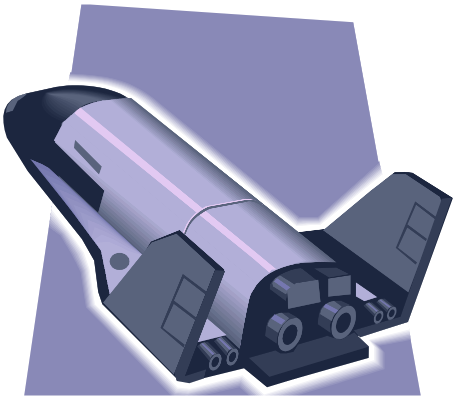
N4 N5

Physics department

Unit 1 Dynamics and Space

Motion, Forces, Satellites & Projectiles, Cosmology, Space Exploration



Homework

Questions

Exercise 1 Average Speed

1. What is meant by the term speed?

2. How long does it take a car travelling at 20 ms^{-1} to travel 4000 m?

3. An athlete ran a 1500 metres race in 3 minutes 40 seconds. Find his average speed.

4. The Calderwood bus travels 3.5 km in a time of 11 minutes 40 seconds. Calculate the average speed of the journey.

5. An aircraft carries passengers at Mach 2 (680 ms^{-1}). Calculate how far it will travel in 100 s.

6. On newly recharged batteries, an electric scooter was able to travel for 3 hours at an average speed of 3 ms^{-1}. Calculate how far it has travelled in this time.

7. A robot in a warehouse moves a total distance of 3 km during an 8 hour shift. Calculate its average speed in kmh^{-1}.

8. The Glasgow to Heathrow shuttle takes an average of 50 minutes to travel the 850 km distance. Calculate the average speed for the journey in ms^{-1}.

9. Give an example of where the average speed of an object is measured in every day life.

10. A pupil rolls a trolley down a slope of length 2.4 m and times the journey. He repeats the experiment another 4 times.

The times recorded are:- 2.86 s 2.98 s 2.74 s 3.01 s 2.91 s

a) Calculate the average time taken.

b) Calculate the average speed of the trolley down the slope.

11. A pupil looks at a Scotrail timetable to find out some facts about the train journey from Glasgow to Inverness.

Journey	**Time taken**	**Distance gone**
Glasgow to Stirling	36 minutes	51 km
Stirling to Perth	48 minutes	39 km
Perth to Inverness	170 minutes	150 km

Find

a) The average speed, in ms^{-1} between Glasgow and Stirling, and

b) The average speed, in ms^{-1}, for the whole journey.

12. The world downhill speed skiing trial takes place in Les arc every year. Describe a method that could be used to find the average speed of the skier over the 1 km run.

Your description should include:

a) Any apparatus required

b) Details of what measurements need to be taken

c) An explanation of how you would use the measurements to carry out the calculations.

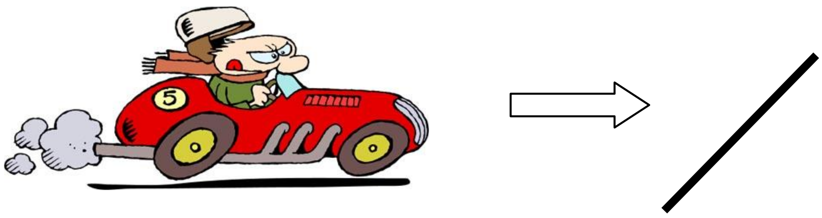
Exercise 2 Instantaneous Speed

1. What is meant by instantaneous speed?

2. Describe how to measure the instantaneous speed of an object. Your description should include:

   - A diagram
   - The measurements that have to be taken
   - How these measurements are made
   - The equation that is used to calculate the speed

3. A pupil tries to measure the instantaneous speed of a fast moving car using a stopwatch. He times how long it takes the car to completely pass the mark on the road.



   a) Apart from the stopwatch reading, what additional piece of information would the pupil need to know in order to calculate the instantaneous speed?

   b) Explain why this is not a suitable method of finding the instantaneous speed.

4. Trolleys with various lengths of card are released from different points on a runway as shown in the diagram. When the card cuts the light gate a reading is obtained on the timer.

   Use the information in the results table below to calculate the instantaneous speed of the trolley for each case. **Show all working.**

	Length of card on the trolley (cm)	Reading on the timer (s)
A	5	0.02
B	5	0.025
C	10	0.15
D	10	0.62
E	4	0.18

5. Describe an example where the instantaneous speed of an object is measured in everyday life?

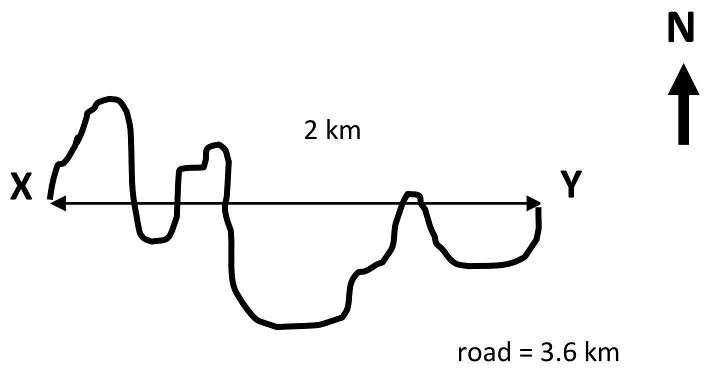
6. Describe a situation where the average speed and instantaneous speed of an object are different.

Exercise 3 Scalars and Vectors

1. What is the difference between a vector quantity and a scalar quantity?

2. Use your answer to question 1 to explain the difference between distance and displacement.

3. A woman walks from X to Y along a winding road.



a) What distance has she walked?

b) What is her displacement at the end of her walk?

4. If the walker in question 3 took 40 minutes for her walk, what was

a) her average speed?

b) her average velocity?

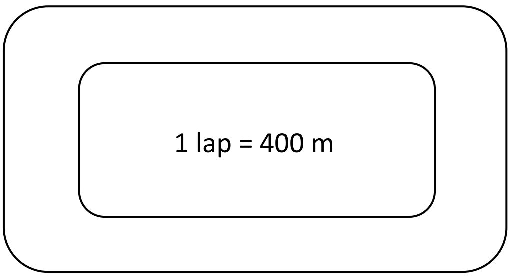
5. One complete lap of a running track is 400 m.
An athlete completes one lap in 48 s
in the 400m race. What is his

a) distance travelled?

b) displacement?

c) average speed?

d) average velocity?



6. A car travels 40 km north, then turns back south for 10 km. The journey takes 1 hour.

What is

a) The displacement of the car?

b) The distance the car has travelled?

c) The average velocity of the car in kmh^{-1}?

d) The average speed of the car in kmh^{-1}?

7. A car drives 60 km north, then 80 km east, as shown in the diagram. The journey takes 2 hours.

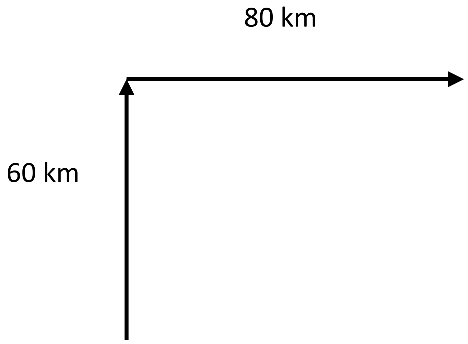
Calculate the

a) Distance travelled

b) Displacement

c) Average speed

d) Average velocity.



