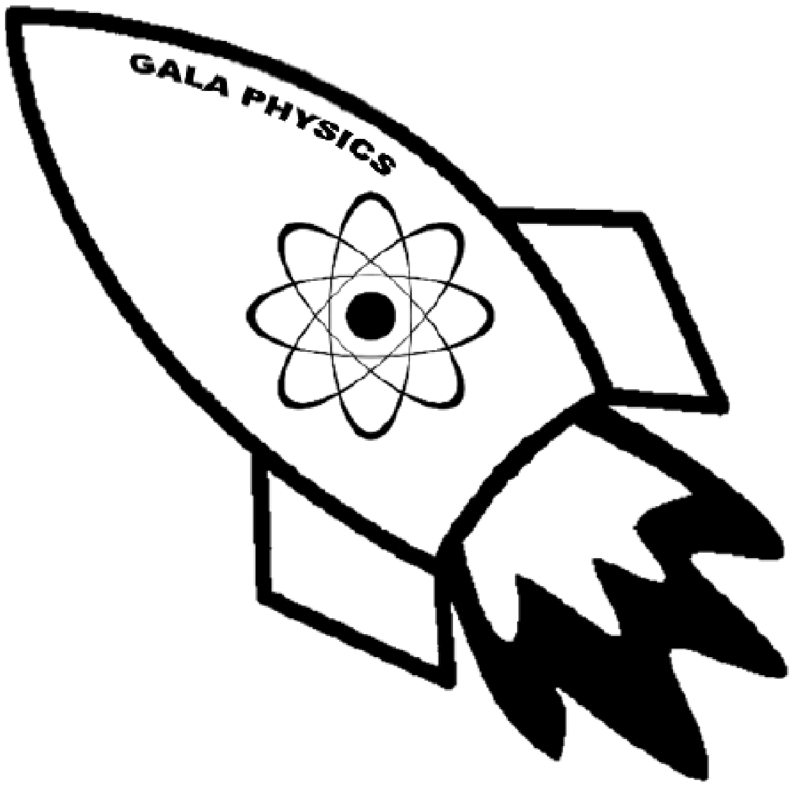
Galashiels Academy

National 5 Physics



Dynamics and Space

Consolidation and Revision Questions

Name:	**Class:**

Dynamics and Space Questions		Date Due	Mark
1	Average and Instantaneous Speed	____________	/20
2	Vectors and Scalars	____________	/20
3	Acceleration	____________	/20
4	Velocity-time and Speed-time graphs	____________	/20
5	Weight, mass and gravitational field strength	____________	/20
6	Friction and Newton's First Law	____________	/20
7	Resultant Force and Newton's 2nd Law	____________	/20
8	Newton's Third Law, free-fall and g	____________	/20
9	Projectile Motion	____________	/20
10	Space Exploration	____________	/20
11	Cosmology	____________	/20
12	Revision Questions: Kinematics		
13	Revision Questions: Dynamics & Space		

National 5 Physics: Dynamics and Space Learning Outcomes

Velocity and displacement — Vectors and scalars

- ☐ I can identify Vector and scalar quantities such as force, speed, velocity, distance, displacement, acceleration, mass, time and energy.
- ☐ I can calculate the resultant of two vector quantities in one dimension or at right angles.
- ☐ I can determine displacement and/or distance using scale diagram or calculation.
- ☐ I can make use of appropriate relationships to calculate velocity in one dimension.

Velocity–time graphs

- ☐ I can draw Velocity–time graphs for objects from recorded or experimental data.
- ☐ I can interpret velocity–time graph to describe the motion of an object.
- ☐ I can find displacement from a velocity–time graph.

Acceleration

- ☐ I can calculate the acceleration of a vehicle between two points using appropriate relationships with initial and final velocity and time of change.
- ☐ I can find the acceleration from a velocity–time graph.

Newton's laws

☐ I can apply Newton's laws and the idea of balanced forces to explain constant velocity, making reference to frictional forces.
☐ I can perform calculations involving the relationship between unbalanced force, mass and acceleration for situations where more than one force is acting.
☐ I can perform calculations involving the relationship between work done, unbalanced force and distance/displacement.
☐ I can perform calculations involving the relationship between weight, mass and gravitational field strength during interplanetary rocket flight.
☐ I can apply Newton's second law and its application to space travel, including rocket launch and landing.
☐ I can apply Newton's third law and its application to explain motion resulting from a 'reaction' force.
☐ I can make use of Newton's laws to explain free-fall and terminal velocity.

