KAYONZA DISTRICT

ADVANCED LEVEL DISTRICT EXAMINATION OF PHYSICS 2023-2024

LEVEL: SENIOR FIVE

SUBJECT: PHYSICS THEORY

MARKING GUIDE

SECTION A:

QUESTION 1:

a) The quantum theory arose out of the inability of the classical physics to explain the experimentally observed distribution of energy in the spectrum of a blackbody. According to the Planck's theory, the exchange of energy between quantized state is not continuous but discrete. This quantized energy is in small packets of bundles. The bundle of energy or the packet of energy is called quantum (plural quanta). **(2 Marks)**

b) 1. The matter is composed of a large number of oscillating particles. These oscillators have different frequencies. **(1 Mark)**

2. The radiant energy which is emitted or absorbed by the blackbody is not continuous but discontinuous in the form of small discrete packets of energy and each such packet of energy is called a 'quantum'. In case of light, the quantum of energy is called a 'photon'. **(1 Mark)**

3. The energy of each quantum is directly proportional to the frequency (*f*) of the radiation, i.e.

(Let '*E*' be the energy and '*f*' be the frequency)

Then, $E \propto f$ or $E = hf$. **(1 Mark)**

4. The oscillator emits energy, when it moves from one quantized state to the other quantized state. The oscillator does not emit energy as long as it remains in one energy state. The total amount of energy emitted or absorbed by a body will be some whole number quanta. **(1 Mark)**

QUESTION 2:

a) i) Simple harmonic motion (SHM) is a type of motion where the restoring force is directly proportional to the displacement and acts in the direction opposite to that of displacement. **or**

SHM is an oscillatory motion under a retarding force proportional to the amount of displacement from an equilibrium position. This means that Simple harmonic motion occurs when the force F acting on an object is directly proportional to the displacement x from a fixed point and is always towards this point. **(2 Marks)**

ii) A simple pendulum can be described as a device where its point mass is

attached to a light inextensible string and suspended from a fixed support. **Or**
A simple pendulum consists of a small bob of mass *m* suspended from a fixed support through a light, inextensible string of length *L*. This system can stay in equilibrium if the string is vertical. This is called the mean position or the equilibrium position. If the particle is pulled aside and released, it oscillates in a circular arc with the center at the point of suspension 'O'. **(2 Marks)**

b) Factors affecting the periodic time of the simple pendulum:

- ✓ Length of string. **(0.5 Mark)**
- ✓ Angle from which pendulum is dropped. **(0.5 Mark)**
- ✓ Acceleration due to gravity. **(0.5 Mark)**
- ✓ Air resistance. **(0.5 Mark)**

QUESTION 3:

. Types: -Under damping oscillation **(0.5mark)**

$$x(t) = e^{-\frac{b}{2m}t}(C_1\cos\omega_d t + C_2\sin\omega_d t)$$ **(0.5mark)**

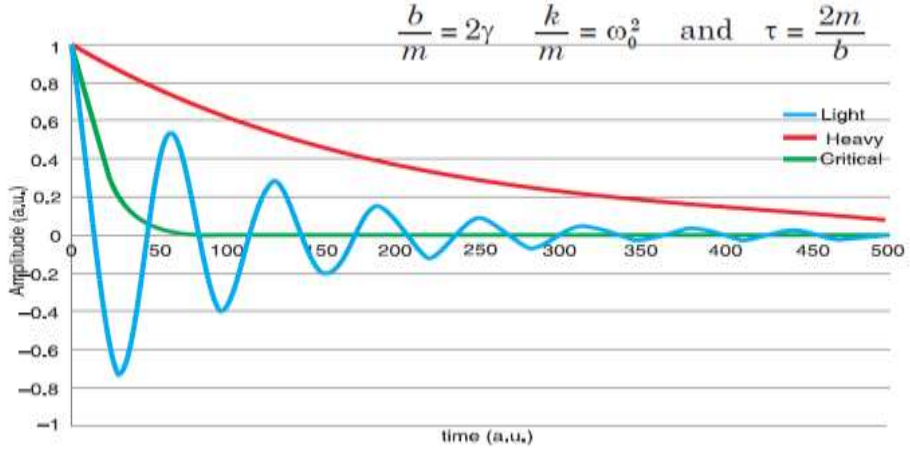
-Over damping oscillation **(0.5mark)**

$$(x)t = e^{-\frac{b}{2m}t}\left(C_1 e^{\omega_d t} + C_2 e^{-\omega_d t}\right)$$ **(0.5mark)**

-Critically damping oscillation **(0.5mark)**

$$x(t) = e^{-\frac{bt}{2m}}(C_1 + C_2 t)$$ **(0.5mark)**

Figure: **(3marks)**



Where g is the damping coefficient, w_0 is the natural frequency and t is the decay constant or the damping constant.

