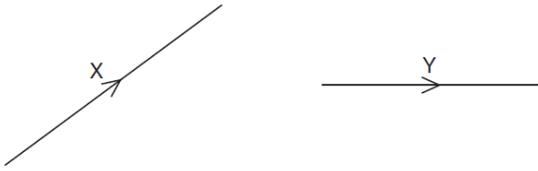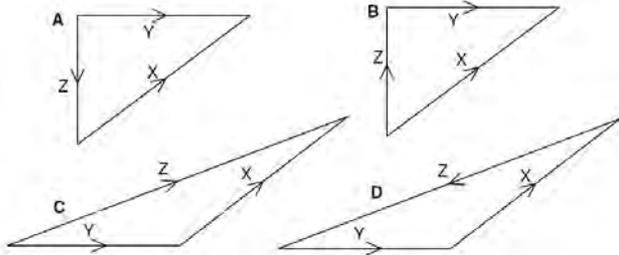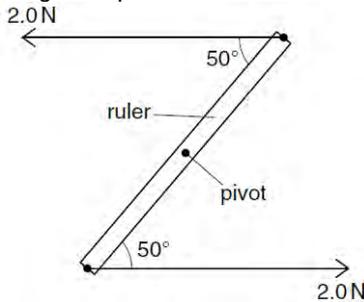# Vectors & Equilibrium

May 02

1. The diagram shows two vectors X and Y.

In which vector triangle does the vector Z show the magnitude and direction of vector X – Y?

2. A ruler of length 0.30m is pivoted at its centre. Equal and opposite forces of magnitude 2.0N are applied to the ends of the ruler, creating a couple as shown.

What is the magnitude of the torque of the couple on the ruler when it is in the position shown?

A 0.23Nm   **B** 0.39Nm   **C** 0.46Nm   **D** 0.60Nm
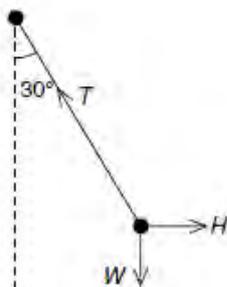
3. The vector diagram shows three coplanar forces acting on an object at P.
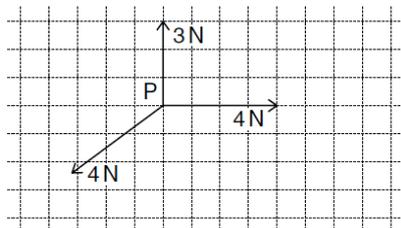
The magnitude of the resultant of these three forces is 1 N. What is the direction of this resultant?

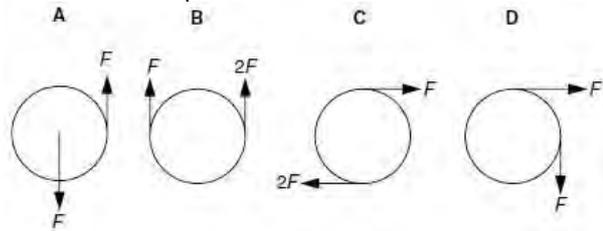**A** ↓   **B** ↘   **C** ↙   **D** ↗

Nov 02

4. A pendulum bob is held stationary by a horizontal force H. The three forces acting on the bob are shown in the diagram.

The tension in the string of the pendulum is T. The weight of the pendulum bob is W.
Which statement is correct?

