thermometer.

I. Narrow bore; II. Thin wall of the bulb

(b) Distinguish between *heat* and *temperature of an object* in terms of energy of a particle.

(c) Explain why evaporation leads to cooling

(d) A kettle rated 200 W, contains water at 20°C . The kettle is switched on and after two minutes, the water starts boiling. After another six minutes, 45% of the water in the kettle boils away.

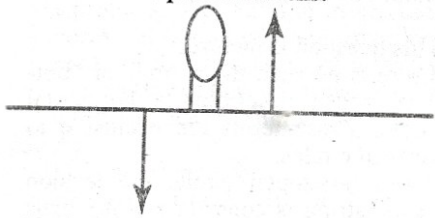
(i) Determine the specific latent heat of vaporization of the water.

(ii) State **One** assumption made in your calculation in 9d(i) above

10(a) State the condition for light ray incident on a concave mirror to reflect through the principal focus of the mirror.

(b) Explain *spherical aberration* as a defect of curved mirrors.

(c) The diagram below illustrates an image formed when an object is placed in front of a particular lens.



Redraw the diagram and indicate the centre of curvature, C , principal focus, F , and the principal axis.

(d) What is meant by *accommodation* in connection to the human?

(e) State quantitatively, the:

(i) values of the near and far point of a normal human eye.

(ii) Use the answer in 10c(i) to determine the change in optical power of the normal human eye when reading a book and viewing the sky. [lens-to-retina distance = 2.5 cm].

11a(i) State the condition for charged particle to experience a force in magnetic field.

(ii) State the expression for the magnetic force, F acting on a charged particle, Q in a magnetic field of flux density, B with a speed, V .

(iii) Prove quantitatively that there is no magnetic force moving along the direction of a magnetic field.

(iv) Mention the main parts of an electrical transformer.

(v) Explain how an alternating potential difference applied to the primary coil gives rise to an induced *e.m.f.* in the secondary coil of a transformer.

(vi) Proton of mass $1.7 \times 10^{-27} \text{ kg}$ enters a

magnetic field of flux density 0.20 T normally and followed a quarter circle path before exiting with constant speed of $4.5 \times 10^6 \text{ m/s}$.

(i) Explain why the speed of the proton remains constant.

(ii) Calculate the
I. radius of the circular path
II. time taken by the proton to move through the magnetic field.

$$[e = 1.6 \times 10^{-19} \text{ C}, \pi = 3.14]$$

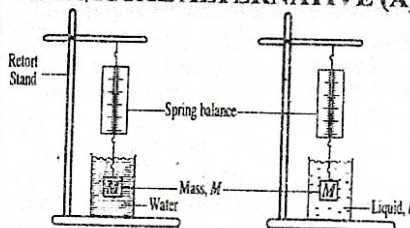
12(a) Mention three facts about photoelectric effect.

(b) An electric magnetic radiation source of power $6 \times 10^{-3} \text{ W}$ emits 1×10^{16} photons per second. The most energetic photoelectron ejected from a metal surface is stopped by a potential difference of 2.2 V. Calculate the work function of the metal. [mass of (photo) electrons $9.1 \times 10^{-31} \text{ kg}$, $h = 6.6 \times 10^{-34} \text{ J s}$]

(c) State two factors on which the activity of a radioactive sample depends.

(d) Cobalt-60 source has an activity of $2.0 \times 10^6 \text{ Bq}$ and a half-life of $1.8 \times 10^8 \text{ s}$. Calculate the number of radioisotope nuclei in the source.

2024 WAEC PHYSICS PRACTICAL QUESTIONS PRACTICAL ALTERNATIVE (A)



(a) You are provided a retort stand, a spring balance, masses, a beaker containing water, another beaker containing a liquid labelled, L and other necessary apparatus.

(i) Suspend the mass, $m = 20 \text{ g}$ on the spring balance and measure the weight in air, W_A in Newton.

(ii) Immerse the suspended mass completely in water and measure weight in water, W_W in Newton.

Evaluate $U_1 = W_A - W_W$.

(iii) Immerse the suspended mass completely in the liquid L of the same volume with water and measure the weight in liquid W_L .

Evaluate $U_2 = W_A - W_L$.

(iv) Repeat the procedure for $m = 40 \text{ g}$, 60 g , 80 g , and 100 g respectively. In each case, evaluate W_A , W_W , U_1 , W_L , U_2 .

(v) Tabulate the readings.

(vi) Plot a graph of U_1 on the vertical axis and U_2 on the horizontal axis starting both axes from the origin (0, 0).

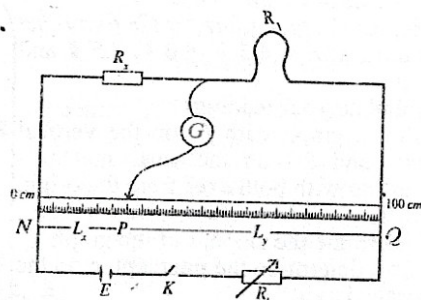
(vii) Determine the slope s of the graph.

(viii) Evaluate $K = \frac{1}{s}$.

(ix) State two precautions taken to ensure accurate results.

b(i) State the Archimedes' Principle.

(ii) State two differences between *density* and *relative density*.



(a) You are provided with two resistance wires labelled: A and B, standard resistor $R_x = 1 \Omega$, metre bridge, cell of *emf*, E , key, Rheostat R_v , galvanometer and other apparatus.

Use the circuit diagram as a guide to perform the experiment.

(i) Connect R_x in the left hand gap of the metre bridge, a length $L = 100 \text{ cm}$ of wire in the right hand gap and the other apparatus as shown.

(ii) Determine and record the balance point P on the metre bridge wire NQ .

(iii) Measure and record $L_x = NP$ and $L_y = PQ$.

(iv) Evaluate $R_1 = \left(\frac{L_y}{L_x}\right) R_x$.

(v) Repeat the procedure for four other values of $L = 90 \text{ cm}$, 80 cm , 70 cm and 60 cm . In each case, determine and record the balance point P , and evaluate R_1 .

(vi) Repeat the experiment with the second wire B. Obtain the balance point P and evaluate R_2 in each case.

