QB365

Model Question Paper 3

12th Standard CBSE

**Physics**

Reg.No. : | | | | | |

Time : 02:00:00 Hrs

Total Marks : 100

## Section-A

1) A particle is dropped from a height H.The de-Broglie wavelength of the particle as a function of height is proportional to **1**

(a) H (b) $H^{1/2}$ (c) $H^0$ (d) $H^{-1/2}$

2) When a momentum point source of light is at a distance of 0.2m front a photoelectric cell, the cutoff voltage and the saturation current are respectively 0.6V and 18.0 mA.If the same source is placed 0.6m away from the photoelectric cell, then **1**

(a) the stopping potential will be 0.2 volt (b) the stopping potential will be 0.6 volt (c) the saturation current will be 6.0 mA

(d) the saturation current will be 2.0 mA

3) Which of the following characteristics of photoelectric effect supports the particle nature of radiations **1**

(a) threshold frequency (b) instantaneous photoelectric emission (c) independent of the velocity of photo-electrons on intensity of radiations

(d) dependence of the velocity of photoelectrons on frequency

4) Taking the Bohr radius as $a_0$=53pm, the radius of $Li^{++}$ ion its ground state, on the basis of Boh''s model, will be about **1**

(a) 53pm (b) 27pm (c) 18pm (d) 13pm

5) In good conductorsof electricity the type of bonding that exists is **1**

(a) ionic (b) vander waals (c) covalent (d) (d)metallic

## Section-B

6) The stopping potential in an experiment on a photoelectric effect is 1.5V. What is the maximum kinetic energy of the photoelectrons emitted? **1**

7) Why are alkali metal surfaces most suited as photosensitive surfaces? **1**

8) How is nuclear size related to its mass number? **1**

9) How does the energy gap of an intrinsic semiconductor vary, when doped with a pentavalent impurity? **1**

10) A specimen of silicon is to be made P-type semiconductor. For this one atom of indium, on an average, is doped in $5 \times 10^7$ silicon atoms. If the number density of silicon is $5 \times 10^{28}$ atom/$m^3$ , then find the number of acceptor atoms per $cm^3$ **1**

## Section-C

11) The number of ejected photoelectrons increases with an increase in the intensity of light but not with the increase in the frequency of light. Why? **2**

12) Binding energies of ${}_8O^{16}$ and ${}_{17}Cl^{35}$ are 127.35 MeV and 289.3 MeV respectively.Which of the two nuclei is more stable? **2**

13) Give the order of magnitude of nuclear mass density and average atomic mass density. Compare these densities with the typical mass density of solids, liquids, and gases (at ordinary temperature and pressure). **2**

14) Explain one similarity and one dissimilarity between nuclear fission and fusion. **2**

15) What are thermal neutrons? Why are neutrons considered as ideal particles for nuclear fission? **2**

16) What do you understand by logic gate? Why is it so called? State the types of gates. **2**

17) What do you understand by truth table and Boolean expression? **2**

18) Distinguish between "point to point" and "Broadcast" modes of communication. **2**

## Section-D

19) The work function of caesium metal is 2.14 eV. When light of frequency $6X10^{14}$ Hz is incident on the metal surface photoemission of electrons occurs. What is the (a)Maximum kinetic energy of the emitted electrons. (b)stopping potential and (c)maximum speed of the emitted photo-electrons? **3**

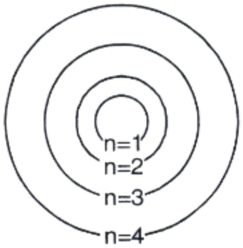
20) (a)For what kinetic energy of a neutron will the associated de Broglie wavelength be $1.40X10^{-10}$m? (b)Also find the de Broglie wavelength of a neutron in thermal equilibrium with matter having an average kinetic energy of 3/2 kT at 300K. **3**

21) An electron (mass m) with an initial velocity $v = v_0\vec{i}$ is in an electric field $E = E_0\vec{j}\,E = E_0\vec{j}$ . If $\lambda = \frac{h}{mv_0}$ its de-Broglie wavelength at time t is given by (a)$\lambda_0$ (b) $\lambda_0\sqrt{1 + \frac{e^2E_0^2\ \ t^2}{m^2v_0^2}}$ (c) $\frac{\lambda_0}{\sqrt{1+\frac{e^2E^2t^2}{m^2v_0^2}}}$ (d) $\frac{\lambda_0}{\sqrt{1+\frac{e^2E^2t^2}{m^2v_0^2}}}$ **3**