A $H = T\cos30°$ **B** $T = H\sin30°$ **C** $W = T\cos30°$ **D** $W = T\sin30°$

5. Which of the following pairs of forces, acting on a circular object, constitutes a couple?


6. A uniform metre rule of mass 100 g is supported by a knife-edge at the 40 cm mark and a string at the 100 cm mark. The string passes round a frictionless pulley and carries a mass of 20 g as shown in the diagram.
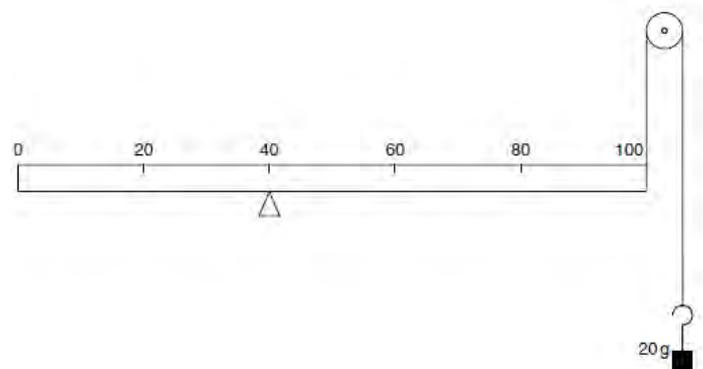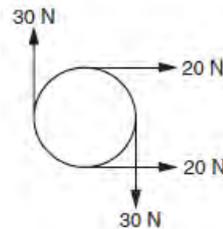

At which mark on the rule must a 50 g mass be suspended so that the rule balances?

A 4 cm   **B** 36 cm   **C** 44 cm   **D** 96 cm

7. The diagrams represent systems of coplanar forces acting at a point. The lengths of the force vectors represent the magnitudes of the forces. Which system of forces is in equilibrium?
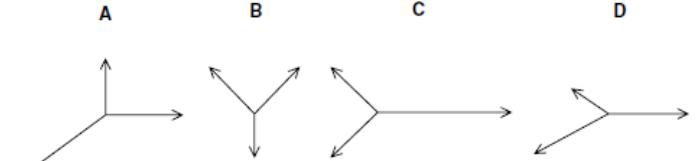
June 03

8. The diagram shows four forces applied to a circular object.

Which of the following describes the resultant force and resultant torque on the object?

	resultant force	resultant torque
A	zero	zero
B	zero	non-zero
C	non-zero	zero
D	non-zero	non-zero

9. Two forces, each of 10 N, act at a point P as shown in the diagram. The angle between the directions of the forces is 120°.
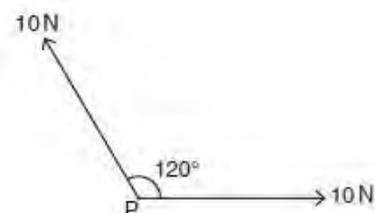
What is the magnitude of the resultant force?

A 5N   **B** 10N   **C** 17N   **D** 20N

Nov 03

10. A spanner is used to tighten a nut as shown.

A force F is applied at right-angles to the spanner at a distance of 0.25 m from the centre of the nut. When the nut is fully tightened, the applied force is 200 N.
What is the resistive torque, in an anticlockwise direction, preventing further tightening?
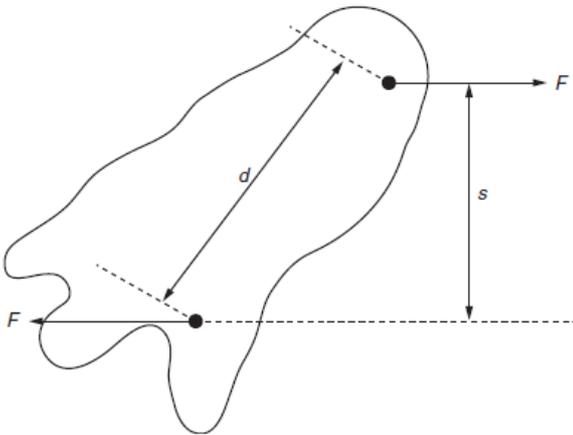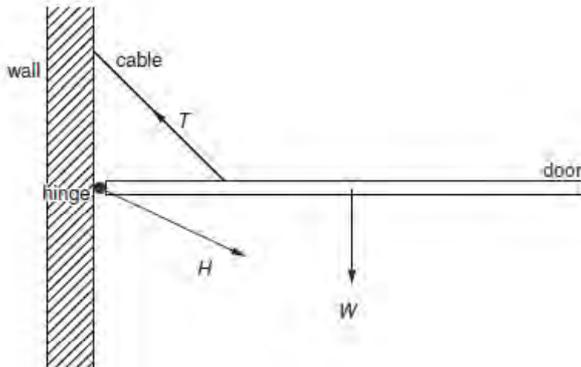A 8Nm   B 25Nm   C 50Nm   D 800Nm

