CHRIST KING HR. SEC. SCHOOL, KOHIMA
CLASS- 9
SUBJECT: SCIENCE (CHEMISTRY AND PHYSICS), SECOND TERM

CHAPTER-3

(ATOMS AND MOLECULES)

TEXTBOOK EXERCISES (Page number: 45- 48)

1. A 0.24 g sample of compound of oxygen and boron was found by analysis to contain 0.096 g of boron and 0.144 g of oxygen. Calculate the percentage composition of the compound by weight.

Solution: Boron and oxygen compound → Boron + oxygen

0.24 g → 0.096 g + 0.144 g

Percentage composition of boron = 100x 0.096 g / 0.24 g

= 40%

Percentage composition of oxygen = = 100x 0.144 g / 0.24 g

= 60%

2. When 3.0 g of carbon is burnt in 8.00 g oxygen, 11.00 g of carbon dioxide is produced. What mass of carbon dioxide will be formed when 3.00 g of carbon is burnt in 50.00 g of oxygen? Which law of chemical combinations will govern your answer?

Solution: $C + O_2 \rightarrow CO_2$

12g 32g 44g

It shows that 12g of carbon burns in 32 g oxygen to form 44 g of carbon dioxide.

3 g of carbon reacts with 8 g of oxygen to produce 11 g of carbon dioxide. Consequently 11g carbon dioxide will be formed when 3 g of carbon is burnt in 50 g of oxygen consuming 8 g of oxygen leaving behind (50-8)= 42 g of oxygen. The above answer is governed by the law of constant proportions.

3. What are polyatomic ions? Give examples.

Ans: Ions which contain more than one atom and behave as a single unit are called polyatomic ions. E.g: Hydroxide ion (OH-)

4. Write the chemical formulae of the following: (a) Magnesium chloride (b) Calcium oxide (c) Copper nitrate (d) Aluminium chloride (e) Calcium carbonate

Answers: (a) Magnesium chloride → $MgCl_2$ (b) Calcium oxide → CaO (c) Copper nitrate → $Cu(NO_3)_2$ (d) Aluminium chloride → $AlCl_3$ (e) Calcium carbonate → $CaCO_3$

5. Give the names of the elements present in the following compounds: (a) Quick lime (b) Hydrogen bromide (c) Baking powder (d) Potassium sulphate

Answers: Quick lime → Calcium and oxygen

Hydrogen bromide → Hydrogen and bromine

Baking powder → Sodium, hydrogen, carbon and oxygen

Potassium sulphate → Potassium, sulphur and oxygen

6. Calculate the molar mass of the following substances:

(a) Ethyne, C_2H_2

(b) Sulphur molecule, S_8

(c) Phosphorus molecule, P_4 (atomic mass of phosphorus = 31)

(d) Hydrochloric acid, HCl

(e) Nitric acid, HNO_3

Solution: (a) Molar mass of ethyne, $C_2H_2 = 2 \times 12 + 2 \times 1 = 28$ g

(b) Molar mass of sulphur molecule, $S_8 = 8 \times 32 = 256$ g

(c) Molar mass of phosphorus molecule, $P_4 = 4 \times 31 = 124$ g

(d) Molar mass of hydrochloric acid, HCl = 1 + 35.5 = 36.5 g

(e) Molar mass of nitric acid, $HNO_3 = 1 + 14 + 3 \times 16 = 63$ g

7. What is the mass of:

(a) 1 mole of nitrogen atoms?

(b) 4 moles of aluminium atoms (Atomic mass of aluminium = 27)?

(c) 10 moles of sodium sulphite (Na_2SO_3)?

Solution: (a) The mass of 1 mole of nitrogen atoms is 14 g.

(b) The mass of 4 moles of aluminium atoms is (4×27) g = 108 g

(c) The mass of 10 moles of sodium sulphite (Na_2SO_3) is

$10 \times [2 \times 23 + 32 + 3 \times 16]$ g = 10×126 g = 1260 g

8: Convert into mole.

(a) 12 g of oxygen gas

(b) 20 g of water

(c) 22 g of carbon dioxide

Solution: (a) Given, mass of oxygen = 12 g

Molar mass of oxygen = 32g

Therefore, number of moles of oxygen gas = 12/32

= 0.375 mole

(b) Given, mass of water = 20 g

Molar mass of water = (2x1) + 16 = 18 g

Therefore, number of moles of water =20/18 = 1.11 moles (approx)

(c) Given, mass of carbon dioxide = 22 g

Molar mass of carbon dioxide = (1x12) + (2 + 16)

=12+ 32 = 44g

Therefore, number of moles of carbon dioxide =22/ 44 = 0.5 mole

9. What is the mass of?

(a) 0.2 mole of oxygen atoms?

(b) 0.5 mole of water molecules?

Solution: (a) Mass of one mole of oxygen atoms = 16 g

Then, mass of 0.2 mole of oxygen atoms = 0.2 × 16g = 3.2 g

(b) Mass of one mole of water molecule = 18 g

Then, mass of 0.5 mole of water molecules = 0.5 × 18 g = 9 g

10. Why initially oxygen was taken as a standard for defining various atomic mass units?

Ans: This is because of the following reasons:

(i)Oxygen reacts with a large number of elements and formed compound.

(ii) This atomic mass unit gives masses of most of the elements as whole numbers.

11. Why was the Dalton's atomic theory modified when the structure of atom was known properly?

Ans: Dalton's atomic theory needs to modify due to the following reasons:

(i) With the discovery of fusion and fission, we know that atoms can be created or destroyed.

(ii) With the discovery of isotopes, not all atoms of a given elements are identical.

12. Atoms are so insignificant in size, but still we are very much concerned about them. Why is it so?

Ans: This is because atoms take part in a chemical reaction and retain all the chemical and physical properties of an element. Atoms are the building blocks of all matter.

