

Applied Analytics

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1. **Write down the base units for the following:**

- A. Base unit of velocity is metre per second
- B. Base unit of momentum is kilogram metre per second
- C. Base unit of current is ampere
- D. Base unit of displacement is metre
- E. Base unit of Energy is Joule

1. **Given that Newton's second law can be expressed mathematically as;**

$$\text{Force} = \text{mass} \times \text{acceleration}$$

Base unit of mass is kilogram

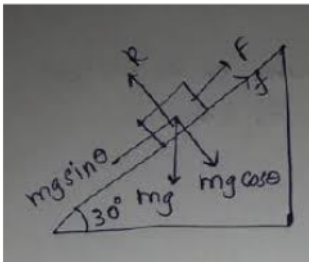
Base unit of acceleration is meter per second square

So the base unit of force is kilogram meter per second square which also represents Newton.

So, the base unit of force is Newton.

2. **A body of mass 10kg rests on a rough inclined plane which is at an angle of 30° to the horizontal.**

- i. Free body diagram



ii. Calculate the magnitude of frictional force.

Mass, $m=10\text{kg}$

Angle, $\alpha= 30^0$

$$F_{\text{parallel}}/F_{\text{normal}} = 1$$

$$1= \mu mg \sin \alpha / mg \cos \alpha$$

$$\tan \alpha = \mu$$

$$\text{Friction Force, } f_r = \mu mg \cos \alpha$$

$$\text{Friction Force, } f_r = \tan \alpha \cos \alpha mg$$

$$\text{Friction Force, } f_r = \tan 30^0 \cos 30^0 10 \times 9.8$$

$$\text{Friction Force, } f_r = 49 \text{ N}$$

iv. Calculate the magnitude of the normal reaction to the surface.

$$\begin{aligned} \text{Normal Reaction Magnitude, } N &= mg \cos \alpha = 10 \times 9.8 \times \cos 30^0 \\ &= 84.8704895709 \text{ N} \end{aligned}$$

3. An object of mass 2kg is dropped from rest from a vertical height of 19.6m above horizontal ground. If initially air resistance is ignored find :

i. $\text{Here, } h = 19.6, g = 9.8 \text{ ms}^{-2}$
 $\text{So, } h = ut + .5gt^2$

$$\begin{aligned}
\Rightarrow 19.6 &= 0t + .5 \times 9.8t^2 \\
\Rightarrow 19.6 &= .5 \times 9.8t^2 \\
\Rightarrow 19.6 \times 2 &= 9.8t^2 \\
\Rightarrow 39.2 &= 9.8t^2 \\
\Rightarrow 39.2/9.8 &= t^2 \\
\Rightarrow t^2 &= 4 \\
\Rightarrow t^2 &= \sqrt{4} \\
\Rightarrow t &= 2
\end{aligned}$$

So, it takes 2s for the object to reach the ground

ii. Here, $h = 19.6$, $g = 9.8 \text{ ms}^{-2}$
 So, $v^2 = u^2 + 2gh$
 $\Rightarrow v^2 = 0 + 2 \times 9.8 \times 19.6$
 $\Rightarrow v^2 = 384.16$
 $\Rightarrow v = \sqrt{384.16}$
 $v = 19.6 \text{ ms}^{-1}$

So, the object hits the ground with a velocity of 19.6 ms^{-1}

iii. $W = mg$
 $= 2 \times 9.8$
 $= 19.6 \text{ N}$

Resistive force = 9.6 N

So, net force = $19.6 - 9.6 \text{ N}$

$$= 10 \text{ N}$$

Net force = ma

$$\begin{aligned}
\Rightarrow 10 &= 2 \cdot a \\
\Rightarrow a &= 10/2 \\
\Rightarrow a &= 5 \text{ ms}^{-2}
\end{aligned}$$

So, if the object experiences a resistive force of 9.6N, the actual acceleration of the object is 5 ms^{-2}

4. Figure 3 shows a 10m uniform beam of weight 6kN which is at rest. The beam is supported by two pillars. Pillar X is positioned 1.5m from the left hand side of the beam, pillar Y is positioned 2.5m from the right hand side of the beam.

ii. Here $R_1 = \text{Force at X pillar}$, $R_2 = \text{Force at y pillar}$

$M_x (\text{clockwise moment positive}) = 0$

$$\Rightarrow \frac{0.6 \times (6 + 2.5) \times (6 + 2.5)}{2} - 6R_2 - (0.6 \times 1.5 \times 1.5 / 2) = 0$$

