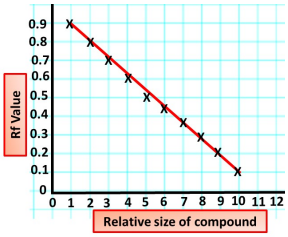
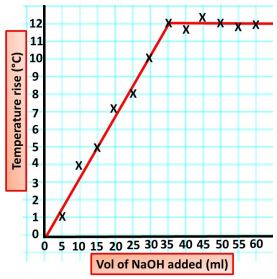
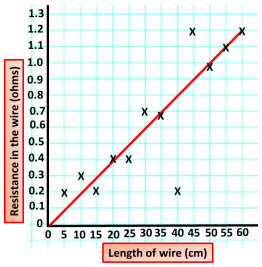
Chromatography



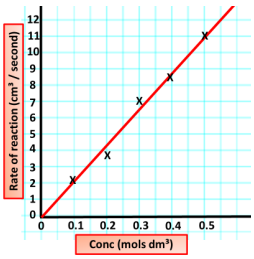
Temperature change



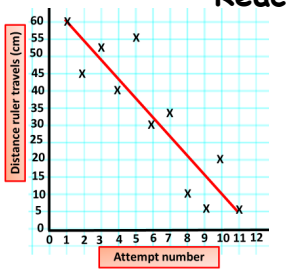
Resistance



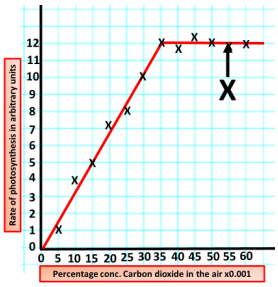
Rate of reaction



Reaction Time

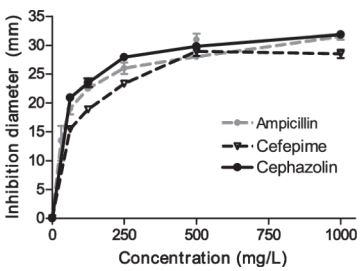


Photosynthesis

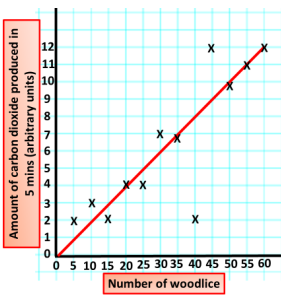


Extension Question
Why is this trend seen

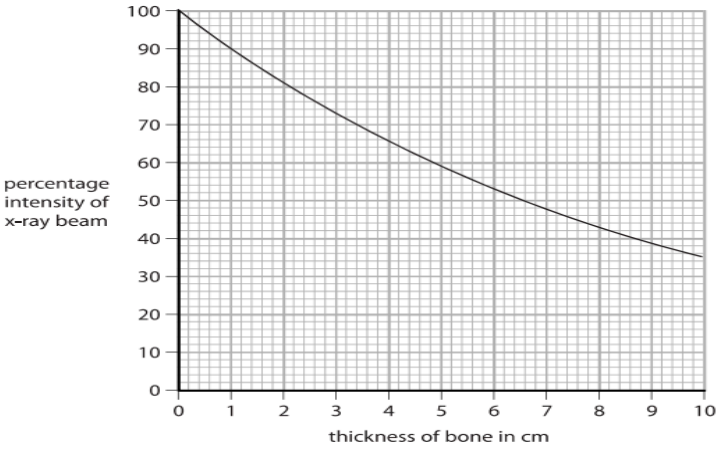
Effect of Antibiotic Concentration



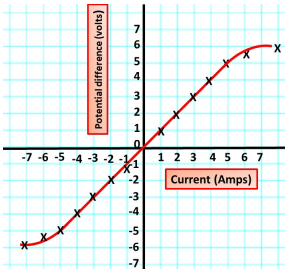
Respiration



Xray

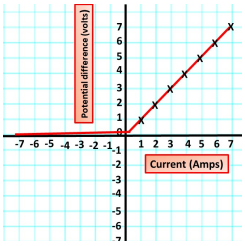


Filament lamp

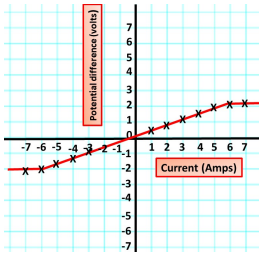


Extension Question
Explain shape

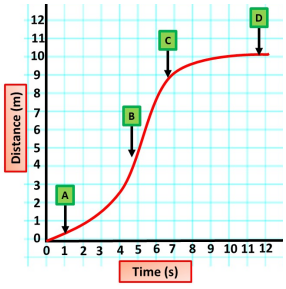
Diode



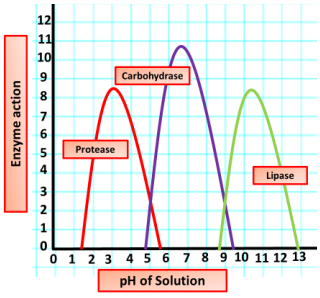
Filament lamp



Speed

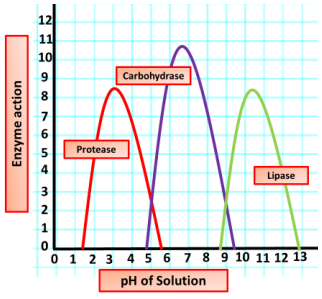


Enzymes (Carbohydrase)



Extension Question
Explain why lipase activity decreases

Enzymes (Protease)



Q46.

