**131/1** **PHYSICS 1**

# MARKING SCHEME

1. (a) (i) - The data obtained by first student Michael are more precise but not accurate. This means that data are very close to each other but are not nearly approximated to value in other hand **(01 marks)**

- The data obtained by the second students Mathew are more accurate but not precise. This means that data are not close to each other butare nearly approximated to the real value. **(01 marks)**

- The data obtained by the third student Raphael are both accuracy and precise. means that data are very close to each other and are very nearly approximated to real value. **(01 marks)**

(ii) Percentage error for each student.

Error for Michael ($\Delta X_1$)

$$\Delta X_1 = \frac{(60-57.5)+(60-57.49)+(60-57.49)+(60-57.48)}{4} = 2.51$$

$$P.E = \frac{\Delta X_1}{X_1} x100\% = \frac{2.51}{60} x100\% = 4.18\%$$ **(01 marks)**

$\therefore$ percentage error for Michael is $4.18\%$

Error for Mathew ($\Delta X_1$)

$$\Delta X_1 = \frac{(60-60.30)+(60-59.8)+(60-60)+(60-59.7)}{4} = \frac{0.8}{4} = 0.20$$

$$P.E = \frac{\Delta X_1}{X_1} x100\% = \frac{0.20}{60} x100\% = 0.33\%$$ **(01 marks)**

$\therefore$ percentage error for Michael is $0.33\%$

Error for Raphael ($\Delta X_1$);

$$\Delta X_1 = \frac{(60-60.02)+(60-60)+(60-60)+(60-60)}{4} = \frac{0.02}{4} = 5x10^{-3}$$

$$P.E = \frac{\Delta X_1}{X_1} x100\% = \frac{5.0x10^{-3}}{60} x100\% = 8.33x10^{-3}\%$$ **(01 marks)**

(b) Given $V = xt^2 + yt + z$

$[V]=M^{\circ}LT^{-1}$; Apply the principle of homogeneity; $[V]=[xt^2]+[y.t]+[z]$

$$[x] = \frac{[v]}{[t^2]} = [x] = \frac{[M^0LT^{-1}]}{[M^0L^0T^2]} = [M^0LT^{-3}] = [x] = [M^{\circ}LT^{-3}]$$ .............(i) **(01 marks)**

Similarly, $[V]=[yt]$

$$[y] = \frac{[v]}{[t]} = [x] = \frac{[M^0LT^{-1}]}{[M^0L^0T]} = [M^0LT^{-2}] = [y] = [M^{\circ}LT^{-2}]$$ .............(ii) **(01 marks)**

$$[x] = \frac{[M^0LT^{-1}]}{[M^0L^0T^2]} = [M^0LT^{-3}]$$

$y = [M^{\circ}L^1T^{-2}]$ ...................(ii) **(01 marks)**

Similarly: $[V] = [z]$

$[V] = [M^{\circ}L^1T^{-1}]$ **(01 marks)**

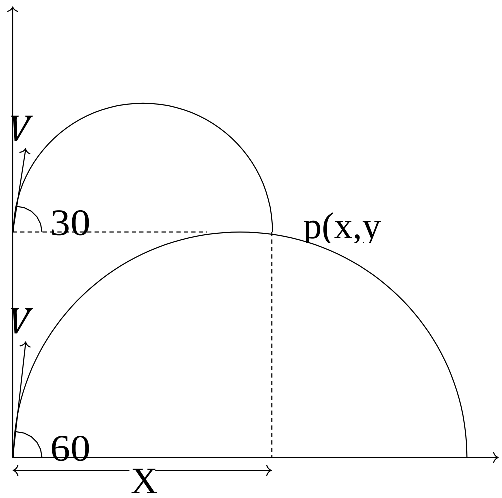
Hence:

Unit of $x = ms^{-3}$, Unit of $y = ms^{-2}$ and $z = ms^{-1}$ **(01 marks)**

2. (a) (i) Before shaking the carpet, the dust was at rest. On beating or shaking the carpet, the dust still at rest due to inertia as a result dust got removed from the carpet.

