

**CHRISTIAN SOCIAL SERVICES COMMISSION (CSSC)  
NORTHERN ZONE JOINT EXAMINATIONS SYNDICATE (NZ-JES)**



**FORM SIX PRE-NATIONAL EXAMINATIONS 2026  
131/1                      PHYSICS 1  
MARKING SCHEME**

1. a) i) The thickness of metre ruler must be range from 0.49 cm to 0.53 cm.....(02 )

ii) Solution

Given that,  $F = kA\rho v^x$ , Required to find the value of  $x$

We write the dimensional formula of each quantity

$$[F] = MLT^{-2}$$

$$[A] = L^2 \quad [\rho]$$

$$= ML^{-3}$$

$$[v] = LT^{-1} \quad (01 \text{ mark})$$

Therefore

$$MLT^{-2} = L^2 \cdot ML^{-3}(LT^{-1})^x$$

$$MLT^{-2} = L^2 \cdot ML^{-3} \cdot L^x T^{-x}$$

$$MLT^{-2} = ML^{x-1}T^{-x} \quad (01 \text{ mark})$$

By equating the indices, we get

for  $M$ :  $1 = 1$

$L$ :  $1 = x - 1 \Rightarrow x = 2$

and  $T$ :  $-2 = -x \Rightarrow x = 2 \quad (01 \text{ mark})$

$\therefore$  The value of  $x$  is 2 and the given formula can be written as  $F = kA\rho v^2$

b) Given  $D = \frac{1}{2}c\rho Av^2$ , applying natural logarithm both sides, we get

$$\ln D = \ln \left( \frac{1}{2}c\rho Av^2 \right)$$

$$\ln D = \ln \left( \frac{1}{2} \right) + \ln(c) + \ln \rho + \ln A + 2\ln v$$

In differentiating, we get

$$\frac{\Delta D}{D} = \frac{\Delta c}{c} + \frac{\Delta \rho}{\rho} + \frac{\Delta A}{A} + \frac{2\Delta v}{v} \quad (01 \text{ mark})$$

OR Applying the concept of errors in product, we get

$$\frac{\Delta D}{D} = \frac{\Delta c}{c} + \frac{\Delta \rho}{\rho} + \frac{\Delta A}{A} + 2 \frac{\Delta v}{v}$$

$$= \pm \frac{\Delta \rho}{\rho} \pm \frac{\Delta A}{A} \pm \frac{2\Delta v}{v}$$

We find the numerical value of D from

$$D = \frac{1}{2} c \rho A v^2 \quad (01 \text{ mark})$$

$$= \frac{1}{2} \times 10 \times 15 \times 5 \times 3^2$$

$$D = 3375 \text{ g/s} \quad (01 \text{ mark})$$

We find the error in D from

$$\pm \frac{\Delta D}{D} = \pm \frac{\Delta c}{c} \pm \frac{\Delta \rho}{\rho} \pm \frac{\Delta A}{A} \pm \frac{2\Delta v}{v}$$

$$\pm \Delta D = \left( \pm \frac{\Delta c}{c} \pm \frac{\Delta \rho}{\rho} \pm \frac{\Delta A}{A} \pm \frac{2\Delta v}{v} \right) \times D \quad (01 \text{ mark})$$

$$\pm \Delta D = \left( \pm \frac{0.01}{10} \pm \frac{0.15}{15} \pm \frac{0.2}{5} \pm 2 \left( \frac{0.5}{3} \right) \right) \times 3375$$

$$\pm \Delta D = \pm 432.375 \text{ g/s} \quad (01 \text{ mark})$$

$\therefore$  The numerical value of  $D = (3375 \pm 1297) \text{ g/s}$

2. a) i) Range is the horizontal distance travelled by the projectile..... (01 )

