RUTSIRO DISTRICT_S5 PCB,PCM,MPG&MPC MONDAY ,11 /03/2024
MARKING GUIDE FOR PHYSICS EXAM_TERM II (2023-2024)

SECTION A: MULTIPLE CHOICE QUESTIONS (20MARKS)

Q1(**4marks)**	**Q2(4marks)**	**Q3(4marks)**	**Q4 (4marks)**	**Q5(4marks)**
a) (iv)	a)T	a) (ii)	(A) (5)	A._3
b) (ii)	b)F	b) (i)	(B) (2)	B._4
c) (iv)	c)F	c) (ii)	(C) (3)	C._1
d) D	d)T	d) (iii)	(D) (1,4)	D._2

Q6.) Not, I disagree with him/her (**1 mark)**

b) A black body is an object that absorbs all radiation falling on it and therefore emitting radiation in whole spectrum of wavelengths (**1mark).** At equilibrium temperature a black body has a characteristic frequency spectrum that depends only on its temperature **(1 mark).**

A perfect blackbody is one that absorbs all incoming light and does not reflect any (**1 mark**). At room temperature, such an object would appear to be perfectly black (hence the term blackbody). However, if heated to a high temperature, a blackbody will begin to glow with thermal radiation.

Therefore, a or black body need not be of black color. Here the student confuses a black color and blackbody (**1mark)**

Q7.**Difference between nuclear fission and nuclear fusion are :**

Nuclear fission :

1.In a nuclear fission, a heavy nucleus splits up into lighter nuclei. **(1 mark)**

2.Harmful radiations are emitted in nuclear fission **(1 mark)**

3.It starts when slow neutrons bombard the heavy nucleus like ranium-235

4.It causes much pollution.

5.A large amount of energy is released in nuclear fission.

It can be controlled.

Nuclear fusion :

1.In a nuclear fusion, two or more light nuclei combine to form a heavy nucleus. **(1 mark)**

2.No harmful radiations are emitted in nuclear fusion. **(1 mark**)

3.It starts when light nuclei are heated at very high temperature.

4.It causes no pollution.

5.Energy released in nuclear fusion is much more than nuclear fission.

6.It cannot be controlled.

Q8. Environmental consequences of using fossil fuels are:

1.Burning of fossil fuel causes air pollution. **(1mark**)

2.Burning of fossil fuel can cause acid rain which corrode the buildings, monuments and reduces the fertility of the soil. (**1mark)**

3.Smog is caused by burning of fossil fuels which block the sun's radiations and hence hamper the process of photosynthesis. (**1mark**)

4.Burning of fossil fuels release greenhouse gases, which in turn be the source of global warming. (**1mark)**

Q9.a)i)**$\lambda=\frac{h}{p}$** , $p = mv, p$: ***momentum***, h: ***planck's constant*** **(1mark)**

a)Given: m = 150 g; v = 50 m/s

The required equation λ=h/p=h/mv**(1mark)**

$\lambda=(6.626\times10^{-34}/150\times10^{-3}\times50)$

$\lambda=8.83\times10^{-35}$ m**(1mark)**

b) The energy of re single photon

$$E=hC/\lambda$$

(1mark)

$$E=\frac{hc}{\lambda}=\frac{6.63\times10^{-34}\times3\times10^{8}}{7.8\times10^{2}\times10^{-9}}=2.55\times10^{-19}J$$

(1mark)

Q10.a) (i)The photoelectric effect is the emission of electrons from the surface

of a metal when electromagnetic radiation with sufficient energy (such as visible or ultraviolet light) strikes on that metal. (**2mark)**

(ii)Threshold frequency is defined as the minimum frequency that is required for the radiation such that photoelectric effect is produced **(1mark)**

b) Frequency of light(**1mark)**, intensity of light (**1mark**), nature of material

Q11.

a) False (1mark)

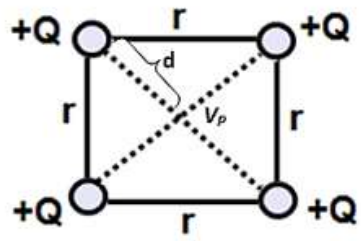
b) True (1mark)

c) False (1mark)

d) True (1mark)

e) False (1mark)