QUESTION 4:

The equation $y(x, t) = 0.003 \cos(20x + 200t)$ has the form $y = A \sin(wt + \phi)$. So, it is travelling towards-x direction.

(a) Angular wave number or propagation constant, $k = \frac{\Phi}{x} = \frac{20x}{x} = 20m^{-1}$ **(1mark)**

(b) Wavelength: $k = \frac{2\pi}{\lambda} \Rightarrow \lambda = \frac{2\pi}{k} = \frac{2\pi}{20} = 0.31m$ **(0.5mark)**

(c) Angular frequency, w = 200 rad/s **(0.5mark)**

(d) Frequency, $f = \frac{\omega}{2\pi} = \frac{200}{2\pi} = 32Hz$ **(0.25mark)**

(e) Time Period, $T = \frac{1}{f}$ = 0.031 s **(0.25mark)**

(f) Wave speed, $v = \lambda f = 0.31 \times 32 = 10$ m/s (approx.) **(1mark)**

(g) Amplitude, $A = 0.003$ m **(0.5mark)**

(h) Given; $x = 0.3$ m, $t = 0.02$ s **(1mark)**

$\therefore v = \frac{dy}{dt} = -0.003 \times 200 \sin(20x + 200t) = -0.6 \sin 10 = +0.33$ m/s

(i) Given; $x = 0.3$ m, $t = 0.02$ s **(1mark)**

$\therefore a = \frac{dv}{dt} = -0.6 \times 200 \cos(20x + 200t) = -120 \cos 10 = +101$ m/s^2

QUESTION 5:

(i) Coal, oil and natural gas are called 'fossil fuels' because they have been formed from the fossilized remains of prehistoric plants and animals. Fossil fuels are non-renewable energy source since they take millions of years to form. They ultimately get their energy from the sun. **(2 Marks)**

(ii) Each advantage **(0.5 Mark)** and disadvantage **(0.5 Mark)**

Advantages	**Disadvantages**
1. Large quantities	1. Causes Acid rain and global warming.
2. Well-distributed	2. Not so readily transported.

3. Converted into synthetic liquid fuels and gases.	3. Mining is dangerous.
4. Yields far more energy than renewable sources.	4. Leaves solid residue and releases toxic gases in air, causing pollution.
5. Safer than nuclear power.	
6. Longer life span than oil or gas.	
7. Feedstock for organic chemicals.	

QUESTION 6:

a) Renewable energy comes from the natural resources that can be replenished during an average human lifetime. e.g. Biomass, solar,…. **(1 Mark)**
while the fossil fuel can take thousands or even millions of years to replenish. e.g. oil, natural gas, coal,….. **(1 Mark)**
b) Uranium. Or other terms related to nuclear power plant. **(1 Mark)**
c) Solar energy. **(1 Mark),** geothermal energy, hydropower, wind energy, biomass.
d) Oil/petroleum products. **(1 Mark),** natural gas, coal.

QUESTION 7:
a) Take positive to be downward. Write Newton's second law in the downward direction.

$\sum \boldsymbol{F_R}$=mg+$\boldsymbol{F_{T_1}}$=m$\boldsymbol{a_R}$=$\frac{\boldsymbol{mV^2}}{\boldsymbol{r}}$. **(1 Mark)**

$\boldsymbol{F_{T_1}}$=m($\frac{\boldsymbol{V^2}}{\boldsymbol{R}}$ − $\boldsymbol{g}$)=(0.300)($\frac{\boldsymbol{(4.00)^2}}{\boldsymbol{0.720}}$) – (9.81)

$\boldsymbol{F_{T_1}}$**=3.71N.** **(1 Mark)**

b) Take positive to be upward. Write Newton's second law in the upward direction.