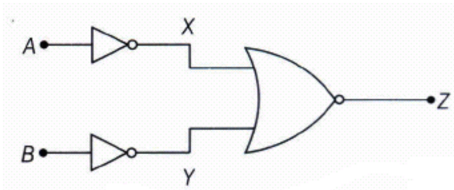
22) 'The half life ${}^{14}_{6}C$ is 5700 years.' What does it mean ? Two radioactive nuclei X and Y initially contain an equal number of atoms. Their half life is 1 hour and 2 hours respectively. Calculate the ratio of their rates of disintegration after two hours. **3**

23) A hydrogen atom initially in the ground level absorbs a photon, which excites it to the n=4 level.Determine the wavelength and frequency of photon. **3**

24) In the given figure for the stationary orbits of the hydrogen atom, mark the transition representing the Balmer and Lyman series 3




25) You are given a circuit below.Write its truth table, identify the logic operation carried out by this circuit.Draw the logic symbol of the gate it corresponds. 3




26) Write any two distinguishing features between conductors, semiconductors and insulators on the basis of energy band diagrams. 3

**Section-E**

27) Einstein was the first to establish the equivalence between mass energy. According to him, whenever a certain mass $(\Delta m)$ disappears in some process, the amount of energy released is $E=(\Delta m)c^2,$ where c is velocity of light vacuum $\left(=3\times10^8 m/s\right)$. The reverse is also true, i.e., whenever energy E disappears, an equivalent mass $(\Delta m)=E/c^2$ appears. 5

Read the above passage and answer the following questions :

(i) What is the energy released when 1 a.m.u. of mass disappears in a nuclear reaction?

(ii) Do you know any phenomenon in which energy materialises?

(iii) What values of life do you learn from this famous relation?

28) Shyamsaw his younger brother wondering with a question which deals with emission of light from a vapour lamp. He was anxious to know how different colours wre being emitted by different lights. He also saw mercury and sodium vapour lamps in the Physics lab and was curious to know what is inside the lamps. On seeing his anxiety to know more about it, Shyam explained about absorption of energy and re-emission of photons in the visible region. He also advised him not to touch or break any items in the lab for the knowledge. 5

Read the above passage and answer the following questions:

(i) What is the moral you derive from Shyam's behaviour?

(ii) Which series in the hydrogen spectrum is in the visible region?

(iii) Write the quality displayed by Shyam's brother.

29) Suppose a 'n'-type wafer is created by doping Si crystal having $5*10^{28}$atoms/$m^3$with 1 ppm concentration of As.On the surface 200 ppm Boron is added to create $'p'$ region in this wafer. Considering $n_i=1.5*10^{16}m^{-3}$ (i) Calculate the densities of the charge carriers in the $n\&p$ regions.(ii)Comment which carriers would contribute largely for the reverse saturation current when diode is reverse biased. 5

30) Sanjay was prparing an electronic project for science exhibition. He required to light the LED using a 6 V supply. LEDs need only a very small current to make them light and they do not heat up in use. So he put a resistor in series to limit the current. Then there would be p.d. of 4 V across the resistor as there is always 2.0 V across the LED itself when it is conducting. The current should be 10 mA through both LED and the resistor. He could use the resistance by equation, R = V/I to calculate the value of R. 5

$R=\frac{V}{I}=\frac{4V}{10mA}=\frac{4V}{0.01A}=400V$

Thus the protecting resistor should be around 400Ω

A semiconductor has equal electron and hole concentration of $6\times10^8/m^3$. On doping with certain impurity, electron concentration increase to $9\times10^{12}/m^3$

31) (a) Distinguish between sinusoidal and pulseshaped signals. 5

(b) Explain, showing graphically, how a sinusoidal carrier wave is superimposed on a modulating signal to obtain the resultant amplitude modulated (AM) wave.