(ii) Water is ejected with a large forward force (action) from the Newton's 3rd law of motion, the fire man experiences a large backward force and feels difficulty in holding hose.

(b) (i) Consider the illustration below




At point of collision; $X_A = X_B$

$V_A \cos 30^\circ . t = V_B \cos 60^\circ . t;$

$V_A = \dfrac{30 \cos 60^\circ}{\cos 30^\circ}$

$\therefore V_A = 17.32 \text{m/s}$

Also; $y_A = y_o + V_A \sin 30^o .t - \frac{1}{2} gt^2$, and

$y_B = V_B \sin 60^o .t - \frac{1}{2} gt^2$

At point of collision; $y_A = y_B$

$y_A = y_o + V_A \sin 30^o .t - \frac{1}{2} gt^2 = y_B = V_B \sin 60^o .t - \frac{1}{2} gt^2$

$y_o + V_A \sin 30^\circ . t = V_B \sin 60^\circ . t$

$2 + 17.32 \sin 30^\circ . t = 30 \sin 60^\circ . t$

$2 + 8.16t = 25.98t$

$t = \dfrac{2}{17.32}$

$t = 0.115 \text{sec}$

(ii) $X_A = V_A \cos 30^\circ . t$

$X_A = 17.32 \cos 30^\circ \times 0.115 X_A = 1.8 \text{m}$

$\therefore$Horizontal displacement is 1.8M

3. (a) (i) When water is in the bucket, they are moving forward and they would like to keep going that way by centripetal force which is given by $Fg = \frac{mv^2}{R}$ ,where $F_g$ is gravitational force. If $F_g \rangle \frac{mv^2}{R}$ water in the bucket will spill out ,but if $F_g \langle \frac{mv^2}{R}$ , water will continue moving forward.

(ii) From; $P.E_P = K.E_\theta ; P.E = mgh$ and $K.E = \frac{1}{2}mv^2$

$mgh = \frac{1}{2}mv^2$ ,But velocity V at $v_\theta = \sqrt{5Rg}$

$gh = \frac{1}{2}\sqrt{5Rg}$ ,Making h the subject $h = \frac{5}{2}R$

4. (b) (i) The restoring force is proportional to the displacement and must act to theopposite direction to the displacement

(ii) Given: V=1.8m/s, y=0.6m, a=2.4m/s$^2$

(ii) From ; $a = \omega^2 y$ ,making $\omega$ subject

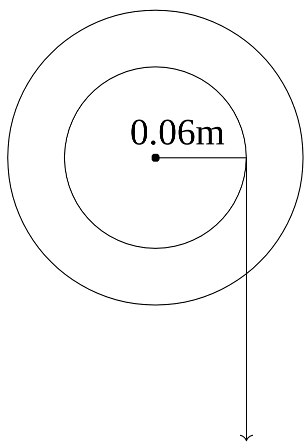
$\omega^2 = \frac{a}{y} = \frac{2.4}{0.6} = 4; \omega = \sqrt{4} = 2rad/s$ ,But $\omega = \frac{2\pi}{T}; T = \frac{2\pi}{2} = \pi \sec$

(ii) For Amplitude;

From $v = \omega\sqrt{A^2 - y^2}$ ;Making A subject

$A = \sqrt{\frac{v^2}{\omega^2} + y^2} = \sqrt{\frac{(1.8)^2}{2^2} + (0.6)^2} = 1.17m$

5. (a) (i) Solution




(a) (i) Given that; Torque; $\tau = Forcexradius = 50x0.06 = 3Nm$ ,if I = 4 kgm$^2$ , radius r = 0.06 m

From; $\tau = I\alpha; \alpha = \frac{\tau}{I} = \frac{3Nm}{4kgm^2} = 0.75rad/s^2$

(ii) Again from ; $\theta = \omega_o t + \frac{1}{2}\alpha t^2$ ,Suppose $\omega_o = 0rad/s$ ,then $\theta = \frac{1}{2}\alpha t^2 = \frac{1}{2}x0.75x16^2 = 96rad$

Hence $1rev = 2\pi rad$ ,then 96 rad will be; $x = \frac{96}{2\pi} = 15rev$

(b) (i) From ; $v = \sqrt{2gr}$ ,where r is the radius of the Earth. Then velocity does not depend on the mass of the projected object, so the velocity will be the same.

