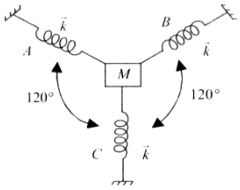
1. Which of the following cannot be in equilibrium?
(a) 10N, 10N, 5N (b) 5N, 7N, 9N
(c) 8N, 4N, 13N (d) 9N, 6N, 5N

2. A block of mass m is connected to three springs, each of spring constant k as shown in fig. The block is pulled by x in the direction of C. Find resultant spring constant.



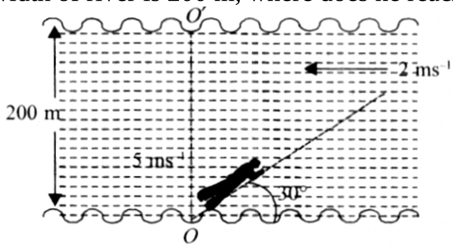
(a) k (b) 2k (c) 3k (d) 3k/2

3. A steamer is moving due east with 36 km/h. To a man in the steamer the wind appears to blow at 18 km/h due north. Find the velocity of the wind.
(a) $5\sqrt{5}$ ms^{-1} 30° North of east (b) 5 ms^{-1} 60° North of east
(c) $5\sqrt{5}$ ms^{-1} 60° North of east (d) 5 ms^{-1} 30°North of east

4. Wind in blowing NE with $18\sqrt{2}$ km h^{-1} and steamer is heading due west with 18 km h^{-1}. In which direction is the flag on the mast fluttering?
(a) North West (b) North (c) South West (d) South

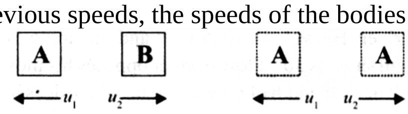
5. A ball is thrown with a velocity $6\hat{j}$ with an acceleration $6\hat{i}+2\hat{j}$. The velocity of the ball after 5 seconds is
(a) $30\hat{i}+10\hat{j}$ (b) $30\hat{i}+16\hat{j}$
(c) $10\hat{i}+24\hat{j}$ (d) None of these

6. A boy swims in a straight line to reach the other side of a river. His velocity is 5 ms^{-1} and the angle of swim with shore is 30°. Flow of river opposes his movement at 2 ms^{-1}. If width of river is 200 m, where does he reach the other bank?



(a) 106 m from O' downstream
(b) 186 m from O' downstream
(c) 186 m from O' upstream
(d) 106 m from O' upstream.

7. Two bodies move uniformly towards each other. They become 4 m nearer in every 1 second, and get 4 m closer every 10 second. If they move in the same direction with their previous speeds, the speeds of the bodies are



(a) 1.8 ms^{-1}, 1.8 ms^{-1} (b) 2.2 ms^{-1}, 2.0 ms^{-1}
(c) 2.2 ms^{-1}, 1.8 ms^{-1} (d) 1.5 ms^{-1}, 2.5 ms^{-1}

8. A particle is moving in a plane with velocity given by $\vec{v}=\hat{i}u_0+\hat{j}$ aωcosωt if the particle is at origin at t = 0. Distance from origin at time 3π/2ω is
(a) $\sqrt{a^2+(3\pi u_0/2\omega)^2}$ (b) $\sqrt{a^2+(2\pi u_0/\omega)^2}$

(c) $(\pi u_0/\omega)^2 + a^2$ (d) $\sqrt{a^2 + (2\pi u_0/3\omega)^2}$

9. Force acting on a particle is $(2\hat{i} + 3\hat{j})$ N. Work done by this force is zero, when a particle is moved on the line 3y + kx = 5. Here value of k is -

(a) 2 (b) 4 (c) 6 (d) 8

10. The sum, difference and cross product of two vectors $\vec{A}$ and $\vec{B}$ are mutually perpendicular if :

(a) $\vec{A}$ and $\vec{B}$ are perpendicular to each other and $|\vec{A}| = |\vec{B}|$

(b) $\vec{A}$ and $\vec{B}$ are perpendicular to each other

(c) $\vec{A}$ and $\vec{B}$ are perpendicular but their magnitudes are arbitrary

(d) $|\vec{A}| = |\vec{B}|$ and their directions are arbitrary

11. A truck travelling due north at 20 m s^{-1} turns west and travels with same speed. What are the changes in velocity?

