Supplementary Exercise - Newton's Law (Certificate level) S_____( ) Name: _____
Take g = 10 ms^{-2}

1. A force of 70 N gives an object of unknown mass an acceleration of 50 m/s^2. What is the mass of the object?

2. To measure the mass of a box, we push it along a smooth surface, exerting a net horizontal force of 75N. The acceleration is observed to be 3.0 m/s^2. What is the mass of the box?

3. A force acts on a 2-kg mass and gives it an acceleration of 3 m/s^2. What acceleration is produced by the same force when acting on a mass of (a) 1 kg? (b) 4 kg? (c) How large is the force?

4. A resultant external force of 7.0 N acts on an object that weight 40 N on earth. What is the object's acceleration (a) on earth? (b) on the Moon where the gravitational acceleration is about 1/6 of the earth?

5. A horizontal cable pulls a 100 kg cart along a horizontal track. The tension in the cable is 250 N. Starting from rest, (a) how long will it take the cart to reach a speed of 7.5 m/s? (b) How far will it have gone?

6. A 1000-kg car is going 20 m/s along a level road. How large a constant retarding force is required to stop it in a distance of 50 m?

7. How much force does it take to give a 20 000 kg locomotive an acceleration of 1.5 m/s^2 on a level track with an average friction of 600 N?

8. A 12.0-g bullet is accelerated from rest to a speed of 700 m/s as it travels 20 cm in a gun barrel. Assuming the acceleration to be constant, how large was the accelerating force?

9. A 20-kg crate hangs at the end of a long rope. Find its acceleration when the tension in the rope is (a)230 N, (b) 170 N,(c) zero , (d) 200N.

10. A 40-kg trunk sliding forward across a floor slows down from 5.0 to 2.0 m/s in 6.0 s. Assuming that the force acting on the trunk is constant, find its magnitude and its direction.

11. A resultant force of 20 N gives a body of mass *m* an acceleration of 8.0 m/s^2, and a body of mass *m'* an acceleration of 24 m/s^2. What acceleration will this force cause the two masses to acquire if the two masses are tied together?

12. An 1100-kg car travels on a straight highway with a speed of 72 km h^{-1}. The driver sees a red light ahead and applied his brakes, which exert a constant braking force of 4.4 kN. (a) What is the deceleration of the car? (b) In how many seconds will the car stop?

13. A boy having a mass of 75 kg holds a bag of flour of 40N in his hands. With what force does the floor push up on his feet?

14. A 45 kg boy is standing in an elevator. Find the force on the boy's feet when the elevator (a) stands still (b) moves downward at a constant velocity of 1 m/s (c) accelerates downward with an acceleration of 1.5 m/s^2, and (d) accelerates upward with an acceleration of 1.5 m/s^2.

15. An elevator starts from rest with a constant upward acceleration. It moves 2.0 m in the first 1.0 s. A passenger in the elevator is holding a 3-kg package by a vertical string. What is the tension in the string during the accelerating process?

16. Just as his parachute opens, a 75 kg parachutist is falling at a speed of 50 m/s. After 0.80 s has passed, the parachute is fully open and his speed has dropped to 12 m/s. Find the average retarding force exerted upon the parachutist during this time.

17. A book sits on a horizontal top of a car as the car accelerates horizontally from rest. If the friction between car top and the book is about 0.45 of the weight of the book, what is the maximum acceleration the car can have if the book is not to slip?

18. A 5-kg mass hangs at the end of a cord. Find the tension in the cord if the acceleration of the mass in (a) 1.5 m/s^2 up, (b) 1.5 m/s^2 down, and (c) 10 m/s^2 down.

19. A 700-N man stands on a scale on the floor of an elevator. The scale records the force it exerts on whatever is on it. What is the scale reading if the elevator has an acceleration of (a) 1.8 m/s^2 up? (b) 1.8 m/s^2 down? (c) 10 m/s^2 down?

20. A constant force accelerates an electron (m = $9.1x10^{-31}$ kg) from rest to a speed of $5x10^7$ m/s in a distance of 0.80 cm. Determine this force. How many times larger than *mg* is it?

21. The breaking strength of a cable is 20 kN. If one pulls horizontally with this cable, what is the maximum horizontal acceleration which can be given to an 8-ton (8 000kg) body resting on a rough horizontal surface if the friction is about 0.15 of the weight of the body.

22. A 20-kg wagon is pulled along the level ground by a rope inclined at 30^o above the horizontal. A frictional force of 30 N opposes the motion. How large is the pulling force if the wagon is moving with (a) constant speed, and (b) an acceleration of 0.40 m/s^2?