Exercise 4 Acceleration

1. A car is accelerating at 3 ms^{-2}. Explain what is meant by the term 3 ms^{-2}.

2. A Jaguar can reach 27 ms^{-1} from rest in 9.0 s. What is its acceleration?

3. The space shuttle reaches 1000 ms^{-1}, 45 s after launch. What is its acceleration?

4. A car reaches 30 ms^{-1} from a speed of 18 ms^{-1} in 6 s. What is its acceleration?

5. A train moving at 10 ms^{-1} increases its speed to 45 ms^{-1} in 10 s. What is its acceleration?

6. A bullet travelling at 240 ms^{-1} hits a wall and stops in 0.2 s. What is its acceleration?

7. A car travelling at 20 ms^{-1} brakes and slows to a halt in 8 s. What is the deceleration?

8. Describe how you would measure the acceleration of a small vehicle as it runs down a slope in the laboratory.

9. On approaching the speed limit signs, a car slows from 30 ms^{-1} to 12 ms^{-1} in 5 s. What is its deceleration?

10. A bowling ball is accelerated from rest at 3 ms^{-2} for 1.2 s. What final speed will it reach?

11. How long will it take a car to increase its speed from 8 ms^{-1} to 20 ms^{-1} if it accelerates at 3 ms^{-2}?

12. A cyclist can accelerate at 0.5 ms^{-2} when cycling at 4 ms^{-1}. How long will she take to reach 5.5 ms^{-1}?

13. The maximum deceleration a car's brakes can safely produce is 8 ms^{-2}. What will be the minimum stopping time if the driver applies the brakes when travelling at 60 mph (27 ms^{-1})?

14. During a safety test on a car, it is required to run into a wall at 14 ms^{-1} while it is being filmed. The car can be accelerated from a standing start at 5 ms^{-2} along a test track.

    a) What time is required to accelerate the car?

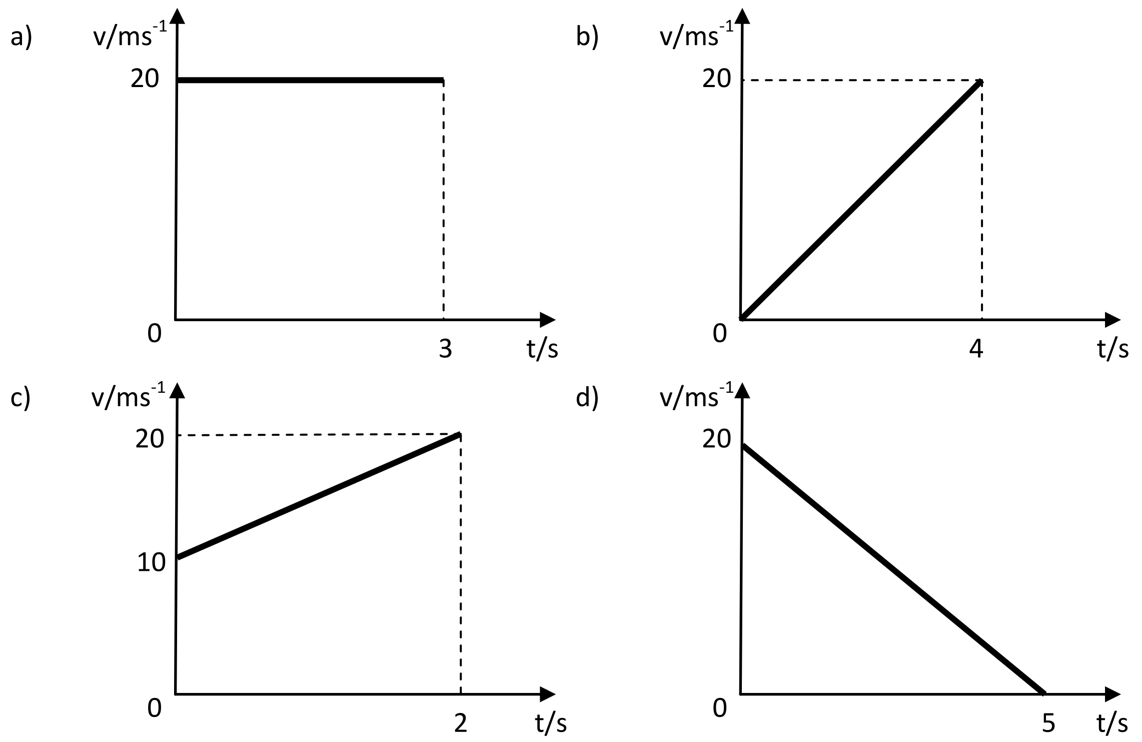
    b) When it hits the wall at 14ms^{-1} it is brought to rest in 250 ms. Calculate the deceleration.

15. Describe how to measure the acceleration of an object. Your description should include:

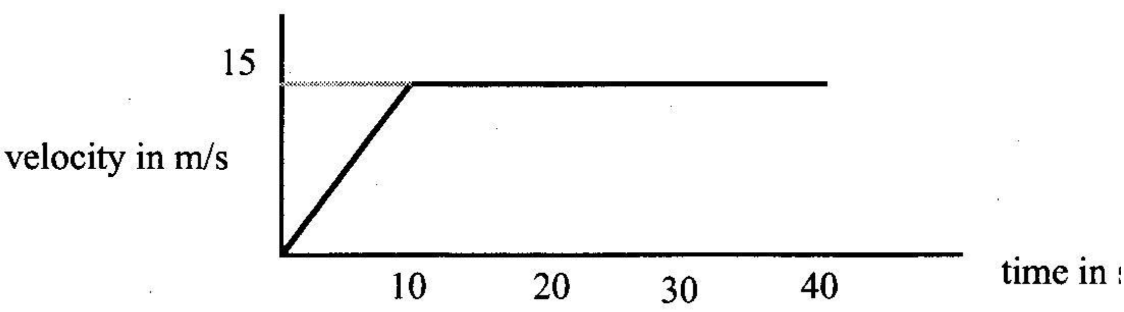
    - A diagram
    - The measurements that have to be taken
    - How these measurements are made
    - The equation that is used to calculate the speed

Exercise 5 Motion Graphs

1. Describe the motion represented by each of the following speed – time graphs.



2. The graph below shows how the velocity of a car varies over a 40 s period.



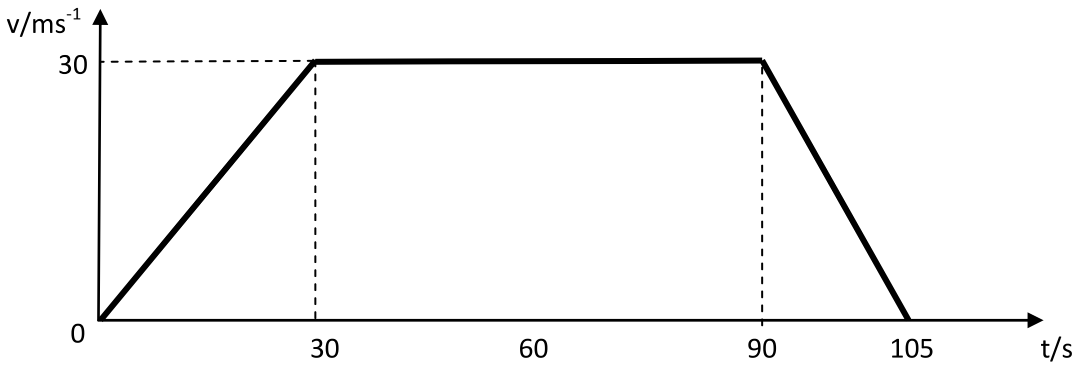
a) Describe the motion of the car during this 40 s period.

b) Calculate the acceleration of the vehicle.

c) How far does the car travel while accelerating?

d) What is the total distance travelled by the car?

