

## Sample paper 2

## Question 1

Force acting on an object is given as

$F = Xx^{-1}$  (Where  $x$  is the distance by which the body is displaced due to the applied force)

What would be the dimensional formula for  $X$ ?

- A.  $MLT^{-2}$
- B.  $MLT^{-1}$
- C.  $M^{-1}LT^{-1}$
- D.  $M^{-1}L^2T^{-1}$
- E.  $ML^2T^{-2}$

**Correct Answer: E**

**Explanation:**

From dimensional analysis we know that dimensional formula of the left hand side of an expression should be the same as the dimensional formula of the individual quantities on the right hand side.

Force has the SI unit of  $\text{kgms}^{-2}$ . Therefore, the dimensional formula of force becomes  $MLT^{-2}$ .

Dimensional formula of  $x$  is  $L$ . Hence, dimensional formula of  $x^{-1}$  becomes  $L^{-1}$ . As said earlier,  $Xx^{-1}$  should have the same dimensional formula as  $F$ . Therefore, it can be written as

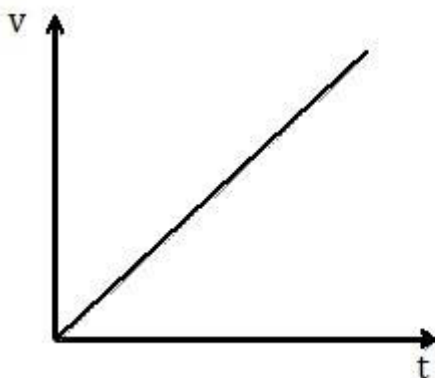
$$MLT^{-2} = X * L^{-1}$$

$$X = ML^2T^{-2}$$

Therefore, E is the correct answer option.

## Question 2

Consider the figure and the statements given below.



( $v$  is velocity and  $t$  is time)

The graph is for a body that is accelerating

The graph is for a body that is falling freely

The graph is for a body that has constant velocity

Which of the following statement(s) is true in accordance to the given figure?

- A. 2
- B. 1
- C. 3
- D. Both 1 and 2
- E. Both 2 and 3

**Correct Answer: A**

**Explanation:**

The graph given in the question is between velocity and time. Slope of the velocity time graph is linear here. Therefore, velocity increases with each instant but change in velocity per unit time is constant throughout the travel. Thus, 3 is an incorrect statement and so is option C. Acceleration of a body is defined as the rate of change of velocity per unit time. As said earlier, for a linear slope between velocity and time, change in velocity is constant per unit time and thus, acceleration is constant for the entire travel. Therefore, statement 1 is incorrect and so is option B. A body falls freely under gravity only. A free falling body always experiences uniform acceleration throughout the travel. Thus, we can say that acceleration is constant for a free fall and the graph essentially represents the motion of free fall. Thus, statement 2 is correct and so A is the correct answer option. In view of the above discussion, options D and E are incorrect as well.

**Question 3**

**If a block of wood weighs 1000 N, what would be its mass?**

- A. 102.04 kg
- B. 10.24 kg
- C. 1020.44 kg
- D. 1.24 kg
- E. 110.24 kg

**Correct Answer: A**

**Explanation:**

Weight of a body is given as

$$W = mg \text{ ----- (1)}$$

Putting the value of W and g in equation 1 we get

$$1000 = m * 9.8$$

$$m = 102.04 \text{ kg}$$

Therefore, A is the correct answer option.

**Question 4**

A force of 25 N is acting along the North direction and a force of 12 N is acting along the South direction on a body of mass 1.5 kg. What acceleration will the force bring in the body?

- A.  $9.87 \text{ m/s}^2$
- B.  $2.36 \text{ m/s}^2$
- C.  $4.67 \text{ m/s}^2$
- D.  $7.67 \text{ m/s}^2$
- E.  $8.67 \text{ m/s}^2$

**Correct Answer: E**

**Explanation:**

A body undergoes acceleration due to an unbalanced force. The unbalanced force here is given as  $F = 25 - 12$  Or  $F = 13\text{N}$

According to Newton's second law of motion

$$F = ma \text{ ----- (1)}$$

$$13 = 1.5 * a$$

$$a = 8.67 \text{ m/s}^2$$

Therefore, E is the correct answer option.

**Question 5**

If a wheel is rotating with an angular velocity of  $2.5 \text{ rad/s}$ , what is the time taken by the wheel to complete one full rotation?