(vii) Tabulate the readings.

(viii) Plot a graph of R_2 on the vertical axis and R_1 on the horizontal axis.

(ix) Determine the slope, s , of the graph.

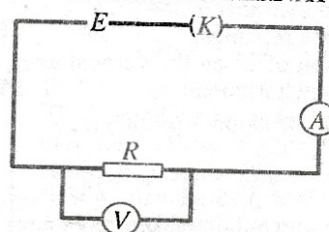
(x) Evaluate $k = \sqrt{s}$.

(xi) State two precautions taken to ensure accurate results.

b(i) State two advantages of *potentiometer* over *voltmeter* for measuring potential difference.

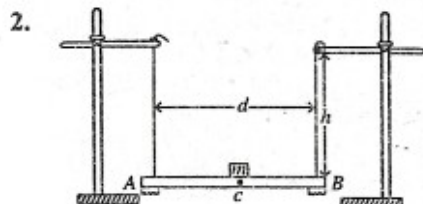
(ii) Define *internal resistance of a cell*.

PRACTICAL ALTERNATIVE (B)



(a) You are provided with a variable DC power supply E , a 2Ω standard resistor, R , a key, an ammeter, a voltmeter and other necessary materials

- (i) Set up a circuit as shown in the diagram above with $E = 3.0 \text{ V}$.
- (ii) Close the key.
- (iii) Record the voltmeter reading, V .
- (iv) Read the corresponding ammeter reading, I .
- (v) Evaluate V^{-1} and I^{-1} .
- (vi) Repeat the procedure for the four other values of $E = 4.5 \text{ V}$, 6.0 V , 7.5 V and 9.0 V .
- (vii) Tabulate your readings.
- (viii) Plot a graph with I^{-1} on the vertical axis and V^{-1} on the horizontal axis starting with both axes from the origin (0, 0).
- (ix) Determine the slope, s of the graph.
- (x) Also, determine the intercept, c on the vertical axis.
- (xi) What does the slope, s represent?
- (xi) State two precautions taken to ensure accurate results.
- (b) State two methods by which an electric current can be produced.
- (i) State Ohm's law.



- (a) You are provided with two metre rules, two retort stands, a mass, $m = 100 \text{ g}$, thread and other necessary apparatus.
- (i) Place one of the metre rules on a knife edge and determine the centre of gravity, C .
- (ii) Measure and record the mass, M_R of the metre rule.
- (iii) Attach the mass $= 100 \text{ g}$ firmly to the metre rule AB at C using paper tape.
- (iv) Suspend the metre rule by two parallel threads of length, $h = 40 \text{ cm}$ each at the 10 cm and 90 cm mark. Ensure that the graduated face of the metre rule is facing upwards.
- (v) Set the metre rule into small angular oscillation about the vertical axis through its centre of gravity.
- (vi) Determine the time, t for 20 complete oscillations. Evaluate the period T and T^2 .
- (vii) Read and record the value of d in metres.
- (viii) Keeping d , constant, repeat the procedure for four other values of $h = 50, 60, 70$, and 80 cm . In each case, determine t and evaluate T and T^2 .
- (ix) Tabulate the readings.
- (x) Plot a graph of T^2 on the vertical axis and h on the horizontal.
- (xi) Determine the slope, s of the graph.
- (xii) Evaluate $k = S/Q$ where $Q = \frac{2}{25d^2}$.
- (xii) State two precautions taken to ensure accurate results.
- (b) (i) Define couple as it relates oscillatory motion.
- (ii) Give two practical applications of a couple in everyday life.

2024 WASSCE PHYSICS (OBJECTIVE) SOLUTIONS

1. B: The vacuum and silvered surfaces of a vacuum flask prevents heat transfer by conduction and convection while the silvered surfaces minimize heat transfer by radiation. This combination helps to maintain the temperature of the contents inside the flask for an extended period of time by reducing all three major modes of heat transfer.
2. B: The gradient of a velocity - time graph of a moving object equals its acceleration. The area under the graph represents the total distance it has covered.

$$\text{Pressure} = \frac{\text{Force (weight)}}{\text{Area}}$$

Since pressure varies inversely as area, the smaller the area, the higher the pressure. Standing on one foot, the weight is concentrated on a very small area.

Thus, the highest pressure is recorded.

4. A: Cathode rays are streams of electrons. They are produced when an electric current is passed through a gas at low pressure, with a high voltage applied between two electrodes. These rays travel from the negatively charged electrode (cathode) to the positively charged electrode (anode).

$$C = \frac{k\epsilon_0 A}{d} \text{ also,}$$

$$C = \frac{Q}{V}$$

With the above formulae (where each symbol carrying its usual meaning), we can easily verify the correctness of each option.

- When the separation (d) decreases, the capacitance must increase because they vary inversely as each other. Thus, option A is wrong.
 - When the potential difference increases, capacitance will decrease (the relationship is inverse). Thus, Option B is wrong.
 - With no dielectric between the plates, $k = 1$ and with a dielectric between the plates $k > 1$. Since C varies directly as k , C will be greater when there is a dielectric between the plates. Thus, option C is wrong while D is correct.
6. B: The distance travelled equals the area of the velocity-time graph. Here, the area equals $\frac{1}{2}(a+b)h$ where a and b represent the length of the two parallel sides, and h , the height.
 - NB: The gradient of the region QR represents the deceleration/retardation.
 7. D: When light travels from one medium to another (of different refractive index), both the wavelength and the velocity will be altered but the frequency remains unchanged. This easily eliminates options A and B (as

those two suggest that the frequency will change). If light travels from a less dense medium to a denser medium, both its velocity and wavelength will decrease. If, on the other hand, light travels from a denser medium to a less dense medium, both its velocity and wavelength will increase.

8. A: The function of a fuse in an electric circuit is to protect the circuit from excessive current flow. It contains a thin wire that melts and breaks the circuit if the current exceeds a safe level, thereby preventing potential damage to the circuit components.

9. C: When a body moves with a uniform velocity, it means there is no acceleration (the acceleration is zero).

$$F = ma.$$

If we plug $a = 0$ into the above relation, it follows that $f = 0$.