3. Use the graph below to answer the following questions.



a) During which time is the vehicle travelling at a constant velocity?

b) Calculate the values of i) the initial acceleration ii) the final deceleration

c) What is the braking distance of the car?

d) What is the total distance travelled?

e) What is the average velocity of the car?

4. Draw a velocity-time graph to describe the following motion:-

A car accelerates from rest at 2 ms^{-1} for 8 s, then travels at a constant velocity for 12 s, finally slowing steadily to a halt in 4 s.

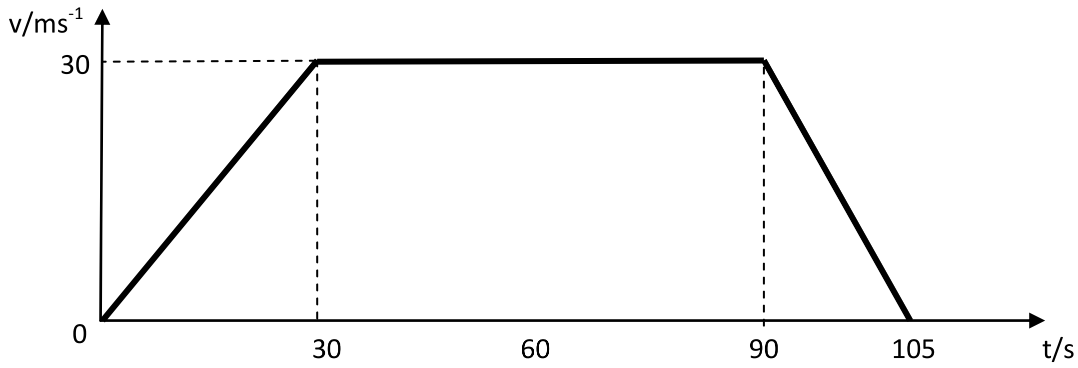
5. For the vehicle in the previous question, what are the values of

a) the maximum velocity

b) the distance travelled

c) the average velocity?

6. The graph below describes the motion of a cyclist.



a) What is the value of the maximum acceleration?

b) Show by calculation whether the cyclist travels farther while accelerating, or while cycling at the maximum velocity.

Answers

Exercise 1

1. Speed is the distance travelled by an object per second.
2. 200 s.
3. 6.82 ms^{-1}
4. 5 ms^{-1}
5. 68000 m or 68 km
6. 32400 m
7. 0.38 kmh^{-1}
8. 283.3 ms^{-1}
9. Sports presenters on tv measure the average speed of a shot at goal.
10. (a) 2.9 s (b) 0.83 ms^{-1}
11. (a) 23.6 ms^{-1} (b) 15.75 ms^{-1}
12. See summary sheets - Speed

Exercise 2

1. The instantaneous speed of an object is the speed at one particular point in the journey.
2. See summary sheets – Speed
3. (a) The length of the car.
   (b) The pupil's reaction time would be a significant percentage of the overall time measure and so the instantaneous speed calculated using this time would be inaccurate.
4. (a) 2.5 ms^{-1} (b) 2 ms^{-1} (c) 0.67 ms^{-1} (d) 0.16 ms^{-1} (e) 0.22 ms^{-1}
5. Speed cameras measure the instantaneous speed of a vehicle at a particular point in a journey to ensure that it is within the speed limit.
6. During a car journey the instantaneous speed will change. These speeds will vary from the overall average speed.

Exercise 3

1. A scalar quantity is described by stating its magnitude (size) only.
   A vector quantity is described by stating its magnitude and direction.
2. Distance is the distance travelled regardless of the direction.
   Displacement is the length measured from the start point to the end point in a straight line. Its direction must be stated.
3. (a) 3.6 km (090) (b) 2 km (090)
4. (a) 1.5 ms^{-1} (b) 0.83 ms^{-1} (090)
5. (a) 400 m (b) 0 m (000) (c) 8.3 ms^{-1} (d) 0 ms^{-1} (000)
6. (a) 30 km (000) (b) 50 km (c) 30 kmh^{-1} (000) (d) 50 kmh^{-1}
7. (a) 140 km (b) 100 km (053) (c) 19.4 ms^{-1} (d) 13.9 ms^{-1} (053)

Exercise 4

1. The object's speed increases by 3ms^{-1} every second.
2. 3 ms^{-2}
3. 22.2 ms^{-2}
4. 2 ms^{-2}
5. 3.5 ms^{-2}
6. -1200 ms^{-2}
7. -2.5 ms^{-2}
8. Place vehicle at top of slope and release from rest (u).
   Place light gate at bottom of slope to record speed at bottom (v).
   Use a stopwatch to time the journey of the vehicle from the top of the slope until it passes through the bottom gate (t).
   Carryout the calculation a = v-u/ t
9. -3.6 ms^{-2}
10. 3.6 ms^{-1}
11. 4 s
12. 3 s
13. 45.6 m
14. (a) 2.8 s (b) -56 ms^{-2}
15. See summary sheet – Acceleration

Exercise 5

1. (a) Constant speed of 20 ms^{-1} for 3 s.
   (b) Constant acceleration of 5 ms^{-2} for 4 s
   (c) Constant acceleration of 5 ms^{-2} for 2 s
   (d) Constant deceleration of 4 ms^{-2} for 5 s
2. (a) Constant acceleration of 1.5 ms^{-2} for 10 s, then a constant speed of 15 ms^{-1} for 30 s.
   (b) Constant acceleration of 1.5 ms^{-2} for 10 s
   (c) 75 m
   (d) 525 m
3. (a) 30 to 90 s.
   (b) i) 1 ms^{-2} ii) -2 ms^{-2}
   (c) 225 m
   (d) 2475 m
   (e) 23.6 ms^{-1}
4. –
5. (a) 16 ms^{-1} (b) 288m (c) 12 ms^{-1}
6. The cyclist covers 200 m in the first 20 s (accelerating) and 160 m in the next 20 s (constant speed). More distance covered whilst accelerating.

Exercise 1 Forces

13. Write down three things which a force can do.

14. (a) Name the piece of apparatus used in the lab to measure force.

    (b) Describe briefly how it works.

    (c) Name the unit used to measure force.

15. Define the Newton.

16. Explain what is meant by friction.

17. In which direction does friction act in relation to the motion of an object?

18. Give 3 examples in everyday life where friction is used to stop motion.

19. Describe two methods of

    (a) increasing friction (b) decreasing friction.

20. Where, in a bicycle, is friction deliberately

    (a) increased (b) decreased?

21. (a) Describe 3 situations where the force of friction is useful.

    (b) Explain how the force of friction can be increased in these situations.

22. (a) Describe 3 situations where the force of friction is unwanted.

    (b) Explain how the force of friction can be decreased in these situations.

23. Explain what is meant by streamlining.

Exercise 2 Newton's 1st Law

7. Describe what is meant by balanced forces acting on an object. Use a diagram to help your description.

8. Describe a situation where 2 or more forces act on an object and yet have the same effect as no forces at all. Include a diagram in your answer.

9. What happens to the speed of an object when it has no forces acting on it?

10. What happens to the speed of an object when it has balanced forces acting on it?

11. A car is travelling along a straight level road at a constant speed along a straight, level road.

    a) What will happen to the motion of the car if the driver supplies an unbalanced force to it?

    b) What is the name of the pedal in a car used to increase the unbalanced force on the car?