(a) $20\sqrt{2}$ m s^{-1} south-west (b) 40 m s^{-1} south-west

(c) $20\sqrt{2}$ m s^{-1} north-west (d) 40 m s^{-1} north-west

12. For two vectors $\vec{a}$ and $\vec{b}$, if $\vec{R} = \vec{a} + \vec{b}$ and $\vec{S} = \vec{a} - \vec{b}$, if $2|\vec{R}| = |\vec{S}|$, when $\vec{R}$ is perpendicular to $\vec{a}$, then –

(a) $\frac{a}{b}\sqrt{\frac{3}{7}}$ (b) $\frac{a}{b} = \sqrt{\frac{7}{3}}$ (c) $\frac{a}{b} = \sqrt{\frac{1}{5}}$ (d) $\frac{a}{b} = \sqrt{\frac{5}{1}}$

13. If vector $\vec{P}, \vec{Q}$ and $\vec{R}$ have magnitudes 5, 12 and 13 units and $\vec{P} + \vec{Q} = \vec{R}$, the angle between $\vec{Q}$ and $\vec{R}$ is-

(a) $\cos^{-1}(5/12)$ (b) $\cos^{-1}(5/13)$

(c) $\cos^{-1}(12/13)$ (d) $\cos^{-1}(2/13)$

14. A particle is moving eastwards with a velocity of 5 ms^{-1}. In to 10 second the velocity changes to 5ms^{-1} northwards. northwards. The average acceleration in this time is

(a) $\frac{1}{\sqrt{2}} ms^{-2}$ towards north-west

(b) Zero

(c) $\frac{1}{2} ms^{-2}$ towards north

(d) $\frac{1}{\sqrt{2}} ms^{-2}$ towards north-east.

15. The vector $5\hat{i} + 2\hat{j} - \ell\hat{k}$ is perpendicular to the vector $3\hat{i} + \hat{j} + 2\hat{k}$ for ℓ =

(a) 1 (b) 4.7 (c) 6.3 (d) 8.5

16. Given: $\vec{A} = 2\hat{i} + 3\hat{j}$ and $\vec{B} = 5\hat{i} - 6\hat{j}$. The magnitude of $\vec{A} + \vec{B}$ is -

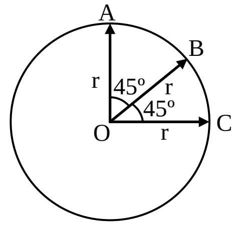
(a) 4 units (b) 10 units

(c) $\sqrt{58}$ units (d) $\sqrt{61}$ units

17. Two forces of magnitude F and $\sqrt{3}$ F act at right angles to each other. Their resultant makes an angle β with F. The value of β is -

(a) 30^0 (b) 45^0 (c) 60^0 (d) 135^0

18. The resultant of the three vectors $\vec{OA}$, $\vec{OB}$ and $\vec{OC}$ shown in figure is –



(a) R (b) 2r (c) $r(1 + \sqrt{2})$ (d) $r(\sqrt{2} - 1)$

19. Given that $\vec{A}+\vec{B}+\vec{C} = 0$, out of three vectors two are equal in magnitude and the magnitude of third vector is $\sqrt{2}$ times that of either of the two having equal magnitude. Then the angles between vectors are given by -

