

HC VERMA Solutions for Class 11 Physics Chapter 4 The Forces

Question 1

When Neils Bohr shook hand with Werner Heisenberg, what kind of force they exerted?

- (a) Gravitational
- (b) Electromagnetic
- (c) Nuclear
- (d) Weak

Solution 1

- (b) Electromagnetic

Question 2

Let E , G and N represent the magnitudes of electromagnetic, gravitational and nuclear forces between two electrons at a given separation. Then

- (a) $N > E > G$
- (b) $E > N > G$
- (c) $G > N > E$
- (d) $E > G > N$

Solution 2

- (d) $E > G > N$

Question 3

The sum of all electromagnetic forces between different particles of a system of charged particles is zero

- (a) only if all the particles are positively charged
- (b) only if all the particles are negatively charged
- (c) only if half the particles are positively charged half are negatively charged
- (d) irrespective of the signs of the charges

Solution 3

- (d) irrespective of the signs of the charges

Question 4

A 60 kg man pushes a 40 kg man by a force of 60 N. The 40 kg man has pushed the other man with a force of

- (a) 40 N
- (b) 0
- (c) 60 N
- (d) 20 N

Solution 4

- (c) 60 N

Question 5

A neutron exerts a force on a proton which is

- (a) gravitational
- (b) electromagnetic
- (c) nuclear
- (d) weak

Solution 5

Neutron exerts gravitational force and nuclear force on proton because neutron is uncharged particle.
(a),(c)

Question 6

A proton exerts a force on a proton which is

- (a) gravitational
- (b) electromagnetic
- (c) nuclear
- (d) weak

Solution 6

Proton exerts gravitational, electromagnetic and nuclear force on a proton because proton is a charged particle (a), (b), (c)

Question 7

Mark the correct statements:

- (a) The nuclear force between two protons is always greater than the electromagnetic force between them.
- (b) The electromagnetic force between two protons is always greater than the gravitational force between them.
- (c) The gravitational force between two protons may be greater than the nuclear force between them.
- (d) Electromagnetic force between two protons may be greater than the nuclear force acting between them

Solution 7

Electromagnetic force is greater than gravitational force and nuclear force.

Also, gravitational force is greater than nuclear force.

- (a), (b), (c)

Question 8

If all matter were made of electrically neutral particles such as neutrons

- (a) there would be no force of friction
- (b) there would be no tension in the string
- (c) it would not be possible to sit on a chair
- (d) the earth could not move around the sun

Solution 8

If all matter were made of electrically neutral particles, then there would be no friction, no tension in the string and also it would not be possible to sit on a chair. But earth could move around the sun as it is due to gravitational force.

- (a), (b), (c)

Question 9

Which of the following systems may be adequately described by classical physics?

- (a) motion of a cricket ball
- (b) motion of a dust particle
- (c) a hydrogen atom
- (d) a neutron changing to a proton

Solution 9

Classical physics is used generally for heavenly bodies and do not work for smaller size particle.

Thus motion of cricket ball, motion of dust particles is adequately described by classical physics.

- (a), (b)

Question 10

The two ends of a spring are displaced along the length of the spring. All displacements have equal magnitudes. In which case or cases the tension or compression in the spring will have a maximum magnitude?

- (a) the right end is displaced towards right and the left end towards left
- (b) both ends are displaced towards right
- (c) both ends are displaced towards left
- (d) the right end is displaced towards left and the left end towards right.

Solution 10

Maximum magnitude in tension is when the right end is displaced towards right and the left end towards left.

Maximum magnitude in compression is when the right end is displaced towards left and the left end towards right.

(a), (d)

Question 11

Action and reaction

- (a) act on two different objects
- (b) have equal magnitude
- (c) have opposite directions
- (d) have resultant zero

Solution 11

According to the third law of motion, every action has equal and opposite reaction. Thus, action and reaction act on different objects, have equal magnitude, have opposite direction and have resultant zero.

