JEE-ADVANCED-2014-P2-Model

Time: 2.00 PM to 5.00 PM **IMPORTANT INSTRUCTIONS** **Max Marks: 180**

PHYSICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 1 – 10)	Questions with Single Correct Choice	3	-1	10	30
Sec – II(Q.N : 11 – 16)	Questions with Comprehension Type (3 Comprehensions – 2 +2+2 = 6Q)	3	-1	6	18
Sec – III(Q.N : 17 – 20)	Matrix Matching Type	3	-1	4	12
Total				**20**	**60**

CHEMISTRY:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 21 – 30)	Questions with Single Correct Choice	3	-1	10	30
Sec – II(Q.N : 31 – 36)	Questions with Comprehension Type (3 Comprehensions – 2 +2+2 = 6Q)	3	-1	6	18
Sec – III(Q.N : 37 – 40)	Matrix Matching Type	3	-1	4	12
Total				**20**	**60**

MATHEMATICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 41 – 50)	Questions with Single Correct Choice	3	-1	10	30
Sec – II(Q.N : 51 – 56)	Questions with Comprehension Type (3 Comprehensions – 2 +2+2 = 6Q)	3	-1	6	18
Sec – III(Q.N : 57 – 60)	Matrix Matching Type	3	-1	4	12
Total				**20**	**60**

PART-I_PHYSICS **Max Marks : 60**

Section-1
(Only one Option correct Type)

This section contains 10 Multiple Choice questions. Each Question has Four choices (A), (B), (C) and (D). Out of Which **Only One is correct**

1. Nuclei X decay into nuclei Y by emitting α particle of only 2 MeV & 1.4MeV. Disregarding the recoil of nuclei Y, the energy of γ photon emitted from the same sample will be

   A) 0.6MeV B) 1.4MeV C) 2 MeV D) 0.8 MeV

2. A point source of γ - radiation has a half-life of 30 minutes. The initial count rate recorded by a Geiger counter placed 2.0 m **form** the source is 360 sec^{-1}. The distance between the counter and the source is altered. After 1.5 hour the count rate recorded is 5 sec^{-1}. What is the new distance between the counter and the source?

   A) 9 m B) 8 m C) 6 m D) 4 m

3. Two identical photo-cathodes receive light of frequencies f_1 and f_2. If the velocities of the photoelectrons (of mass m) coming out are respectively v_1 *and* v_2 then

   A) $v_1^2 - v_2^2 = \frac{2h}{m}(f_1 - f_2)$ B) $v_1^2 + v_2^2 = \left[\frac{2h}{m}(f_1 + f_2)\right]^{1/2}$

   C) $v_1^2 + v_2^2 = \frac{2h}{m}(f_1 + f_2)$ D) $v_1^2 - v_2^2 = \left[\frac{2h}{m}(f_1 - f_2)\right]^{1/2}$

4. The shortest K-line of tungsten is 0.015 nm. The energy difference between the K and L level of the atom is closest to

A) 82.6 keV B) 62.0 keV

C) 110.2 keV D) 42 keV

5. In an x – ray tube, if the accelerating potential difference is increased, then

A) The frequency of characteristic x-rays of a material will get changed.

B) Number of characteristic x-ray lines may increase.

C) The difference between $\lambda_{\min imum}$ and $\lambda_{K\alpha}$ (wavelength of $K_\alpha x-ray$) will decrease.

D) The difference between $\lambda_{\min imum}$ and $\lambda_{K\alpha}$ (wavelength $K_\alpha x-ray$) will remain unchanged.

6. Activity of a radioactive substance is R_1 at time t_1 and R_2 at time t_2 $(t_2 > t_1)$. Then the ratio $\frac{R_2}{R_1}$ is

A) $\frac{t_2}{t_1}$ B) $e^{-\lambda(t_1+t_2)}$ C) $e\left(\frac{t_1-t_2}{\lambda}\right)$ D) $e^{\lambda(t_1-t_2)}$

7. The binding energies of the nuclei of ${}^{4}_{2}He$, ${}^{7}_{3}Li$, ${}^{12}_{6}C$ & ${}^{14}_{7}N$ are 28, 50, 89, 98MeV respectively. Which of these is most stable?

