

INSTRUCTIONS:

- This paper consists of **ten (10) questions** in sections A and B.
- Answer **all questions** from section A and **two (02) questions** from section B.
- Each question carries ten (10) marks in section A and fifteen (15) marks in section B.
- Mathematical table and non-Programmable Calculators **may be used**.
- Cellular phones are not allowed in the examination room.
- Write your **examination number** on every page of your answer booklet(s)
- The following information **may be useful**.

- Acceleration due to gravity, $g = 9.8m/s^2$.
- Density of air = $1.225kg/m^3$
- Pie, $\pi = 3.14$
- Molar gas constant = $8.31J/mol K$
- Plank's constant = $6.62 \times 10^{-34} Js$
- Speed of light in air = $3 \times 10^8 m/s$
- Molar mass of nitrogen $N_2 = 28g$
- Stefan's constant $\sigma = 5.7 \times 10^{-8} Wm^{-2} K^{-4}$
- Specific heat capacity of copper $C_{copper} = 390\text{Jkg}^{-1}\text{K}^{-1}$ Atmospheric pressure
 $= 1.01 \times 10^5 \text{Nm}^{-2}$ Atomic mass of oxygen molecules $O_2 = 32g$ Ratio of molar heat capacity of diatomic molecules $\gamma = 1.4$ Ratio of molar heat capacity of monoatomic gas $\gamma = 1.67$ Coefficient of viscosity of water $\eta_{H_2O} = 1.0 \times 10^{-3} Pas$

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SECTION A:
Answer ALL questions from this section

1. (a) (i) The thickness of metre ruler is 0.51 ± 0.02 cm. What does this mean? (02 marks)
 - (ii) A body moving through fluid at a speed v experiences a opposing force F given by $F = kA\rho v^x$, where A is the surface area of the body, ρ is the density of fluid and k is a dimensional less constant. Deduce the value of x . (03 marks)
 - (b) Estimate the numerical value of the drags force $D = \frac{1}{2} c \rho A v^2$ with its associated error. Given that the measurements of the quantities c , A , ρ and v were recorded as (10 ± 0.01) , $(5 \pm 0.2) \text{cm}^2$, $(15 \pm 0.15) \text{g/cm}^3$ and $(3 \pm 0.5) \text{cm/s}$ respectively. (05 marks)
2. (a) (i) What is meant by the term range of a projectile. (01 marks)
 - (ii) Show that the maximum range of a projectile having an initial velocity is obtained when it is projected at an angle of 45° to the vertical. (02 marks)
 - (b) Find the range of a ball which when projected at a velocity of 29.4m/s just passes over a pole 4.9 m high. (04marks)
 - (c) If the horizontal range of the projectile is R and the maximum height it attains is H , show that the velocity of projection is:

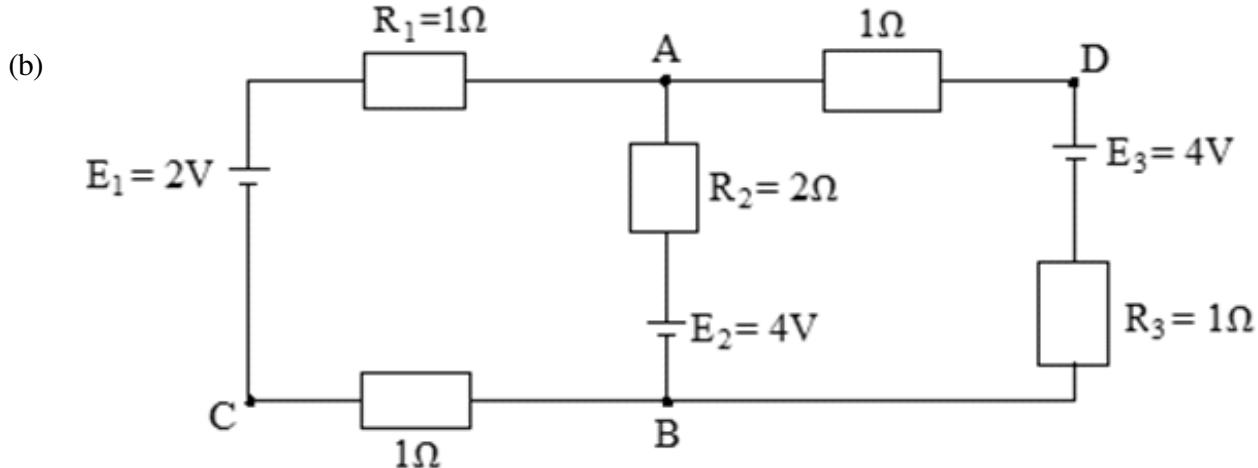
$$u = 2g \left(H + \frac{R^2}{16H} \right)^{\frac{1}{2}} \quad (\text{03 marks})$$
3. (a) Briefly explain why a simple pendulum experiment cannot be performed inside a satellite. (03 marks)
 - (b) Consider two discs in the figure below, with mass less spring of force constant 100N/m . calculate the frequency of oscillation of the spring;
 - (i) When the system is resting on a table (03 marks)
 - (ii) When the table is removed and system is falling freely. (04 marks)
- The diagram shows two rectangular discs, $M_1 = 100\text{g}$ and $M_2 = 200\text{g}$, connected by a spring. They are resting on a horizontal surface labeled "Table". The discs have diagonal hatching patterns.
4. (a) (i) Explain what is meant by centripetal force. (01 marks)
 - (ii) Briefly explain why passengers sitting in a vehicle are thrown outward when a vehicle rounds the curve suddenly. (02 marks)
 - (b) For a particle of mass m to be in a vertical circular path, centripetal force is responsible for providing the correct path of the mass. Also in the path, the particle experiences tension on the string to which it is tied. Show that when it is at the lowest point of the motion the minimum velocity of the body is given by $v = \sqrt{5rg}$, where r is the radius of its path. (04 marks)
 - (c) The driver of a truck travelling at a speed v suddenly notices a broad wall in front of him at a distance r . Is it better for him to apply brakes or to make a circular turn without applying brakes in order to just avoid crashing into the wall? (03 marks)