11. Two parallel forces, each of magnitude F, act on a body as shown.

What is the magnitude of the torque on the body produced by these forces?
A Fd B Fs C $2Fd$ D $2Fs$

**12.** A hinged door is held closed in the horizontal position by a cable.

Three forces act on the door: the weight W of the door, the tension T in the cable, and the force H at the hinge.
Which list gives the three forces in **increasing** order of magnitude?
A H,T,W B T,H,W C W,H,T D W,T,H

June 04

13. A uniform beam of weight 50 N is 3.0 m long and is supported on a pivot situated 1.0 m from one end. When a load of weight W is hung from that end, the beam is in equilibrium, as shown in the diagram.
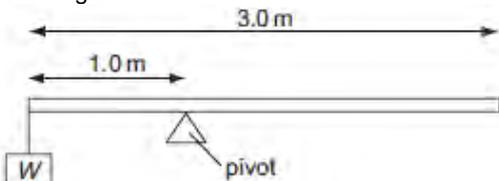
What is the value of W ?
A 25 N   B 50 N   C 75 N   D 100 N

14 The diagram shows a sign of weight 20 N suspended from a pole, attached to a wall. The pole is kept in equilibrium by a wire attached at point X of the pole.
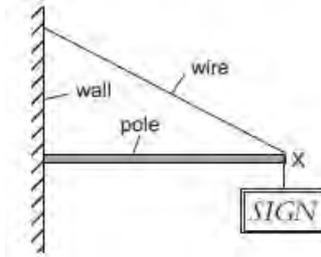
The force exerted by the pole at point X is F, and the tension in the wire is 40 N.
Which diagram represents the three forces acting at point X?
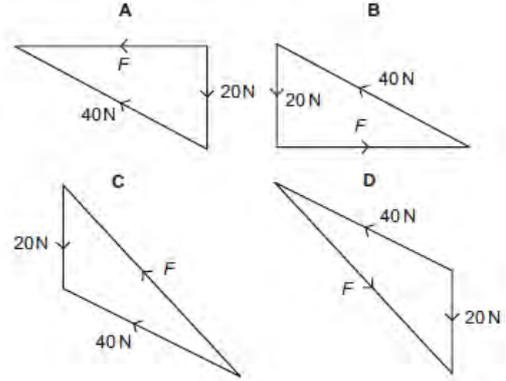
Nov 04

15. Which two vector diagrams represent forces in equilibrium?
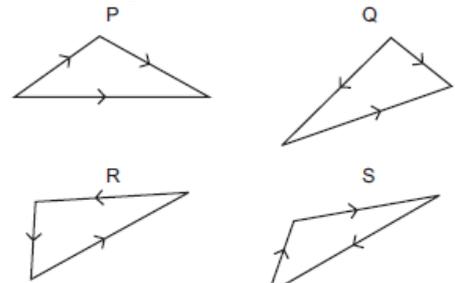
A P and Q   B Q and R   C R and S   D S and P

16. A long uniform beam is pivoted at one end. A force of 300 N is applied to hold the beam horizontally.
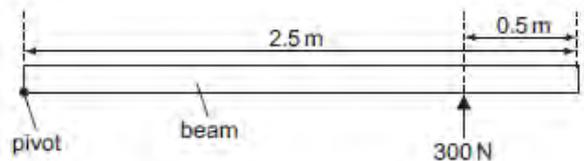
What is the weight of the beam?
A 300 N B 480 N C 600 N D 960 N

June 05

17. What is the centre of gravity of an object?
A the geometrical centre of the object
B the point about which the total torque is zero
C the point at which the weight of the object may be considered to act
D the point through which gravity acts