(a) $30^0, 60^0, 90^0$ (b) $45^0, 45^0, 90^0$

(c) $45^0, 60^0, 90^0$ (d) $90^0, 135^0, 135^0$

20. A force of 6 kgf and another of 8 kgf can be applied to produce the effect of a single force equal to –

(a)1 kgf (b)10 kgf (c)16 kgf (d) 0 kgf

21. A vector $\vec{\mathbf{F}}_1$ is along the positive x-axis. If its vector product with another vector $\vec{\mathbf{F}}_2$ is zero, then $\vec{\mathbf{F}}_2$ could be -

(a) $4\vec{\mathbf{i}}$ (b) $-(\vec{\mathbf{i}} + \vec{\mathbf{j}})$ (c) $(\vec{\mathbf{j}} + \vec{\mathbf{k}})$ (d) $-(4\vec{\mathbf{j}})$

22. There are two vectors $\vec{A} = 2\hat{i} + \hat{j} + \hat{k}$ and $\vec{B} = \hat{i} + 2\hat{j} - 2\hat{k}$ then component of $\vec{A}$ along $\vec{B}$ is -

(a) $\frac{2}{9}(\hat{i}+2\hat{j}-2\hat{k})$ (b) $\frac{2}{3}(2\hat{i}+\hat{j}+\hat{k})$

(c) $\frac{2}{3}(\hat{i}+2\hat{j}-2\hat{k})$ (d) None of these

23. If $\vec{P}$ and $\vec{Q}$ denote the sides of a parallelogram and its area is $\frac{1}{2}$ PQ, then the angle between $\vec{P}$ and $\vec{Q}$ is -

(a) 0^0 (b)30^0 (c) 45^0 (d) 60^0

24. There are two force vectors, one of 5 N and other of 12 N at what angle the two vectors be added to get resultant vector of 17 N, 7 N and 13 N respectively-

(a) $0^0, 180^0$ **and** 90^0 (b) $0^0, 90^0$ **and** 180^0

(c) $0^0, 90^0$ **and** 90^0 (d) 180^0**,** 0^0 **and** 90^0

25. Which pair of the following forces will never give resultant force of 2 N-

(a) 2 N and 2 N (b) 1 N and 1 N

(c) 1 N and 3 N (d) 1 N and 4 N

26. If $\vec{A} = 3\hat{i} + \hat{j} + 2\hat{k}$ and $\vec{B} = 2\hat{i} - 2\hat{j} + 4\hat{k}$ then value of $|\vec{A} \times \vec{B}|$ will be-

(a) $8\sqrt{2}$ (b) $8\sqrt{3}$ (c) $8\sqrt{5}$ (d) $5\sqrt{8}$

27. What is the angle made by $3\hat{i} + 4\hat{j}$ with x-axis ?

(a) 0^0 (b) 180^0 (c) $\tan^{-1}(3)$ (d) $\tan^{-1}\left(\frac{4}{3}\right)$

28. If $|\vec{A}\times\vec{B}| = \sqrt{3}\,\vec{A}.\vec{B}$ then the value of $|\vec{A}+\vec{B}|$ is -

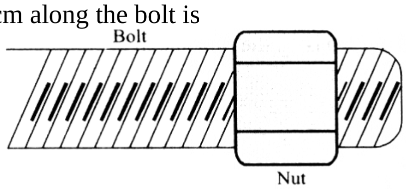
(a) $(A^2 + B^2 + \sqrt{3}\,AB)^{1/2}$ (b) $(A^2 + B^2 + AB)^{1/2}$

(c) $\left(A^2 + B^2 + \frac{AB}{\sqrt{3}}\right)^{1/2}$ (d) A + B

29. An aeroplane is moving in a circular path with a speed 250 km/hr. What is the change in velocity in half revolution ?

