FORM SIX SYNDICATE EXAMINATIONS

131/1-PHYSICS 1 MARKING SCHEME

1.(a)(i) No, the value of n cannot be a fraction. The principle of homogeneity of dimensions requires all terms in an equation to have the same dimensions. Since rate has units of moles/liter/second, and $[H_2O_2]$ has units of moles/liter, the order of the reaction (n) must be dimensionless (no units) to ensure the correct overall units for the rate equation. **(02 marks)**

(ii) If $v_{es} = \sqrt{\frac{R}{2GM}}$ and $v^2 = \frac{R}{2GM} \longrightarrow$ $[v]^2 = \frac{[R]}{[G][M]}$ *(01 mark)*

$L^2T^{-2} \neq L^{-2}T^2$ *(01 mark)*

The formula is WRONG. *(01 mark)*

(b) Least count error in diameter, $\Delta d = \frac{0.5mm}{50} = 0.01mm.$ *(01 mark)*

Diameter of solid ball, $d = 2.5 + (0.01\times 20) = 2.70mm.$ *(01 mark)*

Density of ball material, $\rho = \frac{m}{vol} = \frac{24m}{4\pi d^3} \longrightarrow$

$ln\rho = \ln ln\left(\frac{24}{4\pi}\right) + \ln ln\, m - 3d$.

$\longrightarrow \frac{\delta\rho}{\rho} = \frac{\delta m}{m} + 3\frac{\delta d}{d}$ and percentage error in $\rho = p_m + 3\times\frac{\delta d}{d}\times 100\%.$ *(01 mark)*

$= 2.0\% + \left(3\times\frac{0.01mm}{2.70mm}\times 100\%\right)$ *(01 mark)*

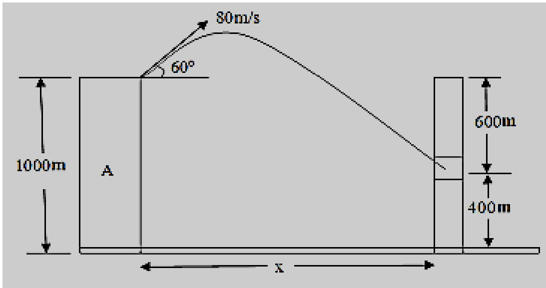
$= 2.0\% + 1.11\% = 3.11\%.$ *(01 mark)*

2 (i) If there is no external force acting to the system, the total momentum is always conserved. **(01 mark)**

ii)Since there is no external force acting on the system the speed of trolley remains constant. **(1.5)**

The trolley comes to rest at original position in the final motion due to force of reaction. **(1.5)**

(b)



(02 marks)

i) Using $-h = V_0 \sin \sin \theta t - \frac{1}{2} g t^2$ **(01 mark)**

$-600 = 80 \sin \sin 60° t - 4.9 t^2$

Hence it will take 20.2 seconds to hit the window of the second building **(01 mark)**

ii) $X = V_0 \cos \cos \theta t$ **(1)**

Hence the distance between buildings is 808 m **(011 mark)**

3. (a)(i) Because waves are phenomenon not objects. The oscillating object does not lose any energy in SHM. *(02 marks)*

(ii) From; $= A\, sin\omega t$. *(01 mark)*

$\longrightarrow$ $v = \frac{dy}{dt} = \omega A\, cos\omega t$ and $a = \frac{d^2 y}{dt^2} =- \omega^2 A\, sin\omega t = \omega^2 A\, sin(\omega t + \pi)$.

(01 mark)

The phase difference between acceleration and displacement = $(\omega t + \pi) - \omega t = \pi$ rad. Or 180°. Hence shown. *(01 mark)*

(b) $a =- \omega^2 x$. Considering magnitude only, $= \sqrt{\frac{a}{x}}$. *(01 mark)*

$\omega = \sqrt{\frac{8.60}{0.575}}$ Hz $= 3.87$ Hz. *(01 mark)*

From: $v = \omega\sqrt{A^2 - x^2}$ where A = amplitude. $A = \sqrt{\left(\frac{v}{\omega}\right)^2 + x^2}$ *(01 mark)*

$= \sqrt{\left(\frac{2.50}{3.87}\right)^2 + 0.575^2}$ m

Amplitude, $A = 0.865m$. *(01 mark)*

The distance moved by the object just before it stops momentarily $= 0.865m - 0.575m = 0.29m$. *(01 mark)*

4. (a)(i) This increases the perpendicular distance from the hinge where the axis of rotation is located as a result little force is required to provide sufficient torque needed to rotate the door while opening. *(02 marks)*

(ii) $f_{min} = \frac{mg\, sin\theta}{1+\frac{mr^2}{I}}$. But $I_{sphere} = \frac{2}{5}mr^2$, substituting we have;

$$f_{min} = \frac{2}{7}mg\, sin\theta. \qquad \textit{(01 mark)}$$

$$= \frac{2}{7}\times5\times9.8\times sin30^o \qquad \textit{(01 mark)}$$

Needed minimum frictional force = $7.0\ N$. *(01 mark)*

(b) From $mg = \frac{GM_E m}{R_E}$ (At normal situation) **(01 mark)**

$$M_E = \frac{gR_E^2}{G} = \frac{10\times(6.4\times10^6)^2}{6.67\times10^{-11}} = 6.14\times10^{24}kg$$ **(01 mark)**