Projectile motion

☐ I can give an explanation of projectile motion.
☐ I can perform calculations of projectile motion from a horizontal launch using appropriate relationships and graphs.
☐ I can give an explanation of satellite orbits in terms of projectile motion.

Space exploration

☐ I can cite evidence to support current understanding of the universe from telescopes and space exploration.
☐ I can explain the impact of space exploration on our understanding of planet Earth, including use of satellites.
☐ I can describe some potential benefits of space exploration including associated technologies and the impact on everyday life.
☐ I can state some risks and benefits associated with space exploration, including challenges of re-entry to a planet's atmosphere.

Cosmology

☐ I can make use of the term 'light year'.
☐ I can make conversions between light years and metres.
☐ I can give a description of the Observable universe in terms of its origin and age.
☐ I can describe the use of different parts of the electromagnetic spectrum in obtaining information about astronomical objects.
☐ I can identify continuous and line spectra.
☐ I can make use of spectral data for known elements, to identify the elements present in stars.

Exercise 1: Average and Instantaneous Speed

1. Explain the difference between average and instantaneous speed. **1**

2. Convert the following speeds into ms^{-1} **3**
   a. 300 m/h
   b. 0.06 k ms^{-1}
   c. 300 km/h

3. Describe a method of finding the average speed of a sprinter in a race. Include any measurement and formula that you need. **2**

4. Describe a method of finding the instantaneous speed of a toy car rolling down a ramp **2**

5. A car travels a distance of 2 km in a time of 160 s. Calculate the average speed of the car in ms^{-1}. **2**

6. A girl runs at 4 ms^{-1} for 5 minutes every day. Calculate how far she runs in a week. **2**

7. A coin is dropped through a light gate connected to a computer. The coin has a width of 0.02 m and it takes 0.005 s to pass through the light gate. Find its instantaneous speed. **2**

8. How far will a jet aircraft travel in 5 minutes if it flies at 400 ms^{-1}? **2**

9. A plane flies from Glasgow to Toronto at an average speed of 223 ms^{-1}. The flight time is 7 hours. Calculate the distance travelled by the plane. **2**

10. A skier, finishing a race, passes between a set of light gates connected across the finish-line. The width of the skier's body is 0.32 m. The time recorded on the timer is 0.016 s. Calculate the speed of the skier. **2**

Total: 20 Marks

Exercise 2: Vectors and Scalars

1. Explain the difference between a scalar and a vector quantity **2**

2. Sort the following variables into a table with the headings: **3**
scalar quantity & *vector quantity*

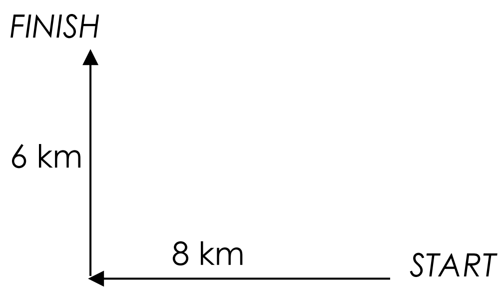
distance	*displacement*	*force*
energy	*acceleration*	*speed*
velocity	*temperature*	*time*

3. During a race, a car makes 25 complete laps of a course of 5 km

a. What is the distance travelled by the car after 25 complete laps? **1**

b. What is the resultant displacement of the car after 25 complete laps? **1**

4. An athlete runs 8 km due west then turns and runs 6 km due north as shown in the diagram



The run was completed in 75 minutes.

a. What is the total distance that the athlete travelled? **1**

b. Find the resultant displacement of the athlete. **3**

c. Calculate the average speed of the athlete in km/h. **2**

d. Calculate the average velocity of the athlete in km/h. **2**

5. A boat sails north at 30 ms^{-1}, a cross wind blows the boat eastward at 10 ms^{-1}.

a. What is the resultant velocity of the boat **3**

b. Calculate the displacement of the boat after 2 minutes **2**

Total: 20 Marks

Exercise 3: Acceleration

1. State the definition of acceleration **1**

2. A car slows from 30 ms^{-1} to 10 ms^{-1} in 1 minute. **2**
Calculate the acceleration in ms^{-2}

3. A car, starting from rest, reaches a speed of 15 metres per second in a time of 30 seconds. Calculate the acceleration of the car. **2**

4. A rocket accelerates at 5.2 ms^{-2} for 10 minutes to reach a final velocity of 6200 ms^{-1}. **2**
Calculate the initial velocity of the rocket.

