SMART EXAM RESOURCES
9702 PHYSICS TOPIC QUESTIONS
TOPIC: PHYSICAL QUANTITIES AND UNITS
SUB-TOPIC: SCALARS AND VECTORS
SUB-SUB-TOPIC: VECTOR DIAGRAMS
SET-2-QP-MS

1 An object O of mass 4.9 kg is suspended by a rope A that is fixed at point P. The object is pulled to one side and held in equilibrium by a second rope B, as shown in Fig. 2.1.

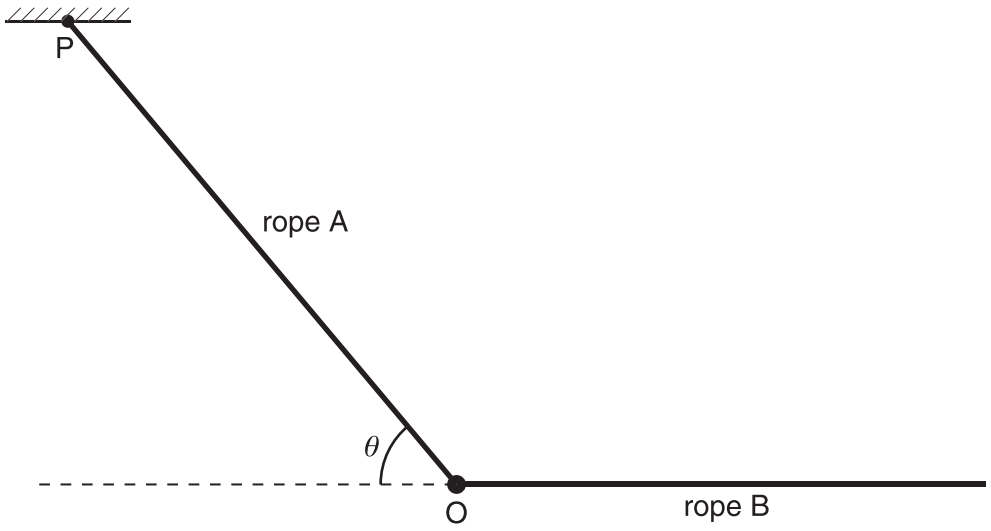


Fig. 2.1

Rope A is at an angle θ to the horizontal and rope B is horizontal. The tension in rope A is 69 N and the tension in rope B is T.

(i) On Fig. 2.1, draw arrows to represent the directions of all the forces acting on object O. [2]

(ii) Calculate

1. the angle θ,

θ = ...° [3]

2. the tension T.

T = ... N [2]

MARKING SCHEME:

(i)	arrow vertically down through O			B1	
	tension forces in correct direction on rope			B1	[2]
(ii)	**1.** weight = mg = 4.9 × 9.81 (= 48.07)			C1	
	69 sin θ = mg			C1	
	θ = 44.(1)°	*scale drawing allow ± 2°*		A1	[3]
	use of cos or tan 1/3 only				
	2. T = 69 cos θ			C1	
	= 49.6 / 50 N	*scale drawing 50 ±2 (2/2)*	*50 ±4 (1/2)*	A1	[2]

correct answers obtained using scale diagram or triangle of forces will score full marks

*cos in **1.** then sin in **2.** (2/2)*

2 Three coplanar forces *X*, *Y* and *Z* act on an object, as shown in Fig. 3.1.

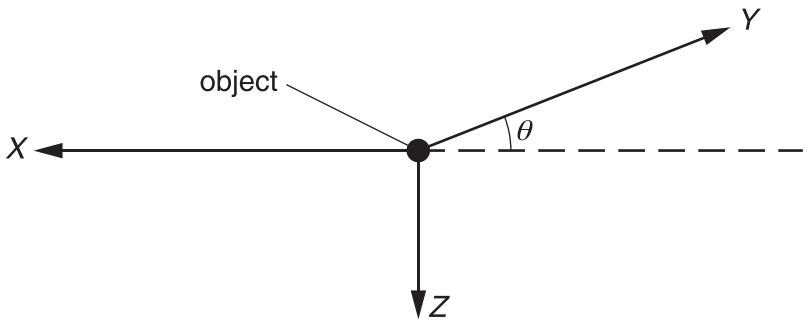


Fig. 3.1

The force *Z* is vertical and *X* is horizontal. The force *Y* is at an angle θ to the horizontal. The force *Z* is kept constant at 70 N.

In an experiment, the magnitude of force *X* is varied. The magnitude and direction of force *Y* are adjusted so that the object remains in equilibrium.

