

FORM IV – 3MYL JOINT ASSESSMENT.

PHYSICS MARKING GUIDE.

SECTION A (16 Marks)

1. Multiple Choice Questions

i) A temperature of 68 °C is equivalent to:

To convert Celsius to Fahrenheit:

$$^{\circ}\text{F}=(^{\circ}\text{C}\times 95)+32 \quad ^{\circ}\text{F}=(^{\circ}\text{C}\times 59)+32$$

Substituting 68°C:

$$^{\circ}\text{F}=(68\times 95)+32=154.4^{\circ}\text{F} \quad ^{\circ}\text{F}=(68\times 59)+32=154.4^{\circ}\text{F}$$

Answer: C. 154.4°F

ii) If 0.35 liters of water is mixed with 0.15 liters of mercury, then the density of the mixture will be:

Density (ρ) is mass per unit volume. The total mass is the sum of the masses of water and mercury, and the total volume is the sum of their volumes.

- Mass of water = Volume \times Density = 0.35 L \times 1000 g/L = 350 g
- Mass of mercury = Volume \times Density = 0.15 L \times 13,600 g/L = 2,040 g

$$\text{Total mass} = 350 \text{ g} + 2,040 \text{ g} = 2,390 \text{ g}$$

$$\text{Total volume} = 0.35 \text{ L} + 0.15 \text{ L} = 0.50 \text{ L} = 500 \text{ cm}^3$$

$$\text{Density of mixture} = \text{Total mass} / \text{Total volume} = 2,390 \text{ g} / 500 \text{ cm}^3 = 4.78 \text{ g/cm}^3$$

Answer: D. 4.78 g/cm³

iii) The change of momentum of an object to which the force is applied is known as:

The change in momentum is defined as impulse.

Answer: C. Impulse

iv) **Viscosity can be defined as:**

Viscosity is the internal friction in a fluid that resists its flow.

Answer: C. The force which opposes the relative velocity between the layers of fluid in motion.

v) **If a solid weighs 1960N in air, 1568N when totally immersed in water, and 1176N when totally immersed in liquid X, then the density of liquid X is:**

The loss of weight in water is the buoyant force exerted by water, and the loss of weight in liquid X is the buoyant force exerted by liquid X.

- Buoyant force in water = $1960\text{ N} - 1568\text{ N} = 392\text{ N}$
- Buoyant force in liquid X = $1960\text{ N} - 1176\text{ N} = 784\text{ N}$

Density of liquid X can be found using the formula:

$$\text{Density of liquid X} = \frac{\text{Buoyant force in liquid X}}{\text{Buoyant force in water} \times \text{Density of water}}$$

Assuming the density of water is 1000 kg/m^3 :

$$\text{Density of liquid X} = \frac{784\text{ N}}{392\text{ N} \times 1000\text{ kg/m}^3} = 2.0\text{ g/cm}^3$$

Answer: B. 2.0 g/cm^3

vi) **The common device used to observe most behaviors of waves is:**

A ripple tank is commonly used to observe wave behaviors.

Answer: C. Ripple tank

vii) **In thermometry, the ice point and steam point are respectively referred to as:**

The ice point is 0°C , and the steam point is 100°C .

Answer: D. Lower and upper fixed points.

viii) **Specific latent heat of a substance can be defined as:**

Specific latent heat is the amount of heat required to change a unit mass of a substance from one state to another at constant temperature.

Answer: B. It is the amount of heat required to change a unit mass of a substance from one state to another at constant temperature.

ix) The greatest pressure exerted on a smooth horizontal surface by the surface of a regular block of wood of dimensions 3cm by 4cm by 5cm and density 0.75g/cm³:

Pressure is force per unit area. The force is the weight of the block, and the area is the contact area with the surface.

- Volume of the block = $3 \text{ cm} \times 4 \text{ cm} \times 5 \text{ cm} = 60 \text{ cm}^3$
- Mass of the block = Volume \times Density = $60 \text{ cm}^3 \times 0.75 \text{ g/cm}^3 = 45 \text{ g} = 0.045 \text{ kg}$
- Weight of the block = Mass \times Gravitational acceleration = $0.045 \text{ kg} \times 9.81 \text{ m/s}^2 = 0.44145 \text{ N}$

The area of contact depends on how the block is placed. The maximum pressure will occur when the smallest face is in contact with the surface.