5. A ball is dropped from the roof of a building.
a. What is the acceleration of the ball if its speed is 30 ms^{-1} after 3s? **2**
b. What force causes the ball to accelerate? **1**

6. A sprinter in a race crossed the finishing line with a speed of 14 ms^{-1}. If her sprint time was 16 seconds, what was her average acceleration? **2**

7. A van travelling at 13 ms^{-1} decelerates at a rate of 0.03 ms^{-2}.
How long does it take to come to a complete stop?

8. A Ford KA increases its velocity from 2 ms^{-1} to 16 ms^{-1} in 10s. **3**
A Vauxhall Corsa takes 8s to accelerate to 11 ms^{-1} from rest.
Show by calculation which car has the greater acceleration.

9. A pupil has two sets of light gates which can be attached to timers. Suggest an experiment she could carry out that would allow her to find the acceleration of a toy car down a ramp. **3**

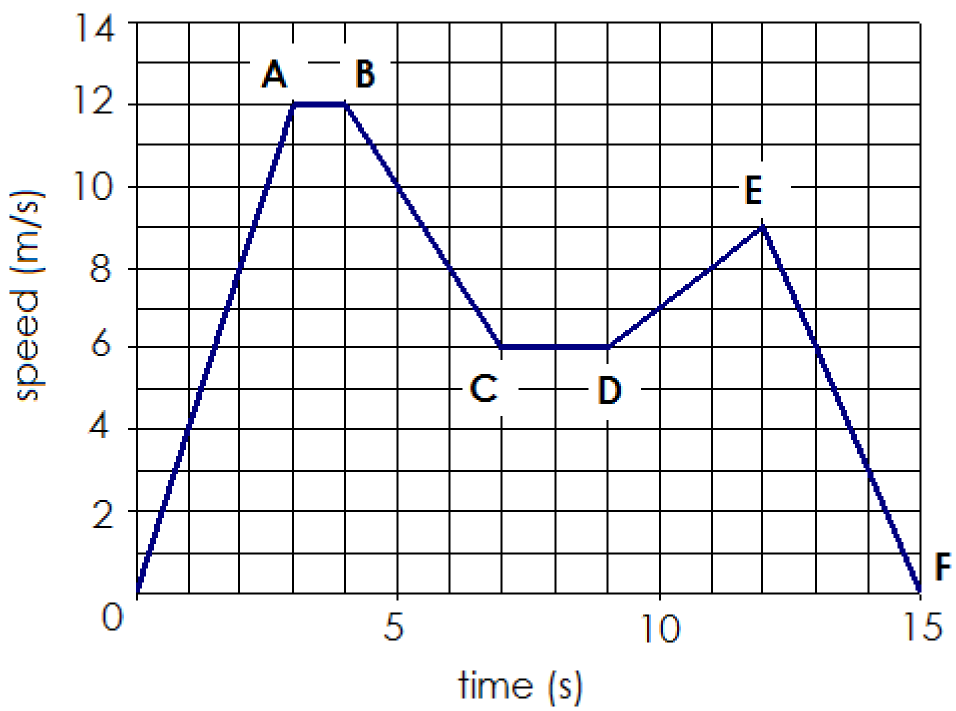
Total: 20 Marks

Exercise 4: Velocity-time and Speed-time graphs

1. A car accelerates from rest to 20 ms^{-1} in a time of 8 seconds. It then travels at a constant speed for a further 12 seconds. The driver brakes sharply and the car comes to rest in a time of 4 seconds.