18. An L-shaped rigid lever arm is pivoted at point P.
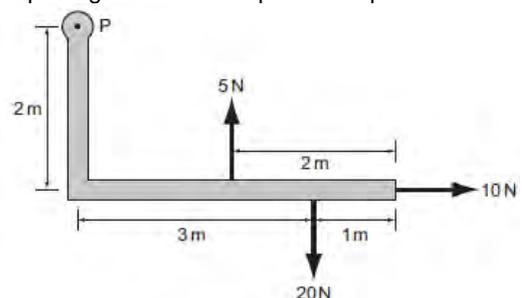
What is the magnitude of the resultant moment of these forces about point P?
A 30 N m   B 35 N m   C 50 N m   D 90 N m

19. The vector diagram shows three coplanar forces acting on an object at P.
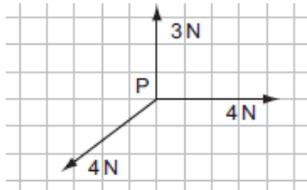
The magnitude of the resultant of these three forces is 1 N. What is the direction of this resultant?

A ↓   B ↘   C ↙   D ↗

Nov 05

20. A uniform beam of weight 100 N is pivoted at P as shown. Weights of 10 N and 20 N are attached to its ends.
The length of the beam is marked off at 0.1 m intervals.
At which point should a further weight of 20 N be attached to achieve equilibrium?
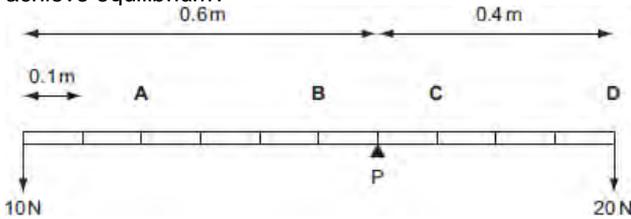
21. The diagram shows four forces applied to a circular object.

Which of the following describes the resultant force and resultant torque on the object?

	resultant force	resultant torque
A	non-zero	non-zero
B	non-zero	zero
C	zero	non-zero
D	zero	zero

June 06

22. Which pair includes a vector quantity and a scalar quantity?
A displacement; acceleration   B force; kinetic energy
C power; speed   D work; potential energy

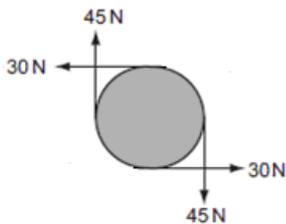23. The following physical quantities can be either positive or negative.
s : displacement of a particle along a straight line
θ : temperature on the Celsius scale
q : electric charge
V : readings on a digital voltmeter
Which of these quantities are vectors?

A s, θ, q, V   B s, q, V   C θ, V   D s only

24. The diagrams show three forces acting on a body.
In which diagram is the body in equilibrium?
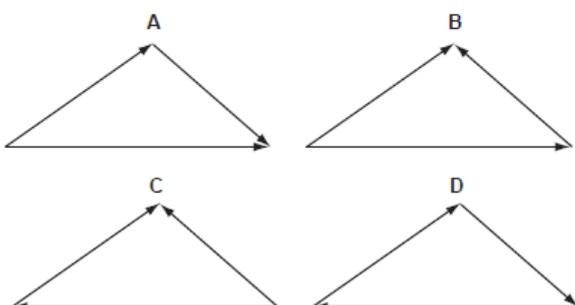
25. A force F is applied to a beam at a distance d from a pivot. The force acts at an angle θ to a line perpendicular to the beam.
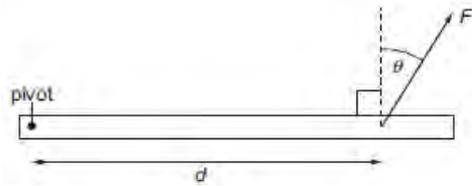
Which combination will cause the largest turning effect about the pivot?

