MYP 4&5 Physics - 2 - copy

Subject	Grade	Points
Physics	**MYP 5**	A 25 B 25 C 25 D 25

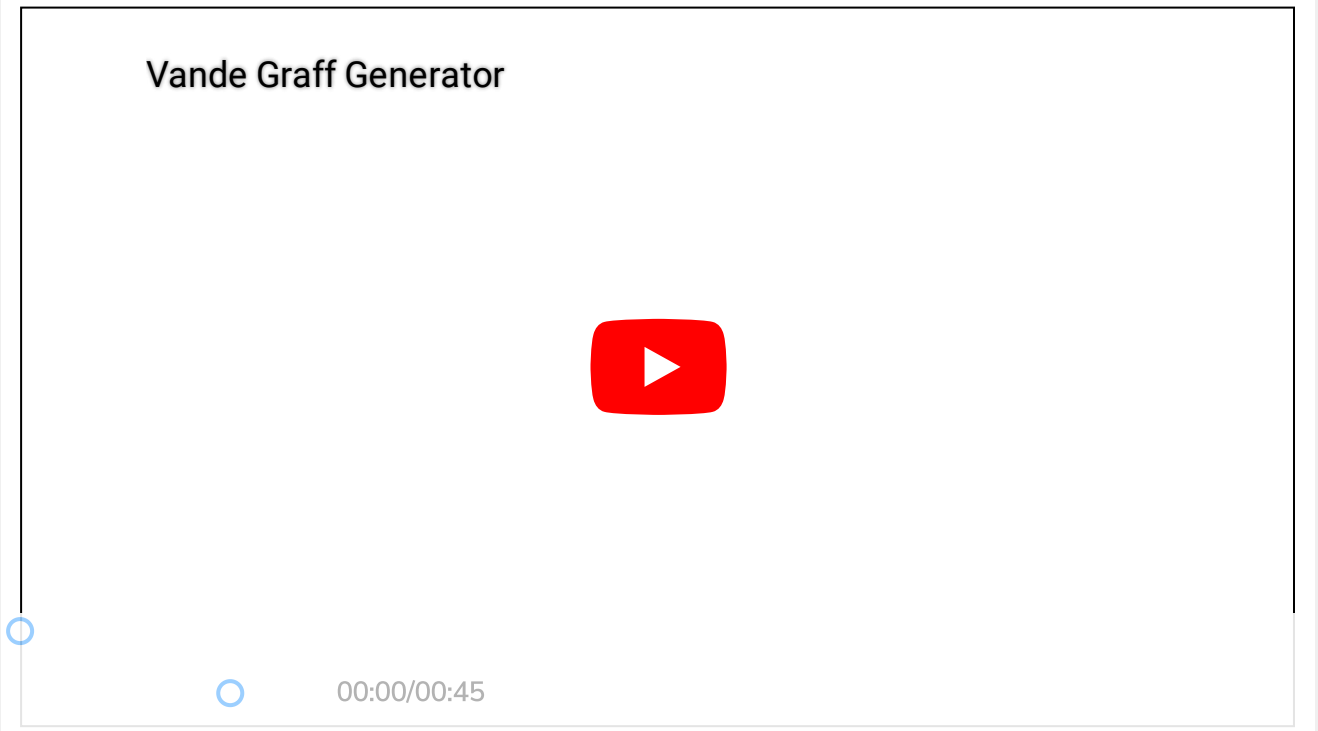
Question 1

Knowing and understanding

This task (questions 1 to 2) addresses the key concept of **relationships** and focuses on **criterion A** (Knowing and understanding).

Static electricity is the accumulation of electric charges on the surface of an object, causing it to attract or repel other charged objects.

Video 1



Q 1.1 In a Van de Graaff generator, the metal sphere is negatively charged. **Determine** the direction in which the electrons will travel. A 2

Words: 0

Q 1.2 **Explain** why the electric field will pull the electrons and the nuclei of air molecules in different directions in a Van de Graaff generator. A 3

Words: 0

Q 1.3 **The presence of a negatively charged metal sphere in a Van de Graaff generator causes nearby objects, such as the ground, to acquire a positive charge through the process of induction. Explain how this works.**

A 5

Words: 0

Question 2

Isotopes of an element exhibit similar chemical properties due to their identical electron configurations and the dominance of electron interactions in chemical reactions.

As a general rule, waves can only be used to see objects that are larger than the wavelength of the waves. Since the wavelength of visible light is about a thousand times larger than an atom, an optical microscope cannot be used to see individual atoms.

Q 2.1 **Compare** and **contrast** the characteristics of transverse waves and longitudinal waves. A 4

Words: 0

Q 2.2 If the wavelength of a wave is 1.5×10^{-10} m, **calculate** the frequency of the wave. A 3

Words: 0

Q 2.3 An electron wave has a frequency of 1.2×10^{15} Hz. **Calculate** the time period of the wave. A 1

Words: 0

Q 2.4 The target nucleus in an experiment is carbon-12 (C-12), which has an atomic number of 6. **Write down** the atomic symbol of this atom. A 1

Words: 0

Q 2.5 A different isotope of carbon, carbon-14 $(C-14)$, has a mass number of 14. **Explain** what is meant by an isotope and how these nuclei differ from the carbon-12 nuclei? A 3

Words: 0

Q 2.6 **Discuss** the reason behind carbon-12 and carbon-14 isotopes exhibiting similar chemical properties? A 3

Words: 0

Question 3

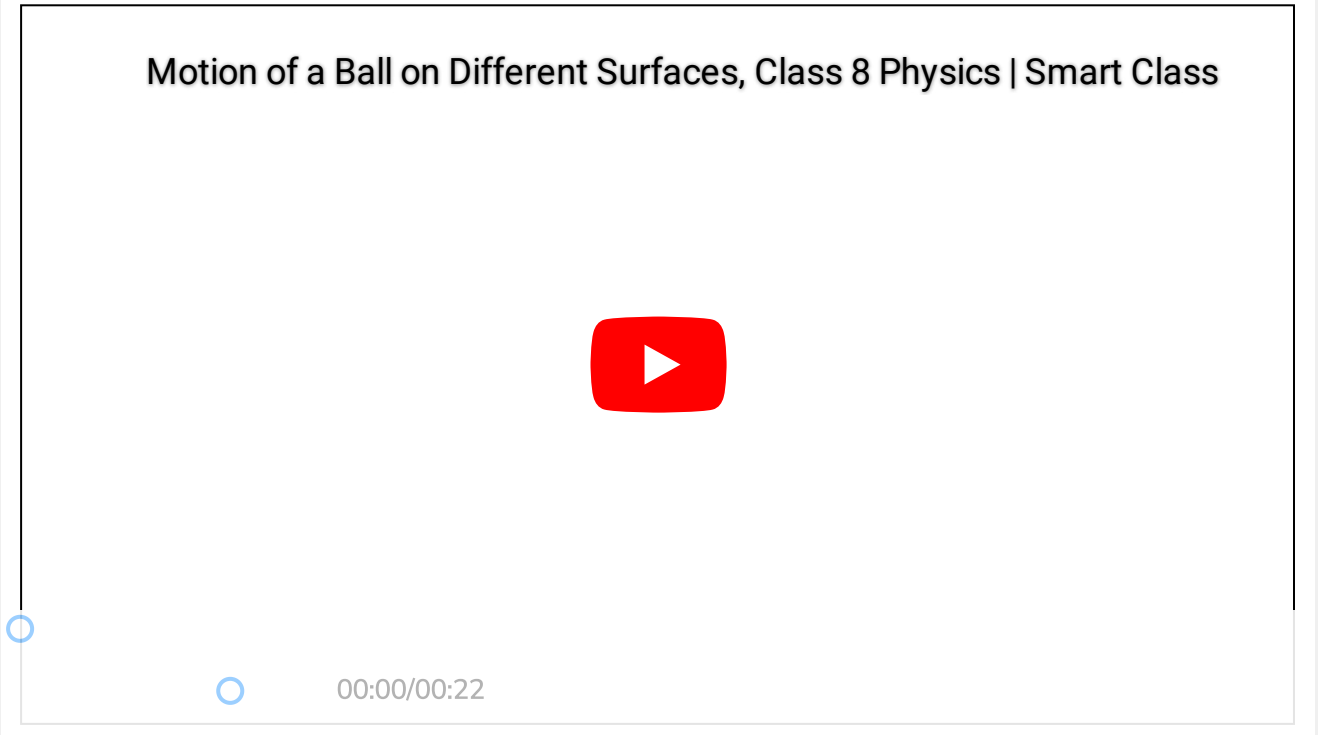
Investigation skills

This task (questions 3 to 5) addresses the key concept of **change** and focuses on **criterion B** (Inquiring and designing) and **criterion C** (Processing and evaluating). In this task you will investigate different changes in physics.

Forces are interactions between objects that cause changes in their motion or shape.

Friction is a force that opposes the relative motion or tendency of motion between two surfaces in contact. It arises due to irregularities and interlocking between the surfaces.

Video 1



An MYP student is interested in learning about the effects of different surfaces on motion.

Q 3.1 **State** a question that would be examined and answered through this research. B 1

Words: 0

Q 3.2 **Identify** the variables for this investigation. B 4

Independent Variable:

Dependent variable:

Control variable 1:

Control variable 2:

Words: 0

The student proposed that, "Increasing the friction between a rolling ball and the surface it rolls on will result in a decrease in its rolling distance."

Q 3.3 **Present** the given data from the video in a tabular form. C 2

Words: 0

Q 3.4 **Evaluate** the validity of the proposed hypothesis. C 2

Words: 0

Q 3.5 **Evaluate** the validity of the method used. C 2

Words: 0

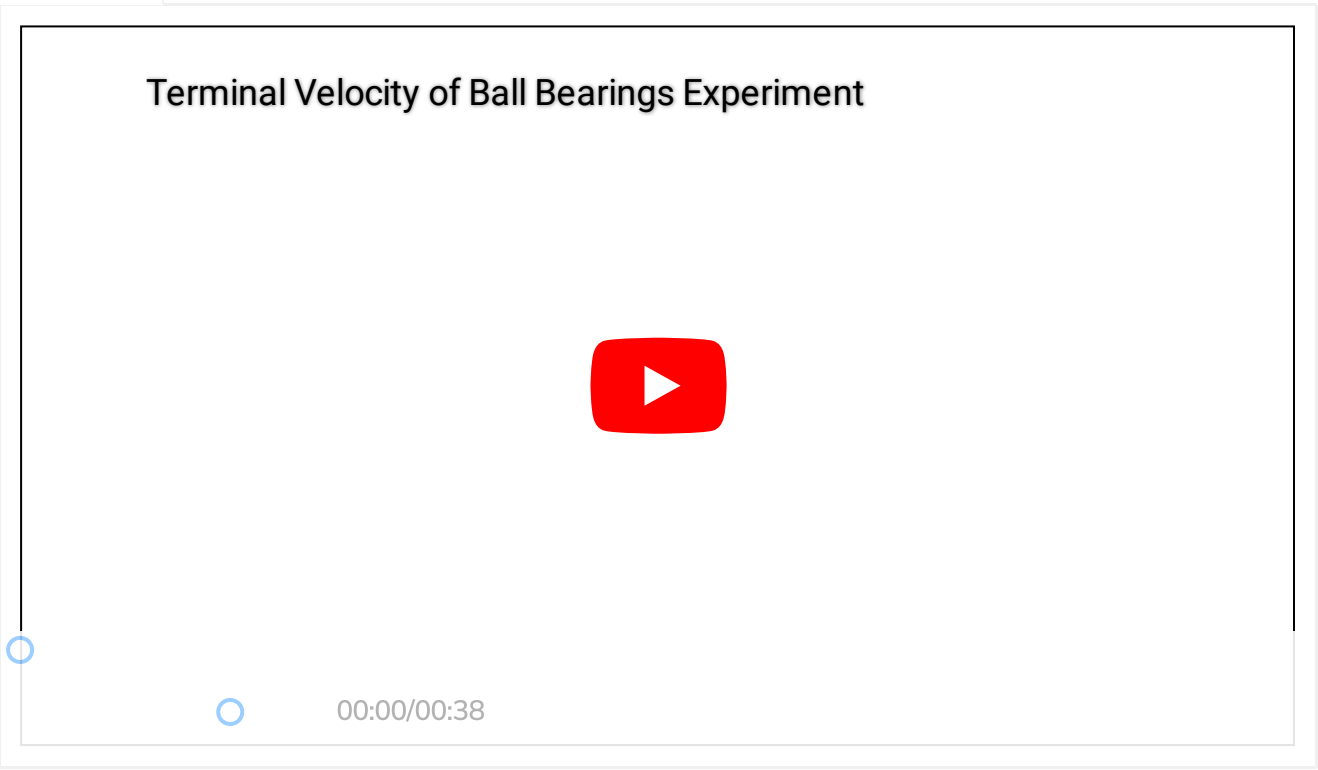
Question 4

The drag force acting on an object moving through a fluid can decrease its efficiency by increasing the energy required to overcome the resistance of the fluid.

Engineers who create fast transportation systems, like airplanes and trains, must pay attention to the impact of drag. At high speeds, drag can decrease efficiency, leading to increased fuel consumption and even destabilization of the vehicle.

To study the effects of drag, you will watch the video and answer the following questions based on your observation.

Video 1



Q 4.1 **Identify** the independent, dependent and control variables. B 4

Independent Variable:

Dependent Variable:

Control Variable 1:

Control Variable 2:

Words: 0

Q 4.2 **Formulate** a hypothesis for the investigation. B 3

When (independent variable) _____ is changed the (dependent variable) _____ will change by _____.

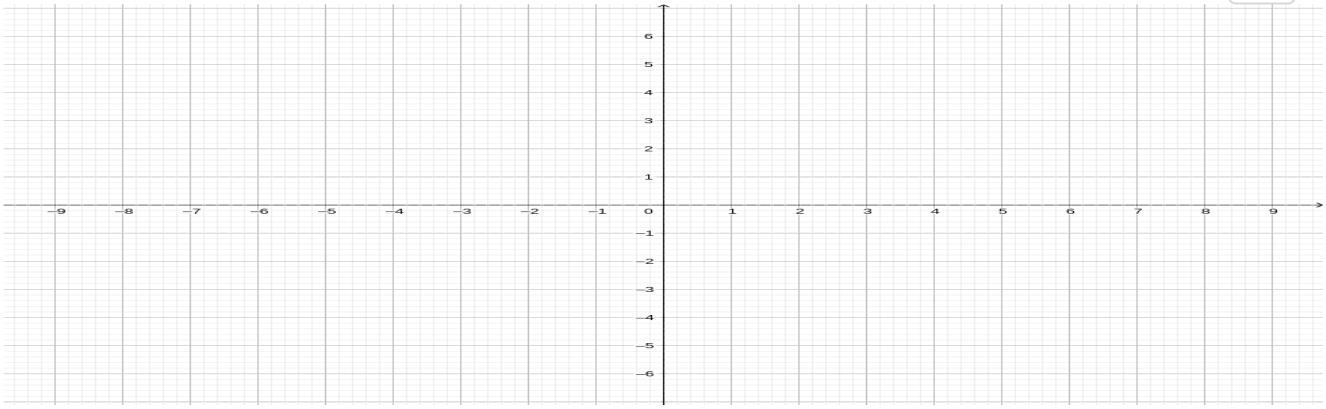
This is because _____.

Words: 0

Q 4.3 **Organize** and **present** the data table using the readings observed in the video. C 4

Words: 0

Q 4.4 **Plot** a graph using the data provided in the observation table from Q 4.3. C 6



Q 4.5 **Interpret** the graph and **comment** on the observations. C 3

Words: 0

Q 4.6 **Identify** the anomalous values in the data collected. **Suggest** a reason for this anomality. C 3

Words: 0

Q 4.7 **Evaluate** the validity of the method used. C 2

Words: 0

Q 4.8 **Suggest** an extension to this investigation. C 1

Words: 0

Question 5

An MYP student decided to investigate the relationship between the shape of an object and the time taken by it to reach the bottom of the cylindrical jar containing liquid.

Q 5.1 **Design** an investigation to help him understand the relationship between the shape of the object and the time taken by it to reach a particular distance through a liquid. In your answer you should include: B 13

- A research question
- A hypothesis to be investigated
- Equipment needed for the investigation
- The variables involved in the investigation
- The method you will follow.

Words: 0

Question 6

Applying science

The global context is **identities and relationships**. This task (questions 6 to 7) addresses the key concept of **systems** and assesses **criterion D** (Reflecting on the impacts of science).

Systems play an important role in astrophysics, as the universe is a vast and complex system made up of countless smaller systems.

The quest to locate exoplanets has resulted in the discovery of numerous planets that bear resemblances to Earth. This discovery has sparked curiosity as to whether these planets may also sustain life. The data for some of these planets is presented in the table below.

Planet name	Orbital radius (AU)	Orbital period (days)	Planet mass (Earth masses)	Planet radius (Earth radii)	Planet temperature (K)	Host star mass (Solar masses)	Host star temperature (K)
Earth	1	365.25	1	1	287	1	5,730
HD 38283b	1.02	363.2	108	?	?	1.08	5,998
Kepler-952b	0.5	130.4	?	7.6	347	0.99	5,730
HD 142245b	2.77	1,299	604	?	288	1.69	4,878
Trappist-1d	0.02	4.05	0.41	0.772	288	0.08	2,559

Q 6.1 Astronomers are interested in investigating whether other planets have life. **Discuss** and **evaluate** if it is a wise decision to search for extraterrestrial life when humans are still finding new species deep in the ocean. D 5

Words: 0

Q 6.2 **Describe** the advantages and disadvantages of the environments of these planets for supporting life. D 8

Words: 0

Question 7

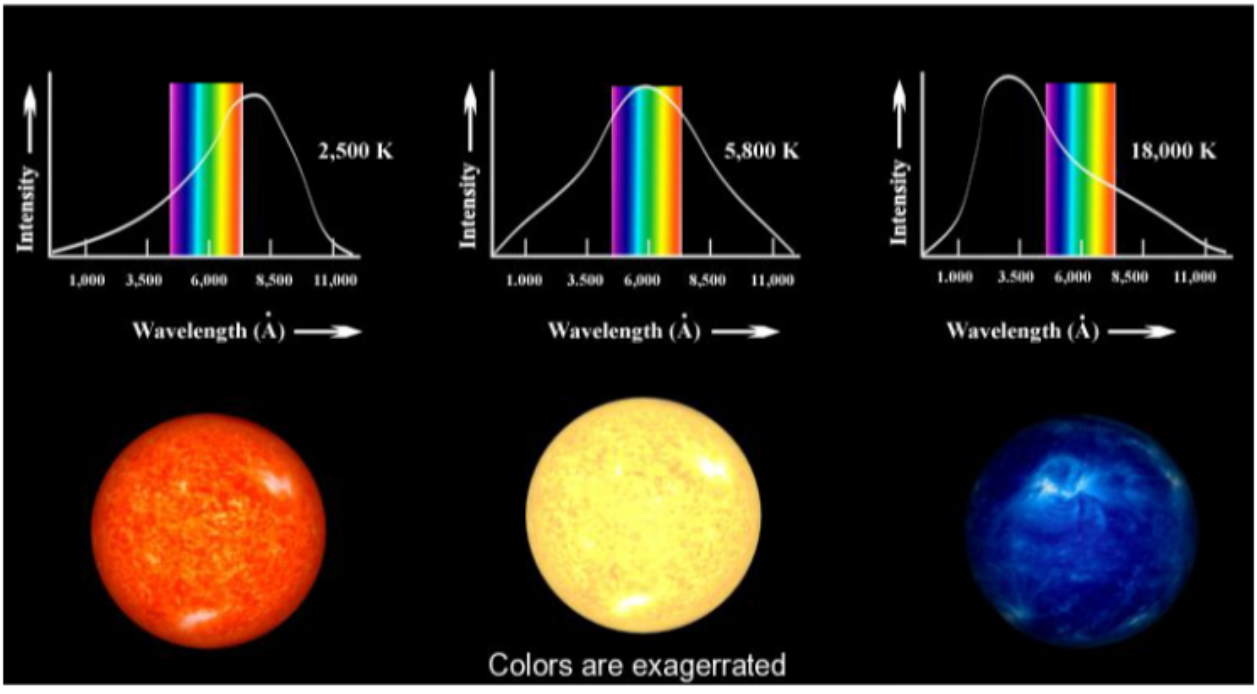
Astronomers determine a star's temperature by analyzing its spectrum using a spectroscope.

Astronomers can determine the temperature of the star by identifying the spectral lines and comparing their strength with the spectra of stars of known temperature. The temperature of a star can be determined by analysing its spectrum using the following steps:

Obtain the spectrum: To obtain the spectrum of a star, astronomers use a device called a spectroscope. The light from the star is passed through a prism, which separates the light into its component colours. This produces a spectrum, which shows the different wavelengths of light that the star is emitting.

Identify the spectral lines: The spectrum of a star contains dark lines or bands, which correspond to specific wavelengths of light that have been absorbed by the elements in the star's atmosphere. By comparing these lines with the known spectra of elements on Earth, astronomers can identify the elements present in the star.

Determine the temperature: The temperature of a star can be determined by analysing the strength of the spectral lines. The strength of these lines depends on the temperature of the star's atmosphere. Hotter stars have stronger spectral lines than cooler stars. By comparing the strength of the lines in a star's spectrum with the spectra of stars of known temperature, astronomers can determine the temperature of the star.



Q 7.1 **Describe** the working of a spectroscope. D 2

Words: 0

Q 7.2 **Explain** the formation of spectral lines. D 3

Words: 0

Q 7.3 **Justify** the relation of spectral lines strengths to the temperature of a star. D 3

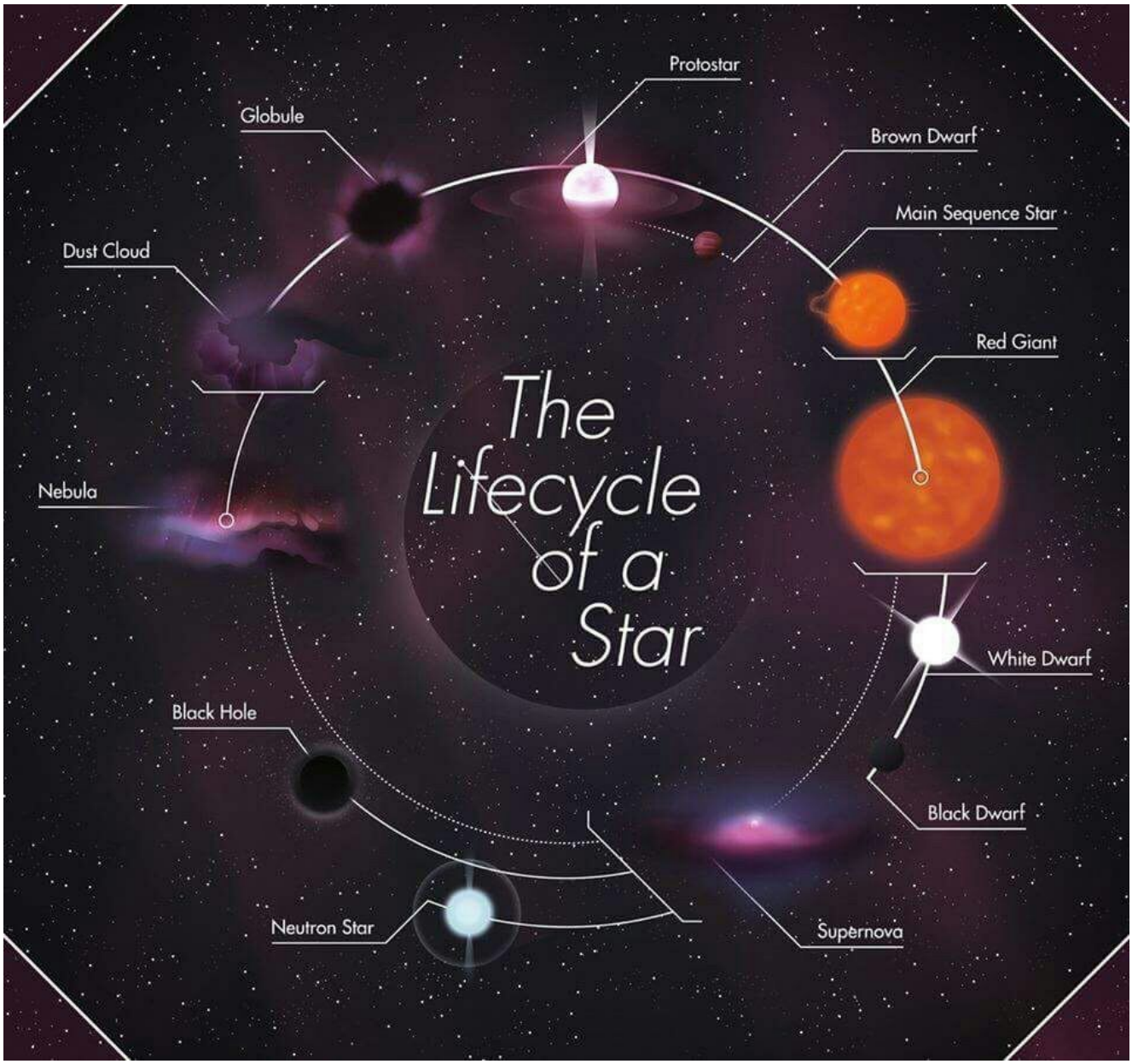
Words: 0

Stars are massive, luminous spheres of plasma held together by their own gravity. They form from clouds of gas and dust in space called nebulae, which collapse under the force of gravity to form protostars. As protostars continue to collapse and heat up, they eventually begin to undergo nuclear fusion reactions in their cores, which cause them to become full-fledged stars.

Most stars spend the majority of their lives in a phase known as the main sequence, where they are fusing hydrogen in their cores to create helium. However, as they begin to run out of fuel, they will begin to expand and cool, becoming red giants. Eventually, red giant stars will shed their outer layers into space and become planetary nebulae, leaving behind a white dwarf that will slowly cool down over billions of years. More massive stars will undergo a more violent end to their lives, exploding in a supernova and either becoming a neutron star or a black hole depending on their original mass.

Life cycle of a star

Image 1



Q 7.4 **Explain** the formation of a star and the end of the life cycle of the massive star. D 4

Words: 0

Name:

Subject : Physics

Grade : MYP 4

Topic : Mid Term Syllabus

MYP 4/5 Science : Physics

Criterion A : Knowing and understanding

Achievement level	Level descriptor
7–8	The student is able to: i. **explain** scientific knowledge ii. apply scientific knowledge and understanding to **solve problems** set in **familiar and unfamiliar situations** iii. **analyse** and **evaluate** information to make **scientifically supported judgments**.

Criterion B : Inquiring and designing

Achievement level	Level descriptor
7–8	The student is able to: i. **explain** a problem or question to be tested by a scientific investigation ii. **formulate and explain** a testable hypothesis **using correct scientific reasoning** iii. **explain** how to manipulate the variables, and **explain** how **sufficient, relevant data** will be collected iv. **design** a **logical, complete and safe method** in which he or she **selects appropriate materials and equipment**..

Criterion C : Processing evaluating

Achievement level	Level descriptor
7–8	The student is able to: i. **correctly collect, organize, transform and present** data in numerical and/or visual forms ii. **accurately interpret** data and **explain** results **using correct scientificreasoning** iii. **evaluate** the validity of a hypothesis based on the outcome of a scientific investigation iv. **evaluate** the validity of the method based on the outcome of a scientific investigation v. **explain** improvements or extensions to the method that would benefit the scientific investigation

Criterion D : Reflecting on the impacts of science

Achievement level	Level descriptor
7–8	The student is able to: i. **explain** the ways in which science is applied and used to address a specific problem or issue ii. **discuss and evaluate** the implications of using science and its application to solve a specific problem or issue, interacting with a factor iii. **consistently apply** scientific language to communicate understanding **clearly and precisely** iv. document sources **completely**

INSTRUCTIONS:

Write your name on top of the Answer sheet.
Write in dark blue font
Answer **all** questions.
Write your answers in the spaces provided.
You can use Phet-Simulation or Paint, calculator
Formulae sheet is provided in the Exam folder

Command Terms:

Analyze:*Break down in order to bring out the essential elements or structure. To identify parts and relationships, and to interpret information to reach conclusions.*
Apply: *Use knowledge and understanding in response to a given situation or real circumstances*
Construct: *Develop information in a diagrammatic or logical form*
Deduce: *Reach a conclusion from the information given.*
Define: *Give the precise meaning of a word, phrase, concept or physical quantity.*
Describe: *Give a detailed account or picture of a situation, event, pattern or process*
Design: *Produce a plan, simulation or model.*
Discuss: *Offer a considered and balanced review that includes a range of arguments, factors or hypotheses. Opinions or conclusions should be presented clearly and supported by appropriate evidence.*
Explain: *Give a detailed account including reasons or causes.*
Evaluate: *Assess the implications and limitations; make judgments about the ideas, works, solutions or methods in relation to selected criteria.*
Identify: Provide an answer from a number of possibilities. Recognize and state briefly a distinguishing fact or feature.
Interpret: *Use knowledge and understanding to recognize trends and draw conclusions from given information.*
Investigate: *Observe, study, or make a detailed and systematic examination, in order to establish facts and reach new conclusions.*
Recall: *Remember or recognize from prior learning experiences*
Show: *Give the steps in a calculation or derivation.*
State: *Give a specific name, value or other brief answer without explanation calculation.*
Suggest: *Propose a solution, hypothesis or other possible answer.*
Calculate:*Obtain a numerical answer showing the relevant stages in the working.*

Question 1 (12 marks)

A raindrop falls from a cloud that is 500 m above the ground.

Question 2a (3 marks)

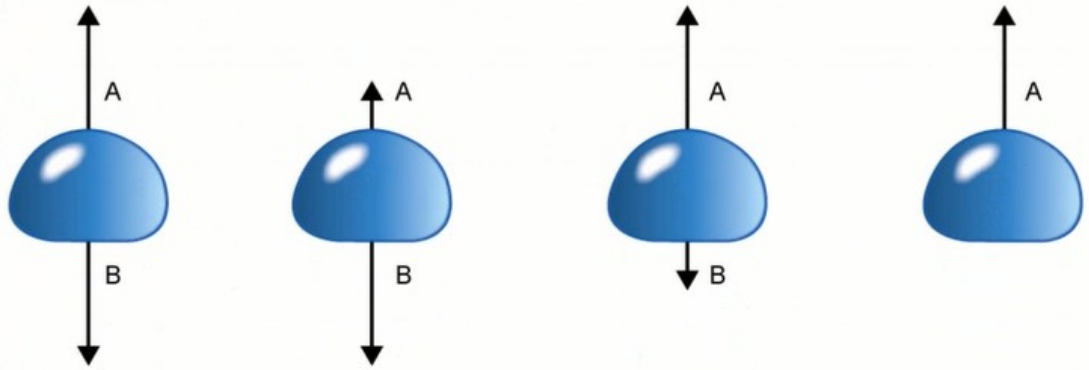
Calculate the theoretical maximum velocity of the raindrop before it hits the ground. Assume that the acceleration due to gravity, g, is equal to 10 ms^{-2}.

Ans:

Question b (1 mark)

The raindrop does not reach this theoretical maximum speed: instead it reaches the terminal velocity.

Select the free body diagram that shows the forces acting on the raindrop when it reaches its terminal velocity.



1. ○ 2. ○ 3. ○ 4. ○

Ans:

Question 2c (1 mark)

Label the forces A and B.

Force A

Force B

A:
B:

Question d (1 mark)

A typical raindrop has a mass of 3.0×10^{-5} kg.

State the mass of the raindrop in grams (g).

Ans:

Question e (2 marks)

Use your answers to part (a) and part (d) to **calculate** the maximum final theoretical momentum of the raindrop. You should include the unit in your answer.

Ans:

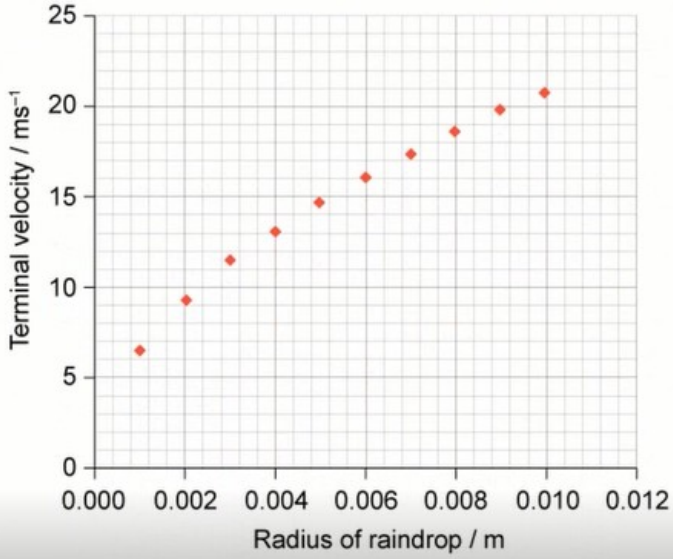
Question f (2 marks)

A student reads that the terminal velocity of a raindrop is determined by its radius.

To determine experimentally if this is true, the student makes the following prediction:

"The terminal velocity of a raindrop is proportional to the radius of the raindrop because the weight will be larger."

The student measures the terminal velocity of different raindrops and produces the following graph.

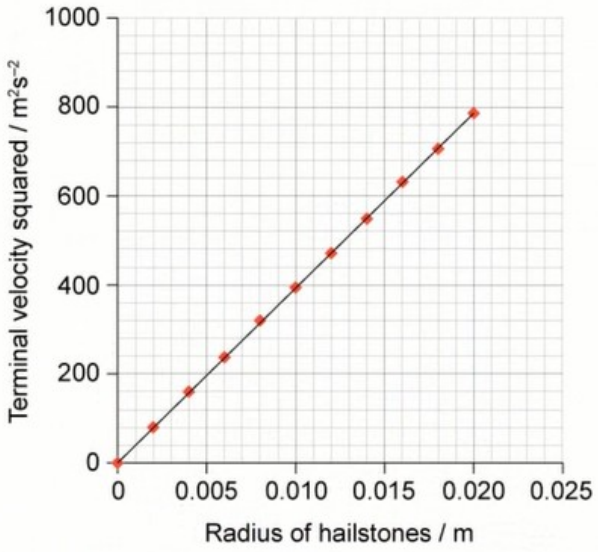


Use the graph to **discuss** the validity of the hypothesis.

Ans:

Question g (2 marks)

A second student decides to complete a similar investigation to measure the terminal velocity of hailstones. He draws a different graph of the results shown below.



Explain what these results show about the relationship between the radius of hailstones and terminal velocity.

Ans:

Question-2

Question (16 marks)

A student living in Tanzania decides to investigate if there is a relationship between the altitude (height above sea level) and the boiling point of water.

She climbs Mount Kilimanjaro recording the temperature at which water boils at different altitudes, from the bottom of the mountain to the top.

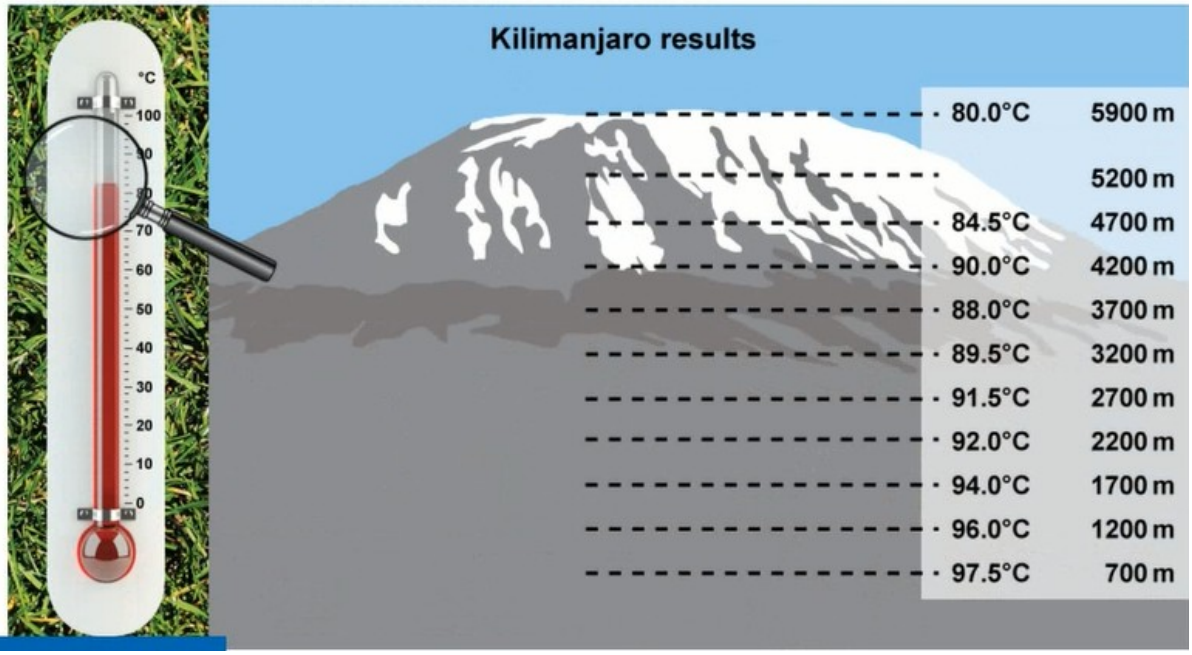
She records her results on a picture of the mountain, shown below.