a.	Draw a speed time graph for the journey	**2**
b.	Calculate the acceleration of the car	**2**
c.	Calculate the deceleration of the car	**2**
d.	How far did the car travel?	**3**
e.	Calculate the average speed of the car over its journey	**2**

2. The motion of a toy car produces a graph of motion as shown below:



a.	Describe the motion of the car over the 15 seconds	**2**
b.	Find the acceleration from O-A and D-E	**2**
c.	Find the deceleration from B-D and E-F	**2**
d.	Calculate the distance travelled by the car in the first 7s	**3**

Total: 20 Marks

Exercise 5: Weight, mass and gravitational field strength

1. Describe how a Newton Balance can be used to measure a force. **2**

2. a. Define the term gravitational field strength **1**
b. State the gravitational field strength on Earth **1**

3. Mass and weight mean different things:
a. Explain what is meant by mass **1**
b. What are the units of mass? **1**
c. Explain what is meant by weight **1**
d. What are the units for weight? **1**

4. Calculate the weight of a 50 kg pupil on Earth (g = 10 N/kg) and the moon (g = 1.6 N/kg) **2**

5. The Mars Rover has a mass of 185 kg and is currently on Mars where the gravitational field strength is 4 N/kg
a. Calculate the weight of the Mars Rover on Earth **2**
b. What is the mass of the Mars Rover on Mars **1**
c. What is the weight of the Mars Rover on Mars **2**
d. What was the weight of the Mars Rover when it was travelling through space? **1**

6. On Jupiter g = 26 N/kg, how much would a 1500 kg rocket weigh? **2**

7. A scientist predicts that a person of mass 75 kg will have a weight of 780 N on a newly-discovered planet. **2**
Calculate the gravitational field strength of this planet.

Total: 20 Marks

Exercise 6: Friction and Newton's First Law

1. Look at the cyclist in the picture below
   a. Identify three ways in which friction acting against the bicycles or cyclists has been reduced **3**
   b. The cyclist find that as they start off, they can accelerate easily. After a while though, they have to pedal hard to keep a constant speed. **1**
   Explain why this happens.

2. A car with a roof rack on top uses more petrol than one without. **2**
   Can you explain in terms of forces why this is?

3. A boat has an engine force of 30,000 N and experiences air resistance of 5,000 N and frictional forces from the water of 12,000 N.
   a. Draw a forces diagram to show the effects of forces on the boat **3**
   b. Calculate the resultant force **1**

4. Copy and complete the following: **6**

   An object will remain at _________ or continue to travel at a ___________ speed in a straight line, unless an _________________ force acts upon it.

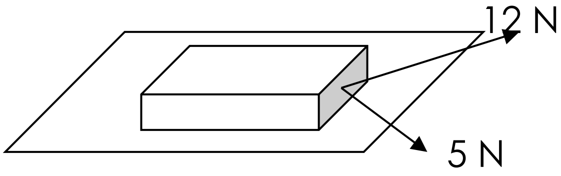
   If the forces acting on the object are ___________ then the object will either be _______________ or will be moving at a ___________ speed.

5. A weightlifter holds a 180 kg bar as shown.
   a. Calculate the weight of the bar. **2**
   b. What size of force did the weightlifter apply to raise the bar at a constant speed? **1**
   c. What is the size of force that the weightlifter applies to hold the bar stationary? **1**

Total: 20 Marks

Exercise 7: Resultant Force and Newton's 2nd Law

1. Two forces, 90° apart, are applied to a 2kg block as shown:



a. Find the size of the resultant force acting on the block. **2**

b. Calculate the initial acceleration of the block. **2**

2. A car of mass 1500 kg accelerates at a rate of 2.3 ms^{-2}. **3**

The engine of the car provides a force of 4000 N.

Calculate the size of the frictional force acting on the car.