	F	d	θ
A	large	large	large
B	large	large	small
C	small	small	large
D	small	large	small

26. A rigid uniform bar of length 2.4 m is pivoted horizontally at its mid-point.
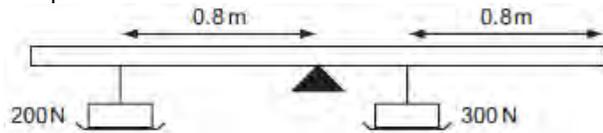
Weights are hung from two points of the bar as shown in the diagram. To maintain horizontal equilibrium, a couple is applied to the bar. What is the torque and direction of this couple?
A 40 N m clockwise   B 40 N m anticlockwise
C 80 N m clockwise   D 80 N m anticlockwise

Nov 06

27. A rigid circular disc of radius r has its centre at X. A number of forces of equal magnitude F act at the edge of the disc. All the forces are in the plane of the disc. Which arrangement of forces provides a moment of magnitude 2Fr about X?
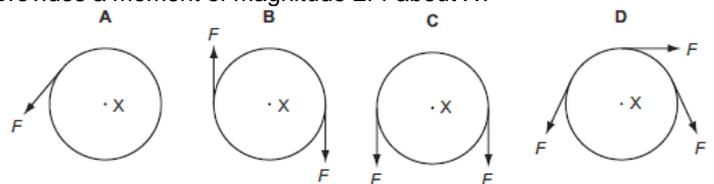
28. Three coplanar forces, each of magnitude 10 N, act through the same point of a body in the directions shown.
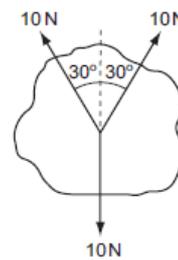
What is the magnitude of the resultant force?
A 0 N   B 1.3 N   C 7.3 N   D 10 N

June 07

29. An object has an initial velocity u. It is subjected to a constant force F for t seconds, causing a constant acceleration a. The force is not in the same direction as the initial velocity.
A vector diagram is drawn to find the final velocity v.
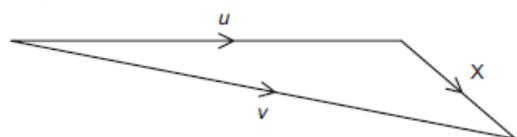
What is the length of side X of the vector diagram?
A F   B F t   C at   D u + at

30. Two 8.0 N forces act at each end of a beam of length 0.60 m. The forces are parallel and act in opposite directions. The angle between the forces and the beam is 60 °.
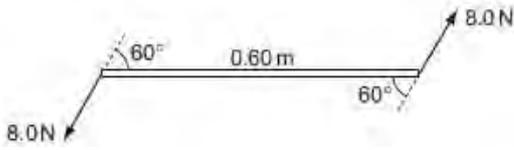
What is the torque of the couple exerted on the beam?
A 2.4 N m   B 4.2 N m   C 4.8 N m   D 9.6 N m

Nov 07
31. The diagram shows a plan view of a door which requires a moment of 12 N m to open it.
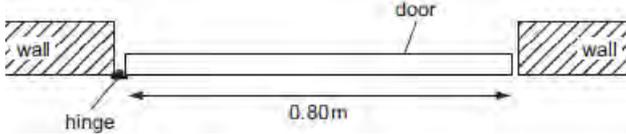
What is the minimum force that must be applied at the door's midpoint to ensure it opens?
A 4.8 N   B 9.6 N   C 15 N   D 30 N