ii) From the formula of the range of Projectile

$$R = \frac{u_0^2 \sin 2\theta}{g} \dots \dots (00 \frac{1}{2} \text{ mark})$$

At the Maximum Range

$$\sin 2\theta = 1 \dots \dots (00 \frac{1}{2} \text{ mark})$$

$$2\theta = \sin^{-1}(1)$$

$$2\theta = 90^\circ$$

$$\theta = 45^\circ \text{ Hence shown } \dots \dots (01 \text{ mark})$$

b)  $u = 29.4 \text{ ms}^{-1}$  and  $H = 4.9 \text{ m}$

$$\begin{aligned} \text{from } H &= \frac{u^2 \sin^2 \theta}{2g} \\ \Rightarrow \sin \theta &= \frac{\sqrt{2gH}}{u} \dots \dots (01 \text{ mark}) \end{aligned}$$

$$\sin \theta = \frac{\sqrt{2 \times 9.8 \times 4.9}}{27.4} = 0.333$$

$$\sin \theta = 0.333$$

$$\Rightarrow \theta = \sin^{-1}(0.333) = 19.5^\circ \dots \dots (01 \text{ mark})$$

$$\begin{aligned} \text{Now } R &= \frac{u^2 \sin 2\theta}{g} \\ &= \frac{(28.4)^2 \sin(2 \times 19.5^\circ)}{9.8} \end{aligned}$$

$$R = 55.5 \text{ m}$$

The range of a ball is 55.5m... (01 mark)

$$\text{c) } = \frac{2 \sin^2}{2g}$$

$$\sin^2 \theta = \frac{2gH}{u^2} \dots\dots (i) \dots\dots (01 \text{ mark})$$

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

$$\sin \theta \cos \theta = \frac{gR}{2u^2}$$

$$\sin^2 \theta \cos^2 \theta = \frac{g^2 R^2}{4u^4}$$

$$\sin^2 \theta (1 - \sin^2 \theta) = \frac{g^2 R^2}{4u^4} \dots \dots \dots (ii) \dots \dots \dots (01 \text{ mark})$$

Substitute (i) into (ii)

$$\frac{2gH}{u^2} \left[ 1 - \frac{2gH}{u^2} \right] = \frac{g^2 R^2}{4u^4}$$

$$2H \left[ 1 - \frac{2gH}{u^2} \right] = \frac{gR^2}{4u^2}$$

$$2H - \frac{4gH^2}{u^2} = \frac{gR^2}{4u^2}$$

$$8u^2H - 16gH^2 = gR^2$$

$$u^2 = 2gH + \frac{R^2}{16H}$$

$$u = \left[ 2g \left( H + \frac{R^2}{16H} \right) \right]^{\frac{1}{2}} \dots \dots \dots (02 \text{ marks})$$

Hence shown

3. a) from

$$T = 2\pi\sqrt{\frac{l}{g}} \dots \dots \dots (01 \text{ mark})$$

Inside the satellite,  $g = 0$

$$\text{then, } T = 2\pi\sqrt{\frac{l}{0}}$$

$$T = \infty \text{ (Infinity)} \dots \dots \dots (01 \text{ mark})$$

Since the time period of the experiment of simple pendulum is infinity inside the satellite, then such an experiment cannot be performed inside the satellite.

... .. (01 mark)

b) i) When the system is resting on a table

$$f = \frac{1}{T} \quad \text{where } T = 2\pi\sqrt{\frac{\bar{k}}{\mu}} \quad \dots\dots (01 \text{ mark})$$

$$\text{so, } f = \frac{1}{2\pi\sqrt{\frac{\bar{k}}{\mu_1}}}$$

$$\Rightarrow f = \frac{1}{2\pi} \sqrt{\frac{\bar{k}}{\mu_1}} \quad \dots\dots (01 \text{ mark})$$