(ii) From ,weight $W = mg = \frac{GMm}{R^2}$ ,Where by; m = Mass of the object

M = Mass of the Earth, R = Radius of the Earth and G = Gravitational constant

If reduced by 1% then, new radius , $R_N = 0.99R$ .From ; $g' = \frac{GM}{(0.99R)^2} = 1.02\frac{GM}{R^2}$

But $\frac{GM}{R^2} = g_e$ ,whose value is 9.79 m/s$^2$.From above; $1.02x9.79 = 9.99m/s^2$

$\therefore$ The new value of acceleration due to gravity will be ; $9.99m/s^2$

6. (a) ( i) Thermometric property of a material refers to the property of material tochange with temperature OR Thermometric property is the property of the substance which varies with temperature and can bein the construction of thermometer

(ii) From the formula of calibration of thermometer.

For gas thermometer; $\theta_g = \left(\frac{P_\theta - P_0}{P_{100} - P_o}\right)x100^o C$ .Substituting the values given;

$$\theta_g = \left(\frac{1.528x10^5 - 1.333x10^5}{1.821x10^5 - 1.333x10^5}\right)x100^o C = 39.96^o C$$

For Resistance thermometer; $\theta_R = \left(\frac{R_\theta - R_0}{R_{100} - R_o}\right)x100^o C$

$$\theta_R = \left(\frac{34.59 - 30}{40.64 - 30}\right)x100^o C = 39.64^o C$$

(b) (i ) Tiles are better heat conductor than wood. The heat will be transferredfrom your foot more quickly to the tiles than to the wood.

(ii) According to Newton's law of cooling

Solution.

From $Kt = In\left[\frac{\theta_i - \theta_S}{\theta_f - \theta_S}\right], K5 = In\left[\frac{40-15}{30-15}\right], 5K = In\left[\frac{25}{15}\right], K = \frac{1}{5}In\left[\frac{5}{3}\right]$................(1)

If the body cools for further 5 minutes, $10K = In\left[\frac{40-15}{\theta - 15}\right]$, $K = \frac{1}{10}In\left[\frac{25}{\theta - 15}\right]$.....(2)

Equating the two equations above; $\frac{1}{5}In\left[\frac{5}{3}\right] = \frac{1}{10}In\left[\frac{25}{\theta - 15}\right]$ ,Solving for $\theta ; \theta =$

7. (a) (i) First law of thermodynamics states that; ;" The heat energy applied in a closed system is equal to the increase in internal energy of the system and external work done by the gas system"

Limitations of 1st law of thermodynamics;

(i)The law doesn't indicate the direction of flow of heat.

It is known that, always heat flows from high temperature region to low temperature region.

But the law doesn't explain why heat can't flow from cold body to hot body.

(ii)The law doesn't tell anything about the condition under which heat can be converted into work. The law doesn't clarify the state that must be reached by the system so as to convert heat energy into mechanical work.

(iii)Also the law doesn't explain why the conversion of heat energy is not 100% efficiency.

(b)(i) Wien's displacement law is the law that indicate how the radiation spectrum varies as the temperature changes. Its limitation is limited on long wavelength. At high wavelength the temperature must be very low which make difficult to obtain the continuous Wien's curve.