**Section-F**

32) The work function of caesium is 2.14 eV.Find (a) the threshold frequency for caesium and (b) wavelength of the incident light if the photocurrent is brought to zero by a stopping potential of 0.60 V. 5

$Given \quad h=6.63\times10^{-34}Js$

33) Complete the decay reaction 5

${}_{10}Ne^{23}\rightarrow\ ?+{}_{-1}e^0+\ ?$

Also, find the maximum KE of electrons emitted during this decay. Given of ${}_{10}Ne^{23}$=22.994465 u, the mass of ${}_{11}Na^{23}$ =22.989768u.

34) If 200 MeV energy is released in the fission of a single nucleus of ${}_{92}U^{235}$ , how many fissions must occur per second to produce a power of 1kW? 5

35) The length of Marconi antenna at a place is 1.5 m. What is the optimum transmission frequency? 5

36) A transmitting antenna at the top of a tower has a height 32 m and that of the receiving antenna is 50 m. What is the maximum distance between them for satisfactory communication in line of sidht mode? Given radius of earth is 6.4 x $10^6$ m. 5

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**Section-A**

1) (d) $H^{-1/2}$ 1

2) (b) the stopping potential will be 0.6 volt 1

3) (a) threshold frequency 1

4) (c) 18pm 1

5) (d) (d)metallic 1

## Section-B

6) $Max.K.E. = K_{max} = eV_0 = e \times 1.5V = 1.5eV$ 1

7) 1

The work function of alkali metal is very low. Even the ordinary visible light can bring about emission of photoelectrons from these metals. Due to this reason, alkali metal surfaces are most suited as photosensitive surfaces.

8) The radius R of atomic nucleus related to mass number A of the nucleus as $R = R_0 A^{1/3}$ where $R_0 = 1.2 \times 10^{-15} m$ ; an empirical constant. 1

9) 1

When an intrinsic semiconductor is doped with the impurity atoms of valence five like As, P or Sb, some additional energy levels are produced, situated in the energy gap slightly below the conduction band which are called donor energy levels. Due to it, energy gap in semiconductor decreases.

10) No density of silicon $= 5 \times 10^{28}$ atoms/$m^3$ $= 5 \times 10^{22}$ atoms/$m^3$ No. of acceptor atom/$m^3$ $= 5 \times 10^{22}/(5 \times 10^7) = 10^{15}/cm^3$ 1

## Section-C

11) 2

One incident photon can eject one photoelectron from a photosensitive surface. Therefore the no. of photoelectrons ejected per second depends upon the intensity of the incident light. The increase in the frequency of the incident photon but one photon of high energy can not eject more than one photoelectron from a photosensitive surface.

12) B.E/nucleon of $_8O^{16}$ $= \frac{127.35}{16}$ 2

$= 7.96 \quad MeV/N$

B.E/nucleon of $_{17}Cl^{35} = \frac{289.3}{35}$

$= 8.27 \quad Mev/N$

As stability of a nucleus $\propto$ B.E./N,

$\therefore$ $_{15}Cl^{35}$ is more stable than $_8O^{16}$.

13) 2

Nuclear mass density is of the order of $PFP - V - II - 91/11$. This is $10^{13}$ to $10^{14}$ times the average atomic mass density, which is of the order of $10^3$ to $10^4 \quad kgm^{-3}$. Typical mass densities of solids and liquids are of the same order as the atomic mass densities.This is because the atoms are tightly packed in these phases.The typical densities of gases at S.T.P are of the order of $10^{-1} \quad kgm^{-3}$ to $1 \quad kgm^{-3}$.

14) 2

Nuclear fission and nuclear fusion are dissimilar in the sense that former involves splitting of a heavy nucleus whereas latter involves fusing of two or more lighter nuclei.The similarity between the two is that both involve mass defect $(\Delta m)$ and hence nuclear energy is released in both the processes as per the relation

$E = (\Delta m)c^2$

15) 2

Thermal neutrons are low energy neutrons $\approx \frac{1}{40}eV$. Neutrons are considered as ideal particles for nuclear fission because they are neutral particles on which neither any force of attraction nor any force of repulsion acts.

16) 2

Logic gate. A digital circuit or electronic circuit which either allows a signal to pass through it or stops it, is called a gate. A gate which allows the signal to pass through it when some logical conditions are satisfied is called a logic gate. It means, for a logic gate there is a certain logical relationship between input and output voltages. The basic logic gates are of three types : 1. OR gate 2. AND gate and 3. NOT gate

17) 2

Truth table. It is a table that shows all possible input combinations and the corresponding output combinations for a given logic gate. It is also called a table of combinations.