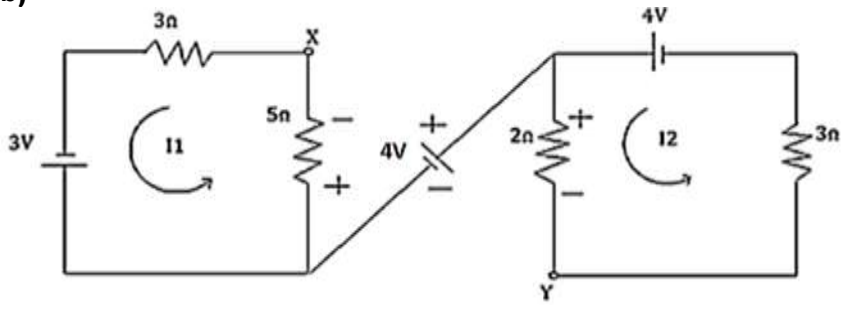
Q12.



The net electric potential at the center of the square, $\mathbf{V_p = 4 \times k\frac{Q}{d}}$ $(2marks)$, *where distance* $\boldsymbol{d} = \frac{\sqrt{2}}{2}r.(2marks)$ *therefore,* $\boldsymbol{V_p = \frac{8}{\sqrt{2}}\frac{kQ}{r}}$ ***(1mark)***

Q13. a) -Kirchhoff's first rule/the junction rule: The sum of all currents entering a junction must equal the sum of all currents leaving the junction. Or **∑I_in =∑I _out (1mark)**

b)



$I_1 = \frac{3}{3+5} = \frac{3}{8} = 0.375A$ ***(1mark)***

$I_2 = \frac{4}{2+3} = \frac{4}{5} = 0.8A$ ***(1mark)***

$V_{xy} = V_x - V_y$ ***(1mark)***

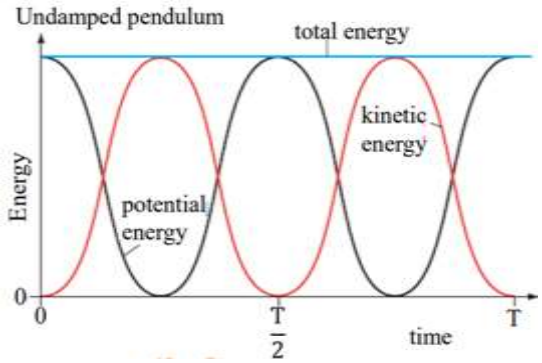
$V_x + 5I_1 + 4 - 2I_2 - V_y = 0$

$V_x - V_y = 2I_2 - 4 - 5I_1 = -4.275V$ ***(1mark)***

The p.d between x and y is -4.275V

Q14.a) D /1mark
b) voltmeter /1mark
c) (i) VT=8V+4V=12V /1mark
(ii) A2=3A /1mark
d)Decreases /1mark

Q15. a)



b) Problems :

- Buildings in earth quakes may be severely damaged. **(1 mark)**
- Resonance may cause engine components to crack or disintegrate with severe consequences. (**1 mark)**
- Microphone held too close to loudspeaker that is emitting waves of the same frequency as the microphone is tuned to, so the waves from the loudspeaker force the amplifier to resonate. etc.....

Usefulness

- Tuning radio; Electric signal in circuit forced by incoming radio waves. **(1 mark)**
- Microwave cooking; water molecules are forced by microwaves. **(1 mark)**
- etc.....

Q16. ESSAY FORM
Introduction (1mark)
Even if in nowadays, nuclear plant are ones appreciated due to their high production, but they cause many problems, so that in the following, we are describing some risks associated with them.
Body some risks associated with nuclear power are described below

Climate change, air and water pollutions **(1mark)**

If an accident occurs, nuclear energy can explode. This can cause air pollution, water pollution and the delayed radioactive fallout, which gradually fall over months and even years to the ground, often in rain.
They produce changes in the climate (possibly by lowering of the earth's temperature over the whole hemisphere which could ruin agricultural crops and cause widespread famine). Nuclear power plants use uranium as fuel. The process of mining uranium releases high amounts of carbon dioxide into the environment. Carbon dioxide is also released into the environment when new nuclear power plants are built. Finally, the transport of radioactive waste also causes carbon dioxide emissions which is greenhouse gas**. (1mark)**