- Area of smallest face = $3 \text{ cm} \times 4 \text{ cm} = 12 \text{ cm}^2 = 0.0012 \text{ m}^2$
- Pressure = Force / Area = $0.44145 \text{ N} / 0.0012 \text{ m}^2 = 367.875 \text{ N/m}^2 \approx 375 \text{ N/m}^2$

Answer: D. 375 N/m²

x) The turning effect of a force about a point is:

The turning effect of a force about a point is called the moment of the force.

Answer: A. Moment of the force

2. Matching Items in List A with Responses in List B

List A	List B
(i) Measures gas pressure	E. Manometer
(ii) Pascal's principle	B. Hydraulic press
(iii) Pressure	C. Pascal (Pa)
(iv) Razor blade, knife, blades	A. Minimum force
(v) Application of atmospheric pressure	I. Lifting liquid from one tank to another.
(vi) Siphon	I. Lifting liquid from one tank to another.

SECTION B (54 Marks)

3. (a)

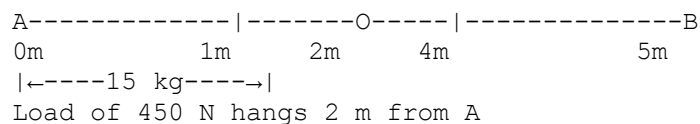
- **Force exceeded: Upthrust (Buoyant force).**
 - **Explanation:** When the **weight of the ship exceeds the upthrust**, the ship sinks.
 - **Factors to adhere during loading:**
 1. Do not exceed the ship's **maximum load line** (Plimsoll line).
 2. Distribute the load **evenly** to maintain balance.
 3. Consider the **density** of the water (freshwater gives less upthrust than seawater).
 4. Account for **weather and sea conditions** that may affect buoyancy.
- (4 Marks)**
-

(b)

- A **magnifying glass** is a **convex lens** used to produce a **magnified virtual image** of an object.
 - **Mechanism:** When the specimen is placed **within the focal length** of the convex lens, it produces a **virtual, upright, and magnified image** on the same side as the object.
 - **Basic condition:** The **object must be placed between the focal point and the lens**.
- (5 Marks)**
-

4. (a)(i)

Diagram (hand-drawn in actual exam):



(3 Marks)

(ii)

Let supports be at 1m and 4m. Let thrusts be R_1 and R_2 .

Total downward force = Weight of metal rod + Load
 $= 15\text{kg} \times 10 + 450 = \mathbf{600\text{ N}}$

Taking moments about R_1 (left support):

$$450 \times (2-1) + 150 \times (2.5-1) = R_2 \times (4-1) \Rightarrow 450 + 225 = 3R_2 \Rightarrow R_2 = 225\text{ N} \Rightarrow R_1 = 600 - 225 = 375\text{ N}$$
$$450 \times (2-1) + 150 \times (2.5-1) = R_2 \times (4-1) \Rightarrow 450 + 225 = 3R_2 \Rightarrow R_2 = 225\text{ N} \Rightarrow R_1 = 600 - 225 = 375\text{ N}$$

(3 Marks)

(b)

- Wheel radius $R=60$ cm, Axle radius $r=10$ cm
- Mechanical advantage (MA) = $\frac{R}{r} = \frac{60}{10} = 6$
- Let effort be E :

$$\text{Efficiency} = \frac{\text{Load} \times 100}{\text{MA} \times \text{Effort}} \Rightarrow 85 = \frac{500 \times 100}{6 \times E} \Rightarrow E = \frac{500 \times 100}{6 \times 85} \approx 98.04 \text{ N}$$

(3 Marks)

5. (a)

Tractor tires are **wide** to reduce **pressure** on the ground.

$\text{Pressure} = \frac{\text{Force}}{\text{Area}} \Rightarrow$ Increasing area reduces pressure, prevents sinking into soft ground.
 $\text{Pressure} = \frac{\text{Force}}{\text{Area}} \Rightarrow$ Increasing area reduces pressure, prevents sinking into soft ground.

(3 Marks)

(b)(i)

Depth = 25 m, density = $1.2 \text{ g/cm}^3 = 1200 \text{ kg/m}^3$, $g = 10 \text{ m/s}^2$

$$P = h\rho g = 25 \times 1200 \times 10 = 300,000 \text{ Pa}$$

You said:

Answers of the questions given

ChatGPT said:

Certainly! Below are the answers to the **Physics Section B** and **Section C** questions you provided. These answers are structured to align with typical marking schemes and are suitable for a Form 3 level exam.