Question a (3 marks)

The student forgot to label the table correctly. **Write down** labels for heading 1 and heading 2. At 5200 m the student did not record a temperature, but took a photo of the thermometer. **Measure** the temperature shown in the photograph and add it to the results table.

This media is interactive

Click on the magnifying glass to enlarge the thermometer.



Heading 1	Heading 2
5900	80.0
5200	
4700	84.5
4200	90.0
3700	88.0
3200	89.5
2700	91.5
2200	92.0
1700	94.0
1200	96.0
700	97.5

Heading 1:

B I U x_2 x^2 Ω Σ Styles

Heading 2:

Ans:

Question b (2 marks)

Explain why a bar chart is not appropriate to display these results.

Ans:

Question c (2 marks)

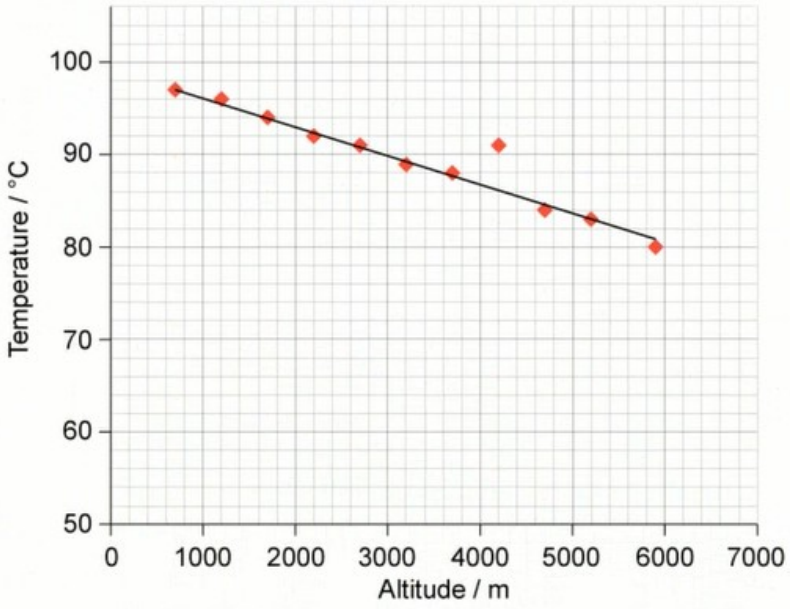
Air pressure reduces as altitude increases.

Resource 01

Before starting her climb, the student writes the following hypothesis:

"As the altitude increases the boiling point will increase. The water molecules will find it harder to escape from the liquid because the pressure is dropping as you go up the mountain."

Once she has completed the experiment the student presents her results on the following graph.



Identify which altitude produced an anomalous result and **justify** your answer.

Ans:

Question d (2 marks)

Outline what this graph shows about the relationship between altitude and boiling temperature of water.

Ans:

Question e (4 marks)

Explain the results of the investigation using particle theory.

Ans:

Question f (2 marks)

"As the altitude increases the boiling point will increase. The water molecules will find it harder to escape from the liquid because the pressure is dropping as you go up the mountain."

Use the results shown on the graph in part (c) to **comment** on the validity of the hypothesis.

Ans:

Question g (1 mark)

Suggest an extension to this investigation.

Ans:

Question-03 (Use Resource 02)

Question (22 marks)

A second student in the class carries out an investigation using a trolley. He investigates how a trolley's stopping distance is affected by the drag force created by a sail, on a horizontal surface. The friction between the wheels and the track is negligible. The variables in the investigation are:

Independent variable:

Area of the sail

Dependent variable:

Stopping distance

Control variable 1:

Initial speed of the trolley

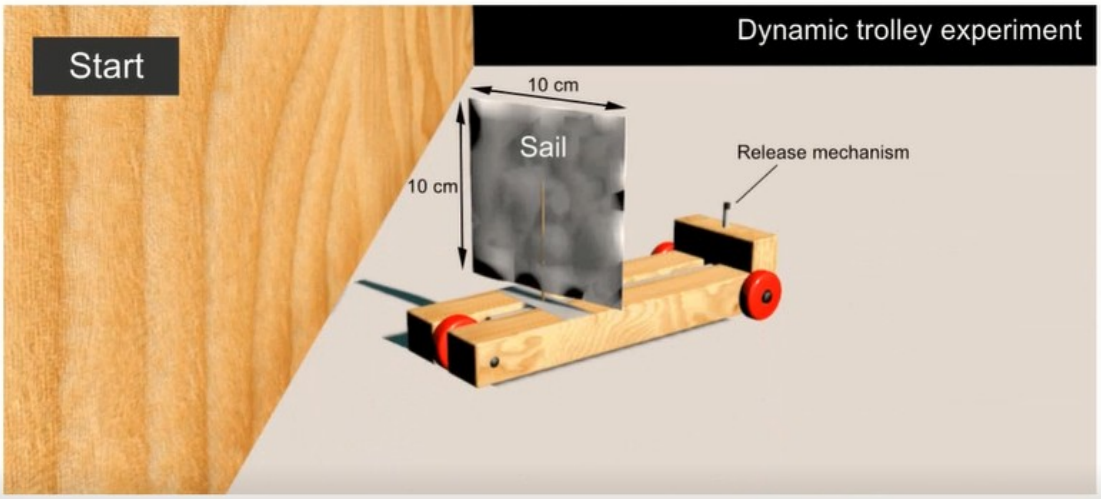
Control variable 2:

Mass of the trolley

Question (3 marks)

Take appropriate measurements and use your measurements to **determine** the stopping distance of the trolley.

This media is interactive



A student repeated the investigation with a circular sail. The student's data for stopping distance and sail radius is given below.

(Consider: Student uses Circular Snail with radius values given)

Question (5 marks)

Organize and **present** the radius and stopping distance data in a suitable table.

Ans: (Insert table by your own)

Question (2 marks)

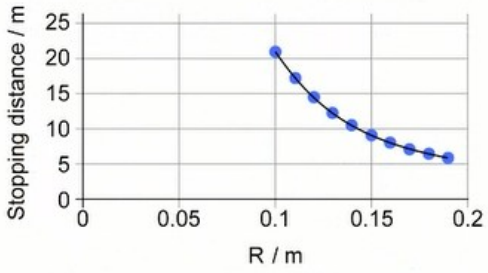
Explain why a scatter/line graph is the most appropriate choice to display and analyse these results.

Question (2 marks)

Before recording his results, the student writes the following hypothesis:

"As the radius of the sail increases, the stopping distance will decrease. Stopping distance will be inversely proportional to radius."

Once the student has completed the experiment he produces the following graph.



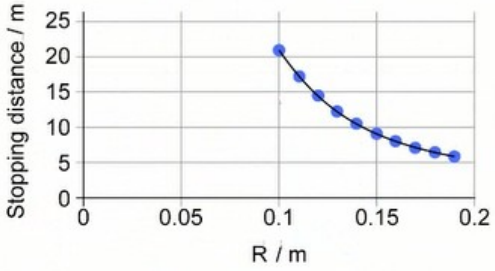
Outline what this graph shows about the relationship between stopping distance and radius.

Styles

Ans: **Use Resource 2 to see further Graphs**

Graph 1 Graph 2 Graph 3 Graph 4

Sail experiment: graph showing stopping distance against sail radius



Question 7e (1 mark)

Deduce the relationship between the variables.

Styles

Ans:

Question (3 marks)

Explain the results of the investigation using scientific reasoning.

Ans:

Question (2 marks)

Evaluate the validity of the hypothesis.

Ans:

Question (1 mark)

Suggest an extension to this investigation.

Ans:

Question 3 marks)

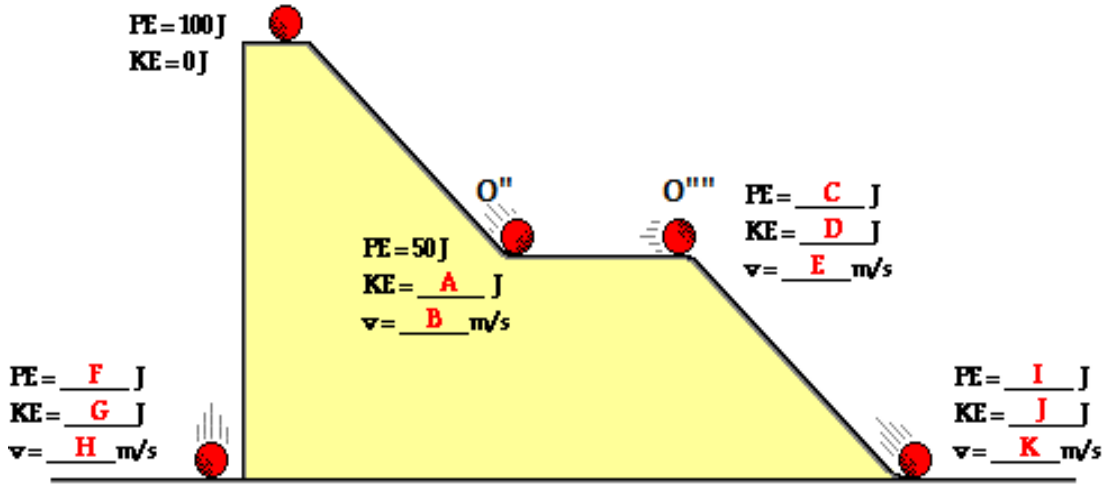
Formulate and **explain** a hypothesis that the extension in part (h) would test.

Ans:

Question-04

Use your understanding of the work-energy theorem to answer the following questions.

1. Consider the falling and rolling motion of the ball in the following two resistance-free situations. In one situation, the ball falls off the top of the platform to the floor. In the other situation, the ball rolls from the top of the platform along the staircase-like pathway to the floor. For each situation, indicate what types of forces are doing work upon the ball. Indicate whether the energy of the ball is conserved and explain why. Finally, fill in the blanks for the 2-kg ball.



(i) **Calculate** the indicated Values and fill the column below:

Indicated Options	Answers
A	
B	
C	
D	
E	
F	
G	
H	

ii) From O" to O"" surface has got friction due to which 20 J energy is lost **calculate** the value of velocity when the ball will hit the ground.

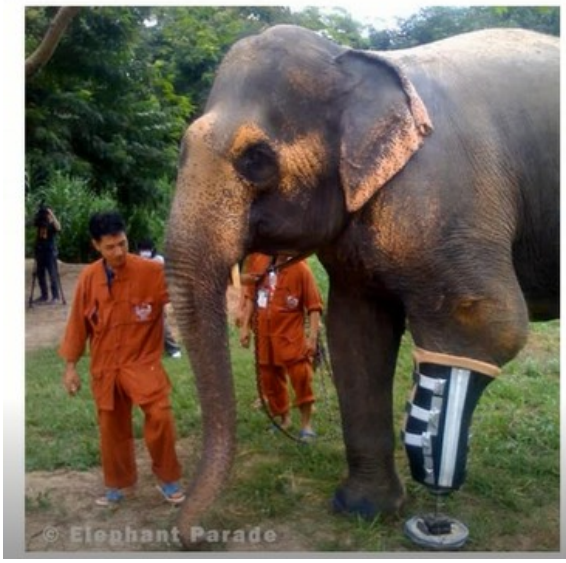
ii) **Calculate** the value of height when the block is at top of ramp, take the value of gravitation field strength to be 10 N Kg^{-1}.

Question-05

Question (14 marks)

Land mines around the world are responsible for thousands of injured people and animals. As advanced prosthetic limbs are not affordable to people on low incomes, solutions have been found for reducing costs to help amputees. Recycled aluminium was used to give an elephant that stepped on to a land mine the possibility of walking again. Human understanding of scientific principles was used to create the artificial leg.

Question (2 marks)



Calculate the pressure on the ground when an elephant weighing 30 000 N is standing on only three feet. Assume each foot has an area of 0.2 m^2.

Ans:

Question (5 marks)

Explain how the design of the prosthesis takes account of pressure when:

creating contact with the ground

providing comfort to the elephant when connecting the prosthesis to its upper leg.

Question (7 marks)

Outline the advantages and disadvantages a prosthetic limb would have on an elephant when returned to its natural habitat. **Evaluate** whether or not you think elephants with prosthetic limbs should be returned to their natural habitat.

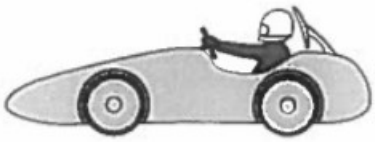
Ans:

Question-06

6 (a) Some students have designed and built an electric-powered go-kart. After testing, the students decided to make changes to the design of their go-kart.

First design **X**

Final design **Y**



The go-kart always had the same mass and used the same motor.

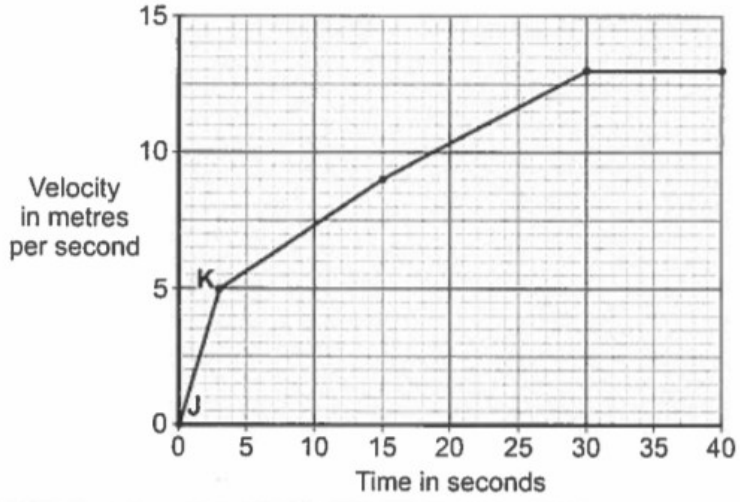
The change in shape from the first design (**X**) to the final design (**Y**) will affect the top speed of the go-kart.

Explain why.

Ans:

(b) The final design go-kart, **Y**, is entered into a race.

The graph shows how the velocity of the go-kart changes during the first 40 seconds of the race.



(b) (i) Use the graph to calculate the acceleration of the go-kart between points **J** and **K**.

Give your answer to **two** significant figures.

Ans:

(b) (ii) Use the graph to calculate the distance the go-kart travels between points **J** and **K**.

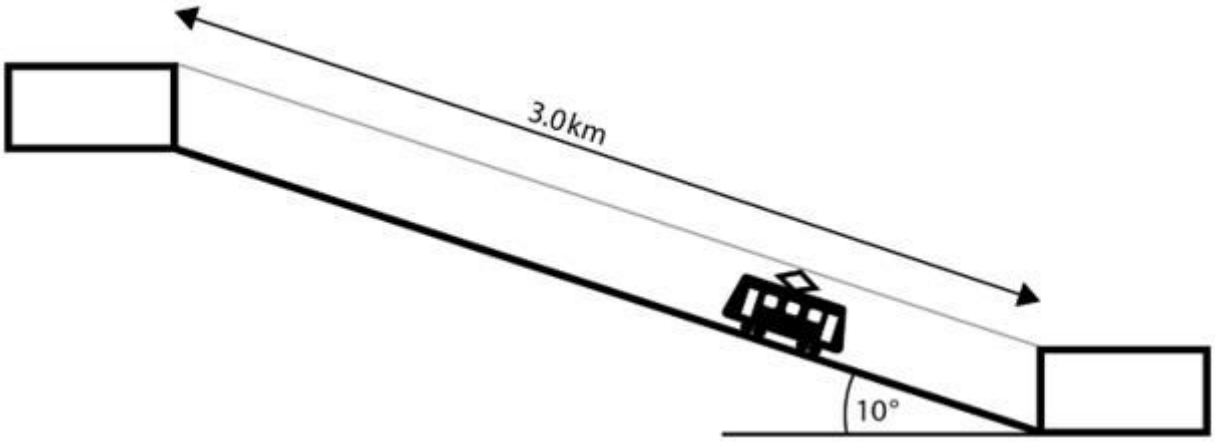
Ans:

(b) (iii) What causes most of the resistive forces acting on the go-kart?

Ans:

1. EXE.2.SL.TZ0.2

An Alpine village uses an electric tram system to transport visitors from a lower station up to an upper station at the village. The length of the tramline is 3.0 km and the gradient of the tramline is a constant 10°.



The tram has a weight of 5.0×10^4 N and can carry a maximum of 75 passengers of average weight 710 N.

The energy is supplied to each tram through a single overhead cable with a resistance per unit length of 0.024 Ω km^{-1}. The tram rails are used for the return path of the current. The return path and the connections from the cable to the electric motor in the tram have negligible resistance.

The power supply maintains a constant emf of 500 V between the rails and the cable at the upper station.

Assume that the current through the motor is constant at 600 A and that the motor efficiency is always 0.90 for the entire range of voltages available to the tram.

(a)

A tram is just leaving the lower railway station.

Determine, as the train leaves the lower station,

[[N/A]]

(a.i)

the pd across the motor of the tram,

[2]

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(a.ii)

the mechanical power output of the motor.

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(b)

Discuss the variation in the power output of the motor with distance from the lower station.

[2]

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(c)

The total friction in the system acting on the tram is equivalent to an opposing force of 750 N.

For one particular journey, the tram is full of passengers.

Estimate the maximum speed *v* of the tram as it leaves the lower station.

[4]

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(d)

The tram travels at *v* throughout the journey. Two trams are available so that one is returning to the lower station on another line while the other is travelling to the village. The journeys take the same time.

It takes 1.5 minutes to unload and 1.5 minutes to load each tram. Ignore the time taken to accelerate the tram at the beginning and end of the journey.

Estimate the maximum number of passengers that can be carried up to the village in one hour.

[4]

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(e)

There are eight wheels on each tram with a brake system for each wheel. A pair of brake pads clamp firmly onto an annulus made of steel.

The train comes to rest from speed *v*. Ignore the energy transferred to the brake pads and the change in the gravitational potential energy of the tram during the braking.

Calculate the temperature change in each steel annulus as the tram comes to rest.

Data for this question

The inner radius of the annulus is 0.40 m and the outer radius is 0.50 m.

The thickness of the annulus is 25 mm.

The density of the steel is 7860 kg m^{-3}

The specific heat capacity of the steel is 420 J kg^{-1} K^{-1}

[4]

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(f)

The speed of the tram is measured by detecting a beam of microwaves of wavelength 2.8 cm reflected from the rear of the tram as it moves away from the station. Predict the change in wavelength of the microwaves at the stationary microwave detector in the station.

[2]

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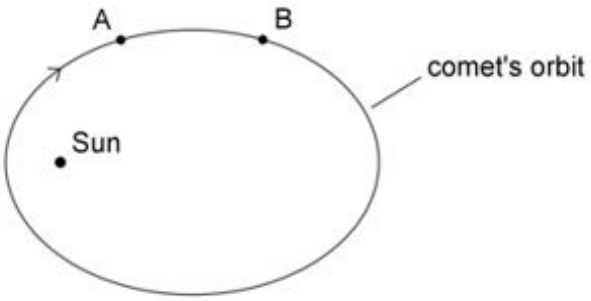
2. EXE.2.SL.TZ0.11

(a)

A comet orbits the Sun in an elliptical orbit. A and B are two positions of the comet.



Explain, with reference to Kepler's second law of planetary motion, the change in the kinetic energy of the comet as it moves from A to B.

[3]

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(b)

An asteroid (minor planet) orbits the Sun in a circular orbit of radius 4.5×10^8 km. The radius of Earth's orbit is 1.5×10^8 km. Calculate, in years, the orbital period of the asteroid.

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3. EXE.2.SL.TZ0.12

One of Kepler's laws suggests that for moons that have circular orbits around a planet:

$$\frac{T^2}{4\pi r^3} = k$$

where T is the orbital period of the moon, r is the radius of its circular orbit about the planet, and k is a constant.

(a)

Show that $k = \frac{1}{GM}$.

[2]

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(b)

The table gives data relating to the two moons of Mars.

Moon	T / hour	r / Mm
Phobos	7.66	9.38
Deimos	30.4	-

Determine r for Deimos.

[2]

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(c)

Determine the mass of Mars.

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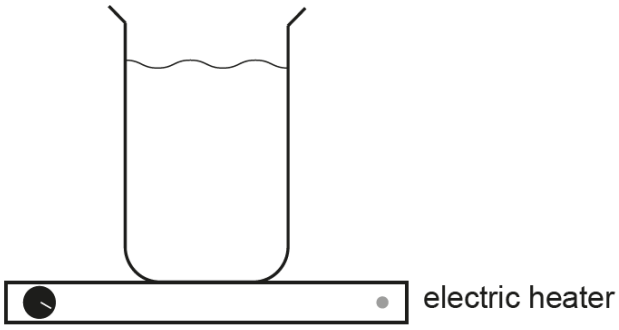
4. 24M.2.SL.TZ1.102

An experiment is conducted to measure the specific heat capacity of water. A mass of water is placed in a glass beaker and energy is transferred from an electric heater.



The data collected are:

Mass of water = (0.250 ± 0.002) kg

Change in temperature of the water = (14.0 ± 0.5) °C

Energy transferred from the electric heater = (16 000 ± 300) J

(a.i)

Calculate the specific heat capacity of water.

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(a.ii)

Determine the absolute uncertainty in the specific heat capacity of water.

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(a.iii)

Write down the specific heat capacity of water and its absolute uncertainty to the appropriate number of significant figures.

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(b)

Outline **one** source of systematic error in the experiment and its effect on the calculated value of the specific heat capacity of water.

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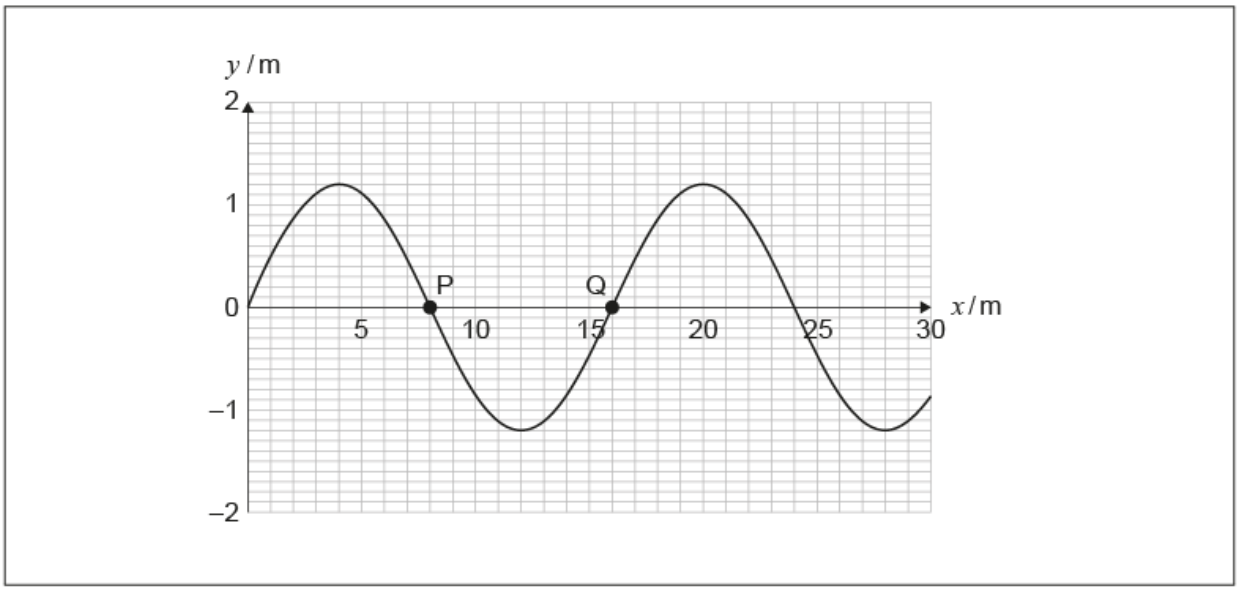
5. 23M.2.SL.TZ1.3

(a)

A transverse water wave travels to the right. The diagram shows the shape of the surface of the water at time $t = 0$. P and Q show two corks floating on the surface.



[[N/A]]

(a.i)

State what is meant by a transverse wave.

[1]

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(a.ii)

The frequency of the wave is 0.50 Hz. Calculate the speed of the wave.

[1]

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(a.iii)

Plot on the diagram the position of P at time t = 0.50 s.

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(a.iv)

Sketch the phase difference between the oscillations of the two corks is π radians.

[1]

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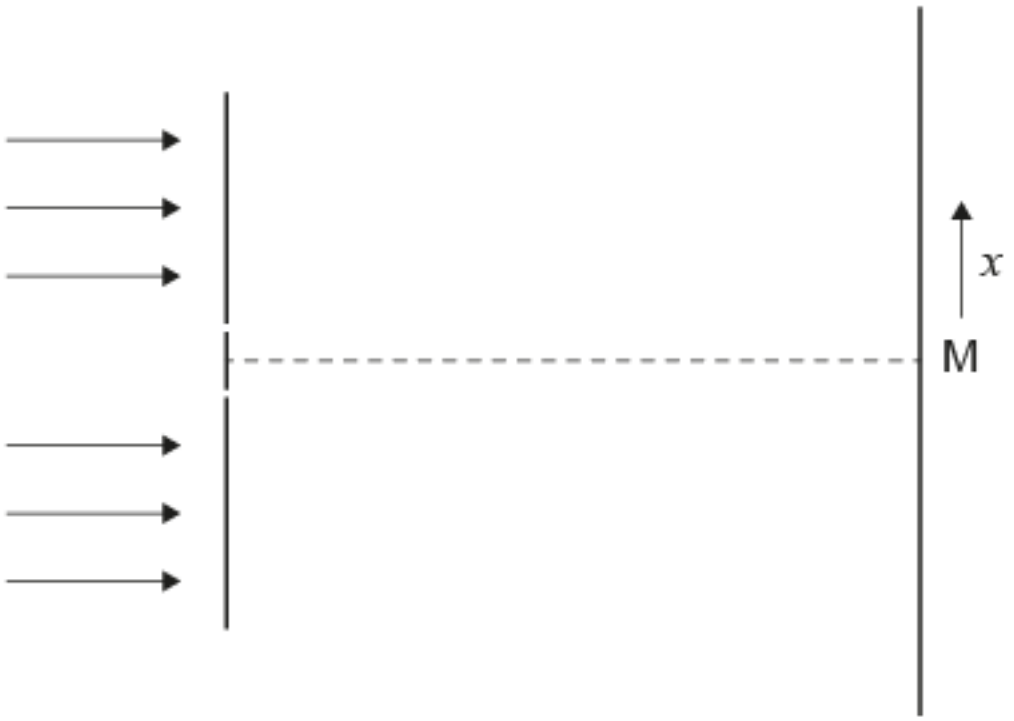
(b)

Monochromatic light is incident on two very narrow slits. The light that passes through the slits is observed on a screen. M is directly opposite the midpoint of the slits. x represents the displacement from M in the direction shown.



A student argues that what will be observed on the screen will be a total of two bright spots opposite the slits. Explain why the student's argument is incorrect.

[2]

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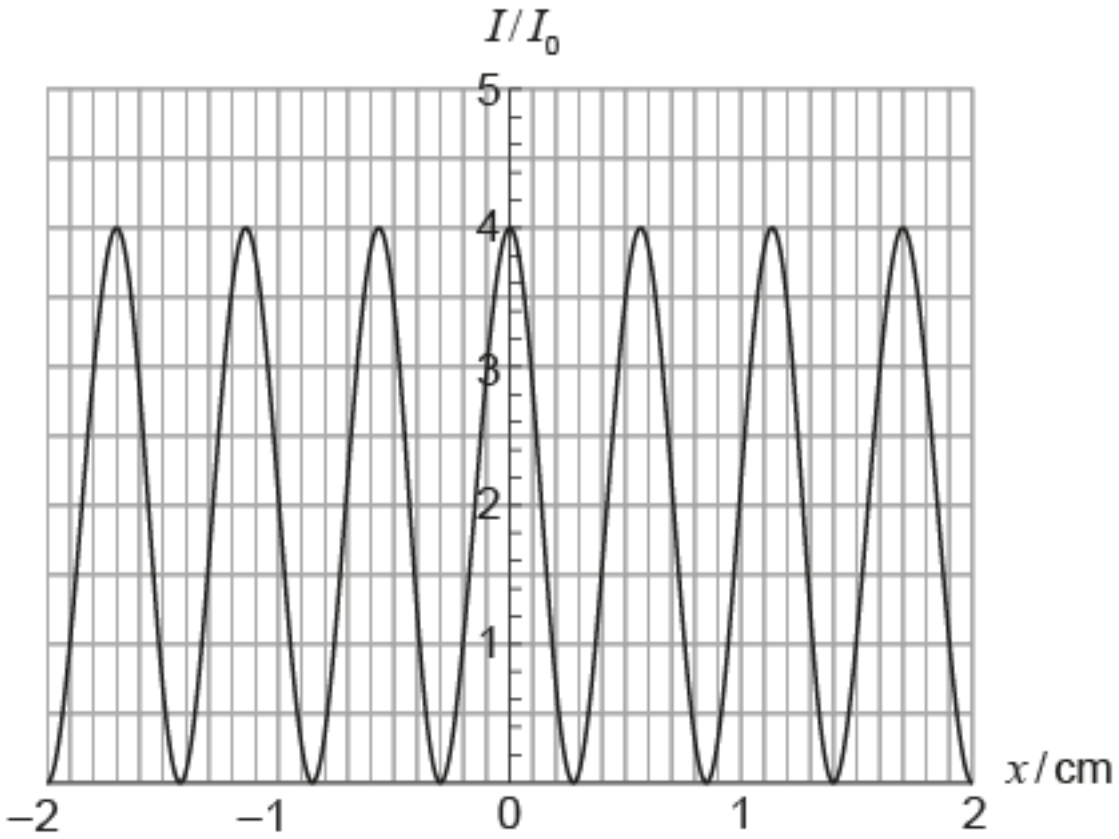
(c)

The graph shows the actual variation with displacement x from M of the intensity of the light on the screen. I_0 is the intensity of light at the screen from one slit only.



The slits are separated by a distance of 0.18 mm and the distance to the screen is 2.2 m.

Determine, in m, the wavelength of light.

[2]

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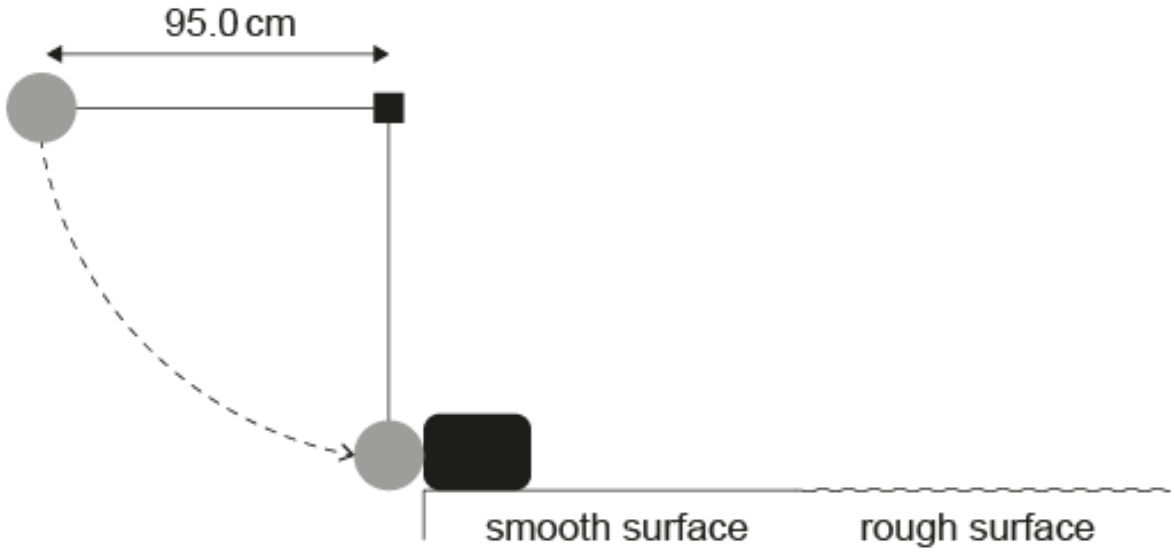
6. 23M.2.HL.TZ1.1

A ball of mass 0.800 kg is attached to a string. The distance to the centre of the mass of the ball from the point of support is 95.0 cm. The ball is released from rest when the

string is horizontal. When the string becomes vertical the ball collides with a block of mass 2.40 kg that is at rest on a horizontal surface.



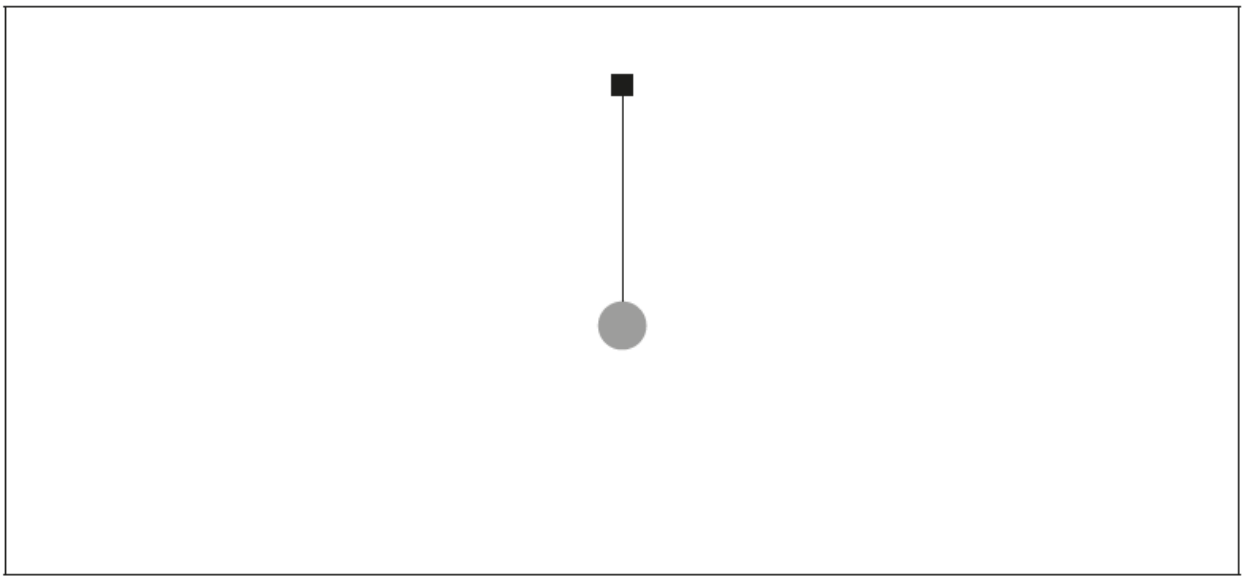
(a)

Just before the collision of the ball with the block,

[[N/A]]

(a.i)

draw a free-body diagram for the ball.



[2]

(a.ii)

show that the speed of the ball is about 4.3 m s^{-1}.

[1]

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(a.iii)

determine the tension in the string.

[2]

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(b)

After the collision, the ball rebounds and the block moves with speed 2.16 m s^{-1}.

[[N/A]]

(b.i)

Show that the collision is elastic.

[4]

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(b.ii)

Calculate the maximum height risen by the centre of the ball.

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(c)

The coefficient of dynamic friction between the block and the rough surface is 0.400.

Estimate the distance travelled by the block on the rough surface until it stops.

[3]

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MYP4 : Physics HW
Assignment
Motion

1. A particle is moving in a circle of diameter 5m. Calculate the distance covered and the displacement when it competes 3 revolutions.

2. A body thrown vertically upwards reaches a maximum height 'h'. It then returns to ground. Calculate the distance travelled and the displacement.

3. A body travels a distance of 15m from A to B and then moves a distance of 20m at right angles to AB. Calculate the total distance travelled and the displacement.

4. An object is moving in a circle of radius 'r'. Calculate the distance and displacement
(i) when it completes half the circle
(ii) when it completes one full circle.

5. An object travels 16m in 4s and then another 16m in 2s. What is the average speed of the object?

6. Vishnu swims in a 90m long pool. He covers 180m in one minute by swimming from one end to the other and back along the same straight path. Find the average speed and average velocity of Vishnu.