3. A firework of mass 0.2 kg provides an initial upwards thrust of 2.8 N.

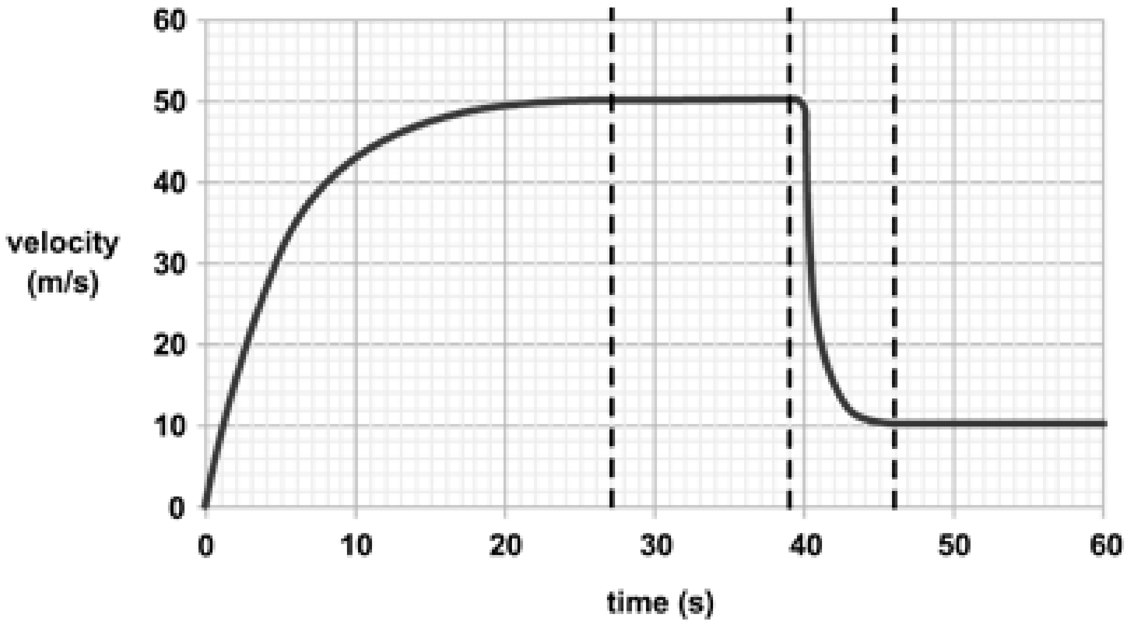
a. Calculate the weight of the firework **2**

b. Draw a diagram and label the forces acting on the firework **2**

c. Calculate the initial acceleration of the firework. **2**

d. As the firework rises, its acceleration increases. Explain why this is. **1**

4. The velocity-time graph for a sky-dive is shown below:



a. Explain why the gradient decreases between 0 and 20 s. **1**

b. At what time is the parachute opened? **2**

C. What is the name given to the constant velocity reached during free-fall? **1**

Total: 20 Marks

Exercise 8: Newton's Third Law, free-fall and acceleration due to gravity

1. State Newton's 3rd Law of Motion **1**

2. Identify the Newton pairs in the following situations **3**

a. A boy kicking a ball

b. A water rocket launching

c. A badminton racket striking a shuttlecock

2. Show how gravitational field strength and acceleration due to the force of gravity are equivalent. **2**

3. A student drops a 1.2 kg football and it lands on the ground 0.5 s later.

a. State the mass and the weight of the football. **2**

b. Calculate the velocity of the ball at the instant it strikes the ground. **2**

c. How would this velocity differ if a heavier ball was used? **2**
Explain your answer

4. An astronaut drops a golf ball on the Moon where the gravitational field strength is 1.6 N/kg.
The ball lands on the surface of the Moon 2.1 seconds after being dropped.

a. Show that the ball strikes the surface of the Moon with a velocity of 3.36 ms^{-1}. **1**

b. Draw a velocity-time graph for the ball as it falls. **2**

c. Use the graph to calculate the height that the ball was dropped from. **2**

5. A student has two pieces of paper. She scrunches one into a ball and leaves the other one flat.
She drops both pieces of paper at the same time.