13. What is the term used to indicate the atomic particle which contains:

(i) More electrons than its neutral atom

(ii) Less electrons than its neutral atom?

Answers: (i) Anion (ii) Cation

14. Calculate the mass of:

(i) 10 atoms of carbon

(ii) 10 molecules of water

(iii) 0.5 moles of CO_2

Solution: (i) Mass of 1 atom of carbon = atomic mass of carbon/ Avogadro number = 12/ 6.022 x 10^{23} = 1.993 x 10^{-23} g

Therefore, mass of 10 atoms of carbon = 10x 1.993 x 10^{-23} g

$$=1.993 \times 10^{-22}$$

(ii) Mass of 1 molecule of water = molecular mass of H_2O/ Avogadro number = 18/ 6.022 x 10^{23} = 2.989 x 10^{-23}

Therefore, mass of 10 molecules of water = 10 x 2.989 x 10^{-23}

$$= 2.989 \times 10^{-22}$$

(iii) Mass of 0.5 moles of CO_2 = molar mass x number of moles

= (1x 12 +2x 16) x0.5

= 44x0.5 = 22 g

15. What is meant by molecules of a compound? How many different types of molecules are known? Explain.

Ans: The combination of atoms of different elements in definite proportion is called molecules of a compound. On the basis of atomicity, molecules can be classified as

Mono atomic molecules which consist only one atom such as Argon (Ar), Helium (He), etc are made up of one atom of that element.

Diatomic molecules which consist two atoms such as oxygen (O_2), Hydrogen (H_2).

Triatomic molecules which consist three atoms e.g. ozone (O_3)

Tetra atomic molecules which consist four atoms e.g. P_4 (Phosphorus).

Polyatomic molecules which consist more than four atoms

e.g CH_4(Methane).

16. Which type of atoms occur in the form of:

(i) Neutral atoms (Noble gases)

(ii) Neutral aggregates (molecules)

(iii)Positively charged aggregates (cations)

(iv) Negatively charged aggregates (anions)

Answers:

(i) Zero balanced atoms of elements.

(ii) Ions of ionic compounds.

(iii) Ions of metals.

(iv) Ions of non-metals.

17. Calculate the number of molecules of sulphur (S_8) present in 16 g of solid sulphur.

Solution: Given, mass of sulphur = 16 g

Molar mass of S_8 = 8x 32 = 256 g = 6.022 x 10^{23} molecules

Molecules of sulphur = $16x\ 6.022x10^{23}/_{256}$

$=96.35x10^{23}/_{256}$

= 0.376 x 10^{23}

= 3.76 x 10^{22}

18. Calculate the number of aluminium ions present in 0.051 g of aluminium oxide. (Hint: The mass of an ion is the same as that of an atom of the same element. Atomic mass of Al = 27 u)

Solution: Molar mass of aluminium oxide (Al_2O_3)

= (2 × 27) + (3 × 16)

=54+48=102g

Therefore, 102 g of Al_2O_3 contains = 2x 6.022 × 10^{23} aluminium ions

Therefore, 0.051 g of Al_2O_3 contains $=2\ x\ 6.022x10^{23}x\ 0.051\ /_{102}$

$=\ 12.044\ x10^{23}x\ 0.051\ /_{102}$

$=0.614\ x10^{23}\ /_{102}$

=0.006022 × 10^{23}

= 6.022 x 10^{20} ions

Tick the correct option:

1. (i) 2. (i) 3. (i) 4. (ii) 5. (iv)

In-text questions page: 34-35

1. Solution: Given, Mass of sodium carbonate = 5.3 g

Mass of ethanoic acid = 6 g

Mass of sodium ethanoate = 8.2 g

Mass of carbon dioxide = 2.2 g

Mass of water = 0.9 g

Now, total mass before the reaction = (5.3 + 6) g = 11.3 g

Total mass after the reaction = (8.2 + 2.2 + 0.9) g = 11.3 g

∴Total mass before the reaction = Total mass after the reaction

Hence, the given observations are in agreement with the law of conservation of mass.

2. Solution: Given, the ratio of hydrogen and oxygen by mass in water is 1:8.

Let reqd mass of oxygen gas = X

Therefore, 1: 8 = 3: X

X= 3x 8

X = 24

3. Solution: Atoms are indivisible particles, which can neither be created nor destroyed in a chemical reaction.

4. Solution: The relative number and kind of atoms in a given compound remains constant.

In-text questions page: 37

1. Solution: One atomic mass unit is a mass unit equal to exactly one-twelfth the mass of one atom of carbon-12. It is written as ‘u’.

2. Solution: This is because atom is so small that it is not possible to see it with naked eyes. The size of an atom is measured in nanometers.

In-text questions page: 41

1. Answers:

(i) Sodium oxide →Na_2O

(ii) Sodium suphide → Na_2S

(iii) Aluminium chloride → $AlCl_3$

(iv) Magnesium hydroxide → $Mg(OH)_2$

2. Answers:

(i) $Al_2(SO_4)_3$ → Aluminium sulphate

(ii) $CaCl_2$ → Calcium chloride

(iii) K_2SO_4 → Potassium sulphate

(iv) KNO_3 → Potassium nitrate

(v) $CaCO_3$ → Calcium carbonate

3. Ans: The chemical formula of a compound means the symbolic representation of the composition of a compound. For example, chemical formula of carbon dioxide = CO_2

4. Answers:

(i) In H_2S molecule, three atoms are present; two of hydrogen and one of sulphur.

(ii) In $PO4^{3-}$ ion, five atoms are present; one of phosphorus and four of oxygen.