For the Relative density of 11.3, density $11300kgm^{-3}$ **(01 mark)**

New mass $M_E^I = \rho\times V = \rho\times\frac{4}{3}\pi R^3 = 11300\times\frac{4}{3}\times3.14\times(6.4\times10^6)^3$

$$M_E^I = 1.24\times10^{25}kg$$ **(01 mark)**

Since $g\alpha M$

$$g^I = g\left(\frac{M_E^I}{M_E}\right) = 10\times\left(\frac{1.25\times10^{25}}{6.14\times10^{24}}\right) = 20.2Nkg^{-1}$$ **(01 mark)**

5 (i)This is because different thermometric properties do not change proportionally with the same change in degree of hotness. **(02 marks)**
(ii) Due to it, when a car is left in the sun, heat radiations form the sun gets into the car but as the temperature inside the car is moderate, they do not pass back through its windows. Hence, the air inside the car becomes considerably warmer. **(3)**

(b) The amount of heat flowing into water through the brass base of the boiler is given by: $Q = \frac{KA(\theta_1 - \theta_2)t}{l}$ ……………………………………………….…..... (i) **(01 mark)**

Where,

θ_1 = Temperature of the flame in contact with the boiler

θ_2 = Boiling point of water 100℃

Heat required for boiling the water:

$Q = mL$ ………………………………………………………….. (ii) **(01 mark)**

Equating equations **(i)** and **(ii)**, we get:

$mL = \frac{KA(\theta_1 - \theta_2)t}{l}$ **(01 marks)**

$\theta_1 - \theta_2 = \frac{mLl}{KAt}$

$\theta_1 - \theta_2 = \frac{6\times2256\times10^3}{109\times0.15} = 137.98℃$

$\theta_1 - 100℃ = 137.98℃$

The temperature of the part of the flame in contact with the boiler is 237.98℃ **(02 marks)**

6. (a) From;-

$$R_t = R_o(1 + at + bt^2)$$

$$R_0 = R_o$$

$$R_{100} = R_o(1 + 3.8\times10^{-3}\times100 + 5.6\times10^{-7}\times100^2) = 1.3856R_o$$ **(01 mark)**

$$R_{100} = R_o(1 + 3.8\times10^{-3}\times200 + 5.6\times10^{-7}\times200^2) = 1.7824R_o$$ **(01 mark)**

Since,

$$\theta = \left(\frac{R_{200} - R_0}{R_{100} - R_0}\right)\times100^oC$$ **(01 mark)**

$$= \left(\frac{1.7824R_o - R_o}{1.3856R_o - R_o}\right)\times100^oC = 202.9^oC$$ **(01 mark)**

(b) (i) From;-

$$P_1^{I-\gamma}T_1^{\gamma} = P_2^{1-\gamma}T_2^{\gamma}$$

$$T_2^{\gamma} = T_1^{\gamma}\left(\frac{P_2}{P_1}\right)^{1-\gamma}$$ **(01 mark)**

$$T_2^{\gamma} = 320^{1.67}\left(\frac{100}{250}\right)^{1-1.67}$$ **(01 mark)**

$$= 462.2K$$ **(01 mark)**

(ii) Work done in adiabatic $W = \frac{nR}{\gamma - 1}(T_1 - T_2)$ **(01 mark)**

$$= \frac{0.15 \times 8.31}{1.67 - 1} \times (320 - 462)$$ **(01 mark)**

$$= -26.42J$$ **(01 mark)**

7. a)(i) Tap water often has added chemicals as it is treated and recycled for human consumption. Rainwater has a higher level of oxygen and is free from harmful mineral additives found in tap water. *(02 marks)*

(ii) 1. Solar energy – is the energy fetched from electromagnetic radiation emitted from the sun which can be converted into usable form of energy.

2. Wind energy – is the kinetic energy of air in motion which can be converted into electrical energy, mechanical, pumping water etc.

3. Geothermal energy – is the energy derived from the heat of the Earth which can be used to generate electricity.

4. Water energy – is the kinetic energy of flowing water which can be used to drive turbines in order to generate electricity (hydroelectric power), transport material etc.

5. Wave energy – is the transport of energy by ocean surface waves and capture of that energy to do useful work e.g. producing electrical energy, pumping water etc.

6. Natural gas – is fossil fuels that exist in a gaseous state and is composed mainly of methane (CH_4) and small percentage of other hydrocarbons.

7. Nuclear energy – is the energy which is obtained as a result of nuclear fission or nuclear fusion to generate electricity. *(03 marks)*, *01 mark@ for any three*.

