Edexcel GCE

Core Mathematics M1

Resolving Forces and Equilibrium

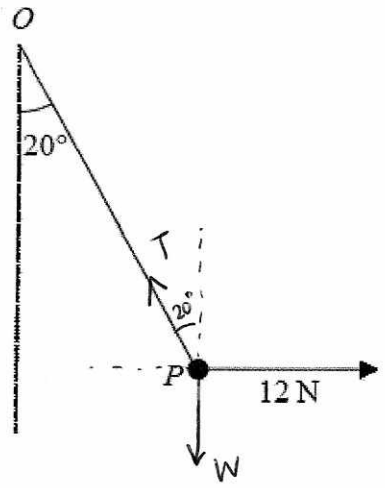
Materials required for examination
Mathematical Formulae (Green)

Items included with question papers
Nil

Advice to Candidates

You must ensure that your answers to parts of questions are clearly labelled.
You must show sufficient working to make your methods clear to the Examiner. Answers without working may gain no credit.

1. **Figure 1**



A particle P is attached to one end of a light inextensible string. The other end of the string is attached to a fixed point O. A horizontal force of magnitude 12 N is applied to P. The particle P is in equilibrium with the string taut and OP making an angle of 20° with the downward vertical, as shown in Figure 1.

Find

(*a*) the tension in the string,

(3)

(*b*) the weight of P.

(4)

a) Resolving →

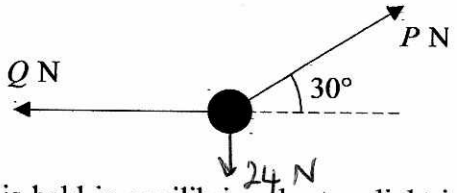
$$T \sin 20 = 12$$
$$T = \frac{12}{\sin 20}$$
$$= 35.1 \text{ N} \quad (3sf)$$

b) Resolving ↑

$$(T)\cos 20 = W$$
$$W = 32.96972903 \text{ N}$$
$$= 33.0 \text{ N} \quad (3sf)$$

2.

Figure 1



A particle of weight 24 N is held in equilibrium by two light inextensible strings. One string is horizontal. The other string is inclined at an angle of 30° to the horizontal, as shown in Figure 1. The tension in the horizontal string is Q newtons and the tension in the other string is P newtons. Find

(*a*) the value of P,

(3)

(*b*) the value of Q,

(3)

a/ Resolving ↑

$$P \sin 30 = 24$$

$$P = \frac{24}{\sin 30}$$

$$= 48 \text{ N}$$

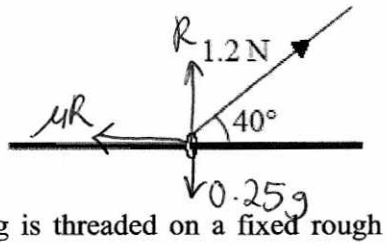
b/ Resolving →

$$48 \cos 30 = Q$$

$$Q = 24\sqrt{3} \text{ N}$$

$$= 41.6 \text{ N} \quad (3\text{ sf})$$

3. **Figure 3**



A small ring of mass 0.25 kg is threaded on a fixed rough horizontal rod. The ring is pulled upwards by a light string which makes an angle 40° with the horizontal, as shown in Figure 3. The string and the rod are in the same vertical plane. The tension in the string is 1.2 N and the coefficient of friction between the ring and the rod is μ. Given that the ring is in limiting equilibrium, find

(*a*) the normal reaction between the ring and the rod,

(4)

(*b*) the value of μ.

(6)

Resolving ↑

$$R + 1.2 \sin 40 = 0.25g$$

$$R = 1.678654868 \text{ N}$$

$$= 1.68 \text{ N} \quad \text{3sf}$$

b/ Resolving →

$$1.2 \cos 40 = \mu (\text{"}1.68\text{"})$$

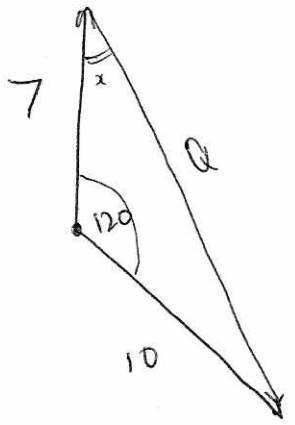
$$\mu = 0.548 \quad (3\text{SP})$$

4. Two forces **P** and **Q** act on a particle. The force **P** has magnitude 7 N and acts due north. The resultant of **P** and **Q** is a force of magnitude 10 N acting in a direction with bearing 120°. Find

(i) the magnitude of **Q**,

(ii) the direction of **Q**, giving your answer as a bearing.