$\sum \boldsymbol{F_R}$=mg+$\boldsymbol{F_{T_2}}$=m$\boldsymbol{a_R}$=$\frac{\boldsymbol{mV^2}}{\boldsymbol{r}}$ **(1 Mark)**

$\boldsymbol{F_{T_2}}$=m($\frac{\boldsymbol{V^2}}{\boldsymbol{R}}$ + $\boldsymbol{g}$)=(0.300)($\frac{\boldsymbol{(4.00)^2}}{\boldsymbol{0.720}}$) + (9.81)

$\boldsymbol{F_{T_2}}$**=9.61N.** **(1 Mark)**

QUESTION 8:

a) For jump from n=4 to n=2, we have

$$\boldsymbol{\lambda=\frac{1.24x10^3 eVnm}{E_4-E_2}=\frac{1.24x10^3 eVnm}{-0.85eV-(-3.4eV)}}$$ **(1 Mark)**

$$\boldsymbol{\lambda = 486nm}$$ **(1 Mark)**

b) For jump from n=3 to n=1, we have

$$\boldsymbol{\lambda=\frac{1.24x10^3 eVnm}{E_3-E_1}=\frac{1.24x10^3 eVnm}{-1.5eV-(-13.6eV)}}$$ **(1 Mark)**

$$\boldsymbol{\lambda = 102nm}$$ **(1 Mark)**

c) The energy of the n=5 level is:

$$\boldsymbol{E_5=\frac{-13.6eV}{5^2}=-0.54eV}$$

For jump from n=5 to n=2, we have

$$\boldsymbol{\lambda=\frac{1.24x10^3 eVnm}{E_5-E_2}=\frac{1.24x10^3 eVnm}{-0.54eV-(-3.4eV)}}$$ **(1 Mark)**

$$\boldsymbol{\lambda = 434nm}$$ **(1 Mark)**

QUESTION 9:

$$\boldsymbol{Y(x,t)=(6.50mm)cos\,2\pi\frac{x}{28.0cm}-\frac{t}{0.0360\,sec}}$$

a) A= 6.50mm **(0.5 Mark)**

b) $\boldsymbol{\lambda = 28.0cm}$ or 0.280m **(0.5 Mark)**

c) $\mathbf{f=\frac{1}{T}=\frac{1}{0.0360}=27.8Hz}$ **(0.5 Mark)**

d) V=$\boldsymbol{\lambda f=(0.280)(27.8)=7.78m/s}$ **(1 Mark)**

e) The wave is traveling in the positive X-direction. **(0.5 Mark)**

QUESTION 10:

The potential difference across a resistor of 17.5Ω

V=IR. **(0.5 Mark)**

V=17.5Ω x 2A

V=35 Volts. **(1 Mark)**

The loop's rule (Loop1) gives: $35=7I_2$

$I_2=\frac{35}{7}A= 5A$ **(1 Mark)**

The junction rule gives: $I_1=5A+2A=7A$. **(1 Mark)**

OR

$5I_1+7(I_1-2) = 70$
$5I_1+7I_1-14=70$
$12I_1=70+14$
$I_1=7A$
$I_2=7A-2A=5A$

QUESTION 11:

L=0.5m
m=5kg
T=mg=5x9.81=49N
f=100Hz

$\boldsymbol{\mu}$ =?

$\boldsymbol{f = \frac{1}{2L}\sqrt{\frac{T}{\mu}}}$ **(1 Mark)**

$100=\frac{\mathbf{1}}{\mathbf{2x0.5}}\sqrt{\frac{\mathbf{49}}{\boldsymbol{\mu}}}$

$100=\sqrt{\frac{49}{\mu}}$ **(1 Mark)**

$(100)^2=\frac{49}{\mu}$

$\boldsymbol{\mu = 0.0049kg/m}$ **(2 Marks)**

QUESTION 12:

a) i) Electric field is defined as the electric force experienced by a unit charge. **(1 Mark)**

ii) Electric potential is defined as the amount of work needed to move a unit charge from a reference point to a specific point against an electric field. **(1 Mark)**

b) i) The electric field strength, $E=\frac{V}{d}$ **(0.5 Mark)**

$E=\frac{12}{0.001}=12000V/m$ **(0.5 Mark)**

ii) The work done W=qV=qEd **(0.5 Mark)**

$W=2.5x10^{-6}x12=30x10^{-6}=30\mu J$ **(0.5 Mark)**

QUESTION 13:

a) _____ (iv) **(1 Mark)**
b) _____ (i) **(1 Mark)**
c) _____ (ii) **(1 Mark)**
d) _____ (iii) **(1 Mark)**

QUESTION 14:

a) Re=6400Km, h=700 Km then
r=R+h **(1 Mark) ,** r=(6400+700)km= 7100km=$7.1x10^6$m **(1 Mark)**

b) The speed of a satellite orbiting around the Earth is given by: $\frac{GMm}{r^2} = \frac{mV^2}{r}$