23. Suppose that a 70-kg box is pulled by a 400-N force at an angle of 30^o to the horizontal and the friction is about 0.5 of the weight of the box. Find the acceleration of the box.

24. Suppose that a 25-kg box is pushed by a 400-N force at an angle of 50^o. The box achieves a velocity of 2.0 m/s in a time of 4 s. Find the friction between box and floor.

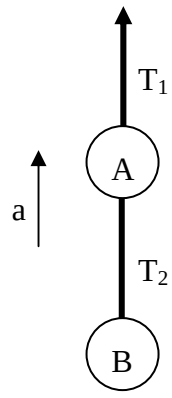
25. A 12-kg box is released from the top of an incline that is 5.0 m long and makes an angle of 40^o to the horizontal. A 60-N friction force impedes the motion of the box. (a) What will be the acceleration of the box and (b) how long will it take to reach the bottom of the incline?

26. An inclined plane makes an angle of 30^o with the horizontal. Find the constant force, applied parallel to the plane, required to cause a 15-kg box to slide (a)up the plane with acceleration 1.2 m/s^2 and (b) down the incline with acceleration 1.2 m/s^2. Neglect friction forces.

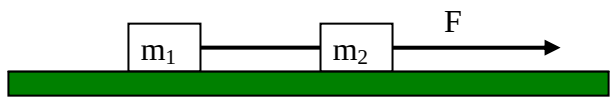
27. An 8.0-kg box is released on a 30^o incline and accelerates down the incline at 0.30 m/s^2. Find the frictional force impeding its motion. How large is the friction in this situation?

28. A horizontal force of 200 N is required to cause a 15-kg block to slide up a 20^o incline with an acceleration of 25 cm/s^2. Find the friction force on the block.

29. In the figure, mass A is 15 kg and mass B is 11 kg. If they are given an upward acceleration of 3 m/s^2 by pulling up on A, find the tension T_1 and T_2.



30. If F = 20N, m_1=m_2=3kg, and the acceleration is 0.50 m/s^2, what will be the tension in the connecting cord if the frictional forces on the two blocks are equal? How large is the frictional force on either block?



Answer 1.

Applying F = ma

70N = m x 50 ms^{-2}

m = 1.4 kg

Answer 2.

Applying F = ma

75N = m x 3.0 ms^{-2}

m = 25 kg

Answer 3.

Applying F = ma
F = 2 x 3 = 6N

a) F = ma
6 = 1 x a
a = 6 ms^{-2}

b) F = ma
6 = 4 x a
a = 1.5 ms^{-2}

c) F = 6 N

Answer 4.

Mass of the object = 40N/10ms^{-2} = 4 kg

a) on earth :
Applying F = ma
7N = 4 kg x a
a = 1.5 ms^{-2}

b) on the Moon :
Applying F = ma
7N = 4kg x a
a = 1.5 ms^{-2}

(Note : acceleration depends on mass and force only)

Answer 5.

Applying F =m a
250 N = 100 kg x a
a = 2.5 m s^{-2}
v =u + at
7.5 m/s = 0 + 2.5 ms^{-2} x t
t = 3 s

b) S = u t + 1/2 a t^2
S = 0 x 3 + 0.5 x 2.5 x 3^2
S = 11.25 m

Answer 6.

2 a s = v^2 - u^2
2 a (50) = 0^2 - 20^2
100 a = - 400
a = -4 m s^{-2}

F = ma
F = 1000 x (-4)
= -4000N

Answer 7.

Applying F = ma
F - 600 N = 20 000 x 1.5
= 30000 N + 600 N
= 30600 N

Answer 8. 2 a s = v^2 - u^2
2 a (0.20) = 700^2 - 0^2
0.4 a = 490000
a = 1225000 ms^{-2}

F = ma
F = 0.012 kg x 1225000 ms^{-2}
F = 14700 N

Answer 9. F = ma
T - mg = ma
a) 230 N - 20 kg x 10 ms^{-2} = 20 kg x a
a = 1.5 ms^{-2} (accelerating upwards)

b) 170 - 200 = 20 a
-30 = 20 a
a = -1.5 ms^{-2} (accelerating downwards)
c) Free falling, a = 10 ms^{-2}
d) Net force = 0, a = 0 ms^{-2}

Answer 10.

Applying v = u + at
2.0 = 5.0 + a x 6
a = -0.5 ms^{-2}

F = ma
F = 40 x (-0.5) = -20 N (20 N backward)

Answer 11.