**Boolean expression.** It is an expression invented by George Boole which deals with logical combination of inputs and outputs for a given logic gate.

The Boolean expression for OR gate is A + B = y, indicates that y equals A OR B. Here symbol plus (+) is referred to as OR. The Boolean expression for AND gate is ; A.B = y, indicates that y equals A AND B. Here symbol dot ( $\cdot$ ) is referred to as AND.

The Boolean expression for NOT gate is $\bar{A} = y$ , indicates that y equals NOT A or A negated. Here symbol bar over A means we change A to the alternative digit i.e. $\bar{1} = 0$ and $\bar{0} = 1$

18) 2

Point to point mode of communictaion is a communication over a link between a single transmitter and receiver.Example of such a system is a telephone.

Broad case mode of communication is a communication in which large number of receivers are linked to a single transmitter Examples of such system are radio,television

## Section-D

19) (a)0.34 eV (b)0.34 V (c)344 km/s 3

20) (a)6.634X10-21J (b)0.145 nm 3

21) 3

Here $\lambda_0 = \frac{h}{mv_0}$ and $\vec{v_x} = v_0\vec{i}$ ie. $v_x = v_0$ $\vec{a} = \frac{\vec{F}}{m} = \frac{(-e)\vec{E}}{m} = \frac{-eE_0\vec{j}}{m}$ Thus electron is accelerated along negative y-axis So $\vec{v_0} = 0 - \frac{eE_0t}{m}\vec{j} \Rightarrow u_y = \frac{eE_0t}{m}$

$\therefore$ Net velocity $v = \sqrt{v_x^2 + v_y^2} = \sqrt{v_0^2 + \frac{e^2E^2t^2}{m^2}}$ $= v_0\sqrt{1 + \frac{e^2E_0^2 \quad t^2}{m^2v_0^2}}$ So $\lambda = \frac{h}{mv} = \frac{h}{mv_0} \frac{1}{\sqrt{1+\frac{e^2E^2t^2}{m^2v_0^2}}} = \frac{\lambda_0}{\sqrt{1+\frac{e^2E_0^2 \quad t^2}{m^2v_0^2}}}$

22) 1 : 1 3

23) The energy of electron in nth state of hydrogen atom is given by: 3

$E_n = \frac{13.6}{n^2}$

So energies in 1st and 4th states will be:

$E_1$=-13.6 eV and $E_4 = -\frac{13.6}{4^2}$ =-0.85 eV

energy absorbed during excitation

$E=E_4-E_1$=-0.85+13.6

=12.75 eV

or hv=12.75 x 1.6 x $10^{-9}$J

v=$\frac{12.75 \times 1.6 \times 10^{-19}}{6.62 \times 10^{-34}}$

=3.0815 x $10^{15}$Hz

=3.1 x $10^{15}$Hz

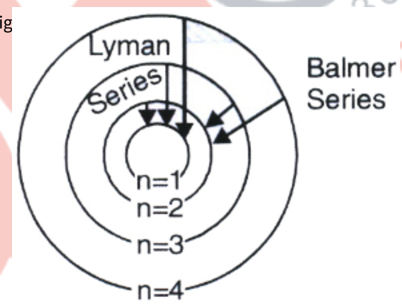
Since wavelencth

$\lambda = \frac{c}{v} = \frac{3 \times 10^8}{3.0815 \times 10^{15}}$

=973.5 x $10_{-10}$m=973.5$\overset{0}{A}$

=9.7 x $10^{-8}$

24) The transition representing the Balmer and Lyman series are shown in fig 3




25) Truth table of given circuit is given below: 3

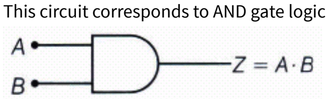
| A | B | X=$\bar{A}$ | Y=$\bar{B}$ | $Z = \overline{(X+Y)} = \overline{\bar{A} + \bar{B}}$ |
|---|---|---|---|---|
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 |
| 1 | 1 | 0 | 0 | 1 |

This circuit out the logic operation of AND gate which can be verified also by De-Morgan's theorem

$Z = \overline{(X+Y)} = \overline{\bar{A} + \bar{B}}$

$Z = \bar{\bar{A}}.\bar{\bar{B}} = A.B$

This circuit corresponds to AND gate logic symbol is




26) 3

(a) metals, (b) insulators and (c) semiconductors

Two distinguishing features:

(i) In conductors, the valence band and conduction band tend to overlap (or nearly overlap) while in insulators they are separated by a large energy gap and in semiconductors they are separated by a smaJ1'ep.ergygap.