Figure 7 shows a skier going down a hill.

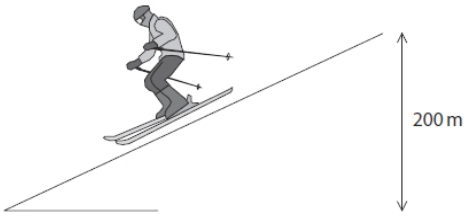


Figure 7

She descends through a vertical height of 200 m.
The skier's mass is 65 kg.

(i) Calculate the change in gravitational potential energy.
Take the gravitational field strength, *g*, as 10 N / kg.

(2)

change in gravitational potential energy = ... J

(ii) At the bottom of the slope her speed was 36 m/s.

Calculate her kinetic energy at the bottom of the slope.

(3)

kinetic energy = ... J

Q47.

(b) A javelin has a mass of 0.8 kg. In one throw, the javelin left the athlete's hand at a velocity of 25 m/s.

(i) Calculate the kinetic energy of the javelin as it left the athlete's hand. State the unit.

(3)

kinetic energy = ... unit .....

(ii) State the amount of work done by the athlete on the javelin to get it to a velocity of 25 m/s.

(1)

work done = ...

Q1.

(a) The students took five results for the left hand and five results for the right hand.
Figure 5 shows their results.

which hand	distance dropped (cm)					
	trial 1	trial 2	trial 3	trial 4	trial 5	average
left	10.1	25.5	18.4	14.6	11.7	14
right	17.5	16.1	19.4	18.6	20.2	.....

Figure 5

(i) Calculate the average distance dropped for the right hand.
Give your answer correct to 2 significant figures.

(2)

distance = ... cm

(ii) Calculate the average time for the left hand.
Use the equation

$$\text{time}^2 = \frac{\text{distance}}{500}$$

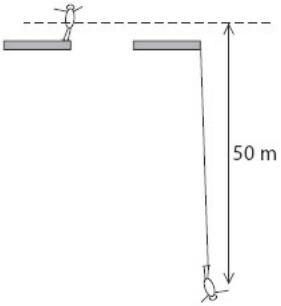
(2)

average time = ... s

Q5.

A 60 kg student weighs 600 N.

He does a bungee jump.



(c) (i) Calculate the change in gravitational potential energy as the student falls 50 m.
Give the unit.

(3)

Gravitational potential energy = ... unit .....

Q6.

A steel ball has a volume of 3.6 cm^3 and a mass of 28 g.

(i) Calculate the density of steel in $kg/m^{3.}$

(3)

density = ... kg/m^3

(ii) The steel ball is at a room temperature of 20 °C.
It is then put in a pan of boiling water maintained at 100 °C.
Calculate how much thermal energy the ball gains as its temperature increases from 20 °C to 100 °C.
Specific heat capacity of steel = 510 J/kg °C

(2)

thermal energy gained = ... J

Q7.

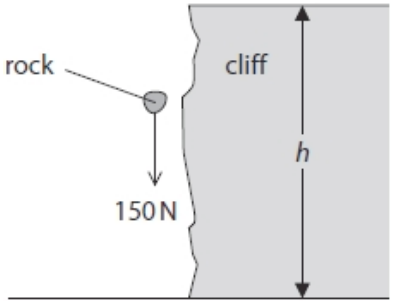
The distance between the Earth and the Sun is 1.50×10^{11} m.
Light takes 500 s to travel from the Sun to the Earth.
The wavelength of red light is 670 nm.
Calculate the frequency of red light, using only the data provided.

(4)

frequency = ... Hz

Q8.

A rock falls off the top of a cliff of height *h*.
Figure 1 shows the rock falling.
The Earth exerts a force of 150 N on the rock.



The work done by this force when the rock falls from the top to the bottom of the cliff is 2700 J.
(i) Calculate the height, *h*, of the cliff.

(2)

h = ... m

(ii) State the value of the kinetic energy of the rock just before it hits the ground.

(1)

kinetic energy = ... J

(iii) The mass of the rock in Figure 1 is 15 kg.
Calculate the velocity of the rock just before it reaches the bottom of the cliff.

(2)

velocity = ... m/s

Q9.

A ball has a mass of 0.046 kg.

(i) Calculate the change in gravitational potential energy when the ball is lifted through a vertical height of 2.05 m.