a. What is the acceleration due to gravity on each piece of paper? **1**

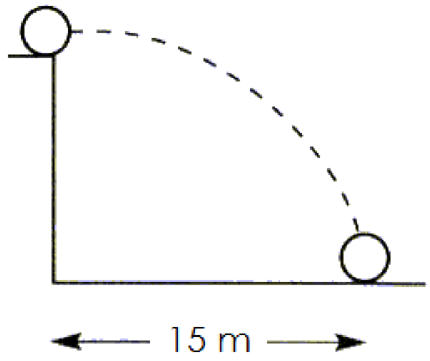
b. Which piece will hit the ground first? **1**

c. Explain your answer in terms of forces acting on the paper **1**

Total: 20 Marks

Exercise 9: Projectile Motion

1. A ball is launched horizontally at a speed of 5 ms^{-1}.

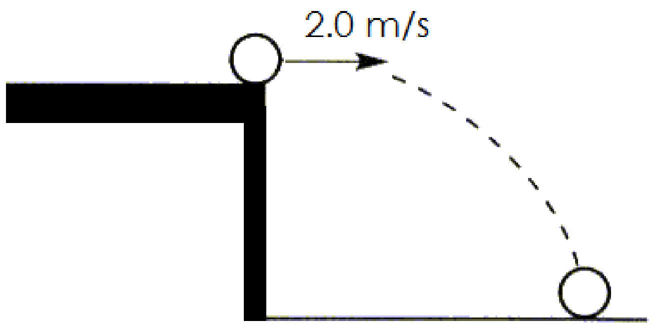


a. Calculate the time that the ball is in the air for. **2**
b. Calculate the final vertical velocity of the ball as it hits the ground. **2**
c. Find the size of the final resultant velocity of the ball and the angle of impact. **3**

2. A stone is thrown out of a window with a horizontal speed of 10 ms^{-1}. At the moment it is released out of the window, the initial vertical speed is zero. It takes 4 s to reach the ground.

a. State the horizontal speed of the stone just before it hits the ground. **1**
b. Calculate the total horizontal distance covered by the stone **2**
c. What is the value of the vertical acceleration of the stone? **1**
d. Calculate the vertical speed of the stone just before it hits the ground **2**
e. Calculate the final velocity of the stone just before it hits the ground **3**

3. A ball rolls off a table top with a horizontal speed of 2.0 ms^{-1} and hits the ground 0.3 seconds later.



a. Sketch a velocity-time graph of the vertical motion of the ball **2**
b. Use the graph to find the height of the table. **2**

Total: 20 Marks

Exercise 10: Space Exploration

1. State **two** pieces of evidence that scientists have provided that support the Big Bang Theory. **4**
For each piece of evidence give a brief description of how it supports ideas in the Big Bang Theory.

2. Technologies that were originally developed in space exploration programmes has proved to be useful in everyday life **1**
Write down one technology that was originally developed for a space programme that is now used in everyday life.

3. During re-entry to the Earth's atmosphere, a spacecraft will undergo a considerable increase in temperature.
   a. What causes this increase in temperature? **1**
   b. Choose **two** features of a heat shield that will help to protect the spacecraft. For each feature that you chose, explain how it protects the spacecraft **4**

4. A heat shield on a spacecraft has a mass of 70 kg.
The spacecraft is travelling at 900 ms^{-1}. On re-entry into the Earth's atmosphere, the velocity of the spacecraft is reduced to 250 ms^{-1}.
   a. Calculate the change in kinetic energy of the heat shield. **2**
   b. Calculate the change in temperature of the heat shield. (Assume all the kinetic energy changes to heat and the s*pecific heat capacity of heat shield material = 980 J/kg°C)* **2**

5. A solid heat shield is being tested that has the following properties:.

Specific Heat Capacity: 880 J/kg°C

Melting point: 900 °C

Specific latent heat of fusion: 500 J/kg

Mass of heat shield material: 90 kg

   a. Explain why it is a good idea for the shield to melt **1**
   b. Calculate the energy absorbed by the heat shield when its temperature is raised from -10 °C to the melting point on re-entry. **2**
   c. Calculate the energy absorbed by the heat shield as it melts. **2**
   d. Use your answers to calculate the total amount of heat energy absorbed by the heat shield. **1**

Total: 20 Marks

Exercise 11: Cosmology

1. An astronomer views the following objects in the night sky:

- Jupiter, which orbits the Sun;
- Europa, which orbits Jupiter;
- the Andromeda Galaxy.

a. Which of the objects mentioned is a moon? **1**

b. Which of the objects mentioned is a star? **1**

c. Which of the objects mentioned is a planet? **1**

2. Cosmologists use "light years" as a unit of distance

a. Calculate the number of metres in 1 light year **2**

b. The Leo A Galaxy is 2.25 million light years from the Earth. Calculate this distance in metres **2**