Thus, for a body to move at uniform velocity, the net/resultant force on it must be equal to zero.

Does it mean that no force acts on the body at all? Maybe!

However, this is not necessarily so!

It is possible that no force acts on the body or the forces acting on the body align in such a way that their effects cancel out.

10. A: There should be no external force acting on the system and the mass should be constant.

11. : This question is incorrect!

There is no such thing "top" or "bottom" when describing a horizontal circle. Those terms are exclusive to vertical circles.

For a horizontal circle, the tension in the string is constant and it equals

$$\frac{mv^2}{r}.$$

$$\text{Here, } m = 200\text{g} = 0.2\text{kg}$$

$$V = 5 \text{ ms}^{-1}, r = 1.5\text{m}.$$

Then,

$$T = \frac{0.2 \times 5^2}{1.5}$$

$$= 3.33\text{N} \quad \left(\begin{array}{l} \text{which produces} \\ \text{option B} \end{array} \right)$$

So, if we assume the examiner meant a horizontal circle truly (which will force us to delete the 'bottom' part of the question), the correct option will be B.

For a vertical circle, the tension in the string when the stone is at the bottom of the circle

$$= \frac{mv^2}{r} + mg.$$

So, if we assume that the examiner meant 'vertical' instead of 'horizontal',

$$T = \frac{mv^2}{r} + mg$$

$$= \frac{0.2 \times 5^2}{1.5} + 0.2 \times 10$$

$$= (3.3333 + 2)N$$

$$= 5.3333N \text{ (which will produce option B)}$$

NB:

Tension (T) when the stone is at the top of the circle (a vertical circle of course) is given by:

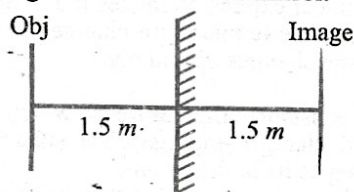
$$T = \frac{mv^2}{r} - mg.$$

12. C:

- To convert a milliammeter to ammeter, a low resistance known as shunt must be connected to it in parallel.
- To convert a milliammeter to voltmeter, a high resistance known as multiplier must be connected to it in series.

13. A:

The distance of the object in front of a plane mirror equals the distance of its image at the back of the mirror.



Thus, the distance between the object and the image = $1.5 \text{ m} + 1.5 \text{ m} = 3.0 \text{ m}$

14. A:

Chromatic aberration in lenses can be corrected by combining two lenses made of different types of glass (usually a convex lens of crown glass and a concave lens of flint glass).

15. A:

Volume of the cube
 $= 10 \text{ cm} \times 10 \text{ cm} \times 10 \text{ cm}$
 $= 1000 \text{ cm}^3$
 Volume of the cube submerged
 $= 10 \text{ cm} \times 10 \text{ cm} \times 4.5 \text{ cm}$
 $= 450 \text{ cm}^3$
 Then, volume of water displaced
 $= 450 \text{ cm}^3$
 Density of water = 1 gcm^{-3} .
 Then, mass of water displaced
 $= 1 \text{ gcm}^{-3} \times 450 \text{ cm}^3$
 $= 450 \text{ g}$
 Mass of cube = $V_{\text{cube}} \times \rho_{\text{cube}}$
 From the principle of flotation,
 Mass of cube = mass of H_2O displaced
 $V_{\text{cube}} \times \rho_{\text{cube}} = 450 \text{ g}$
 $1000 \text{ cm}^3 \times \rho_{\text{cube}} = 450 \text{ g}$
 $\rho_{\text{cube}} = \frac{450 \text{ g}}{1000 \text{ cm}^3} = 0.45 \text{ gcm}^{-3}$

16. D:

$$\frac{F-32}{9} = \frac{C}{5}$$

$$\frac{F-32}{9} = \frac{60}{5} = 12$$

$$F-32 = 9 \times 12 = 108$$

$$F = (108 + 32)^\circ \text{F} = 140^\circ \text{F}$$

17. B:

X-ray can be used in the treatment of tumours, in dental operation and in detecting fracture in bones. Its application does not include determining the depth of a mine. Techniques

like seismic reflection and fraction, ground-penetrating radar (GPR) and electromagnetic surveys are used to map the subsurface and determine the depth and structure of a mine

18. A:

$$q_1 = 1 \times 10^{-6} \text{ C}, q_2 = 1 \times 10^{-6} \text{ C}$$

$$r = 2 \times 10^{-1} \text{ m} = 0.2 \text{ m}$$

$$k = 9 \times 10^9 \text{ Nm}^2 \text{C}^{-2}$$

$$F = \frac{kq_1q_2}{r^2}$$

$$= \frac{9 \times 10^9 \times 1 \times 10^{-6} \times 1 \times 10^{-6}}{(0.2)^2}$$

$$= 0.225 \text{ N}$$

$$= 2.25 \times 10^{-1} \text{ N}$$

19. D:

If lamp s goes off, all other lamps will clearly go off. This is because lamp s is required to complete the whole circuit. If any other lamp goes off, some other lamps will still be on.

For instance, if lamp Q goes off, lamp R will go off but both P and S will stay on.

20. B:

$$a_c = a_r = 4.3 \times 10^7 \text{ ms}^{-2}$$

$$m = 3.6 \times 10^{-6} \text{ kg}$$

$$F_c = ma_c$$

$$= (3.6 \times 10^{-6} \times 4.3 \times 10^7) \text{ N}$$

$$= 154.8 \text{ N}$$

$$= 155 \text{ N} = 1.55 \times 10^2 \text{ N}$$

21. :

This is yet another incorrect question! There are many positions that will produce a real image for a convex lens. The examiner probably meant: "For a convex lens to form a virtual image, the distance between the object and the lens will be ...". If modified in this way, the correct option will be B.

