higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ENGINEERING PHYSICS N6

17 November 2022

This marking guideline consists of 9 pages.

Copyright reserved

QUESTION 1: SOUND

1.1 1.1.1

$$L_{lonest} = \frac{C}{2\,x\,f_{\min}} \qquad L_{shorest} = \frac{C}{2\,x\,f_{\min}}$$

A✓✓ calculation $L_{lonest} = \frac{340}{2\,x\,85}$ **AND** $L_{shorest} = \frac{340}{2\,x\,2290}$

$L_{lonest} = 2\,m$ $L_{shorest} = 0{,}075\,m$ (2)

1.1.2

$$f_b = f_o$$

$$f_b = f_o\,(\frac{\mathrm{V} \pm \mathrm{V_o}}{\mathrm{V}})$$

C✓✓✓✓ calculation is

$$53000 = 49500(\frac{340 \pm \mathrm{V_o}}{340}) \quad ✓$$

$$\frac{53000}{49500} = \frac{340 \pm \mathrm{V_o}}{340} \quad ✓$$

$$1{,}071 = \frac{340 \pm \mathrm{V_o}}{340}$$

$$1{,}071\,x\ 340 = 340 + \mathrm{V_o} \quad ✓$$

$$\mathrm{V_o} = 364{,}04 - 340$$

$$\mathrm{V_o} = 24{,}04\,m/s \quad ✓$$

(4)

1.1.3 2 400 Hz A (1)

1.1.4 40 Hz C (1)

1.1.5 2 400 Hz A (1)

1.1.6 500 Hz B (1)

Copyright reserved

1.2

$$\mu = \frac{mass}{length}$$

$$\mu = \frac{4{,}8\,x\,10^{-4}\ kg}{0{,}75\,m} \quad ✓$$

$$\mu = 6{,}4\,x\,10^{-4}\ kg/m \quad ✓$$

$$C = \sqrt{\frac{T}{\mu}}$$

$$C = \sqrt{\frac{75}{6{,}4\,x\,10}} \quad ✓$$

$$C = 342{,}327\ Hz \quad ✓$$

$$Fundamental\ frequency = 342{,}327\,x\,0{,}75 = 256{,}745\ Hz \quad ✓$$

$$frequency\ 1^{st}\ overtone = 256{,}745\ x\ 2 = 513{,}49\ Hz \quad ✓$$

$$frequency\ 2^{nd}\ overtone = 256{,}745\ x\ 3 = 770{,}235\ Hz$$

(6)

1.3

$$360 + \varepsilon = \frac{1}{4}h$$

$$1440 + \varepsilon = h \qquad Equation\ 1 \quad ✓$$

$$555 + \varepsilon = \frac{3}{4}h$$

$$2220 + 4\varepsilon = 3h \qquad Equation\ 2 \quad ✓$$

$$1440 + \varepsilon = h \qquad Equation\ 1$$

$$2220 + 4\varepsilon = 3h \qquad Equation\ 2$$

$$1 - 2 \quad -780 + 0 = -2h$$

$$h = \frac{-780}{-2} \quad ✓$$

$$h = 390\ mm \quad ✓$$

$$V = f\ x\ \ell \qquad \ell = 2\,x\,0{,}39 = 0{,}78\,m \quad ✓$$

$$V = 586\,x\,(1250 - 0{,}78)$$

$$V = 275{,}42\,m/s \quad ✓$$

$$\frac{1}{2}h = 1{,}25 + 2\varepsilon$$
$$\frac{1}{2}h = 1{,}25 + 2(0{,}39)$$
$$\frac{1}{2}h = 1{,}25 + 0{,}78 \quad \checkmark$$
$$\frac{1}{2}h = 2{,}03$$
$$h = 4{,}06\ m\ or\ 4060\ mm$$

$$V = f\ x\ \lambda$$
$$f = \frac{V}{\lambda} \quad \checkmark$$
$$f = \frac{275{,}42}{4{,}06}$$
$$f = 67{,}837\ Hz$$

$$The\ lowest\ fequency\ at\ which\ the\ open\ tube\ will\ resonate\ is\ 67{,}837\ m/s \quad \checkmark$$ (9)

[25]

QUESTION 2: THERMODYNAMICS

2.1
2.1.1 True
2.1.2 True
2.1.3 False
2.1.4 True
2.1.5 True

(5 × 1) (5)