(9)



$Q^2 = 7^2 + 10^2 - 2(7)(10)\cos 120$

$Q^2 = 219$

$Q = 14.8$ N (3sf)

ii) $\frac{\sin x}{10} = \frac{\sin 120}{"14.8"}$

$\sin x = 0.5852$

$x = 35.8^\circ$ (3sf)

$180 - "35.8" = \underline{\underline{144^\circ}}$

5.

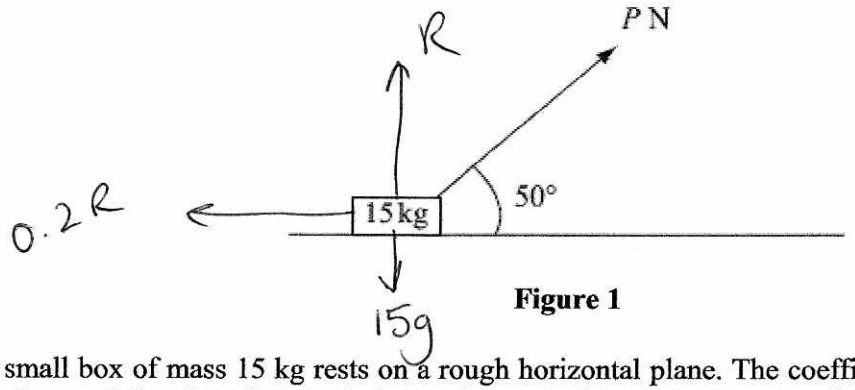


Figure 1

A small box of mass 15 kg rests on a rough horizontal plane. The coefficient of friction between the box and the plane is 0.2 . A force of magnitude P newtons is applied to the box at 50° to the horizontal, as shown in Figure 1. The box is on the point of sliding along the plane.

Find the value of P, giving your answer to 2 significant figures.

(9)

Resolving →

$P\cos 50 = 0.2R$

$5P\cos 50 = R$ ①

Resolving ↑

$R + P\sin 50 = 15g$ ②

Sub ① into ②

$5P\cos 50 + P\sin 50 = 15g$

$P(5\cos 50 + \sin 50) = 15g$

$P = \dfrac{15g}{5\cos 50 + \sin 50}$

$= 37$ N (2sf)

6.

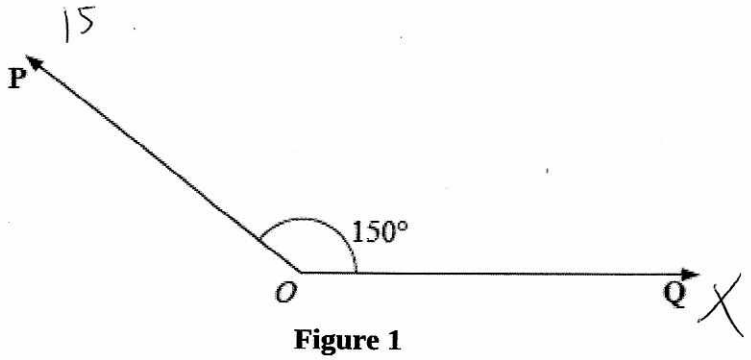


Figure 1

Two forces **P** and **Q** act on a particle at a point *O*. The force **P** has magnitude 15 N and the force **Q** has magnitude *X* newtons. The angle between **P** and **Q** is 150°, as shown in Figure 1. The resultant of **P** and **Q** is **R**.

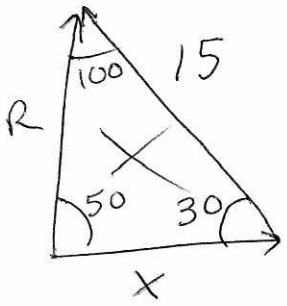
Given that the angle between **R** and **Q** is 50°, find

(*a*) the magnitude of **R**,

(4)

(*b*) the value of *X*.

(5)



a/ $\frac{R}{\sin 30} = \frac{15}{\sin 50}$

$R = \frac{15}{\sin 50} \times \sin 30$

$= 9.79$ N (3sf)

b/ $\frac{X}{\sin 100} = \frac{15}{\sin 50}$

$X = \frac{15}{\sin 50} \times \sin 100$

$= 19.3$ N (3sf)