In-text questions page: 42

1. Answers:

Molecular mass of H_2 = 2 × Atomic mass of H = 2 × 1 = 2 u

Molecular mass of O_2 = 2 × Atomic mass of O = 2 × 16 = 32 u

Molecular mass of Cl_2 = 2 × Atomic mass of Cl = 2 × 35.5 = 71 u

Molecular mass of CO_2 = Atomic mass of C + 2 × Atomic mass of O

= 12 + 2 × 16 = 44 u

Molecular mass of CH_4 = Atomic mass of C + 4 × Atomic mass of H

= 12 + 4 × 1 = 16 u Molecular mass of C_2H_6 = 2 × Atomic mass of C + 6 × Atomic mass of H

= 2 × 12 + 6 × 1 = 30 u Molecular mass of C_2H_4 = 2 × Atomic mass of C + 4 × Atomic mass of H = 2 × 12 + 4 × 1 = 28 u Molecular mass of NH_3 = Atomic mass of N + 3 × Atomic mass of H = 14 + 3 × 1 = 17 u
Molecular mass of CH_3OH = Atomic mass of C + 4 × Atomic mass of H + Atomic mass of O = 12 + 4 × 1 + 16 = 32 u

2. Answers:

Formula unit mass of ZnO = Atomic mass of Zn + Atomic mass of O = 65 + 16 = 81 u Formula unit mass of Na_2O = 2 × Atomic mass of Na + Atomic mass of O = 2 × 23 + 16 = 62 u Formula unit mass of K_2CO_3 = 2 × Atomic mass of K + Atomic mass of C + 3 × Atomic mass of O = 2 × 39 + 12 + 3 × 16 = 138 u

In-text questions page: 44

1. Solution: Given, 1 mole of carbon atoms= $6.022x10^{23}$ atoms = 12g Therefore, mass of 1 atom of carbon = $12g/6.022x10^{23}$

= $1.99x\ 10^{-23}$ g

2. Solution: 23 g of Na = 6.022×10^{23} atoms (1mole)

Therefore number of atoms in 100 g of Na =$100x6.022x10^{23}$ / 23

= $602.2x10^{23}$ / 23

$= 26.182 \times 10^{23}$

$= 2.6182 \times 10^{24}$ atoms

56 g of Fe $= 6.022 \times 10^{23}$ atoms

Therefore, number of atoms in 100g of Fe

$= 100 \times 6.022 \times 10^{23} / 56$

$= 602.2 \times 10^{23} / 56$

$= 10.753 \times 10^{23} = 1.075 \times 10^{24}$ atoms

100g of Na contains 2.618×10^{24} atoms

100 g of Fe contains 1.075×10^{24} atoms

Therefore, 100g of Na contains more atoms.

CHAPTER-10

(GRAVITATION)

TEXTBOOK EXERCISES (Page number: 153 -156)

1. How does the force of gravitation between two objects change when the distance between them is reduced to half?

Solution: We have, Force of gravitation between two objects,

$$F = G \frac{M1 \, x \, M2}{d^2}$$

Given, distance $d_1 = \frac{d}{2}$ i.e. $F_1 = G \frac{M1 \, x \, M2}{(d1)^2}$

Therefore, $F_1 = G \frac{M1 \, x \, M2}{(\frac{d}{2})^2}$

$$F_1 = G \frac{M1 \, x \, M2}{\frac{d^2}{4}}$$

$$F_1 = \frac{4xGM1 \, x \, M2}{d^2}$$

$$F_1 = 4 \text{ x } \frac{GM1 \, x \, M2}{d^2}$$

$$F_1 = 4 \text{ x } F$$

Hence, the gravitational force becomes four times of the original value.

2. Gravitational force acts on all objects in proportion to their masses. Why then, a heavy object does not fall faster than a light object?

Solution: The heavy object when falls, the 'g' is acting on it, which is independent of the mass of the body. $g = \frac{GM}{d^2}$ Therefore, a heavy object does not fall faster than a light object.

3. What is the magnitude of the gravitational force between the earth and a 1 kg object on its surface? (Mass of the earth is 6×10^{24} kg and radius of the earth is 6.4×10^6 m).

Solution: The magnitude of the gravitational force between earth and an object is given by: $F = \frac{GMm}{R^2}$

Given, m= 1kg, M= 6×10^{24} kg R= 6.4×10^6 m,

G = $6.67 \times 10^{-11} Nm^2/Kg^2$

Now, $F = \frac{6.67 \times 10^{-11} \times 6 \times 10^{24} \times 1}{(6.4 \times 10^6)^2}$

= 9.8 N

4. The earth and the moon are attracted to each other by gravitational force. Does the earth attract the moon with a force that is greater or smaller or the same as the force with which the moon attracts the earth? Why?

Ans: The value of gravitational force is same for the earth and the moon. This is because according to the universal law of gravitation, everybody attracts the other body with some force and this force is same for both the bodies.

5. If the moon attracts the earth, why does the earth not move towards the moon?

Ans: This is because the mass of the earth is large and the distance between the moon and the earth is very large, even the earth moves towards the moon, it is negligible.

6. What happens to the force between two objects, if

(i) the mass of one object is doubled?

(ii) the distance between the objects is doubled and tripled?

(iii) the masses of both objects are doubled?

Solution:

(i) If mass of one object is doubled, then the force will get doubled.

(ii) When the distance between the objects is doubled, then force will become one-fourth.

When the distance between the objects is tripled, then force will become one-ninth.

(iii) If masses of both objects are doubled, then new force will get four times.

7. What is the importance of universal law of gravitation?

Ans: Newton's law of gravitation has given us the understanding as to how artificial satellites will keep on moving in their orbit. This law has also given us the understanding as to why the heavenly bodies do not have a random motion.

8. What is the acceleration of free fall?

Ans: The acceleration produced in the motion of an object when it falls freely towards the earth is called acceleration of free fall.