32. The diagram shows two vectors X and Y.
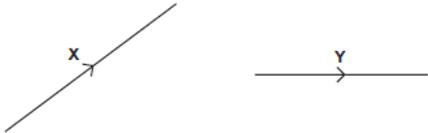
In which vector triangle does the vector Z show the magnitude and direction of vector X–Y?
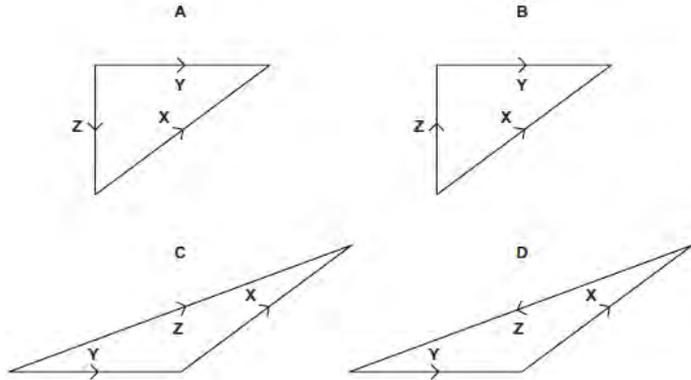
33. Which two vector diagrams represent forces in equilibrium?
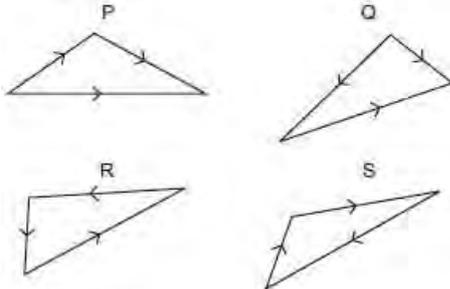
A P and Q   B Q and R   C R and S   D S and P

June 08
34. Two rigid rods, XZ and YZ, are fixed to a vertical wall at points X and Y. A load of weight *W* is hung from point Z. The load is not moving.
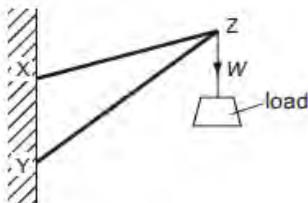
Which diagram shows the forces acting at point Z?
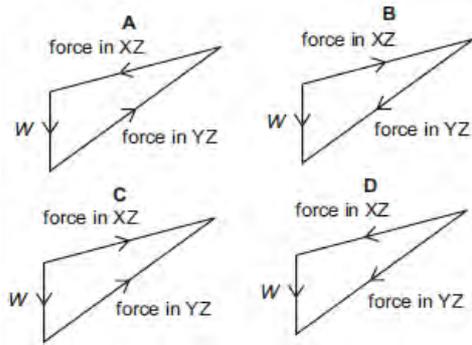
35. A uniform ladder rests against a vertical wall where there is negligible friction. The bottom of the ladder rests on rough ground where there is friction. The top of the ladder is at a height h above the ground and the foot of the ladder is at a distance 2a from the wall.
The diagram shows the forces which act on the ladder.
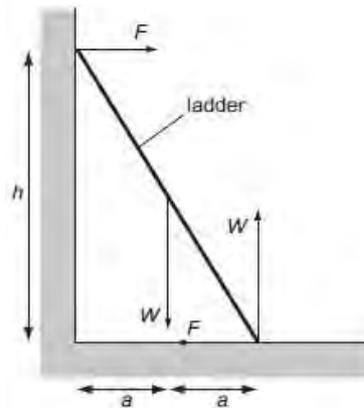
Which equation is formed by taking moments?
A W a + F h = 2W a
B F a + W a = F h
C W a + 2W a = F h
D W a – 2W a = 2F h

Nov 08
36. Which pair of forces acts as a couple on the circular object?
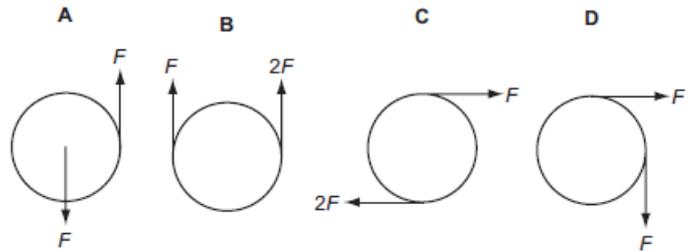
June 09
37. The diagram shows a resultant force and its horizontal and vertical components.