7. In along distance race, the athletics were expected to take four rounds of the track such that the line of finish was same as the line of start. Suppose the length of the track was 200m.

(a) What is the total distance to be covered by the athletics?

(b) What is the displacement of the athletics when they touch the finish line?

(c) Is the motion of the athletics uniform or non-uniform?

(d) Is the displacement of an athletic and the distance covered by him at the end of the race equal?

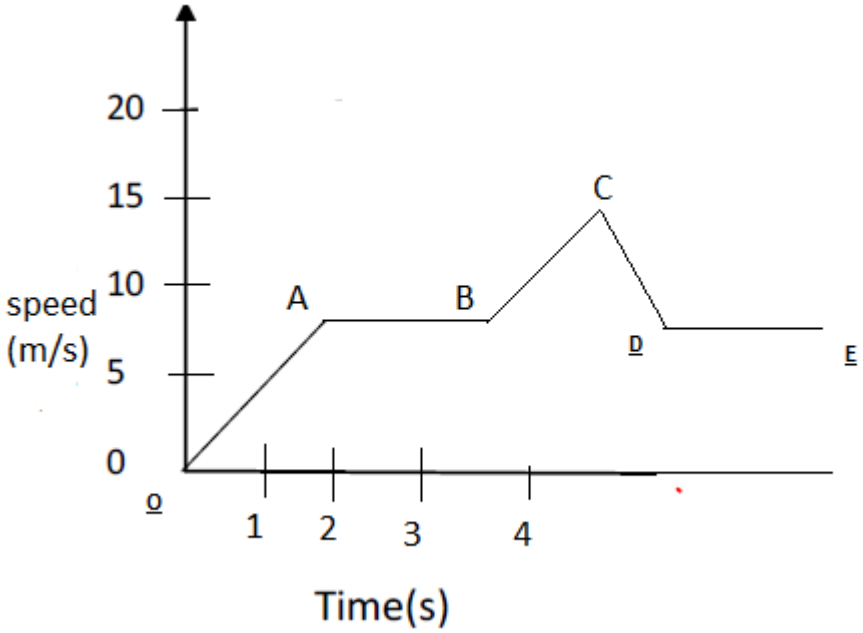
8. Starting from a stationary position, Bhuvan paddles his bicycle to attain a velocity of 6m/s in 30s. Then he applies brakes such that the velocity of bicycle comes down to 4m/s in the next 5s. Calculate the acceleration of the bicycle in both the cases.

9. Amit is moving in his car with a velocity of 45km/hr. How much distance will he cover
(a) in one minute and
(b) in one second.

10. The odometer of a car reads 2000 km at the start of a trip and 2400km at the end of the trip. If the trip took 8 hr, calculate the average speed of the car in km/hr and m/s.

CRITERIA C : MOTION IN ONE DIMENSION.

Study the speed time graph



Find following based on the graph
a) Which paths have constant speed :
b) when is the maximum speed reached :
c) what is the value of acceleration during path OA and BC

d) what is the value of deceleration during the path CD.

e) how much distance is covered during the journey from B to D

f) how much distance is covered during the journey from A to B

g) how much is the total distance covered during the entire journey

h) how much is the average speed of the entire journey.

1 **(a)** **(i)** On Fig. 3.1, draw a graph of extension against load for a spring which obeys Hooke's law. [1]

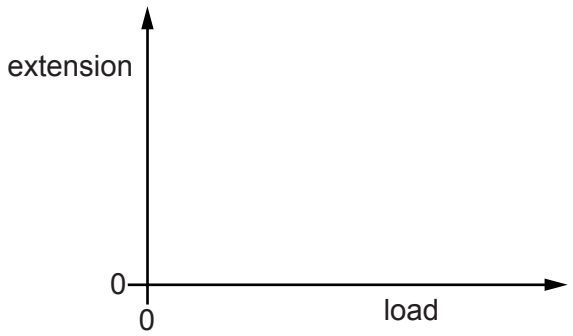


Fig. 3.1

(ii) State the word used to describe the energy stored in a spring that has been stretched or compressed.

.....[1]

(b) Fig. 3.2 shows a model train, travelling at speed *v,* approaching a buffer.

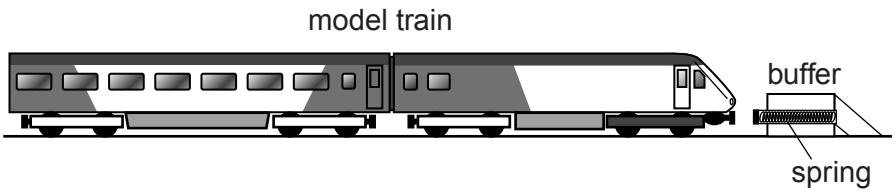


Fig. 3.2

The train, of mass 2.5 kg, is stopped by compressing a spring in the buffer. After the train has stopped, the energy stored in the spring is 0.48 J.

Calculate the initial speed *v* of the train.

v = ...[4]

[Total: 6]

2 Fig. 2.1 shows a conveyor belt transporting a package to a raised platform. The belt is driven by a motor.

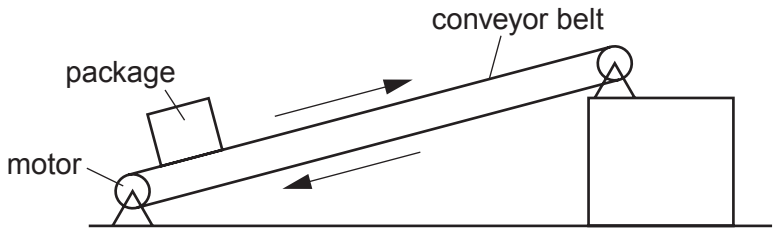


Fig. 2.1

(a) The mass of the package is 36 kg.

Calculate the increase in the gravitational potential energy (g.p.e.) of the package when it is raised through a vertical height of 2.4 m.

increase in g.p.e. = ... [2]

(b) The package is raised through the vertical height of 2.4 m in 4.4 s.

Calculate the power needed to raise the package.

power = ... [2]

(c) The electrical power supplied to the motor is much greater than the answer to **(b)**.

Explain how the principle of conservation of energy applies to this system.

.....

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..... [2]

(d) Assume that the power available to raise packages is constant. A package of mass greater than 36 kg is raised through the same height.

Suggest and explain the effect of this increase in mass on the operation of the conveyer belt.

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..... [3]

[Total: 9]

3 An athlete of mass 64 kg is bouncing up and down on a trampoline.

At one moment, the athlete is stationary on the stretched surface of the trampoline. Fig. 3.1 shows the athlete at this moment.

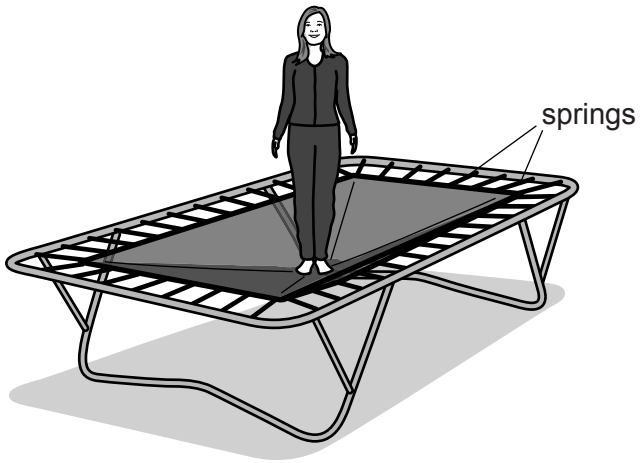


Fig. 3.1

(a) State the form of energy stored due to the stretching of the surface of the trampoline.

.....[1]

(b) The stretched surface of the trampoline begins to contract. The athlete is pushed vertically upwards and she accelerates. At time *t*, when her upwards velocity is 6.0 m / s, she loses contact with the surface.

(i) Calculate her kinetic energy at time *t*.

kinetic energy = ...[2]

(ii) Calculate the maximum possible distance she can travel upwards after time *t*.

maximum distance = ...[3]

(iii) In practice, she travels upwards through a slightly smaller distance than the distance calculated in **(ii)**.

Suggest why this is so.

.....

.....[1]

(c) The trampoline springs are tested. An extension-load graph is plotted for one spring. Fig. 3.2 is the graph.

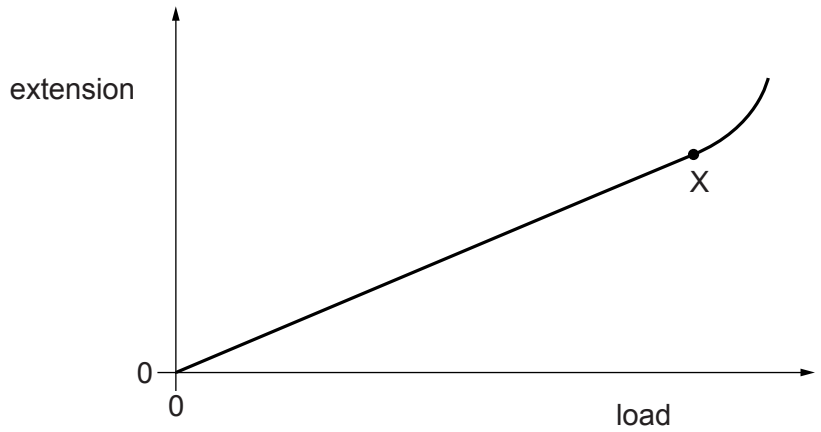


Fig. 3.2

(i) State the name of the point X.

.....[1]

(ii) State the name of the law that the spring obeys between the origin of the graph and point X.

.....[1]

[Total: 9]

4 An electric train is initially at rest at a railway station. The motor causes a constant force of 360 000 N to act on the train and the train begins to move.

(a) State the form of energy gained by the train as it begins to move.

.....[1]

(b) The train travels a distance of 4.0 km along a straight, horizontal track.

(i) Calculate the work done on the train during this part of the journey.

work done = ...[2]

(ii) The mass of the train is 450 000 kg.

Calculate the maximum possible speed of the train at the end of the first 4.0 km of the journey.

maximum possible speed = ...[3]

(iii) In practice, the speed of the train is much less than the value calculated in **(ii)**.

Suggest **one** reason why this is the case.

.....

.....[1]

(c) After travelling 4.0 km, the train reaches its maximum speed. It continues at this constant speed on the next section of the track where the track follows a curve which is part of a circle.

State the direction of the resultant force on the train as it follows the curved path.

.....[1]

[Total: 8]

5 **(a)** The boxes on the left contain the names of some sources of energy. The boxes on the right contain properties of some sources of energy.

Draw **two** straight lines **from each box** on the left to the two boxes on the right which describe that source of energy.

solar energy	renewable
	not renewable
natural gas	polluting
	not polluting

[2]

(b) Coal-fired power stations are polluting.

State an advantage of using coal as a source of energy.

.....

.....[1]

(c) A coal-fired power station generates electricity at night when it is not needed.

Some of this energy is stored by pumping water up to a mountain lake. When there is high demand for electricity, the water is allowed to flow back through turbines to generate electricity.

On one occasion, 2.05×10^8 kg of water is pumped up through a vertical height of 500 m.

(i) Calculate the weight of the water.

weight = ...[1]

(ii) Calculate the gravitational potential energy gained by the water.

energy gained = ...[2]

(iii) The electrical energy used to pump the water up to the mountain lake is 1.2×10^{12} J. Only 6.2×10^{11} J of electrical energy is generated when the water is released.

Calculate the efficiency of this energy storage scheme.

efficiency = ...[2]

[Total: 8]

6 Fig. 3.1 shows a skier taking part in a downhill race.

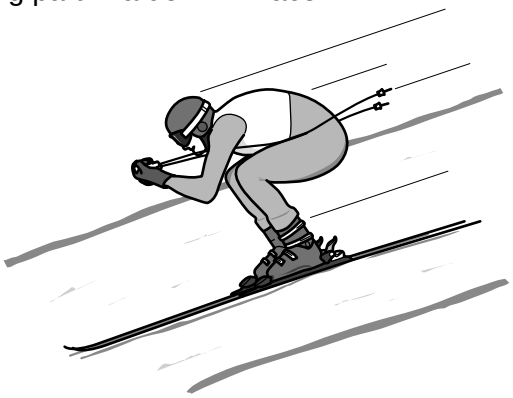


Fig. 3.1

(a) The mass of the skier, including his equipment, is 75 kg. In the ski race, the total vertical change in height is 880 m.

Calculate the decrease in the gravitational potential energy (g.p.e.) of the skier.

decrease in g.p.e. = ...[2]

(b) The skier starts from rest. The total distance travelled by the skier during the descent is 2800 m. The average resistive force on the skier is 220 N.

Calculate

(i) the work done against the resistive force,

work done = ...[2]

(ii) the kinetic energy of the skier as he crosses the finishing line at the end of the race.

kinetic energy = ...[2]

(c) Suggest why the skier bends his body as shown in Fig. 3.1.

.....[1]

[Total: 7]

1 **(a) (i)** (power =) work (done) / time (taken) OR energy (supplied) / time (taken) OR rate of doing work OR rate of supplying energy B1

(ii) box 2 (force acting on the object) AND box 5 (distance moved by the object) B1

(b) (i) multiplies mass of <u>all passengers</u> by h C1
(increase in gpe =) mgh OR uses $12 \times 650 \times 150$ C1
(power = increase in) gpe / time C1
1.8×10^4 W OR 18 kW A1

(ii) energy to raise the lift OR weight / load / mass of lift OR more weight / load / mass

[Total: 7]

2 **(a) (i)** gravitational (potential energy) to kinetic (energy) B1

(ii) kinetic (energy) to elastic / strain (potential energy) B1

(iii) elastic / strain (potential energy) to kinetic (energy) B1

(b) mgh OR $0.15 \times 10 \times 2.0$ OR 3(.0 J) C1
$\frac{1}{2} mv^2$ OR $v^2 = 2gh$ C1
$v^2 = 2 \times 3.0 / 0.15$ OR 40 C1
6.3(24555) m / s A1

(c) heat / thermal / internal energy lost OR ball / surface gains heat / thermal / internal energy B1

[Total: 8]

3 **(a) (i)** kinetic B1

(ii) (GPE =) mgh OR $1.0 \times 10 \times 300$ C1
3000 J A1

(iii) $Q = mc\Delta\theta$ in any form OR $Q \div mc$ OR $3000 \div [(1.0 \times) 4200]$ C1
0.71 °C A1

(iv) Energy used to heat air (via air resistance) / Heat lost to surroundings B1
OR Energy retained as KE of water (at bottom of waterfall)
OR Sound (energy) produced

(b) Temperature change/difference is (very) small B1

[Total: 7]

4 **(a** Fd OR weight × d OR mgh OR 30 000 × 10 × 140 OR 4.2×10^7 seen anywhere C1

(P =) E / t OR W / t OR mgh / t symbols or words C1

$4.2 \times 10^7 / 60$ C1

7.0×10^5 W / 700 kW / 0.7 MW A1

(b) efficiency = output / input OR (P_{in} =) 100 × P_{out} / efficiency

(P_{in} =) $100 \times 7 \times 10^5 / 70$

1.0×10^6 W OR 1 000 000 W OR 1.0 MW A1

(c) (horizontal) wind has no effect on P.E gained / vertical force on water
OR same upward / vertical force acts on water
OR force from wind is horizontal B1

[Total: 8]

5 **(a) (i)** $\frac{1}{2}mv^2$ in words, symbols or numbers C1

$(v = \sqrt{(2 \times \frac{1}{2} \times 16.2)} =) 4.0\,\text{m/s}$ accept 4 A1

(ii) mgh or KE / mg or $v = \sqrt{(2gh)}$ or $v^2 = u^2 + 2as$ words, symbols or numbers C1

correct substitution e.g. $h = 16.2 / 2 \times 10$ C1

0.81 m allow e.c.f. from **3(a)(i)** A1

(iii) heating of <u>water</u> o.w.t.t.e. B2
compensation mark: award B1 for one of heat, internal energy, sound, KE of water
ignore intermediate states throughout **3(a)(iii)** e.g. KE / PE of splashed water

(b) same height M1

m affects both KE and GPE (in same way) / $v^2 = u^2 + 2as$ applies in both cases
ignore "height doesn't depend on mass" A1
special case : M1 for logical argument about not all KE becoming GPE
A1 for consequent statement about height gained

[Total: 9]

6 **(a) (i)** (increase in g.p.e. = mgh **OR** $65 \times 10 \times 8 =) 5200\,\text{J}$ B

(ii) **EITHER**
k.e. gained = g.p.e. lost C1
$\frac{1}{2}\,mv^2 = 5200$ in any form C1
$v^2 = 5200 / (0.5 \times 65)$ **OR** 160 C1
$v = 12.6\,\text{m/s}$ e.c.f. **(a)(i)** A1
OR
$v^2 = u^2 + 2as / v^2 = 2\,gh$ (C1)
$v^2 = 2 \times 10 \times 8$ (C1)
$v^2 = 160$ (C1)
$v = 12.6\,\text{m/s}$ e.c.f. **(a)(i)** (A1)

(b) speed is the same B1
EITHER
loss in g.p.e. is the same B1
k.e. gained is the sa B1
OR
acceleration is the same (B1)
distance fallen is the same (B1)

[Total: 8]

1 **(a)** **(i)** Define *power*.

.....[1]

(ii) In the following list, tick the **two** boxes next to the two quantities needed to calculate the work done on an object.

- ☐ mass of the object
- ☐ force acting on the object
- ☐ speed of the object
- ☐ acceleration of the object
- ☐ distance moved by the object [1]

(b) A lift (elevator) in a high building transports 12 passengers, each of mass 65 kg, through a vertical height of 150 m in a time of 64 s.

(i) Calculate the power needed to transport the passengers through this height.

power = ...[4]

(ii) The lift (elevator) is driven by an electric motor.

State a reason, other than friction, why the power supplied by the motor is greater than the power needed to transport the passengers.

.....

.....[1]

[Total: 7]

2 A soft rubber ball of mass 0.15 kg is dropped, in a vacuum, from a height of 2.0 m on to a hard surface. The ball then bounces.

(a) State the main energy changes taking place when

(i) the ball is falling,

.....

(ii) the ball hits the surface and is changing shape,

.....

(iii) the ball is regaining its shape and is rising from the surface.

.....
[3]

(b) Calculate the speed with which the ball hits the surface.

speed = ... [4]

(c) After rebounding from the surface, the ball rises to a height of 1.9 m.

Suggest why the height to which the ball rises is less than the height from which the ball falls.

.....

.....[1]

[Total: 8]

3 A scientist finds that the temperature of the water at the bottom of waterfalls is greater than the temperature of the water at the tops of those waterfalls.

(a) (i) State the type of energy that falling water has because of its motion.

..... [1]

(ii) In one waterfall, the water falls 300 m.

Calculate the decrease in the gravitational potential energy (g.p.e.) of 1.0 kg of water as it falls through this distance.

decrease in g.p.e. = ... [2]

(iii) Assume that the increase in internal energy of the 1.0 kg of water is equal to its decrease in g.p.e.

Calculate the rise in temperature of the water. The specific heat capacity of water is 4200 J / (kg °C).

rise in temperature = ... [2]

(iv) Suggest a reason why the actual increase in temperature of the water is less than the value calculated in **(a)(iii)**.

.....

..... [1]

(b) State why the thermometer used to measure the temperature of the water in the scientist's experiment required a high sensitivity.

.....

..... [1]

[Total: 7]

4 **(a)** On a day with no wind, a fountain in Switzerland propels 30 000 kg of water per minute to a height of 140 m.

Calculate the power used in raising the water.

power = ... [4]

(b) The efficiency of the pump which operates the fountain is 70%.

Calculate the power supplied to the pump.

power = ... [3]

(c) On another day, a horizontal wind is blowing. The water does not rise vertically.

Explain why the water still rises to a height of 140 m.

.....

..... [1]

[Total: 8]

5 When a salmon swims up a river to breed, it often has to jump up waterfalls. Fig. 3.1 shows a salmon jumping above the surface of the water. On this occasion the salmon falls back down into the river.

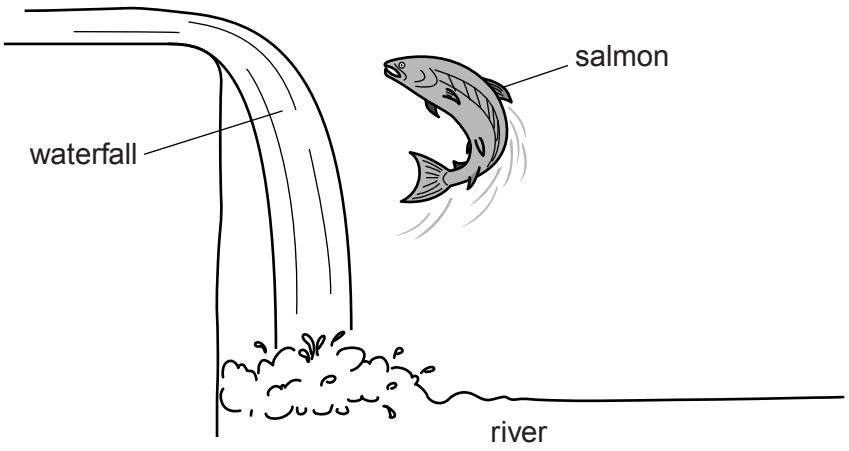


Fig. 3.1

The salmon has a mass of 2.0 kg.

(a) The salmon leaves the water vertically with a kinetic energy of 16.2 J.

(i) Calculate the speed of the salmon as it leaves the water.

speed = ... [2]

(ii) Calculate the maximum height gained by the salmon. Ignore air resistance.

gain in height = ... [3]

(iii) After the salmon has re-entered the river, it has lost nearly all its original kinetic energy.

State what has happened to the lost energy.

.....

.....

.....

..... [2]

(b) Another salmon, of much greater mass, leaves the water vertically with the same speed.

State and explain how the height of this salmon's jump compares to the height reached by the first salmon.

.....

.....

..... [2]

[Total: 9]

6 A diver climbs some steps on to a fixed platform above the surface of the water in a swimming-pool. He dives into the pool. Fig. 2.1 shows the diver about to enter the water.

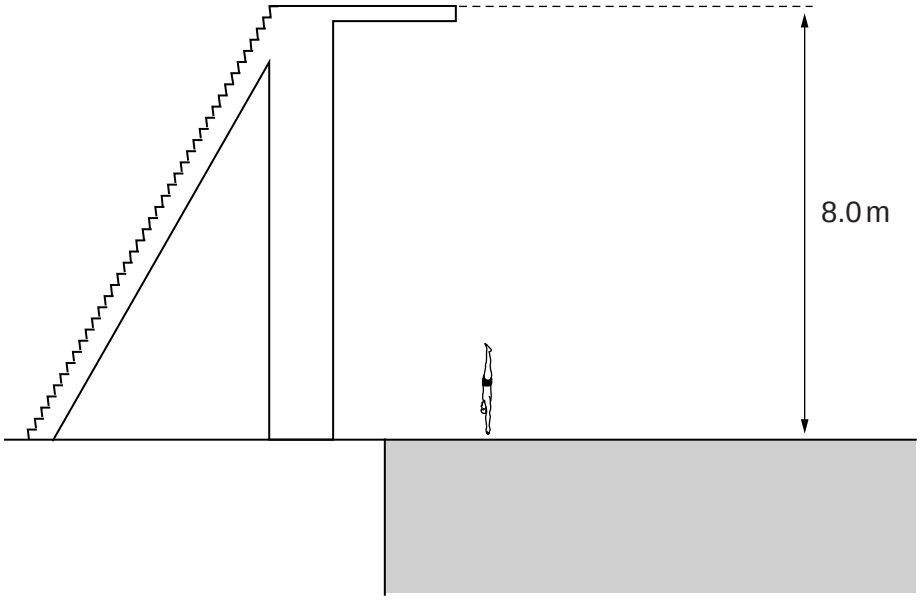


Fig. 2.1

The mass of the diver is 65 kg. The platform is 8.0 m above the surface of the water.

(a) Calculate

(i) the increase in the gravitational potential energy of the diver when he climbs up to the platform.

increase in gravitational potential energy = ...[1]

(ii) the speed with which the diver hits the surface of the water. Ignore any effects of air resistance.

speed = ...[4]

(b) In another dive from the same platform, the diver performs a somersault during the descent. He straightens, and again enters the water as shown in Fig. 2.1.

Discuss whether the speed of entry into the water is greater than, less than or equal to the speed calculated in **(a)(ii)**. Ignore any effects of air resistance.

.....

.....

.....

.....[3]

[Total: 8]

1 (a) A car driver makes an emergency stop.

The chart shows the 'thinking distance' and the 'braking distance' needed to stop the car.

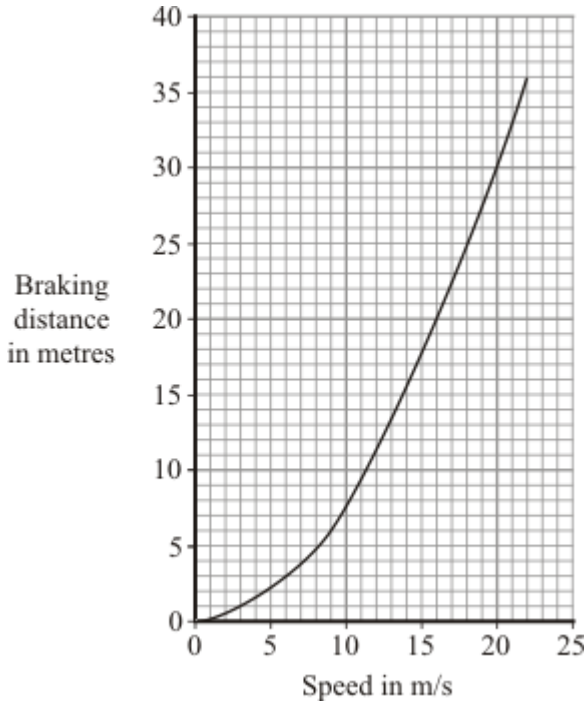
Calculate the total stopping distance of the car.

_____

Stopping distance = _____ m

(1)

(b) The graph shows how the braking distance of a car driven on a dry road changes with the car's speed.



The braking distance of the car on an icy road is longer than the braking distance of the car on a dry road.

(i) Draw a new line on the graph to show how the braking distance of the car on an icy road changes with speed.

(2)

(ii) Which **two** of the following would also increase the braking distance of the car?

Put a tick (✓) next to each of your answers.

rain on the road ☐

the driver having drunk alcohol ☐

car brakes in bad condition ☐

the driver having taken drugs ☐

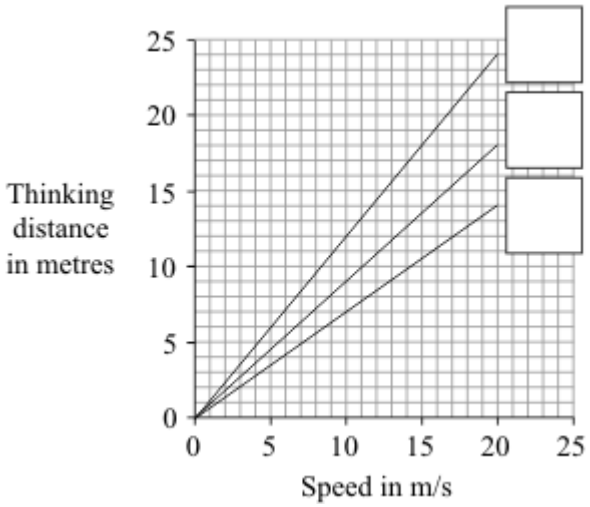
(2)

(c) The thinking distance depends on the driver's reaction time.

The table shows the reaction times of three people driving under different conditions.

Car driver	Condition	Reaction time in seconds
A	Wide awake with no distractions	0.7
B	Using a hands-free mobile phone	0.9
C	Very tired and listening to music	1.2

The graph lines show how the thinking distance for the three drivers, **A**, **B** and **C**, depends on how fast they are driving the car.



(i) Match each graph line to the correct driver by writing **A**, **B** or **C** in the box next to the correct line.

(2)

(ii) The information in the table cannot be used to tell if driver **C**'s reaction time is increased by being tired or by listening to music.

Explain why.

_____

_____

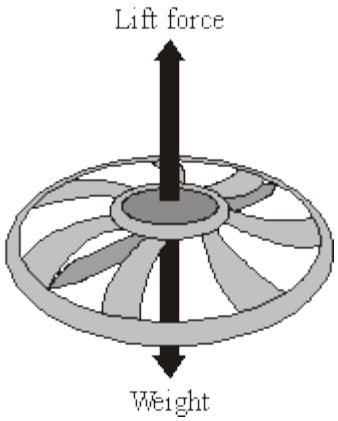
_____

_____

(2)

(Total 9 marks)

2 The diagram shows the forces on a small, radio-controlled, flying toy.



(a) (i) The mass of the toy is 0.06 kg.
Gravitational field strength = 10 N/kg

Calculate the weight of the toy.

Show clearly how you work out your answer and give the unit.

_____

_____

Weight = _____

(3)

(ii) Complete the following sentence by drawing a ring around the correct line in the box.

When the toy is hovering stationary in mid-air, the lift force is

bigger than
the same as
smaller than

the weight of the toy.

(1)

(b) When the motor inside the toy is switched off, the toy starts to *accelerate* downwards.

(i) What does the word *accelerate* mean?

_____

(1)

(ii) What is the direction of the resultant force on the falling toy?

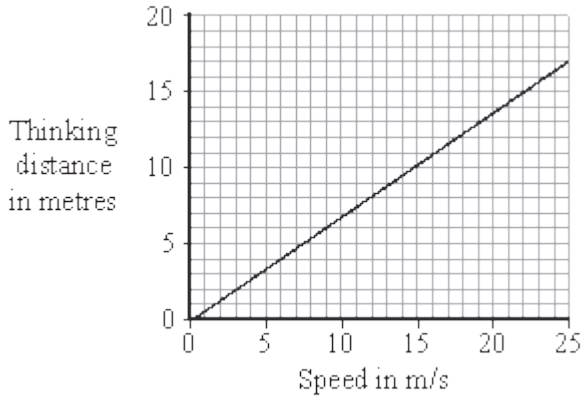
_____

(1)

(Total 6 marks)

3 (a) A car driver takes a short time to react to an emergency before applying the brakes. The distance the car will travel during this time is called the 'thinking distance'.

The graph shows how the thinking distance of a driver depends on the speed of the car.



(i) What is the connection between thinking distance and speed?

_____

(1)

(ii) Many people drive while they are tired.

Draw a new line on the graph to show how thinking distance changes with speed for a tired driver.

(1)

(iii) The graph was drawn using data given in the Highway Code.

Do you think that the data given in the Highway Code is likely to be reliable?

Draw a ring around your answer.

Yes **No** **Maybe**

Give a reason for your answer.

_____

_____

(1)

(b) The distance a car travels once the brakes are applied is called the 'braking distance'.

(i) What is the relationship between thinking distance, braking distance and stopping distance?

_____

(1)

(ii) State **two** factors that could increase the braking distance of a car at a speed of 15 m/s.

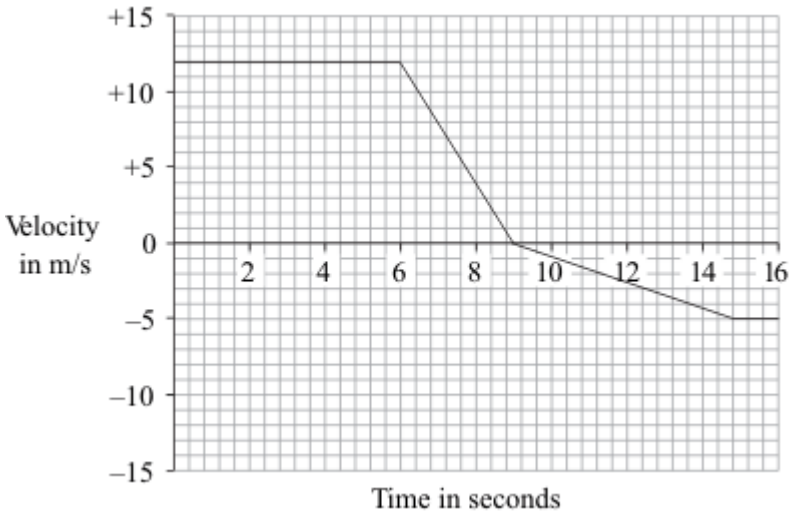
1. _____

2. _____

(2)

(Total 6 marks)

4 A car is driven along a straight road. The graph shows how the velocity of the car changes during part of the journey.



(a) Use the graph to calculate the deceleration of the car between 6 and 9 seconds.

Show clearly how you work out your answer and give the unit.

_____

_____

_____

Deceleration = _____

(3)

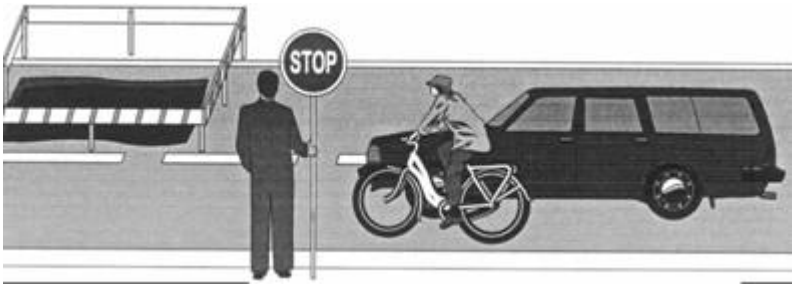
(b) At what time did the car change direction?

_____ seconds

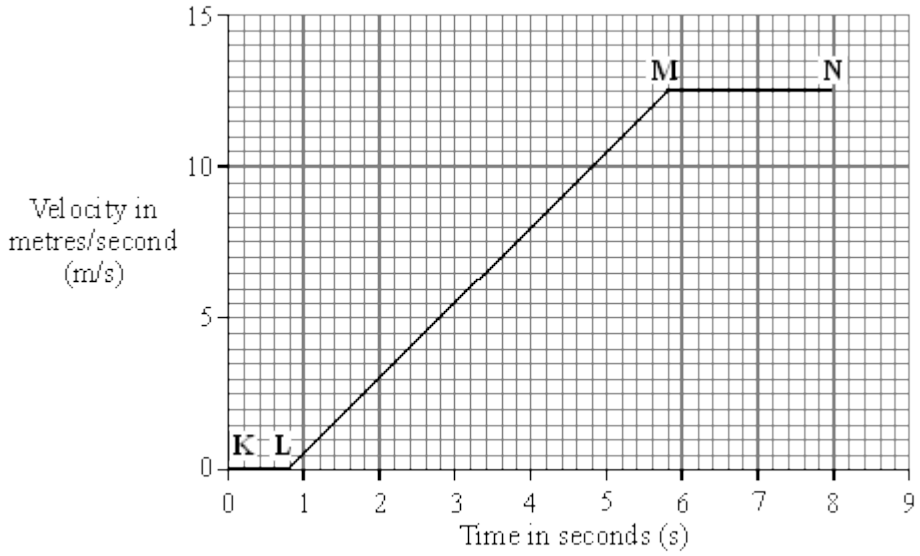
(1)

(Total 4 marks)

5 A car and a bicycle are travelling along a straight road. They have stopped at road works.



The graph shows how the velocity of the car changes after the sign is changed to GO.



(a) Between which two points on the graph is the car moving at constant velocity?

_____

(1)

(b) Between which two points on the graph is the car accelerating?

_____

(1)

(c) Between the sign changing to GO and the car starting to move, there is a time delay. This is called the reaction time.

(i) What is the reaction time of the car driver?

Reaction time = _____ seconds

(1)

(ii) Which **one** of the following could increase the reaction time of a car driver? Tick the box next to your choice.

Drinking alcohol ☐

Wet roads ☐

Worn car brakes ☐

(1)

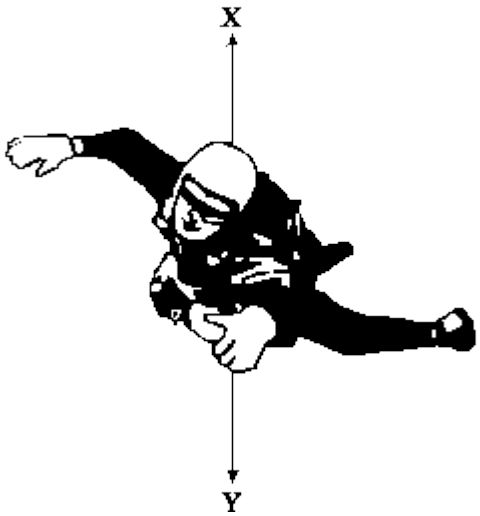
(d) The cyclist starts to move at the same time as the car. For the first 2 seconds the cyclist's acceleration is constant and is greater than that of the car.