$v=\sqrt{\frac{GM}{R}}$ **(1 Mark)**

$V=\sqrt{\frac{(6.67x10^{-11})(5.97x10^{24})}{7.1x10^{6}}}$ **= 7489m/s** **(1 Mark)**

QUESTION 15:

a) Cathode Ray tube (CRT) is a vacuum tube in which a beam of electrons is accelerated and deflected under the influence of electric or magnetic fields. **(2 Marks)**

b) $ke=3.2x10^{-6}J$, $e=1.6x10^{-19}C$, $D=2.1cm=2.1x10^{-2}m$, $d=5mm=5x10^{-3}m$

$mV^2=2Ke= 2x3.2x10^{-6}=6.4x10^{-6}Kgm^2/s^2$

$Z=\frac{L}{2}$ + 20cm but L=2cm then $Z=21cm=21x10^{-2}m$

From $D=\frac{VeLz}{dmV^2}$ **(1 Mark)**

$V=\frac{dmV^2D}{eLz}$ **(1 Mark)**

$V=\frac{(5x10^{-3})(6.4x10^{-6})(2.1x10^{-2})}{(1.6x10^{-19})(2x10^{-2})(21x10^{-2})}$ **= $1.0x10^{12}$Volts** **(2 Marks)**

SECTION B:

QUESTION 16:

a) i) **Will not affect**. **(0.5 Mark)**

The maximum kinetic energy of the photoelectrons cannot be affected by the intensity of the incident light because the letter does not appear in the Einstein's equation, $\frac{mv_{max}^2}{2}$ **=hf-Φ**. The intensity of the incident light depends on the amplitude of light wave. **(0.5 Mark)**

ii) **Increases.** **(0.5 Mark)**

The maximum kinetic energy of the photoelectrons increases when the light of higher frequency f is used because the term hf increases. **(0.5 Mark)**

iii) **Decreases.** **(0.5 Mark)**

The maximum kinetic energy of the photoelectrons decreases when the light of longer wavelength λ is used because the term $hf=h\frac{C}{\lambda}$ decreases. **(0.5 Mark)**

iv**) Decreases.** **(0.5 Mark)**

The maximum kinetic energy of the photoelectrons decreases when a metal surface with a large work function **Φ** is used because of the negative sign of **Φ** used in the following equation. $\frac{mv_{max}^2}{2}$ **=hf-Φ.** **(0.5 Mark)**

b) i) $2.3eV= (1.6x10^{-19})(2.3) =3.68x10^{-19}J$. **(1 Mark)**

ii) The frequency, f= $\frac{c}{\lambda}$ **(1 Mark)**

f=$\frac{3.0x10^{8}}{250x10^{-9}}$= 12x$10^{14}$Hz =**1.2x$10^{15}$Hz**. **(2 Marks)**

iii) The maximum kinetic energy KE=hf-**Φ**. **(1 Mark)**

KE= (6.626x10^{-34})(12x10^{14}) – 3.68x10^{-19}= **4.27x10^{-19}J** **(1 Mark)**

QUESTION 17:

(a) The table below summarized the differences

Rutherford's model	**Bohr's model**
Rutherford model states that an atom is composed of a central core where nearly the whole mass of that atom is concentrated and light weight particles move around this central core. **(1 Mark)**	Bohr model explains that electrons always travel in specific shells orbits which are located around the nucleus and these shells have discrete energy levels. **(1 Mark)**
Rutherford model was developed based on observations of gold foil experiment. **(1 Mark)**	Bohr model was developed based on observations of line spectra of the hydrogen atom. **(1 Mark)**
Rutherford model does not describe the presence of discrete energy level.	Bohr model describes the presence of the discrete energy levels.
Rutherford model does not explain the relationship between orbital size and the energy of the orbital.	Bohr model explains the relationship between orbital size and the energy of the orbital, smallest orbital has the lowest energy.

(b) An atom has a number of stable orbits in which an electron can reside without the emission of radiant energy. Each orbit corresponds to a certain energy level. **(1 Mark)**

An electron may jump spontaneously from one orbit (energy level E_i) to the other orbit (energy level E_f), $E_f > E_i$. Then the energy change $E_f - E_i$ = hf. Where f is the frequency of the light emitted and h is the Planck's constant. **(1 Mark)**

The motion of an electron in a circular orbit is restricted in such a manner that its angular momentum is an integral multiple of $\frac{h}{2\pi}$. Thus mvr=$\frac{nh}{2\pi}$. **(1 Mark)**

(c) –Cannot be applied to multi-electron atoms. **(1 Mark)**

- Does not provides a method to calculate relative intensities of spectra lines. **(1 Mark)**
- Does not predict fine structure of atomic spectral lines. **(1 Mark)**
- Predicts the wrong value of angular momentum for the electron in the atom. **(1 Mark)**
- Violates the Heisenberg uncertainty principle (although Bohr's model preceded this more than decade).