$$\Rightarrow 21 - 6R_2 = 0$$

$$\Rightarrow -6R_2 = -21$$

$$\Rightarrow 6R_2 = 21$$

$$\Rightarrow R_2 = \frac{21}{6}$$

$$\Rightarrow R_2 = 3.5 \text{ kN}$$

$\Sigma F_y (\text{clockwise moment positive}) = 0$

$$\Rightarrow R_1 + R_2 - \text{UDL} \times \text{distance} = 0$$

$$\Rightarrow R_1 + R_2 - \left(\frac{6}{10}\right) \times 10 = 0$$

$$\Rightarrow R_1 + R_2 - 6 = 0$$

$$\Rightarrow R_1 + R_2 = 6$$

$$\Rightarrow R_1 + 3.5 = 6$$

$$\Rightarrow R_1 = 6 - 3.5$$

$$\Rightarrow R_1 = 2.5 \text{ kN}$$

So both the support forces are 2.5kN and 3.5kN

6. Solve the following by factorising:

A. $X^2 + 3x + 2 = 0$

$$\Rightarrow X^2 + 2x + x + 2 = 0$$

$$\Rightarrow X(X+2) + 1(X+2) = 0$$

$$\Rightarrow (X+2)(X+1) = 0$$

$$\Rightarrow X+1=0 \text{ or } X+2=0$$

$$\Rightarrow X=-1 \text{ or } X=-2$$

$$\text{So, } X_1 = -1, X_2 = -2$$

$$\text{B. } X^2 - 7X + 12 = 0$$

$$\Rightarrow X^2 - 4X - 3X + 12 = 0$$

$$\Rightarrow X(X-4) - 3(X-4) = 0$$

$$\Rightarrow (X-4)(X-3) = 0$$

$$\Rightarrow X-4=0 \text{ or } X-3=0$$

$$\Rightarrow X=4 \text{ or } X=3$$

$$\text{So, } X_1 = 4, X_2 = 3$$

$$\text{C. } X^2 + 6X = -9$$

$$\Rightarrow X^2 + 6X + 9 = 0$$

$$\Rightarrow X^2 + 3X + 3X + 9 = 0$$

$$\Rightarrow X(X+3) + 3(X+3) = 0$$

$$\Rightarrow (X+3)(X+3) = 0$$

$$\Rightarrow X+3=0$$

$$\Rightarrow X=-3$$

$$X = -3$$

$$\text{D. } x^2 - 2x - 15 = 0$$

$$\Rightarrow X^2 - 2X - 15 = 0$$

$$\Rightarrow X^2 - 5X + 3X - 15 = 0$$

$$\Rightarrow X(X-5) + 3(X-5) = 0$$

$$\Rightarrow (X-5)(X+3) = 0$$

$$\Rightarrow (X+3)=0 \text{ or } X-5=0$$

$$\Rightarrow X=-3 \text{ or } X=5$$

$$\text{So, } X_1 = -3, X_2 = 5$$

$$\text{F. } 2x^2 + x - 1 = 0$$

$$\Rightarrow 2X^2 + 2X - X - 1 = 0$$

$$\Rightarrow 2X(X+1) - 1(X+1) = 0$$

$$\begin{aligned} \Rightarrow (X+1)(2X-1) &= 0 \\ \Rightarrow X+1=0 \text{ or } 2X-1 &= 0 \\ \Rightarrow X=-1 \text{ or } 2X &= 1 \\ \Rightarrow X=-1 \text{ or } X &= \frac{1}{2} \end{aligned}$$

$$\text{So, } X_1 = -1, X_2 = \frac{1}{2}$$

7. Solve the following by using the quadratic formula:

$$\text{A. } x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x^2 - x - 1 = 0$$

Here $a=1$.

$$b=-1$$

$$c=-1$$

$$\text{So, } x = \frac{-(-1) \pm \sqrt{(-1)^2 - 4(1)(-1)}}{2(1)}$$

$$= \frac{1 \pm \sqrt{5}}{2}$$

$$\text{So, } X_1 = \frac{1 + \sqrt{5}}{2}$$

$$X_2 = \frac{1 - \sqrt{5}}{2}$$

$$\text{B. } x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\text{The equation, } 10x^2 + 5x - 4 = 0$$

Here $a=10$.

$$b=5$$

$$c=-4$$

$$\text{So, } x = \frac{-(5) \pm \sqrt{(5)^2 - 4 \cdot 10 \cdot (-4)}}{2 \cdot 10}$$

$$= \frac{-5 \pm \sqrt{185}}{20}$$

$$\text{So, } X_1 = \frac{-5 + \sqrt{185}}{20}$$

$$X_2 = \frac{-5 - \sqrt{185}}{20}$$

8. Solve the following equations:

i. The equation is $\frac{3x}{2} = \frac{x+4}{3}$

$$\Rightarrow 9x = 2x + 8$$

$$\Rightarrow 9x - 2x = 8$$

$$\Rightarrow 7x = 8$$

$$\Rightarrow x = 8/7$$

ii. The equations, $3x + 4y = 7$ ----- Eq(i)

$$2x + y = 3 \text{ -----Eq(ii)}$$

From eq 2,

$$y = 3 - 2x \text{ ----Eq(iii)}$$

We will put the value of y in the eq.i

So, $3x + 4(3 - 2x) = 7$

$$\Rightarrow 3x + 12 - 8x = 7$$

$$\Rightarrow -5x = 7 - 12$$

$$\Rightarrow -5x = -5$$

$$\Rightarrow x = 1$$

We will now put the x value to eq3

$$y = 3 - 2 \cdot 1$$

$$y = 1$$

So, $(x, y) = (1, 1)$

FINAL GRADE

98/100

GENERAL COMMENTS

Instructor

Q1. Base Units 4/5

Joule is not a base unit

.

Q2 2/2 correct

Q3. Inclined planes 11/11

Q4. Vertical motion under gravity 8/8. All correct - good.

Q5. Moments and equilibrium 8/9

No force diagram.

Q6. Solution of quadratics by factorisation 15 /15

All correct -good.

Q7. Solution of quadratics by formula 9/ 10 Unless the answer is a surd value give the solutions to 2 dp's.

Q8 . Simultaneous equations 10 /10

All correct - Well done.

Total = 68/70 ,98%

This is a very nicely completed assignment and shows you have a thorough and sound grasp of the topics involved. Really well done!

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