(2)

change in gravitational potential energy = ... J

(ii) The ball is released.

Calculate the kinetic energy of the ball when the speed of the ball is 3.5 m/s.

(3)

kinetic energy of the ball = ... J

Q10.

Figure 8 shows two ice skaters during a performance.

(i) The two ice skaters are travelling together in a straight line at 3.50 m/s.
Their total momentum is 371 kgm/s.
The man has a mass of 64.5 kg.
Calculate the mass of the woman.

(4)

mass = ... kg

(ii) Calculate the kinetic energy of the man.

(2)

kinetic energy = ... J

Q11.

A beaker contains 0.25 kg of water at room temperature.
The beaker of water is heated until the water reaches boiling point (100 °C).
The specific heat capacity of water is 4200 J/kg °C.
The total amount of thermal energy supplied to the water is 84 000 J.

(i) Calculate the temperature of the water before it was heated.

(3)

temperature before heating = ... °C

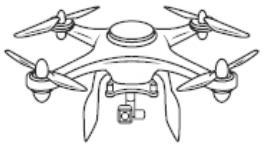
(ii) The heating continues until 0.15 kg of the water has turned into steam.
The thermal energy needed to turn the boiling water into steam is 0.34 MJ.
Calculate the specific latent heat of vapourisation of water.

(2)

specific latent heat = ... MJ/kg

Q12.

Figure 4 shows a drone.



© Liubov Kotliar/123RF

Figure 4

A different drone has a mass of 4.5 kg.
This drone rises from the ground to a height of 20 m.

(i) Calculate the change in gravitational potential energy when the drone rises through a height of 20 m.
The gravitational field strength g = 10 N/kg.

(2)

change in gravitational potential energy = ... J

(ii) State the amount of useful work done by the blades as the drone rises through 20 m.

(1)

useful work done = ... J

(iii) It takes 4 s for the drone to rise through 20 m.
Calculate the useful power developed by the blades in this time of 4 s.

(2)

useful power developed = ... W

Q13.

An electric heater is connected to a 230 V supply.
The power supplied to the heater is 2.6 kW.
Calculate the current in the heater.

(3)

current = ... A

Q14.

(ii) The mass of the piece of copper is 0.058 kg.
The volume of the piece of copper is 6.5×10^{-6} m^3.
Calculate the density of copper.

(2)

density of copper = ... kg/m^3

Q15.

Figure 9 shows a skier on a slope.
The skier travels down the slope with a constant acceleration.
The speed of the skier is measured at points P and Q.

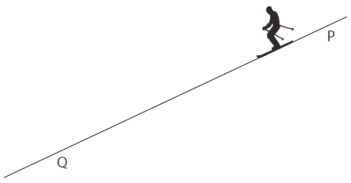


Figure 9

The table in Figure 10 gives some data about the skier making one downhill run.

acceleration	3.0 m/s^2
speed at P	7.6 m/s
speed at Q	24 m/s

Figure 10

(i) Calculate the distance from P to Q.
Use an equation selected from the list of equations at the end of this paper.

(3)

distance from P to Q = ... m

(ii) Calculate the time taken for the skier to travel from P to Q.

(3)

time from P to Q =..... s

Q16.

Figure 8 shows two metal rods carrying a current.
A metal roller touches both rods and completes the circuit.
The roller is in the magnetic field produced by a magnet.

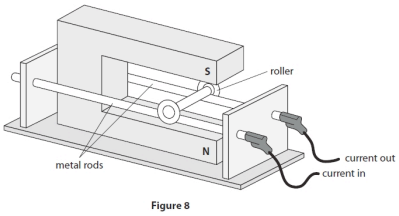


Figure 8

(i) The magnetic flux density of the magnetic field at the roller is 1.2 T.
The current in the roller is 2.5 A.
The length of the roller carrying the current is 0.060 m.
Calculate the force on the roller.

(2)

force on the roller = ... N

Q17.

A radio station transmits on 97.4 MHz.

To receive the waves an aerial needs a length equal to half the wavelength of the radio waves being transmitted.

Calculate the length of the aerial needed.

The speed of the radio waves is 3.00×10^8 m / s.

(3)

length of aerial = ... m

Q18.

A different circuit is then set up with two resistors as shown in Figure 12.

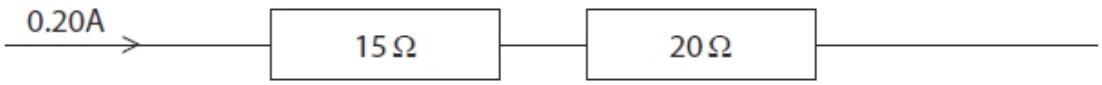


Figure 12

(i) Calculate the potential difference across the 15 Ω resistor.

(2)

potential difference = ... V

(ii) Calculate the total power dissipated when there is a current of 0.20 A in the two resistors.

(2)

power produced ..... W

Q19.

