Problem Set 3 – Newton’s laws

All surfaces are level and frictionless unless I tell you differently. All forces are parallel to any surface unless I tell you differently. All objects move to the right unless I tell you differently.

1. A rocket sled has a mass of 1500 kg and is propelled horizontally by an engine which produces a thrust of 88,000 newtons for 3.75 seconds. The thrust of the engine is the NET force on the sled.

(a) What is the magnitude of the acceleration of the sled in m/s2 ?

(b) What is the maximum speed of the sled if it started from rest?

2. (a) A 70-kg object is moving at 30 m/s. What magnitude force is required to stop the object in 1 second?

(b) A 70-kg object is moving at 30 m/s. What magnitude force is required to stop the object in 0.1 second?

B

A

2 kg

frictionless surface

10 m/s

20 N

3. The object right has a mass of 2 kg and is moving right at 10 m/s.

Force A is 20 N. Determine the magnitude and direction of

the NET force and the magnitude and direction of

the acceleration of the object if force B is:

(a) 15 N? (b) 20 N? (c) 25 N?

4. What NET force is needed to accelerate a 2-kg object from a speed of 5 m/s to a speed of 20 m/s

in 10 seconds?

5. An elevator with its passengers weighs 10,000 N. The elevator is moving downward at 6 m/s. The cable that holds the elevator stops the elevator by pulling upward with a force of 12,000 N. **Use *g* = 10 m/s2.**

(a) How much time will the cable take to stop the elevator?

(b) How far does the elevator move downward while stopping?

6. The two masses are connected by a rope over a frictionless,

A

B

pulley

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massless pulley. Mass A is 5.5 kg and mass B is 4.5 kg.

The masses are held motionless. When released, mass A

reaches a speed of 1.0 m/s in 1.0 second.

(a) What is the acceleration of mass A?

(b) What is the acceleration of mass B?

(c) What is the NET force on mass A?

(d) What is the NET force on mass B?

(e) What is the tension in the rope?

7. A 0.6 kg ball rolls across the floor at +30 m/s. The ball

hits the wall and rebounds off the wall along its original line of motion

at 20 m/s. The ball was in contact with the wall for 0.2 seconds.

(a) What was the average acceleration of the ball while in contact with the wall?

(b) What average force (magnitude and direction) does the wall exert on the ball?

8. A 2-kg object slides from rest down a frictionless ramp. The object reaches a speed of 3 m/s in 6 seconds. Assign down the ramp as positive direction.

(a) What is the weight of the object?

(b) What is the NET force on the object?

9. A 2-kg object slides across a level surface that exerts a constant friction of 6 N on the object.

(a) How long will it take the object to slow from 15 m/s to 9 m/s?

(b) How long will it take the object to slow from 15 m/s to a stop?

10. A airplane has a mass of 4000 kg and its engines develop a thrust (force) of 50,000 N. The plane flies

level at 130 m/s. The pilot accelerates at maximum thrust for 10 seconds. What is the maximum speed of the plane if there is no air resistance (drag)?

11. The airplane in problem #10 actually experiences an average drag of 26,000 N for the 10 seconds while the plane accelerates. What speed does the plane actually reach?

12. A 10-kg object has a weight of 80 N on planet X. What is the acceleration due to gravity on planet X?

13. The object below has a mass of 5-kg and is initially at rest. The force pulling the object (force P) is 10 N. Force P makes an angle of 60o with the surface.

P

60o

(a) What is the size of the NET force on the object?

(b) What is the acceleration of the object?

(c) How far will force P pull the object in 4 seconds?

14. In the drawing right, object A has a mass of 2 kg

A

B

rope P

rope Q

MOTOR

and object B has a mass of 4 kg. The objects move

together with changes in the tension in rope P.

What is the tension in rope P and in rope Q for each situation?

Suggestion: Look at object B first!

(a) The objects hang motionless.

(b) Mass B moves upward at constant speed.

(c) Mass B accelerates upward at 2 m/s2.

(d) Mass B accelerates downward at 2 m/s2.

rope A

rope B

rope C

53o

15. The object at the right hangs motionless.

The mass of the object is 4 kg. Calculate

the tension in each labeled rope.

***Use g = 10 m/s2.***

16. ***Use g = 10 m/s2.*** A person weighs 700 N. The person stands on a bathroom scale while in an elevator car. What is the reading on the scale when the elevator car is

(a) motionless? (b) accelerating upward at 15 m/s2? (c) accelerating downward at 10 m/s2?

Answers - UP and RIGHT are assigned positive direction

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1. (a) 58.7 m/s2 | 4. +3 N | 8. (a) 19.6 N | 13. (a) +5 N | 15. rope A = 50 N |
| (b) 220 m/s |  | (b) +1 N | (b) +1 m/s2 | rope B = 30 N |
|  | 5. (a) 3 s |  | (c) 8 m | rope C = 40 N |
| 2. (a) 2100 N | (b) 9 m | 9. (a) 2 s |  |  |
| (b) 21,000 N |  | (b) 5 s | 14. Rope Q | 16. (a) 700 N |
|  | 6. (a) -1 m/s2 |  | (a) 39.2 N | (b) 1750 N |
| 3. NET force | (b) +1 m/s2 | 10. 255 m/s | (b) 39.2 N | (c) zero |
| (a) +5 N | (c) -5.5 N |  | (c) 47.2 N |  |
| (b) 0 N | (d) +4.5 N | 11. 190 m/s | (d) 31.2 N |  |
| (c) -5N | (e) 48.4 N |  | Rope P |  |
| acceleration |  | 12. 8 m/s2 | (a) 58.8 N |  |
| (a) +2.5 m/s2 | 7. (a) -250 m/s2 |  | (b) 58.8 N |  |
| (b) 0 m/s2 | (b) -150 N |  | (c) 70.8 N |  |
| (c) -2.5 m/s2 |  |  | (d) 46.8 N |  |