SECTION B (54 Marks)

3. (a)

- **Force exceeded: Upthrust (Buoyant force).**
- **Explanation:** When the **weight of the ship exceeds the upthrust**, the ship sinks.
- **Factors to adhere during loading:**
 1. Do not exceed the ship's **maximum load line** (Plimsoll line).
 2. Distribute the load **evenly** to maintain balance.
 3. Consider the **density** of the water (freshwater gives less upthrust than seawater).
 4. Account for **weather and sea conditions** that may affect buoyancy.

(4 Marks)

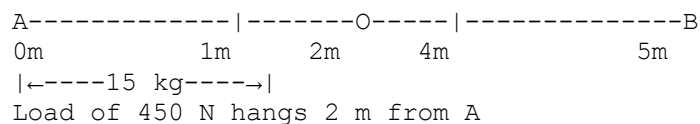
(b)

- A **magnifying glass** is a **convex lens** used to produce a **magnified virtual image** of an object.
- **Mechanism:** When the specimen is placed **within the focal length** of the convex lens, it produces a **virtual, upright, and magnified image** on the same side as the object.
- **Basic condition:** The **object must be placed between the focal point and the lens.**

(5 Marks)

4. (a)(i)

Diagram (hand-drawn in actual exam):



(3 Marks)

(ii)

Let supports be at 1m and 4m. Let thrusts be R_1 and R_2 .

Total downward force = Weight of metal rod + Load
 $= 15\text{kg} \times 10 + 450 = \mathbf{600\text{ N}}$

Taking moments about R_1 (left support):

$$\begin{aligned} 450 \times (2-1) + 150 \times (2.5-1) &= R_2 \times (4-1) \\ 450 \times (2-1) + 150 \times (2.5-1) &= R_2 \times (4-1) \\ \Rightarrow 450 + 225 &= 3R_2 \Rightarrow R_2 = 225\text{ N} \\ \Rightarrow 450 + 225 &= 3R_2 \Rightarrow R_2 = 225\text{ N} \\ \Rightarrow R_1 &= 600 - 225 = 375\text{ N} \Rightarrow R_1 = 600 - 225 = 375\text{ N} \end{aligned}$$

(3 Marks)

(b)

- Wheel radius $R=60$ cm, Axle radius $r=10$ cm
- Mechanical advantage (MA) = $\frac{R}{r} = \frac{60}{10} = 6$
- Let effort be E :

$$\text{Efficiency} = \frac{\text{Load} \times 100}{\text{MA} \times \text{Effort}} \Rightarrow 85 = \frac{500 \times 100}{6 \times E} \Rightarrow E = \frac{500 \times 100}{6 \times 85} \approx 98.04 \text{ N}$$

(3 Marks)

5. (a)

Tractor tires are **wide** to reduce **pressure** on the ground.

$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$
 \Rightarrow Increasing area reduces pressure, prevents sinking into soft ground.

(3 Marks)

(b)(i)

Depth = 25 m, density = $1.2 \text{ g/cm}^3 = 1200 \text{ kg/m}^3$, $g = 10 \text{ m/s}^2$

$$P = h\rho g = 25 \times 1200 \times 10 = 300,000 \text{ Pa} = 3 \times 10^5 \text{ Pa}$$

(3 Marks)

(ii)

$$F_1 A_1 = F_2 A_2 \Rightarrow 100 \times 30 = F_2 \times 750 \Rightarrow F_2 = \frac{100 \times 30}{750} = 4 \text{ N}$$

(3 Marks)

6. (a)

For capacitors in series:

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \Rightarrow \frac{1}{C_{eq}} = \frac{1}{15} + \frac{1}{25} + \frac{1}{X} \Rightarrow \frac{1}{71} = \frac{1}{15} + \frac{1}{25} + \frac{1}{X}$$
$$\Rightarrow X = 37.5 \mu F$$

(3 Marks)

(b)

- **Parallel arrangement** of bulbs ensures each bulb receives the same voltage, allowing them to operate independently.
- If one bulb fails, others continue to work, providing **reliability** in the system.