Draw a line on the graph to show how the velocity of the cyclist might change during the first 2 seconds of its motion.

(2)

(Total 6 marks)

6 The diagram shows a sky-diver in free fall. Two forces, **X** and **Y**, act on the sky-diver.



(a) Complete these sentences by crossing out the **two** lines in each box that are wrong.

(i) Force **X** is caused by

friction
gravity
weight

.

(1)

(ii) Force **Y** is caused by

air resistance
friction
gravity

.

(1)

(b) The size of force **X** changes as the sky-diver falls. Describe the motion of the sky-diver when:

(i) force **X** is smaller than force **Y**,

_____

_____

(2)

(ii) force **X** is equal to force **Y**.

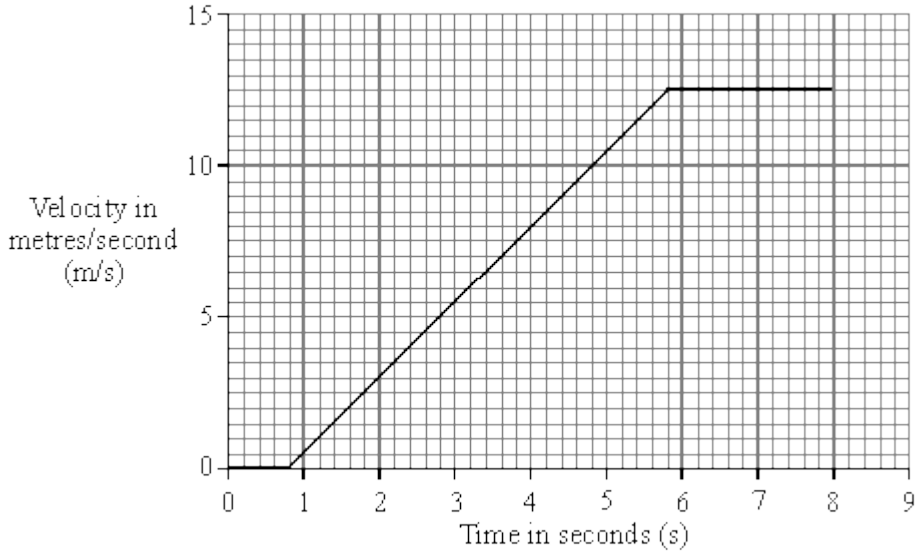
_____

_____

(1)

(Total 5 marks)

7 A car travelling along a straight road has to stop and wait at red traffic lights. The graph shows how the velocity of the car changes after the traffic lights turn green.



(a) Between the traffic lights changing to green and the car starting to move there is a time delay. This is called the reaction time. Write down **one** factor that could affect the driver's reaction time.

_____

(1)

(b) Calculate the distance the car travels while accelerating. Show clearly how you work out your answer.

_____

_____

Distance = _____metres

(3)

(c) Calculate the acceleration of the car. Show clearly how you work out your final answer and give the units.

_____

_____

_____

Acceleration = _____

(4)

(d) The mass of the car is 900 kg.

(i) Write down the equation that links acceleration, force and mass.

_____

(1)

(ii) Calculate the force used to accelerate the car. Show clearly how you work out your final answer.

_____

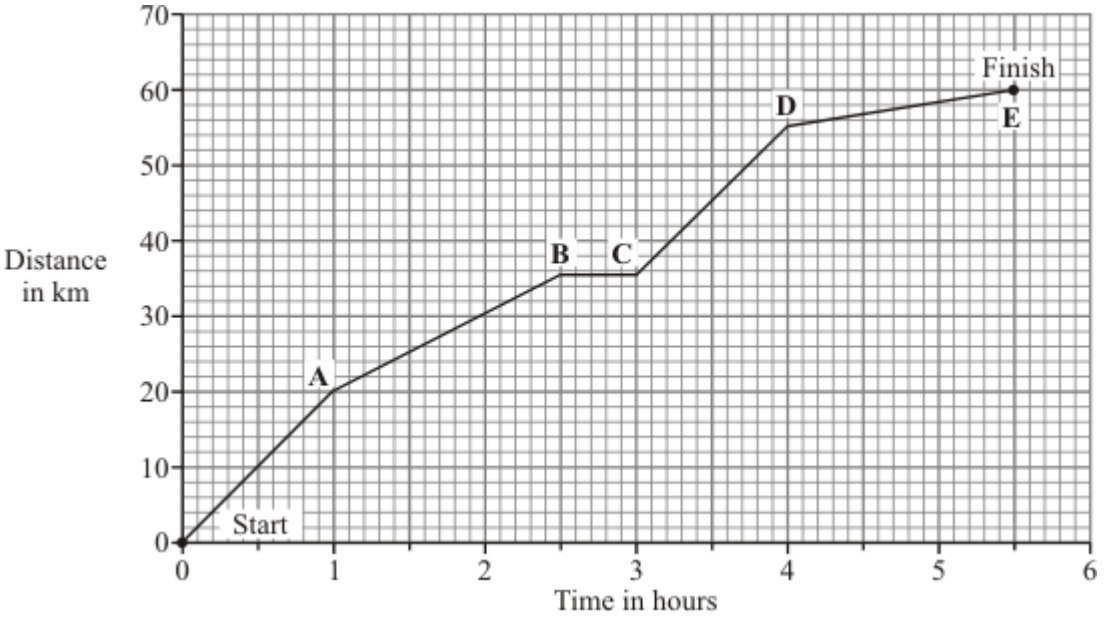
_____

Force = _____ newtons

(2)

(Total 11 marks)

8 A horse and rider take part in a long distance race. The graph shows how far the horse and rider travel during the race.



(a) What was the distance of the race?

distance = _____ km

(1)

(b) How long did it take the horse and rider to complete the race?

_____

(1)

(c) What distance did the horse and rider travel in the first 2 hours of the race?

distance = _____ km

(1)

(d) How long did the horse and rider stop and rest during the race?

_____

(1)

(e) Not counting the time it was resting, between which two points was the horse moving the slowest?

_____ and _____

Give a reason for your answer.

_____

_____

(2)

(Total 6 marks)

9

(a) The arrows in the diagram represent the size and direction of the forces on a space shuttle, fuel tank and booster rockets one second after launch. The longer the arrow the bigger the force.

Thrust force

Weight of shuttle, fuel tanks and booster rockets plus air resistance

(i) Describe the upward motion of the space shuttle one second after launch.

_____

(1)

(ii) By the time it moves out of the Earth's atmosphere, the total weight of the space shuttle, fuel tank and booster rockets has decreased and so has the air resistance.

How does this change the motion of the space shuttle? (Assume the thrust force does not change).

_____

(1)

(b) The space shuttle takes 9 minutes to reach its orbital velocity of 8100 m/s.

(i) Write down the equation that links acceleration, change in velocity and time taken.

_____

(1)

(ii) Calculate, in m/s^2, the average acceleration of the space shuttle during the first 9 minutes of its flight. Show clearly how you work out your answer.

_____

_____

average acceleration = _____ m/s^2

(2)

(iii) How is the velocity of an object different from the speed of an object?

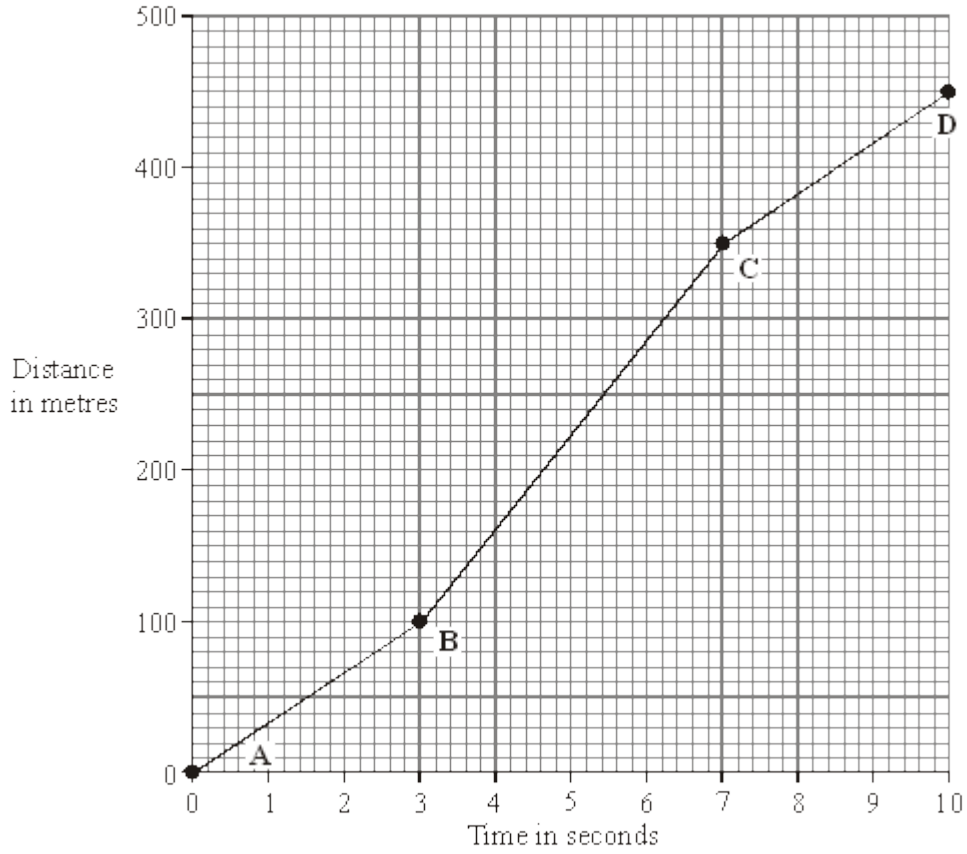
_____

_____

(1)

(Total 6 marks)

10 The distance-time graph represents the motion of a car during a race.



(a) Describe the motion of the car between point **A** and point **D**. You should not carry out any calculations.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

_____

_____

_____

_____

_____

(3)

(b) Calculate the gradient of the graph between point **B** and point **C**. Show clearly how you get your answer.

_____

_____

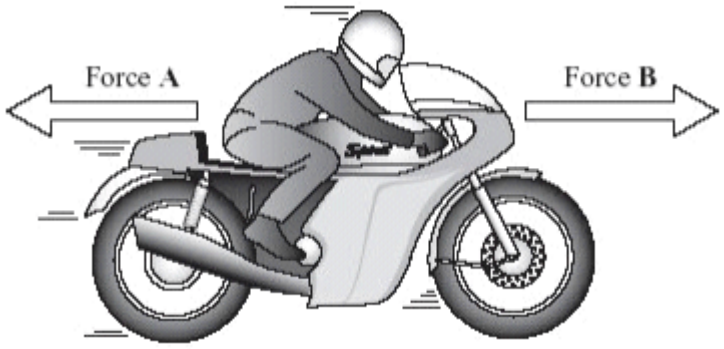
_____

gradient = _____

(3)

(Total 6 marks)

11 (a) The diagram shows the horizontal forces that act on a **moving** motorbike.



(i) Describe the movement of the motorbike when force **A** equals force **B**.

_____

_____

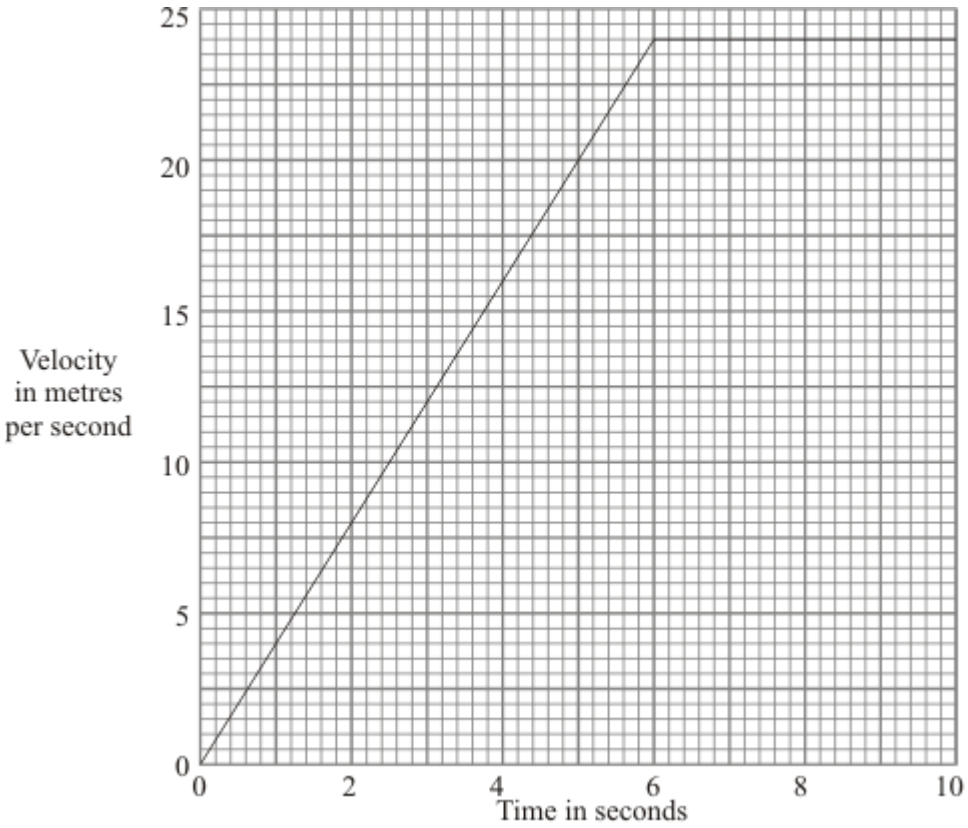
(2)

(ii) What happens to the speed of the motorbike if force **B** becomes smaller than force **A**?

_____

(1)

(b) The graph shows how the velocity of a motorbike changes when it is travelling along a straight road.



(i) What was the change in velocity of the motorbike in the first 5 seconds?

_____

(1)

(ii) Write down the equation which links acceleration, change in velocity and time taken.

_____

(1)

(iii) Calculate the acceleration of the motorbike during the first 5 seconds.
Show clearly how you work out your answer and give the unit.

_____

_____

Acceleration = _____

(3)

(c) A car is travelling on an icy road.

Describe and explain what might happen to the car when the brakes are applied.

_____

_____

_____

_____

(2)

(d) Name **three** factors, other than weather conditions, which would increase the overall stopping distance of a vehicle.

1. _____

_____

2. _____

_____

3. _____

_____

(3)

(Total 13 marks)

12 (a) Two skydivers jump from a plane. Each holds a different position in the air.

A

B

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Complete the following sentence.

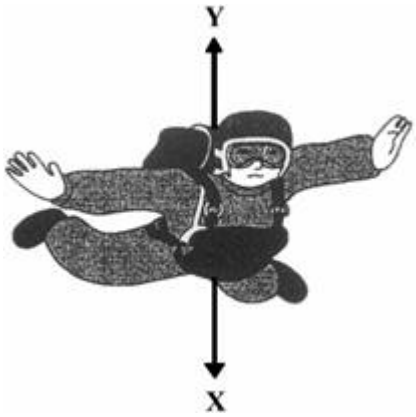
Skydiver _____ will fall faster because_____

_____

_____

(2)

The diagram shows the direction of the forces acting on one of the skydivers.



Adapted from Progress with Physics by Nick England, reproduced by permission of Hodder Arnold

(b) In the following sentences, cross out in each box the **two** lines that are wrong.

(i) Force **X** is caused by

air resistance
friction
gravity

(1)

(ii) Force **Y** is caused by

air resistance
gravity
weight

(1)

(iii) When force **X** is bigger than force **Y**, the speed of the skydiver will

go up
stay the same
go down

(1)

(iv) After the parachute opens, force **X**

goes up
stays the same
goes down

(1)

(c) How does the area of an opened parachute affect the size of force **Y**?

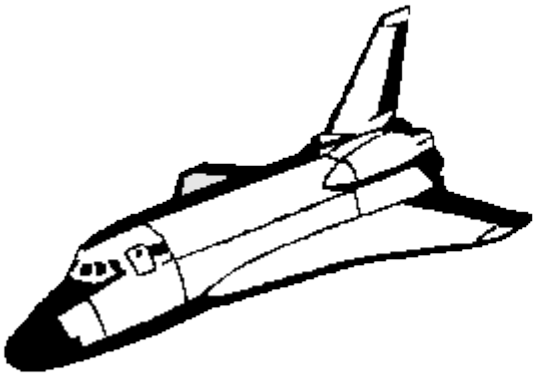
_____

_____

(1)

(Total 7 marks)

13 The diagram shows an orbiter, the reusable part of a space shuttle. The data refers to a typical flight.



Orbiter data	
Mass	78 000 kg
Orbital speed	7.5 km/s
Orbital altitude	200 km
Landing speed	100 m/s
Flight time	7 days

(a) (i) What name is given to the force which keeps the orbiter in orbit around the Earth?

_____

(1)

(ii) Use the following equation to calculate the kinetic energy, in joules, of the orbiter while it is in orbit.

$$\text{kinetic energy} = \tfrac{1}{2}\, mv^2$$

_____

_____

Kinetic energy = _____ joules

(2)

(iii) What happens to most of this kinetic energy as the orbiter re-enters the Earth's atmosphere?

_____

_____

(1)

(b) After touchdown the orbiter decelerates uniformly coming to a halt in 50 s.

(i) Give the equation that links acceleration, time and velocity.

_____

(1)

(ii) Calculate the deceleration of the orbiter. Show clearly how you work out your answer and give the unit.

_____

_____

Deceleration = _____

(2)

(c) (i) Give the equation that links acceleration, force and mass.

_____

(1)

(ii) Calculate, in newtons, the force needed to bring the orbiter to a halt. Show clearly how you work out your answer.

_____

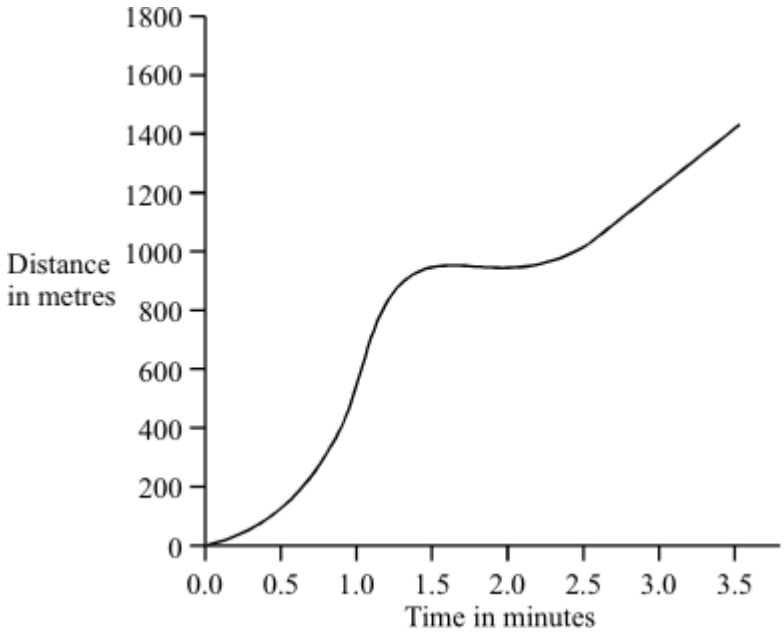
_____

Force = _____ newtons

(1)

(Total 9 marks)

14 The graph shows how the distance travelled by a car changes with time during a short journey.



(i) Describe fully the motion of the car during the first **two** minutes of the journey.

_____

_____

_____

_____

_____

(3)

(ii) During the last minute of the journey the velocity of the car changes although the speed remains constant. How is this possible?

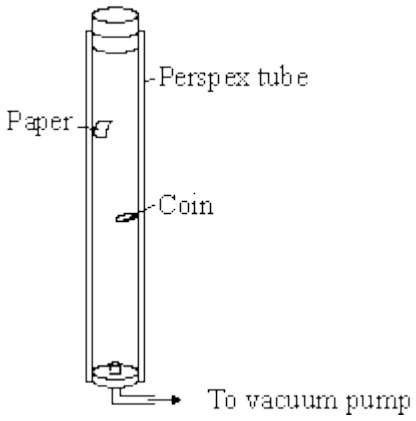
_____

_____

(1)

(Total 4 marks)

15 The apparatus shown is used to compare the motion of a coin with the motion of a piece of paper as they both fall.



(a) When the tube is filled with air the coin falls faster than the piece of paper. Why?

_____

_____

(1)

(b) The air in the tube is removed by the vacuum pump. The tube is turned upside down. State **two** ways in which the motion of the coin and piece of paper will change compared to when there was air in the tube.

1. _____

_____

_____

2. _____

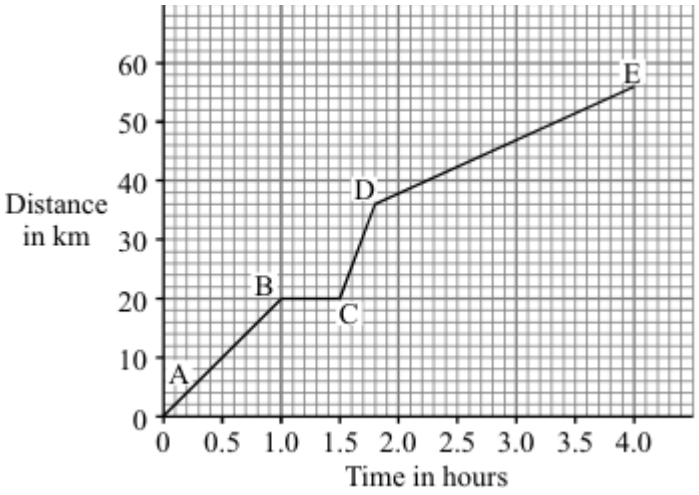
_____

_____

(2)

(Total 3 marks)

16 A cyclist goes on a long ride. The graph shows how the distance travelled changes with time during the ride.



(i) Between which **two** points on the graph was the cyclist moving at the fastest speed?

_____

(1)

(ii) State **one** way cyclists can reduce the air resistance acting on them.

_____

_____

(1)

(iii) How long did the cyclist stop and rest?

_____

(1)

(iv) Write down the equation which links distance, speed and time.

_____

(1)

(v) Calculate, in km/hr, the average speed of the cyclist while moving.

_____

_____

_____

_____

Average speed = _____ km/hr

(3)

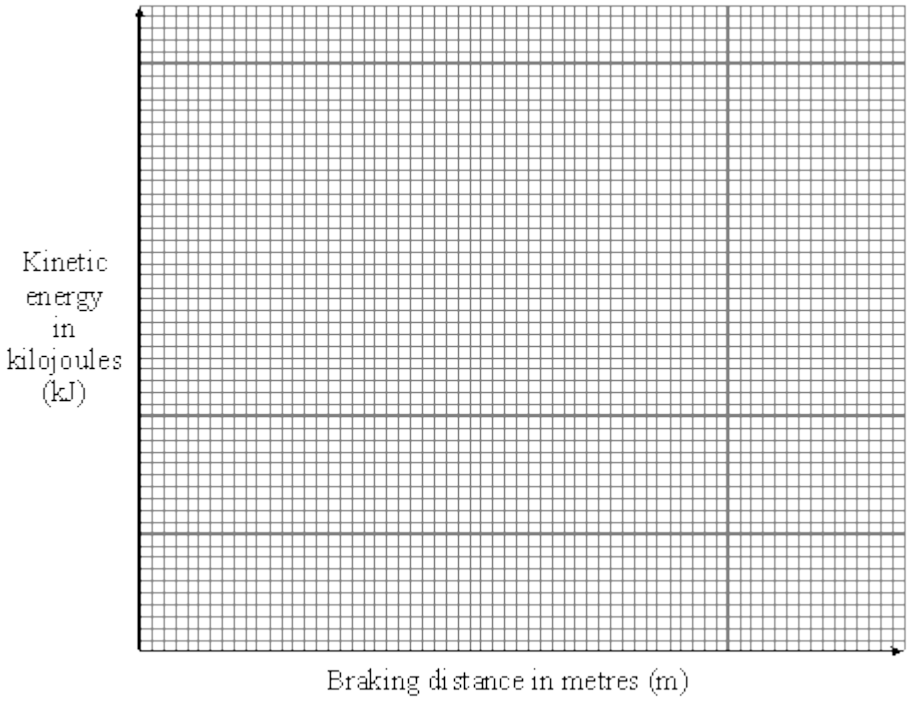
(Total 7 marks)

17 The table shows the braking distances for a car at different speeds and kinetic energy. The braking distance is how far the car travels once the brakes have been applied.

Braking distance in m	Speed of car in m/s	Kinetic energy of car in kJ
5	10	40
12	15	90
20	20	160
33	25	250
45	30	360

(a) A student suggests, "*the braking distance is directly proportional to the kinetic energy*."

(i) Draw a line graph to test this suggestion.



(3)

(ii) Does the graph show that the student's suggestion was correct or incorrect? Give a reason for your answer.

_____

_____

(1)

(iii) Use your graph and the equation for kinetic energy to predict a braking distance for a speed of 35 metres per second (m/s). The mass of the car is 800 kilograms (kg). Show clearly how you obtain your answer.

_____

_____

Braking distance = _____ m

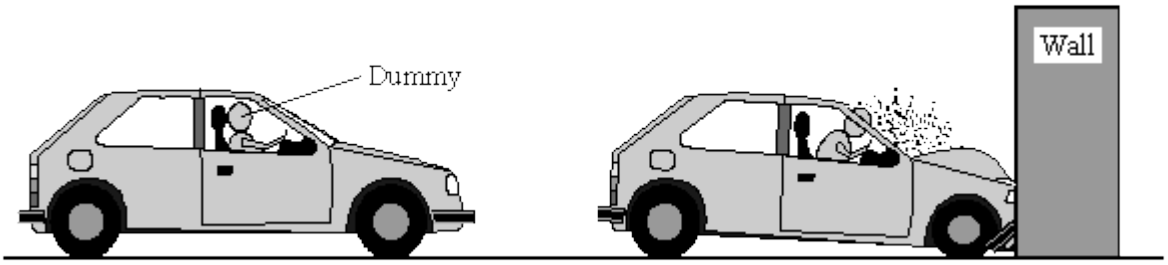
(2)

(iv) State **one** factor, apart from speed, which would increase the car's braking distance.

_____

(1)

(b) The diagram shows a car before and during a crash test. The car hits the wall at 14 metres per second (m/s) and takes 0.25 seconds (s) to stop.



(i) Write down the equation which links acceleration, change in velocity and time taken.

_____

(1)

(ii) Calculate the deceleration of the car.

_____

Deceleration = _____ m/s^2

(1)

(iii) In an accident the crumple zone at the front of a car collapses progressively. This increases the time it takes the car to stop. In a front end collision the injury to the car passengers should be reduced. Explain why. The answer has been started for you.

By increasing the time it takes for the car to stop, the _____

_____

_____

_____

(2)

(Total 11 marks)

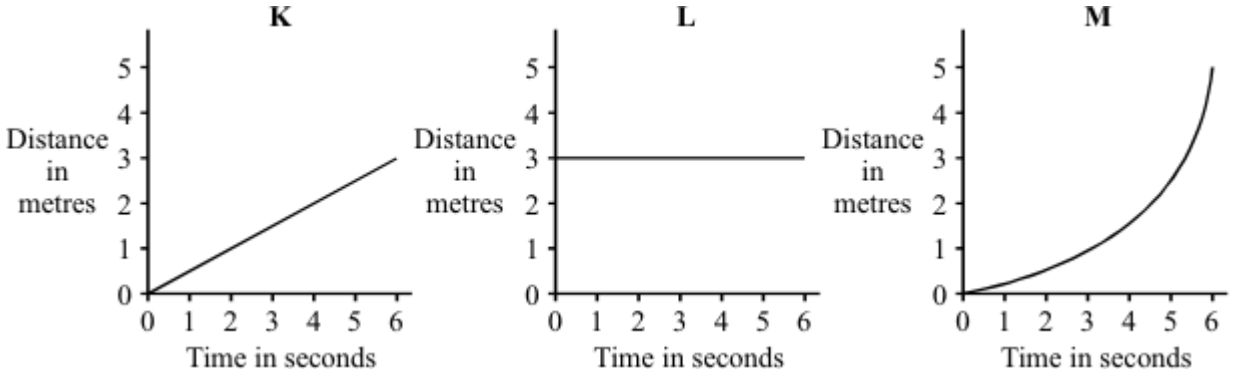
18 (a) A shopping trolley is being pushed at a constant speed. The arrows represent the horizontal forces on the trolley.

(i) How big is force **P** compared to force **F**?

_____

(1)

(ii) Which **one** of the distance-time graphs, **K**, **L** or **M**, shows the motion of the trolley? Draw a circle around your answer.



(1)

(b) Complete the sentence by crossing out the **two** words in the box that are wrong.

Acceleration is the rate of change of

energy.
speed.
velocity.

(1)

(c) Three trolleys, **A**, **B** and **C**, are pushed using the same size force. The force causes each trolley to accelerate.

Which trolley will have the smallest acceleration?

_____

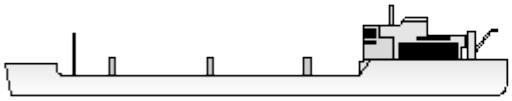
Give a reason for your answer.

_____

(2)

(Total 5 marks)

19 The table contains typical data for an oil tanker.



Mass	56 000 000 kg
Cruising speed	12 m/s
Deceleration force	392 000 N
Stopping distance	10 000 m

(i) Write down the equation which links acceleration, force and mass.

_____

(1)

(ii) Calculate the deceleration of the oil tanker. Show clearly how you work out your answer.

_____

_____

_____

Deceleration = _____ m/s^2

(2)

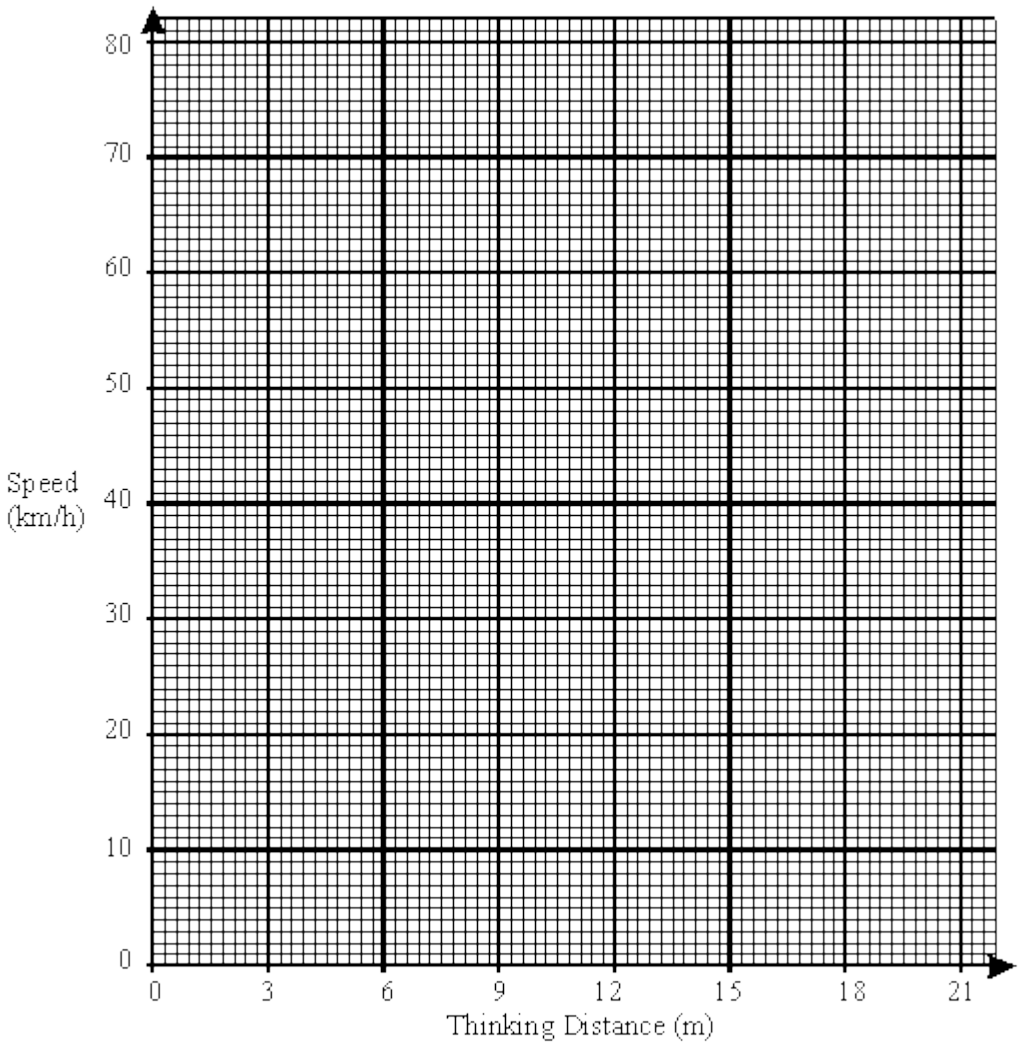
(Total 3 marks)

20 When a car driver has to react and apply the brakes quickly, the car travels some distance before stopping. Part of this distance is called the "thinking distance". This is how far the car travels while the driver reacts to a dangerous situation.

The table below shows the thinking distance (m) for various speeds (km/h).

Thinking distance (m)	0	9	12	15
Speed (km/h)	0	48	64	80

(a) On the graph paper below, draw a graph of the thinking distance against speed.



(2)

(b) Describe how thinking distance changes with speed.

_____

_____

(1)

(c) The time the driver spends thinking before applying the brakes is called the “thinking time”.

A driver drank two pints of lager. Some time later the thinking time of the driver was measured as 1.0 seconds.

(i) Calculate the thinking distance for this driver when driving at 9 m/s.

_____

_____

Answer _____ m

(1)

(ii) A speed of 9 m/s is the same as 32 km/h. Use your graph to find the thinking distance at 32 km/h for a driver who has not had a drink.

_____

Answer _____ m

(1)

(iii) What has been the effect of the drink on the thinking distance of the driver?

_____

_____

(1)

(Total 6 marks)

21 The manufacturer of a family car gave the following information.

Mass of car 950 kg

The car will accelerate from 0 to 33 m/s in 11 seconds.

(a) Calculate the acceleration of the car during the 11 seconds.

_____

_____

_____

(2)

(b) Calculate the force needed to produce this acceleration.

_____

_____

_____

(2)

(c) The manufacturer of the car claims a top speed of 110 miles per hour. Explain why there must be a top speed for any car.

_____

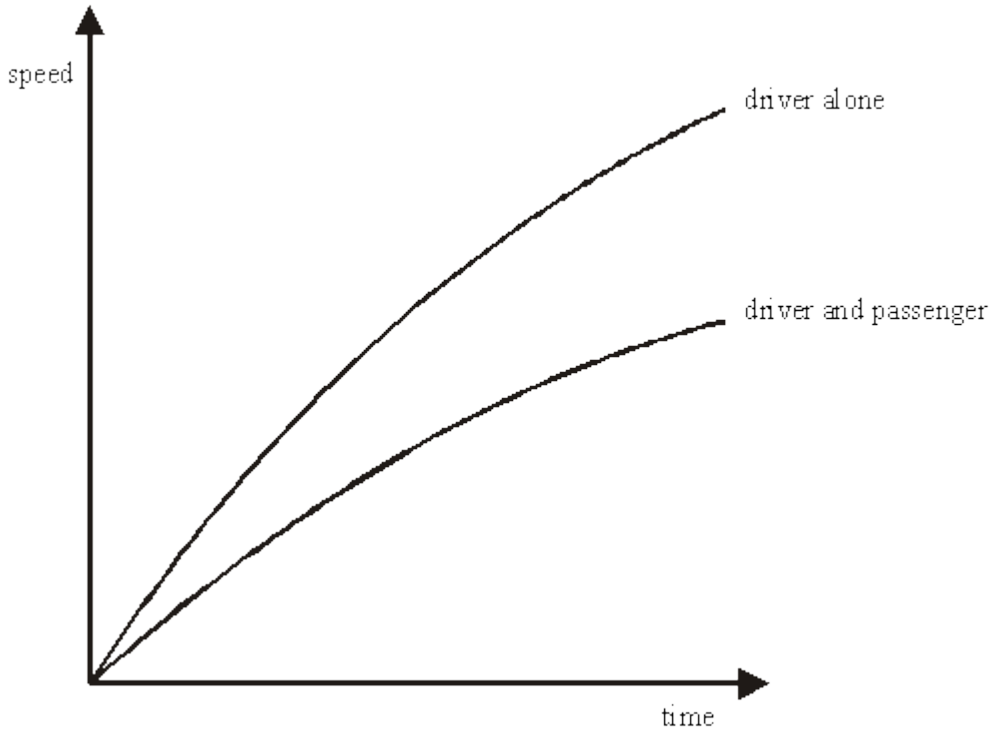
_____

_____

(3)

(Total 7 marks)

22 (a) When a car is driven efficiently the engine gives a constant forward pull on the car as the car accelerates to its maximum speed. During this time frictional forces and air resistance oppose the forward motion of the car. The sketch graphs below show how the car's speed increases when only the driver is in the car, and when the driver has a passenger in the car.