12. Use Newton's First Law of Motion to explain the following situations:

    a. Why a book sitting on a table does not move;

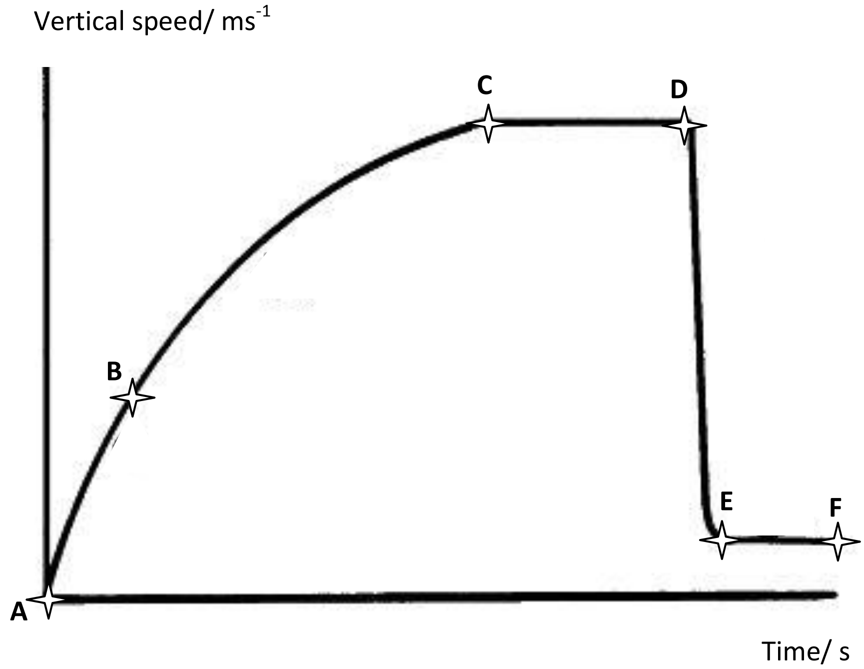
    b. How a car can travel along a straight level road at a constant speed;

    c. Why a spaceship in outer pace continues moving at the same speed in the same direction.

13. What does an unbalanced or resultant force cause in an object?

14. Explain, using Newton's First Law, why passengers without seat belts in a stationary car, are thrown forwards in the car, when the car stops suddenly.

15. The graph below shows how the speed of a free-falling parachutist varies during her journey to the ground.
A is the point where she leaves the plane.



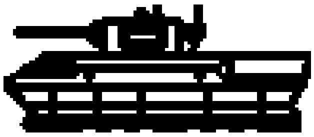
a) At which point did she open the parachute?
b) At which point did she hit the ground?
c) State and explain which parts of the graph illustrate Newton's 1st Law of Motion.
d) Explain why her steady speed during EF is less than her steady speed during CD.

Exercise 3 Resultant forces

1. What is meant by the resultant force on an object?

2. What are the resultants of the following forces?

a)

2000 N ←  → 1200 N

1400 kg

b)

72 kg

↑ 600 N

↓ 700 N

c)

→ 150 000 N

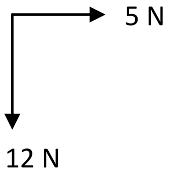
→ 150 000 N

40 000 kg

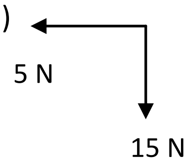
d) Now calculate the acceleration of the objects in parts a, b and c.

3. By using a scale diagram or otherwise, find the resultant of the following pairs of forces.

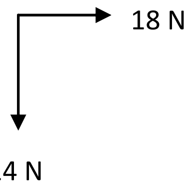
a)



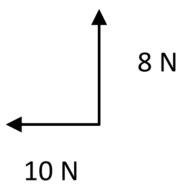
b)



c)



d)



Exercise 4 Newton's 2nd Law

1. What force is needed to accelerate a 5 kg mass at 3 ms^{-2}?

2. What will be the acceleration of a 12 kg mass acted on by a force of 30 N?

3. What mass would accelerate at 2 ms^{-2} when acted on by a 12 N force?

4. What force will accelerate 250 g at 2 ms^{-2}?

5. What force would be needed to accelerate a 10 tonne lorry at 1.5 ms^{-2}?
   (1 tonne = 1000 kg)

6. Give two reasons why a car will have a smaller acceleration in similar conditions when a roof rack is added.

7. Describe an experiment to investigate the effect of varying the unbalanced force acting on a fixed mass.

8. A car of mass 1200 kg experiences friction equal to 500 N when travelling at a certain speed. If the engine force is 1400 N, what will be the car's acceleration?

9. A car of mass 2000 kg has a total engine force of 4500 N. The frictional drag force acting against the car is 1700 N. What is the acceleration of the car?

10. Two girls push a car of mass 1000 kg. Each pushes with a force of 100 N and the force of friction is 120 N. Calculate the acceleration of the car.

11. A boat engine produces a force of 10000 N and the friction and water resistance total 3500 N. If the mass of the boat is 2000 kg, what will be its acceleration?

12. A careless driver tries to start his car with the hand brake still on. The engine exerts a force of 2500 N and the hand brake exerts a force of 1300 N. The car moves off with an acceleration of 1.2 ms^{-2}. What is the mass of the car?

13. A car of mass 1200 kg can accelerate at 2 ms^{-2} with an engine force of 3000 N. What must be the total friction force acting on the car?

14. A helicopter winches an injured climber up from a mountainside. The climber's mass is 65 kg.

    a) What is the weight of the climber?
    b) If he is accelerated upwards at 1.0 ms^{-2}, what unbalanced force is required?
    c) What total upwards force must be produced by the helicopter?

15. An 800 kg car is accelerated from 0 to 18 ms^{-1} in 12 seconds.
    a) What is the resultant force acting on the car?
    b) At the end of the 12 s period the brakes are operated and the car comes to rest in a time of 5 s. What is the average braking force acting on the car?

Exercise 5 Work done

1. Copy and complete these examples of energy transformations.

    a) Car moving at a steady speed along level road
    chemical energy -> ________

    b) Car accelerating along level road
    chemical energy -> ________ + _______

    c) Car braking
    kinetic energy -> ________

    d) Car freewheeling downhill (engine switched off)
    ________ -> ________ + _______

2. A locomotive exerts a pull of 10000 N to pull a train a distance of 400 m. How much work is done?

3. A gardener does 1200 J pushing a wheelbarrow with a force of 100 N. How far did she push the barrow?

4. A man uses up 1000 J by pulling a heavy load for 20 m. What force did he use?

5. A girl is pushing her bike with a force of 80 N and uses up 4000 J of energy. How far did she push the bike?

6. A man weighing 600 N climbs stairs in an office block which are 40 m high. How much work does he do?

7. A worker pushes a 4 kg crate along the ground for 3 m using a force of 20 N, then lifts the crate up to a ledge 1 m high. How much work does he do altogether?

8. What is work done a measure of?

Exercise 6 Weight

1. What is meant by the 'mass' of an object?
2. What is meant by the 'weight' of an object?
3. What is meant by gravitational field strength?
4. What is the weight of a 10 kg bag of potatoes?
5. What is the weight of a 250 g bag of sweets?
6. What is the mass of a 450 N girl?
7. What is the weight of a 10,000 kg spacecraft on

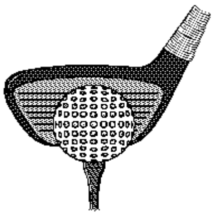
   a) Earth b) Mars c) Venus?