**(02 marks)**

**(i)** Hence the process took place under isobaric condition

$W = P(V_2 - V_1) = 1.013x10^5 x(1671-1)x10^{-6} = 184.201J$

**(ii)** From first law of thermodynamics; $dQ = dU + dW$

For steam $dQ = mL_v = 1x10^{-3} x2.256x10^6 = 2256\,J$ hence making $dU$ subject and substituting the values; $dU = dQ - dW = (2256 - 184.201) = 2071.8J$

(ii) **Solution**

Surface area of the lamp $A = \pi dl = 3.14 \times (6 \times 10^{-5} m) \times 0.5m = 9.42 \times 10^{-5} m^2$

Since $P = 60W$ and $e = \dfrac{80\%}{100\%} = 0.8$, then from $P = e\sigma AT^4$

$$T = \left(\frac{P}{e\sigma A}\right)^{\frac{1}{4}} = \left(\frac{60W}{0.8 \times (5.7 \times 10^{-8} Wm^{-2}K^{-4}) \times 9.42 \times 10^{-5} m^2}\right)^{\frac{1}{4}} = 1933K$$

(a) (i) When P and S seismic waves are sent from one side of the earth to the other, only P-waves can be detected on the other side **WHILE** S-wavesdo not pass through the core provides the evidence that the core consistsof a liquid core (**03 marks**)

(ii) Ozone absorbs harmful radiation from the sun. The ozone protects plantand shield people from skin cancer and eye cataracts (**03 marks**)

(b) (i)To control soil erosion by eliminating plant roots stresses thus favor plant growth condition (01 marks)

It controls pesticide spray drift and provide buffers to delineateproperty lines and protect neighbors (**01 marks**)

(ii)-Changes on the density of rocks

-Occurrence of stresses

-Faults

-Waves

9. (a) (i) A.C does not carry larger current in electrical supplies than D.C. Also most of domestic appliances use D.C (**02 marks**)

(ii)First Kirchhoff's law states that; "The algebraic sum of current entering the junction is equal to the algebraic sum of electric current leaving the junction"

This law implies Conservation of electric charges

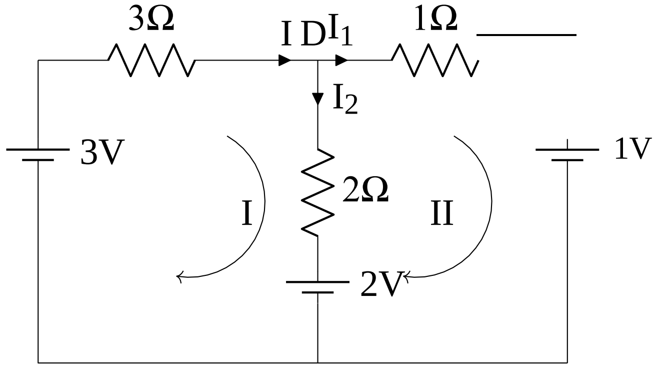
Kirchhoff's second law states that;" The sum of electromotive force is equal to the sum of the product of electric current and resistance in a given loop"

This law implies Conservation of energy in a given loop

(b) (i) Junction is the point whereby various electric connection meet.

(**02 marks**)

(ii) Consider




At D, $I = I_1 + I_2$

Applying KVL around loop I

$3I + 2I_2 + 3V - 2V = 0$ ;But $I = I_1 + I_2$

$1V = 3(I_1 + I_2) - 2I_2$

$1V = 3I_1 + I_2$..............................(i) **(01 marks)**

Loop II

$2 - 2I_2 + I_1 - 1V = 0$; $1V = 2I_2 + I_1$..........................(ii) **(01 marks)**

Solving simultaneously, (i) and (ii) $I_1 = 0.2A$ and $I_2 = 0.4A$

$I = I_1 + I_2$; $I = 0.2 + 0.4 = 0.6$

$\therefore$Current through $3\Omega$ is 0.6A

Current through $1\Omega$ is 0.2A

Current through $I_2$ is 0.4A **(01 marks)**

(c) (i) Inductive reactance of the coil; $X_L = 2\pi fL = 2\pi x50x31.8x31.8x10^{-3} = 10\Omega$

Impedance , $Z = \sqrt{R^2 + X_L^2} = \sqrt{7^2 + 10^2} = 12.2\Omega$

Current , $I_V = \frac{E_V}{Z} = \frac{230}{12.2} = 18.85A$ (01 marks)