Applying F = ma
20 N = m x 8.0 ms^{-2}
m = 2.5 kg
20 N = m' x 24 m s^{-2}
m' = 0.833 kg

20N = (2.5 + 0.833)kg x a
a = 6 ms^{-2}

Answer 12.

v = 72 km/h = 20 m/s
Applying F = ma
a) 4.4 kN = 1100 kg x a
a = 4 ms^{-2}

b) v = u + at
0 = 20 +(-4) t
t = 5 s

Answer 13.

F = mg + W_{flour}
F = 75 x 10 + 40
F = 790 N

Answer 14.
R - W = ma
a) R - 45 x 10 = 45 x 0
R = 450N
b) R- 450 = 45 x 0
R = 450 N
c) R -450 = 45 x (-1.5)
R = 382.5 N
d) R - 450 = 45 (1.5)
R = 517.5 = 518N.

Answer 15.
$s = u\,t + 1/2\,a\,t^2$
$2 = 0 \times 1 + 0.5 \times a \times 1^2$
$a = 4\ ms^{-2}$
T - W = ma
T - 3 (10) = 3 (4)
T = 42N

Answer 16.
v=u + at
12 = 50 + a (0.80)
$a = -47.5\ ms^{-2}$
F = ma
F = 75 x (-47.5)
F = - 3562.5 N

Answer 17.
Let *m* be the mass of the book.
Friction = 0.45 *m*g = 4.5 *m*
4.5 *m* = *m* a
$a = 4.5\ ms^{-2}$

Answer 18.
Applying F = ma
a) T -5(10) = 5 x 1.5
T = 57.5 N
b)T -5(10) = 5 (-1.5)
T = 42.5
c) T - 5(10) = 5(10)
T = 0 (free falling)

Answer 19.
R - W = ma
a) $a = 1.8\ ms^{-2}$
R - 700 = 70 (1.8)
R= 826 N
b) $a = -1.8\ ms^{-2}$
R -700 = 70 (-1.8)
R = 574 N
c) Free falling, R = 0 N

Answer 20.
$2\,a\,s = v^2 - u^2$
$2\,a\,(0.008) = (5x10^7)^2$
$a = 1.5625x10^{17}$
$F = ma = (9.1 \times 10^{-31})(1.5625x10^{17}) = 1.42x10^{-13}$ N

Answer 21.
Friction = 0.15 mg
=0.15(8000)(10)
=12000N
F = ma
20 000 - 12000 = 8 000 a
$a = 1\ m\ s^{-2}$

Answer 22.
Let T be the pulling force
The horizontal component of the pulling force = T cos 30^o
a) Constant speed, a = 0 then
T cos 30^o = 30 N
T = 34.6N
b) a = 0.40 ,
T cos 30^o - 30N = 20 kg x 0.40 ms^{-2}
T = 43.9 N

Answer 23. Tx = 400 x cos 30^o =346.41N
Net force = Tx - f = 346.41 - 0.5 (70)(10) -3.6N
As the Tx is less than the friction. The box will not move at all.

Answer 24.
Tx = 400 cos 50^o =257.1N
v = u + at
2.0 = 0 + a x 4
$a = 0.5\ ms^{-2}$
Tx -f = ma
257.1 -f = 25 x 0.5
f = 245 N

Answer 25.
Weight component along the incline,
Ws: = (12)(10)x sin 40^o =77.13 N
Ws - f = ma
77.13 - 60 = 12 a
$a = 1.43\ ms^{-2}$
$s = u\,t + 0.5\,at^2$
$5.0 = 0 + 0.5(1.43)\,t^2$
t = 2.64 s

Answer 26.

Wight component along the incline,

Ws = (15)(10) sin 30^o =75 N

a) F - Ws = ma

F - 75 = 15 x 1.2

F = 93 N

b) F+Ws = ma

F + 75 = 15 x 1.2

F = -57N (57 N acting upwards and parallel the incline)

Answer 27.

8(10)sin 30^o - f = 8(0.3)

f = 37.6 N

Answer 28.

200cos20^o-15(10)sin 20^o-f=15 x 0.25

f = 133 N

Answer 29.

Applying F = ma

T_1 - mg = ma

T_1 - (15+11) (10) = (15+11) (3)

T_1 = 338 N

T_2 - mg = ma

T_2 -(11)(10) = (11)(3)

T_2 = 143 N

Answer 30.

Applying F = ma

Pulling force - total friction = ma

F - 2 (f) = (3+3) a

20 - 2(f) = 6 (0.5)

f = 8.5 N