Planet	**g (N kg^{-1})**
Mercury	3.7
Venus	8.8.
Earth	10
Mars	3.8
Jupiter	26.4
Saturn	11.5
Uranus	11.7
Neptune	11.8
Pluto	4.2

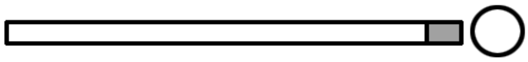
8. What would a 60 kg man weigh on Jupiter?
9. Which planet's gravity is closest to our own?
10. An astronaut who weighs 700 N on Earth goes to a planet where he weighs 266 N. Calculate his mass and state which planet he was on.
11. What would an astronaut weigh on Earth, if his weight on Venus was 528 N?

Exercise 7 Newton's 3rd Law

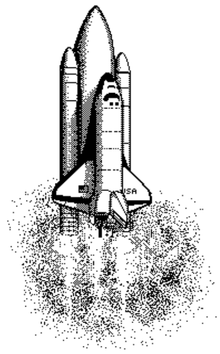
1. State Newton's Third Law.
2. Identify the 'Newton pairs' in the following situations.



a) golf club strikes ball



b) snooker cue strikes ball



c) space shuttle on take off

(consider only the forces between the shuttle and the exhaust gases.)

Exercise 1 – Forces Numerical Answers

1. See summary 1.2 – Effects of Forces
2. See summary 1.2 – Measurement of Forces
3. See summary 1.2 – Force, Mass and Acceleration Equation
4. See summary 1.2 – Introduction to Friction
5. See summary 1.2 – Introduction to Friction
6. See summary 1.2 – Friction
7. See summary 1.2 – Increasing/ Decreasing Friction
8. See summary 1.2 – Increasing/ Decreasing Friction
9. See summary 1.2 – Increasing/ Decreasing Friction
10. See summary 1.2 – Increasing/ Decreasing Friction
11. See summary 1.2 –Decreasing Friction

Exercise 2 – Newton's 1st Law Numerical Answers

1. See summary 1.2 – Balanced Forces
2. See summary 1.2 – Newton's 1st Law of Motion
3. See summary 1.2 – Newton's 1st Law of Motion
4. See summary 1.2 – Newton's 1st Law of Motion
5. a) it will accelerate. b) accelerator.
6. See summary 1.2 – Newton's 1st Law of Motion
7. See summary 1.2 – Newton's 1st Law of Motion
8. See summary 1.2 – Newton's 1st Law of Motion
9. See summary 1.2 – Motion during Free Fall and Terminal Velocity

Exercise 3 – Resultant Forces

1. See summary 1.2 – Resultant Forces
2. a) 800 N b) 100 N c) 300 000 N d) a) 0.57 ms^{-2} b) 1.39 ms^{-2} c) 7.7 ms^{-2}
3. a) 13 N b) 15.8 N c) 30 N d) 12.8 N

Exercise 4 – Newton's 2nd Law

1. 15 N
2. 2.5 ms^{-2}
3. 6 kg
4. 0.5 N
5. 15 000 N
6. See summary 1.2 – Newton's 2nd Law of Motion
7. See summary 1.2 – Newton's 2nd Law of Motion
8. 0.75 ms^{-2}
9. 1.4 ms^{-2}
10. 0.22 ms^{-2}
11. 3.25 ms^{-2}
12. 1000 kg
13. 600 N
14. a) 650 N b) 65 N c) 715 N
15. a) 1200 N b) -2880N

Exercise 5 – Work Done

1. a) kinetic energy

   b) kinetic and heat energy

   c) heat energy

   d) potential to kinetic and heat energy
2. 4 000 000 J or 4 MJ
3. 12 m
4. 50 N
5. 50 m
6. 24 000 J
7. 100 J
8. See summary 1.2 – Work Done

Exercise 6 – Weight

1. See summary 1.2 – Mass
2. See summary 1.2 – Weight
3. See summary 1.2 – Weight, Mass and Gravitational Field Strength Equation
4. 10 N
5. 2.5 N
6. 45 kg
7. a) 100 000 N b) 38 000 N c) 88 000N
8. 1584 N
9. Venus
10. 70 kg on Mars
11. 600 N

Exercise 7 – Newton's 3rd Law

1. See summary 1.2 – Newton's 3rd Law of Motion
2. See summary 1.2 – Newton's 3rd Law of Motion

Exercise 1 Satellites

1. What is meant by the period of a satellite?

2. a) What does the period of a satellite depend on?

   b) How could the period of a satellite be increased?

3. a) What group of satellites always stay at the same point above the surface of the Earth?

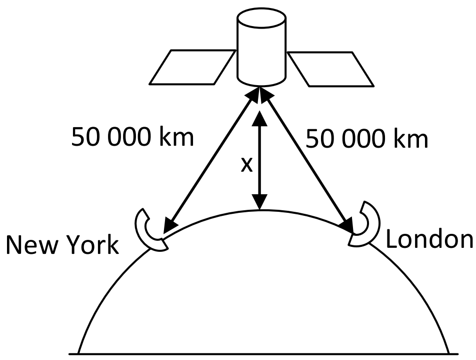
   b) What is the period of such satellites?

   c) Explain why such satellites are particularly useful.

4. If a satellite was launched to continually monitor the weather around the world, how would its period compare to that in question 3. b)?

5. Name 4 uses of satellites in everyday life.

6. Look at the diagram below of system of telecommunication:-



   a) Explain why very high frequency waves cannot be sent directly from London to New York.

b) Explain in some detail, with reference to the above diagram, how such radio waves may be sent.

c) What is the value, in km of height X?

d) Using the figures shown in the diagram, calculate how long a radio signal will take to reach New York from London by the method described in b)?

7. Explain how satellites have developed our understanding of the global impacts of our actions.

8. How can a satellite be used to monitor environmental changes on the earth?

Exercise 2 Curved Reflectors

1. Why are dish aerials used?

2. Describe how a dish aerial makes a signal 'stronger'.

3. Describe how we communicate using dish aerials over long distances.

4. a) In what circumstances might a large curved reflector be necessary?

   b) Explain how this large surface area helps.

5. Draw a diagram showing a curved reflector:

   a) Receiving a signal

   b) Transmitting a signal

6. Describe how a curved reflector can be used in satellite communication between Britain and America.

Exercise 3 Projectiles

1. Explain how projectile motion can be treated as two independent motions.

2. A stone thrown horizontally from a cliff lands 24 m out from the cliff after 3 s. Find:

   a) the horizontal speed of the stone
   b) the vertical speed at impact.

3. 75. A ball is thrown horizontally from a high window at 6 m/s and reaches the ground after 2 s. Calculate:

   a) the horizontal distance travelled
   b) the vertical speed at impact.

4. An aircraft flying horizontally at 150 ms^{-1}, drops a bomb which hits the target after 8 s. Find:

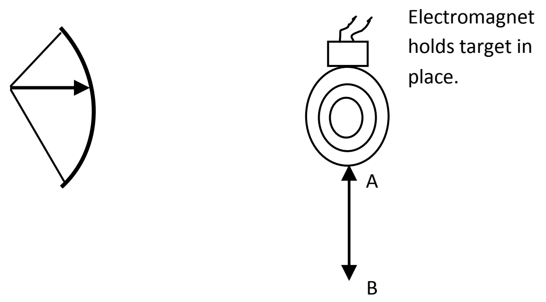
   a) the distance travelled horizontally by the bomb
   b) the vertical speed of the bomb at impact
   c) the distance travelled horizontally by the aircraft as the bomb fell
   d) the position of the aircraft relative to the bomb at impact.