9. What do we call the gravitational force between the earth and an object?

Ans: Force due to gravity.

10. Amit buys few grams of gold at the poles as per the instruction of one of his friends. He hands over the same when he meets him at the equator. Will the friend agree with the weight of gold bought? If not, why? [Hint: The value of g is greater at the poles than at the equator.]

Solution: We have, w=mg

But it depends on the value of g

Weight of gold at poles, $W_p = m \times g$

Weight of gold at equator, $W_e = m \times g$

$W_p > W_e$

Hence, the friend will not agree with the weight of the gold bought.

11. Why will a sheet of paper fall slower than one that is crumpled into a ball?

Ans: When a sheet of paper is crumbled into a ball, then its surface area becomes much lesser than the surface area of plain flat sheet of paper. Hence, resistance to its motion through the air decreases and it falls faster than the sheet of paper.

12. Name the instrument with which weight is measured.

Ans: Spring balance

13. When an object falls to the ground the earth moves up to meet it. Why is the earth's motion not noticeable? Explain.

Ans: This is because the mass of the earth is very large. So, the acceleration produced in the earth is too small.

14. Explain why one can jump higher at the surface of the moon than on the surface of earth.

Ans: This is because acceleration due to gravity (g) is much less on the surface of moon than on the surface of earth.

15. Where does the centre of gravity of the following bodies lie (i) Sphere (ii) Square (iii) Triangle (iv) Rectangle

Answers: (i) Sphere – Centre of gravity lies at its centre.

(ii) Square - Centre of gravity lies at its point of intersection of their diagonals.

(iii) Triangle - Centre of gravity lies at its centroid.

(iv) Rectangle - Centre of gravity lies at its point of intersection of their diagonals.

16. Mention some applications of Newton's law of gravitation.

Ans: Some applications of Newton's law of gravitation are:

(i) The force that binds us to the earth.

(ii) The motion of the moon around the earth.

(iii)The motion of the planets around the sun and

(iv) The tides due to the moon and the sun.

17. The mass of a planet is 10^{18} kg and its radius is 10^3m . Calculate the acceleration due to gravity on its surface. Use the known value of G.

Solution: Given, m=10^{18} kg , R= 10^3m ,G= G = 6.67x10^{-11}Nm^2/ Kg^2

We have, g = G x$\frac{m}{R^2}$

$=\frac{6.67x10^{-11}x10^{18}}{(10^3)^2}$

=6.67 x10 = 66.7 m/s^2

18. A boy throws a ball upwards from the ground ,it reaches back to him after 4 s.(a) With what velocity was it thrown? (b) What was the maximum height reached? Take g = 10m s^{-2}

Solution: (a) Given, u=? v=0, t= 4s, g= -10m/s^2

We have, v = u + gt

0 = u + (-10) x 4

0 = u - 40

u = 40m/s

(b) u = 40m/s, v = 0, h = ?

We have, v^2 – u^2 = 2gh

0^2 - (40)^2 = 2 x (-10) x h

0 -1600 = -20 h

20 h =1600

h =$\frac{1600}{20}$ = 80 m

19. Gravitational force on the surface of the moon is only 1/6 as strong as gravitational force on the Earth. What is the weight in Newton of a 10 kg object on the moon and on the Earth?

Solution: Mass of the object = 10 kg

We have, weight of the object on earth, w = m x g

= 10 x 9.8

= 98 N

Weight of the object on moon = $\frac{1}{6}$ th the weight on the earth.

Weight of the object on moon, w = $\frac{98}{6}$ = 16.3N

Weight on earth = 98N

Weight on moon = 16.3N

20. A ball is thrown vertically upwards with a velocity of 49 m/s. Calculate (i) the maximum height to which it rises.

(ii) the total time it takes to return to the surface of the earth.

Solution:

(i) u= 49 m/s, v= 0m/s

A=g= -9.8 m/s^2 (Going against gravity)

Height = Distance = s =?

We have, v^2-u^2 =2gs

$0^2 – (49)^2 = 2 (-9.8) x s$

s = $\frac{-49x49}{-2x9.8}$

= 122.5 m

(ii) Time taken, t = ?

We have, v = u + g t

0 = 49 + (- 9.8) x t

t = $\frac{-49}{-9.8}$ = 5 s

Total time taken to return the surface of the earth by the ball is 5s + 5 s = 10s

21. A stone is released from the top of a tower of height 19.6 m. Calculate its final velocity just before touching the ground.

Solution: Given, u= 0m/s, h= s= 19.6 m, g= 9.8 m/s^2 (Falling down),

v=?

We have, $v^2 − u^2 = 2 g s$

$v^2 - 0 = 2x 9.8 x 19.6$

$v^2 = 19.6 x 19.6$

Therefore, v= 19.6 m/s

22. A stone is thrown vertically upward with an initial velocity of 40 m/s. Taking g = 10 m/s², find the maximum height reached by the stone. What is the net displacement and the total distance covered by the stone?

Solution: Given, u = 40 m/s, v = 0, g = −10 m/ s², h=s =?

We have, $v^2 - u^2 = 2gs$

$0^2 - (40)^2 = 2(-10) \times s$

$s = \frac{1600}{20}$

$s = 80$ m

Net displacement of the stone = 0

(As the stone falls, back to the same point)

Total distance covered by stone = 80m + 80 m

(up) (down)

= 160 m

23. Calculate the force of gravitation between the earth and the Sun, given that the mass of the earth = 6×10^{24} kg and of the Sun = 2×10^{30} kg. The average distance between the two is 1.5×10^{11} m.

Solution: $M_e = 6 \times 10^{24}$ kg, $M_s = 2 \times 10^{30}$ kg, G = 6.7×10^{-11} Nm² kg²

d = 1.5×10^{11} m.