22. C:

In an RLC circuit, the effective voltage (V) is given by:

$$V = \sqrt{V_R^2 + (V_L - V_C)^2}$$

$$\text{Here, } V_R = 3 \text{ V}, V_L = 6 \text{ V}, V_C = 2 \text{ V}$$

Then,

$$V = \sqrt{3^2 + (6-2)^2}$$

$$= \sqrt{3^2 + 4^2}$$

$$= \sqrt{9+16}$$

$$= \sqrt{25} = 5 \text{ V}$$

23. A:

$$X_C = \frac{1}{2\pi fC}$$

$$= \frac{1}{2 \times 3.142 \times 60 \times 2 \times 10^{-6}}$$

$$= 1326.1192 \Omega$$

$$I = \frac{V}{X_C}$$

$$= \left(\frac{150}{1326.1192} \right) \text{ A} = 0.113 \text{ A}$$

24. C:

The potential energy will be maximum at the maximum height (since $P.E. = mgh$).

$$H_{\text{max}} = \frac{u^2 \sin^2 \theta}{2g}$$

Here,

$u = v$ (given)

$$\theta = 90^\circ \quad \left(\begin{array}{l} \text{since the body} \\ \text{is projected} \\ \text{vertically upwards} \end{array} \right)$$

Then,

$$H_{\text{max}} = \frac{y^2 \times (\sin 90^\circ)^2}{2g} = \frac{y^2 \times 1^2}{2g}$$

$$= \frac{y^2}{2g}$$

25. A:

$$E = W_o + K.E.$$

$$E = 1.12 \times 10^{-18} - 8 \times 10^{-19}$$

$$= 3.2 \times 10^{-19} \text{ J}$$

$$W_o = hf_o$$

$$3.2 \times 10^{-19} = 6.626 \times 10^{-34} \times f_o$$

$$f_o = \left(\frac{3.2 \times 10^{-19}}{6.626 \times 10^{-34}} \right) \text{ Hz}$$

$$= 4.83 \times 10^{14} \text{ Hz}$$

26. D:

When an object is placed at the centre of curvature of a concave mirror, an image which is same size as the object will be formed.

27. A:

$$\text{Total mass} = 27.3 \text{ kg} + 6.2 \text{ kg}$$

$$= 33.5 \text{ kg}$$

$$F = ma$$

$$150 = 33.5a$$

$$a = \left(\frac{150}{33.5} \right) \text{ ms}^{-2} = 4.5 \text{ ms}^{-2}$$

28. C:

Mass of the boy, $m_b = 40 \text{ kg}$

Final velocity of the boy, $v_b = 1.5 \text{ ms}^{-1}$.

Final velocity of the skateboard,

$$v_s = -20 \text{ m/s}.$$

Initially, both the boy and the skateboard are at rest, so total initial momentum = 0.

From the principle of conservation of momentum.

Total initial momentum

$$= \text{Total final momentum}$$

$$0 = m_b v_b + m_s v_s$$

$$0 = (40 \times 1.5) + m_s (-20)$$

$$0 = 60 - 20 m_s$$

$$20 m_s = 60,$$

$$m_s = \left(\frac{60}{20} \right) \text{ kg} = 3 \text{ kg}$$

29. B:

The depolarization agent in a Leclanché cell is manganese dioxide (MnO_2).

In a Leclanché cell, MnO_2 is used to prevent the build-up of hydrogen gas at the cathode. It acts as a depolarizer by reacting with the hydrogen gas to form water, thus maintaining the efficiency of the cell.

30. D:

$$\text{Stress} = \frac{\text{Force}}{\text{Area}} = \frac{MLT^{-2}}{L^2} = MLL^{-1}T^{-2}$$

$$\text{Strain} = \frac{\text{Extension}}{\text{Length}} = \frac{L}{L} = 1$$

Thus, strain is dimensionless. This follows that both stress \times strain and stress/strain will have the same dimension ($ML^{-1}T^{-2}$).

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}} = ML^{-1}T^{-2}$$

$$\begin{aligned}\text{Torque} &= \text{force} \times \text{distance} \\ &= MLT^{-2} \times L \\ &= ML^2T^{-2}\end{aligned}$$

Thus, it is torque that has different dimension.

31. C:

A mica capacitor is simply a capacitor with a dielectric made of mica. Mica is known for its excellent electrical properties.

32. D:

Thermal expansion in the balance wheel of a watch is disadvantageous because it causes dimensional changes that alter the wheel's moment of inertia, impacting the oscillation period and thus the accuracy of timekeeping.

33. C:

If the diameter is 20 cm, the radius of curvature (R)

$$= \frac{\text{diameter}}{2} = 10\text{cm}.$$

Also,

$$f = \frac{R}{2} = \frac{10\text{cm}}{2} = 5\text{cm}.$$

When the inside portion of a hollow metal sphere is painted/coated/polished, the outside is the reflecting surface. This means it forms a convex mirror.

34. C:

The time to reach maximum height, the maximum height reached, the time of flight and the range all depend on the initial velocity, the angle of projection and the acceleration due to gravity. This is evident in their formulae. For instance,

$$R = \frac{u^2 \sin 2\theta}{g}$$

u = initial velocity

θ = angle made with the horizontal

g = acceleration due to gravity.

35. D:

At higher altitudes, there is less air above a given point exerting downward pressure. As a result, the weight of the air column is less, leading to a lower atmospheric pressure.

36. D:

X-rays are produced by the interaction of high-energy electrons with matter whereas gamma rays are emitted from the nucleus of an atom during radioactive decay or other nuclear reactions.

37. B:

Dispersion causes a rainbow by separating white sunlight into its component colours when sunlight enters a raindrop, it is refracted and dispersed due to varying wavelengths.

rating white sunlight into its component colours when sunlight enters a raindrop, it is refracted and dispersed due to varying wavelengths.

38. A:

Recall that the power loss due to resistance in the transmission lines is given by $P = I^2 R$. Thus, by transmitting at high voltage and low current, the current I is minimized, significantly reducing power loss.

39. D:

- Gamma has the highest penetration power while alpha has the lowest.

- In terms of ionization power, alpha particle ranks first while gamma ray ranks last i.e. alpha > beta > gamma.

40. A:

From the formula $R = \frac{\rho l}{A}$, we can easily infer that the resistance (R) of a wire increases as cross-sectional area decreases.

Since cross-sectional area is large for wires with large diameter and small for those with small diameter, it follows that a wire with a small diameter will have a high resistance.