Where  $k = 100\text{N/m}$  and  $m_1 = 0.1\text{kg}$

$$f = \frac{1}{6.28} \sqrt{\frac{100}{0.1}} = 5.0\text{Hz} \quad \dots\dots (01 \text{ mark})$$

ii) Recalling,

$$f = \frac{1}{2\pi} \sqrt{\frac{\bar{k}}{\mu_1}} \quad \text{where}$$

$$\mu_1 = \frac{m_1 m_2}{m_1 + m_2} \quad \dots\dots (01 \text{ mark})$$

$$f = \frac{1}{2\pi} \sqrt{\frac{\bar{k}}{\frac{m_1 m_2}{m_1 + m_2}}}$$

$$f = \frac{1}{2\pi} \sqrt{\frac{\bar{k}(m_1 + m_2)}{m_1 m_2}}$$

$$f = \frac{1}{6.28} \sqrt{\frac{100(0.1 + 0.2)}{0.1 \times 0.2}} \quad \dots\dots (01 \text{ mark})$$

$$f = \frac{1}{6.28} \sqrt{1500} \quad \dots\dots (01 \text{ mark})$$

$$f = 6.2\text{Hz} \quad \dots\dots (01 \text{ mark})$$

4 (a)(i) Centripetal force

— is the force which acts towards the center of the circle for the particle describing a circular motion.

It is given as

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

(ii) Because there is no centripetal force to hold them in curve.

(b)

(i)

From the law of conservation of energy (Mechanical).

$$M_a + K_a = M_b + K_b$$

$$M_a = mgh, \quad M_b = 0$$

$$K_a = 0, \quad K_b = \frac{1}{2}mv^2$$

$$mgh + 0 = 0 + \frac{1}{2}mv^2$$

$$mgh = \frac{1}{2}mv^2$$

$$gh = \frac{v^2}{2} \quad \text{but for a body to}$$

curve the whole circle  $h = 2\frac{1}{2}r$

or  $\frac{5}{2}r$ .

$$\frac{5}{2}gr = \frac{v^2}{2}$$

$$\sqrt{5gr} = \frac{v}{\sqrt{2}}$$

$$v = \sqrt{5gr} \quad \text{— hence shown}$$

$$(ii) \quad l = 1.5 \text{ m}$$

$$m = 0.4 \text{ kg.}$$

from

$$v = \sqrt{5rg}$$

$$v = \sqrt{5 \times 1.5 \times 9.8} \quad \text{m/s.}$$

$$v = 8.57 \text{ m/s.}$$

(iii)

4 (c) It is better to apply brakes because when the driver tries to ~~cancel~~ make a circular turn the car will overturn. Since ~~at critical~~ beyond critical velocity car will overturn, because for safe turn the velocity is given as  $v \leq \sqrt{rg}$ .



5. a) For the lower fixed point

$$C - 0 \quad \overline{100} \quad \theta - (-10)$$

$$= n \sin^{-1} \left( \frac{C}{50} \right), \quad \theta = 60^\circ \dots \dots (01 \text{ mark})$$

$$\frac{50}{100} = \frac{60 + 10}{n} \Rightarrow n = 140 \dots \dots (01 \text{ mark})$$

For the upper fixed point

$$\frac{100 - 0}{100} = \frac{\theta - (-10)}{140} \dots \dots (01 \text{ mark})$$

$$\therefore \theta = 130^\circ \dots \dots (02 \text{ marks})$$

b) From

$$\theta = \left( \frac{R_\theta - R_0}{R_{100} - R_0} \right) \times 100^\circ\text{C} \dots \dots (01 \text{ mark})$$

$$\text{But } R_\theta = 50 + 0.17 \times 60 + 0.003 \times 60^2 = 61.28\Omega \dots \dots (01 \text{ mark})$$

$$R_0 = 50\Omega \dots \dots (01 \text{ mark})$$

$$R_{100} = 50 + 0.17 \times 100 + 0.003 \times 100^2 = 70\Omega \dots \dots (01 \text{ mark})$$

$$\therefore \theta = \left( \frac{61.28 - 50}{70 - 50} \right) \times 100^\circ\text{C} \dots \dots (01 \text{ mark})$$

$$\theta = 56.4^\circ\text{C} \dots \dots (01 \text{ mark})$$

6. a) Adiabatic process is the process which takes place when there is no heat changes between the system and the surroundings ... .. (01 mark)

b) i) When the gas expands adiabatically the decrease in internal energy be equal to the work done by it.  $\Delta V$  is positive, hence  $PdV$   
 $PdV = du \dots \dots (02 \text{ marks})$