(ii) The conduction band, of a conductor, has a large number of electrons available for electrical conduction. However the conduction band of insulators is almost empty while that of the semiconductor has only a (very) small number of such electrons available for electrical conduction.

**Section-E**

27) 5

(i) Here, $\Delta m = 1 \quad a.m.u. = 1.66 \times 10^{-27} kg$

$$E = (\Delta m)c^2 = 1.66 \times 10^{-27}\left(3 \times 10^8\right)^2 = 1.49 \times 10^{-10} J$$

(ii) Yes, in the phenomenon of pair production. Under suitable conditions, a photon materialises into an electron and a position : $\gamma = e^{-1} + e^{+1}$

(iii) Einstein's relation, $E = (\Delta m)c^2$ emphasis that when certain mass disappears, an equivalent amount of energy appears. The reverse is also true. It Implies that to gain something, you have to lose another in equivalent amount. No one can have all gains together or all losses together. It also implies that nothing come for free. You have to pay the price in one form and acquire something in the desired form.

28) (i) Concern for his brother, care about the school thorough subject knowledge. 5

(ii) Balmer series.

(iii) His brother has zeal to learn.

29) 5

(i)When As is implanted in Si-crystal,n-type wafer is created.The no of majority carrier electrons due to doping of As is

$$n_e = N_D = \frac{1}{10^6} * 5 * 10^{28} = 5 * 10^{22} / m^{-3}$$

No of minority carriers (holes) in $n -$ type wafer is

$$n_h = \frac{n_1^2}{n_e} = \frac{(1.5 * 10^{16})^2}{5 * 10^{22}} = 0.45 * 10^{10} / m^3$$

when B is implanted in Si-crystal p-type wafer is created with no of holes

$$n_h = N_A = \frac{200}{10^6} * (5 * 10^{28}) = 1 * 10^{25} / m^3$$

Minority carriers (electrons) created in p-type wafer is

$$n_e = \frac{n_1^2}{n_h} = \frac{(1.5 * 10^{16})^2}{1 * 10^{25}} = 2.25 * 10^{10} / m^3$$

When $p - n$junction is reverse biased,the minority carrier holes of $n -$ region wafer ($n_h = 0.45 * 10^{10} / m^3$) would contributte more to the reverse saturation current than minority carrier than minority carrier electrons ($n_e = 2.25 * 10^7 / m^3$)

30) (i) New semiconductor must be n-type, because the electron concentration increases. 5

(ii) Given,

$$n_i = 6 \times 10^8 / m^3 n_e = 9 \times 10^{12} / m^3 n_e n_h = n_i^2 \Rightarrow \quad n_h = \frac{n_i^2}{n_e} = \frac{(6 \times 10^8)^2}{9 \times 10^{12}} = \frac{36 \times 10^{16}}{9 \times 10^{12}} = 4 \times 10^4 / m^3$$

31) **5**

(a) In the process of modulation, some specific characteristics of the carrier wave is varied in accordance with the information or message signal.

The carrier wave may be :

(i) Continuous (sinusoidal) wave, or

(ii) Pulse, which is discontinuous.

A continuous sinusoidal carrier wave can be expressed as

$$E = E_0 sin(\omega t + \phi).$$

Three distinct characteristics of such a wave are amplitude ($E_0$ ), angular frequency ($\omega$) and phase angle ($\phi$) . Anyone of these three characteristics can be varied in accordance with the modulating baseband (AF) signal, giving rise to the respective amplitude modulation; frequency modulation and phase modulation.

Again, the significant characteristics of a pulse are pulse amplitude, pulse duration or pulse width and pulse position (representing the time of rise or fall of the pulse amplitude). Anyone of these characteristics can be varied in accordance with the modulating baseband (AF)signal, giving rise to the respective, pulse amplitude modulation (PAM), pulse duration modulation (PDM) or pulse width modulation (PWM) and pulse position modulation (PPM).