41. B:

The maximum displacement of particles from equilibrium position in a wave motion is known as amplitude.

42. C:

$$m_c c \Delta \theta_c = m_h c \Delta \theta_h$$

$$70 \times c \times (f - 25) = 70 \times c \times (35 - f)$$

then,

$$f - 25 = 35 - f$$

$$f + f = 35 + 25$$

$$2f = 60$$

$$f = \left(\frac{60}{2}\right)^\circ\text{C} = 30^\circ\text{C}$$

43. A:

$$\begin{aligned}R_{\text{shunt}} &= \frac{I_g R_g}{I - I_g} = \frac{0.01 \times 5}{2 - 0.01} \\ &= \frac{0.05}{1.99} = 0.025\Omega\end{aligned}$$

44. B:

Keepers reduce self-demagnetization of magnets by providing a low reluctance path for magnetic flux, thereby containing the flux within the keeper. This minimizes external magnetic field interference, prevents pole reversal and offers mechanical protection, ultimately preserving the magnet's strength and stability.

45. A:

Loudness does not affect the speed of sound. Loudness is related to the amplitude of the sound wave and this has no influence on the speed at which the sound wave travels.

46. D:

The main disadvantage of a convex mirror as a driving mirror is that it distorts the perception of distance, making objects appear farther away than they actually are. This can make it difficult for drivers to accurately judge the speed and distance of other vehicles.

47. A:

The heat that will be extracted when steam (at 100 °C) condenses to water at 100 °C

$$\begin{aligned}&= mL \\ &= (0.02 \times 2.26 \times 10^6)\text{J} \\ &= 45,200\text{J}\end{aligned}$$

Now, to cool the water at 100 °C to 97 °C,

$$\begin{aligned}\text{the heat extracted} &= mc\Delta\theta \\ &= 0.02 \times 4200 \times (100 - 97) \\ &= 0.02 \times 4200 \times 3 = 252\text{J}\end{aligned}$$

$$\begin{aligned}\text{Total heat extracted} &= (45,200 + 252)\text{J} \\ &= 45,452\text{J}\end{aligned}$$

48. B:

All the points given are reasons why water is not a good thermometric liquid but the lack of uniform expansion is the most critical. Water has an anomalous behaviour, particularly near its freezing point, where it actually contracts upon heating until it reaches 4 °C and then expands. This non-linear expansion makes it difficult to correlate temperature changes with volume changes accurately.

49. D:

The constant temperature at which a liquid changes into gaseous state is known as its boiling point.

50. D: This is the anomalous expansion of water as describe in Q48. Water has its highest density and consequently its lowest volume (for a constant mass) at 4 °C.

2024 WAEC PHYSICS THEORY SOLUTIONS

1(a) Dimension of surface Tension:

$$\begin{aligned}\text{Surface Tension} &= \frac{\text{force}}{\text{length}} \\ &= \frac{\text{mass} \times \text{acceleration}}{\text{Length}} \\ &= \frac{MLT^{-2}}{L} = MT^{-2}\end{aligned}$$

(b) Instruments used for measuring the force of gravity:

- Spring balance
- Gravimeter
- Gravitational accelerometer

2(a) Uses of polar satellite

- for location identification
- to collect data on climate change
- observe and predict a natural disaster
- use for communication

(b) The slope represents the Young's Modulus or Modulus of elasticity

3(a) S.I. base units of

$$\begin{aligned}\text{Stress} &= \frac{\text{Force}}{\text{Area}} = \frac{\text{kg m s}^{-2}}{\text{m}^2} \\ &= \frac{\text{kg}}{\text{m}^2} = \text{kg m}^{-1} \text{s}^{-2}\end{aligned}$$

- (b) Force constant k

$$k = \frac{F}{e} = \frac{kgms^{-2}}{m} = kgs^{-2}$$

- (c) Planck constant,

$$h = \frac{\text{Energy}}{\text{Freq.}} = \frac{J}{s^{-1}} = Js$$

$$= \text{Force} \times \text{distance} \times \text{time}$$

$$= kg \cancel{ms^{-2}} \times \cancel{m} \times \cancel{s} = kgm^2s^{-1}$$

4. Given: Time of flight, $T = 4s$, $g = 10 ms^{-2}$
required, $h_{\max} = ?$

Using, $h_{\max} = \frac{u^2 \sin^2 \theta}{2g}$ and

$$T = \frac{2u \sin \theta}{g}$$

$$4 = \frac{2u \sin \theta}{10}$$

$$40 = 2u \sin \theta$$

$$20 = u \sin \theta$$

$$u = \frac{20}{\sin \theta}$$

$$\sin \theta = \frac{20}{u}$$

$$h_{\max} = \frac{u^2 \sin^2 \theta}{2g}$$

$$4 = \frac{2u \sin \theta}{10}$$

$$40 = 2u \sin \theta$$

$$20 = u \sin \theta$$

$$u = \frac{20}{\sin \theta}$$

$$\sin \theta = \frac{20}{u}$$

$$h_{\max} = \frac{u^2 \sin^2 \theta}{2g}$$

5. Uses of ferromagnetic materials

- they are used in
- electromagnets
 - electric bells
 - electric generators
 - transformers
 - data storage in hard disk

6. To show that

$$\lambda = \frac{h}{\sqrt{2meV_0}}$$

The deBroglie wavelength λ , is given by

$$\lambda = \frac{h}{mV}$$

for an electron accelerating through an electric field, the kinetic energy acquired by the electron is given by

$$K.E. = eV_0 = \frac{1}{2}mV^2$$

$$\text{So, } V = \sqrt{\frac{2eV_0}{m}}$$

$$\lambda = \frac{h}{m \times \sqrt{\frac{2eV_0}{m}}} = \frac{h}{\sqrt{2eV_0 m}}$$

$$\lambda = \frac{h}{\sqrt{2meV_0}}$$

7. given: $k = 680N/m$, $F = 306N$
Fractional change in length

$$= \frac{e}{l} = 1.5$$

$$\text{but } f = ke$$

$$e = \frac{f}{k} = \frac{306}{680}$$

$$e = 0.45$$

$$\text{and strain} = \frac{e}{l} = 1.5$$

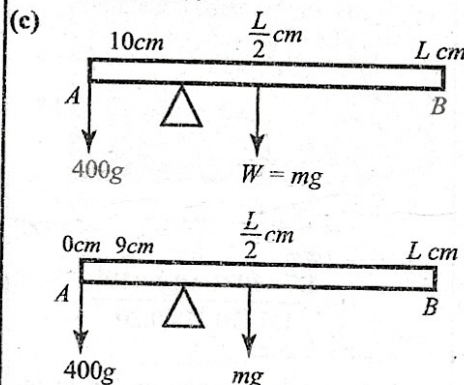
$$l_0 = \frac{0.45}{1.5} = 0.30m$$

- 8a(i) Increasing temperature of a liquid decreases the viscosity of the liquid.