Gravitational force $F = G\frac{MeMs}{d^2}$

$= \frac{6.7 \times 10^{-11} \times 6 \times 10^{24} \times 2 \times 10^{30}}{(1.5 \times 10^{11})^2}$

$= 3.56 \times 10^{22}$ N

24. A stone is allowed to fall from the top of a tower 100 m high and at the same time another stone is projected vertically upwards from the ground with a velocity of 25 m/s. Calculate when and where the two stones will meet.

Solution: Given, h =100m, g = 9.8m/s² =10m/s²

Let the height covered by the falling stone = s_1

$s_1 = ut + \frac{1}{2}gt^2$

$= 0 \times t + \frac{1}{2} \times 10\ t^2$

$s_1 = 5t^2$ ……(1)

The height covered by stone thrown upward = s_2

u = 25 m/s, g = -10m/s²

$s_2 = u\,t + \frac{1}{2} gt^2$

$= 25t + \frac{1}{2}(-10)\,t^2$

$= 25t + -5t^2$ …….(2)

(i) Total height = 100m

$s_1 + s_2 = 100m$

$5t^2 + (25t - 5t^2) = 100m$

$T = \frac{100m}{25} = 4$ sec

(ii) $s_1 = 5t^2$

$= 5 \times 4^2$

$= 80m$

25. A ball thrown up vertically returns to the thrower after 6 s. Find

(a) the velocity with which it was thrown up,

(b) the maximum height it reaches, and

(c) its position after 4 s.

Solution : Given,

U =? , v = 0, g = - 9.8m/s² (thrown upward)

Total time = 6s (to go up and down)

Therefore, time for upward journey = $\frac{6}{2}$ =3s

(a) We know, v = u + gt

$0 = u + (-9.8) \times 3$

$u = 29.4m/s$

(b)Maximum height, h = s =?

Therefore, we have, $s = \frac{1}{2} gt^2$

$= (29.4 \times 3) + \frac{1}{2}(-9.8)\,(3)^2$

$= 88.2 + \frac{1}{2}(-88.2)$

$= 88.2 - 44.1$

$h = 44.1$ m

(c) Position after 4s

t = 4s

Therefore, we have,

$s = u\,t + \frac{1}{2} gt^2$

$s = (29.4 \times 4) + \frac{1}{2}(-9.8) \times (4)^2$

$= 117.6 + \frac{1}{2}(-156.8)$

$= 117.6 + 78.4$

Therefore, Position after 4s = 39.2m from the top.

26: In what direction does the buoyant force on an object immersed in a liquid act?

Ans: The buoyant force on an object immersed in a liquid acts upwards, i.e. opposite to the direction of the force exerted by the object.

27: Why does a block of plastic released under water come up to the surface of water?

Ans: Two forces act on an object immersed in water. One is the gravitational force, which pulls the object downwards, and the other is the buoyant force, which pushes the object upwards. If the upward buoyant force is greater than the downward gravitational force, then the object comes up to the surface of the water as soon as it is released within water. Here the upward buoyant force is more than the downward gravitational force on the plastic block. Due to this reason, a block of plastic released under water comes up to the surface of the water.

28. The volume of 50 g of a substance is $20 cm^3$. If the density of water is 1 gcm^{-3}, will the substance float or sink?

Ans: Given, Mass = 50 g

Volume = $20 cm^3$

Density = $\frac{Mass}{Volume}$

Therefore, density of a given substance = $\frac{50g}{20 cm^3}$

$= 2.5\ g/cm^3$

Density of water = $1 g / cm^3$

As the density of a given substance is more than the density of water, the substance will sink in water.

29: The volume of a 500 g sealed packet is $350 cm^3$. Will the packet float or sink in water if the density of water is 1 g cm^{-3}? What will be the mass of the water displaced by this packet?

Solution: Given, Mass of the packet =500g

Volume of the packet = 350cm^3

Density of the packet =?

Density = $\frac{Mass}{Volume} = \frac{500g}{350\ cm3}$ = 1.428g /cm^3

Density of the water = 1g /cm^3

The packet will sink in water as the density of packet is greater than the density of water.

Mass of the water displaced by this packet

=Volume of the packet x Density of water

= 350cm^3 x 1g / cm^3= 350g

30. If the upthrust is considered as action, what is the reaction? This reaction is exerted on what and by what?

Ans: The force exerted by the body is the reaction. This reaction is exerted on the fluid where the object is immersed by the gravitational force of the earth.

31. Will a body weigh more in air or in vacuum when weighed with a spring balanced? Give a reason for your answer.

Ans: Because there is no upthrust in vacuum, so the gravitational force is the weight of the body in vacuum.

In air, there is an upthrust which gets subtracted from the gravitational force.

32. A steel needle sinks in water but a steel ship floats. Explain how?

Ans: Density of steel needle is greater than density of water and experiences smaller upward force by the water, so steel needle sinks

in water.

The density of steel ship is smaller than density of water, and experiences large upward force by water, so, it floats in water.

33. A body of mass 4.5 kg displaces 200 cm^3 of water when fully immersed inside it. Calculate: (a) The volume of the body (b) Upthrust on body (c) Apparent weight of body in water.

Solution: (a) The volume of the body = volume of water displaced

=200 cm^3

(b) Density of water = 997kg/m^3

Upthrust on body = volume of water displaced x density of water x acceleration due to gravity

=200cm^3 x 997kg/m^3 x 10m/s^2

$= 0.0002m^2 \times \frac{997kg}{m^3} \times \frac{10m}{s^2}$

$= \frac{2 \times 997 \times 10kg \times m}{10000s^2}$

$= \frac{1994}{1000} = 1.994 = 2kgm/s^2 = 2N$

(c) Actual weight = 4.5 x 10g =45N

Apparent weight of body in water = Actual weight – Buoyant force

= 45 N -2 N = 43N

34. A cube of wood of side 10cm floats in water with 4.5cm of its depth below the surface, and with its sides vertical. What is the density of wood? Density of water = $1.0 \times 10^3 kgm^{-3}$.