ii) When the gas undergoes compression, there is increase in internal energy of the gas.  $\Delta V$  is negative, hence  $PdV$   
 $-PdV = du \dots \dots (02 \text{ marks})$

c) From

$$PV^\gamma = \text{const} \quad \Rightarrow P_1V_1^\gamma = P_2V_2^\gamma$$

$$\text{But } PV = nRT \quad \Rightarrow P = \frac{nRT}{V}$$

$$\Rightarrow P_1 = \frac{nRT_1}{V_1} \quad \text{and} \quad P_2 = \frac{nRT_2}{V_2}$$

$$\text{So } \frac{nRT_1V_1^\gamma}{V_1} = \frac{nRT_2V_2^\gamma}{V_2}$$

$$T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$$

$$\text{Also } V_1 = \frac{nRT_1}{P_1} \quad \text{and} \quad V_2 = \frac{nRT_2}{P_2} \dots \dots (00^1 \text{ mark})$$

$$P_1 \left( \frac{nRT_1}{P_1} \right)^\gamma = P_2$$

2

—

$$\frac{nRT_2}{P_2}$$

$P_2$

) <sup>$\gamma$</sup>

—

$$P_1^{1-\gamma} T_1^\gamma = P_2^{1-\gamma} T_2^\gamma \dots \dots (00 \frac{1}{2} \text{ mark})$$

Where  $P_1 = 250\text{KPa}$ ,  $P_2 = 100\text{KPa}$ ,  $T_1 = 320\text{K}$  and  $\gamma = 1.67$

Therefore,

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

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

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

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

$$T_2 = T_1 \left( \frac{P_1}{P_2} \right)^{\frac{1-\gamma}{\gamma}} \dots \dots (00 \frac{1}{2} \text{ mark})$$

$$T_2 = 32 \left( \frac{250}{100} \right)^{\frac{1-1.67}{1.67}} \dots \dots (00 \frac{1}{2} \text{ mark})$$

$$\therefore T_2 = 221.8\text{K} \dots \dots (00 \frac{1}{2} \text{ mark})$$

$$\text{But Work done} = \frac{R}{1-\gamma} (T_1 - T_2) \dots \dots (00 \frac{1}{2} \text{ mark})$$

$$\text{Work done} = \frac{8.314}{1-1.67} (320 - 221.8) \dots \dots (01 \text{ mark})$$

$$\text{Work done} = -1218.6\text{J} \dots \dots (01 \text{ mark})$$

7. a) i) When P and S seismic waves are sent from one side of the earth to another, only P-waves can be

detected on other side, WHILE S-waves do not pass through the core provides the evidence that the core consists of a liquid core..... (03 marks)

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

b) i) – Change on the density of rocks ... .. (00  $\frac{1}{2}$  mark)

– Occurrence of stresses  $\frac{1}{-}$

..... (00 2 .....)  
– Faults... .. (00  $\frac{1}{2}$  mark)

– Waves... .... (00  $\frac{1}{2}$  mark)

ii) – To control soil erosion by eliminating plant roots stresses thus favors plant growth condition (01 mark)

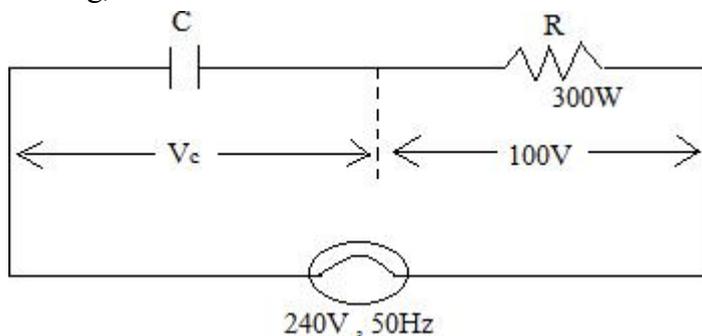
– It control pesticide spray drift and provide buffers to delineate property lines and protect neighbors ... .... (01 mark)