5. A ball is projected horizontally at 15 ms^{-1} from the top of a vertical cliff. It reaches the ground 5 s later. For the period between projection, until it hits the ground, draw graphs with numerical values on the scales of the ball's:

   a) horizontal velocity against time
   b) vertical velocity against time

   From the graphs calculate the horizontal and vertical distances travelled.

6. In the experimental set-up shown below, the arrow is lined up towards the target. As it is fired, the arrow breaks the circuit supplying the electromagnet, and the target falls downwards from A to B.



   a) Explain why the arrow will hit the target.
   c) Suggest one set of circumstances when the arrow would fail to hit the target (you must assume it is always lined up correctly).

Exercise 1 – Satellites Numerical Answers

1. See summary 1.3 – Satellites – Introduction
2. a) See summary 1.3 – Satellites – Introduction

   b) See summary 1.3 – Satellites – Introduction
3. a) Geostationary b) 24 hours c) used for global communication
4. lower
5. See summary 1.3 – Applications of Satellites
6. a) To prevent confusion between transmitted and received signals.

   b) See summary 1.3 – Satellites Communication

   c) 36 000 km

   d) 0.3 s
7. See summary 1.3 – Using Satellites to Monitor Global Change
8. See summary 1.3 – Using Satellites to Monitor Global Change

Exercise 2 – Curved Reflectors Numerical Answers

1. See summary 1.3 – Satellite Communication – Parabolic (Curved) Reflectors
2. See summary 1.3 – Satellite Communication – Parabolic (Curved) Reflectors
3. See summary 1.3 – Satellite Communication – Parabolic (Curved) Reflectors
4. See summary 1.3 – Satellite Communication – Parabolic (Curved) Reflectors
5. See summary 1.3 – Satellite Communication – Parabolic (Curved) Reflectors
6. See summary 1.3 – Satellite Communication – Parabolic (Curved) Reflectors

Exercise 3 – Projectiles

1. See summary 1.3 – Projectile Motion
2. a) 8 ms^{-1} b) 30 ms^{-1}
3. a) 12m b) 20 ms^{-1}
4. a) 1200 m b) 80 ms^{-1} c) 1200m d) directly above
5. a) straight line at 15 ms^{-1} for 5s and straight line through origin from 0 ms^{-1} to 50 ms-1 for 5 s.

   b) 75 m and 125 m
6. a) they fall at the same rate

1.4 Cosmology

Exercise 1 The Universe

9. Copy and complete the table below.

Name	**Description**
	A planet outside our solar system.
Galaxy	
	A lump of matter which orbits a planet.
Planet	
Solar System	
Star	
	Consists of many galaxies separated by empty space.

10. Name the parts of the universe in order, biggest first.

11. Name the five basic needs for human life to survive.

12. What conditions are required for an exo – planet to sustain life?

Exercise 2 Light Year

7. Explain clearly what is meant by the term light year.

8. Calculate the distance, in metres, which light travels in one year.

9. State the distance in light years from Earth to:

   a) The Sun;

   b) The next nearest star;

   c) The next glaxay;

   d) The edge of the known universe.

10. Use the information from the previous question to calculate the distance in metres from the Earth to:

    a) The Sun;

    b) The next nearest star;

    c) The next glaxay;

    d) The edge of the known universe.

11. Change to metres:

    a) 1 light minute

    b) 1 light second

Exercise 3 Cosmogony

7. What is the name given to the theory of the origin of the universe?
8. Describe what astronomers believe occurred when the universe began.
9. List 3 pieces of evidence which support the theory of the origin of the universe.
10. How old do astronomers believe the universe is?
11. What evidence do astronomers use to estimate the age of the universe?

Exercise 4 The Electromagnetic Spectrum

1. What is the electromagnetic spectrum?

2. What do all waves in the electromagnetic spectrum have in common?

3. List the waves of the electromagnetic spectrum in order of increasing wavelength?

4. List the waves of the electromagnetic spectrum in order of increasing frequency?

5. Copy and complete the table.

Type of Radiation	Detector
Gamma rays	
	Blackened thermometer
Micro wave	
Radio and TV	
	Fluorescent paint
Visible light	
X-Rays	

6. List the colours of the visible spectrum in order of increasing frequency?

7. Why have astronomers developed telescopes to detect the different parts of the electromagnetic spectrum?

8. For each part of the spectrum, state what information has been found using these telescopes.

Exercise 5 Spectroscopy

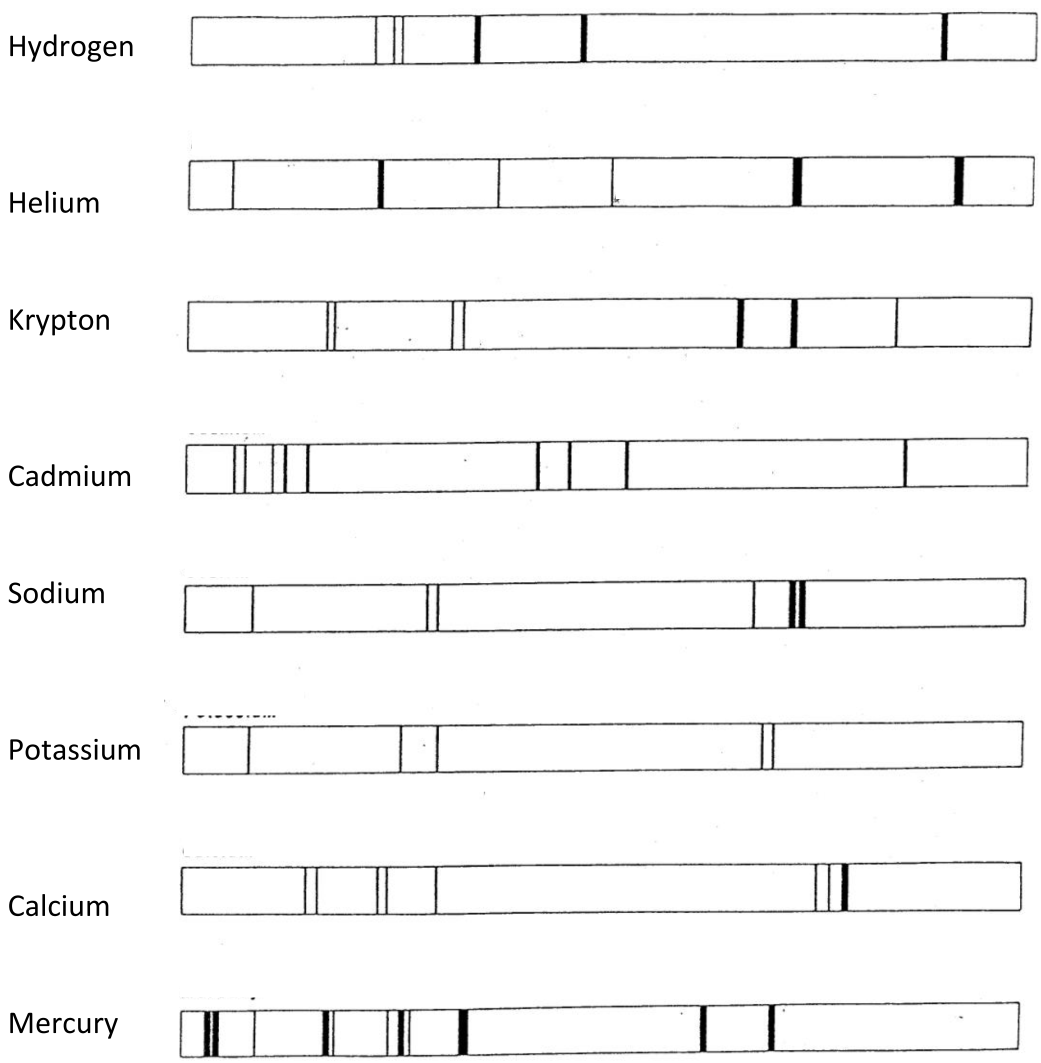
1. What do line spectra tell us about?