(i) How does the acceleration of the car change with time?

_____

_____

(1)

(ii) What conclusion can be made about the resultant (net) forward force on the car as its speed increases?

_____

_____

(1)

(ii) On the graph, draw a line to show how you would expect the car's speed to vary if it carried three passengers.

(1)

(b) The manufacturer of a family car gave the following information.

Mass of car 950g

The car will accelerate from 0 to 33 m/s in 11 seconds.

(i) Calculate the acceleration of the car during the 11 seconds.

Answer _____

(2)

(ii) Calculate the force needed to produce this acceleration.

Answer _____ N

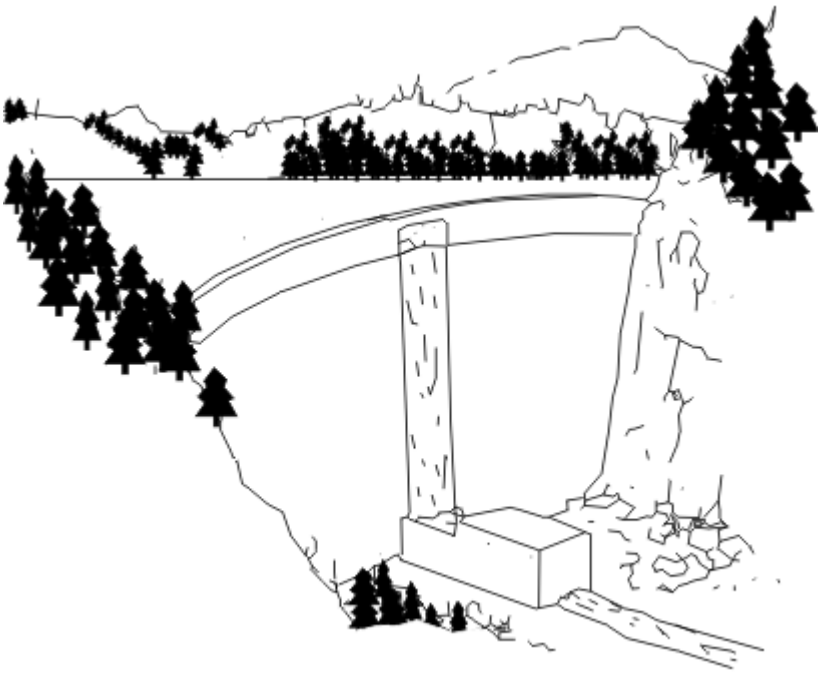
(2)

(iii) The manufacturer of the car claims a top speed of 110 miles per hour. Explain why there must be a top speed for any car.

(2)

(Total 9 marks)

23 The diagram below shows water falling from a dam. Each minute 12 000 kg of water falls vertically into the pool at the bottom.



The time taken for the water to fall is 2 s and the acceleration of the water is 10 m/s^2.

(a) Assume the speed of the water at the bottom of the dam is zero. Calculate the speed of the water just before it hits the pool at the bottom.

_____

_____

(2)

(b) Use your answer to part (a) to calculate the average speed of the falling water.

_____

(1)

(c) Calculate the height that the water falls.

_____

_____

(2)

(d) What weight of water falls into the pool each minute?

_____

_____

(2)

(e) How much work is done by gravity each minute as the water falls?

_____

_____

(2)

(f) A small electrical generator has been built at the foot of the waterfall. It uses the falling water to produce electrical power.

(i) How much energy is available from the falling water each minute?

_____

(ii) How much power is available from the falling water?

_____

_____

(iii) If the generator is 20% efficient, calculate the electrical power output of the generator.

_____

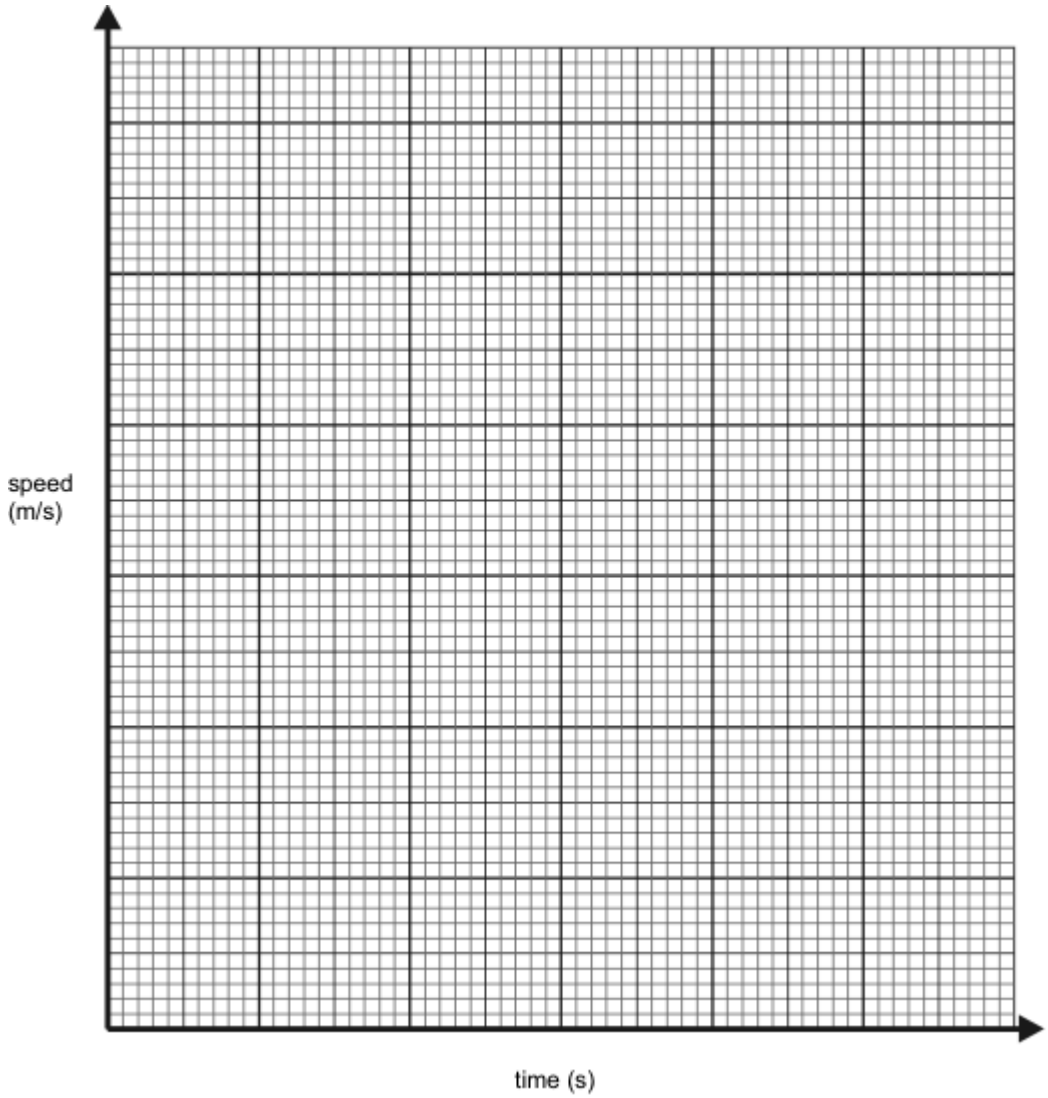
_____

(4)

(Total 13 marks)

24 A driver is driving along a road at 30 m/s. The driver suddenly sees a large truck parked across the road and reacts to the situation by applying the brakes so that a constant braking force stops the car. The reaction time of the driver is 0.67 seconds, it then takes another 5 seconds for the brakes to bring the car to rest.

(a) Using the data above, draw a speed-time graph to show the speed of the car from the instant the truck was seen by the driver until the car stopped.



(5)

(b) Calculate the acceleration of the car whilst the brakes are applied.

Answer = _____ m/s^2

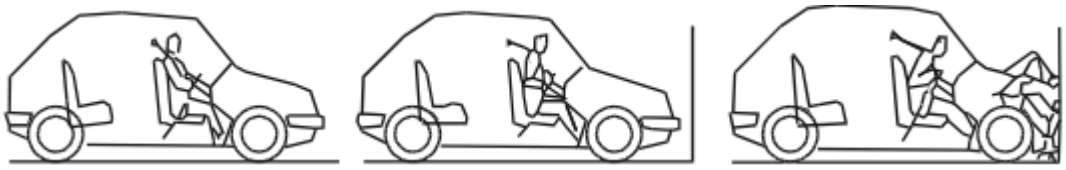
(3)

(c) The mass of the car is 1500 kg. Calculate the braking force applied to the car.

Answer = _____ N

(3)

(d) The diagrams below show what would happen to a driver in a car crash.



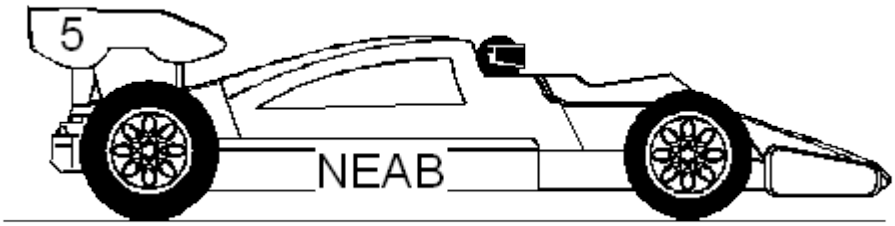
(i) Explain why the driver tends to be thrown towards the windscreen.

(ii) The car was travelling at 30 m/s immediately before the crash. Calculate the energy which has to be dissipated as the front of the car crumples.

(8)

(Total 17 marks)

25 A racing driver is driving his car along a **straight** and **level** road as shown in the diagram below.



(a) The driver pushes the accelerator pedal as far down as possible. The car does not accelerate above a certain maximum speed. Explain the reasons for this in terms of the forces acting on the car.

(4)

(b) The racing car has a mass of 1250 kg. When the brake pedal is pushed down a constant braking force of 10 000 N is exerted on the car.

(i) Calculate the acceleration of the car.

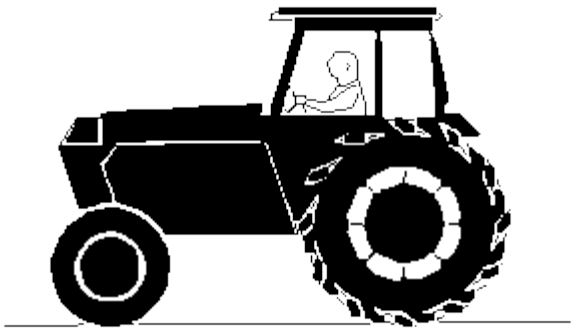
(ii) Calculate the kinetic energy of the car when it is travelling at a speed of 48 m/s.

(iii) When the brakes are applied with a constant force of 10 000 N the car travels a distance of 144 m before it stops. Calculate the work done in stopping the car.

(12)

(Total 16 marks)

26 (a) The diagram below shows a moving tractor. The forward force from the engine exactly balances the resisting forces on the tractor.



(i) Describe the motion of the tractor.

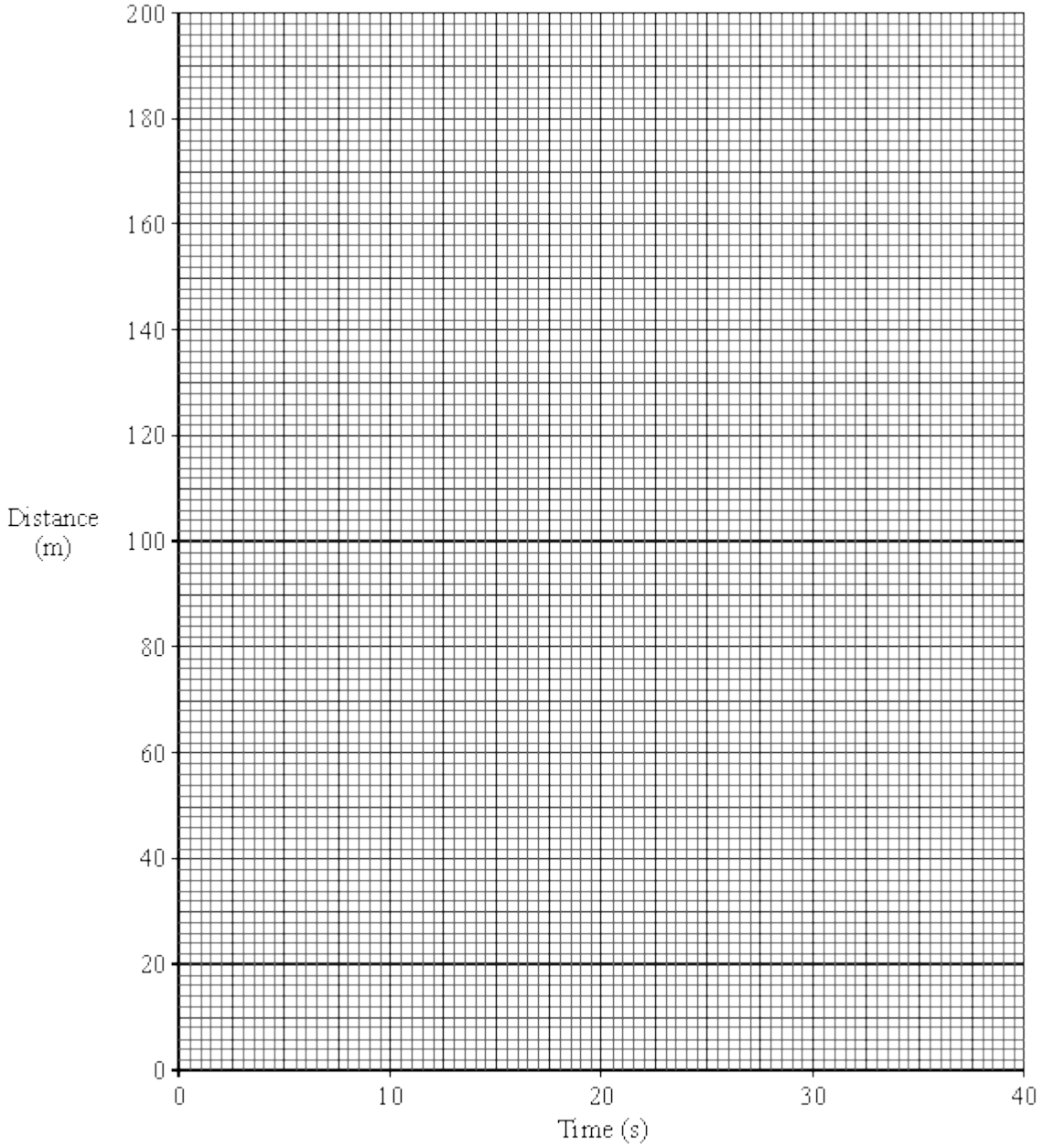
(ii) The tractor comes to a drier part of the field where the resisting forces are less. If the forward force from the engine is unchanged how, if at all, will the motion of the tractor be affected?

(3)

(b) Two pupils are given the task of finding out how fast a tractor moves across a field. As the tractor starts a straight run across the field the pupils time how long it takes to pass a series of posts which are forty metres apart. The results obtained are shown in the table below.

Distancetravelled (m)	0	40	80	120	160	200
Timetaken (s)	0	8	16	24	32	40

(i) Draw a graph of distance travelled against time taken using the axes on the graph below. Label your graph line A.



(2)

(ii) Calculate the speed of the tractor.

_____

_____

(3)

(c) In another, wetter field there is more resistance to the movement of the tractor. It now travels at 4 m/s.

(i) Calculate the time needed to travel 200m.

_____

_____

_____

(ii) On the graph in part (b) draw a line to represent the motion of the tractor across the second field. Label this line B.

(4)

(d) On a road the tractor accelerates from rest up to a speed of 6 m/s in 15 seconds.

Calculate the acceleration of the tractor.

_____

_____

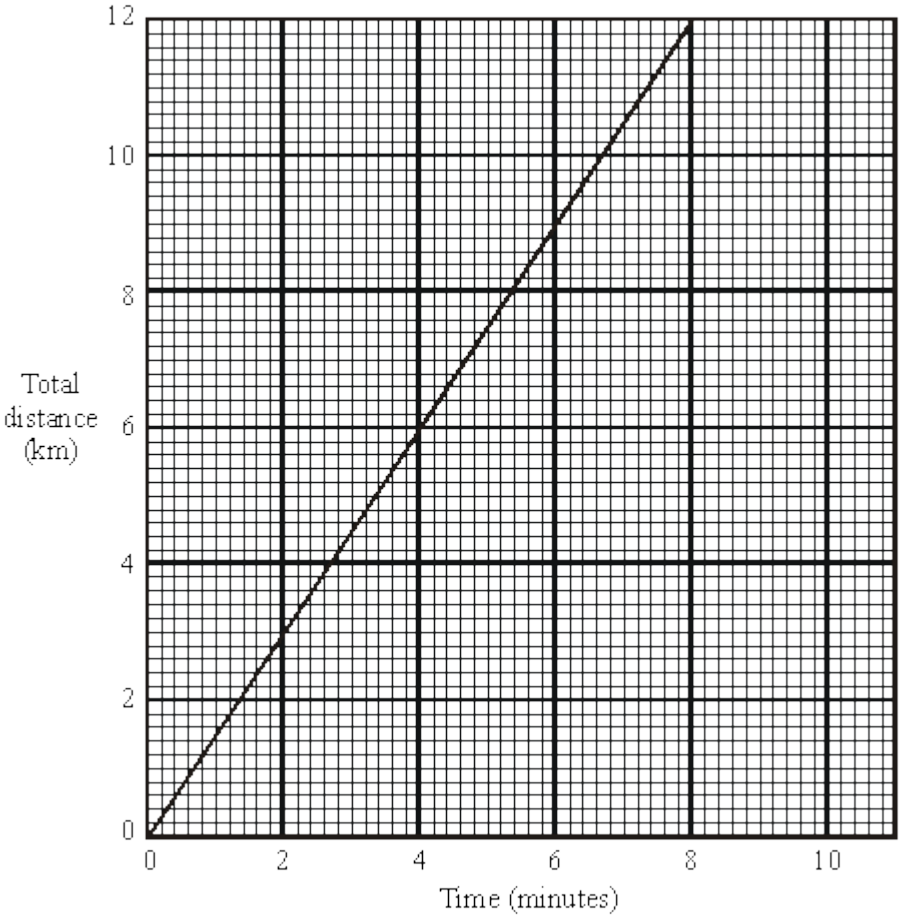
_____

_____ Acceleration = _____ m/s^2

(3)

(Total 15 marks)

27 Below is a distance-time graph for part of a train journey.
The train is travelling at a constant speed.



(a) Use the graph to find

(i) how far the train travels in 2 minutes _____ km.

(ii) how long it takes the train to travel a distance of 10 kilometres

_____ minutes.

(2)

(b) Calculate the speed of the train.

_____

_____

_____

_____

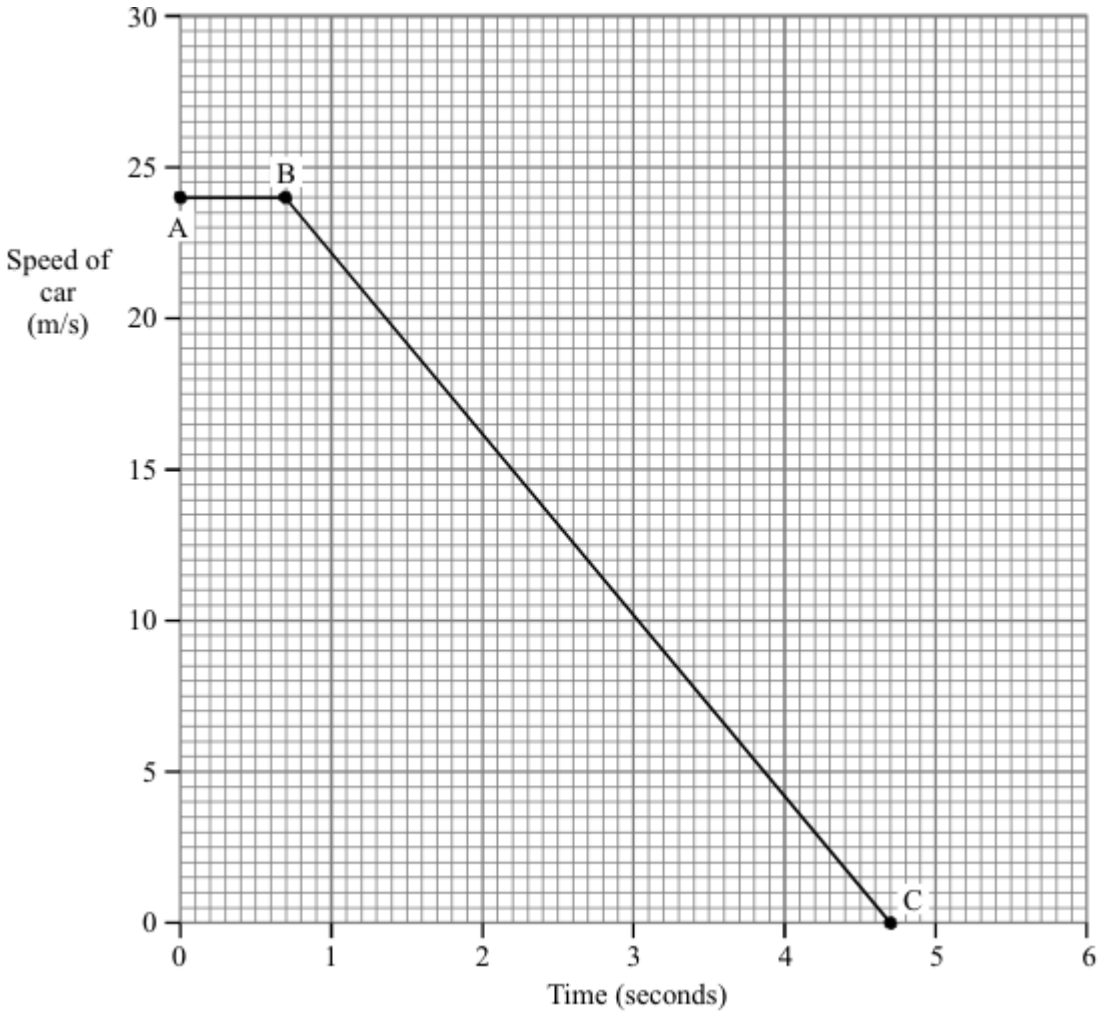
_____

(4)

(Total 6 marks)

28 A car driver sees a dog on the road ahead and has to make an emergency stop.

The graph shows how the speed of the car changes with time after the driver first sees the dog.



(a) Which part of the graph represents the "reaction time" or "thinking time" of the driver?

_____

(1)

(b) (i) What is the thinking time of the driver?

Time _____ seconds

(1)

(ii) Calculate the distance travelled by the car in this thinking time.

_____

_____

_____

Distance _____ m

(3)

(c) Calculate the acceleration of the car after the brakes are applied.

Acceleration _____

(4)

(d) Calculate the distance travelled by the car during braking.

Distance _____ m

(3)

(e) The mass of the car is 800 kg. Calculate the braking force.

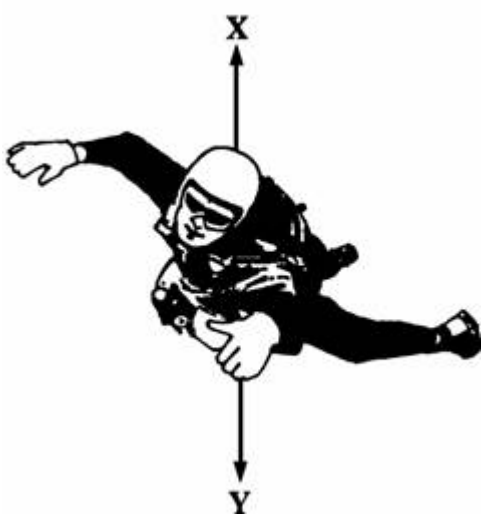
Braking force _____ N

(3)

(Total 15 marks)

29 A sky-diver jumps from a plane.

The sky-diver is shown in the diagram below.



(a) Arrows **X** and **Y** show two forces acting on the sky-diver as he falls.

(i) Name the forces **X** and **Y**.

X _____

Y _____

(2)

(ii) Explain why force **X** acts in an upward direction.

_____

_____

(1)

(iii) At first forces **X** and **Y** are unbalanced.

Which of the forces will be bigger? _____

(1)

(iv) How does this unbalanced force affect the sky-diver?

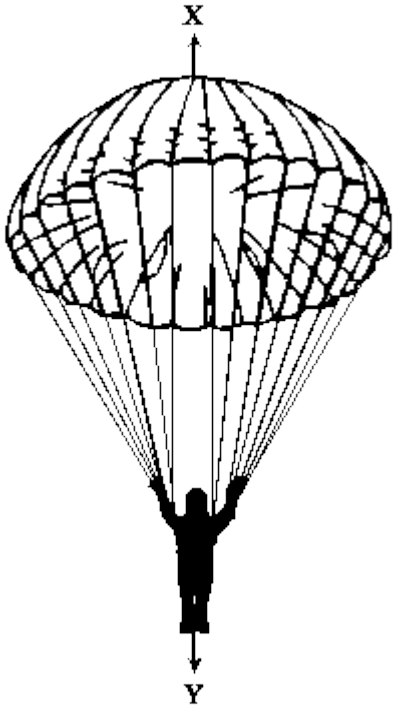
_____

_____

(2)

(b) After some time the sky-diver pulls the rip cord and the parachute opens.

The sky-diver and parachute are shown in the diagram below.



After a while forces **X** and **Y** are balanced.

Underline the correct answer in each line below.

Force **X** has

increased / stayed the same / decreased.

Force **Y** has

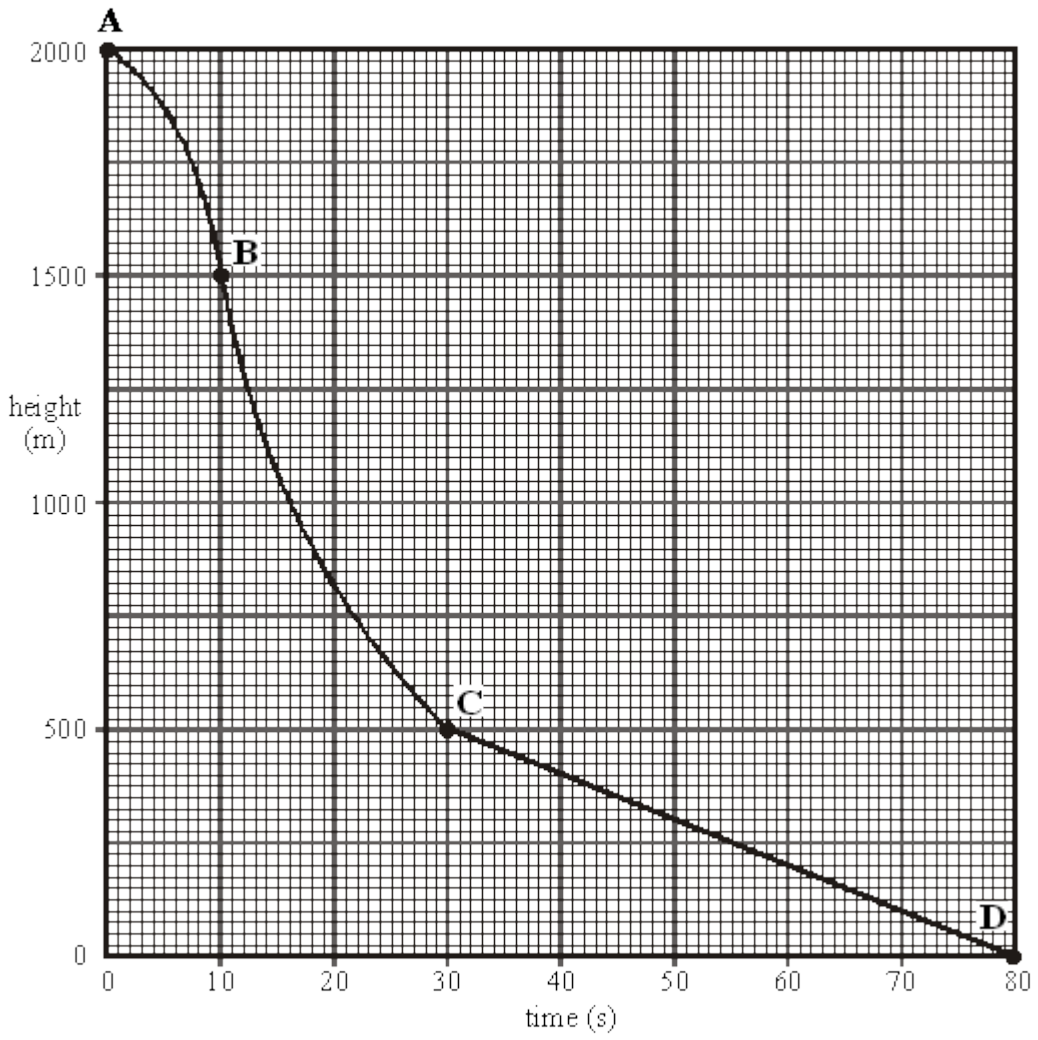
increased / stayed the same / decreased.

The speed of the sky-diver will

increase / stay the same / decrease.

(3)

(c) The graph below shows how the height of the sky-diver changes with time.



(i) Which part of the graph, **AB**, **BC** or **CD** shows the sky-diver falling at a constant speed?

_____

(1)

(ii) What distance does the sky-diver fall at a constant speed?

Distance _____ m

(1)

(iii) How long does he fall at this speed?

Time _____ s

(1)

(iv) Calculate this speed.

_____

_____

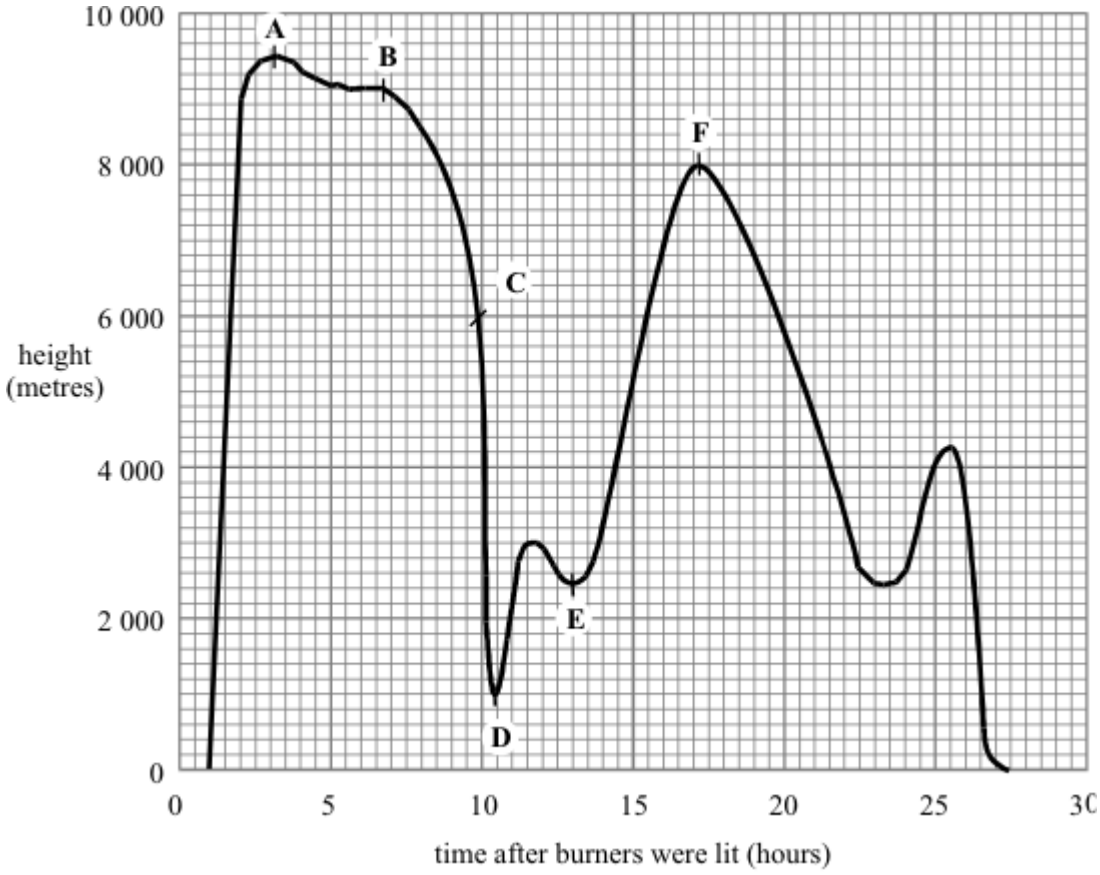
_____

Speed _____ m/s

(2)

(Total 14 marks)

30 A hot air balloon called Global Challenger was used to try to break the record for travelling round the world.
The graph shows how the height of the balloon changed during the flight.



The balloon took off from Marrakesh one hour after the burners were lit and climbed rapidly.

(a) Use the graph to find:

(i) the maximum height reached.

Maximum height _____ metres.

(ii) the total time of the flight.

Total time _____ hours.

(2)

(b) Several important moments during the flight are labelled on the graph with the letters **A**, **B**, **C**, **D**, **E** and **F**.
At which of these moments did the following happen?

(i) The balloon began a slow controlled descent to 2500 metres.

_____

(ii) The crew threw out all the cargo on board in order to stop a very rapid descent.

_____

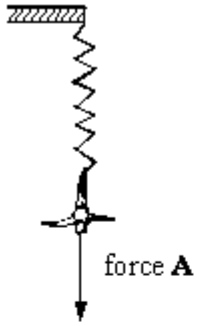
(iii) The balloon started to descend from 9000 metres.

_____

(3)

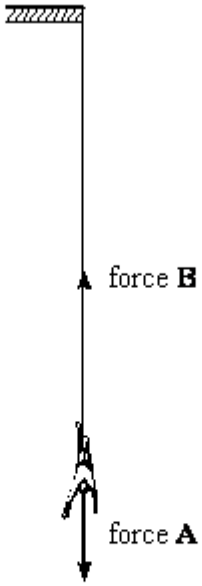
(Total 5 marks)

31 When a bungee-jump is made the jumper steps off a high platform. An elastic cord from the platform is tied to the jumper.
The diagram below shows different stages in a bungee-jump.
Forces **A**, **B** and **C** are forces acting on the jumper at each stage.



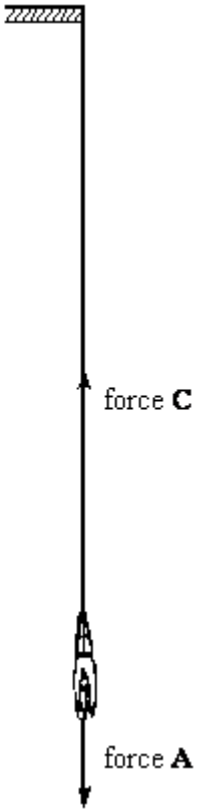
moving down
large acceleration

diagram **X**



moving down
small acceleration

diagram **Y**



moving down
slowing acceleration

diagram **Z**

(a) Name force **A**.

_____

(1)

(b) The motion of the jumper is shown in the diagrams.
By comparing forces **A**, **B** and **C**, state how the motion is caused in:

(i) diagram **X**;

_____

(ii) diagram **Y**;

_____

(iii) diagram **Z**.