(a) 500 km/hr (b) 250 km/hr (c)125 km/hr (d) Zero

30. A nut is screwed onto a bolt with 12 turns per cm and diameter 1.18 cm. The blot is lying in horizontal direction. The nut spins at 216 r.p.m. Time taken by the nut to cover 1.5 cm along the bolt is



(a) 2s (b) 3 s (c) 4 s (d) 5 s

1. (c)
as 13 N > 8 + 4 [$\because$ R_{max} = A + B]

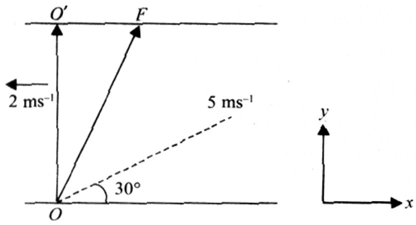
2. (b)
F_{net} = -(kx + kxcos60 + kx cos60)
= -2kx $\therefore$ k_{eq} = 2k

3. (a)
$V_{ws} = V_w - V_s \Rightarrow (V_{wx}\hat{i} + V_{wy}\hat{j}) - 10\hat{i} = 5\hat{j}$ or $(V_{wx}\hat{i} + V_{wy}\hat{j}) = 5\hat{j} + 10\hat{i}$
$|V_w| = 5\sqrt{5}$ tan θ = 1/2 or
θ = 30^0 i.e. wind is blowing at $5\sqrt{5}$ ms^{-1} 30^0 North of east.

4. (d)
$\vec{V}_{Res} = \vec{V}_{steamer} + \vec{V}_{wind} = -5 - 5\hat{i} + 5\hat{i} + 5\hat{j} = 5\hat{j}$. The flag will flutter in a direction opposite to the direction of motion.

5. (b)
using v = u + at v_x = 6(5) = 30 ms^{-1}
v_y = 6 + 2(5) = 16 ms^{-1} v = $30\hat{i} + 16\hat{j}$

6. (c)
Velocity of river $\vec{v}_r = -2\hat{i}$
Velocity of swimmer w.r.t river is
$\vec{v}_s = 5\cos 30\hat{i} + 5\sin 30\hat{j}$
$= 4.3\hat{i} + 2.5\hat{j}$



Using $\vec{v}_R = \vec{v}_s + \vec{v}_r$ we get
$\vec{v}_R = 2.33\hat{i} + 2.5\hat{j}$
Time taken by swimmer = Distance along y – axis/ y component of velocity
= 200/2.5 = 80 s
Distance moved along x – axis,
O'F = x component of relative velocity × time
= 2.33 × 80 = 186.4 m
$\simeq$ 186 m upstream

7. (c)
$u_1 + u_2 = 4$ ……….. (i)
$u_1 - u_2 = 0.4$ ………. (ii)
Adding (i) and (ii)
$2u_1 = 4.4$ or $u_1 = 2.2$ ms^{-1}
and $u_2 = 1.8$ ms^{-1}

8. (a)
Comparing the given equation with $\vec{v} = \hat{i}v_x + \hat{j}v_y$, we get $v_x = u_0$ and dy/dt = aω cos ωt or dx/dt = u_0 and dy/dt = aωcosωt. Integrating x = $\int u_0 dt$ and y = $\int a\omega\cos\omega dt$ or x = $u_0t + c_1$ and y = 0 we get c_1 and c_2 as zero $\therefore$ x = u_0 t and y = a sin ωt but t = 3π/2ω $\therefore$ x = $u_0(3\pi/2\omega)$ and y = -a. Then distance from origin, d = $\sqrt{x^2 + y^2} = \sqrt{a^2 + (3\pi u_0/2\omega)^2}$

9. (a)
Force is parallel to a line y = $\frac{3}{2}$ x + c

The equation of given line can be written as

$y = -\frac{k}{3}x + \frac{5}{3}$

Work done will be zero, when force is perpendicular to the displacement i.e., the above two lines are perpendicular or $m_1m_2 = -1$

or $\left(\frac{3}{2}\right)\left(-\frac{k}{3}\right) = -1$

or $k = 2$

10. (d)