Solution: Weight of the wood = Buoyant force

Volume of wood x Density of water x g = Volume of water displaced x Density of water x g

$1000cm^3$ x Density of wood = $450\ cm^3 \times 1.0 \times 10^3 kgm^{-3}$.

Density of wood = $\frac{450\ cm^3 \times 1.0 \times 10^3 kgm^{-3}}{1000 \times 10}$

$= 45kg/m^3$

Tick the correct option:

1. (iv) 2. (i) 3. (iii) 4. (ii) 5. (iv) 6.(iv) 7.(iii)

In-text questions page-144

1: Ans: The universal law of gravitation states that every object in the universe attracts every other object with a force called the gravitational force. The force acting between two objects is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centers. For two objects of masses M and m and the distance between them R, the force (F) of attraction acting between them is given by the universal law of gravitation as: $F \propto \frac{Mm}{R^2}$

Or $F = \frac{GMm}{R^2}$

2. Ans: $F \propto \frac{M\ em}{R^2}$

Or $F = \frac{GMem}{R^2}$ where Me = mass of the Earth

R = Radius of the Earth

m = mass of an object

G= Gravitational constant

In-text questions page-146

1: Ans: Gravity of the Earth attracts every object towards its centre. When an object is released from a height, it falls towards the surface of the Earth under the influence of gravitational force. The motion of the object is said to be free fall.

2: Ans: When an object falls freely towards the surface of earth from a certain height, then its velocity changes. This change in velocity produces acceleration. This acceleration is known as acceleration due to gravity (g). The value of acceleration due to gravity is 9.8 m/s^2.

In-text questions page-148

1. Ans:

Mass	Weight
(i) Mass is the quantity of matter contained in the body	(i)Weight is the force of gravity acting on the body
(ii) . It is the measure of inertia of the body	(ii) It is the measure of gravity.
(iii) Mass is a constant quantity	(iii) Weight is not a constant quantity
(iv) It only has magnitude.	(iv) It has magnitude as well as direction.
(v) . Its SI unit is kilogram (kg).	(v) Its SI unit is Newton (N).

2. Ans: Because the value of 'g' on earth and moon is not same. At moon, the acceleration due to gravity is $1/6^{th}$ that of the earth. Due to this, weight of an object on the moon is $1/6^{th}$ of its weight on the earth.

In-text questions page-151

1. Ans: This is because force exerted by a thin and strong string distributed to very less area and force applied to the bag is more and hence pressure exerted on the body by thin straps will be more.

2. Ans. The upward force exerted by any fluid (liquid, gas) on an object is known as upthrust or buoyancy.

3. Ans: The density of the object and water decides the floating or sinking of the object in water.

If the density of the object is less than the density of water, then the object will float.

If the density of the object is more than the density of water, then the object will sink.

In-text questions page-152

1. Ans: The weighing machine measures the mass of the body. Mass reading of 42 kg given by weighing machine is same as the actual mass of the body .As mass is the quantity of inertia, it remains the same.

2. Ans: The heaviness of the bag can be given by density.

We have, density= $\frac{mass}{volume}$

Mass of both cotton bag and iron bag is same but the volume of cotton bag is more than the iron bag. Hence, density is inversely proportional to volume. The bag of iron will be heavier.

CHAPTER-11

(WORK AND ENERGY)

TEXTBOOK EXERCISES (Page number: 169 -171)

1. Look at the activities listed below. Reason out whether or not work is done in the light of your understanding of the term 'work'.

•Suma is swimming in a pond.

•A donkey is carrying a load on its back.

•A wind mill is lifting water from a well.

•A green plant is carrying out photosynthesis.

•An engine is pulling a train.

•Food grains are getting dried in the sun.

•A sailboat is moving due to wind energy.

Answers: (a) Work is being done by Suma, she displaces the water by applying the force.

(b) No work is being done by the donkey because the direction of force i.e. load is vertically downward and displacement is along horizontal. If displacement and force are perpendicular, then no work is done.

(c) Work is done because wind mill is lifting the water i.e. it is changing the position of water.

(d)No work is done because there is no force and displacement.

(e) Work is done because engine is changing the position of the train.

(f) No work is done because there is no force and no displacement.

(g)Work is done because of the force acting on the boat, it starts moving.

2. An object thrown at a certain angle to the ground moves in a curved path and falls back to the ground. The initial and the final points of the path of the object lie on the same horizontal line. What is the work done by the force of gravity on the object?

Ans: Work done by the force of gravity on the object is zero. Force of gravity acts in the vertical downward direction and the distance covered by the object is in the horizontal direction. As there is no displacement in the direction. Hence the work done is zero.

3. A battery lights a bulb. Describe the energy changes involved in the process.

Ans: When a bulb is connected to a battery, then the chemical energy of the battery is transferred into electrical energy. When the bulb receives this electrical energy, hence it converts it into light and heat energy.

4. Certain force acting on a 20 kg mass change its velocity from 5 ms^{-1} to 2 ms^{-1} . Calculate the work done by the force.

Solution 4: Given,m=20 kg, u= 5 ms^{-1} ,v=2 ms^{-1}

We have, W= Fx S

$= ma \times \frac{v^2-u^2}{2a}$

$=20 \times a \times \left(\frac{2^2-5^2}{2a} \right)$

$= 20 a \times \frac{4-25}{2a}$

$= \frac{-20x21}{2} = -210$ J

5. A mass of 10 kg is at a point A on a table. It is moved to a point B. If the line joining A and B is horizontal, what is the work done on the object by the gravitational force? Explain your answer.