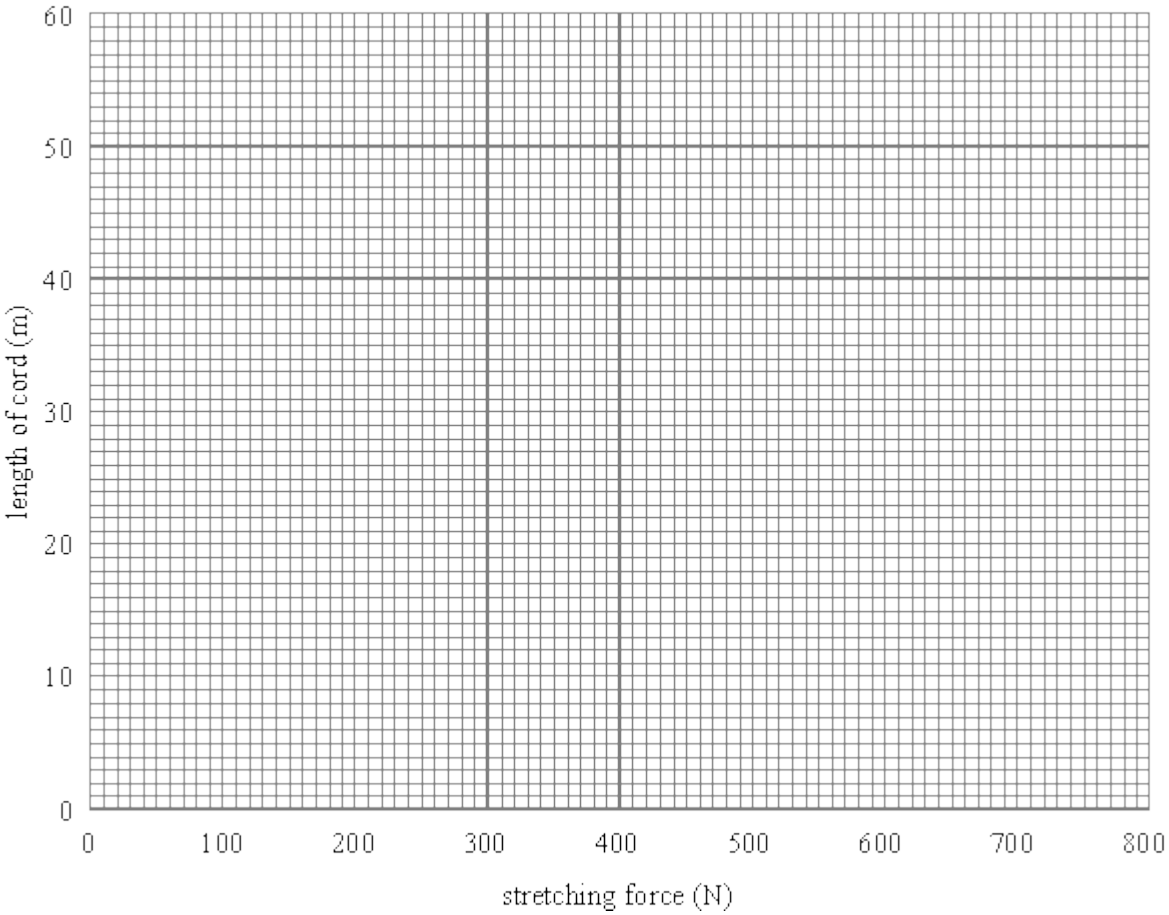
_____

(3)

(c) The table gives results for a bungee cord when it is being stretched.

STRETCHING FORCE (N)	100	200	400	600	800
LENGTH OF CORD (m)	20	24	32	40	48

(i) Plot a graph of these results on the graph paper.



(3)

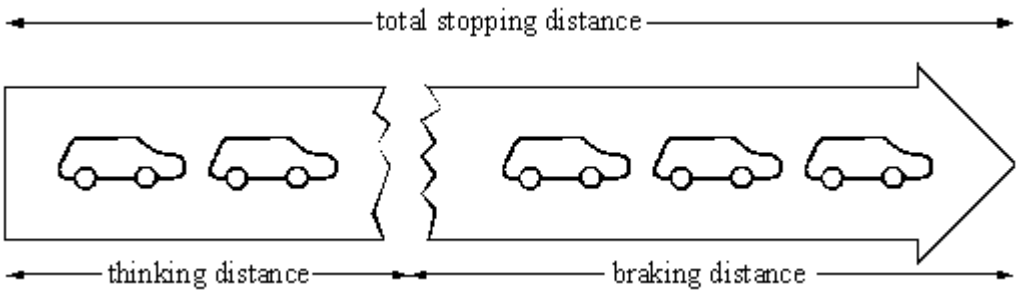
(ii) Use the graph to find the length of the cord before it was stretched.

Length _____ m

(1)

(Total 8 marks)

32 The Highway Code gives tables of the shortest stopping distances for cars travelling at various speeds. An extract from the Highway Code is given below.



thinking distance + braking distance = total stopping distance

(a) A driver's reaction time is 0.7 s.

(i) Write down **two** factors which could increase a driver's reaction time.

1. _____

2. _____

(2)

(ii) What effect does an increase in reaction time have on:

A thinking distance; _____

B braking distance; _____

C total stopping distance? _____

(3)

(b) Explain why the braking distance would change on a wet road.

_____

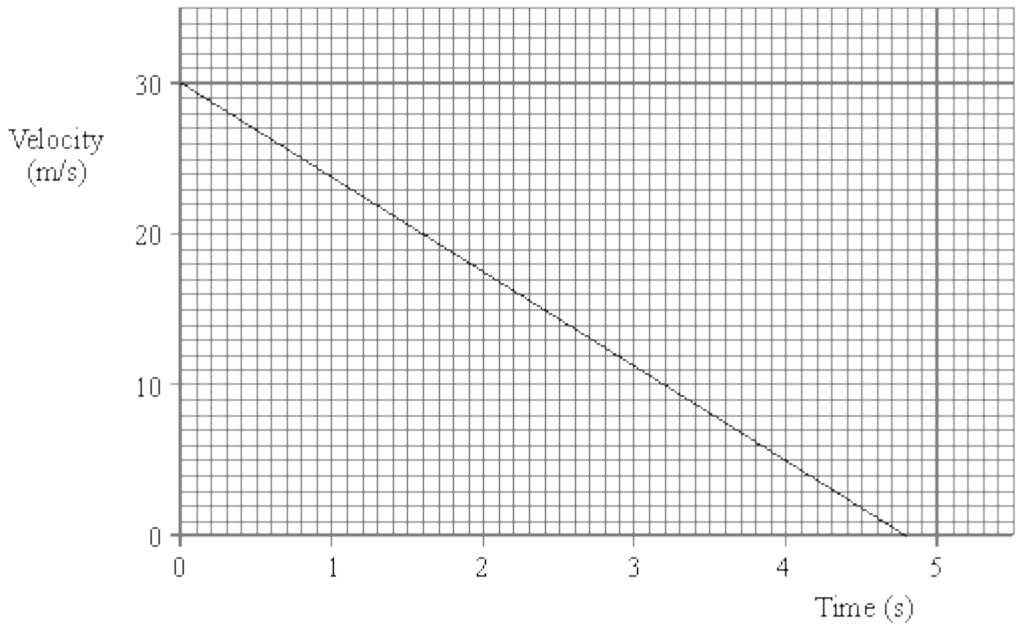
_____

_____

_____

(2)

(c) A car was travelling at 30 m/s. The driver braked. The graph below is a velocity-time graph showing the velocity of the car during braking.



Calculate:

(i) the rate at which the velocity decreases (deceleration);

_____

_____

Rate _____ m/s^2

(2)

(ii) the braking force, if the mass of the car is 900 kg;

_____

_____

Braking force _____ N

(2)

(iii) the braking distance.

_____

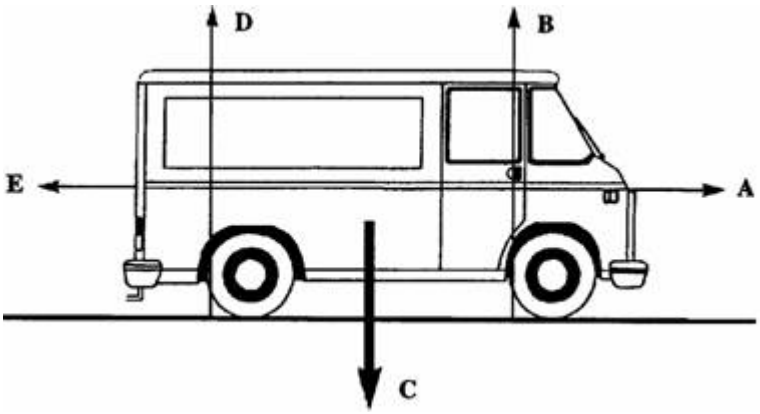
_____

Braking distance _____ m

(2)

(Total 13 marks)

33



Five forces, **A**, **B**, **C**, **D** and **E** act on the van.

(a) Complete the following sentences by choosing the correct forces from **A** to **E**.

Force _____ is the forward force from the engine.

Force _____ is the force resisting the van's motion.

(1)

(b) The size of forces **A** and **E** can change.
Complete the table to show how big force **A** is compared to force **E** for each motion of the van.
Do this by placing a tick in the correct box.
The first one has been done for you.

MOTION OF VAN	FORCE **A** SMALLER THAN FORCE **E**	FORCE **A** EQUAL TO FORCE **E**	FORCE **A** BIGGER THAN FORCE **E**
Not moving			
Speeding up			
Constant speed			
Slowing down			

(3)

(c) When is force **E** zero?

_____

(1)

(d) The van has a fault and leaks one drop of oil every second.
The diagram below shows the oil drops left on the road as the van moves from **W** to **Z**.

Describe the motion of the van as it moves from:

W to X _____

X to Y _____

Y to Z _____

(3)

(e) The driver and passengers wear seatbelts.
Seatbelts reduce the risk of injury if the van stops suddenly.

backwards **downwards** **force** **forwards** **mass** **weight**

Complete the following sentences, using words from the list above, to explain why the risk of injury is reduced if the van stops suddenly.

A large _____ is needed to stop the van suddenly.

The driver and passengers would continue to move _____ .

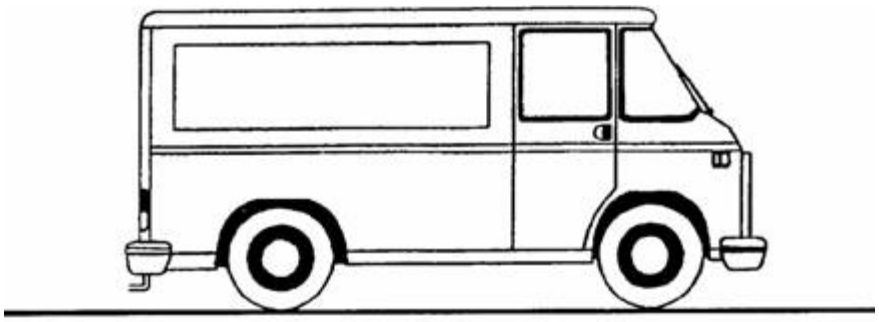
The seatbelts supply a _____ force to keep the driver and passengers

in their seats.

(3)

(Total 11 marks)

34



(a) The van shown above has a fault and leaks one drop of oil every second.

The diagram below shows the oil drops left on the road as the van moves from **W** to **Z**.

Describe the motion of the van as it moves from:

W to **X** _____

_____

X to **Y** _____

_____

Y to **Z** _____

_____

(3)

(b) The van was driven for 20 seconds at a speed of 30m/s.

Calculate the distance travelled.

Distance _____ m

(2)

(c) The van was travelling at 30m/s. It slowed to a stop in 12 seconds.

Calculate the van's acceleration.

Acceleration _____ m/s^2

(3)

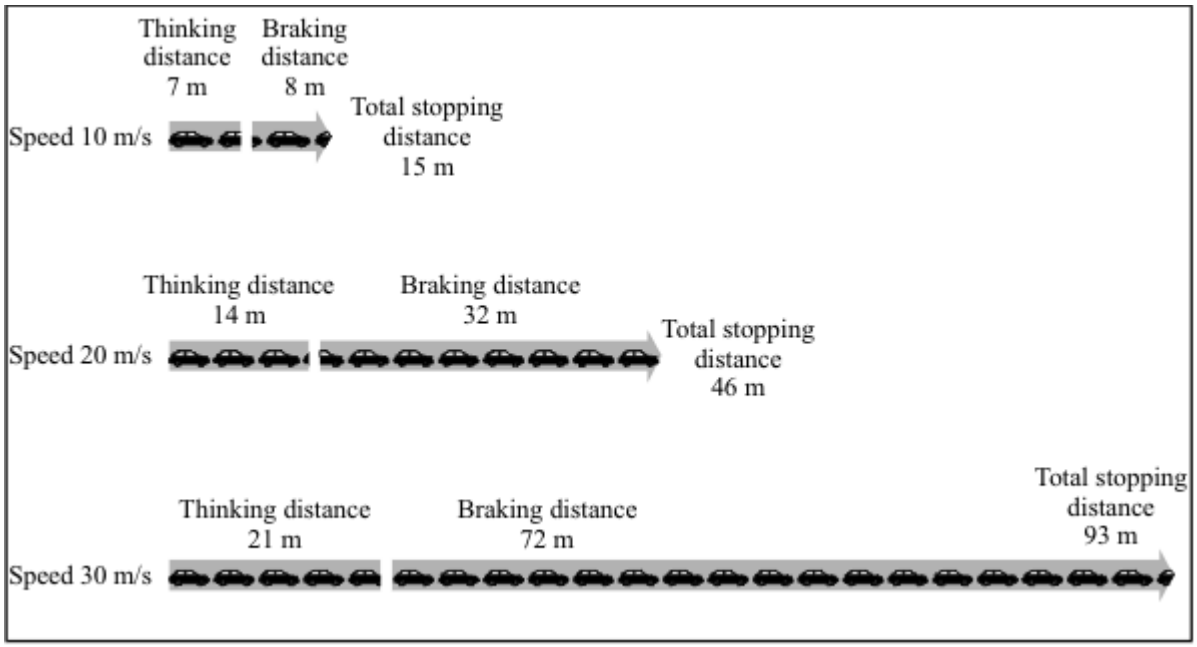
(d) The driver and passenger wear seatbelts. Seatbelts reduce the risk of injury.

Explain how seatbelts reduce the risk of injury.

(4)

(Total 12 marks)

35 The diagram below shows the thinking distances, braking distances and total stopping distances at different speeds.



(a) Look at the total stopping distances at each speed.

Complete the sentence by choosing the correct words from the box.

distance	**force**	**mass**	**time**

The total stopping distance depends on the distance the car travels during the driver's reaction _____ and under the braking _____ .

(2)

(b) Give **three** other factors that could cause the total stopping distance of a car to be greater. Do **not** give the factors in **Figure 1.**

1. _____

_____

2. _____

_____

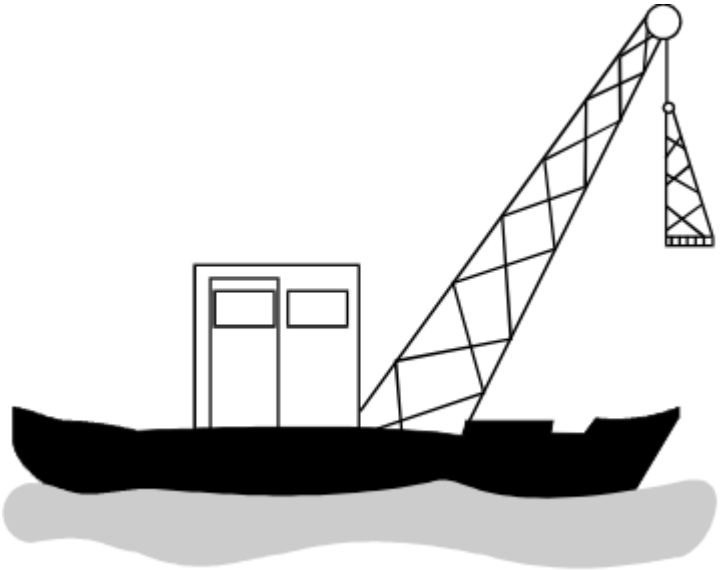
3. _____

_____

(3)

(Total 5 marks)

36 A crane on a barge lifts a girder and then carries it along the river.



The girder has a weight of 1 000 000 N and is lifted to a height of 1500 cm.

(a) Complete the sentence.

The weight of the girder is caused by the Earth's gravitational field strength acting on its _____ .

(1)

(b) Calculate the work done in lifting the girder.

Write the equation you are going to use.

_____

(1)

Show clearly how you work out your answer and give the unit.

_____

_____

_____

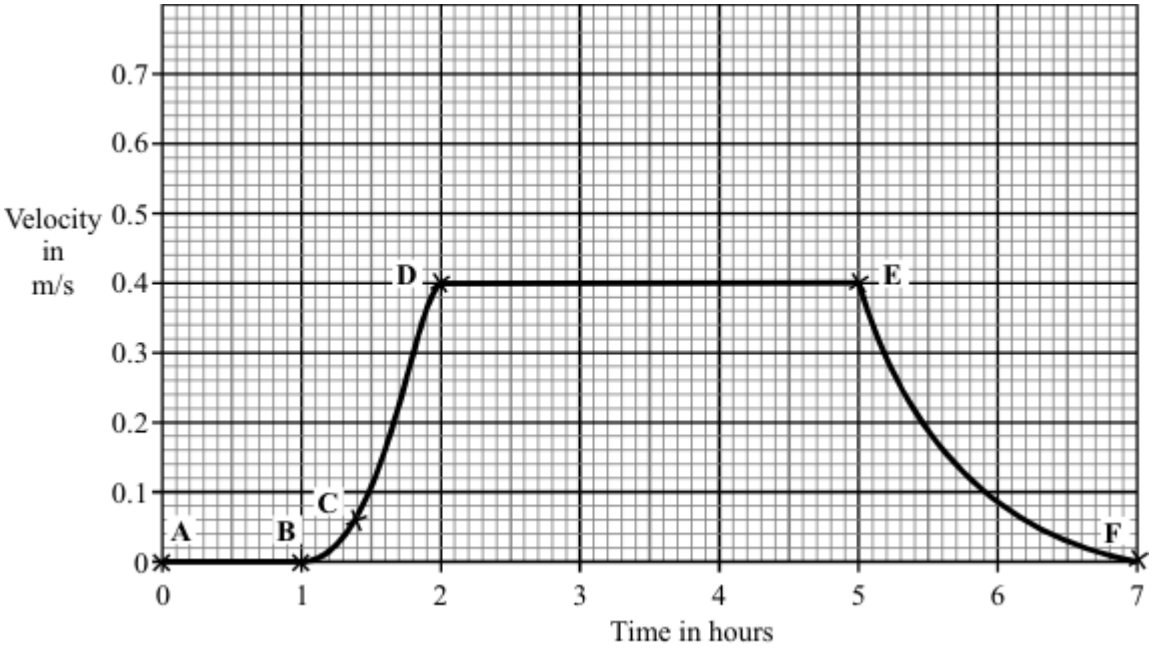
_____

_____

Work done = _____

(3)

(c) The velocity–time graph represents the motion of the barge after the girder had been lifted.



To gain full marks in this question you should write your ideas in good English. Put them in a sensible order and use the correct scientific words.

Describe the motion of the barge over this period of seven hours. You must refer to the points **A**, **B**, **C**, **D**, **E** and **F** in your description.

(5)

(Total 10 marks)

37 When you transfer *energy* to a shopping trolley, the amount of *work done* depends on the *force* used and the *distance moved*.

Complete the table by using the correct units from the box.

joule (J)	**metre (m)**	**newton (N)**

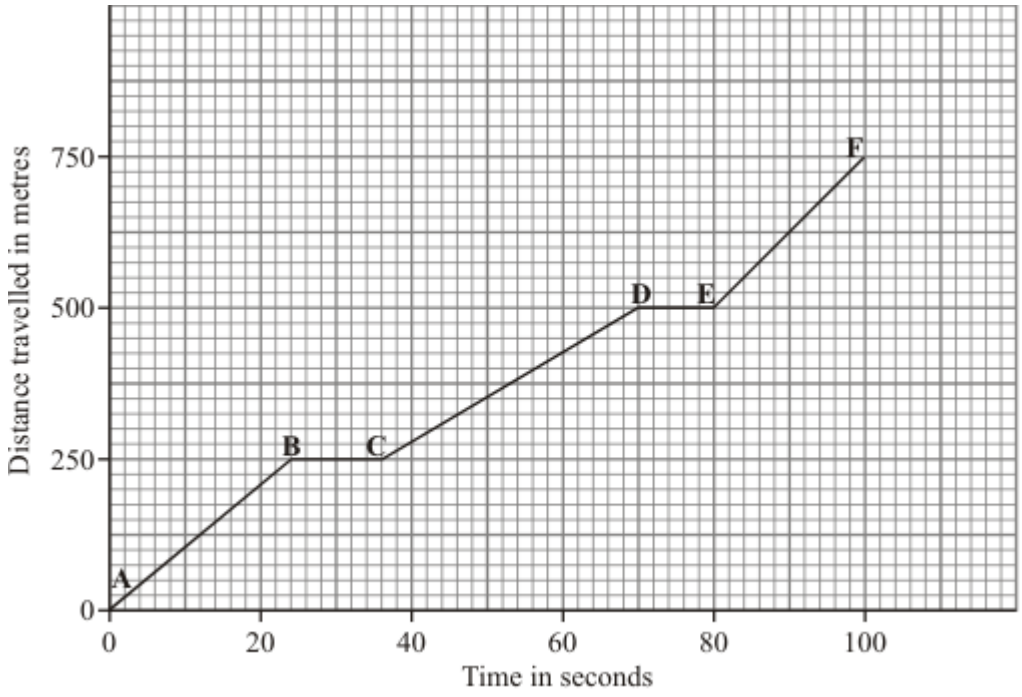
The first one has been done for you.

Quantity	**Unit**
energy (transferred)	joule
force	
distance (moved)	
work done	

(Total 2 marks)

38 This question is about a car travelling through a town.

(a) The graph shows how far the car travelled and how long it took.



(i) Between which points was the car travelling fastest? Tick (✓) your answer.

Points	Tick (✓)
A – B	
B – C	
C – D	
D – E	
E – F	

(1)

(ii) Between which points was the car stationary?

_____

_____

(1)

(b) Complete the sentences by writing the correct words in the spaces.

When a car has to stop, the **overall** stopping distance is greater if:

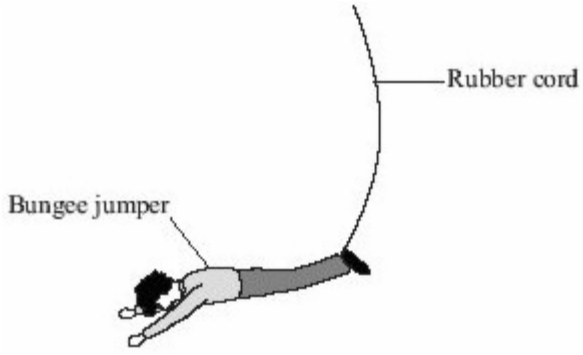
- the car is poorly maintained;
- there are adverse weather conditions;
- the car is travelling _____ ;
- the driver's reactions are _____ .

Also, the greater the speed of the car, then the greater the braking _____ needed to stop in a certain time.

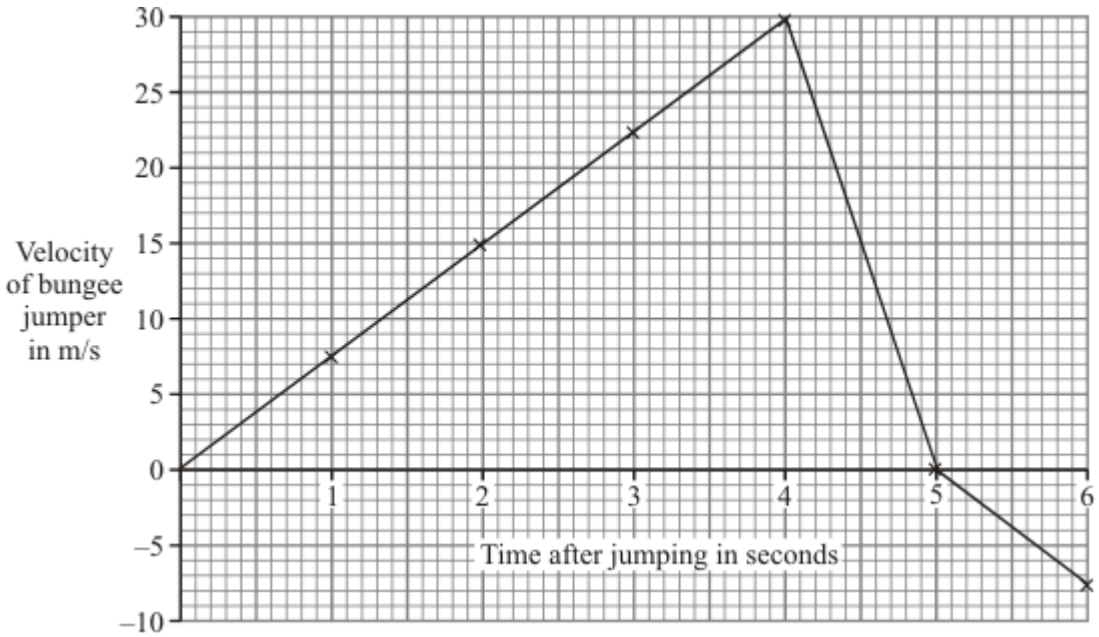
(3)

(Total 5 marks)

39 In bungee jumping, a fixed rubber cord is fastened to the jumper's ankles.



The graph shows how the bungee jumper's velocity changes during part of the jump.



(a) Calculate the acceleration of the bungee jumper between 2 and 4 seconds. Show your working.

Acceleration = _____ m/s^2

(3)

(b) Describe, in as much detail as you can, what happens to the bungee jumper after 4 seconds.

(3)

(Total 6 marks)

40 A rollercoaster car stops above a vertical drop. Suddenly it falls under gravity.

The drop is 60 metres high and at the bottom of the drop the car travels at 125 km/h.
The acceleration experienced by the people in the car is 10 m/s^2. The mass of the car and its passengers is 1210 kg.

Calculate the force exerted on the car and its passengers. Show your working.

_____

_____

_____

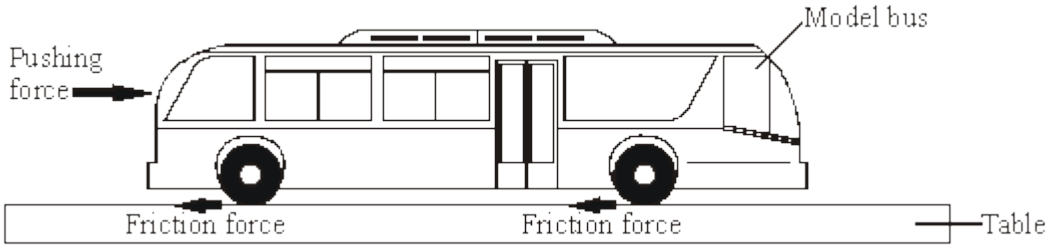
_____

_____

Force = _____ N

(Total 3 marks)

41 (a) The model bus is being pushed on a table.



(i) At first the pushing force does **not** make the model bus move. Explain why.

_____

_____

(1)

(ii) Write down **two** things that happen as the pushing force increases.

1. _____

_____

2. _____

_____

(2)

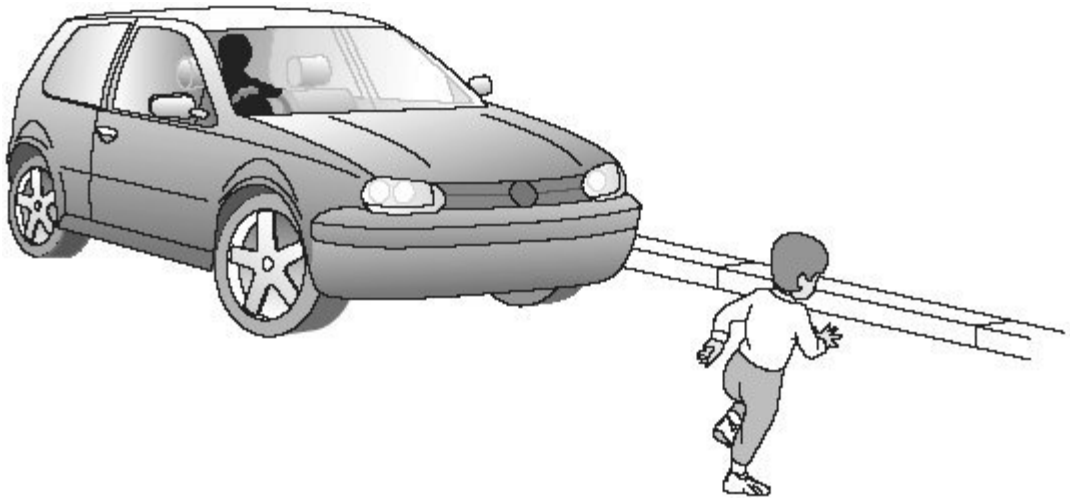
(iii) Complete the formula by choosing the correct words from the box.

acceleration	**distance moved**	**force applied**
speed	**time taken**	

Work done on the model bus = _____ × _____

(2)

(b) In this situation, the car driver needs to stop the car in the shortest possible distance.



(i) Complete the table by putting ticks (✓) to show which factors would make the stopping distance greater. The first one has been done for you.

Factor	Tick (✓) makes stopping distance greater
brakes are old and worn	✓
car is travelling fast	
driver has been drinking alcohol	
four new tyres are fitted	
hot, dry, sunny weather	
ice on the road	

(3)

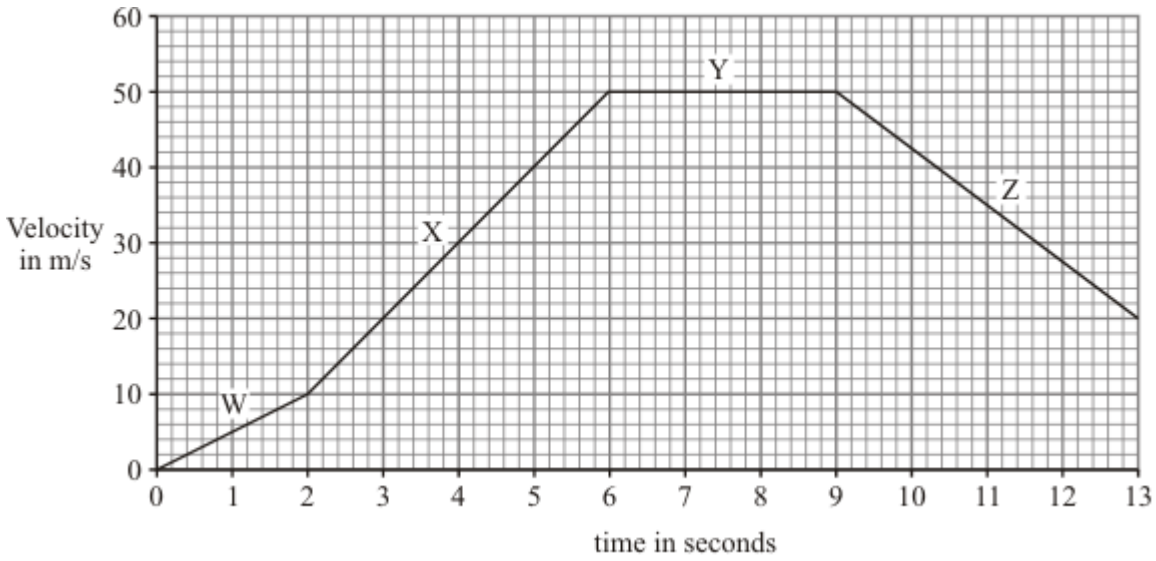
(ii) Complete the sentence by writing the correct words in the spaces.

The car will skid if the braking force is too big compared with the friction between the car's _____ and the _____ .

(1)

(Total 9 marks)

42 The graph shows changes in the velocity of a racing car.



(a) Describe the motion of the racing car during:

(i) the period labelled **W**; _____

_____

(1)

(ii) the period labelled **Y**. _____

_____

(1)

(b) Calculate the acceleration of the racing car during the period labelled **X**.
Show clearly how you work out your answer and give the unit.

_____

_____

_____

_____

_____

_____

_____

_____

Acceleration = _____

(4)

(Total 6 marks)

43

(a) A driver may have to make an emergency stop.

Stopping distance = thinking distance + braking distance.

Give **three** different factors which affect the thinking distance or the braking distance. In your answer you should explain what effect **each** factor has on the stopping distance.

1. _____

_____

_____

_____

2. _____

_____

_____

_____

3. _____

_____

_____

_____

(6)

(b) Complete the following sentences by writing in the **two** missing words.

Acceleration is the rate of change of _____ .

The acceleration of a car depends on the force applied by the engine and the

_____ of the car.

(2)

(c) A car moves because of the force applied by the engine.

Name **two** other forces which act on the car when it is moving. Give the direction in which **each** of these factors acts.

1. _____

Direction of this force _____

2. _____

Direction of this force _____

(4)

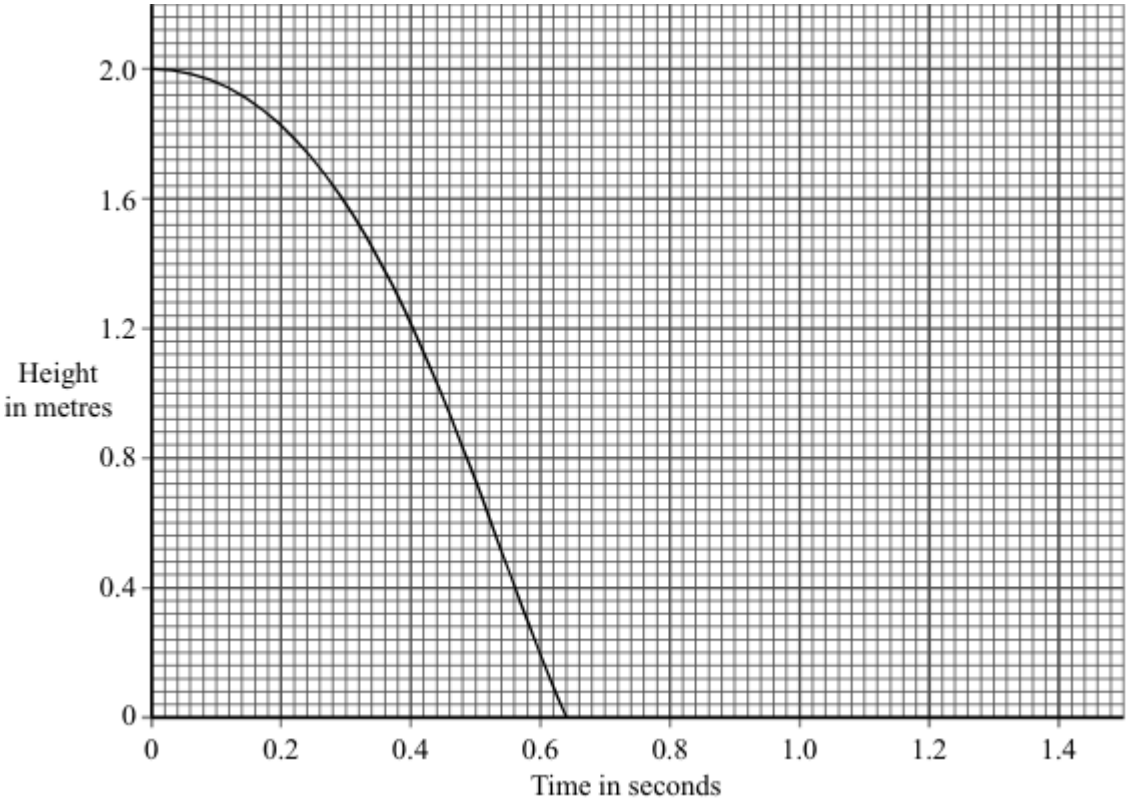
(d) Complete the following sentence by writing in the missing word.

The velocity of a car is its speed in a particular _____

(1)

(Total 13 marks)

44 A bouncy ball is dropped vertically from a height of 2.00 m onto the floor. The graph shows the height of the ball above the floor at different times during its fall until it hits the floor after 0.64 s.



(a) What is the average speed of the ball over the first 0.64 s? Show clearly how you work out your answer.

_____

_____

Average speed = _____ m/s

(1)

(b) After it hits the floor the ball bounces back to a height of 1.25 m. It reaches this height 1. 16 s after it was dropped. Plot this point on the grid above and sketch a graph to show the height of the ball above the floor between 0. 64 s and 1.16 s.

(3)

(c) (i) The ball bounces on the floor 0.64 s after being dropped. How long after being dropped will it be before it bounces a second time?

_____

_____

(1)

(ii) What distance will the ball travel between its first and second bounce?

_____

_____

(1)

(d) The ball was held stationary before being dropped. On the graph and your sketch mark **two** other points $\mathbf{X_1}$ and $\mathbf{X_2}$, where the ball is stationary, and in each case explain why the ball is not moving.

