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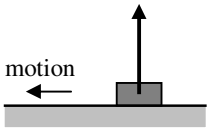
Physics worksheet solutions - Reaction force I

Q1 A 3-kg box slides along a smooth (i.e. frictionless) horizontal surface. Draw an arrow to show the direction of the reaction force of the surface on the box. What is the magnitude of the reaction force?

$R = mg = 3 \times 9.8 \approx 29$ N



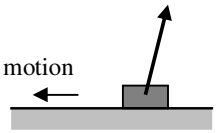
Q2 A 3-kg box slides along a rough horizontal surface. The coefficient of friction between the box and the surface is 0.35. Draw an arrow to show the direction of the reaction force of the surface on the box. What is the angle made by the reaction force with the horizontal? What is the magnitude of the reaction force?

Normal force $N = 3 \times 9.8 \approx 29$ N

Horizontal force due to friction $= \mu N = 0.35 \times (3 \times 9.8) \approx 10.3$ N

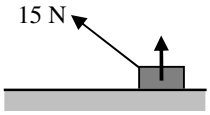
Angle $= \tan^{-1}\left(\dfrac{29}{10.3}\right) \approx 71°$

$R \approx \sqrt{29^2 + 10.3^2} \approx 31$ N



Q3 A 3-kg box is pulled along a smooth horizontal surface with a force of 15 N at 30° to the horizontal. Draw an arrow to show the direction of the reaction force of the surface on the box. What is the magnitude of the reaction force?

$R + 15 \sin 30° - 3 \times 9.8 = 0$, $R \approx 22$ N (21.9N)



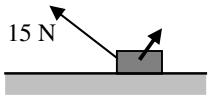
Q4 A 3-kg box is pulled along a rough horizontal surface with a force of 15 N at 30° to the horizontal. The coefficient of friction between the box and the surface is 0.35. Draw an arrow to show the direction of the reaction force of the surface on the box. What is the angle made by the reaction force with the horizontal? What is the magnitude of the reaction force?

$N + 15 \sin 30° - 3 \times 9.8 = 0$, $N \approx 21.9$ N

Horizontal force due to friction $= 0.35 \times 21.9 \approx 7.67$ N

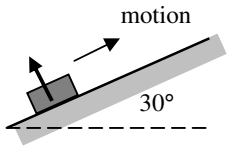
Angle $= \tan^{-1}\left(\dfrac{21.9}{7.67}\right) \approx 71°$

$R \approx \sqrt{21.9^2 + 7.67^2} \approx 23$ N



Q5 A 3-kg box slides uphill along a smooth surface inclined at 30° to the horizontal. Draw an arrow to show the direction of the reaction force of the surface on the box. What is the magnitude of the reaction force?

$R - mg \cos\theta = 0$, $R = 3 \times 9.8 \times \cos 30° \approx 25$ N (25.46 N)



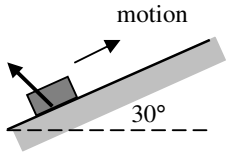
Q6 A 3-kg box slides uphill along a rough surface inclined at 30° to the horizontal. The coefficient of friction between the box and the surface is 0.35. Draw an arrow to show the direction of the reaction force of the surface on the box. What is the angle made by the reaction force with the rough surface? What is the magnitude of the reaction force?

Normal force $N = 3 \times 9.8 \times \cos 30° \approx 25.46$ N

Force due to friction $= \mu N = 0.35 \times 25.46 \approx 8.91$ N

Angle $= \tan^{-1}\left(\dfrac{25.46}{8.91}\right) \approx 71°$

$R \approx \sqrt{25.46^2 + 8.91^2} \approx 27$ N

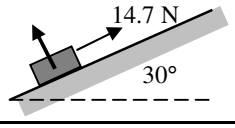


Q7 A 14.7 N force is used to keep a 3-kg box at rest on a rough surface inclined at 30° to the horizontal. The coefficient of friction between the box and the surface is 0.35. Draw an arrow to show the direction of the reaction force of the surface on the box. What is the angle made by the reaction force with the rough surface? What is the magnitude of the reaction force?

The 14.7 N force is just enough to keep the box from sliding down the plane. No force of friction is required.

Angle = 90°

$R - mg \cos\theta = 0$, $R = 3 \times 9.8 \times \cos 30° \approx 25$ N (25.46 N)



Q8 A 20 N force is used to keep a 3-kg box at rest on a rough surface inclined at 30° to the horizontal. The coefficient of friction between the box and the surface is 0.35. Draw an arrow to show the direction of the reaction force of the surface on the box. What is the angle made by the reaction force with the rough surface? What is the magnitude of the reaction force?

Normal force $N = 3 \times 9.8 \times \cos 30° \approx 25.46$ N

Force due to friction $= 20 - 14.7 = 5.3$ N

Angle $= \tan^{-1}\left(\dfrac{25.46}{5.3}\right) \approx 78°$

$R \approx \sqrt{25.46^2 + 5.3^2} \approx 26$ N