Figure 10 shows two electrical devices for heating water.

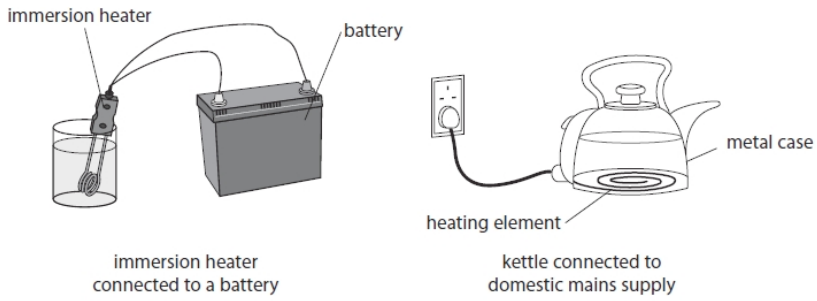


Figure 10

(i) The current in the element of the immersion heater is 14 A.
The power of the immersion heater is 130 W.
Calculate the resistance of the immersion heater.
Give your answer to two significant figures.

(3)

resistance of immersion heater = ... Ω

Q20.

Figure 7 shows an athlete using a fitness device.

The athlete stretches the spring in the device by pulling the handles apart.
The spring constant of the spring is 140 N/m.
The athlete does 45 J of work to extend the spring.
The athlete takes 0.6 s to expand the spring.
(i) Calculate the useful power output of the athlete when stretching the spring.

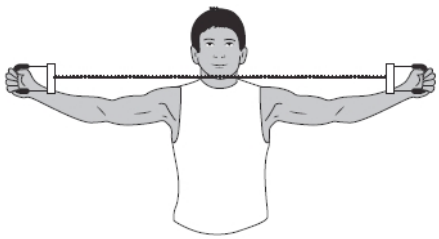


Figure 7

(2)

useful power output of the athlete = ... W

Q21.

A different water wave has a wavelength of 0.25 m and a frequency of 1.5 Hz.
Calculate the wave speed.

(2)

wave speed = ... m/s

Q22.

Figure 23 shows an electric car connected to a battery charger.

Figure 23

(Source: © Danil Roudenko/123RF)

The car has a rechargeable battery to drive its motor.
The rechargeable battery provides a potential difference of 330 V and can store up to 64 MJ.
It takes 8 hours for the battery to receive a full charge.
Assume that the charging process is 100% efficient.

(a) Calculate the total charge that flows while the battery is being charged.

(3)

total charge = ... C

(b) Calculate the average charging current.

(3)

current = ... A

Q23.

Figure 1 shows part of a roller coaster ride seen from the side.

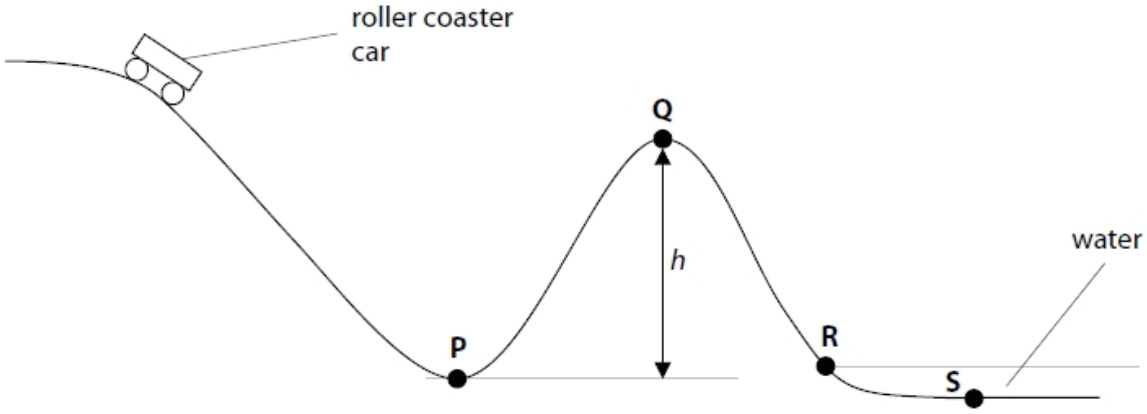


Figure 1

(b) The mass of the car is 580 kg.
The car gains 39 000 J of gravitational potential energy as it climbs from **P** to **Q**.
(i) State the equation relating change in gravitational potential energy, mass, gravitational field strength and change in vertical height.

(1)

(ii) Calculate the height *h*, shown in Figure 1.
(gravitational field strength, *g* = 10 N/kg)

(3)

h = ... m

Q24.

A car travelling at 15 m/s comes to rest in a distance of 14 m when the brakes are applied.
Calculate the deceleration of the car.

(3)

deceleration = ... m/s^2

Q28.

(a) A car accelerates at a constant rate of 1.83 m/s^2 along a flat straight road.
The force acting on the car is 1.870 kN.
Calculate the mass of the car.
Give your answer to three significant figures.