Ans: Work done by gravity depends only on the vertical displacement of the body. It does not depend upon the path of the body. Therefore, work done by gravity is given by the expression, W = mgh Where, Vertical displacement, h = 0

∴ W = mg × 0 = 0 Hence, the work done by gravity on the body is zero.

6. The potential energy of a freely falling object decreases progressively. Does this violate the law of conservation of energy? Why?

Ans: No, because the potential energy is converted into kinetic energy during free fall. Therefore, total energy remains conserved and the law of conservation of energy is not violated.

7. What are the various energy transformations that occur when you are riding a bicycle?

Ans: Muscular energy changed into mechanical energy.

8. Does the transfer of energy take place when you push a huge rock with all your might and fail to move it? Where is the energy you spend going?

Ans: When we push a huge rock with all your might, the energy transferred does not allow moving the rock. Here, no work is said to be done. The energy we spend gets transformed into heat energy.

9. A certain household has consumed 250 units of energy during a month. How much energy is this in joules?

Solution: Given, energy consumed = 250 units

1 unit = 1 kWh

250 units = 250 x 1 kWh = 250 x 3.6 × 10^6 J (Since 1 kWh = 3.6 × 10^6 J)

$$= \frac{250\ x\ 36\ x10^6}{10}$$

$$= 900 \text{ x } 10^6 \text{ J}$$

$$= 9 \times 10^8 \text{ J}$$

10. An object of mass 40 kg is raised to a height of 5 m above the ground. What is its potential energy? If the object is allowed to fall, find its kinetic energy when it is half-way down.

Solution: Given, m = 40kg, h= 5m, g = 10m/s²

P.E = m g h

= 40 x 10 x 5 = 2000 J

When the object is half-way down the P.E of object = $\frac{mgh}{2}$

=1000J

The remaining energy (2000-1000) J is K.E

(By energy conservation)

Therefore, K.E = 1000 J

11. What is the work done by the force of gravity on a satellite moving round the earth? Justify your answer.

Ans: When the satellite moves around the earth the force acting is perpendicular to the direction of displacement, hence the work done is zero.

12. Can there be displacement of an object in the absence of any force acting on it? Think. Discuss this question with your friends and teacher.

Ans: According to the Newton's first law of motion, in the absence of any external force acting on it, the object maintains its motion along a given straight line. Yes, there will be displacement on the object .But when the object is initially at rest, then there will be no displacement.

13. The earth moving round the sun in a circular orbit is acted upon by a force and hence work must be done on the earth by the force. Do you agree with this statement?

Ans: When earth moves round the sun in a circular orbit, a centripetal force acts along the radius towards the centre. The displacement acts tangentially .The angle between the force and displacement= 90°

Therefore, W=F x s x cos90°

= 0 (cos 90° = 0)

14. When an arrow is shot from a bow, it has kinetic energy. From where does it get the kinetic energy?

Ans: When an arrow is shot from a bow, it comes back to original shape and P.E is converted into K.E.

15. What kind of energy is possessed by the following?

(i) A man climbing a hill.

(ii) Water stored in a dam

(iii) Running water

(iv) A stretched rubber band

Answers: (i) P.E

(ii) P.E

(iii) P.E

(iv) K.E

(v) P.E

16. What is the work done by the force of gravity in the following cases?

(a) Satellite moving around the earth in a circular orbit of radius 35000 km.

(b) A stone of mass 250 g is thrown up through a height of 2.5 m.

Answers: (a) The force of gravity of the earth on the satellite and direction of motion of satellite are perpendicular to each other

Therefore, Work done by the force of gravity = F x S X Cos 90°

= F x S X 0 = 0

(b) Given, m = 250 g = $\frac{250}{1000}$ kg

h = 2.5 m, g =10 m/s

Work done = mgh = $\frac{250}{1000}$ x 10 x 2.5

= $\frac{25\ x\ 25}{100}$ = $\frac{625}{100}$ =6.25 J

17. A light body and a heavy body have the same momentum. Which of the two bodies will have greater kinetic energy?

Ans: Kinetic energy is inversely proportional to the mass of the body i,e. kinetic energy of the body increases if the mass of the body decreases. Hence, lighter body has large kinetic energy.

18.(a) Give two conditions for work to be done.

(b)What is the work done by frictional force on an object when dragged along a rough surface?

(c) Relate power and work.

(d) A machine does 1960 joule of work in 4 minutes. What is the power?

Ans : (a)(i) A force should act on an object.

(ii) The object must be displaced.

(b)The work done by frictional force on an object when dragged along a rough surface is negative.

(c)Power = $\frac{work}{time}$

(d) Given, w = 1960 joule, t = 4 min = 4 x 60 =240s

We have, p =$\frac{w}{t}$ =$\frac{1960\ J}{240s}$ =8.166w.

19. It takes 20 s for A to climb up a stair while B does the same in 15 s. Compare the work done and power developed by A and B.

Ans: Ratio of work done by A and B = $\frac{1}{1}$

= 1 : 1

Given, t_1 = 20s, t_2= 15 s.

Ratio of power developed by A and B=$\frac{w1}{t1}$ / $\frac{w2}{t2}$ = $\frac{1}{20}$ / $\frac{1}{15}$

= $\frac{1x15}{1x20}$ = $\frac{3}{4}$

20. A man climbs a ladder carrying a concrete block of mass 5 kg.If the ladder makes an angle of 30° to the vertical and is 3m long ,how much work the man does on the block.