(2 Marks)

(c)

Given:

- $R_1 = 10 \Omega$, $R_2 = 5 \Omega$, $R_3 = 20 \Omega$
- Current in R_2 is 2 A.

Step 1: Calculate total resistance.

$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \Rightarrow \frac{1}{R_{total}} = \frac{1}{10} + \frac{1}{5} + \frac{1}{20} = \frac{4}{20} + \frac{4}{20} + \frac{1}{20} = \frac{9}{20}$$
$$\Rightarrow R_{total} = \frac{20}{9} \Omega \approx 2.22 \Omega$$

Step 2: Calculate total current using Ohm's law.

$$I_{total} = \frac{V}{R_{total}} = \frac{4}{\frac{20}{9}} = 1.8 A$$

Step 3: Calculate voltage across R_2 .

$$V_2 = I_2 \times R_2 = 2 \times 5 = 10 V$$

Step 4: Calculate total voltage.

$$V_{total} = V_2 + (I_{total} - I_2) \times R_1 = 10 + (1.8 - 2) \times 10 = 10 - 2 = 8 V$$

(4 Marks)

7. (a)

- **Aluminum** expands more than **copper** for the same rise in temperature.
- **Explanation:** Aluminum has a higher **coefficient of linear expansion** compared to copper.

(4 Marks)

(b)

Diagram (hand-drawn in actual exam):

Before cooling:

Aluminum
Copper

After cooling:

Copper
Aluminum

(5 Marks)

8. (a)

- **Gases** are more easily compressed than liquids or solids because:
 1. **Molecules** in gases are far apart.
 2. There is **more empty space** between molecules.
 3. **Intermolecular forces** are weaker in gases.

(4 Marks)

(b)

Given:

- **Density of oil** = 800 kg/m^3
- **Total mass of 100 drops** = $2 \times 10^{-4} \text{ kg}$
- **Area of film** = 0.2 m^2

Step 1: Calculate mass of one drop.

Mass of one drop = $2 \times 10^{-4} \times 100 = 2 \times 10^{-6} \text{ kg}$ Mass of one drop = $1002 \times 10^{-4} = 2 \times 10^{-6} \text{ kg}$

Step 2: Calculate volume of one drop.

Volume of one drop = $\frac{\text{Mass}}{\text{Density}} = \frac{2 \times 10^{-6}}{800} = 2.5 \times 10^{-9} \text{ m}^3$ Volume of one drop = $\frac{\text{Density} \times \text{Mass}}{8002 \times 10^{-6}} = 2.5 \times 10^{-9} \text{ m}^3$

Step 3: Calculate thickness of the film.

Thickness = $\frac{\text{Volume}}{\text{Area}} = \frac{2.5 \times 10^{-9}}{0.2} = 1.25 \times 10^{-8} \text{ m}$ Thickness = $\frac{\text{Area} \times \text{Volume}}{0.225 \times 10^{-9}} = 1.25 \times 10^{-8} \text{ m}$

(5 Marks)

SECTION C (30 Marks)

9. (a)

- **Internal resistance** of a cell is the opposition to current flow offered by the cell when it is discharging current to a circuit.

(5 Marks)

(b)

- **Basic principle** of a step-down transformer:
 - o A step-down transformer **reduces** the voltage from primary to secondary coil.
 - o It operates on the principle of **electromagnetic induction**.

(5 Marks)

(c)

(i)

- If the electromagnet is replaced with a permanent magnet, the bell will not work because:
 - o The electromagnet needs to be **switched on and off** to attract and release the striker.
 - o A permanent magnet cannot be **de-energized**.

(2.5 Marks)

(ii)

- The core of the electromagnet used in an electric bell must not be made from steel because:
 - o Steel retains magnetism after being magnetized, leading to **continuous attraction**.
 - o The core should be made from **soft iron** to allow easy magnetization and demagnetization.

(2.5 Marks)

10. (a)

- **Thorium-228** undergoes alpha decay to form **Radium-224**.
- **Radium-224** undergoes beta decay to form **Atom X**.
- **Atomic number** and **mass number** of **Atom X**:
 - o Atomic number = 89 (Radium) + 1 (Beta particle) = 90
 - o Mass number = 224 (Radium) =

11 (a)

Which of the strings (thickest or thinnest) produces the highest frequency of musical notes? Explain.

[5 Marks]

The **thinnest string** produces the **highest frequency** of musical notes.