2. What instrument do we use to see spectra?

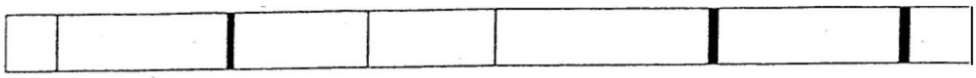
3. Use the spectrum reference chart to identify elements A and B.

4. Use the spectrum reference chart to identify the elements present in C, D, E and F.

Spectrum Reference Chart

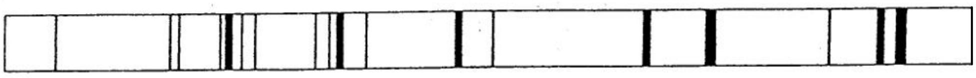


Element A

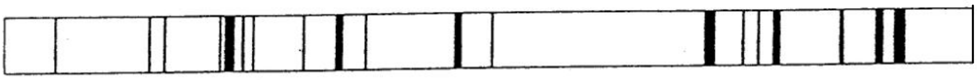


Element B

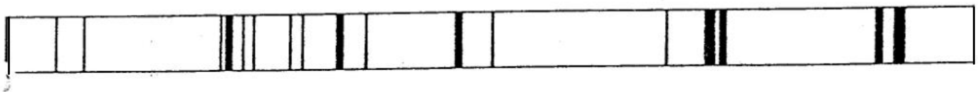
Spectrum C



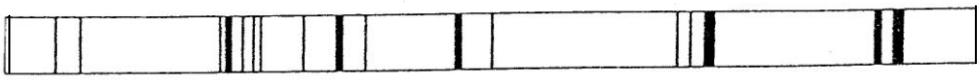
Spectrum D



Spectrum E



Spectrum F



Answers

Exercise 1

9.

Name	**Description**
Exo Planet	A planet outside our solar system.
Galaxy	**A large cluster of stars, some of which have planets orbiting them.**
Moon	A lump of matter which orbits a planet.
Planet	**A spherical ball of rock and/ or gas which orbits a star.**
Solar System	**Consists of a star and all the objects orbiting it.**
Star	**A hot ball of matter which is undergoing nuclear fusion emitting light.**
Universe	Consists of many galaxies separated by empty space.

10. Universe, Galaxy, Solar System, Star, Plant/ Exo Planet and Moon.
11. Oxygen, Water, Food, Shelter and Warmth.
12. Similar atmosphere to Earth.
    The potential to build shelter.
    The potential to grow and nurture a sustainable food source.

Exercise 2

7. 1 light year is the distance light travels in 1 year.
8. 9.4608×10^{15} m
9. a) 0·000016 light years b) 4·2 light years
   c) 25 000 light years d) 4.6×10^{9} light years
10. a) 1.51×10^{11} m b) 3.97×10^{16} m
    c) 2.37×10^{20} m d) 4.35×10^{26} m
11. a) 1.8×10^{10} m b) 3×10^{8} m

Exercise 3

7. The Big Bang Theory
8. See summary 1.4 – cosmogony, The Big Bang Theory
9. See summary 1.4 – cosmogony, Evidence
10. 14 billion years.
11. See summary 1.4 – cosmogony, Evidence

Exercise 4

1. A group of radiations.
2. All travel at $3x\ 10^{8}\ ms^{-1}$
3. Gamma Rays, X-Rays, Ultra Violet, Visible Light, Infra Red, Micro Waves, Radio & TV.
4. Radio & TV, Micro Waves, Infra Red, Visible Light, Ultra Violet, X-Rays, Gamma Rays.
5.

Type of Radiation	Detector
Gamma rays	**Geiger-Muller Tube**
Infra red	Blackened thermometer
Micro wave	**Diode Probe**
Radio and TV	**Aerial**
Ultra violet	Fluorescent paint
Visible light	**Photographic film**
X-Rays	**Photographic film**

6. Red, Orange, Yellow, Green, Blue, Indigo and Violet.
7. In an attempt to fully understand the universe.
8. See summary 1.4 – The Electromagnetic Spectrum, Detectors of Electromagnetic Radiation.

Exercise 5

1. The elements present in a star.
2. Spectroscope
3. A) Helium B)Hydrogen
4. C) Hydrogen, Krypton and Helium.
   D) Hydrogen, Helium and Calcium.
   E) Hydrogen, Helium and Sodium.
   F) Hydrogen, Potassium and Helium.

1.5 Space Exploration

Exercise 1 Heading into Space

1. Why do you think Governments should spend money on space exploration?

2. a) List 3 discoveries made about the Earth as a result of space exploration.

   b) Explain the importance of each of the discoveries mention in part a.

3. a) List 3 discoveries made about the Universe as a result of space exploration.

   b) Explain the importance of each of the discoveries mention in part a.

4. What is meant by a model of the universe?

5. Describe how our model of the universe has changed over time.

6. What evidence is there to suggest that our current model of the universe is correct?

Exercise 2 The Space Rocket

12. At launch, a space shuttle rocket of mass 75 000 kg produces an engine thrust of 800 000 N.

    a) Use Newton's 3rd Law of motion to explain how the rocket gets off the ground.

    b) Draw a free body diagram to show all the vertical forces acting on the rocket as it accelerates upwards.

    c) Calculate the rate of acceleration of the rocket.

13. At launch, a rocket of mass 18 000 kg accelerates away from the earth's surface at 9 ms^{-2}. Calculate the engine thrust of the rocket which causes this acceleration.

14. At launch, a space shuttle rocket of mass 50 000 kg produces an engine thrust of 620 000 N.

    a) Draw a free body diagram to show all the vertical forces acting on the rocket as it accelerates upwards.

    b) Calculate the rate of acceleration of the rocket.

15. Copy and complete the following paragraph, using the word list below.

    Due to the large amount of fuel in the rocket's tanks at lift-off its ________ is large. The rocket engine provides the thrust to overcome the _________ . As the rocket rises, its mass decreases and the ___________ increases. Far out in space the engine is switched off and the rocket continues on its way at constant __________.

    Word list: **speed** **mass** **acceleration** **weight**

16. During space flight, a rocket of mass 25 000 kg, reaches a speed of 12 000 ms^{-1}.

    a) Suggest 3 reasons why the acceleration of the rocket will increase.

    b) When the rocket is in space the force of gravity is negligible. Use all of Newton's Laws of Motion to explain how the rocket moves in space.

17. A space shuttle rocket engine produces a thrust of 100 000 N when fired to reposition the shuttle during space flight. If the total mass of the shuttle is 7500 kg, what will be its acceleration?

18. A satellite has a mass of 200 kg. Its rocket engine produces an acceleration of 5 ms^{-2}. Assuming no other forces act on the satellite, what thrust is exerted by the engine?

19. A space vehicle fully laden with fuel; has a mass of $2x10^6$ kg. During launch from the Earth the engines produce a constant thrust of $2.6x10^7$ N.

    a) Calculate the acceleration at lift-off.

    b) After some time, the spacecrafts engines are usually switched off. Explain why the spacecraft does not stop moving.

20. A space vehicle, far out in space, has its rockets engine fired so that it will return to Earth. The vehicle has a mass of 4 500 kg and increases it speed by 12 000 ms-1 when the engine is fired for 240.

    a) Calculate the average acceleration of the vehicle during the time the engine operates.

    b) Find the thrust produced by the engine.