2.2 Isothermal expansion of gas is one in which the temperature of the gas remains constant throughout the process. ✓

i.e. $P_1V_1=P_2V_2$ ✓

Adiabatic expansion is one in which no heat flow takes place across the boundaries of the system.✓ In practice it can be obtained by compressing the gas very slowly so that the gas has time to give off the generated heat to its environment.✓ (4)

2.3 2.3.1 $T_1 = 218\,^oC + 273 = 491K = 218\,^oC + 273 = 491K$ ✓

$T_2 = 48{,}9\,^oC + 273 = 321{,}9\,K$

$\eta = [\frac{T_1 - T_2}{T_1}] x \frac{35}{100} x 100$ ✓

$\eta = [\frac{491 - 321{,}9}{491}] x \frac{35}{100} x 100$

$\eta = 12{,}054\,\%$ ✓ (3)

2.3.2 $\eta = \frac{P_{output}}{P_{input}} x 100$

$P_{input} = \frac{P_{output}}{\eta} x 100$ ✓

$P_{input} = \frac{7200}{12{,}054} x 100$

$P_{input} = 59{,}731 kW$ ✓ (2)

2.4 2.4.1 $V_1 = 2{,}6\,x10^{-3}\,m^3$, $C_v = 0{,}715\,kJkg.K$, $C_p = 1{,}00\,kJkg.K$, $P_r = 98\,kPa$

$T_1 = 25\,^oC + 273 = 298\,K$ ✓

$\gamma = \frac{C_p}{C_v} = \frac{1000}{715} 1{,}399$ ✓

$P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$ $(\frac{V_1}{V_2})^{\gamma} = \frac{P_2}{P_1}$

$P_2 = (\frac{V_1}{V_2})^{\gamma}\ x\ P_1$

$P_2 = (\frac{1}{3})^{1{,}399}\ x\ 98000$ ✓

$P_2 = (0{,}215)\,x\,98000$

$P_2 = 21{,}073\,kPa$ ✓

$$\frac{T_1}{T_2} = (\frac{P_2}{P_1})^{\frac{\lambda-1}{\lambda}}$$

$$T_2 = (\frac{P_2}{P_1})^{\frac{\lambda-1}{\lambda}} \; x \; T_1$$

$$T_2 = (\frac{21073}{98000})^{\frac{1,399-1}{1,399}} \; x \; 298 \; ✓$$

$$T_2 = (0,215)^{0,285} \; x \; 298$$

$$T_2 = 192,231 \, K \quad ✓$$

OR

$$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\lambda-1}$$

$$T_2 = \left(\frac{V_1}{V_2}\right)^{\lambda-1} x \, T_1$$

$$T_2 = \left(\frac{1}{3}\right)^{1,399-1} x \, 298$$

$$T_2 = 192,393 \, K$$

(6)

2.4.2 $T_2 = T_3 \; and \; V_2 = 3xV_1 = 3x2,6x10^{-3} = 7,8x10^{-3} \, m^3$

$V_3 = 3,8 \, x10^{-3} \, m^3$

$P_2V_2 = P_3V_3$

$21,109x10^3 \, x7,8x10^{-3} = P_3 \, x \, 7,8x10^{-3}$ ✓

$P_3 = 43,329 \, kPa$ ✓

(2)

2.5 $Q_{gain} = Q_{lost}$

$Q_{gain} = Q_{lost}$

$m_w \, x \, shc \, x \, \Delta t = m_{ice} \, x \, shc \, x \, \Delta t$

$0,87 \, x \, 4187 \, x \, (t_2 - 96) = 0,222 \, x \, 2108 \, x \, (-18 - t_2)$ ✓

$3642,69 \, x \, (t_2 - 96) = 467,976 \, x \, (-18 - t_2)$

$3642,69t_2 - 349698,24 = -8423,568 - 467,976t_2$

$3642,69t_2 + 467,976t_2 = -8423,568 + 349698,24$ ✓

$4110,666t_2 = 341274,672$

$t_2 = \frac{341274,672}{4110,666}$

$t_2 = 83,022 \, ^\circ C$ ✓

(3)

[25]

QUESTION 3: ELECTROSTATICS

3.1
3.1.1 False
3.1.2 True
3.1.3 False
3.1.4 True
3.1.5 False
3.1.6 True

(6 × 1) (6)

3.2 $F = m\,x\,g$

$F = 25x10^{-14}\ x\ 9{,}81$ ✓

$F = 2{,}453x10^{-12}\ N$ ✓

$Upwards\ electric\ \ force\ F = \frac{V\,x\,Q}{s}$

$V = \frac{F\,x\,s}{Q}$

$V = \frac{2{,}453x10^{-12}\ x\ 0{,}15}{8{,}2x10^{-18}}$ ✓

$V\ =\ 4{,}486\ x\ 10^{4}\ V$ ✓ (4)