A) ${}^{4}_{2}He$ B) ${}^{7}_{3}Li$ C) ${}^{12}_{6}C$ D) ${}^{14}_{7}N$

8. In a $\alpha-$decay the Kinetic energy of $\alpha-$particle is 4 MeV and Q-value of the reaction is 4.2 MeV. The mass number of the daughter nucleus is: - (Assume that daughter nucleus is in ground state)

A) 96 B) 100 C) 84 D) 80

9. The wavelengths of K_α x-rays of two metals 'A' and 'B' are $\frac{1}{1875R}$ and $\frac{1}{675R}$ respectively, which 'R' is rydberg constant. The number of elements lying between 'A' and 'B' excluding A and B, according to their atomic numbers is

A) 9 B) 10 C) 19 D) 20

10. One of the lines in the emission spectrum of Li^{2+} has wavelength of 486 nm. The electronic transition corresponding to this line is:

A) $n = 4 \rightarrow n = 2$ B) $n = 8 \rightarrow n = 2$ C) $n = 8 \rightarrow n = 4$ D) $n = 12 \rightarrow n = 6$

Section-2
(Paragraph Type)

This section contains 3 paragraphs each describing theory, experiment, data etc. Six questions relate to three paragraphs with two questions on each paragraph. Each question pertaining to a particular **paragraph** should have only one correct answer among the four choices A, B, C and D.

Paragraph for Questions 11 & 12:

If two deuterium nuclei get close enough to each other, the attraction of the strong nuclear force will fuse them to make an isotope of helium. This process releases a huge amount of energy. The range of nuclear force is 10^{-15} m. This is the principle behind the nuclear fusion reactor. The deuterium nuclei moves so fast that, it is not possible to contain them by physical walls. Therefore, they are confined magnetically. (Assume coulomb law to hold even at 10^{-15} m)

11. Two deuterium nuclei having same speed undergo a head on collision. which of the following is closest to the minimum value of v (in km/sec) for which fusion occurs.

A)1000 B) 5000 C) 10000 D) 50000

12. Which of the following strength of magnetic field will make deuterium nuclei moving at minimum possible speed in previous question, to be confined in a circle of diameter 2.5m

A) 122mT B) 160Mt C) 139 mT D) 212 mT

Paragraph for Questions 13 & 14:

For heavy elements BE per nucleon decreases with increase in mass number. Suppose a nucleus X at rest undergoes α-decay $^{225}_{92}\mathrm{X} \rightarrow \mathrm{Y} + \alpha$. Some of the emitted α-particles are found to move along a helical path in a uniform magnetic field B = 5 T. Radius and pitch traced by the α-particle are R = 5 cm and P = 7.5π cm respectively.

[Given m(Y) = 221.003 U, m(n) = 1.009 U, m(P) = 1.008 U, mass of α-particle $= \frac{2}{3} \times 10^{-26}\,\mathrm{kg}$, 1 U = 931 MeV/$c^2$].

13. Speed of the alpha particle mentioned in the passage is

A) 9 x 10^6 m/s B) 12 x 10^6 m/s

C) 15 x 10^6 m/s D) 18 x 10^6 m/s

14. Total energy released during the α-decay, which is called Q value of the reaction, is (assume daughter nucleus in above α decay to be in ground state)

A) 3.54 MeV B) 4.77 MeV C) 3.93 MeV D) 4.5 MeV

Paragraph for Questions 15 & 16:

A hydrogen like atom of atomic number Z is in an excited state of quantum number 2n. It can emit a maximum energy photon of 204 eV. If it makes a transition to quantum state n, a photon of energy 40.8 eV is emitted. Ground state energy of hydrogen atom is –13.6 eV

15. Find the value of atomic number Z of this atom is

A) 2 B) 3 C) 4 D) 6

16. The minimum energy that can be emitted by this atom during de-excitation is

A) 10.58 eV B) 40.8 eV C) 6.2 eV D) 20.4 eV

Section-3
(Matching List Type)

This section contains four questions, each having two matching lists (List-1 & List-II). The options for the **correct match** are provided as (A), (B),(C) and (D) out of which **ONLY ONE** is correct.

17. An unstable nucleus decays by various decay processes. Match each of the decay process in Column I with the relevant statement in Column II.