8. a) i) = Electrical appliances are connected in parallel so as to reduce the resistance of these devices to the current flowing which reduce the power losses. (02 )

- To operate Electrical appliances independently
- If appliance get default is very easy to replace
- All devices will operate under constant voltage

ii) Consider the circuit below

Recalling,



$$E_V^2 = V_c^2 + V_R^2 \dots\dots (00 \frac{1}{2} \text{ mark})$$

$$V_c^2 = E_V^2 - V_R^2$$

$$V_c = \sqrt{E_V^2 - V_R^2}$$

$$V_c = \sqrt{(240)^2 - (100)^2}$$

$$V_c = 218.1742V \dots\dots (00 \frac{1}{2} \text{ mark})$$

$$\text{But } V_c = I_r \chi_c \quad \text{where } I_r = \frac{P}{V_R} \Rightarrow I_r = \frac{300}{100} = 3$$

$$\therefore \chi_c = \frac{V_c}{I_r}$$
$$\chi_c = \frac{218.1742}{3} \dots\dots (01 \text{ mark})$$

Again,

$$X_c = \frac{1}{2\pi fC} = \frac{218.1742}{3}$$

$$C = \frac{3}{218.1742 \times 2 \times 3.14 \times 50}$$

$$C = 0.438\mu F \dots \dots (01 \text{ mark})$$

b) Soln

i) At the junction A / B

$$I_1 = I_2 + I_3 \dots \dots \dots (i)$$

Applying KVL at the loop ABCFA

$$-I_2 \times 2 - 4 - I_1 + 2 - I_1 = 0$$

$$-2I_2 - 2I_1 - 2 = 0$$

$$I_1 + I_2 = -1 \dots \dots \dots (ii) \dots \dots (01 \text{ mark})$$

Applying KVL at the loop ADEBCFA

$$-I_3 - 4 - I_3 - I_1 + 2 - I_1 = 0$$

$$-2I_3 - 2I_1 - 2 = 0$$

$$I_3 + I_1 = -1 \dots \dots \dots (iii) \dots \dots (01 \text{ mark})$$

From eqn (i)

$$I_3 = I_1 - I_2$$

Substituting into eqn (iii)

$$I_1 - I_2 + I_1 = -1$$

$$2I_1 + I_2 = -1 \dots \dots \dots (iv)$$

Solving eqn (ii) and (iv) we get

$$I_1 = -2/3 A \text{ and } I_2 = -1/3 A$$

$\therefore$  The current through  $R_2$  is  $1/3 A \dots \dots (01 \text{ mark})$

ii) The p. d across C and D

Taking

$$V_D - \frac{1}{3} + 2\left(\frac{1}{3}\right) - 4 - \frac{2}{3} = V_C \dots \dots (01 \text{ mark})$$

$$V_D - 1 + \frac{2}{3} - 4 = V_C$$

$$V_D - V_C = 5 - \frac{2}{3} = \frac{13}{3} V \dots \dots (01 \text{ mark})$$

$$V_{DC} = \frac{13}{3}V \dots \dots (01 \text{ mark})$$

c) i) The greater the length of potentiometer wire, the smaller the potential gradient along the wire. Hence the distance of the null position will be increased which will be measured more accurate.

(02 marks)

ii) For high sensitivity of the bridge, all resistances should have high value. This will reduce the value of the current through the galvanometer. (02 marks)

9. a) i)  $= \frac{0}{1+sA}$

$$A = \frac{10,000}{1 + (0.5 \times 10,000)}$$

$A = 10 \dots \dots (03 \text{ marks})$

ii)  $A = \frac{-R_f}{R_{in}}$

$$A = \frac{-20,000}{1.6 \times 10^3}$$

$A = -12.5$

$V_{out} = A_{in}$

$V_{out} = -12.5 \times 1.8$

$V_{out} = -22.5V$

But the supply voltage is  $\pm 15V$ , so the Opamp saturates and output is  $-15V \dots \dots (02 \text{ marks})$

b) i) Logic gate is a basic building block of a digital circuit (any relevant definition)  $\dots \dots (01 \text{ mark})$

ii) Truth table

A	B	D	C	$X = A' + B'$	$Y = X$
0	0	1	1	1	0
0	1	1	0	1	0
1	0	0	1	1	0
1	1	0	0	0	1

(02 marks)