(b) Amplitude Modulation: When a modulating AF wave is superimposed on a high frequency carrier wave in a manner that the frequency of modulated wave is same as that of the carrier wave, but its amplitude is made proportional to the instantaneous amplitude of the audio frequency modulating voltage, the process is called amplitude modulation (AM).

Let the instantaneous carrier voltage ($e_c$ ) and modulating voltage (em) be represented by

$$e_c = E_c sin\omega_c t \quad ...(i) e_m = E_m sin\omega_m t \quad ...(ii)$$

Thus, in amplitude modulation, amplitude A of modulated wave is made proportional to the instantaneous modulating voltage $e_m$

$i.e.,\quad A = E_c + ke_m \quad ...(iii)$

where k is a constant of proportionality.

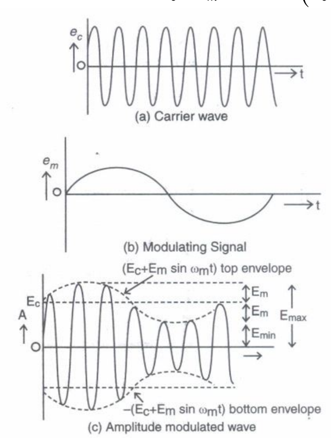
In amplitude modulation, the proportionality constant k is made equal to unity. Therefore, maximum positive amplitude of AM wave is given by

$$A = E_c + e_m = E_c + E_m \quad sin \quad \omega_m t \quad ...(iv)$$

It is called top envelope.

The maximum negative amplitude of AM wave is given by

$$-A = -E_c - e_m \quad = -\left(E_c + E_m sin \quad \omega_m t\right)...(v)$$






## Section-F

32) (a) **5**

$$V_0 = \frac{\phi_0}{h} = \frac{2.14eV}{6.63 \times 10^{-34}Js} \quad = \frac{2.14 \times 1.6 \times 10^{-19}J}{6.63 \times 10^{-34}Js} = 5.16 \times 10^{14}Hz$$

(b)

$$eV_0 = \frac{hc}{\lambda} - \phi_0 \quad or \quad \lambda = \frac{hc}{\left(eV_0 + \phi_0\right)} or \quad \lambda = \frac{\left(6.63 \times 10^{-34}Js\right) \times \left(3 \times 10^8 m/s\right)}{(e \times 0.6V + 2.14eV)} \quad = \frac{19.89 \times 10^{-26}Jm}{2.74 \times 1.6 \times 10^{-19}J} = 454nm$$

33) **5**

Applying conservation of charge number and mass number, we can write the decay reaction as

$${}_{10}Ne^{23} \rightarrow {}_{11}Na^{23} + {}_{-1}e^0 + \bar{v} Neglecting \quad mass \quad of \quad e^-, \quad mass \quad defect, \Delta m = m({}_{10}Ne^{23}) - m({}_{11}Na^{23}) = 22.994465 - 22.989768 \Delta m = 0.004697u Max \quad K.E. \quad of \quad electron \quad = \quad Q$$

34) **5**

Here, energy released/fission

=200MeV

$$= 200 \times 1.6 \times 10^{-13}J = 3.2 \times 10^{-11}J Total \quad energy \quad required/sec = 1 \quad kW = 1000w = 1000J/s. Number \quad of \quad fissions/sec = \frac{Energy \quad reqd. \quad per \quad sec.}{energy \quad released/fission} = \frac{1000}{3.2 \times 10^{-11}} = 3.125 \times 10^{13}s$$

35) Here, $l = \frac{\lambda}{4} = 1.5m$ **5**

$\therefore \quad \lambda = 4 \times 1.5 = 6m$

$v = \frac{c}{\lambda} = \frac{3 \times 10^8}{6} = 5 \times 10^7 Hz = 50MHz$

36) Here, $h_T$ = 32 m ; $h_R$ = 50 m ; 

R = 6.4 x $10^6$ m

Maximum distance for line of sight communication

$$d_m = \sqrt{2Rh_T} + \sqrt{2Rh_R}$$

$$= \sqrt{2 \times 6.4 \times 10^6 \times 32} + \sqrt{2 \times 6.4 \times 10^6 \times 50}$$

= 45.5 x $10^3$ m = 45.5 km.