

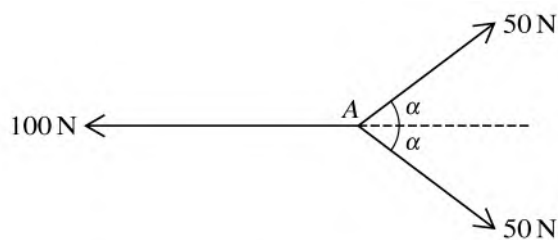
A LEVEL Cambridge Topical Past Papers

MECHANICS

2020 — 2024

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1 - (9709/41_Summer_2020_Q1) - Forces & Equilibrium

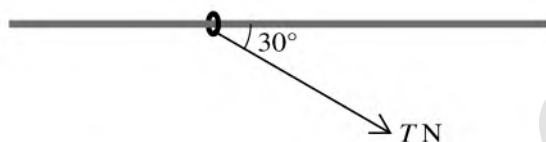


Three coplanar forces of magnitudes 100 N, 50 N and 50 N act at a point A, as shown in the diagram. The value of $\cos \alpha$ is $\frac{4}{5}$.

Find the magnitude of the resultant of the three forces and state its direction.

[3]

2 - (9709/41_Summer_2020_Q4) - Forces & Equilibrium, Newton's Laws Of Motion



The diagram shows a ring of mass 0.1 kg threaded on a fixed horizontal rod. The rod is rough and the coefficient of friction between the ring and the rod is 0.8. A force of magnitude T N acts on the ring in a direction at 30° to the rod, downwards in the vertical plane containing the rod. Initially the ring is at rest.

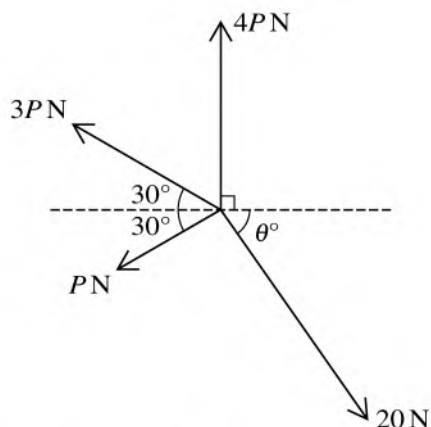
(a) Find the greatest value of T for which the ring remains at rest.

[4]

(b) Find the acceleration of the ring when $T = 3$.

[3]

3 - (9709/42_Summer_2020_Q2) - Forces & Equilibrium

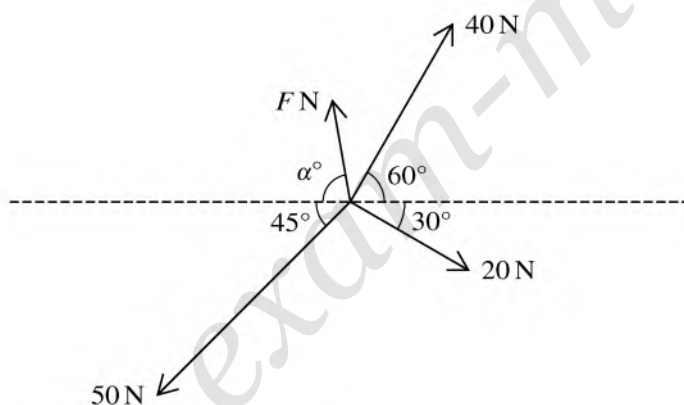


Coplanar forces of magnitudes 20 N , $P\text{ N}$, $3P\text{ N}$ and $4P\text{ N}$ act at a point in the directions shown in the diagram. The system is in equilibrium.

Find P and θ .

[6]

4 - (9709/43_Summer_2020_Q3) - Forces & Equilibrium

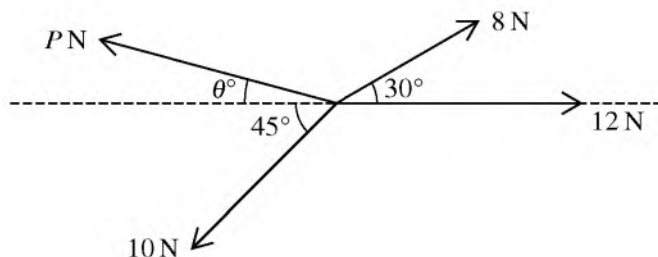


Four coplanar forces of magnitudes 40 N , 20 N , 50 N and $F\text{ N}$ act at a point in the directions shown in the diagram. The four forces are in equilibrium.

Find F and α .

[6]

5 - (9709/41_Winter_2020_Q3) - Forces & Equilibrium

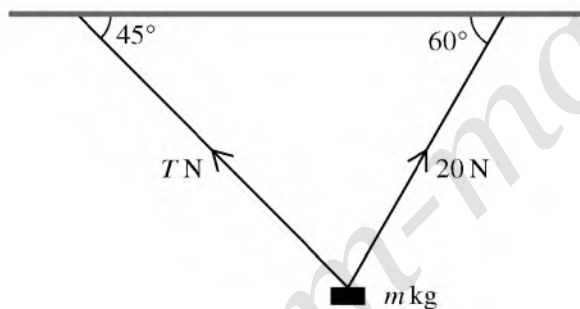


Coplanar forces of magnitudes 8 N, 12 N, 10 N and P N act at a point in the directions shown in the diagram. The system is in equilibrium.

