IMPORTAT PHYSICAL CONSTANTS

Planck's constant <i>, h</i> Electronic mass <i>, m</i>	6.63 x 10 ⁻³⁴ J/s 9.11 x 10 ⁻³¹ kg
Electronic charge, <i>e</i>	1.6 x 10 ⁻¹⁹ C
Speed of light, C	2.9998 x 10 ⁸ m/s
Reydeberg's constant, R	$1.09677 \text{ x } 10^5 \text{ cm}^{-1}$

Section A: This section contains ONE COMPULSORY question

Question 1 (Compulsory -30 marks)

- a. Explain each of the following terms
 - i. Wave number
 - ii. Black body
 - iii. Energy quantization
 - iv. Absorption spectroscopy
 - v. jelly model of an atom
 - vi. Angular velocity
 - vii. Work function
- b. Giving appropriate examples where necessary, outline the main classification of elements in the periodic table. (6 marks)
- c. Sketch the shapes of each of the following orbitals: (3 marks)
 - i. dz²
 - ii. dyz
 - iii. $dx^2 y^2$
- d. starting from electronic configuration of Cu,

i.	Write the electronic configuration for Cu ²⁺ ions.	(2 marks)
ii.	Zinc, which is element number 30, is not always classified as a transition	element yet
	copper, which element number 29 is. Explain.	(4 marks)
iii.	Briefly discuss different types of chemical bonds.	(8 marks)

Section B: This section contains FOUR questions. Answer ONLY TWO questions.

Question 2 (Optional, 20 marks)

- a. According to Max Born the symbol Ψ used to represent wave functions in wave mechanics do not represent an amplitude function in the common sense used for ordinary waves but it is a measure of probability of a mechanical event:
 - i. Briefly discuss the main assumptions of Bohr's theory of atomic structure (4 marks)
 - ii. Explain the limitations of this theory (3 marks)

(7 marks)

- b. The molecular orbital theory assumes that bonding is delocalised so that electrons belong to all atoms in the molecule:
 - i. Draw an energy level diagram to illustrate distribution of electrons in the molecular orbitals of the molecule NO. (6 marks)
 - ii. From the diagram, write the electronic configuration of NO⁻ (2 mark)
 - iii. Calculate the
 - I. magnetic moments and (2 marks)
 - II. bond order of NO⁻
 - iv. State the magnetic properties of NO⁻ (1 mark)

Question 3 (Optional, 20 marks)

- a. In 1924 de Broglie postulated that every moving particle is associated with a wave:
 - i. Derive an expression for the relationship between the wavelength () of the associated wave and the mass (*m*) of the particle. (6 marks)
 - ii. Determine the momentum (*P*) and corresponding de Broglie wavelength of electrons when the accelerating voltage is 56 V. (4 marks)
- b. At 298 K for NaCl, lattice energy, U = +757.3 kJ/mol; electron affinity of chlorine, E.A. = -348.5 kJ/mol; ionization energy of sodium, I.E. = +495.4 kJ/mol, dissociation energy of chlorine, ΔH_{diss} = +129.9 kJ/mol and sublimation energy of sodium, ΔH_{sub} = +08.49 kJ/mol. Draw a Born-Haber cycle to represent this information and use it to calculate the heat of formation, ΔH_f of NaCl. (10 marks)

Question 4 (Optional, 20 marks)

- a. Discovery of photoelectric effect was one of the key developments in understanding the structure of the atom.
 - i. With the aid of a diagram to illustrate, discuss production photoelectrons.

(4 marks)

(2 mark)

- ii. Briefly explain how the kinetic energy of photo electrons can be measured.
- b. Briefly discuss Heisenberg's uncertainty principle. (4 marks) (6 marks)
- c. Suppose the velocities of an electron (mass = 9.11×10^{-31} kg) and that of a rifle bullet (mass = 3.0×10^{-2} kg) were each measured with uncertainties of $\Delta V = 10^{-3}$ m/s. Determine the minimum uncertainties in there positions according to the uncertainty principle. Comment on the values of uncertainties for the two particles. (6 marks)

Question 5 (Optional, 20 marks)

- a. Briefly discuss the properties of an acceptable wave function according to Max Born's interpretation of wave functions.
 (6 marks)
- b. Work out and sketch the shape of *d*-orbitals for which the angular part of their wave function is $f = 3 \operatorname{co}^2 \theta 1$. (4 marks)
- c. Briefly discuss different types of molecular orbitals (MOs). (6 marks)
- Sketch the titanium dioxide crystal structure and use it to determine the formula of titanium dioxide.
 (4 marks)