(a), (b), (c), (d)

Chapter 4 - The Forces Exercise 63

Question 1

The gravitational force acting on a particle of 1 g due to a similar particle is equal to 6.67×10^{-11} N. Calculate the separation between the particles.

Solution 1

$$F = \frac{Gm_1m_2}{r^2}$$

$$6.67 \times 10^{-17} = \frac{6.67 \times 10^{-11} \times \frac{1}{1000} \times \frac{1}{1000}}{r^2}$$

$$r^2 = \frac{6.67 \times 10^{-17}}{6.67 \times 10^{-17}}$$

$$r = 1 \text{ m.}$$

Question 2

Calculate the force with which you attract the earth.

Solution 2

Force acting on us = mg

Let $m = 60 \text{ kg}$

Then, $F = W = m \times g = 60 \times 10$

$F = 600 \text{ N.}$

Question 3

At what distance should two charges, each equal to 1 C, be placed so that the force between them equals your weight?

Solution 3

$$F = W$$

$$\frac{kq_1q_2}{r^2} = mg$$

$$\frac{9 \times 10^9 \times 1 \times 1}{r^2} = m \times 10$$

$$r = \frac{3 \times 10^4}{\sqrt{m}} \text{ meters}$$

$$\text{If } m = 49 \text{ kg}$$

$$r = 4285.7 \text{ m}$$

Question 4

Two spherical bodies, each of mass 50 kg, are placed at a separation of 20 cm. Equal charges are placed on the bodies and it is found that the force of Coulomb repulsion equals the gravitational attraction in magnitude.

Find the magnitude of the charge placed on either body.

Solution 4

$$\text{Gravitational force } F_1 = \frac{Gm_1m_2}{r^2}$$

$$F_1 = \frac{6.67 \times 10^{-11} \times 2500}{(0.2)^2} \text{ --- (1)}$$

$$\text{Coulomb's Force } F_2 = \frac{kq_1q_2}{r^2}$$

$$F_2 = \frac{9 \times 10^9 \times q^2}{(0.2)^2}$$

Now,

$$F_1 = F_2$$

$$\frac{6.67 \times 10^{-11} \times 2500}{0.04} = \frac{9 \times 10^9 \times q^2}{0.04}$$

$$q^2 = 18.07 \times 10^{-18}$$

$$q = 4.3 \times 10^{-9} \text{ C}$$

Question 5

A monkey is sitting on a tree limb. The limb exerts a normal force of 48 N and a frictional force of 20 N. Find the magnitude of the total force exerted by the limb on the monkey.

Solution 5

$$F_N = 48 \text{ N and } F_F = 20 \text{ N}$$

$$F_R = \sqrt{F_N^2 + F_F^2}$$

$$F_R = \sqrt{48^2 + 20^2}$$

$$F_R = 52 \text{ N}$$

Question 6

A body builder exerts a force of 150 N against a bullworker and compresses it by 20 cm. Calculate the spring constant of the spring in the bullworker.

Solution 6

Net Force

$$F = kx$$

$$150 = k \times 0.2$$

$$k = 750 \text{ N/m}$$

Question 7

A satellite is projected vertically upwards from an earth station. At what height above the earth's surface will the force on the satellite due to the earth be reduced to half its value at the earth station? (Radius of the earth is 6400 km.)

Solution 7

$$F_h = \frac{1}{2} F_e$$

$$\frac{GMm}{(R+h)^2} = \frac{1}{2} \frac{GMm}{R^2}$$

$$(R+h)^2 = 2R^2$$

$$h^2 + 2Rh - R^2 = 0$$

Solving equation,

$$h = \frac{-2R \pm \sqrt{4R^2 + 4R^2}}{2}$$

$$h = -R \pm \sqrt{2} R$$

$$h = R(-1 \pm \sqrt{2})$$

$$h = R(\sqrt{2} - 1)$$

$$h = 6400 \times (1.414 - 1)$$

$$h = 2649.6 \approx 2650 \text{ km}$$

Question 8

Two charged particles placed at a separation of 20 cm exert 20 N of Coulomb force on each other. What will be the force if the separation is increased to 25 cm?