5. (a) A thermometer has wrong calibration. If it records the melting point of ice -10°C and it reads 60°C in place of 50°C . What is the temperature of the boiling point of water on this scale? (05marks)
- (b) The resistance R_0 of a particular resistance thermometer at a Celsius temperature θ as measured by constant volume gas thermometer is given by $R_0 = 50 + 0.7\theta + 0.0003\theta^2$. Calculate the temperature as measured on the scale of resistance thermometer which corresponds to a temperature of 60°C on the gas thermometer. (03 marks)
6. (a) Briefly explain what is meant by adiabatic process. (02 marks)
- (b) In adiabatic process, no heat enters or leaves the system. Briefly explain what happens to the internal energy of the gas under the following conditions;
- When the gas expands adiabatically. (02 marks)
 - When the gas is compressed adiabatically. (02 marks)
- (c) An ideal monatomic gas of 0.15 moles is enclosed in a cylinder at a pressure of 250kPa and a temperature of 320K. The gas is allowed to expand adiabatically and reversibly until its pressure is 100kPa. Calculate the final temperature and the amount of work done by the gas. (04 marks)
7. (a) (i) The main interior of the earth core is believed to be in molten form.
What is seismic evidence supporting this belief? (03 marks)
- (ii) Explain why the ozone layers on the top of the stratosphere is crucial for human survival? (03 marks)
- (b) (i) List down four physical changes that takes place at a location just before onset of an earth quake at that particular location. (02 marks)
- (ii) What are the advantages of wind breaks to plant environment? (02 marks)

SECTION B:

Answer any Two (2) questions from this section

8. (a) (i) Briefly explain why electrical appliances are connected in parallel at home? (02 marks)
- (ii) A resistor R in series with capacitor C is connected to 50Hz, 240V supply. Find the value of



- (i) Find the current through R_2 . (03 marks)
- (ii) Find the potential difference between point C and D (03 marks)
- (c) (i) What is the advantage of using a greater length of potentiometer wire. (02marks)

- (ii) Why is Wheatstone bridge not suitable for measuring low resistances? **(02 marks)**
9. (a) (i) An operating amplifier has an open loop gain of 10,000. Calculate the amplifier gain when 50% of the output is fed back to the inverting input. **(03 marks)**
- (ii) The figure below has a supply voltage of 15V. The input resistance is $1.6\text{k}\Omega$, and the feedback resistance is $20\text{k}\Omega$. Calculate the output voltage when the input voltage is 1.8V **(02marks)**
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- (b) (i) What do you understand by the term logic gate? **(01 marks)**
- (ii) In the circuit shown in figure below, identify the equivalent gate of the circuit. **(03 marks)**
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- (c) (i) Why high frequency carrier waves are needed for effective transmission? **(02 marks)**
- (ii) A 10 MHz sinusoidal carrier wave of amplitude 10 mV is modulated by a 5 kHz sinusoidal audio signal wave of amplitude 6 mV. Find the frequency components of the resultant modulated wave and their amplitude. **(04 marks)**
10. (a) (i) Why is the conductivity of an intrinsic semiconductor is very low? **(02 marks)**
- (ii) Briefly explain why the energy gap varies with doping? **(02 marks)**
- (iii) The forbidden energy gap of silicon is 2.25eV. What is the maximum wavelength at which silicon absorbs energy? **(03 marks)**
- (b) (i) Briefly explain why a bridge rectifier is preferred than centre tap rectifier? **(02 marks)**
- (ii) Briefly explain if zener diode can be used as rectifier? **(01 marks)**
- (c) In the circuit below, what is the voltage needed to maintain 12V across the load resistor, of $2.1\text{k}\Omega$ assuming that the series resistance R is 150Ω , and the zener requires a minimum current of 8mA to work effectively. What is the zener rating required?