21. On returning from space the rocket must travel through the Earth's atmosphere (re-entry).

    a) What happens to the velocity of the rocket as it travels through the atmosphere?

    b) Explain your answer to part a.

    c) What is the main energy change during re-entry.

22. Once the rocket has passed through the atmosphere and is approaching the Earth's surface, a parachute is deployed.

    a) Draw a free body diagram to show all the vertical forces acting on the rocket after the parachute has been deployed.

    b) Explain in terms of forces why the parachute is able to bring the rocket safely to rest.

Exercise 3 Benefits and Risks

12. List at least 4 technologies that were developed as a result of space exploration.

13. Describe how each of the technologies listed above impacts on our everyday lives.

14. Describe at least 3 benefits associated with space exploration.

15. Which technology that was developed as a result of space exploration has the biggest impact on your life? Explain why.

16. Space exploration also has its associated risk.

    a) Describe some of these risks.
    b) Give 2 examples of disasters which have occurred in the history of space exploration.

17. What is your opinion about space exploration? Explain in detail why you feel this way.

Exercise 4 Re -entry - Changes of State

9. What is meant by the change of state of a substance?

10. What must be added to or given out by a substance, for a change of state to occur?

11. What happens to the temperature of a substance during a change of state?

12. What is meant by the specific heat capacity of a substance?

13. What is meant by the specific latent heat of fusion?

14. What is meant by the specific latent heat of vaporisation?

Exercise 5 Re –entry – Specific Heat Capacity

1. 1000 J of energy raises the temperature of 1 kg of liquid by 2 ^{o}C. How much energy will be required to raise the temperature of 4 kg of liquid by 1 ^{o}C?

   The specific heat capacity of water is 4200 Jkg^{-1} ^{o}C

2. 2 kg of water at 10 ^{o}C is supplied with energy. Its temperature rises to 30 ^{o}C. What amount of energy is supplied to the water?

3. 5 kg of water at 50 ^{o}C has its temperature changed to 100 ^{o}C by an immersion heater. How much energy has been supplied?

4. 16 000 J of energy is supplied to a liquid which has a specific heat capacity of 3000 Jkg^{-1} ^{o}C. If there is 2 kg of the liquid, by how much does its temperature change?

5. 2 kg of a metal is supplied with 2000 J of energy. Its temperature goes from 10 ^{o}C to 15 ^{o}C. What is its specific heat capacity?

Exercise 6 Re –entry – The Challenges

1. Describe, in detail 2 of the challenges faced by a space craft during re-entry.

2. Explain how the challenges mentioned above are overcome.

3. What is a thermal protection system?

4. Why is a thermal protection system need during re-entry?

5. Thermal protection systems are used on spacecraft.

   a) Describe how a thermal protection system works?
   b) Which materials used are used in a thermal protection system?

6. The main structure of the shuttle is made of aluminium. The table below compares data on aluminium and silica.

Material	Specific heat capacity/ $jkg^{-1}\,^oC$	Melting point/ ^oC
Aluminium	902	720
Silica	1040	1613

   a) Using the information in the table, explain why silica is a good protector for the shuttle.

   b) If the total mass of protective silica on the shuttle is 3500 kg, what would be the rise in temperature if $3{\cdot}2 \times 10^{12}$ J of energy was absorbed by the silicon?

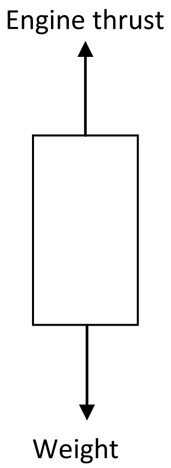
Answers

Exercise 1

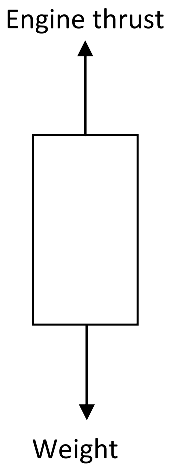
12. See summary 1.5 – Space Exploration, Heading into Space
13. a) See summary 1.5 – Space Exploration, Heading into Space
    b) See summary 1.5 – Space Exploration, Heading into Space
14. a) See summary 1.5 – Space Exploration, Heading into Space
    b) See summary 1.5 – Space Exploration, Heading into Space
15. A representation of what we believe the universe to look like/ how it behaves.
16. See summary 1.5 – Space Exploration, Heading into Space
17. See summary 1.5 – Space Exploration, Evidence to Support …

Exercise 2

12. a) The rocket pushes the gas out the back downwards (action) and the gas pushes the rocket upwards (reaction)
    b)

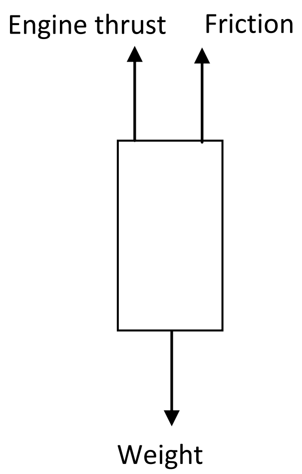


    c) W = 750 000 N, a = 0·67 ms^{-2}
13. 342 000 N
14. a)



    b) 2·4 ms^{-2}

15. Correct order: mass, weight, acceleration and speed.
16. a) See summary 1.5 – Space Exploration, The Space Rocket – During Flight
    b) See summary 1.5 – Space Exploration, The Space Rocket – During Flight
17. $3{\cdot}33\,ms^{-2}$
18. 3000 N
19. a) $3\,ms^{-2}$
    c) Negligible gravity and no frictional forces opposing the motion. (Newton 1).
20. a) $50\,ms^{-2}$ b) 270 000 N
21. See summary 1.5 – Space Exploration, The Space Rocket – Landing
22. a)



23. b) See summary 1.5 – Space Exploration, The Space Rocket – Landing

Exercise 3

1. See summary 1.5 – Space Exploration, Risks and Benefits, Made for us in Space
2. See summary 1.5 – Space Exploration, Risks and Benefits, Made for us in Space
3. See summary 1.5 – Space Exploration, Risks and Benefits, Made for us in Space
4. Personal, but must be well justified.
5. See summary 1.5 – Space Exploration, Risks and Benefits, Risks
6. Personal, but must be well justified.

Exercise 4

9. A substance changing from a solid to liquid or liquid to gas etc.
10. Energy.
11. No change in temperature.
12. See summary 1.5 – Space Exploration, Re-entry, Specific Heat Capacity
13. See summary 1.5 – Space Exploration, Re-entry, Specific latent Heat of Fusion
14. See summary 1.5 – Space Exploration, Re-entry, Specific latent Heat of Vaporisation

Exercise 5

5. 2000J
6. 168 000J
7. 1 050 000J
8. $2{\cdot}7\,^{o}C$
9. $200\ Jkg^{-1}\,^{o}C$

Exercise 6

1. See summary 1.5 – Space Exploration, Re-entry, Challenges During Re-entry
2. See summary 1.5 – Space Exploration, Re-entry, Challenges During Re-entry
3. See summary 1.5 – Space Exploration, Re-entry, Challenges During Re-entry
4. See summary 1.5 – Space Exploration, Re-entry, Challenges During Re-entry
5. a) See summary 1.5 – Space Exploration, Re-entry, Challenges During Re-entry
   b) See summary 1.5 – Space Exploration, Re-entry, Challenges During Re-entry
6. a) Silica has a high specific heat capacity
10. b) $879121\,^{o}C$