$\mathbf{X_1}$ _____

_____

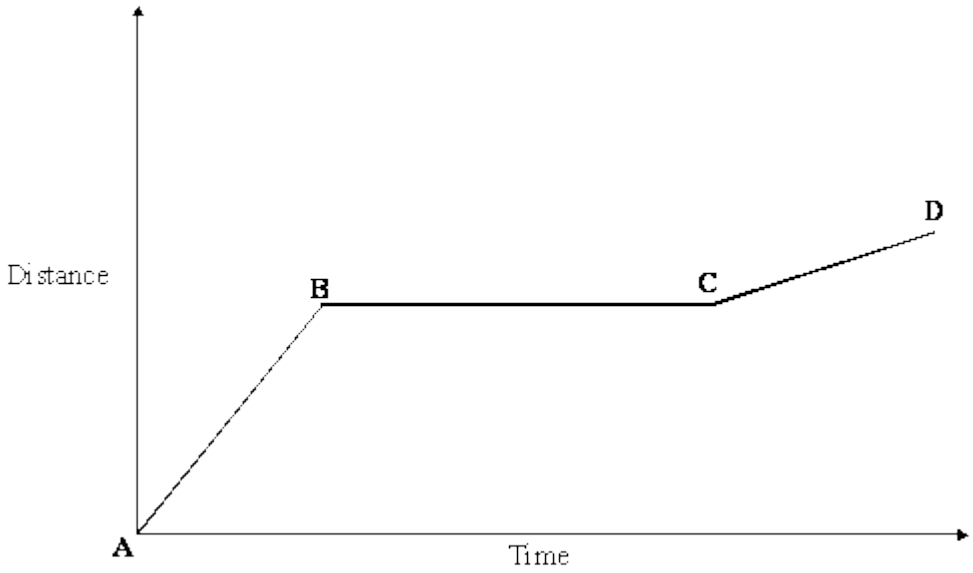
$\mathbf{X_2}$ _____

_____

(2)

(Total 8 marks)

45 The graph shows the distance a person walked on a short journey.



(a) Choose from the phrases listed to complete the statements which follow. You may use each statement once, more than once or not at all.

standing still

walking at constant speed

walking with an increasing speed

walking with a decreasing speed

(i) Between points **A** and **B** the person is

_____

(1)

(ii) Between points **B** and **C** the person is

_____

(1)

(b) Complete the sentence.

You can tell that the speed of the person between points **A** and **B** is _____

than the speed between points **C** and **D** because _____

_____

(2)

(c) Write the equation which relates distance, speed and time.

_____

(1)

(Total 5 marks)

46 Mira and Susan are rock climbing. They are using a nylon climbing rope. Mira has fastened herself to the rock face and to one end of the rope. The other end of the rope is fastened to Susan. This means that, if Susan falls, the rope will hold her. Susan weighs 540 N.

(a) (i) Use the words *distance*, *force* and *work* to write an equation which shows the relationship between them

_____

(1)

(ii) What vertical distance up the rock face does Susan climb when she does 2000 J of work against gravity? Show your working and give your answer to the nearest 0.1 m.

_____

_____

Distance = _____ metres

(2)

(iii) How much gravitational energy will Susan gain when she does 2000 J of work against gravity?

_____

(1)

(b) The climbers dislodge a 3 kg stone which falls down the rock face.

What is the speed of the stone when its kinetic energy is 600 J?

kinetic energy = $\frac{1}{2}$ mass × speed^2

Show clearly how you get to your answer and give the unit.

_____

_____

_____

Speed = _____

(3)

(c) The climbing rope is made of nylon. Nylon is very strong. Another advantage is that it stretches. This means that, if Susan falls, it transfers some of her kinetic energy to elastic (or strain) energy at the end of the fall.

Explain, in terms of *force* and *deceleration*, what would happen if Susan fell and the climbing rope did **not** transfer any of her kinetic energy to elastic energy.

_____

_____

_____

_____

_____

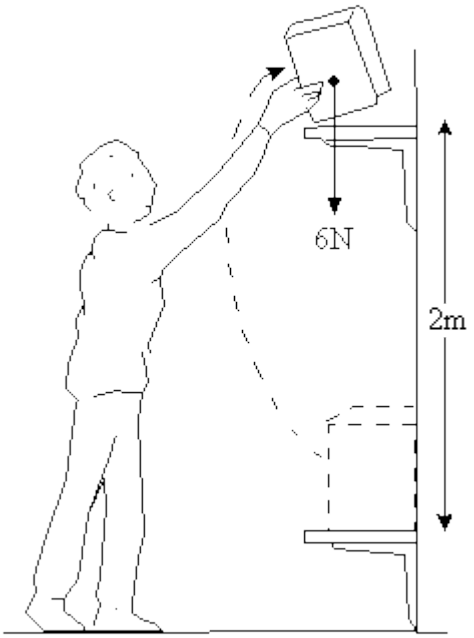
_____

(3)

(Total 10 marks)

47 A book weighs 6 newtons.

A librarian picks up the book from one shelf and puts it on a shelf 2 metres higher.



(a) Calculate the work done on the book. [Show your working].

_____

_____

_____

(3)

(b) The next person to take the book from the shelf accidentally drops it.

The book accelerates at 9.8m/s².

Use this information to calculate the mass of the book. [Show your working].

_____

_____

_____

Answer _____ kg.

(3)

(c) If the book was dropped from an aeroplane high in the sky, it would accelerate to begin with. Eventually it would fall at a steady speed.

Explain, in as much detail as you can, why this happens.

_____

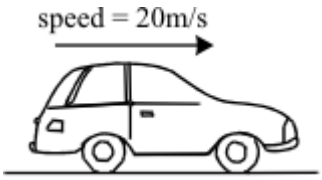
_____

_____

(3)

(Total 9 marks)

48 A car travels along a level road at 20 metres per second.



(a) Calculate the distance travelled by the car in 4 seconds.

(Show your working.)

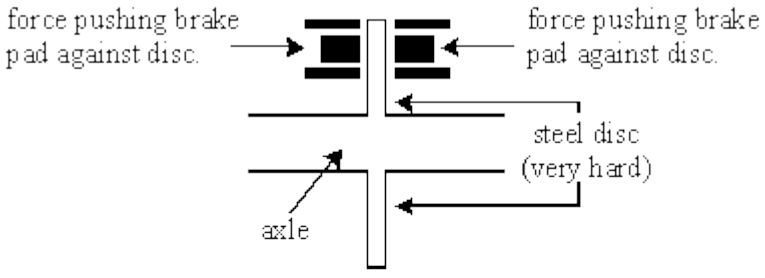
_____

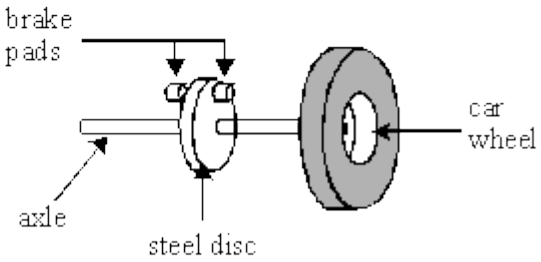
_____

_____

(3)

(b) When the brake pedal of the car is pushed, brake pads press against very hard steel discs.





The force of friction between the brake pads and the steel discs gradually stops the car.

What **two** effects does using the brakes have on the **brake pads** and **wheel discs**?

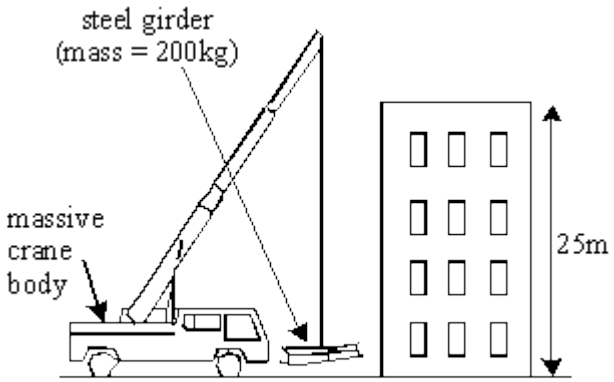
1. _____

2. _____

(3)

(Total 6 marks)

49 A crane is used to lift a steel girder to the top of a high building.



When it is lifted by the crane:

- the girder accelerates from rest to a speed of 0.6 m/s in the first 3 seconds;
- it then rises at a steady speed.

(a) Calculate the **acceleration** of the girder.

(Show your working.)

_____

_____

_____

_____

(3)

(b) (i) What is the **weight** of the steel girder?

Answer _____ N

(1)

(ii) Calculate the **power** of the crane motor as it lifts the girder at a steady speed of 0.6 m/s.

(*Show your working. You can ignore the weight of the cable and hook which is small compared to the weight of the girder.*)

_____

_____

_____

Answer _____ W

(2)

(c) A new motor is fitted to the crane. This motor accelerates the girder at 0.3 m/s^2.

Calculate the **force** which the crane applies to the girder to produce this acceleration.

(Show your working.)

_____

_____

_____

Answer _____ N

(3)

(Total 9 marks)

50 When a gun is fired, a very large force acts on the bullet for a very short time.

The change in momentum of the bullet is given by the following relationship:

force (N) × time(s) = change in momentum (kg m/s)

(a) An average force of 4000 newton acts for 0.01 seconds on a bullet of mass 50g.

Calculate the speed of the bullet. (*Show your working*.)

_____

_____

_____

Answer _____ m/s

(4)

(b) The bullet is fired horizontally. In the short time it takes for the bullet to reach its target, its horizontal speed has fallen to 80% of its initial speed.

(i) Explain why the speed of the bullet decreases so quickly.

_____

_____

(2)

(ii) Calculate the percentage of its original kinetic energy the bullet still has when it reaches its target.

(Show your working.)

_____

_____

_____

_____

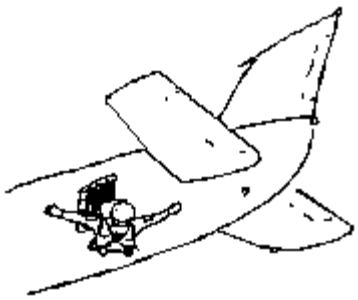
(4)

(Total 10 marks)

51 A sky-diver steps out of an aeroplane.

After 10 seconds she is falling at a steady speed of 50m/s.

She then opens her parachute.



After another 5 seconds she is once again falling at a steady speed.

This speed is now only 10m/s.

(a) Calculate the sky-diver's average acceleration during the time from when she opens her parachute until she reaches her slower steady speed. (Show your working.)

_____

_____

_____

(3)

(b) Explain, as fully as you can:

(i) why the sky-diver eventually reaches a steady speed (with or without her parachute).

_____

_____

_____

_____

(3)

(ii) why the sky-diver's steady speed is lower when her parachute is open.

_____

(1)

(c) The sky-diver and her equipment have a total mass of 75kg. Calculate the gravitational force acting on this mass. (Show your working.)

_____

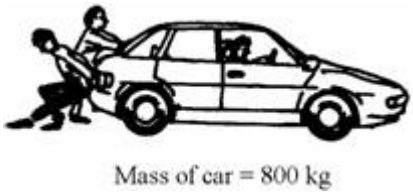
_____

Answer _____ N

(1)

(Total 8 marks)

52 A man's car will not start, so two friends help him by pushing it.



Mass of car = 800 kg

By pushing as hard as they can for 12 seconds they make the car reach a speed of 3 metres per second.

(a) Calculate the acceleration they give to the car.

_____

_____

_____ Answer _____ m/s^2

(2)

(b) Whilst pushing the car the two friends together do a total of 2400 joules of work. Calculate their total power.

_____

_____

_____ Answer _____ watts

(2)

(c) Another motorist has the same problem. The two friends push his car along the same stretch of road with the same force as before.

It takes them 18 seconds to get the second car up to a speed of 3 metres per second.

What does this tell you about the mass of the second car?
(You can ignore forces of friction.)

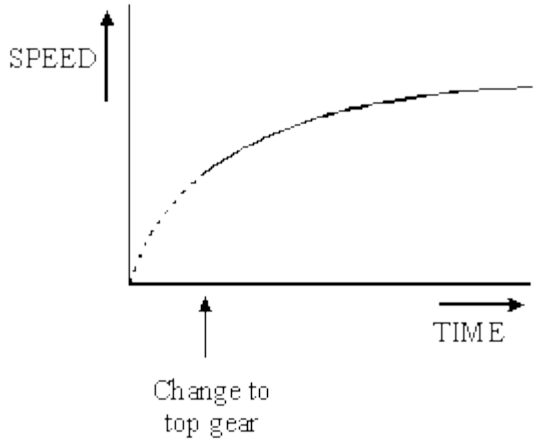
_____

_____

(2)

(d) On a flat stretch of a motorway a lorry driver changes into top gear. He then makes the lorry go as fast as he can.

The graph shows what happens to the speed of the lorry.



Explain why the speed of the lorry increases at first but then levels out.

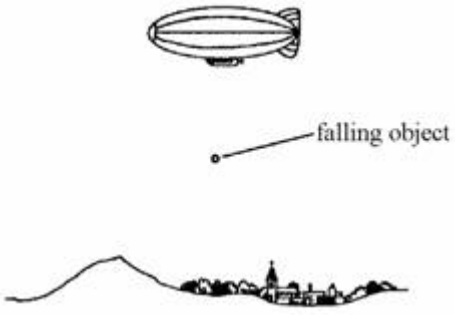
_____

_____

(3)

(Total 9 marks)

53 A small object falls out of a balloon.



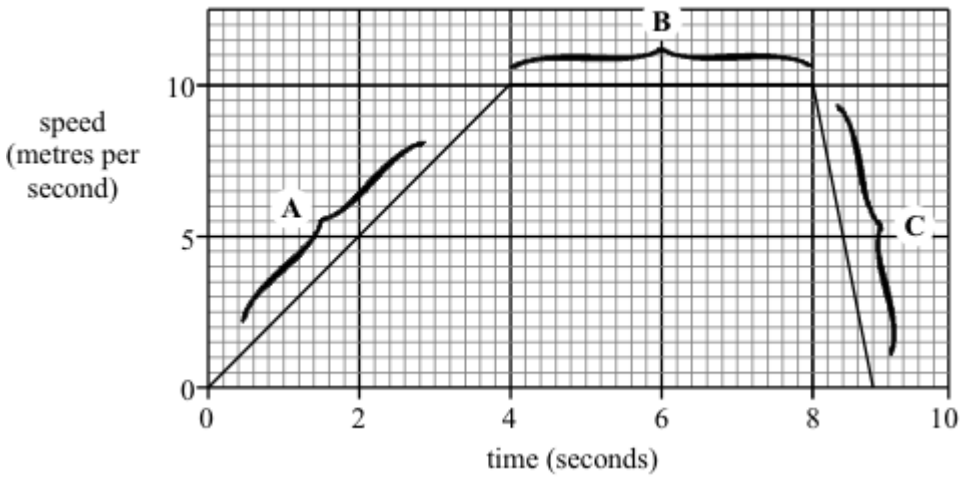
Choose words from the list to complete the sentences below.

friction	**gravity**	**air pressure**
accelerates	**falls at a steady speed**	**slows down**

- The weight of an object is the force of _____ which acts on it.
- When you drop something, first of all it _____ .
- The faster it falls, the bigger the force of _____ which acts on it.
- Eventually the object _____ .

(Total 4 marks)

54 The graph shows the speed of a runner during an indoor 60 metres race.



(a) Choose words from this list to complete the sentences below.

moving at a steady speed **slowing down**

speeding up **stopped**

Part **A** of the graph shows that the runner is _____

Part **B** of the graph shows that the runner is _____

Part **C** of the graph shows that the runner is _____

(3)

(b) Calculate the acceleration of the runner during the first four seconds.
(Show your working.)

_____

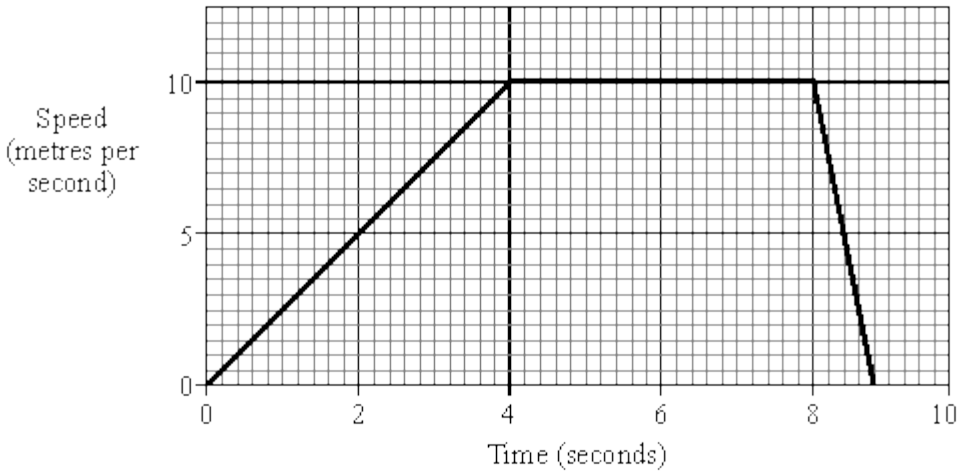
_____

_____

(3)

(Total 6 marks)

55 The graph shows the speed of a runner during an indoor 60 metres race.



(a) Calculate the acceleration of the runner during the first four seconds.
(Show your working.)

_____

_____

_____

(3)

(b) How far does the runner travel during the first four seconds?
(Show your working.)

_____

_____

_____

(3)

(c) At the finish, a thick wall of rubber foam slows the runner down at a rate of 25 m/s^2.
The runner has a mass of 75kg.
Calculate the average force of the rubber foam on the runner.
(Show your working.)

_____

_____

_____

Answer _____ newtons (N)

(2)

(Total 8 marks)

56 The diagram shows a shuttlecock that is used for playing badminton.

The shuttlecock weighs very little.
When you drop it from a height of a few metres, it accelerates at first but soon reaches a steady speed.

Explain, as fully as you can:

(a) why the shuttlecock accelerates at first,

_____

_____

_____

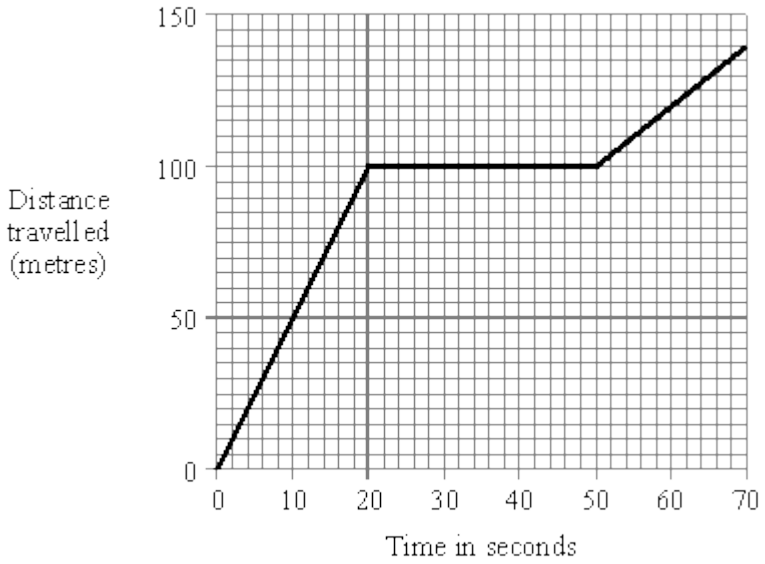
(2)

(b) why the shuttlecock reaches a steady speed.

(3)

(Total 5 marks)

57 A child goes out to visit a friend.
The graph shows the child's journey.



(a) Calculate the child's average speed for the whole journey.
[Show your working and give the units in your answer.]

(3)

(b) How many times faster is the child travelling in part A of the graph than in part C?
[You should show how you obtained your answer.]

(2)

(Total 5 marks)

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Homework task _ MYP 4

Unit 1: travelling through space and time

Topic: Distance and displacement

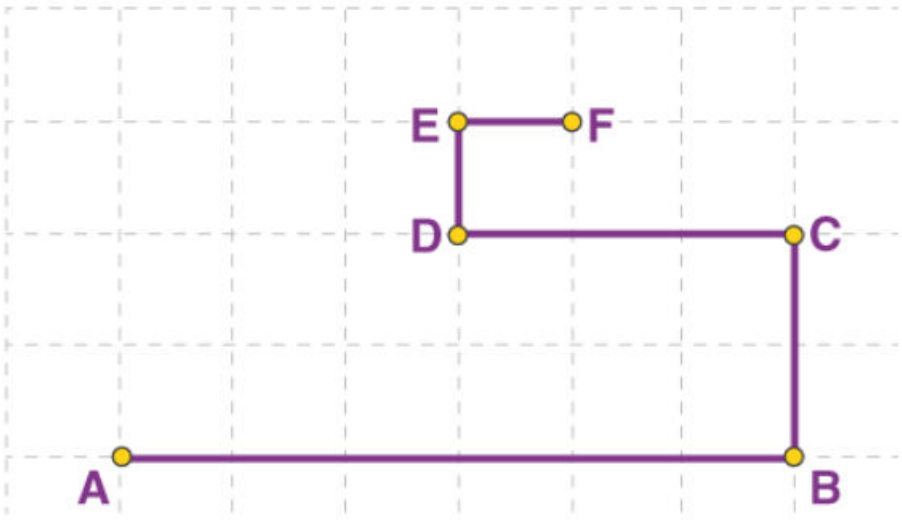
<u>The following questions are to be solved in the notebook.</u>

Question 1. John travels 250 miles to North but then back-tracks to South for 105 miles to pick up a friend. What is John's total displacement?

Question 2. An object moves along the grid through points A, B, C, D, E, and F as shown below. The side of square tiles measures 0.5 km.

a) Calculate the distance covered by the moving object.

b) Find the magnitude of the displacement of the object.



3. Compare and contrast between distance and displacement?

5. A person travels a distance of 5 m towards east, then 4 m towards north and then 2 m towards west.

(i) Calculate the total distance travelled.

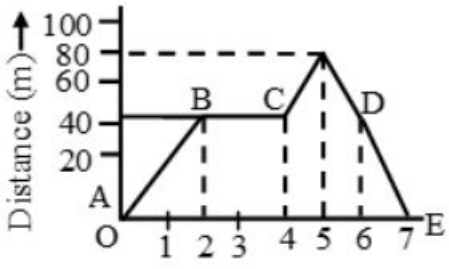
(ii) Calculate the resultant displacement.

6. A body is moving in a straight line. Its distances from origin are shown with time in Fig. A, B, C, D and E represent different parts of its motion. Find the following :

(i) Displacement of the body in first 2 seconds.

(ii) Total distance travelled in 7 seconds.

(iii) Displacement in 7 seconds



Displacement-time graph

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MYP 4 Sciences – Inquiry on Motion Graphs

Unit 1 : Travelling through Space and Time

Criterion A: Knowing and Understanding

Criterion B : Processing and Evaluating

ATL addressed : Critical thinking >Gather and organize relevant information to formulate an argument

> Draw reasonable conclusions and generalizations.

Motion Graphs { Source Credits : Author: Simon Lees 2017 1.}

In this activity students will be exploring motion graphs with the "Moving Man" PhET simulation. Open the simulation by clicking on the link: https://phet.colorado.edu/en/simulation/legacy/moving-man

[Additional help required? Watch YouTube: https://youtu.be/Hlua6ybbpVM]

Learning Objectives :

By the end of these activities it is hoped that students will have an acquired the following skills:

• Following explicit instructions to gain acquired knowledge

• Explore how changing various variables affect the graphs of distance; displacement; velocity and acceleration.

• Using gradient calculations to determine velocity and acceleration.

• Using area to calculate distance from a velocity - time graph.

1.Comparing displacement and constant velocity.

Instructions:

- Click on the CHARTS tab at the top of the screen, green circle.

- Move the man by dragging him to the far LEFT.

You will notice that the blue arrow, blue circle, moves down.

- In the velocity box, red circle, type 2.

- Press PLAY, yellow circle, and allow the program to run until the man gets to the end of the track and then STOP the animation.

- Take a screenshot of the graphs and paste a print out in the notebook.

Now answer the following questions in the notebook.

• What is the total distance travelled?

_____

• If 0m is home what is the man's displacement?

_____

• What can be said about the man's velocity and how do you know?

_____

• How does this compare to the blue distance - time line?

_____

_____

• If the velocity is constant what do you notice about the acceleration line, green line?

_____

• Use the blue distance - time line and calculate the gradient by dividing the RISE ÷ RUN. (Note: the time of the journey is shown in the top blue area)

_____

• What does this number relate to?

_____

• Produce a generic equation from the graph that combine velocity distance and time.

_____

- CLEAR and RESET ALL

- Now do exactly the same thing but move the man to the other end, the RIGHT side.

- Place **-2** in the velocity box. - Press PLAY.

- Screen shot the screen

• What do you notice about these graphs compared to the first set?

_____

_____

• Use the blue distance v time line and calculate the gradient by dividing the RISE ÷ RUN. (Note: the time of the journey is shown in the top blue area as the line is going down the distance must be negative) _____

• What then do you think the negative on **-2** tells us?

_____

2. **What is the relationship when acceleration is not 0?** –

Move the man to the LEFT by pulling the blue arrow to the bottom, blue circle.

- In the box of acceleration, green circle, type in 1 for 1m/s/s. –

Press PLAY and STOP before the mane hits the wall. - Take a screenshot and place in the area below.

• What is the total distance travelled?

_____

• Compare and contrast the three curves.

_____

_____

_____

_____

• Use the red velocity - time line and calculate the gradient by dividing the RISE ÷ RUN. (Note: the time of the journey is shown in the top blue area as the line is going down the distance must be negative)

_____

This is virtually the same as the acceleration.

• Calculate the area under the velocity v time graph

_____

• What does the area under the velocity v time graph represent?

_____

- Now do exactly the same thing but move the man to the other end, the RIGHT side. –

Place **-2** in the acceleration box. –

Press PLAY.

- Screen shot the screen and place in the space provided.

• What do you notice about these graphs compared to the first set?

_____

_____

• Pull the red arrow to the base of the velocity line to determine the maximum velocity reached. Use the time then to determine the distance by calculating the area.

_____

SUMMARY

• Complete the table below to summarise what you have found. • If the value of either the displacement, velocity or acceleration is negative what does this mean?

_____

SUMMARY GRAPH

Summary	**GRAPH**		
	Distance Vs Time	Velocity Vs time	Acceleration Vs Time
Constant velocity			
Constant acceleration			
Area under the curve			

If the value of either the displacement, velocity or acceleration is negative what does this mean?

OAKRIDGE INTERNATIONAL SCHOOL

Revision Worksheet

Subject : Physics **Name of the Student:**

Topic :Energy

Grade : MYP 4/5

1. A body of mass 2kg is moving with a speed of 20m/s Find the kinetic energy. (400J)

2. A moving body of 30kg has 60 J of KE. Calculate the speed.

3. A hammer of mass 1kg falls freely from a height of 2 m .Calculate (I) The velocity and (II) The KE of the hammer just before it touches the ground. Does the velocity of hammer depend on the mass of hammer? (6.26m-2 , 19.6 J)

4. Calculate the energy possessed by a stone of mass 10kg kept at a height of 5m If 196x102 J of energy were used to raise a 40kg boy above the ground, how high would he be raised? (50m)

5. Calculate the change that should be affected in the velocity of a body to maintain the same KE , if mass of the body is increased to 4 times (half the original velocity)

OAKRIDGE INTERNATIONAL SCHOOL

Revision Worksheet

Subject : Physics **Name of the Student:**

Topic Work, Power, Energy

Grade : MYP 4/5

1. A machine does 192 J of work in 240Sec. What is the power of the machine? (8w)

2. A weighting 50kg runs up a hill rising himself vertically 10m in 20Sec. Calculate power. given g=9.8m-1 (245w)

3. A rickshaw puller pulls the rickshaw by applying a force of 100 N. If the rickshaw moves with constant velocity of 36 kmh-1. Find the power of rickshaw puller. (1000w)

4. A athlete weighing 60kg runs up a staircase having 10 steps each of 1m in 30 sec. Calculate power (g=8.8ms-1 200W)

5. The heart does 1.5 J of work in each heartbeat. How many times per minute does it beat if its power is 2watt? (80 times)
hint: total work =power x time =120J ,
number times heartbeat in 1 min. =total work done / work done in each beat =120/1.5=80 times

6. Calculate the time taken 60 w bulb to consume 3000 J of energy . (50sec.)

7. A horse exert a force of 200N to pull the cart. If the horse cart system moves with velocity 36km/h on the level road., then find the power of horse in terms of horse power (1hp=746W) Ans. 2.68 hp

KINEMATICS

1. A stone is dropped from the top of a vertical cliff. At time t seconds after the stone has been dropped, the height, h metres, of the stone above the ground is given by $h = 125 - 5t^2$, $(t \geq 0)$.

(a) Write down the height of the cliff.

(b) Find the value of t when the stone hits the ground.

(c) Find the speed of the stone when $t = 2$. **[May 15R/P1/Q22]**

2. A particle, P, is moving along a straight line. At time t seconds, the distance s metres of P from a fixed point O of the line is given by $s = kt^2 - 6t + 3$, where k is a constant and $t \geq 0$.

(a) Given that at $t = 1$, P is momentarily at rest, find the value of k.

(b) Find the distance moved in the 3rd second. **[May 13/P1/Q28]**

3. A particle is moving in a straight line through O. The displacement, s metres, of the particle from O at time t seconds is given by $s = 3t^2 - 4t + 10$, $t \geq 0$.

(a) Find an expression, in terms of t, for the velocity, v m/s, of the particle at time t seconds.

(b) Calculate the value of t when the particle is instantaneously at rest.

(c) Calculate the distance, in metres, travelled by the particle in the fifth second. **[May 14/P2/Q3]**

4. A particle, P, is moving along a straight line so that, at time t seconds, the displacement, s metres, of P from a fixed point O of the line is given by $s = 4t^3 - 26t^2 + 40t$. The particle starts at the point O when $t = 0$.

(a) Write down the values of t when P passes through O.

(b) Find an expression for the velocity, v m/s, of P at time t.

(c) Find the values of t when the velocity of P is zero.

(d) Find the acceleration of P when $t = 3$. **[Jan 15R/P2/Q11]**

5. A particle P is moving along a straight line. The displacement, s metres, of P from a fixed point O on the line at time t seconds is given by $s = 4 + 12t - t^3$, $t \geq 0$.

(a) Write down the distance, in m, of the particle from O at time $t = 0$.

Particle P comes to instantaneous rest at the point A.

(b) Find the value of t when P is at A.

(c) Find the acceleration, in m/s^2, of P when P is at A. **[May 14R/P1/Q29]**

6. A particle P is moving along a straight line. At time t seconds, the displacement, x metres, of P from a fixed point O on the line is given by $x = -3t^3 + 6t^2 + kt + 4$, $t \geq 0$. At time t seconds, the velocity of P is v m/s such that $v = 9$ when $t = 2$.

(a) Show that $k = 21$.

Particle P comes to instantaneous rest at the point A.

(b) Using $k = 21$, find the value of t when P is at A.

(c) Find, to the nearest meter, the distance OA. **[May 19/P1/Q28]**

7. A particle P is moving along a straight line. At time t seconds, the displacement, s metres, of P from a fixed point O of the line is given by $s = 6t^3 - t^4$. At time t seconds, the velocity of P is v m/s.

(a) Find an expression for v in terms of t.

For $t > 0$, the particle comes to instantaneous rest at the point A.

(b) Find the distance, in metres to 3 significant figures, of A from O. **[May 16R/P1/Q25]**

8. A particle P is moving along a straight line. At time t seconds, $(t \geq 1)$, the displacement, s metres, of P from a fixed point O of the line is given by $s = t + \frac{4}{t}$. The particle comes to instantaneous rest at the point A.

(a) Find the value of t for which P is at A.

When $t = 8$, P is at the point B.

(b) Find, in metres, the distance AB. **[Jan 18R/P1/Q20]**

9. A particle P is moving along a straight line. At time t seconds, the displacement, x metres, of P from a fixed point O on the line is given by $x = 4 + 7t - 2t^2$, $t \geq 0$. At time t seconds, the velocity of P is v m/s .

(a) Find an expression for v in terms of t.

In the interval $0 \leq t \leq 4$, P is furthest away from O when P is at the point A on the line.

(b) Find the value of t when P is at the point A.

(c) Find the distance, in metres, of A from O.

(d) Find the total distance, in metres, travelled by P in the interval $0 \leq t \leq 4$. **[Jan 19R/P1/Q26]**

10. A particle P is moving along a straight line through the fixed point O. The displacement, s metres, of P from O at time t seconds is given by $s = t^3 - 27t + 55$, $t \geq 0$.

(a) Write down the distance, in metres, of P from O when $t = 0$.

(b) Find an expression, in terms of t, for the velocity, v m/s, of P at time t seconds.

(c) Find the value of t when P is closest to O.

(d) Find the distance, in metres, of P from O when P is closest to O.

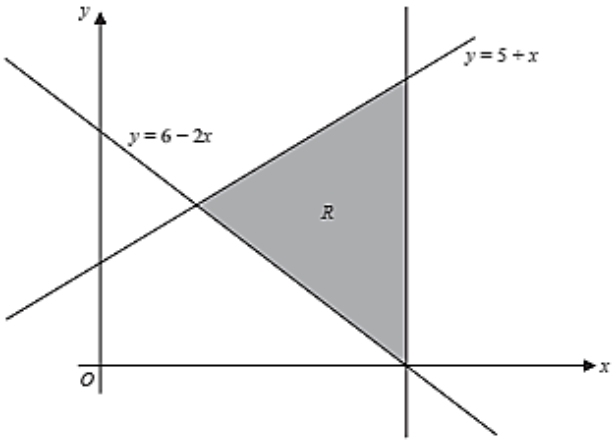
(e) Find the distance, in metres, travelled by P in the interval $0 \leq t \leq 5$. **[Jan 17R/P2/Q4]**

Answers:

[1] (a) 125 m, (b) 5 s, (c) -20 m/s, **[2]** (a) 3, (b) 9 m, **[3]** (a) $v = 6t - 4$, (b) $\frac{4}{6}$ s, (c) 23 m, **[4]** (a) 2.5 s, 4 s, (b) $v = 12t^2 - 52t + 40$, (c) $\frac{10}{3}$ s, 1 s, (d) 20 m/s^2, **[5]** (a) 4 m, (b) 2 s, (c) -12 m/s^2, **[6]** (b) $\frac{7}{3}$ s, (c) 48 m, **[7]** (a) $v = 18t^2 - 4t^3$, (b) 136.69 m, **[8]** (a) 2 s, (b) 4.5 m, **[9]** (a) $v = 7 - 4t$, (b) $\frac{7}{4}$ s, (c) $\frac{81}{8}$ m, (d) $\frac{65}{4}$ m, **[10]** (a) 55 m, (b) $3t^2 - 27$, (c) 3 s, (d) 1 m, (e) 98 m.

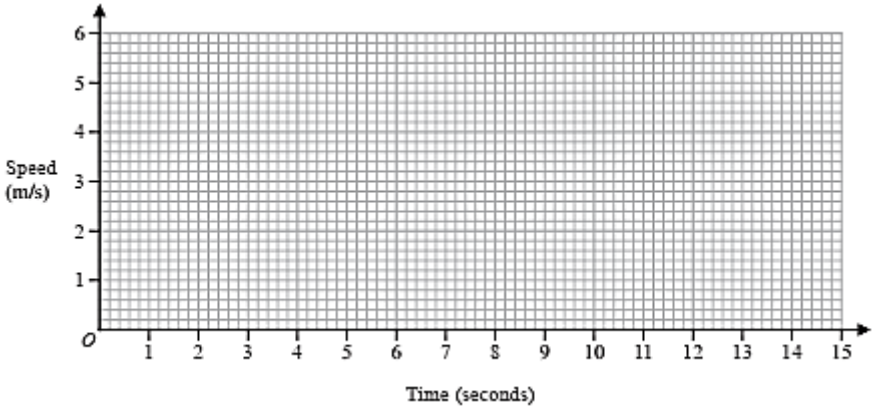
EQUATION GRAPH

1. The diagram shows the shaded region R, which is bounded by three straight lines, one of which is parallel to the y-axis. One vertex of R lies on the x-axis.



Find three inequalities that define R. **[Jan 20/P1/Q15]**

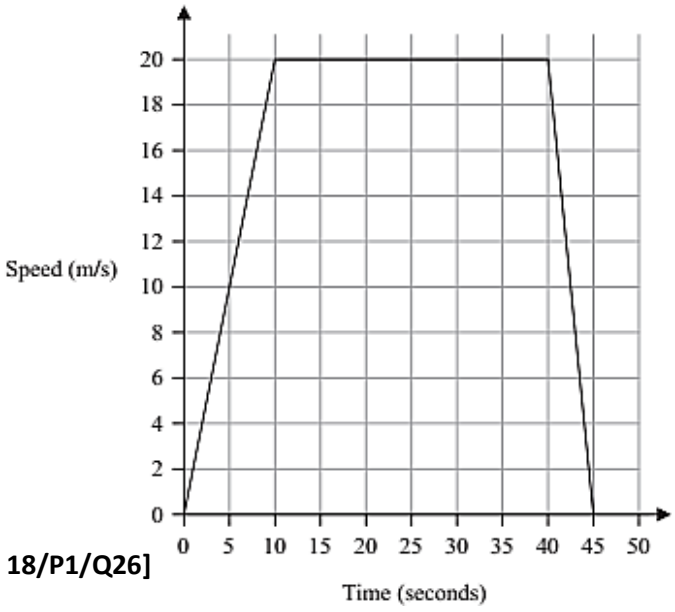
2. At time $t = 0$ seconds, a cyclist passed the point P on a straight horizontal road. The cyclist was moving with a constant speed of 5 m/s. The cyclist travelled a distance of 35 m at this speed to the point Q on the road. On reaching Q, the cyclist decelerated at a constant rate, coming to rest at the point R on the road such that PQR is a straight line and $QR = 10$ m.