(3)

mass = ... kg

(b) The car accelerates from rest for 16 s.
Calculate the speed of the car after 16 s.

(3)

speed = ... m/s

Q29.

The espresso machine shown in Figure 27 is an electrical appliance.

(Source: © tanawaty/123RF)

Figure 27

The espresso machine has an electrical heater connected to a 440 V mains supply.
The power of the electrical heater is 3.5 kW.

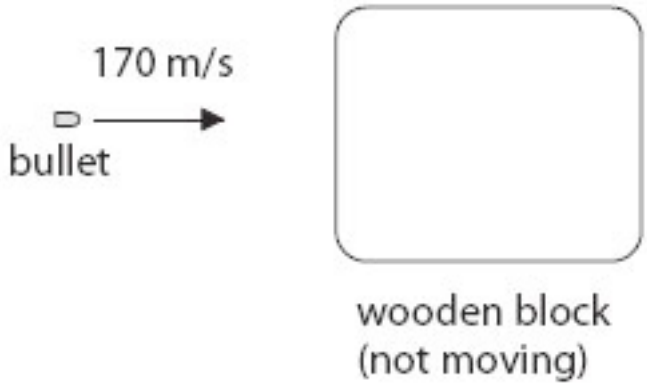
(ii) Before the espresso machine can be used, its heater must raise the temperature of some cold water.
The specific heat capacity of water is 4200 J/kg K.
Show that it takes the heater about 90 s to raise the temperature of 1 kg of water from 18°C to 95°C.
Use an equation from the formula sheet.

(3)

.....

Q30.

(a) The diagram shows a bullet moving towards a wooden block.



(i) The bullet is moving with a velocity of 170 m/s.
The mass of the bullet is 0.030 kg.
Show that the momentum of the bullet is about 5.0 kg m/s.

(1)

.....

(ii) The bullet collides with the wooden block and sticks in it.
The bullet and the wooden block move off together.
The mass of the wooden block is 0.80 kg.
Calculate the velocity of the wooden block and bullet immediately after the collision.

(3)

.....

(ii) Calculate the minimum total energy of the photons produced when an electron and positron collide.

Use the equation
$E = mc^2$
mass of an electron = 9.1×10^{-31} kg
speed of light = 3.0×10^{8} m/s

(2)

.....

Q31.

Figure 8 shows a demolition ball of mass 400 kg.
The ball is used to demolish a wall.

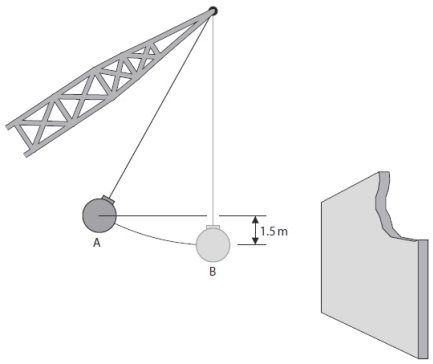


Figure 8

As the ball swings from A to B, it moves through a vertical height of 1.5 m.

(i) Calculate the change in gravitational potential energy.

Take gravitational field strength, g, to be 10 N/kg.

(3)

.....

Q32.

A pilot begins to land an aircraft.
(a) The height of the aircraft decreases from 200 m above the ground to 100 m.
(ii) The velocity of the aircraft when it lands is 75 m/s.
The mass of the aircraft is 130 000 kg.
Calculate the momentum of the aircraft.

(2)

.....

(iii) The aircraft comes to a stop.

State the momentum change of the aircraft from when it lands to when it stops.

(1)

.....

Q33.

The photograph shows a man dropping an egg inside a padded box from a height.

(b) The weight of the egg is 0.6 N.

Calculate the work done on the egg to lift it up by 20 m. State the unit.

(3)

.....

(c) The velocity of the container was 18 m/s as it hit the floor.

The mass of the container was 0.5 kg.

Calculate the momentum of the container.

(2)

.....

Q34.

A man monitors how much money he spends on electricity.

He uses a device which calculates the cost of electrical energy used.

He connects his 2.9 kW electric kettle to the 230 V mains supply.

(i) Calculate the current in the kettle element.

(3)

current = ... A

(ii) The device shows that in one week the total cost of the electrical energy used by the kettle is 97 p.

1kW h of electrical energy costs 17 p.

Calculate the length of time for which the kettle has been switched on during the week.

(3)

time = ... hours

Q35.

A resistor is connected to a power supply.
The potential difference across the resistor is 6.0 V.
(ii) The resistor remains connected for a period of time.
The current in the resistor is 200 mA.
A total charge of 42 C flows through the resistor.
Calculate, in minutes, the time taken for this amount of charge to flow through the resistor.

(3)

time = ... minutes

(iii) Calculate the total energy transferred by the 6.0 V power supply when a charge of 42 C flows through the resistor.