The output is similar to  $Y = A.B$

$\therefore$  The equivalent gate of the circuit is an AND gate  $\dots \dots (01 \text{ mark})$

c) i) Because high frequency carrier waves allow smaller antenna design...  $\dots (02 \text{ marks})$

ii) Data given

Frequency of the carrier =  $f_c = 10 \text{ MHz}$

Frequency of the signal =  $f_s = 5 \text{ kHz} = 0.005 \text{ MHz}$

*Amplitude of the carrier signal =  $E_c = 10\text{ mV}$*

*Amplitude of the audio signal =  $E_s = 6\text{ mV}$*

Frequency components of modulated wave = ?

Amplitude of the components in the modulated wave = ?

$$\text{Upper side band frequency} = f_c + f_s = 10 + 0.005 \quad \text{1 mark} \\ = 10.005 \text{ MHz}$$

$$\text{Lower side band frequency} = f_c - f_s = 10 - 0.005 \quad \text{1 mark} \\ = 9.995 \text{ MHz}$$

The modulation factor  $m = \frac{E_s}{E_c}$

$$m = 0.6 \quad \text{1 mark}$$

$$= \frac{mE_c}{2}$$

$$= 0.6 \times 0.5 \times 10 \text{ mV} \\ = 3 \text{ mV} \quad \text{1 mark}$$

10.a) i) At room temperature, there are few number of free charge carriers crossing the forbidden gap hence low conductivity. Also at 0K the valence band is full of combined charge carriers and conduction band has no charge carriers. Therefore the semiconductor behaves like an insulator.

(02 marks)

ii) The energy gap decreases with doping, when a pentavalent impurity is added to an intrinsic semiconductor, the energy gap reduces to about 0.1 eV. It is due to the fact that there is creation of donor energy level just below the conduction band. Even at room temperature, many electrons in the valence band move to conduction band and hence conductivity increases. (02 marks)

iii) Soln

Given that  $E = 2.25 \text{ eV}$

$$E = 2.25 \times 1.6 \times 10^{-19} \text{ J}$$

$$\text{from } E = hf = \frac{hc}{\lambda}$$

$$\Rightarrow \lambda = \frac{hc}{E}$$

$$\lambda = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{2.25 \times 1.6 \times 10^{-19}}$$

$$\lambda = 5.525 \times 10^{-7} \text{ m} \quad \text{(03 marks)}$$

b) i) It is because Zener diode utilizes the reverse characteristic for acting as a voltage regulator at a

break down region where Zener diode operates, there is a constant voltage and for that reason, Zener diode cannot be burnt out. (02 marks)

ii) It is cost full to construct centre tap rectifier compared to bridge rectifiers .

In Centre tap rectifier there must be a transformer but for bridge rectifier it is not necessary (02 marks)

c) Given

$$R_c = 2.1 \times 10^3 \Omega, \quad R = 150 \Omega, \quad V = 12V \quad I_d = 8 \times 10^{-3}A$$

From the diagram

$$I_{R_c} = \frac{V}{R_c} = \frac{12}{2.1 \times 10^3} \dots \dots (01 \text{ mark})$$

$$I_{R_c} = 5.714 \text{mA}$$

$$\begin{aligned} \text{Current through } R(I) &= I_{R_c} + I_d \\ &= 5.714 \text{mA} + 8 \text{mA} \\ &= 13.714 \text{mA} \dots \dots (01 \text{ mark}) \end{aligned}$$

$$\begin{aligned} \text{Voltage drop across } (R) &= IR \\ &= 13.714 \text{mA} \times 150 \Omega \\ &= 2.057 \text{V} \dots \dots (01 \text{ mark}) \end{aligned}$$

$$\begin{aligned} \text{Voltage required, } E &= 12 + 2.057 \\ &= 14.057 \text{V} \dots \dots (01 \text{ mark}) \end{aligned}$$