QUESTION 18:

a) i) **Work function** is the least or minimum energy needed to just liberate an electron from it. **(2 Marks)**

ii) **Stopping potential** is the least negative potential to stop all the electron emitted from a cathode in a photoelectric cell. **(2 Marks)**

iii) **Threshold frequency** is the lowest radiation frequency needed to just liberate an electron from the surface of a metal. **(2 Marks)**

b) $\boldsymbol{f_{violet}=\frac{C}{\lambda_{violet}}=\frac{3.0x10^{8}}{425x10^{-9}}=7.058x10^{14}Hz.}$ **(0.5 Mark)**

$\boldsymbol{f_{yellow}=\frac{C}{\lambda_{yellow}}=\frac{3.0x10^{8}}{580x10^{-9}}=5.17x10^{14}Hz.}$ **(0.5 Mark)**

Both sources are not able to eject photoelectrons from metal, only violet is one which is able to eject photoelectrons because it has the frequency above the threshold, $\boldsymbol{7.058x10^{14}Hz > 6.20x10^{14}Hz}$ **(1 Mark)**

ii) $\boldsymbol{\Phi = hf_0}$ **(1 Mark)**

$\boldsymbol{\Phi}$ = (6.626x10^{-34}) (6.20x10^{14})= 4.108x10^{-19}J. **(1 Mark)**

QUESTION 19:

a) **Resonance** occurs when the natural frequency of vibration of an object or a system is equal to the driving frequency, giving a maximum amplitude of vibration. **(2 Marks)**

b) **Damped oscillation** are oscillations in which the oscillating system loses energy to the surrounding due to dissipative forces such as friction, air resistance, the amplitude of the oscillation decreases with time **(2 Marks) while forced oscillation** are oscillations which occurs when a system which is capable of vibrating is subjected to an external periodic forces, so as to set it oscillating for the required time. e.g. air in pipes. **(2 Marks)**

c) i) K=90N/m

b=40g/s=0.04Kg/s

m=200g=0.200Kg

$\boldsymbol{\omega' = \sqrt{\frac{K}{m}+\frac{b^2}{4m^2}}}$, $\boldsymbol{\omega' = \sqrt{\frac{90}{0.2}+\frac{(o.o4)^2}{4(0.2)^2}}}$ $\boldsymbol{\omega' = 21.21rad/sec}$ **(2 Marks)**

$\boldsymbol{T' = \frac{2\pi}{\omega'}=\frac{2X3.14}{21.21}=0.296sec}$ **(2 Marks)**

QUESTION 20:

a) (i) **Crest:** This is the point on the wave profile with maximum positive displacement(upwards) while **Trough:** This is the point on the wave profile with maximum negative displacement (downwards). **(2 Marks)**

(ii) (2 Marks)

Transverse waves	Longitudinal waves
particles vibrate perpendicular to the direction of propagation of the wave profile	Particles vibrate parallel to the direction of propagation of the wave profile
No variation in particle density occurs along the wave profile	particle density varies along the wave profile.
consists of troughs and crests	consists of compressions and rarefactions.
they undergo polarization	do not undergo polarization
distance between successive crests or troughs is a wavelength	distance between successive compressions of successive rarefactions is a wavelength

(iii) (2 Marks)

Sound waves	Light waves
they are mechanical waves	They are electromagnetic waves
require a material medium for their propagation i.e. can not travel in a vacuum.	do not require a material medium for their propagation i.e. can travel through a vacuum
they are longitudinal waves	they are transverse waves
they have a low speed/ low frequency or long wavelength.	have high speed/ high frequencies or short wavelength.
can not be polarized	can be polarized

c) **(4 Marks)**

(i) $\Phi = \frac{2\pi x}{\lambda}\ and \lambda = \frac{v}{f} \Rightarrow \Phi = \frac{2\pi x f}{v} = \frac{2\pi \times 0.17 \times 600}{340} = 0.6\pi$ radians

(ii) 6π radians

END!!!!!!!!!!!!!!!