(2)

energy = ... J

Q36.

The International Space Station (ISS) has several solar panels called wings.

(b) In one second, the useful energy available from one wing is 34.3 kJ.
The energy incident on the wing from the Sun is five times this amount.

What is the percentage efficiency of the wing?

(3)

efficiency = ... %

Q37.

A student investigates the motion of a trolley along a horizontal runway.

Figure 6 shows the apparatus.

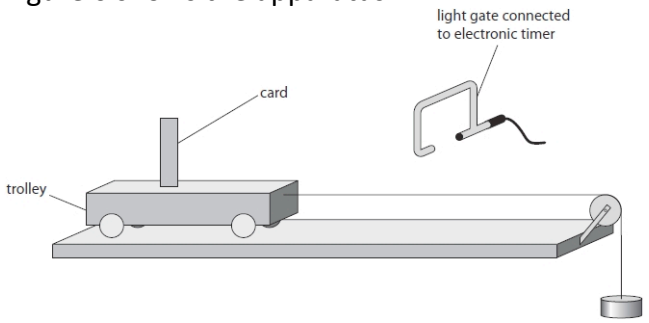


Figure 6

The trolley is attached to a string passing over a pulley.

A 100 g metal disc hangs on the end of the string.

The light gate measures the time it takes for the card to pass through it.

When the trolley is released, it accelerates along the track.

(ii) The card takes 0.040 s to travel through the light gate.

The student calculates that the average speed of the trolley through the light gate is 1.15 m/s.

Calculate the width of the card.

(2)

width = ... cm

(iii) The trolley travels 1.2 m along the track from the start before the card reaches the light gate.

Show that acceleration of the trolley along this distance is approximately 0.55 m/s^2.

(2)

Q38.

(a) A car is travelling along a level road.

(ii) The car now accelerates in a straight line.

Its average acceleration is 12 m/s^2.

Calculate the increase in velocity of the car in 4.0 s.

(3)

.....

Q39.

(iii) The mass of the aeroplane is 750 kg.

Calculate the change in gravitational potential energy of the aeroplane as it descends from 1300 m to the ground.

Gravitational field strength (g) = 10 N/kg

(2)

energy = ... J

Q40.

The speed of light is 3.0×10^{8} m/s.

The wavelength of yellow light is 5.8×10^{-7} m.

Calculate the frequency of yellow light.

State the unit.

(3)

frequency = ... unit .....

Q41.

Andrew skis down a hill.

(i) His mass is 67 kg.

Show that his momentum is about 2000 kg m/s when his velocity is 31 m/s.

(2)

(ii) He falls over when his momentum is 2000 kg m/s.

After he falls over, he slows down by sliding across the snow.

It takes 2.3 s for his momentum to reduce to zero.

Calculate the average force on Andrew as he slows down.

(2)

.....

Q42.

Figure 9 is a diagram showing a rocket that is sent into space to try and change the path of a small asteroid.

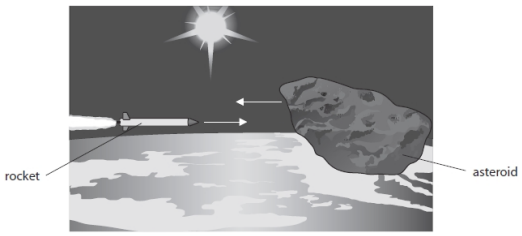


Figure 9

(i) The rocket has a mass of 5.5×10^5 kg and is travelling to the right at 14 km / s.

Which of these is a correct calculation of the momentum of the rocket in kg m / s?
Use the equation

$$p = m \times v$$

(1)

- ☒ **A** 7.7×10^3 kg m / s
- ☒ **B** 7.7×10^6 kg m / s
- ☒ **C** 7.7×10^9 kg m / s
- ☒ **D** 7.7×10^{12} kg m / s

(ii) The asteroid has a momentum of 7.5×10^{10} kg m / s and a mass of 8.0×10^6 kg.

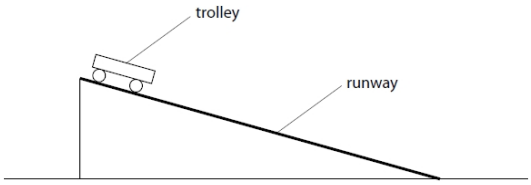
Calculate the speed of the asteroid.

(2)

speed of the asteroid = ... m / s

Q43.

A student investigates how the average speed of the trolley varies with starting height.
Figure 9 shows the trolley and runway.



(b) Figure 10 shows his results.

starting height / m	v / ms^{-1}
0.01	0.22
0.02	0.31
0.04	0.44
0.09	0.66
0.12	0.77
0.14	0.83
0.18	0.94

Figure 10

Figure 11 shows the student's graph.