Let $\vec{A} = a_1\hat{i} + a_2\hat{j} + a_3\hat{k}$ and $\vec{B} = b_1\hat{i} + b_2\hat{j} + b_3\hat{k}$

Given that $\vec{A} + \vec{B}$ is perpendicular to $\vec{A} - \vec{B}$

i.e., $(\vec{A} + \vec{B}) . (\vec{A} - \vec{B}) = 0$

or $(a_1 + b_1)(a_1 - b_1) + (a_2 + b_2)(a_2 - b_2) + (a_3 + b_3)(a_3 - b_3) = 0$

or $a_1^2 + a_2^2 + a_3^2 = b_1^2 + b_2^2 + b_3^2$

or $|\vec{A}| = |\vec{B}|$

cross product of $\vec{A}$ and $\vec{B}$ is perpendicular to the plane formed by $\vec{A}$ and $\vec{B}$ or $\vec{A} + \vec{B}$ and $\vec{A} - \vec{B}$.

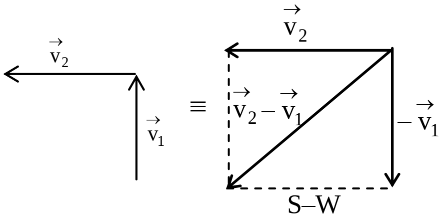
11. (a)

$\vec{v}_1$ = 20 m/s due north

$\vec{v}_2$ = 20 m/s due west

$|\vec{v}_2 - \vec{v}_1| = \sqrt{v_1^2 + v_2^2 - 2v_1v_2\cos\theta}$

$= \sqrt{20^2 + 20^2 - 0}$ $[\because \theta = 90^0] = 20\sqrt{2}$ m/s



Direction of $\vec{v}_2 - \vec{v}_1$ is due South –West

12. (a)

As $\vec{R}$ is perpendicular to $\vec{a}$ therefore

$\cos\theta = \frac{-a}{b} \Rightarrow R = \sqrt{b^2 - a^2}$ and $S = \sqrt{3a^2 + b^2}$

As $2|\vec{R}| = |\vec{S}|$

$\Rightarrow 4b^2 - 4a^2 = 3a^2 + b^2 \Rightarrow 3b^2 = 7a^2$

13. (c)

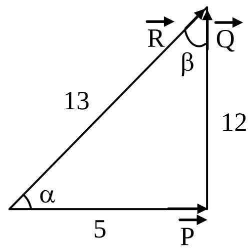
Here $R^2 = P^2 + Q^2 + 2PQ\cos\theta$

θ = angle between $\vec{P}$ and $\vec{Q}$ $\therefore \theta = 90^o$

From $\tan\alpha = \frac{Q\sin\theta}{P + Q\cos\theta}$

(α = angle between $\vec{P}$ and $\vec{R}$)

$= \frac{12.\sin 90^0}{5+12\cos 90^0} = \frac{12}{5}$



$\cos\beta = \frac{12}{13}$ $\therefore$ $\beta = \cos^{-1}\left(\frac{12}{13}\right)$

14. (a)

$\vec{a} = \frac{5\hat{j}-5\hat{i}}{10}$

$|\vec{a}| = \frac{1}{\sqrt{2}}$ m/s^2 North –West

15. (d)

$\vec{A}.\vec{B} = 15 + 2 - 2\ell = 0$

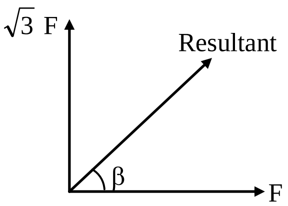
$2\ell = 17 \Rightarrow \ell = \frac{17}{2} = 8.5$

16. (c)

$\vec{A}+\vec{B} = 7\hat{i}-3\hat{j}$

$|\vec{A}+\vec{B}| = \sqrt{49+9} = \sqrt{58}$

17. (c)