(b)(i) Seismical lines are lines plotted to show places suffering from equal damage due to an earthquake, while seismic waves are mechanical waves associated with an earthquake when the earthquake occurs. *(02 marks), 01 mark@*

(ii) According to Elastic rebound Theory; "The plates inside the Earth are pushed together at a fault line until they are deformed and the built up energy is released and the plates snap back to their original position which results in the vibration of the Earth's crust". *(03 marks)*

8. (a)(i)Because when touching the live wire, the human complete the circuit hence the electrons will be flowing from the live wire to the ground which cause electric shock. **(02 mark)**

(ii) $n\varepsilon = i(nr + R)$ $\quad i = \frac{n\varepsilon}{nr+R}$. *(01 mark)*

$0.6 = \frac{1.5n}{0.5n+20}$. *(01 mark)*

$0.6(0.5n + 20) = 1.5n$, solving for n we have;

Required number of cells = 10. *(01 mark)*

(b)(i) $12 - 500i - 2 = 0$ *(01 mark)*

solving for i we have; $i = \frac{10}{500}$ A.

Needed current = 0.02 A. *(01 mark)*

(ii) $12 - (500\times 0.02) - 0.02X = 0$ *(01 mark)*

$12 - 10 - 0.02X = 0$ *(01mark)*

$0.02X = 2$

Needed value of $X = 100\Omega$. *(01 mark)*

(c)(i) $Z = \sqrt{\left(X_L - X_C\right)^2 + R^2}$ *(01 mark)*

$= \sqrt{(184 - 144)^2 + 30^2}$ *(01 mark)*

Needed impedance =50Ω *(01 mark)*

(ii) From $tan\theta = \frac{X_L - X_C}{R}$ $\quad \theta = tan^{-1}\left(\frac{X_L - X_C}{R}\right)$ *(01 mark)*

$\theta = tan^{-1}\left(\frac{184-144}{30}\right)$

Needed phase angle = 53.13° *(01 mark)*

9. (a) (i) A p-n junction is the semiconductor device which consists of P-type semiconductor in one side and the other side N-type semiconductor and conducts electric current in one direction only **(01 mark)**

The potential barrier is formed when P-type materials come in contact with N-type semiconductor hence electrons from the N-type side fills the holes in p-type so the barrier developed between them **(03 marks)**

(ii) Because it has low potential barrier compared to Germanium. **(02 marks)**

(iii) From the diagram, the current flows through 100Ω and 150Ω is the same. No current is flowing through 50Ω. **(01 mark)**

$$I = \frac{V}{R_T} = \frac{V}{R_{100} + R_{150}}$$ **(01 mark)**

$$= \frac{6}{100 + 150}$$

$$= 0.024A$$ **(01 mark)**

(b) (i) Both are amplifiers and acts as switching devices in saturation region or cut-off region **(01 mark)**

(ii) A large number of combinations of electrons and holes will take place in base region, resulting in increase in base current; as a result, current amplification will increase **(01 mark)**

(c) (i) Minimum base current when transistor reach saturation

$$V_{CE} = 0$$

$$V_{CC} = I_C R_C$$

$$I_C = \frac{V_{CC}}{R_C} = \frac{6V}{4 \times 10^3 \Omega} = 1.5 \times 10^{-3} A$$ **(01 mark)**

$$\beta = \frac{I_C}{I_B}$$

$$I_B = \frac{I_C}{\beta} = \frac{1.5\times10^{-3}}{100}$$

$$= 1.5\times10^{-5}A$$ **(01 mark)**

(ii) Input voltage $V_{in} = I_B R_B + V_{BE} = (1.5\times10^{-5}\times10\times10^{3}) + 0.7 = 0.85V$ **(01 mark)**

(ii) When transistor is off, $I_C = 0$

$$V_{in} = V_{BE} = 0.7V$$

Range from $0.7V$ to $0.85V$ **(01 mark)**

10.(a)(i) $X = AB + CD + E.$

AND AND *(01 mark)*

Therefore there are two AND gates. *(01 mark)*

(ii) Truth table

A	B	Q
0	0	0
1	0	1
1	1	1
0	1	1
0	0	0
1	0	1
0	1	1

(02 marks)

OR gate (02 mark)

(b)(i) Current, $i_1 = 0$ as no current enters the operational amplifier. *(01 mark)*

Current, $i_f = \frac{V_o}{R_f} = \frac{7.0V}{8\Omega} = 0.875\ A$. *(01 mark)*

(ii) $V_o = -\left(\frac{R_f}{R_1}V_1 + \frac{R_f}{R_2}V_2\right)$ *(01 mark)*

$V_o = -\left(\frac{8}{4}\times 2V + \frac{8}{8}\times 3V\right)$ *(01 mark)*

$V_o = -(4V + 3V) = -7.0V$. *(01 mark)*

(c)(i) is the process of varying some characteristic of a carrier wave (amplitude or frequency) by using an information signal. *(01 mark)*

- It is used to send an information bearing signal over long distances without attenuation. *(01 mark)*

(ii) $d_m = \sqrt{2h_t r_E} + \sqrt{2h_r r_E}$ *(01 mark)*

$d_m = \sqrt{2\times 40\times 6.4\times 10^6}$ m $+ \sqrt{2\times 60\times 6.4\times 10^6}$ m

$= 50340m$

= 50Km. *(01 mark)*