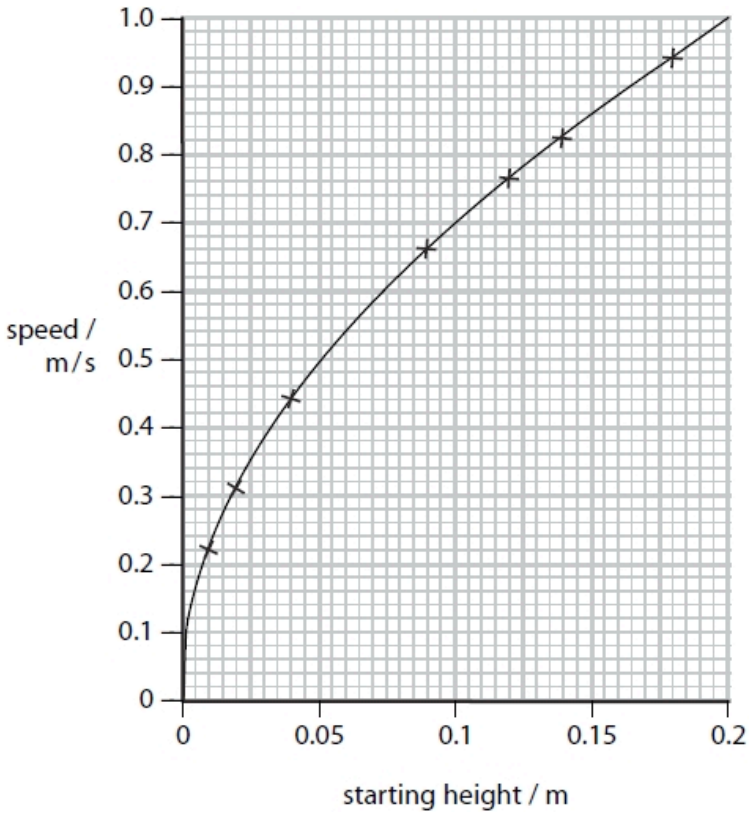


Figure 11

(i) The trolley has a mass of 650 g.
Calculate the average kinetic energy of the trolley which had a starting height of 0.075 m.

(2)

average kinetic energy = ... J

Q44.

Electricity can be generated using a water turbine.

(i) Water gains kinetic energy by falling from the top of a dam.

Calculate the minimum height that 7.0 kg of water must fall to gain 1300 J of kinetic energy.

(3)

minimum height = ... m

(ii) As water enters the turbine at the bottom of the dam, the kinetic energy of 8.0 kg of moving water is 1100 J.
Calculate the speed of the moving water as it enters the turbine.

(3)

speed = ... m/s

Q45.

A pilot begins to land an aircraft.
The aircraft lands with its wheels on the runway as shown.

The aircraft is moving forwards.
(ii) The velocity of the aircraft when it lands is 75 m/s.
The mass of the aircraft is 130 000 kg.
Calculate the momentum of the aircraft.

(2)

.....

(iii) The aircraft comes to a stop.
State the momentum change of the aircraft from when it lands to when it stops.

(1)

.....

Q46.

Two students try to determine a value for *g*, the acceleration due to gravity.
(i) They measure the time, *t*, for a small steel ball to fall through a height, *h*, from rest.
They measure *t* to be 0.74 s, using a stopwatch.
They measure *h* to be 2.50 m, using a metre rule.
Calculate a value for *g* from the students' measurements.
Use the equation

$$g = \frac{2h}{t^2}$$

(2)

g = ... m/s^2

(ii) They record the time *t* for two more drops from the same height.
The three values for time *t* are

0.74 s, 0.69 s, 0.81 s.

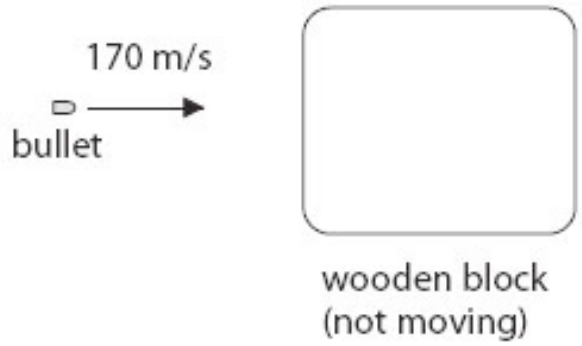
Calculate the average value of time *t* to an appropriate number of significant figures.

(2)

average value of time *t* = ... s

Q47.

The diagram shows a bullet moving towards a wooden block.



(i) The bullet is moving with a velocity of 170 m/s.
The mass of the bullet is 0.030 kg.
Show that the momentum of the bullet is about 5.0 kg m/s.

(1)

(ii) The bullet collides with the wooden block and sticks in it.
The bullet and the wooden block move off together.
The mass of the wooden block is 0.80 kg.
Calculate the velocity of the wooden block and bullet immediately after the collision.

(3)

.....

Q48.

Andrew skis down a hill.

Andrew returns to the top of the hill and starts again.