-END-

Element	Symbol	Atomic no.	Atomic weight	Element	Symbol	Atomic no.	Atomic weight
Actinium	Ac	89	(227)	Mercury	Hg	80	200.59
Aluminium	Al	13	26.981 539	Molybdenum	Mo	42	95.94
Americium	Am	95	(243)	Neodymium	Nd	60	144.24
Antimony	Sb	51	121.75	Neon	Ne	10	20.1797
Argon	Ar	18	39.948	Neptunium	Np	93	(237)
Arsenic	As	33	74.921 59	Nickel	Ni	28	58.69
Astatine	Al	85	(210)	Niobium	Nb	41	92,906 38
Barium	Ba	56	137.327	Nitrogen	N	7	14.006 74
Berkelium	Bk	97	(247)	Nobelium	No	102	(255)
Bervllium	Be	4	9.012 182	Osmium	Os	76	190.2
Bismuth	Bi	83	208,980 37	Oxygen	0	8	15,9994
Boron	B	5	10.811	Palladium	Pd	46	106.42
Bromine	Br	35	79.904	Phosphorus	P	15	30.973 762
Cadmium	Cd	48	112.411	Platinum	Pt	78	195.08
Caesium	Cs	55	132.90543	Plutonium	Pu	94	(244)
Calcium	Ca	20	40.078	Polonium	Po	84	(209)
Californium	Cf	98	(251)	Potassium	ĸ	19	39 098 3
Carbon	C.	6	12011	Praseodymium	Pr	59	140 907 65
Cerium	Ce	58	140 115	Promethium	Pm	61	(145)
Chlorine	CI	17	35 452 7	Protectinium	Pa	91	231 035
Chromium	Cr	24	51 996 1	Radium	Pa	88	226 025 4
Cobalt	Co	24	58 933 20	Radon	Rn	86	(222)
Copper	Cu	20	63 546	Phonium	Ra	75	196 207
Cupper	Cu	25	(247)	Rhemum	Ph	15	100.207
Duenrosium	Du	90	(247)	Rhodium	Ph	45	95 467 9
Einsteinium	Eg	00	(254)	Rubicium	RU D.	37	101 07
Erbium	Es Er	59 69	167.26	Samurium	Sm	67	150.36
Europium	E.	63	151 045	Samarium	Sa	02	44.055.010
Earmium	Em	100	(257)	Selanium	Se	24	78.06
Fluerine	rm F	100	(257)	Scientum	50	14	70.90
Francium	Г Г-	9	(222)	Silver	31	14	20.0033
Cadalinium	C.	61	(223)	Silver	Ag	4/	107.0002
Gadonnum	Ga	04	137.23	Socium	INa C-	11	22.989 /08
Gamum	Ga	31	09.725	Strontium	Sr	38	87.02
Germanium	Ge	32	12.01	Sulphur	5	10	32.000
Gold	Au	79	196.900 04	Tantalum	Ta	13	180.9479
Hainium	HI	12	1/8.49	Technetium	TC T	43	(97)
Henum	не	2	4.002.602	Tellurium	Te	52	127.60
Holmium	Но	6/	164.93032	Terbium	15	65	158.925 34
Hydrogen	н	1	1.00794	Thailium	<u> </u>	81	204.383 3
lodine	1	53	126.904 47	Thulium	Im	69	168.934 21
Indium	In	49	114.82	Thorium	In	90	232.0381
Iridium	lr F	11	192.22	Tin	Sn	50	118.710
Iron	Fe	26	55.847	Titanium	11	22	47.88
Krypton	Kr I	36	83.80	lungsten	w	/4	183.85
Lanihanum	La	57	138.905 5	Uranium	0	92	238.0289
Lawrencium	Lr	103	(260)	Vanadium	v	23	50.941 5
Lead	Pb	82	207.2	Xenon	Xe	54	131.29
Lithium	Li	3	6.941	Ytterbium	Yb	70	173.04
Lutetium	Lu	71	174.967	Yttrium	Y	39	88.905 85
Magnesium	Mg	12	24.305 0	Zinc	Zn	30	65.38
Manganese	Mn	25	54.938 05	Zirconium	Zr	40	91.224
Mendelevium	Md	101	(258)				

LIST OF ELEMENTS