$\tan\beta = \frac{\sqrt{3}\,F\sin 90^o}{F+\sqrt{3}\,F\cos 90^o}$

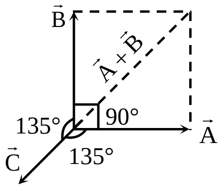
$= \frac{\sqrt{3}\,F}{F} = \sqrt{3}$

$\beta = 60^0$

18. (c)

$= r\,(\sqrt{2} + 1)$

19. (d)



Let $|\vec{A}| = |\vec{B}| = a$ and $|\vec{C}| = \sqrt{2}a$

then, $\vec{A}+\vec{B}+\vec{C} = 0 \Rightarrow \vec{C} = -(\vec{A}+\vec{B})$

$\Rightarrow C^2 = A^2 + B^2 + 2AB\cos\theta$

$\Rightarrow 2a^2 = a^2 + a^2 + 2a^2\cos\theta$

$\Rightarrow \cos\theta = 0 \Rightarrow \theta = 90^0$

20. (b)

Range of 6 kgf and 8 kgf is $|8-6| \le |\vec{R}| \le |8+6|$

21. (a)

$\vec{F_1} = F_1\hat{i}$

$\vec{F_1} \times \vec{F_2} = 0 \Rightarrow F_1\hat{i} \times (4\hat{i}) = 0$

22. (a)

Component of $\vec{A}$ along $\vec{B} = \dfrac{\vec{A}.\vec{B}}{|\vec{B}|}.\hat{B}$

23. (b)

Area = PQ sin θ = $\dfrac{PQ}{2}$

sin θ = ½

24. (a)

For 17N both the vector should be parallel i.e. angle between them should be zero.

For 7N both the vectors should be antiparallel i.e. angle between them should be 180^0

For 13N both the vectors should be perpendicular to each other i.e. angle between them should be 90^0

25. (d)

If two vectors A and B are given then Range of their resultant can be written as $(A-B) \le R \le (A+B)$.

i.e. $R_{max} = A+B$ and $R_{min} = A-B$

If B = 1 and A = 4 then their resultant will lies in between 3N and 5N. It can never be 2N.

26. (b)

$$\vec{A}\times\vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 1 & 2 \\ 2 & -2 & 4 \end{vmatrix}$$

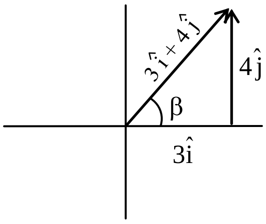
$= 8\hat{i} - 8\hat{j} - 8\hat{k}$

$\therefore$ Magnitude of

$\vec{A}\times\vec{B} = |\vec{A}\times\vec{B}| = \sqrt{(8)^2 + (-8)^2 + (-8)^2} = 8\sqrt{3}$

27. (d)

$\tan\beta = \frac{4}{3}$, $\beta = \tan^{-1}\left(\frac{4}{3}\right)$



28. (b)

Given that $|\vec{A}\times\vec{B}| = \sqrt{3}\ \vec{A}.\vec{B}$

AB sin θ = $\sqrt{3}$ AB cosθ

$\Rightarrow \tan\theta = \sqrt{3}$

or $\theta = \frac{\pi}{3}$

$\therefore |\vec{A}+\vec{B}|$

$= \sqrt{A^2 + B^2 + 2AB\cos\pi/3}$

$= \sqrt{A^2 + B^2 + AB}$

29. (a)

$|\vec{\Delta v}|$ = 2v sin (θ/2)

in half revolution θ = π

$\therefore |\vec{\Delta v}| = 2v$

30. (d)

Here, number of revolutions to cover 1.5 cm 'n' = $\frac{1.5}{1/12}$

= 18

Angular speed = ω 2πv = 2π × (216/60) = 7.2 π rds^{-1}

But $\omega = \frac{\theta}{\omega}$ or $t = \frac{\theta}{t} = \frac{2\pi n}{\omega} = \frac{2\pi\times 18}{7.2\pi} = 5s$