Column – I	**Column – II**
A) γ - decay	P) accompanied by the emission of neutrino
B) β - decay	Q) without change of number of nucleons
C) β^+ - decay	R) followed by X-ray emission
D) K – capture	S) generally followed by γ - decay
	T) is mediated by weak nuclear forces

A) A-Q,B-QST,C-QST,D-PQRT

B) A-P,B-PQST,C-PQST,D-PQRS

C) A-Q,B-PQST,C-PQST,D-PQRST

D) A-QT,B-PQST,C-QST,D-PQRST

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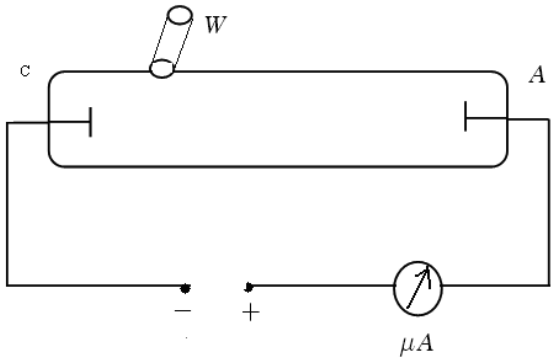
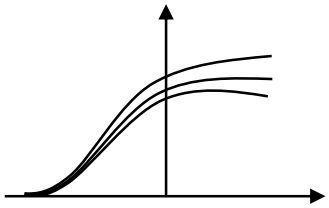
Column-I	Column-II
A) frequency of K_α line	P) Decreases with increase in acceleration potential
B) Difference between wavelengths of K_β & K_α lines	Q) May be smaller then that for K_β line
C) Minimum wavelength of the X-rays emitted from Coolidge tube	R) is dependent on atomic number of material of anticathode
	S) is independent of atomic number of material of anticathode

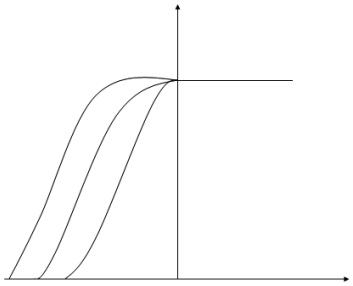
A) A-QR, B-R, C-PQS
B) A-QR, B-RS, C-PQS
C) A-QS, B-R, C-RS
D) A-QS, B-RS, C-PR

19. As shown in experimental setup to study photoelectric effect, two conducting electrodes are enclosed in a evacuated glass tube as shown. A parallel beam of monochromatic radiation falls on photosensitive electrode. Assume that for each photons incident, a photoelectron is ejected if it's energy is greater than work function of electrode. Match the statement in column I with corresponding graphs in column II

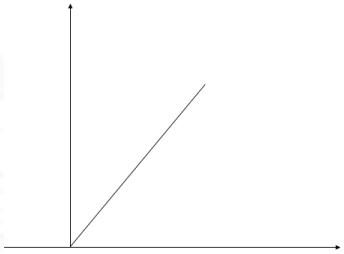


Column I	Column II
A) Saturation photocurrent versus intensity of radiation is represented by	(P) 

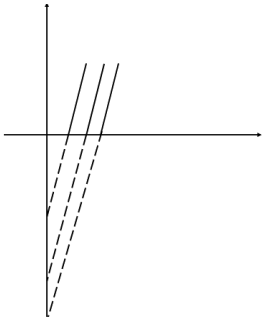
B) Maximum K.E of ejected photoelectrons versus frequency for electrodes of different work function is represented by (Q)



C)Photo current versus applied voltage for different intensity but same frequency of radiation is represented by (R)



D) Photo current versus applied voltage at constant photon flux density and constant frequency of radiation for electrodes of different work functions S)



A) A-R,B-S,C-Q,D-PQ B) A-R,B-S,C-P,D-PQ

C) A-R,B-S,C-P,D-Q D) A-S,B-R,C-PQ,D-Q

20. m_e = mass of electron

m= mass of nucleus

M= mass of atom

Column – I lists radio active decays

Column – II lists Q value of the reactions

List – I	**List – II**
A) ${}_{Z}X^{A} \rightarrow {}_{Z+1}Y^{A} \rightarrow +e^{-} + \bar{\eta}$	P) $m_x - m_y$
B) ${}_{Z}X^{A} \rightarrow {}_{Z-1}Y^{A} \rightarrow +e^{+} + \eta$	Q) $M_x - M_y$
C) ${}_{Z}X^{A} + \bar{e} \rightarrow {}_{Z-1}Y^{A} + \eta$	R) $m_x - m_y - m_e$
	S) $m_x - m_y + m_e$
	T) $m_x - m_y - 2m_e$

A) A-QR, B-RT, C-QS

B) A-QS, B-RT, C-RS

C) A-QR, B-RS, C-RT

D) A-PR, B-RT, C-PR