Destruction of ozone layer (1mark)
The massive columns of smoke generated by a nuclear war would alter the world's climate for years and devastate the ozone layer engendering both human health and food supplies. They would cause partial destruction of the ozone layer, which protects the earth from the sun's ultraviolent rays. If ozone layer is depleted, unprotected people would suffer a type of snow blindness from the rays which, if repeated, would lead to permanent blindness. Many animals would suffer the same fate **(1mark)**
Nuclear meltdown (**1mark)**
A nuclear meltdown occurs when a nuclear power plant system or component fails so the reactor core becomes overheated and melts. A meltdown releases the core's highly radioactive and toxic elements into the atmosphere and environment. (**1mark)**
Weapons Proliferation Risk (**1 mark)**
The growth of nuclear energy has historically increased the ability of nations to obtain or harvest plutonium or enrich uranium to manufacture nuclear weapons. The nuclear weapons proliferation concern is a barrier and risk to the increasing development of nuclear energy. Radioactive dust from the

detonating bombs rises up into the atmosphere and spreads out over large areas of the world from where it falls down and causes deadly levels of radiation. A nuclear weapon could cause great destruction, death, and injuries such as burns, blindness and radiation sickness. **(1mark)**
Nuclear energy produces radioactive waste A major environmental concern related to nuclear power is the creation of radioactive wastes such as uranium mill tailings, spent (used) reactor fuel, and other radioactive wastes. These materials can remain radioactive and dangerous to human health for thousands of years.
Conclusion
Nuclear energies are more efficient than other forms of energy sources existing in the world. During operation nuclear power plants produce almost no greenhouse gas emissions except during the mining of uranium. But it can cause other many strong bad risks relatively to others, the reason why when its used or exploited, a considerable pay attention must be taken, to reduce dangers that may arise. **(1 mark)**

Q17.**Potentiometer**
Advantages (**1 mark**) for one of the examples

Easy to use
Low cost
High amplitude output
Easily available
Can be used for measuring even large displacement

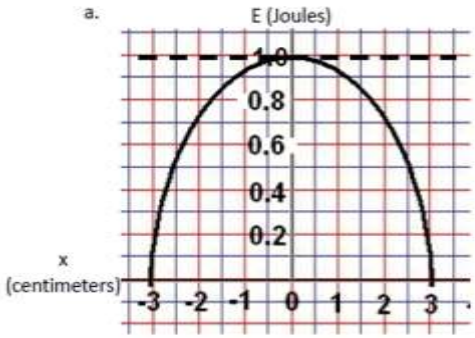
Disadvantages **(1 mark)** for one of the examples
Wear
Noise
Inertia
Limited Power

b) Good introduction, body and conclusion **(1mark)** ,the following is an example essay
A simple potentiometer is a device used for taking a number of electrical measurements (0.5mark). It is a piece of resistance wire, usually a metre long, fixed between two points A and B with a cell of output voltage, V, connected between the two ends. And It works on the principle of change of resistance of the wire with its length (**0.5mark**). The principle of potentiometer states that: "The potential difference across any length of a wire of uniform cross-section and uniform composition is proportional to its length when a constant current flows through it"(**0.5mark).**
The battery in primary circuit creates a potential difference across the length of the potentiometer wire (**0.5mark**). A potential gradient K is also developed across the wire. (K=Potential supplied by main battery divided by length of wire) **(0.5mark).** The potentiometer wire is thus a source of variable potential difference. That is, potential depends on length of wire selected. (Potential = length ×potential gradient) **(0.5mark**).
Why Potentiometer is chosen over Voltmeter to measure the potential of a cell? When Voltmeter is used, current flows through the circuit, and because of the internal resistance of the cell, always terminal potential will be less than the actual cell potential (**0.5mark**). But in a potentiometer circuit, when the potential difference is balanced, no current flows in the circuit, so terminal potential will be equal to actual cell potential(0.5mark). Voltmeter measures the terminal potential of a cell, but Potentiometer measures actual cell potential **(0.5mark**).