Fig. 3.2 shows the variation of the magnitude of force *Y* with the magnitude of force *X*.

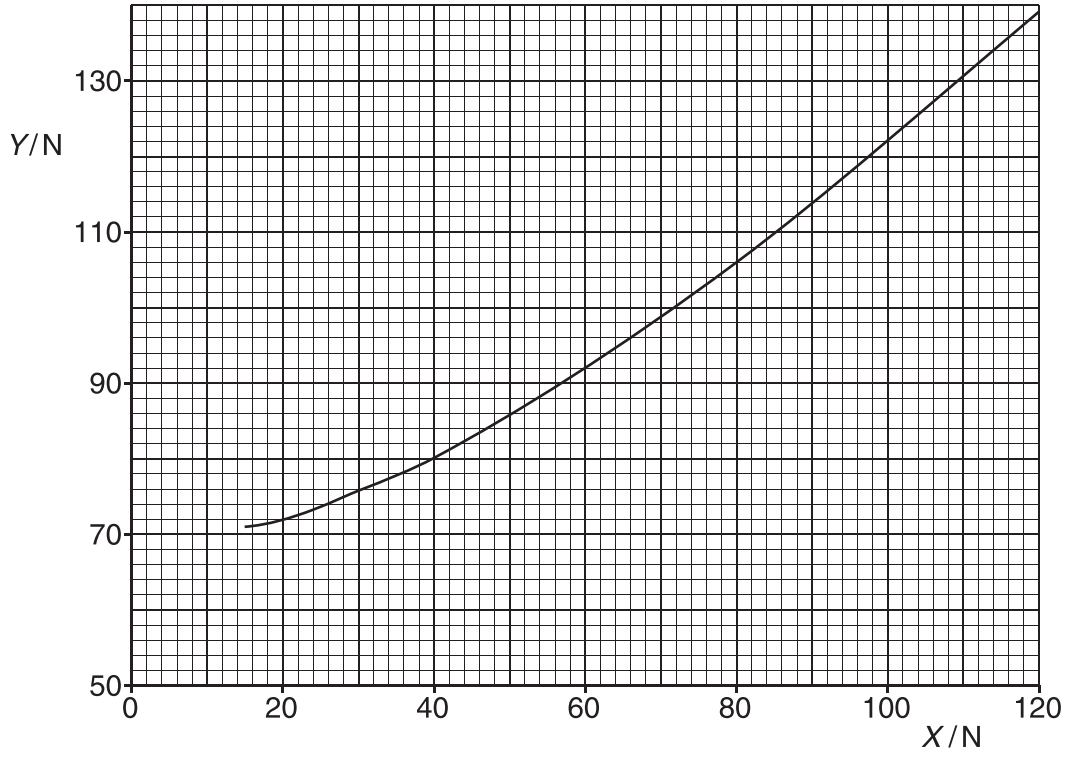


Fig. 3.2

a

(i) Use Fig. 3.2 to estimate the magnitude of Y for $X = 0$.

$Y =$ ..... N [1]

(ii) State and explain the value of θ for $X = 0$.

.....

.....

.....[2]

(iii) The magnitude of X is increased to 160 N. Use resolution of forces to calculate the value of

1. angle θ,

$\theta =$ ..... ° [2]

2. the magnitude of force Y.

$Y =$ ..... N [2]

b The angle θ decreases as X increases. Explain why the object cannot be in equilibrium for $\theta = 0$.

.....

.....

.....[1]

MARKING SCHEME:

(b)	**(i)**	Y = 70 N [allow 71 N as +½ small square on graph]	A1	[1]
	(ii)	$\theta = 90°$	M1	
		(for equilibrium) the direction of Y must be <u>opposite</u> to Z		
		or using $Y \sin \theta = Z$, hence $\sin \theta = 70 / 70 = 1$, $\theta = 90°$	A1	[2]
	(iii)	**1.** $Y \cos \theta = 160$ and $Y \sin \theta = 70$	C1	
		$\tan \theta = 70/160$ hence $\theta = 23.6°$ (24°)	A1	[2]
		2. $Y = 160 / \cos 23.6°$ or $70 / \sin 23.6°$	C1	
		$= 174.6$ or 175 or 170 N	A1	[2]
		or:		
		$160^2 + 70^2 = Y^2$	(C1)	
		$Y = 174.6$ or 175 or 170 N	(A1)	
(c)		(equilibrium not possible as) there is no vertical component from Y to balance Z	B1	[1]

3 A boat is travelling in a flowing river. Fig. 1.1 shows the velocity vectors for the boat and the river water.

Fig. 1.1

The velocity of the boat in still water is 14.0 m s^{-1} to the east. The velocity of the water is 8.0 m s^{-1} from 60° north of east.