Solution: Given, m= 5kg, g= 10m/s^2,Q= 30°,s= 3m

Work done = F x s x cos30° ^{2}

= (m x g) x s x cos30°

= 5x 10 x 3 x $\frac{\sqrt{3}}{2}$

= 5x 10 x 3 x 0.75 = 112.5 J

21. How fast a man of mass 60kg should run so that his kinetic energy is 750 J?

Solution: Given, m= 60 kg, g= 10m/s^2

K.E = 750 J

i.e. $\frac{1}{2}$ x m x v^2 = 750

$\frac{1}{2}$ x 60 x v^2 = 750

30 x v^2 = 750

$v^2 = \frac{750}{30}$

v^2 = 25

v = $\sqrt{25}$

v= 5 m/s

22. A person holds a bundle of hay over his head for 30 minutes and gets tired. Has he done some work or not? Justify your answer.

Ans: Work is done by the person on the bundle of hay is zero. This is because there is no displacement of the bundle.

23. An electric heater is rated 1500 W. How much energy does it use in 10 hours?

Solution: Given, P = 1500w = 1.5 kW, t = 10 hrs

Energy consumed = P x t

=1.5 kW x 10 hrs

$= \frac{15}{10}$ x 10 kwh = 15 kwh

24. Illustrate the law of conservation of energy by discussing the energy changes which occur when we draw a pendulum bob to one side and allow it to oscillate. Why does the bob eventually come to rest? What happens to its energy eventually? Is it a violation of the law of conservation of energy?

Ans: When the pendulum oscillates, the energy of the bob at an extreme end is potential energy. When it moves towards the mean position the potential energy decreases and converts into kinetic energy. At the mean position, the total energy is kinetic energy. The total energy at all points remains the same if resistance forces are absent. In the presence of air resistance some energy of the bob is used up in displacing air and therefore its energy goes on decreasing and ultimately it will stop. The energy of bob is transferred as the kinetic energy of air molecules.

25. An object of mass, m is moving with a constant velocity, v. How much work should be done on the object in order to bring the object to rest?

Ans: Kinetic energy of an object of mass, m moving with a velocity, v is given by the expression $\frac{1}{2}$ mv^2.When the object comes to rest, the kinetic energy becomes zero. Therefore, work required to be done is $\frac{1}{2}$ mv^2.

26. Calculate the work required to be done to stop a car of 1500 kg moving at a velocity of 60 km/h?

Solution: Given, m = 1500 kg, v = 60 km/h = $\frac{50}{3}$ m/s

Work done to stop a car = $\frac{1}{2}$ mv²

$= \frac{1}{2}$ x 1500 x $(\frac{50}{3})^2$

$= \frac{625000}{3}$

=208333.3 J

27. In each of the following a force, F is acting on an object of mass, m. The direction of displacement is from west to east shown by the longer arrow. Observe the diagrams carefully and state whether the work done by the force is negative, positive or zero.

Ans: Angle between force and displacement is 90° . Therefore, W=0.

Angle between force and displacement is 0° . Therefore, work done is positive.

Angle between force and displacement is 180° . Therefore, work done is negative.

28. Soni says that the acceleration in an object could be zero even when several forces are acting on it. Do you agree with her? Why?

Ans: Yes, this can happen when the several forces acting on an object produce a zero resultant force.

29. Find the energy in kW h consumed in 10 hours by four devices of power 500 W each.

Solution: Given, P = 500 W = 0.50 kW, t = 10 hrs

Number of devices = 4,

Energy used by one device = Power × Time = 0.50 × 10 = 5 kWh

Therefore, energy used by four devices = 4 × 5 kWh = 20 kWh.

30. A freely falling object eventually stops on reaching the ground. What happens to its kinetic energy?

Ans : The kinetic energy is converted into heat and sound energy .

Tick the correct option:

1. (iv) 2. (iii) 3. (i) 4. (iii) 5. (ii) 6.(iii)

In-text questions page-159

1. Solution: Given, F = 7 N, S = 8 m

We have, W = F × S

= 7 × 8 = 56 Nm = 56 J

In-text questions page-160

1. Ans: Work is said to be done when force applied on a object shows the displacement in that object.

2. Ans: W = F × s

Where F = Constant force acting in the direction of displacement.

s= Displacement of the body

3. Ans: 1 J is the amount of work done on an object when a force of 1 N displaces it by 1 m along the line of action of the force.

4. Solution: Given, F= 140 N, s = 15 m, W =?

We have, W = F × s

= 140N x 15m

= 2100 J

In-text questions page-163

1. Ans: Kinetic energy is the energy possessed by an object due to its motion.

2. Ans: K.E = $\frac{1}{2}\ m\ v^2$ where m = mass of the object and v= velocity of the object.

3. Solution: Given, K.E= 25 J, v= 5m/s

K.E = $\frac{1}{2}\ m\ v^2$

25 J = $\frac{1}{2}\ m\ (5)^2$

m = $\frac{50}{25}$ = 2 kg

(i) If velocity is doubled, v= 10m/s, m= 2kg

K.E = $\frac{1}{2}\ m\ v^2$

= $\frac{1}{2}(2)(10)^2$

= $\frac{2x10x10}{2}$ = 100J

K.E will become 4 times

(iii)) If velocity is 3 times, v= 15m/s, m= 2kg

K.E = $\frac{1}{2}\ m\ v^2$

= $\frac{1}{2}(2)(15)^2$

= $\frac{2x15x15}{2}$ = 225J

K.E will become 9 times

In-text questions page-167

1. Ans: Power is defined as the rate of doing work.

2. Ans: Power is said to be 1 watt when 1Joule of work is done in 1 second.

3. Solution: Given, W= 1000 J, t= 10 s, P =?

We have, P= $\frac{W}{t}$

= $\frac{1000}{10}$ = 100 w

4. Ans: Average power is defined as the total energy consumed divided by the total time taken.