As sum, Potentiometer provides the exact value of potential difference across any two points in a circuit(**0.5mark**) because it never draws any current from the circuit whereas in the case of voltmeter there is always loss of energy due to internal resistance of cell(**1mark**). Accuracy of potentiometer can be increased by increasing length of potentiometer but some cannot hold for voltmeter (**1 mark).**

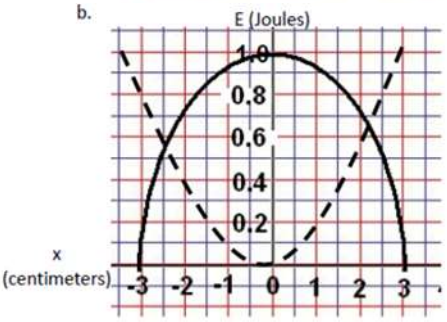
Q18. a**) 2marks**

a.



Total Energy is a straight line (dashed) at 1.0 J.

b.



Potential Energy is a positive parabola (dashed) that intersects the Total Energy curve at -3 cm and 3 cm.

b) 0.03 m **(2 marks)**

c) $PE = ME - KE$

$PE = 1 - 0.56 = 0.44\,J$ range (0.3J to 0.44)

(1 mark)

d) range (0.56 J to 0.7J) **(1 marks)**

e) range 0.0212 m to 0.25 m **(2 marks)**

f) $PE = \frac{1}{2} m \omega^2 x^2 = 0.44\,J$ **(2 marks)**

$$\frac{1}{2} \times 0.4 \times \omega^2 \times (0.02)^2 = 0.44$$

$$\omega = 74.16$$

$$\omega = \frac{2\pi}{T}$$

$$T = \frac{2\pi}{\omega} = 0.0847\ s \quad \textbf{(2marks)}$$

Q19.

(a) Bohr's model postulates:

- Each electron moves in a circular orbit centered at the nucleus. (**1mark)**

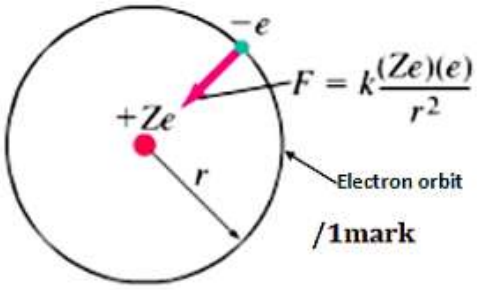
- The centripetal force needed by the electron moving in a circle is provided by electrostatic
force of attraction between the nucleus and electrons. (**1mark)**

etc……

(b) Any two limitations/drawbacks of Bohr's model of the hydrogen atom :

- It is valid only for single valency atoms, e.g. : H, , , etc. **(1mark)**
- Orbits were taken as circular but according to Sommerfield these are elliptical. (**1mark)**
- Intensity of spectral lines could not be explained.
- Nucleus was taken as stationary but it also rotates on its own axis.
- It could not explain the minute structure in spectral lines.

b. (i) Consider an electron orbiting the nucleus in its orbit of radius r



/1mark

From the second Bohr's postulate $F_c = F_{el}$ where $F_c = \frac{mv^2}{r}$ (centripetal force) and

$F_{el} = \frac{k|ze||-e|}{r^2}$ (electrostatic force of attraction between electron and nucleus)

Then, let's find kinetic energy (K.E) and potential energy (P.E):

$$\frac{mv^2}{r} = \frac{k|ze||-e|}{r^2} \rightarrow mv^2 = \frac{ze^2}{4\pi\epsilon_0 r} \quad \left[as\ k = \frac{1}{4\pi\epsilon_0}\right],\ \frac{1}{2}mv^2 = \frac{ze^2}{8\pi\epsilon_0 r}$$

$$implies\ \boldsymbol{K.E} = \frac{\boldsymbol{e^2}}{\boldsymbol{8\pi\epsilon_0 r}} \quad (\boldsymbol{2marks})\ [as\ z = 1\ for\ hydrogen\ atom]$$

But also $P.E = -eV$ *or* $V = \frac{ke}{r}$ *so,* $\boldsymbol{P.E} = -\frac{\boldsymbol{e^2}}{\boldsymbol{4\pi\epsilon_0 r}}$ $(\boldsymbol{2marks})\ [as\ z = 1\ for\ hydrogen\ atom]$