- (ii) Increasing temperature of a gas increases the viscosity of a gas.

- (b) Factors that determine the magnitude of moment of a force about a point:

- magnitude of the applied force
- perpendicular distance from the pivot to the line of action of the applied force
- Angle between the distance from the turning point and the line of action of the force



- (ii) I. To find the mass m of the stick

Moment about the support

Σ clockwise moment

$= \Sigma$ anticlockwise moment

$$400 \times 10 = m \times \left(\frac{L}{2} - 10 \right) \quad \left[\begin{array}{c} \text{diagram} \\ (1) \end{array} \right]$$

$$4000 = m \left(\frac{L}{2} - 10 \right) \dots \dots \dots (1)$$

$$400 \times 6 = m \left(\frac{L}{2} - 15 \right) \dots \dots \dots (2)$$

divide (1) by (2)

$$\frac{4000}{400 \times 6} = \frac{m \left(\frac{L}{2} - 10 \right)}{m \left(\frac{L}{2} - 15 \right)}$$

$$\frac{5}{3} = \frac{\frac{L}{2} - 10}{\frac{L}{2} - 15}$$

$$3 \left(\frac{L}{2} - 10 \right) = 5 \left(\frac{L}{2} - 15 \right)$$

$$\frac{3L}{2} - 30 = \frac{5L}{2} - 75$$

$$\frac{5L}{2} - \frac{3L}{2} = 75 - 39$$

$$L = 45 \text{ cm}$$

from (2)

$$400 \times 6 = m \left(\frac{L}{2} - 15 \right)$$

$$400 \times 6 = m \left(\frac{45}{2} - 15 \right)$$

$$400 \times 6 = m \times 7.5$$

$$m = \frac{400 \times 6}{7.5} = 320g$$

Therefore, I. $m = 320g$

II. $L = 45 \text{ cm}$

- (d) Reasons for less pressure at the top of a mountain:

There are fewer molecules of air per unit volume at the mountain top than at sea level. Hence, there is less weight pushing down per unit area at the mountain top than at sea level.

- e(i) Density $= \rho = \frac{m}{V}$

$$m = \rho \times V \text{ and } V = Ah.$$

$$m = \rho \times A \times h$$

$$= 13.6 \times 10^3 \times 40 \times 20 \times 10^{-6}$$

$$= 10.88kg$$

- (ii) Pressure exerted by the surface of mercury

$$\text{from } P_T = P_{atm} + \rho hg$$

$$P_{atm} = P_T - \rho hg$$

$$= 1.42 \times 10^5 - 13.6 \times 10^3 \times 0.2 \times 10$$

$$P_{atm} = 1.148 \times 10^5 Pa$$

- 9a(i) A thermometric liquid is a liquid whose physical property changes uniformly with temperature.

- (ii) I. Reason where bore is narrow:

- it increases its sensitivity
- enables the detection of a small change in temperature

- II. Reasons why bulb has a thin wall:

- it increases its conductivity
- enables faster heat transfer

- (b) Heat is a form of energy that is transferred from one body to another due

to temperature differences while temperature is the measure of the average kinetic energy of a molecule of the body.

(c) **Reasons evaporation leads to cooling:**

- liquid molecules move randomly with different velocities;
- molecules with enough energy escape the liquid's surface, becoming vapour.

These escaping molecules reduce the liquid's average kinetic energy, causing cooling.

d(i) Given: $P = 200W$, $\theta = 20^\circ C$,
 $t = 2 \text{ min} = 2 \times 60 = 120s$

Energy output = $P \times t = mc\Delta\theta$

$$m = \frac{Pt}{c\Delta\theta} = \frac{2000 \times 120}{4200 \times (100 - 20)} = \frac{2000 \times 120}{4200 \times 80} = \frac{240,000}{336,000}$$

$$m = 0.714 \text{ kg}$$

$$\text{also, } Pt = ml$$

$$l = \frac{Pt}{m}$$

where, $m = 45\%$ of 0.7

$$\frac{2000 \times 6 \times 60}{0.714 \times 0.45} = 2.29 \times 10^6 \text{ J kg}^{-1}$$

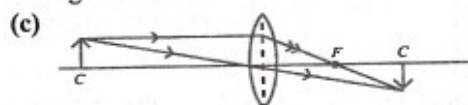
(ii) **Assumption made:**

- There is no loss to the surroundings;
- The heat capacity of the material of the kettle is negligible.

10(a) The incident light rays must be parallel and close to the principal axis.

(b) **Spherical aberration as a defect of curved mirrors:**

When a wide parallel beam is incident on a spherical mirror, it is not brought to the same focus. This makes the image distorted.



2F or C: centre of curvature

F: principal focus

(d) Accommodation is the ability of the eyes to alter its focal length to form a clear image on the retina.

(e) quantitatively,

(i) far point = infinity/ ∞

Near point = 25 cm

$$P_{\text{near point}} = \frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

(ii)

for near point $u = 0.25 \text{ m}$

$$P_{\text{near point}} = \frac{1}{f} = \frac{1}{0.25} + \frac{1}{v}$$

similarly for far point, $u = \infty$

$$P_{\text{far point}} = \frac{1}{f} = \frac{1}{0.25} + \frac{1}{v}$$

$$P_{\text{far}} = \frac{1}{\infty} + \frac{1}{v}$$

$$P_{\text{far}} = 0 + \frac{1}{v} = \frac{1}{v}$$

So, change in optical power

$$\Delta P = P_{\text{near}} - P_{\text{far}}$$

$$= 4 + \frac{1}{v} - \frac{1}{v}$$

$$\Delta P = 4.0D$$

11a(i) The charged particle must be in motion or have velocity and the particle's velocity must be inclined to the magnetic field at an angle θ .