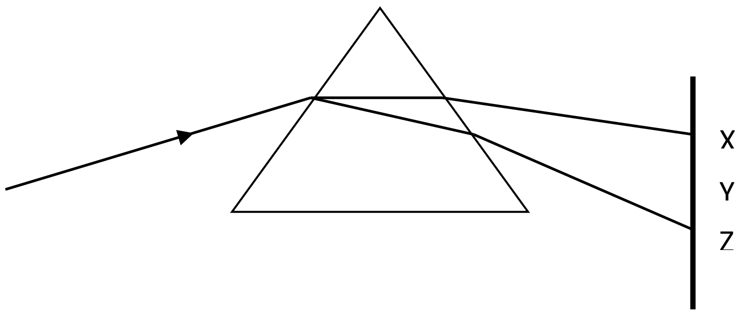
3. Scientists searching for exoplanets use the Astronomical Unit where 1 AU is the distance from the Sun to Earth. The "*Habitable Zone*" is the range of distances from a star which could be suitable for a planet to support life. Estimate of the distance that a planet capable of sustaining life would have to be from a brighter star in AU and explain your answer. **2**

4. White light is part of the electromagnetic spectrum – a family of radiation waves with different wavelengths.

a. List all of the members of the electromagnetic spectrum, from shortest wavelength to longest wavelength. **4**

b. What property do all of the members have in common? **1**

c. White light can be split into different colours:



i. Name the block that splits light into different colours **1**

ii. Name another piece of equipment that can split white light. **1**

iii. Which of the colours red, blue and green appear at X, Y and Z? **2**

iv. The same device can be used to analyse light from a star. What information can be obtained from this analysis? **2**

Total: 20 Marks

Revision Questions: Kinematics

1. a. Convert 90km/h into ms^{-1}.
   b. Convert 15 ms^{-1} into km/h.

2. Write down the equation for average speed and all the units involved.

3. A toy train travels 15 m at an average speed of 1.5 ms^{-1}, how long does the journey take?

4. A boat sails 60 km in one hour, what is its average speed in ms^{-1}?

5. Describe an experiment to measure the average speed of a person jogging over a distance of 15m.This should include the apparatus required and the measurements taken.

6. What is meant by 'Human Reaction Time'?

7. What is meant by the term 'Instantaneous Speed'?

8. How do average speed and instantaneous speed differ?

9. Describe an experiment to measure the instantaneous speed of a Formula One car when it passes the finishing line in a race. This should include the apparatus required and measurements taken.

10. Calculate the average speed of a train in ms^{-1} if it travels 300km in 4 hours.

11. Explain the difference between vectors and scalars

12. A boy runs 50m North and 12m west in 40s.
    Find:
    a. the distance he travels
    b. his displacement
    c. his average speed
    d. his average velocity

13. A plane flies 4 km North and 5 km south in 5 minutes
    Find:
    a. the distance it travels
    b. its displacement
    c. its average speed
    d. its average velocity

14. What is meant by the term 'Acceleration'?

15. State the equation for acceleration with all the units involved.

16. Calculate the acceleration of a car if it accelerates from 8 ms^{-1} to 14 ms^{-1} in 12s.

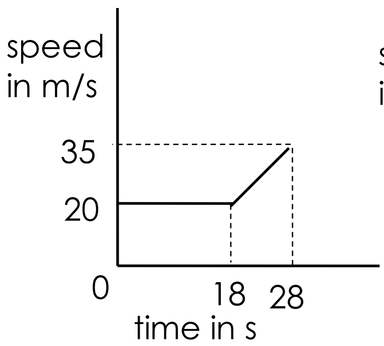
17. What is meant by the term 'deceleration' and how is the acceleration equation used to show this?

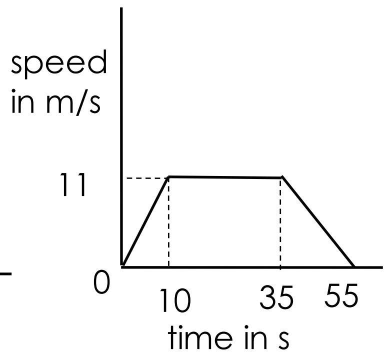
18. A lorry accelerates from rest with an acceleration of 0.25 ms^{-2} for 6 seconds. What will its speed be after 6 seconds?