(ii) Power factor= $\cos\theta = \cos 55^\circ = 0.573$ **(01 marks)**

(iii) Power consumed, $P = E_V I_V \cos\theta = 230x18.85x\cos 55^o = 2424.24W$ **(01 marks)**

8. (a) (i) $A = \frac{A_O}{1 + \varepsilon_o A} = \frac{10000}{1 + (0.5x10000)} = 10$

(ii) $A = -\frac{R_f}{R_i} = -\frac{20000}{1.6x10^3} = -12.5$

$V_{out} = AV_{in} = -12.5X1.8 = -22.5V$

But the supply voltage is + 15 V, so the OPAMP saturates and the output is – 15V

(b) (i) Logic gate is a basic building block of a digital circuit.

Logic gates have inputs and outputs that are Boolean values, which means that they have one of two values. **(02 marks)**

(ii) truth table **(02 Marks)**

| A | B | A’ | B’ | Y’=A’+B’ | Y= $y'$ |
|---|---|---|---|---|---|
| 0 | 0 | 1 | 1 | 1 | 0 |
| 0 | 1 | 1 | 0 | 1 | 0 |
| 1 | 0 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 | 1 |

(iii) The equivalent gate of the circuit is an AND gate (01 mark)

(c) (i) Because high frequency carrier waves allow smaller antenna design

(ii)Lower side Band (LSB) , $f_c - f_m = (1000-5) = 995kHz$

Upper side Band (USB), $f_c + f_m = (1000+5) = 1005kHz$

Amplitude of each Band; $\frac{MaE_C}{2} = \frac{0.5x1000}{2} = 250V$

10. (a) (i) A P-n junction allows a large current to flow through it when forward biased and it offers a high resistance when it is reverse biased. This unidirectional property is similar those of a vacuum diode. Hence p-n junction is also called a junction diode. (**02 marks**)

(ii) When p-n junction is reverse biased the positive terminal of the external battery is connected to N-side of p-n junction and its negative terminal to P-side of P-n junction. Due to it the junction and this increases the width of the depletion layer (**01 marks**)

**solution.**

(i) P.d across R; $V_{RI} = \left[\frac{R_1}{R_1+R_2}\right]V_{CC} = \left[\frac{39}{39+3.9}\right]22 = 20V$

P.d across R2, $V_{R2} = V_{CC} - V_{RI} = 22-20 = 2V$ ,If $V_{R2} = V_{BE} + I_E R_E$ ,But $\alpha = \frac{I_C}{I_E}$, then $I_E = \frac{I_C}{\alpha}$ From above; $V_{R2} = V_{BE} + \frac{I_C}{\alpha}R_E$

From Collector –Emitter circuit above; $V_{CC} = I_C R_L + V_{CE} + I_E R_E$ $V_{CC} = I_C R_L + V_{CE} + I_E R_E$

$V_{R2} = V_{BE} + V_{RE}$; $I_E = \frac{V_{R2} - V_{BE}}{R_E} = \frac{2-0.7}{1.5x10^3} = 8.67x10^{-4} A$

From above.

(ii) $\alpha = \frac{I_C}{I_E}$, $therefore, I_C = \alpha I_E = 0.993x8.67x10^{-4} A = 8.61x10^{-4} A.$

(iii) And $V_{CC} = I_C R_L + V_{CE} + I_E R_E$

Making $V_{CE}$ the subject and substituting the values;

$V_{CE} = V_{CC} - (I_C R_L + I_E R_E) = 22 - (8.61x10^{-4} x10x10^3 + 8.67x10^{-4} x1.5x10^3)$; $V_{CE} = 12.09V$

(c)(i) From the relation; $V_o = -R_f\left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}\right)$,Substituting the above values ;

$V_o = -20\left(\frac{6}{10} + \frac{4}{12} - \frac{3}{14}\right) = 14.38\text{V}$

(ii) The circuit above can be used as music mixer.