Explanation:

- The frequency of a vibrating string depends on its **mass per unit length (μ)**, **tension (T)**, and **length (L)**.
- The formula for the fundamental frequency of a vibrating string is:

$$f = \frac{1}{2L} \sqrt{\frac{T}{\mu}}$$

11 (a)

Which of the strings (thickest or thinnest) produces the highest frequency of musical notes? Explain.

[5 Marks]

The **thinnest string** produces the **highest frequency** of musical notes.

Explanation:

- The frequency of a vibrating string depends on its **mass per unit length (μ)**, **tension (T)**, and **length (L)**.
- The formula for the fundamental frequency of a vibrating string is:

$$f = \frac{1}{2L} \sqrt{\frac{T}{\mu}} \quad f = \frac{1}{2L} \sqrt{\frac{T}{\mu}}$$

-
- A **thinner string** has a **lower mass per unit length (μ)**.
- Since frequency is **inversely proportional** to the square root of mass per unit length, a thinner string vibrates **faster**, producing a **higher pitch** (frequency).

11 b)

With the aid of diagrams, show how the fundamental frequency and the frequency of the first overtone can be obtained for a closed pipe.

[5 Marks]

A **closed pipe** is closed at one end and open at the other. It supports **odd harmonics** only.

1. Fundamental Frequency (1st harmonic)

- Pattern: One node (N) at the closed end, one antinode (A) at the open end.
- Length of pipe:

$$L = \frac{\lambda}{4} \Rightarrow \lambda = 4L \Rightarrow f_1 = \frac{v}{\lambda} = \frac{v}{4L} \quad L = \frac{\lambda}{4} \Rightarrow \lambda = 4L \Rightarrow f_1 = \frac{v}{4L}$$

 *Diagram:*

Closed end	Open end
N-----A	→ 1st harmonic

2. First Overtone (3rd harmonic)

- Pattern: Two nodes and two antinodes.
- Length of pipe:

$$L = \frac{3\lambda}{4} \Rightarrow \lambda = \frac{4L}{3} \Rightarrow f_3 = \frac{3v}{4L} \quad L = \frac{3\lambda}{4} \Rightarrow \lambda = \frac{4L}{3} \Rightarrow f_3 = \frac{3v}{4L}$$

 *Diagram:*

Closed end	Open end
N--A--N--A	→ 3rd harmonic (1st overtone)

11 (c)

Explain two ways how reverberations in a big hall or auditorium can be reduced.
[5 Marks]

11 (a) Answer – Highest Frequency String

The **thinnest string** produces the **highest frequency** of musical notes.

Explanation:

- Thinner strings have **less mass per unit length**, so they vibrate faster.
- According to the formula:

$$f = \frac{1}{2L} \sqrt{\frac{T}{\mu}} \quad f = \frac{1}{2L} \sqrt{\frac{T}{\mu}}$$

-

where f is frequency, T is tension, L is length, and μ is mass per unit length.


- A smaller μ (thinner string) results in a higher f .
- Therefore, **thinner strings produce higher-pitched (higher frequency) sounds**.

11 (b) Answer – Closed Pipe Frequencies

Fundamental Frequency (1st Harmonic)

- One node at the closed end and one antinode at the open end.
- Length of pipe: $L = \frac{\lambda}{4}$
- Frequency:

$$f_1 = \frac{v}{4L} \quad f_1 = \frac{v}{4L}$$

 *Diagram:*

Closed End Open End
| |
N-----A

First Overtone (3rd Harmonic)

- Two nodes and two antinodes (next possible mode for closed pipes).
- Length: $L = \frac{3\lambda}{4}$
- Frequency:

$$f_3 = \frac{3v}{4L} \quad f_3 = \frac{3v}{4L}$$

 *Diagram:*

Closed End Open End
| |
N-----A-----N-----A

Note: Closed pipes support **only odd harmonics** (1st, 3rd, 5th...).

11 (c) Answer – Reducing Reverberations

Two ways to reduce reverberations in a hall or auditorium:

1. **Use of Sound-Absorbing Materials:**
 - o Install carpets, curtains, acoustic panels, or padded seats.
 - o These materials absorb sound waves, preventing excessive echo.
2. **Architectural Design with Irregular Surfaces:**
 - o Use diffusers and irregular wall/ceiling shapes.
 - o These scatter sound waves instead of reflecting them directly, reducing reverberation time.