Solution 8

$$F = \frac{kq_1q_2}{r^2}$$

$$F \propto \frac{1}{r^2}$$

$$\frac{F}{F'} = \frac{r'^2}{r^2}$$

$$F' = \frac{F \times r^2}{r'^2}$$

$$F' = \frac{20 \times (0.20)^2}{(0.25)^2}$$

$$F' = 12.8 \text{ N}$$

Question 9

The force with which the earth attracts an object is called the weight of the object.

Calculate the weight of the moon from the following data: The universal constant of gravitation $G = 6.67 \times 10^{-11} \text{ N-m}^2/\text{kg}$, mass of the moon $= 7.36 \times 10^{22} \text{ kg}$, mass of the earth $= 6 \times 10^{24} \text{ kg}$ and the distance between the earth and the moon $= 3.8 \times 10^5 \text{ km}$.

Solution 9

$$\begin{aligned} W_M = F &= \frac{GM_E M_M}{R^2} \\ &= \frac{6.67 \times 10^{-11} \times 6 \times 10^{24} \times 7.36 \times 10^{22}}{(3.8 \times 10^5 \times 10^3)^2} \\ &= 2.03 \times 10^{20} \text{ N} \\ F &\approx 2 \times 10^{20} \text{ N} \end{aligned}$$

Question 10

Find the ratio of the magnitude of the electric force to the gravitational force acting between two protons.

Solution 10

63×R SAQ - 10 Find the ratio.

$$\begin{aligned} F_e &= \frac{kq_p q_p}{r^2} \\ F_e &= \frac{9 \times 10^9 \times (1.6 \times 10^{-19})^2}{r^2} \\ F_G &= \frac{Gm_p m_p}{r^2} \\ F_G &= \frac{6.67 \times 10^{-11} \times (1.732 \times 10^{-27})^2}{r^2} \end{aligned}$$

Ratio is

$$\begin{aligned} \frac{F_e}{F_G} &= \frac{\frac{9 \times 10^9 \times (1.6 \times 10^{-19})^2}{r^2}}{\frac{6.67 \times 10^{-11} \times (1.732 \times 10^{-27})^2}{r^2}} \\ \frac{F_e}{F_G} &= 1.24 \times 10^{36} \end{aligned}$$

Question 11

The average separation between the proton and the electron in a hydrogen atom in ground state is $5.3 \times 10^{-11} \text{ m}$.

- (a) Calculate the Coulomb force between them at this separation
(b) When the atom goes into its first excited state the average separation between the proton and the electron increases to four times its value in the ground state. What is the Coulomb force in this state?

Solution 11

$$\begin{aligned} F_C &= \frac{kq_p q_e}{r^2} = \frac{9 \times 10^9 \times (1.6 \times 10^{-19})^2}{(5.3 \times 10^{-11})^2} \\ \text{(a)} \quad F_C &= 8.2 \times 10^{-8} \text{ N} \end{aligned}$$

$$(b) F_C = \frac{kq_p q_e}{(4r)^2} = \frac{9 \times 10^9 \times (1.6 \times 10^{-19})^2}{16 \times (5.3 \times 10^{-11})^2}$$

$$F_C = 5.1 \times 10^{-9} \text{ N}$$

Question 12

The geostationary orbit of the earth is at a distance of about 36000 km from the earth's surface. Find the weight of 120 kg equipment placed in a geostationary satellite. The radius of the earth is 6400 km.

Solution 12

$$g = \frac{GM}{R^2}$$

$$g' = \frac{GM}{(R + h)^2}$$

$$\frac{g'}{g} = \frac{GM/(R + h)^2}{GM/R^2} = \frac{R^2}{(R + h)^2}$$

$$g' = \left[\frac{(6400)^2}{(36000 + 6400)^2} \right] \times g$$

$$g' = 0.0227 \times 9.8$$

$$g' = 0.0223$$

$$W = Mg' = 120 \times 0.223$$

$$W = 27 \text{ N}$$