IB1 physics (NOM)
Forces - problems

42 Figure 2.56 shows two unequal masses connected by string over a frictionless pulley.
Copy the diagram and show the forces acting on the two masses.

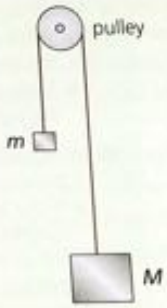


Figure 2.56

43 Figure 2.57 represents a hot air balloon. The two ropes are stopping it from moving vertically away from the ground. Draw a free-body diagram for all the forces acting on the basket.

Figure 2.57

47 The mass of the pendulum shown in Figure 2.58 is 382 g and the angle θ is 27.4°.
- **a** What is the tension in the string?
- **b** What is the force acting in the direction of motion?

48 The mass shown in Figure 2.59 is stationary on the slope (inclined plane).
- **a** Draw a free-body diagram showing the forces acting on the mass.
- **b** Resolve the weight of the mass into two components that are parallel and perpendicular to the slope.

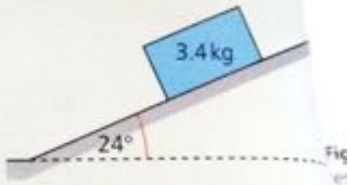


Figure 2.59

49 A resultant forward force of 8.42×10^4 N acts on a train of mass 3.90×10^5 kg accelerates it a rate of 0.216 m s^{-2} when it is travelling on a horizontal track.
- **a** If the train starts to climb a slope of angle 1.00° to the horizontal, calculate the component of weight acting down the slope.
- **b** What is the new resultant force acting on the train?
- **c** Predict a possible acceleration of the train as it starts to climb the slope.
- **d** Suggest why it is difficult for trains to travel up steeper slopes.

59 What resultant force is needed to accelerate a train of mass 3.41×10^5 kg from rest to 15.0 m s^{-1} in exactly 20 s?

60 When a force of 5.6 N was applied to a 4.3 kg mass it accelerated by 0.74 m s^{-2}. Calculate the frictional force acting on the mass.

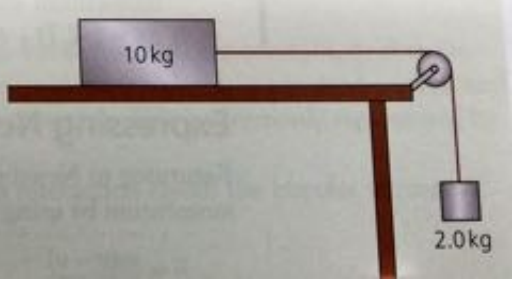
61 A small plane of mass 12 400 kg is accelerated from rest along a runway by a resultant force of 29 600 N.
- **a** What is the acceleration of the plane?
- **b** If the acceleration remains constant, what distance is needed before the plane reaches its take-off speed of 73.2 m s^{-1}?

62 A car of mass 1200 kg was travelling at 22 m s^{-1} when the brakes were applied. The car came to rest in a distance of 69 m.
- **a** What was the deceleration of the car?
- **b** What was the average resultant force acting on the car?

63 A big box of mass 150 kg is pulled by a horizontal, thin rope in an effort to move it sideways along the ground. The frictional force is 340 N.
- **a** Draw a free-body diagram to show all the forces acting on the box when it just begins to move.
- **b** If the tension in the rope is 380 N, calculate the acceleration of the box.
- **c** Explain what might happen if an attempt was made to accelerate the box at 1 m s^{-2}.

64 A man of mass 82.5 kg is standing still in an elevator that is accelerating upwards at 1.50 m s^{-2}.
- **a** What is the resultant force acting on the man?
- **b** What is the normal reaction force acting upwards on him from the floor?

65 Figure 2.69 shows two masses connected by a light string passing over a pulley.
- **a** Assuming there is no friction, calculate the acceleration of the two blocks.
- **b** What resultant force is needed to accelerate the 2.0 kg mass by this amount?
- **c** Draw fully labelled free-body diagrams for the two masses, showing the magnitude and direction of all forces.



44 10.6 N at an angle of 41° to the 12 N force

45 9.1 N at an angle of 32° to the 7.7 N force

46 76 N at an angle of 14° to the 74 N force

47 **a** 3.33 N
b 1.72 N

48 **b** 14 N parallel to the slope; 30 N perpendicular to the slope

49 **a** 6.68×10^4 N
b 1.74×10^4 N
c 0.0045 $m\,s^{-2}$
d The component of weight (acting down the slope) of a heavy train is so large that it may be larger than the it resultant forward force provided by the engine

51 All arrows identical; pointing downwards

52 **a** A force vector of 300 N acting downwards from the middle of the suitcase, labelled weight; an equal and opposite arrow pushing up on the suitcase, labelled normal reaction force
b Add an arrow upwards from the handle of half the length of the previous vectors, labelled pull of hand, 150 N; the normal reaction force reduces to 150 N

53 The reading rises when a force is needed to accelerate the book upwards; and falls when the book is accelerated downwards

54 **a** Not if the elevator is moving with constant velocity; this is because the forces acting on you would be the same in all three cases
b In all diagrams the weight vector will be the same; if the person is accelerating, the force from the floor will be greater or less than the weight

55 **a** **i** Weight and air resistance on the sky diver's body will be equal and opposite; then there will be an upwards force from the parachute on the skydiver
ii The upwards forces from the parachute and air resistance on the skydiver will together be equal and opposite to the weight

56 14 N

57 Weight acting downwards from climber's centre of mass; tension acting along the rope, away from the climber; push of rock acting from climber's feet to the point where the other two forces cross. (This could be resolved into a normal force and friction.)

58 **a** The weight of B will be eight times greater than A; the air resistance acting on B will be four times greater than A
b A moves with constant velocity because the forces are balanced; B accelerates because there is a resultant force, since its weight is greater than the air resistance acting on it

59 2.56×10^5 N

60 2.4 N

61 **a** 2.39 $m\,s^{-2}$
b 1120 m

62 **a** −3.5 $m\,s^{-2}$
b 4200 N

63 **b** 0.27 $m\,s^{-2}$
c A much greater force would be needed for the larger acceleration; the thin rope may not be strong enough, and may break

64 **a** 124 N
b 933 N

65 **a** 1.6 $m\,s^{-2}$
b 3.3 N
c (Tension = 16.4 N)