(ii) $F = QvB\sin\theta$

(iii) for a charged particle moving parallel to the magnetic field,

$$\theta = 0 \text{ and } F = QvB\sin\theta$$

$$F = QvB\sin 0$$

$$F = 0$$

b(i) main parts of an electrical transformer

- Coil
- (laminated) or soft iron core

(ii) An alternating current in the primary coil produces a changing magnetic field in the primary coil. The changing magnetic field around the core gives rise to a changing magnetic flux linking the secondary coil thereby inducing an alternating *emf* in the secondary coil as stated in Faraday's law.

c(i) **Why the speed of the proton remains constant:**

The proton enters the magnetic field in the direction perpendicular to the field thereby the work done by the magnetic field is zero or no work done meaning no change in the kinetic energy of the proton and hence, the speed does not change but remains constant

(ii) I. radius of curved path

$$qvB = \frac{mv^2}{r}$$

$$qvB = \frac{m}{r}$$

$$r = \frac{m}{qvB}$$

$$r = \frac{1.7 \times 10^{-27} \times 4.5 \times 10^6}{1.6 \times 10^{-19} \times 0.20}$$

$$r = 0.24 \text{ m}$$

II. time taken by the proton to move through the magnetic field,

$$t = \frac{\pi r}{2v}$$

$$t = \frac{3.14 \times 0.24}{2 \times 4.5 \times 10^6} = 8.37 \times 10^{-8} \text{ s}$$

12(a)- electrons are only emitted when

the photon frequency exceeds the threshold frequency.

- the energy of each photon is proportional to its frequency
- the emission of photoelectrons depends on the frequency of incident light on the metal surface.
- the intensity of light does not affect the energy of the electrons emitted/photoelectrons.
- the energy of the photoelectron depends on the frequency of incident radiation.

(b) Given: $P = 6 \times 10^{-3} \text{ W}$

no of photons per second

$$= 1 \times 10^{16} \text{ photons/second}$$

$$Pd, V = 2.2V$$

$$m_e = 9.1 \times 10^{-31} \text{ kg}$$

$$ic = 1.6 \times 10^{-19} \text{ C}$$

required, $W_0 = ?$

$$\text{Photon energy, } E = \frac{\text{Power}}{\text{Number of photons per second}} = \frac{P}{n} = \frac{6.0 \times 10^{-3}}{1.0 \times 10^{16}} = 6.0 \times 10^{-19} \text{ J}$$

$$\text{But } K.E = E - W_0$$

$$\text{or } W_0 = E - K.E$$

$$W_0 = E - eV_s = 6.0 \times 10^{-19} - 2.2 \times 1.6 \times 10^{-19}$$

$$W_0 = 2.48 \times 10^{-19} \text{ J}$$

(c) **Factors which radioactive activity depends**

- decay constant
- no of unstable nuclei present at a given
- time of the decay process

(d) Given:

$$\frac{dN}{dt} = 2.0 \times 10^6 \text{ Bq}$$

$$T_{1/2} = 1.8 \times 10^8 \text{ s}$$

$$\text{using } \frac{dN}{dt} = -\lambda N_0$$

$$\text{and } \lambda = \frac{\ln 2}{T_{1/2}}$$

$$\Rightarrow \frac{dN}{dt} = \frac{-\ln 2}{T_{1/2}} N_0$$

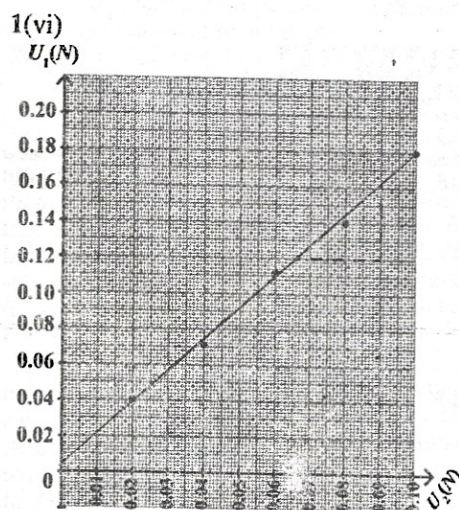
$$2 \times 10^6 = \frac{0.693}{1.8 \times 10^8} \times N_0$$

$$N_0 = \frac{2 \times 10^6 \times 1.8 \times 10^8}{0.693} = 5.2 \times 10^{14} \text{ nuclei}$$

PRACTICAL ALTERNATIVE (A) SOLUTIONS

1(v)

M(g)	$W_A(N)$	$W_B(N)$	$U_1 = W_C - W_D$	$W_E(N)$	$U_2 = W_F - W_G$
20.0	0.20	0.16	0.04	0.18	0.02
40.0	0.40	0.33	0.07	0.36	0.04
60.0	0.60	0.49	0.11	0.54	0.06
80.0	0.80	0.66	0.14	0.72	0.08
100.0	1.00	0.82	0.18	0.90	0.10



(vii) $s = \frac{\Delta U_1}{\Delta U_2} = \frac{0.162 - 0.2}{0.09 - 0.067}$
 $= \frac{0.042}{0.023} = 1.826$

(viii) $K = \frac{1}{s} = \frac{1}{1.826} = 0.5476$

(ix) (I) I avoided error due to parallax when reading the spring balance.

(II) I cleared the mass thorough before immersing in liquid L

b(i) **Archimedes principle** states that when a body is totally, or partially immersed in a fluid (liquid or gas), it experiences an upthrust which is equal to the weight of fluid displaced.