Total electric energy of electron,

$$E = K.E + P.E = \frac{e^2}{8\pi\epsilon_0 r} - \frac{e^2}{4\pi\epsilon_0 r} = -\frac{\boldsymbol{e^2}}{\boldsymbol{8\pi\epsilon_0 r}} \qquad (\boldsymbol{1mark})$$

For the n[th] energy levels, $E_n = -\frac{\boldsymbol{e^2}}{\boldsymbol{8\pi\epsilon_0 r_n}}$, with $r_n = \frac{\varepsilon_0 h^2 n^2}{\pi m e^2}$,

$\boxed{\boldsymbol{E_n = -\frac{me^4}{8\,\epsilon_0{}^2 h^2 n^2}}}$ $(\boldsymbol{1mark})$ i.e $\boldsymbol{E_n \propto \frac{1}{n^2}}$ **as required.**

And $E_n = -\frac{E_0}{n^2}\ where\ E_0 = \frac{me^4}{8\,\epsilon_0{}^2 h^2} = 13.6eV = 2.17 \times 10^{-18}J$

so, $E_n = -\frac{13.6eV}{n^2} = -\frac{2.17\times10^{-18}J}{n^2}$.

b.(ii) the orbital radius for $n = 1\ and\ n = 2$ levels:

$$r_n = \frac{\varepsilon_0 h^2 n^2}{\pi m e^2} \rightarrow r_n = r_1.n^2 \quad with\ r_1 = \frac{\varepsilon_0 h^2}{\pi m e^2}\ i.e\ r_n \propto n^2$$

For n=1: $r_1 = \frac{\varepsilon_0 h^2 (1)^2}{\pi m e^2} = \frac{\varepsilon_0 h^2}{\pi m e^2} = \frac{\left(8.85\times\frac{10^{-12}F}{m}\right)(6.62\times10^{-34}J.S)^2}{\frac{22}{7}(9.11\times10^{-31}kg)(1.60\times10^{-19}C)^2}$

$$= 0.53 \times 10^{-10}m = 0.53\text{Å}$$

$$\boldsymbol{r_1 = 0.53 \times 10^{-10}m = 0.53}\text{Å}\ (Bohr's\ radius)\ \textbf{(1 mark)}$$

For n=2: $r_n = r_1.n^2 \rightarrow r_2 = (0.53 \times 10^{-10}m)(2^2) = 2.12 \times 10^{-10}m$=*2.12*Å

$$\boldsymbol{r_2 = 2.12 \times 10^{-10}m = 2.12}\text{Å} \quad \textbf{(1 mark)}$$

Q20. a) Any four properties of the universal gravitational force :

- It is always attractive in nature while electric and magnetic force can be attractive or repulsive. **(1mark)**
- It is independent of the medium between the particles while electric and magnetic forces depend on the nature of the medium between the particles. **(1mark)**
- It is a central force, i.e. it acts along the line joining the centres of two interacting bodies.
- It is a two-body interaction, i.e. gravitational force between two particles is independent of the presence or absence of other particles.
- It is the weakest force in nature : As $F_{\text{nuclear}} > F_{\text{electromagnetic}} > F_{\text{gravitational}}$.
- It is a conservative force, i.e. work done by it is path independent or work done in moving a particle round a closed path under the action of gravitational force is zero.
- It is an action reaction pair, i.e. the force with which one body (say, earth) attracts the second body (say, moon) is equal to the force with which moon attracts the earth. This is in accordance with Newton's third law of motion.

b)

(i) Using the symbols above, the centripetal force needed to maintain the satellite in this orbit is $F = \dfrac{m_s v_s^2}{(R_E + h)}$ **(2marks)**

(ii) The gravitational field strength in the region of the satellite is

$g = \dfrac{GM_E}{(R_E + h)^2}$ **(2marks)**

(iii) The appropriate unit for this quantity. is $N\,kg^{-1}$ **(2marks)**

(iv) Using the two expressions above, $\dfrac{m_s v_s^2}{(R_E + h)} = \dfrac{GM_E m_s}{(R_E + h)^2}$ **(1mark)**

$v_s^2 = \dfrac{GM_E}{(R_E + h)}$ **(0.5mark)**, therefore the **greater the height** (h) of the satellite above the earth, the **smaller will be its orbital speed** (v_s) since G, M_E and R_E are constant. **(0.5mark)**

END