(i) His mass is 67 kg.

Show that his momentum is about 2000 kg m/s when his velocity is 31 m/s.

(2)

(ii) He falls over when his momentum is 2000 kg m/s.

After he falls over, he slows down by sliding across the snow.

It takes 2.3 s for his momentum to reduce to zero.

Calculate the average force on Andrew as he slows down.

(2)

.....

Q49.

(a) A father pushes his child in a cart. The cart starts to move.

(iii) The child and cart have a total mass of 50 kg. They travel at a velocity of 4 m/s.

Calculate the momentum of the child and cart.

(2)

momentum = ... kg m/s

(iv) The father applies a steady force for a time of 1.5 s. The momentum of the child and cart increases by 450 kg m/s.

Calculate the force which the father applies.

(2)

force = ... N

Q50.

A truck is towing a car along a level road at a constant velocity.

(c) Both vehicles are travelling at 13 m/s.

The driver of the truck then accelerates at 1.2 m/s^2 until both vehicles are travelling at 20 m/s.

(i) Calculate the time taken for this acceleration.

(3)

time = ... s

(ii) The mass of the car is 1400 kg.

Calculate the resultant force on the car needed to produce an acceleration of 1.2 m/s^2.

(2)

force = ... N

Q51.

Figure 18 shows identical filament lamps connected together to a 12 V power supply.

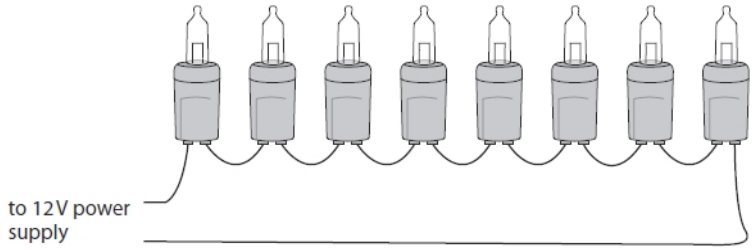


Figure 18

(i) Calculate the potential difference across each lamp.

(1)

potential difference = ... V

(ii) The power output of each lamp is 0.75 W

Calculate the resistance of each lamp.

(4)

resistance = ... Ω

Q52.

Figure 14 shows the vertical forces on an aeroplane.

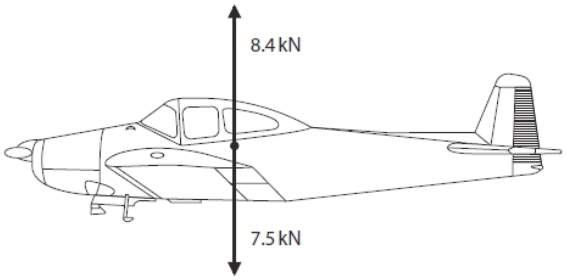


Figure 14

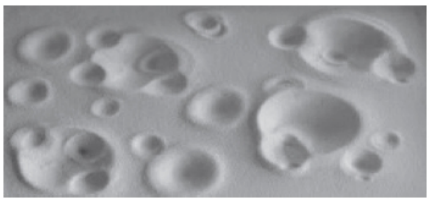
The aeroplane is powered by an engine that burns fuel.
The fuel supplies a total of 6500 kJ of energy every minute.
The efficiency of the engine is 0.70 (70%).
(i) Calculate the power output of the engine.
Give your answer in kW.

(4)

power = ... kW

Q53.

Some students investigate a model of the craters produced by meteorite impacts.



They drop balls into a tray filled with sand.
They use six balls with different masses.
They drop each ball from the same height.
This photograph shows the sand after several balls have hit it.

(c) When one ball hits the sand, it has a velocity of 6.2 m/s.

It has a momentum of 0.46 kg m/s.
(i) Calculate the mass of the ball.

(3)

mass of ball = ... kg

(ii) The ball takes 0.17 s to come to rest after it hits the sand.
Calculate the average impact force.

(2)

average impact force = ... N

Q54.

A car headlamp has a power rating of 55 W when the current in the headlamp is 4.4 A.

(ii) Calculate the resistance of the headlamp.

(3)

resistance = ... Ω

Q55.

Sound travels slower in cold air than it does in warm air.

The equation relating the speed of sound in air to the density of the air is

$$\text{speed of sound} = \frac{K}{\sqrt{(\text{density})}} \qquad \text{where K is a constant.}$$

The table in Figure 7 gives some data about the speed of sound in air and the density of air.

	speed of sound in m/s	density of air in kg / m³
in cold air	331	1.29
in warm air		1.16

Figure 7

Use the equation and the data in the table in Figure 7 to calculate the speed of sound in warm air.
Give your answer to an appropriate number of significant figures.

(3)

speed of sound in warm air = ... m/s

Q56.

(c) A LED lamp has a power rating of 3 W.
The voltage across the lamp is 12 V.
Calculate the current in the lamp.

(3)

current in the lamp =.....A