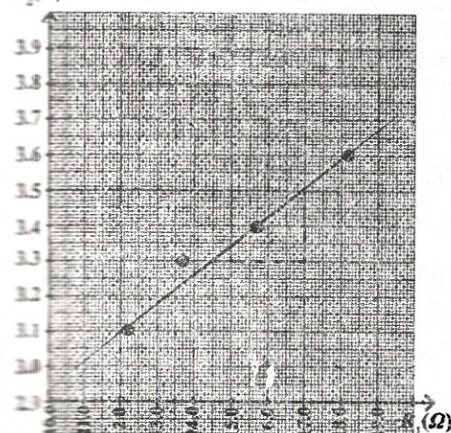
(ii) (I) Density has unit, but relative density has no unit

(II) The value of density is different in different systems of measurement, but that of relative density is the same in all systems of measurement.

2a(vii)

L (cm)	L _x (cm)	L _y (cm)	R ₁ = $\frac{L_y}{L_x} R_1(\Omega)$	L _x (cm)	L _y (cm)	R ₂ = $\frac{L_y}{L_x} R_1(\Omega)$
100.0	5.2	94.8	18.2	21.5	78.5	3.6
90.0	6.0	94.0	15.7	22.5	77.5	3.4
80.0	6.8	93.2	13.7	23.4	76.6	3.3
70.0	7.6	92.4	12.2	24.5	75.5	3.1
60.0	8.4	91.6	10.9	25.6	74.4	2.9

2(viii)



(ix) $\text{Slope} = \frac{\Delta R_2}{\Delta R_1}$
 $s = \frac{3.5 - 3.3}{17.0 - 14.6}$
 $= \frac{0.2}{2.4} = 0.083$

(x) $k = \sqrt{0.083} = 0.2881$

(xi) I. Tight connection/clean terminal was ensured.

II. Key removed when readings were not being taken

b(i)- Potentiometer gives the exact value of potential difference across any two points in a circuit.

Potentiometer can be used for measuring the internal resistance of a cell and also compare the e.m.f. of two cells.

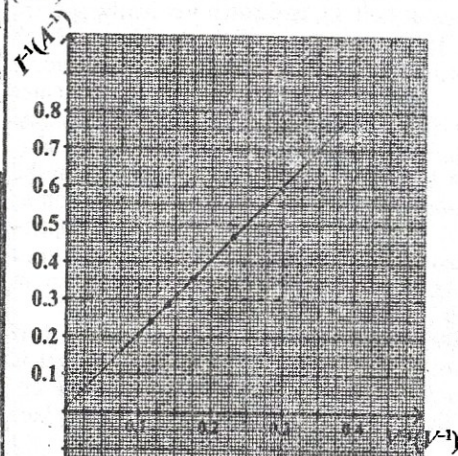
(ii) It refers to the opposition to the flow of current offered by the cells and batteries themselves resulting in the generation of heat.

ALTERNATIVE (B) SOLUTIONS

1(vii)

E (V)	V (V)	I (A)	V ⁻¹ (V ⁻¹)	E ⁻¹ (A ⁻¹)
3.00	2.86	1.43	0.350	0.699
4.50	4.28	2.14	0.234	0.467
6.00	5.70	2.86	0.175	0.350
7.50	7.14	3.57	0.140	0.280
9.00	8.57	4.28	0.117	0.234

(viii)



(ix) $\text{Slope}, s = \frac{\Delta E^{-1}}{\Delta V^{-1}}$
 $= \frac{0.6 - 0.3}{0.3 - 0.15}$
 $= \frac{0.3}{0.15} = 2$

(x) Intercept, $c = 0.01$

(xi) slope, s represents external resistance of the circuit

(xii) (I) I ensured tight connections

(II) I avoided error due to parallax on the Ammeter/Voltmeter

b(i) (I) Use of cell

(II) hydropower

(ii) **Ohm's law** states that the electric current passing through a metallic conductor at constant temperature is

directly proportional to the potential difference applied between its ends.

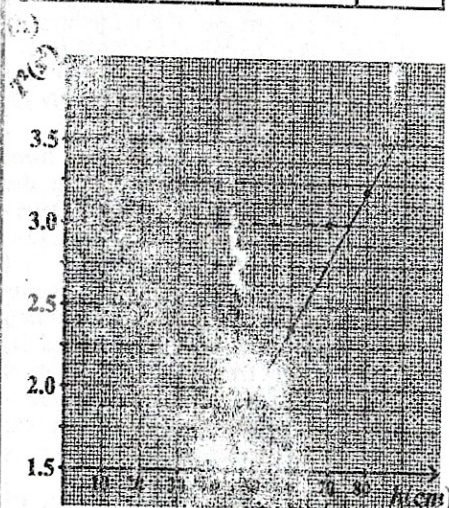
2a(i) $c = 50.0 \text{ cm}$

(ii) $MR = 90.0 \text{ grams}$

(vii) $d = 0.8 \text{ m}$

(ix)

S/N	h (cm)	t (s)	T = t/20 (s)	T ² (s ²)
1	40.0	26.12	1.306	1.7056
2	50.0	27.80	1.390	1.9321
3	60.0	30.68	1.534	2.3532
4	70.0	34.60	1.730	2.9929
5	80.0	35.80	1.790	3.2041



(xi) $\text{Slope}, s = \frac{\Delta T^2}{\Delta h}$
 $= \frac{3.0 - 1.75}{75 - 46}$
 $= \frac{1.25}{29}$
 $s = 0.431 \text{ s}^2/\text{cm}$

(xii) $k = \frac{S}{Q}$
 where $Q = \frac{2}{25d^2} = \frac{2}{25 \times (0.8)^2}$
 $= 0.123$
 $k = \frac{S}{Q} = \frac{0.431 \text{ s}^2/\text{cm}}{0.123}$
 $= 0.3448$

2b(i) A couple, in the context of oscillatory motion, refers to a pair of forces that are equal in magnitude, opposite in direction, and act on opposite sides of a pivot or fulcrum, causing rotation or torsion

2b(ii) I. **Screwdrivers:** When you use a screwdriver to tighten or loosen a screw, you are applying a couple. The force you apply to the handle of the screwdriver is transmitted to the tip, causing the screw to rotate

II. **Steering wheels:** When you turn a steering wheel, you are applying a couple. The force you apply to the wheel is transmitted to the axle, causing the wheels to turn and the vehicle to change direction