Find P and θ .

[6]

6 - (9709/42_Winter_2020_Q3) - Forces & Equilibrium



A block of mass m kg is held in equilibrium below a horizontal ceiling by two strings, as shown in the diagram. One of the strings is inclined at 45° to the horizontal and the tension in this string is T N. The other string is inclined at 60° to the horizontal and the tension in this string is 20 N.

Find T and m .

[5]

ANSWERS

1 - (9709/41_Summer_2020_Q1) - Forces & Equilibrium

	Resultant = $100 - 2 \times 50 \cos \alpha$	M1
	20 N	A1
	Direction is to the left (or equivalent)	B1
		3

2 - (9709/41_Summer_2020_Q4) - Forces & Equilibrium, Newton's Laws Of Motion

(a)	Resolving forces in either direction	M1
	$R = T \sin 30 + 0.1g$, $F = T \cos 30$	A1
	$T \cos 30 = 0.8 (T \sin 30 + 0.1g)$	M1
	$T = 1.72 (1.7166\dots)$	A1
		4
(b)	$R = 3 \sin 30 + 0.1g$	B1
	$3 \cos 30 - 0.8(3 \sin 30 + 0.1g) = 0.1a$	M1
	$a = 5.98 \text{ ms}^{-2} (5.9807\dots)$	A1
		3

3 - (9709/42_Summer_2020_Q2) - Forces & Equilibrium

	Resolving forces in either direction	M1
	$20 \cos \theta = 4P \cos 30$	A1
	$4P + 2P \sin 30 = 20 \sin \theta$	A1
	$\cos \theta = \frac{\sqrt{3}}{10} P$ $\sin \theta = \frac{P}{4}$ $\frac{3}{100} P^2 + \frac{1}{16} P^2 = 1$	M1
	$P = 3.29$	A1
	$\theta = 55.3$	A1
		6

4 - (9709/43_Summer_2020_Q3) - Forces & Equilibrium

	Attempt to resolve, either direction with correct number of terms	M1
	$F \cos \alpha = 40 \sin 30 + 20 \sin 60 - 50 \sin 45 (= 1.965\dots)$	A1
	$F \sin \alpha = 50 \cos 45 + 20 \cos 60 - 40 \cos 30 (= 10.714\dots)$	A1
	Method for either F or α	M1
	$F = \sqrt{(1.965\dots)^2 + (10.714\dots)^2} = 10.9 (10.893)$	A1
	$\alpha = \tan^{-1}(10.714\dots / 1.965\dots) = 79.6 (79.606\dots)$	A1
		6

5 - (9709/41_Winter_2020_Q3) - Forces & Equilibrium

Resolve forces either horizontally or vertically	M1	Correct number of relevant terms
$P \cos \theta = 12 + 8 \cos 30 - 10 \cos 45 [= 11.857]$	A1	
$P \sin \theta = 10 \sin 45 - 8 \sin 30 [= 3.071]$	A1	
$P = \sqrt{(11.857^2 + 3.071^2)}$	M1	OE. Use of correct method for finding P
$\theta = \tan^{-1} \left(\frac{3.071}{11.857} \right)$	M1	OE. Use of correct method for finding θ
$P = 12.2$ and $\theta = 14.5$	A1	Both correct
	6	

6 - (9709/42_Winter_2020_Q3) - Forces & Equilibrium

$20 \cos 60 = T \cos 45$	M1	Resolve forces horizontally, 2 terms
$T = 10\sqrt{2}$ or $T = 14.1$	A1	
$20 \sin 60 + T \sin 45 = mg$ or W	M1	Resolve forces vertically, 3 terms
$20 \sin 60 + T \sin 45 = mg$	A1	
$m = 2.73 [= \sqrt{3} + 1]$	A1	
Alternative method for question 3		
$\left[\frac{T}{\sin 150} = \frac{mg \text{ or } W}{\sin 75} = \frac{20}{\sin 135} \right]$	M1	Attempt at one pair of terms using Lami's Method
$\frac{T}{\sin 150} = \frac{mg}{\sin 75} = \frac{20}{\sin 135}$	A1	All terms correct in Lami's Method
Attempt to solve for either T or m or W	M1	
$T = 10\sqrt{2}$ or $T = 14.1$	A1	
$m = 2.73 [= \sqrt{3} + 1]$	A1	
	5	
Alternative method for question 3		
$\left[\frac{T}{\sin 30} = \frac{mg \text{ or } W}{\sin 105} = \frac{20}{\sin 45} \right]$	M1	Attempt the triangle of forces method and state one equation which involves any two of the forces T , m and 20 .
$\frac{T}{\sin 30} = \frac{mg}{\sin 105} = \frac{20}{\sin 45}$	A1	All correct
Attempt to solve for either T or m or W	M1	
$T = 10\sqrt{2}$ or $T = 14.1$	A1	
$m = 2.73 [= \sqrt{3} + 1]$	A1	
	5	