3.3 3.3.1 $q = \frac{m\,x\,g\ x\,s}{V} = \frac{0{,}945x10^{-15}\ x\ 9{,}81\,x\,0{,}035}{2650}$ ✓

$q = 1{,}23x10^{-20}$ ✓

$q = 12{,}3x10^{-19}$ ✓ (3)

3.3.2 $Number\ of\ electrons = \frac{12{,}3x10^{-1}}{1{,}6x10^{-19}}$ ✓

$Number\ of\ electrons = 7{,}6$

$Number\ of\ electrons = 8\ electrons$ ✓ (2)

3.3.3 $W = V\,x\,Q$

$W = 2650\,x\,8{,}45x10^{-16}$ ✓

$W = 2{,}239x10^{-12}\ Joule$ ✓ (2)

3.4 3.4.1 $C\ =\ \frac{Q}{V}$ ✓

$C\ =\ \frac{55\,x\,10^{-6}\ F\ x\,220}{0{,}01}$

$C = 1{,}21\ Coulomb$ ✓

$V = \frac{Q}{C}$

$V = \frac{0{,}01}{93x10^{-6}}$ ✓

$V = 107{,}527\ Volts$ ✓ (4)

3.4.2 $Q = ½ x\ C\ x V^2$ ✓

$Q = ½ x\ 55 x10^{-6}\ x\ (220)^2$

$Q = 1{,}331\ Joule$ ✓

$Q = ½ x\ C\ x V^2$

$Q = ½ x\ 93 x10^{-6}\ x\ (107{,}527)^2$ ✓

$Q = 0{,}578\ Joule$ ✓

(4)
[25]

QUESTION 4: ATOMIC PHYSICS

4.1
4.1.1 Thermionic emission
4.1.2 Electrons
4.1.3 10^9 or GV/m
4.1.4 Minimum
4.1.5 Radiated
4.1.6 $1{,}6 \times 10^{-19}$ C

(6 × 1) (6)

4.2
- Carry a negative charge
- More in a straight line unless deflected by a field
- Metals (platinum) glow if they collide (3)

4.3 $E = ½ \times C \times V^2$
$E = ½ (9{,}68 \times 10^{-7}\ F) \times (0{,}125\ V)^2$ ✓
$E = 7{,}5625 \times 10^{-9}$ J✓ (2)

4.4 4.4.1

$E = h\ x\ f = \frac{h x c}{\lambda}$

$E = \frac{6{,}9\ x10^{-34}\ x\ 380 x10^{6}}{9{,}1\ x10^{-7}}$ ✓

$E = 2{,}881 x10^{-19}\ J$ ✓

$f = \frac{V}{\lambda} = \frac{3{,}8 x10^{8}}{7{,}8 x10^{-7}} = 4{,}17\ x10^{14}$

$E = h\ x\ f = 4{,}17\ x10^{14}\ x 6{,}9\ x10^{-34}$

$E = 2{,}881 x10^{-19}\ J$

4.4.2 $E_k = hf - W$
$= 2{,}54 \times 10^{-19} - 2{,}881 \times 10^{-19}$ ✓
$E_k = 6{,}132 \times 10^{-21}$ J ✓

(2 × 2) (4)

4.5 $E = h \times f$
$E = 6{,}6 \times 10^{-34} \times 3{,}5 \times 10^9$✓
$E = 2{,}31 \times 10^{-24}$ J✓ (2)

4.6 $E = \frac{k(Q_1 \times Q_2)}{r^2}$

$= \frac{9 \times 10^9 (1,6 \times 10^{-19})^2}{(6,53 \times 10^{-11})^2}$ ✓

$E = 8,2 \times 10^{-8}$J ✓ (3)

4.7 4.7.1 Emits an electron: Z is the atomic number increased by 1 and the mass number is unchanged.

4.7.2 Undergoes electron capture: Z is the atomic number decreased by 1 and the mass number is unchanged.

4.7.3 Emits an alpha particle: Z is the atomic number decreased by 2 and the mass number decreased by 4.

(3 × 1) (3)

4.8 The slow neutron is a very efficient agent in causing transmutations, since it has no positive charge✓ and hence can approach the nucleus without being repelled.✓ A charged particle such as a proton must have high energy in order to cause transformation. (2)

[25]

TOTAL: 100

Copyright reserved