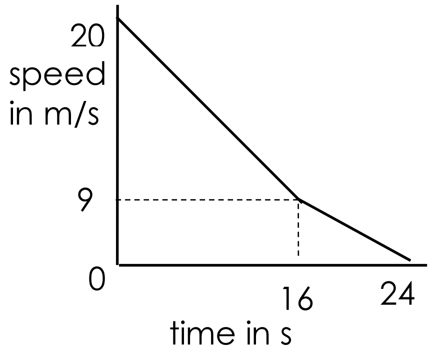
19. A van travelling at a constant speed begins to accelerate at 1.25 ms^{-2} for 8 seconds and reaches a speed of 18 ms^{-1}.
Calculate the original speed of the van.

20 For the following speed time graphs find:

a. The initial acceleration
b. The total distance travelled







Revision Questions: Dynamics

1. Name the three things about an object that can change when a force acts upon it.

2. Explain the difference between mass and weight (and state the units used to measure each)

3. Name the instrument used to measure force

4. A boat has a mass of 300 kg, calculate the weight of the boat?

5. Calculate the total weight of a 70kg man carrying a 10 kg box

6. Explain what is meant by friction

7. What type of energy is created when two surfaces rub together?

8. State Newton's 1st Law

9. State the formula for Newton's 2nd Law with all the units involved.

10. An unbalanced force of 40 N is applied to a trolley of mass 8 kg. What is the acceleration of the trolley?

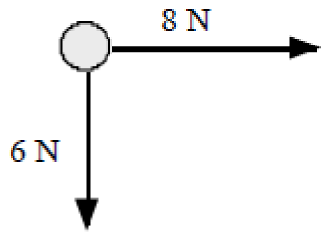
11. A bumble-bee has a mass of 3.0 g. What force is needed to accelerate the bee at 3.4 ms^{-2}?

12. An unbalanced force of 20 N is applied to a trolley of mass 10 kg.

    a. Calculate the acceleration of the trolley
    b. The trolley starts from rest and accelerates for 10 seconds.
       What speed does the trolley reach?
    c. Sketch a speed-time graph and use it find how far the trolley travels.

13. A rocket of mass 20 000 kg is propelled into space from the earth's surface by a constant thrust of 300 000 N
    a. Calculate the weight of the rocket
    b. Calculate the unbalanced force on the rocket
    c. Find the initial acceleration of the rocket
    d. Use Newtons 2nd Law to explain why the acceleration of the rocket increases as it leaves Earth's atmosphere

14. Two forces act on a box as shown:

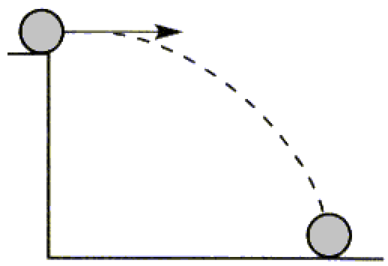


Draw a vector diagram showing how the two vectors add to produce a resultant vector and calculate the size of the resultant vector.

15. A ball is kicked horizontally off the edge of a cliff with a horizontal speed of 9 ms^{-1} and hits the ground 3s later.
Calculate:

a. Horizontal speed of the ball
b. Vertical speed of the ball as it hits the ground
c. Range of the ball.
d. Sketch a graph of the vertical speed against time to find the height of the cliff.

16. A ball is fired from a canon horizontally at a speed of 8 ms^{-1} and lands 40m away.



a. Calculate the time that the ball is in the air for.
b. Calculate the final vertical velocity of the ball as it hits the ground.
c. Find the size of the final resultant velocity of the ball and the angle of impact.

17. State Newton's third law of motion.

18. Explain the following terms

a. Moon	b. Star	c. Satellite
d. Galaxy	e. Planet	f. Universe

19. The star Vega is 25.05 light years away.

a. Explain what is meant by a light year
b. How far is this in metres?

20. Explain how line spectra help us understand more about our universe.