(i) On Fig. 1.1, draw an arrow to show the direction of the resultant velocity of the boat. [1]

(ii) Determine the magnitude of the resultant velocity of the boat.

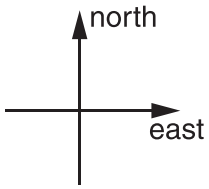
magnitude of velocity = ... $m\,s^{-1}$ [2]

MARKING SCHEME:

(i)	arrow in the direction 30° to 40° south of east	B1	[1]
(ii)	triangle of velocities completed (i.e. correct scale diagram) or correct working given e.g. $[14^2 + 8.0^2 - 2(14)(8.0)\cos 60°]^{1/2}$ **or** $[(14 - 8.0\cos 60°)^2 + (8.0\sin 60°)^2]^{1/2}$	C1	
	resultant velocity = 12(.2) (or 12.0 to 12.4 from scale diagram) $m\,s^{-1}$	A1	[2]

4 **(b) A girl runs 120 m due north in 15 s. She then runs 80 m due east in 12 s.**

i) Sketch a vector diagram to show the path taken by the girl. Draw and label her resultant displacement R.



[1]

(ii) Calculate, for the girl,

1. the average speed,

average speed = ... $m\,s^{-1}$ [1]

2. the magnitude of the average velocity v and its angle with respect to the direction of the initial path.

magnitude of v = ... $m\,s^{-1}$

angle = ... °

[3]

MARKING SCHEME:

(i)	triangle with right angles between 120 m and 80 m, arrows in correct direction and result displacement from start to finish arrow in correct direction and labelled R		B1	[1]
(ii)	**1.**	average speed (= 200 / 27) = 7.4 $m s^{-1}$	A1	[1]
	2.	resultant displacement (= $[120^2 + 80^2]^{1/2}$) = 144 (m)	C1	
		average velocity (= 144 / 27) = 5.3(3) $m s^{-1}$	A1	
		direction (= $\tan^{-1}$ 80 / 120) = 34° (33.7)	A1	[3]

5 A rod AB is hinged to a wall at A. The rod is held horizontally by means of a cord BD, attached to the rod at end B and to the wall at D, as shown in Fig. 2.1.

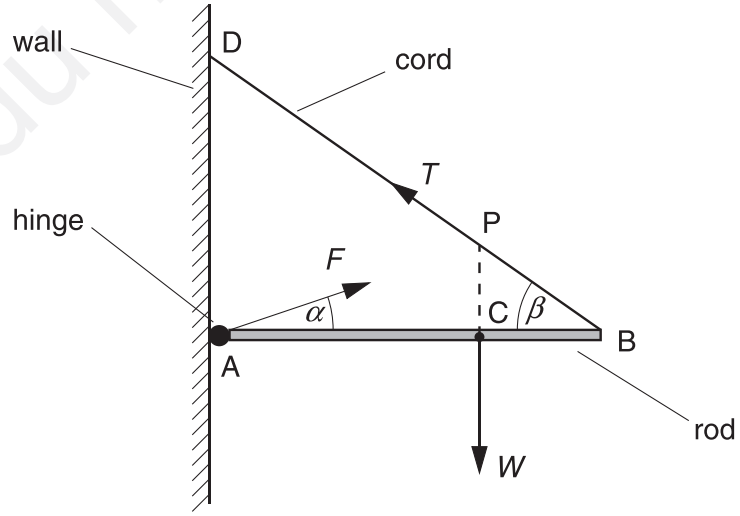


Fig. 2.1

The rod has weight W and the centre of gravity of the rod is at C. The rod is held in equilibrium by a force T in the cord and a force F produced at the hinge.

(c) The forces F and T make angles α and β respectively with the rod and AC = $\frac{2}{3}$AB, as shown in Fig. 2.1.

Write down equations, in terms of F, W, T, α and β, to represent

(i) the resolution of forces horizontally,

..... [1]

(ii) the resolution of forces vertically,

..... [1]

(iii) the taking of moments about A.

..... [1]

MARKING SCHEME:

(i)	$F\cos\alpha = T\cos\beta$	B1	**[1]**
(ii)	$W = F\sin\alpha + T\sin\beta$	B1	**[1]**
(iii)	$2W = 3T\sin\beta$	B1	**[1]**