The horizontal component is 20.0 N and θ = 30°. What is the vertical component?
A 8.7 N   B 10.0 N   C 11.5 N   D 17.3 N

38. An object, made from two equal masses joined by a light rod, falls with uniform speed through air.
The rod remains horizontal.
Which statement about the equilibrium of the system is correct?
A It is not in equilibrium because it is falling steadily.
B It is not in equilibrium because it is in motion.
C It is not in equilibrium because there is a resultant torque.
D It is in equilibrium because there is no resultant force and no resultant torque.

39. A spindle is attached at one end to the centre of a lever 1.20 m long and at its other end to the centre of a disc of radius 0.20 m. A cord is wrapped round the disc, passes over a pulley and is attached to a 900 N weight.

What is the minimum force F, applied to each end of the lever, that could lift the weight?
A 75 N   B 150 N C 300 N D 950 N

Nov 09

40. What is the centre of gravity of an object?
A the geometrical centre of the object
B the point about which the total torque is zero
C the point at which the weight of the object may be considered to act
D the point through which gravity acts

41. The diagrams show two ways of hanging the same picture.

In both cases, a string is attached to the same points on the picture and looped symmetrically over a nail in a wall. The forces shown are those that act on the nail.
In diagram 1, the string loop is shorter than in diagram 2.
Which information about the magnitude of the forces is correct?

A $R_1 = R_2$ $T_1 = T_2$ B $R_1 = R_2$ $T_1 > T_2$

C $R_1 > R_2$ $T_1 < T_2$ D $R_1 < R_2$ $T_1 = T_2$

42. The diagram shows two pulley wheels connected by a belt.

Wheel Q is driven by a motor and rotates clockwise at a constant rate. Wheel Q puts tension in the top portion of the belt, which in turn drives the wheel P. The lower portion of the belt is slack and has no tension. The weight of the belt and frictional forces are negligible.
The diameter of P is 150 mm. The diameter of Q is 100 mm. The torque applied to Q is 3.0 N m.
What is the tension in the belt and the torque on wheel P?

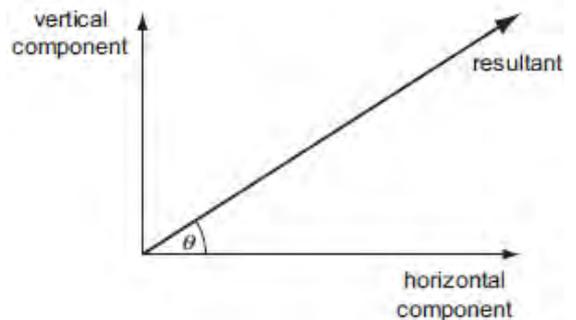|	tension in top of belt /N	torque on wheel P /N m
A	20	2.0
B	30	4.5
C	40	2.0
D	60	4.5

June 10

43. A vector quantity V is resolved into two perpendicular components X and Y. The angle between V and component X is θ.

The angle between component X and the vector V is increased from 0° to 90°.
How do the magnitudes of X and Y change as the angle θ is increased in this way?

	X	Y
A	increase	increase
B	increase	decrease
C	decrease	increase
D	decrease	decrease

44. Forces of 3 N, 4 N and 5 N act at one point on an object. The angles at which the forces act can vary.
What is the value of the minimum resultant force of these forces?
A 0   B between 0 and 2 N
C 2 N   D between 2 N and 4 N

Answers
1-B, 2-C, 3-D, 4-C, 5-A, 6-C, 7-A, 8-D, 9-B, 10-C, 11-B, 12-C, 13-A, 14-B, 15-C, 16-B, 17-C, 18-A, 19-D, 20-D, 21-C, 22-B, 23-D, 24-D, 25-B, 26-A, 27-B, 28-C, 29-C, 30-B, 31-D, 32-B, 33-C, 34-A, 35-A, 36-A, 37-C, 38-D, 39-B, 40-C, 41-B, 42-D, 43-C, 44-A,