- A.  $1.57 \text{ s}$
- B.  $2.51 \text{ s}$
- C.  $1.84 \text{ s}$
- D.  $3.52 \text{ s}$
- E.  $2.22 \text{ s}$

**Correct Answer: B**

**Explanation:**

Time taken to complete one rotation is known as time period. Angular velocity is related to time period as

$$\omega = 2\pi/T \text{ ----- (1)}$$

Putting the values of ( $\pi = 3.14$ ) and  $\omega$  in equation 1 we get

$$2.5 = (2*3.14)/T$$

$$T = 2.51 \text{ s}$$

Therefore, B is the correct answer option.

**Question 6**

An object is to be lifted from the ground to a height of 5m in 25 seconds. If the energy consumed during the process is 2000 J, what is the power required?

- A. 75 J/s
- B. 72 J/s
- C. 80 J/s
- D. 100 J/s
- E. 125 J/s

**Correct Answer: C**

**Explanation:**

Power is given as

$$P = W/t \text{ ----- (1)}$$

Putting the values in equation 1 we get

$$P = 2000 / 25$$

$$P = 80 \text{ J/s or Watt}$$

Hence, C is the correct answer option.

**Question 7**

A block of mass M, connected to a spring of spring constant k (a spring-mass system), is executing SHM with time period, T on Earth. If the same system executes SHM on the surface of Moon, what will be the new time period?

- A. More than that on the Earth
- B. Less than that on the Earth
- C. Same as that on the Earth
- D. Zero
- E. Not enough data is provided to predict the answer

**Correct Answer: C**

**Explanation:**

Time period is given as

$$T = 2\pi \sqrt{M/k} \text{ ----- (1)}$$

At the surface of the Moon, acceleration due to gravity is (1/6)th of that on the surface of the Earth.

As, there is no term related to acceleration due to gravity in equation 1, time period of the system will remain unaffected. Hence, time period of the system on the moon will be the same as that of the system on the Earth. Therefore, C is the correct answer option.

**Question 8**

If the speeds of sound in solid, liquid and gas are arranged in increasing order, which of the following is a correct arrangement?

- A. Solids < liquids < gas
- B. Liquids < solids < gas
- C. Gas < liquids < solids
- D. Gas < solids < liquids
- E. Liquids < gas < solids

**Correct Answer: C**

**Explanation:**

The speed of sound in solids like steel and iron is 5000 m/s and 5130 m/s. The speed of sound in liquids like water at 0° C and 20° C is 1402 m/s and 1482 m/s respectively. The speed of sound in air (gas) at 0° C and 20° C is 331.5 m/s and 344 m/s respectively. Thus, from the above discussion it can be concluded that the speed of sound in solids is more than that in liquids and air. Therefore, the correct arrangement for speeds of sound is air (gas) < liquids < solids. Thus, C is the correct answer option.

**Question 9**

What would be the specific gravity of a fluid having density of 944 kg/m<sup>3</sup>?

- A. 0.967
- B. 0.456
- C. 0.944
- D. 0.789
- E. 0.45

**Correct Answer: C**

**Explanation:**

Specific gravity is a dimensionless quantity and is given as

$$SG = \rho_{\text{fluid}} / \rho_{\text{water}} \text{ ----- (1)}$$

It is quite obvious from equation 1 that specific gravity is a unitless quantity. Putting the values of densities in equation 1 we get

$$SG = 944 / 1000 \text{ Or } SG = 0.944$$

Therefore, C is the correct answer option.

**Question 10**

A sample of gas at 313 K occupies a volume of 10 m<sup>3</sup>. What would be its volume at 373 K?

- A. 11.92 m<sup>3</sup>
- B. 15.56 m<sup>3</sup>
- C. 10.45 m<sup>3</sup>

- D.  $12.67 \text{ m}^3$
- E. Cannot be determined

**Correct Answer: A**

**Explanation:**

This question can be solved by applying Charles's law, which is given as

$$V_1/T_1 = V_2/T_2 \text{ ----- (1)}$$

Putting the values in equation 1 we get

$$10/313 = V_2/373$$

$$V_2 = 11.92 \text{ m}^3$$

Therefore, A is the correct answer option.

**Question 11**

**What is the dipole moment between an electron and a proton separated by a distance of 1 nm?**

- A.  $3.8 \times 10^{-28} \text{ Cm}$
- B.  $4.5 \times 10^{-28} \text{ Cm}$
- C.  $4.5 \times 10^{-26} \text{ Cm}$
- D.  $1.6 \times 10^{-28} \text{ Cm}$
- E.  $3.2 \times 10^{-28} \text{ Cm}$

**Correct Answer: D**

**Explanation:**

Electric dipole moment between two charges of opposite polarity is given as

$$p = Qd \text{ ----- (1)}$$

The distance is in nm so we need to convert it into m.

$$1 \text{ nm} = 10^{-9} \text{ m}$$

Putting the values in equation 1 we get

$$P = 1.6 \times 10^{-19} \times 10^{-9}$$

$$\text{Or, } 1.6 \times 10^{-28} \text{ Cm}$$

Hence, D is the correct answer option.

**Question 12**

**For a conductor having a cross section of  $2 \times 10^{-4} \text{ m}^2$ , average drift velocity of the electrons flowing through it is  $10^{-3} \text{ m/s}$ . If the density of free electrons in the conductor is  $6 \times 10^{24} \text{ m}^{-3}$ , what is the current flowing through the conductor? (Charge on electron =  $1.6 \times 10^{-19} \text{ C}$ )**

- A. 0.45 A
- B. 0.045 A
- C. 0.27 A
- D. 0.31 A
- E. 0.19 A

**Correct Answer: E**

**Explanation:**

Current flowing through the conductor is given as

$$I = neAv_d \text{ ----- (1)}$$

Putting the values in equation 1 we get

$$I = 6 \times 10^{24} \times 1.6 \times 10^{-19} \times 2 \times 10^{-4} \times 10^{-3}$$

$$I = 0.19\text{A}$$

Hence, E is the correct answer option.

### Question 13

**A long straight conductor carries a current of 2 A. What would be the magnetic field at a distance of 0.05 m from the axis of the conductor? (Permeability of free space is  $4\pi \times 10^{-7} \text{ WbA}^{-1}\text{m}^{-1}$ )**

- A.  $8 \times 10^{-6} \text{ T}$
- B.  $4 \times 10^{-6} \text{ T}$
- C.  $2.5 \times 10^{-6} \text{ T}$
- D.  $1.5 \times 10^{-6} \text{ T}$
- E.  $6 \times 10^{-6} \text{ T}$

**Correct Answer: A**

**Explanation:**

Magnetic field due to a long straight conductor is given as

$$B = \left[ \frac{\mu_0}{4\pi} \right] \left( \frac{2I}{a} \right) \text{ ----- (1)}$$

Putting the values in equation 1 we get

$$B = \left( \frac{4\pi \times 10^{-7}}{4\pi} \right) \times \left( \frac{2 \times 2}{0.05} \right)$$

$$B = 8 \times 10^{-6} \text{ T}$$

Hence, A is the correct answer option.

### Question 14

**A small water drop on a surface is viewed through a glass. If the real depth of the water drop is 15 cm, what will be the apparent depth of the water drop? (Refractive index of glass = 1.5 and refractive index of air = 1)**

- A. 5 cm
- B. 7.5 cm
- C. 8.4 cm
- D. 1.5 cm
- E. 10 cm

**Correct Answer: E**

**Explanation:**

The apparent depth is given as

$$\mu_{\text{glass}}^{\text{air}} = \mu_{\text{glass}} / \mu^{\text{air}} = \text{real depth} / \text{apparent depth} \text{ ----- (1)}$$

Putting the values in equation 1 we get

$$1.5/1 = 15 \text{ cm} / \text{apparent depth}$$

$$\text{apparent depth} = 10 \text{ cm}$$

Hence, E is the correct answer option.

**Question 15**

**Work function of Nickel is 5.01 eV. What is the threshold frequency for Nickel? (Planck's constant =  $6.6 \times 10^{-34} \text{ Js}$ )**

- A.  $1.21 \times 10^{15} \text{ Hz}$
- B.  $0.56 \times 10^{15} \text{ Hz}$
- C.  $4.56 \times 10^{15} \text{ Hz}$
- D.  $3.67 \times 10^{14} \text{ Hz}$
- E.  $2.23 \times 10^{15} \text{ Hz}$

**Correct Answer: A**

**Explanation:**

Threshold frequency is the minimum frequency required to eject photoelectrons out of a material in photoelectric effect. It is given as

$$\Phi = h\nu_0 \text{ ----- (1)}$$

Work function is given in eV. So, we need to convert it into Joules.

$$1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$$

$$5.01 \text{ eV} = 8.02 \times 10^{-19} \text{ J}$$

Putting the values in equation 1 we get

$$8.02 \times 10^{-19} = 6.6 \times 10^{-34} \times \nu_0$$

$$\nu_0 = 1.21 \times 10^{15} \text{ Hz}$$

Therefore, A is the correct answer option.