Represent, on the grid, the information for the journey of the cyclist from P to R as a speed-time graph.

[Jan 20R/P1/Q27]

3. A car travels from rest between two sets of traffic lights in 45 seconds. The speed-time graph below gives information about this journey.

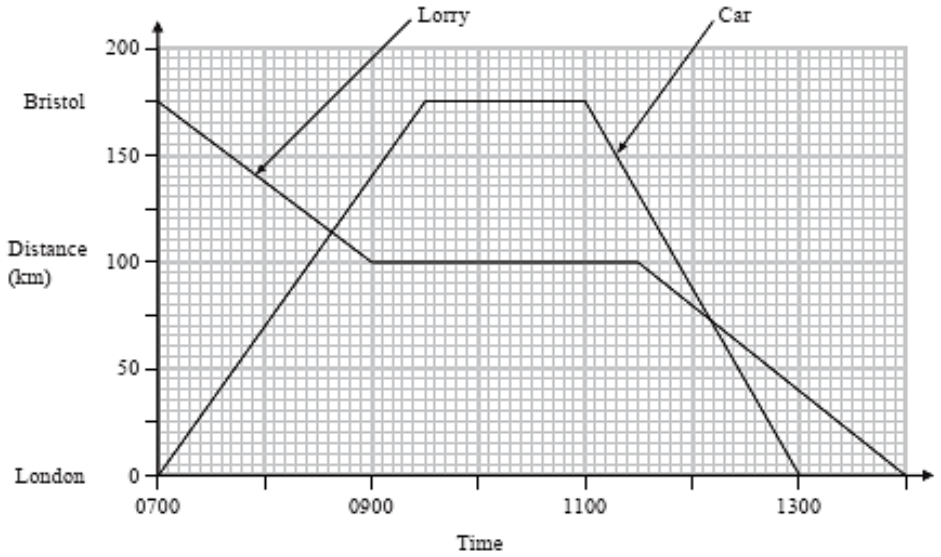


(a) Calculate the acceleration of the car during the first 10 seconds of its journey.

(b) Find the total distance travelled by the car between the two sets of traffic lights.

(c) Find the average speed of the car on its journey between the two sets of traffic lights. **[Jan 18/P1/Q26]**

4. The distance-time graph for the journey of a car between London and Bristol and the distance-time graph for the journey of a lorry travelling from Bristol to London are shown on the grid. The car and the lorry travel along the same roads.



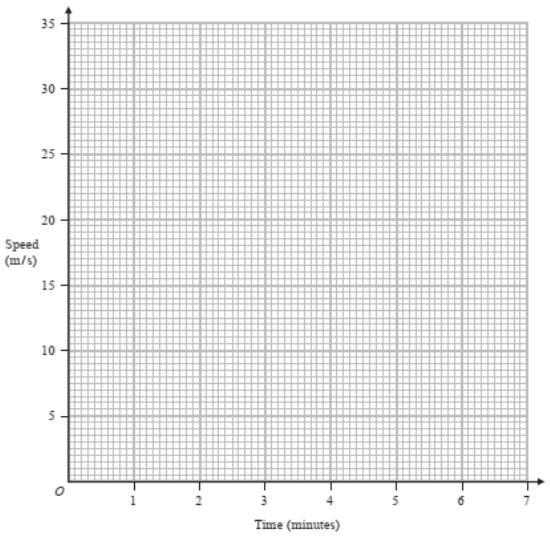
(a) For how long was the car stationary in Bristol?

(b) Calculate the average speed, in km/h, of the car as it travelled back from Bristol to London.

(c) At what time did the car overtake the lorry when they were both travelling in the same direction?

[Jan 15/P1/Q18]

5. A train, starting from rest, accelerates at a constant rate and attains a speed of 30 m/s after 30 seconds. The train then travels at this speed for 5 minutes. The train then slows down at a constant rate and comes to rest in 1 minute.



(a) Represent this information on a speed-time graph.

(b) Find the total distance, in metres, travelled by the train.

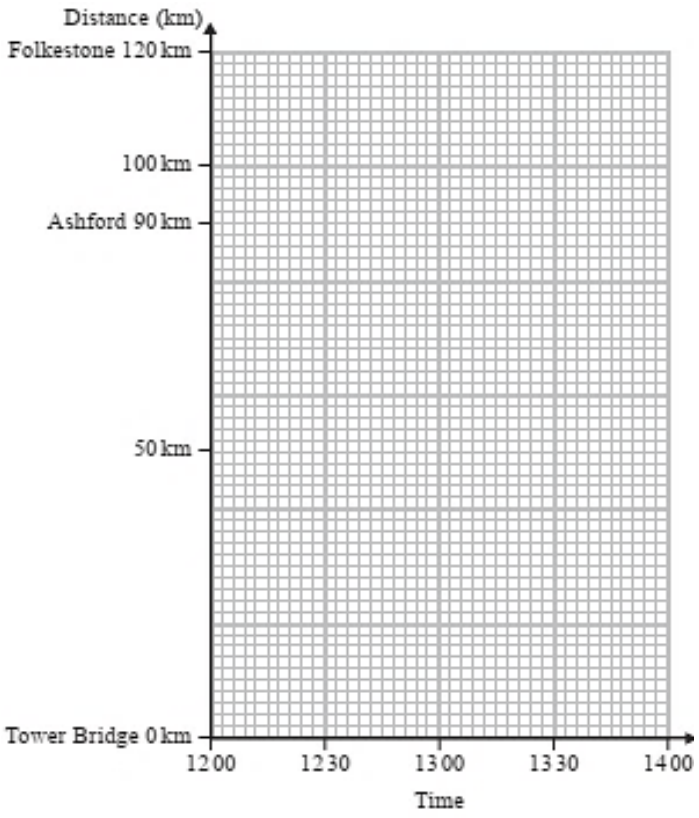
Find:

(c) the average speed, in m/s, of the train,

(d) the rate, in m/s^2, at which the train slows down.

[Jan 16/P1/Q28]

6. A lorry leaves Tower Bridge at 12 00 and is driven at a constant speed for 90 km, arriving in Ashford at 13 15. The lorry is parked in Ashford for 15 minutes. The lorry is then driven at a constant speed to Folkestone. The lorry arrives in Folkestone at 14 00, having been driven a total distance of 120 km.



(a) Represent, on the grid, the journey of the lorry as a distance-time graph. Label your graph clearly.

A car is driven from Folkestone to Tower Bridge through Ashford, along the same roads as the lorry. The car leaves Folkestone at 1200 and is driven at a constant speed to Tower Bridge, arriving at 13 30.

(b) Represent on the same grid the journey of the car as a distance-time graph. Label your graph clearly.

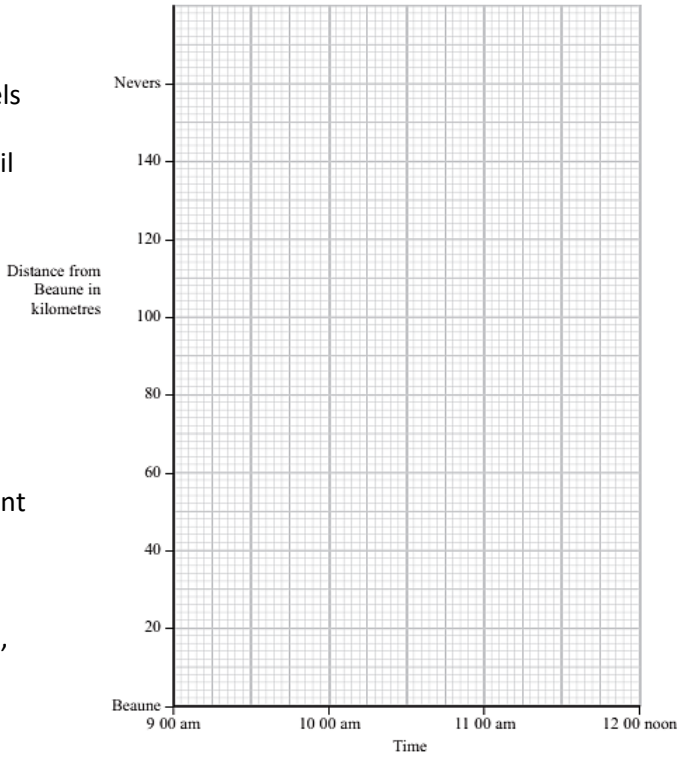
(c) Calculate the speed, in km/h, of the lorry from Tower Bridge to Ashford.

(d) Use your graph to write down the distance between the lorry and the car at 12 30. **[May 16R/P1/Q26]**

7. The distance from Beaune to Nevers is 160 km.

A motorist starts from Beaune at 9 00 am and travels towards Nevers at a constant speed of 64 km/h until he arrives at Autun, which is 48 km from Beaune.

At Autun he rests for 24 minutes before continuing his journey at a constant speed to arrive at Nevers at 11 45 am.



(a) Using the grid opposite, draw a graph to represent the motorist's journey.

(b) Using your graph, calculate the motorist's speed, in km/h, for his journey from Autun to Nevers.

At 9 30 am a second motorist starts from Nevers to journey to Beaune on the same road as the first motorist.

The second motorist travels at a constant speed of 80 km/h.

(c) Draw, on the same graph, a straight line to represent the second motorist's journey.

(d) Using your graph, write down:

(i) the time that the two motorists meet.

(ii) how far both motorists are from Autun when they meet. **[May 15R/P2/Q6]**

8. $f(x) = 4x^3 - 13x - 6$.

(a) Use the factor theorem to show that $(2x + 1)$ is a factor of $f(x)$.

(b) Hence factorize $f(x)$ fully.

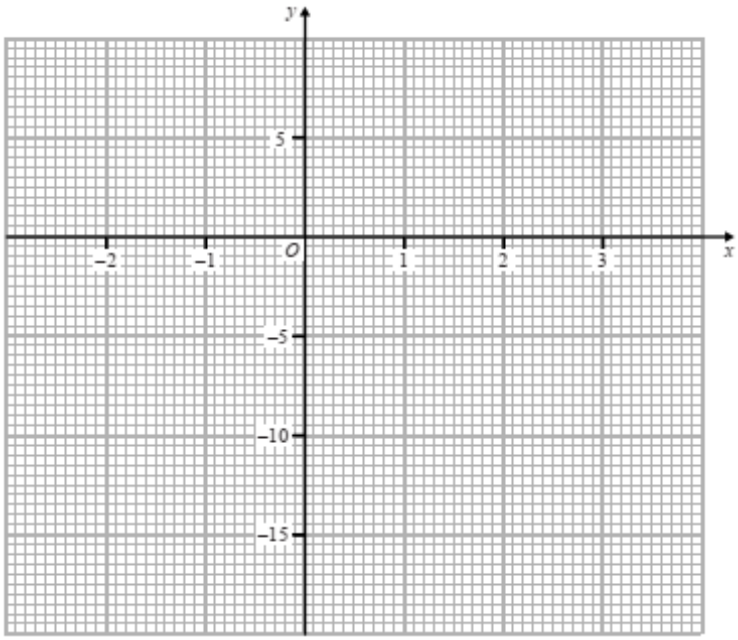
The curve C has equation $y = f(x)$.

(c) Find the coordinates of the points of intersection of C with the x-axis.

(d) Find the coordinates, to 2 decimal places, of the turning points of C.

The table below gives the coordinates of three points on C.

x	–2	0.5	1.5
y	–12	–12	–12

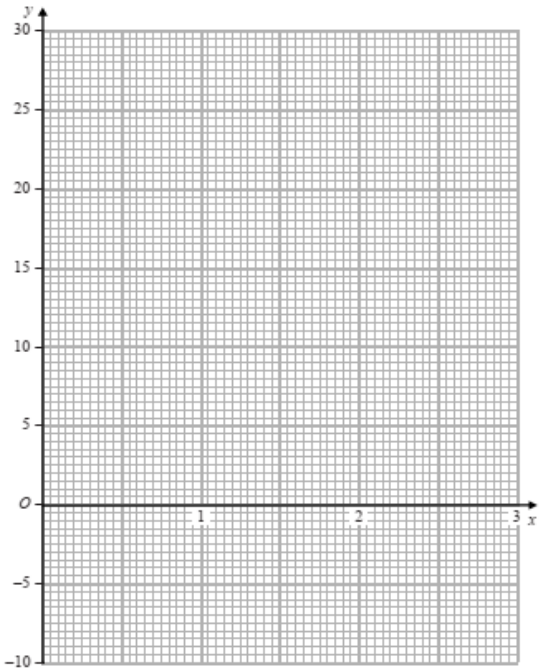


(e) On the grid opposite, draw the curve C for $-2 \leq x \leq 2$. Clearly label the coordinates of the turning points of C and the coordinates of the points of intersection with the x-axis and the y-axis.

[Jan 19/P2/Q11]

9. (a) Complete the following table of values for $y = 2x^3 - x^2 - 6x$.

x	0	0.5	1	1.5	2	2.5	3
y	0		−5		0	10	



(b) On the grid, plot the points from your completed table and join them to form a smooth curve.

(c) Using your graph, find an estimate, to 1 decimal place, of the minimum value of $2x^3 - x^2 - 6x$ in the interval $0 \leq x \leq 3$.

(d) On your grid, draw the straight line with equation $y = 4x - 7$.

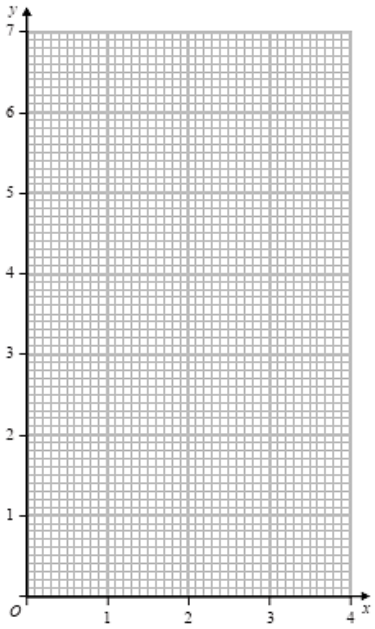
(e) Use your graphs to find the range of values, to 1 decimal place, of x in $0 \leq x \leq 3$ for which $2x^3 - x^2 - 10x + 7 < 0$. **[Jan 19/P2/Q11]**

10. $y = \frac{9}{x^2} + 2x - \frac{8}{x}$

(a) Complete the table of values for $y = \frac{9}{x^2} + 2x - \frac{8}{x}$ giving your values of y to 2 decimal places.

x	0.75	1	1.25	1.75	2	2.5	3	3.5
y	6.83	3			2.25		4.33	5.45

(b) On the grid, plot the points from your completed table and join them to form a smooth curve.



(c) Using your curve, write down an estimate, to 2 decimal places, of the value of x for which $\frac{9}{x^2} + 2x - \frac{8}{x}$ has a minimum value in the interval $0.75 \leq x \leq 3.5$.

(d) Show that $4x^3 - 6x^2 - 8x + 9 = 0$ can be written in the form $\frac{9}{x^2} + 2x - \frac{8}{x} = ax + b$ where a and b are integers. Give the value of a and the value of b.

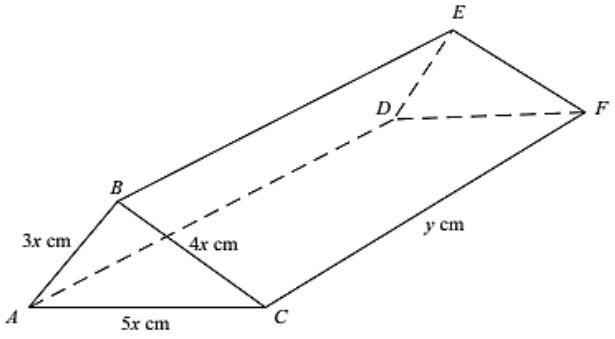
(e) Hence, by drawing a suitable straight line on the grid, find estimates, to 2 decimal places, of the solutions of the equation $4x^3 - 6x^2 - 8x + 9 = 0$ in the interval $0.75 \leq x \leq 3.5$. **[Jan 19R/P2/Q10]**

11. $ABCFED$ is a prism with triangular cross section in which $CF = AD = BE = y$ cm, $AB = DE = 3x$ cm, $BC = EF = 4x$ cm and $AC = DF = 5x$ cm. Given that the total surface area of the prism is S cm^2.

(a) (i) Write down the size, in degrees, of $\angle ABC$,

(ii) Show that the area of ΔABC is $6x^2$ cm^2,

(iii) Find an expression for S in terms of x and y.



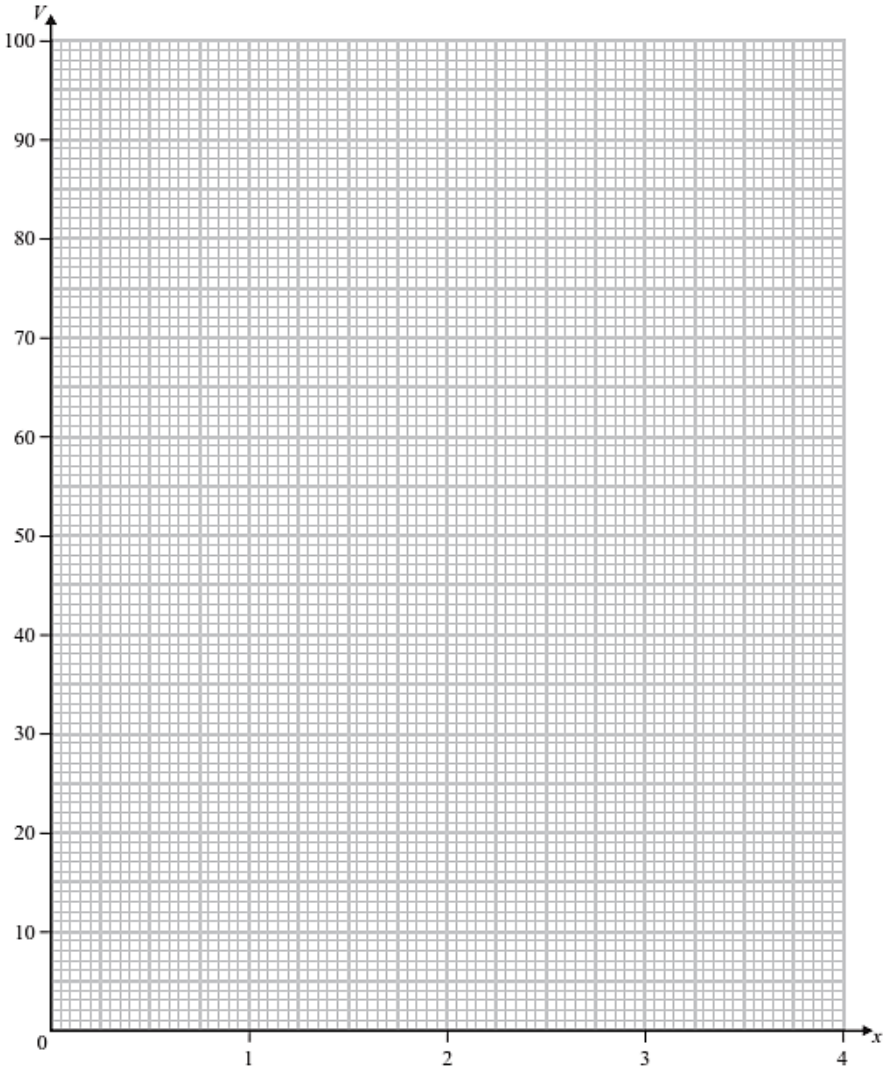
(b) Given also that $S = 144$, show that $y = \frac{12 - x^2}{x}$

The volume of the prism is V cm^3.

(c) Show that $V = 6x(12 - x^2)$.

(d) Complete the table for $V = 6x(12 - x^2)$, giving the values of V to 1 decimal place where necessary.

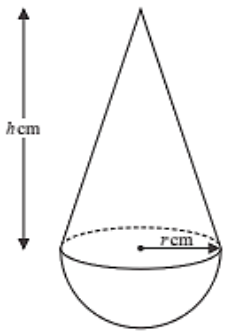
x	0	0.5	1	1.5	2	2.5	3	3.4
V	0		66				54	9.0



(e) On the graph paper, plot the points from your completed table and join them to form a smooth curve.

(f) Using your graph, write down the maximum value of V. **[Jan 13/P2/Q9]**

12. A child's toy is made by fixing a solid right circular cone, with base radius $r$cm and height h cm, on the flat circular face of a solid hemisphere of radius $r$cm. The centre of the base of the cone coincides with the centre of the hemisphere, as shown in figure.



Given that $h + 6r = 15$.

(a) Find the upper bound for the value of r. Give a reason for your answer.

The volume of the toy is V cm^3.

(b) Show that $V = \frac{1}{3}\pi r^2(15 - 4r)$.

(c) Complete, to 1 decimal place, the table of values for $V = \frac{1}{3}\pi r^2(15 - 4r)$.

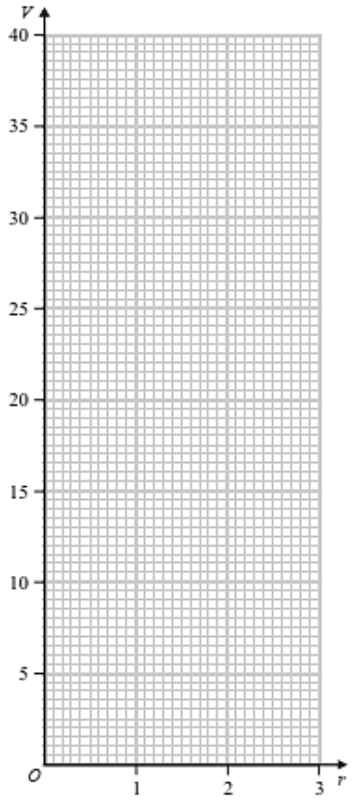
r	0	0.4	0.8	1.2	1.6	2.0	2.4
V	0		7.9			29.3	32.6

(d) On the grid, plot the points from your completed table and join them to form a smooth curve.

The volume of one particular toy is 26 cm^3.

(e) Use your curve to find, to one decimal place, the value of r.

The manufacturer of the toy decides that the value of V should be twice the value of h.



(f) By drawing a suitable straight line on the grid, find an estimate, to the nearest integer, for the value of V.

[May 19/P2/Q11]

Answers:

[1] $x \leq 3, y \leq 5 + x, y \geq 6 - 2x$, **[3]** (a) 2 m/s^2, (b) 750 m, (c) $\frac{50}{3}$ m/s, **[4]** (a) 90 mins, (b) 87.5 km/h, (c) $12{:}\,12$, **[5]** (b) 10350 m, (c) 27 m/s, (d) $\frac{1}{2}$ m/s^2, **[6]** (c) 72 km/h, (d) 44 km, **[7]** (b) 70 km/h, (d) (i) $10{:}\,33$, (ii) 28 km, **[8]** (a) $(2x + 1)$, (b) $(2x + 1)(2x + 3)(x - 2)$, (c) $\left(-\frac{1}{2}, 0\right), \left(-\frac{3}{2}, 0\right), (2, 0)$, (d) $(1.04, -15.02)$, $(-1.04, 3.02)$, **[9]** (a) $-3, -4.5, 27$, (c) -5.0, (e) $x > 0.7$, $0.8 < x < 2.1$, **[10]** (a) $1.86, 1.87, 3.24$, (c) 1.46, (d) $a = -2, b = 6$, (e) $0.88, 1.93$, **[11]** (a) (i) $90°$, (ii) $S = 12x^2 + 12xy$, (d) $35.3, 87.8, 96, 86.3$, (f) 96 cm^3, **[12]** (a) 2.5 cm, (b) $V = \frac{1}{3}\pi r^2(15 - 4r)$, (c) $2.2, 15.4, 23.1$, (f) 16 cm^3.

KINEMATICS

1) $h = 125 - 5t^2 \quad (t \geq 0)$

a) $h = 125\,m$ high

b) $h = 0$,

$125 - 5t^2 = 0$

$t = +5\,s \quad (t \geq 0)$

c) $v = \frac{dh}{dt} = -10t$

at $t = 2\,s$,

$v = -10(2) = -20\,m/s$

2) $s = kt^2 - 6t + 3$ for $t \geq 0$;

a) $v = \frac{ds}{dt} = 2kt - 6$

at $t = 1s$, $v = 0$;

$\Rightarrow 2k(1) - 6 = 0$

$\therefore k = 3$

b) distance moved in

the third second $= s_3 - s_2$

$= [3(3)^2 - 6(3) + 3] - [3(2)^2 - 6(2) + 3]$

$= 9\,m$

3) $s = 3t^2 - 4t + 10$ for $t \geq 0$;

a) $v = \frac{ds}{dt} = 6t - 4$ m/s

b) at instantaneous rest, $v = 0$;

$\Rightarrow 6t \quad 4 = 0$

$\therefore t = 2/3$ s

c) distance travelled in

the fifth second $= s_5 - s_4$

$= [3(5)^2 - 4(5) + 10] - [3(4)^2 - 4(4) + 10]$

$= 23$ m

4) $s = 4t^3 - 26t^2 + 40t$

a) at 0, $s = 0$,

$\Rightarrow 2t(2t^2 - 13t + 20) = 0$

$\Rightarrow 2t(2t - 5)(t - 4) = 0$

$\therefore t = 0s, 2.5s, 4s$.

b) $v = \frac{ds}{dt} = 12t^2 - 52t + 40 \text{ m/s}$

c) $v = 0$,

$\Rightarrow 12t^2 - 52t + 40 = 0$

$\Rightarrow 4(3t^2 - 13t + 10) = 0$

$\Rightarrow 4(3t - 10)(t - 1) = 0$

$\therefore t = 1s, 10/3 s$

d) $a = \frac{dv}{dt} = 24t - 52 \text{ m/s}^2$

at $t = 3$,

$a = 24(3) - 52$

$= 20 \text{ m/s}^2$

5) $s = 4 + 12t - t^3$ for $t \geq 0$

a) at $t = 0$,

$s = 4\,m$

b) at instantaneous rest, $v = 0$;

$v = \frac{ds}{dt} = 12 - 3t^2$

$\Rightarrow 12 - 3t^2 = 0$

$\therefore t = +2s \quad (t \geq 0)$

c) $a = \frac{dv}{dt} = -6t$

at $t = 2s$,

$a = -6(2) = -12\,m/s^2$

6) $x = -3t^3 + 6t^2 + kt + 4$ for $t \geq 0$

a) $v = \frac{dx}{dt} = -9t^2 + 12t + k$

given that $v = 9$ at $t = 2$,

$\Rightarrow 9 = -9(2)^2 + 12(2) + k$

$\Rightarrow k = 21$ (shown)

b) $v = -9t^2 + 12t + 21$

at instantaneous rest,

$v = 0$;

$-9t^2 + 12t + 21 = 0$

$-3[3t^2 - 4t - 7] = 0$

$-3(3t - 7)(t + 1) = 0$

$t = 7/3$ s, $\cancel{-1 \text{ s}}$ (N/A)

c) $OA = \left[-3(7/3)^3 + 6(7/3)^2 + 21(7/3) + 4\right]$

$= 47.6$ m

$\simeq 48$ m

7) $s = 6t^3 - t^4$

a) $v = \frac{ds}{dt} = 18t^2 - 4t^3$ m/s

b) at instantaneous rest, $v = 0$;

$\Rightarrow 18t^2 - 4t^3 = 0$

$\Rightarrow 2t^2(9 - 2t) = 0$

$\Rightarrow t \neq 0,\ t = 9/2$ s

at $t = 9/2$ s,

$s = 6(9/2)^3 - (9/2)^4$

$= 137$ m (3 s.f.)

8) $s = t + \frac{4}{t}$ for $t \geq 1$

a) $v = \frac{ds}{dt} = 1 - \frac{4}{t^2}$

at instantaneous rest, $v = 0$;

$$1 - \frac{4}{t^2} = 0$$

$$\Rightarrow t = +2s \quad (t \geq 1)$$

b) at $t = 8$,

$s_8 = 8 + \frac{4}{8} = 8.5\,m$ (point B from O)

at $t = 2$,

$s_2 = 2 + \frac{4}{2} = 4m$ (point A from O)

$\therefore AB = s_8 - s_2$

$= 8.5 - 4$

$= 4.5\,m$

9) $x = 4 + 7t - 2t^2$ for $t \geq 0$

a) $v = \frac{dx}{dt} = 7 - 4t$ m/s

b) for furthest distance reached,

$v = 0$

$\Rightarrow 7 - 4t = 0$

$t = 7/4$ s at point A

c) at $t = 7/4$ s,

$x = 4 + 7(7/4) - 2(7/4)^2$

$= \frac{81}{8}$ m from O.

d) total distance $= \left[x_t \right]_0^{7/4} + \left[x_t \right]_4^{7/4}$

$= \left[4 + 7t - 2t^2 \right]_0^{7/4} + \left[4 + 7t - 2t^2 \right]_4^{7/4}$

$= \left[\frac{81}{8} - 4 \right] + \left[\frac{81}{8} - 0 \right]$

$= \frac{65}{4}$ m

10) $s = t^3 - 27t + 55$ for $t \geq 0$

a) at $t = 0$,

$s = (0)^3 - 27(0) + 55 = 55\ m$

b) $v = \frac{ds}{dt} = 3t^2 - 27\ m/s$

c) for closest distance, $v = 0$,

$\Rightarrow 3t^2 - 27 = 0$

$\Rightarrow t^2 = 9$

$\therefore t = +3s \quad (t \geq 0)$

d) at $t = 3$,

$s = (3)^3 - 27(3) + 55$

$= 1\ m$

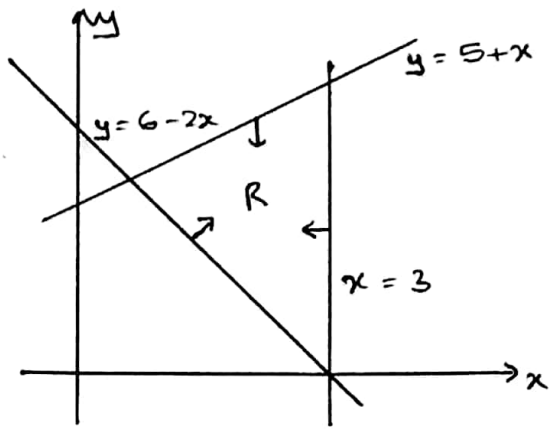
e) total distance $= [s]_0^3 + [s]_3^5$

$= |[1 - 55]| + |[1 - 45]|$

$= 98\ m$

EQUATION GRAPH

1) $y = 6 - 2x$ — ①
$y = 5 + x$ — ②



for ①, at x-axis, $y = 0$

$\Rightarrow 6 - 2x = 0$

$\therefore x = 3$

the point is $(3, 0)$

R is defined by -

$y \leq 5 + x$, $y \geq 6 - 2x$, $x \leq 3$

3) a) slope is the acceleration;

$\Rightarrow a = \frac{20}{10} = 2\ m/s^2$

b) total distance travelled = Area under graph

$= \frac{1}{2} \times (30 + 45) \times 20$

$= 750m$

c) average speed

$= \frac{\text{total distance travelled}}{\text{total time taken}} = \frac{750}{45} = \frac{50}{3}\ m/s$

4) a) From 9:30 to 11:00 $\Rightarrow$ 90 min , or 1.5 hrs

b) average speed $= \frac{175\ km}{2\ hrs}$

$= 87.5\ km/h$

c) 5 small gaps $\longrightarrow$ 30 min

2 " " $\longrightarrow \frac{30}{5} \times 2 = 12$ min

$\therefore$ at 12:12

2)

time taken (P to Q) $= \frac{35}{5} = 7s$

let t_2 be time taken to travel from Q to R.
(constant deceleration)

$\Rightarrow \frac{1}{2} \times 5 \times t_2 = 10$

$t_2 = 4s$

5) a) graph

b) total distance

= area under graph

$= \frac{1}{2} \times (5 + 6.5) \times 60 \times 30$

$= 10350\ m$

c) average speed

$= \frac{\text{total distance travelled}}{\text{total time taken}}$

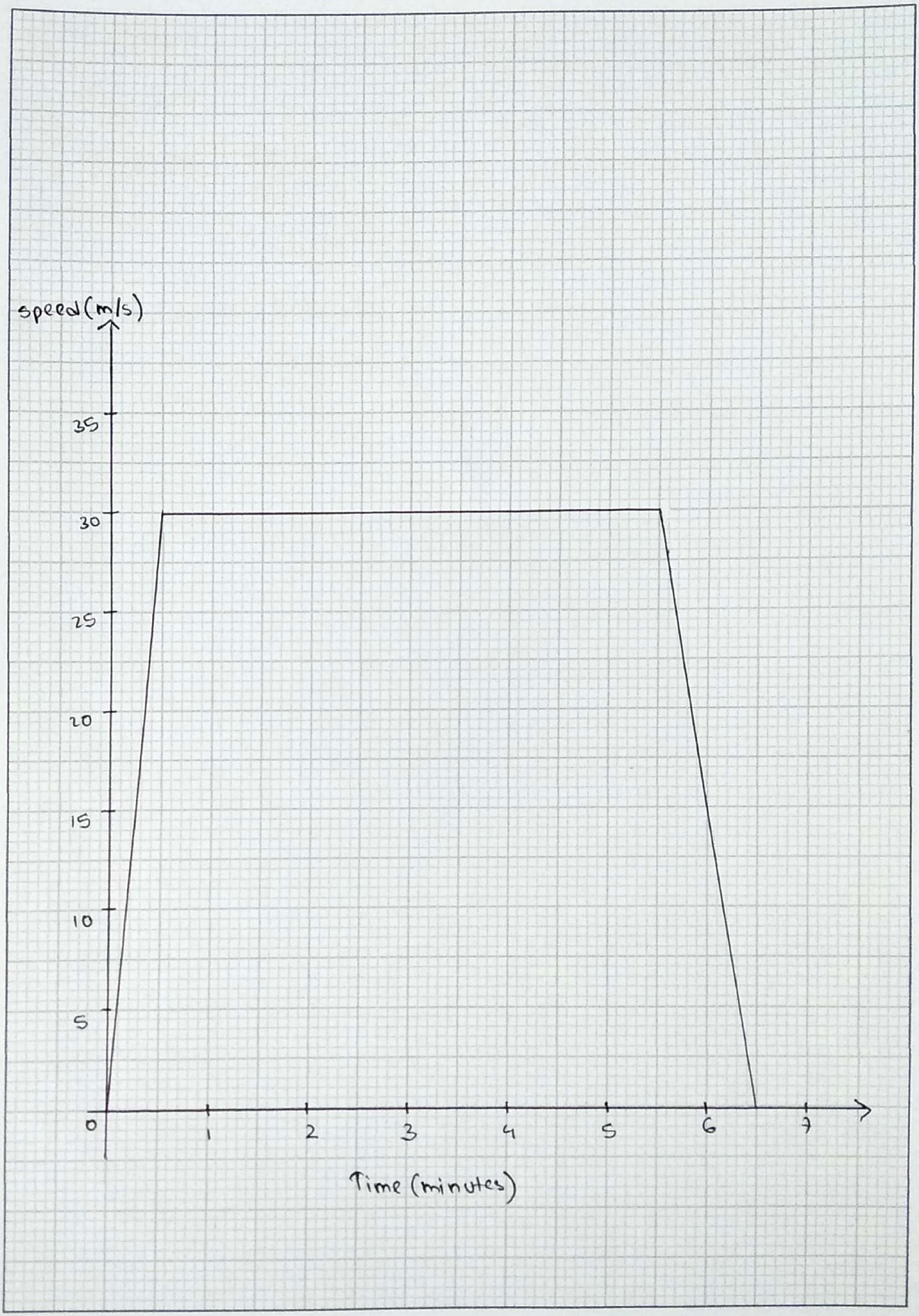
$= \frac{10350}{6.5 \times 60}$

$= 26.53\ m/s$

d) deceleration $= \frac{0 - 30}{1 \times 60}$

$= 0.5\ m/s^2$

5) a)



18 cm x 26 cm

FAISAL MIZAN

6) a) graph

b) graph

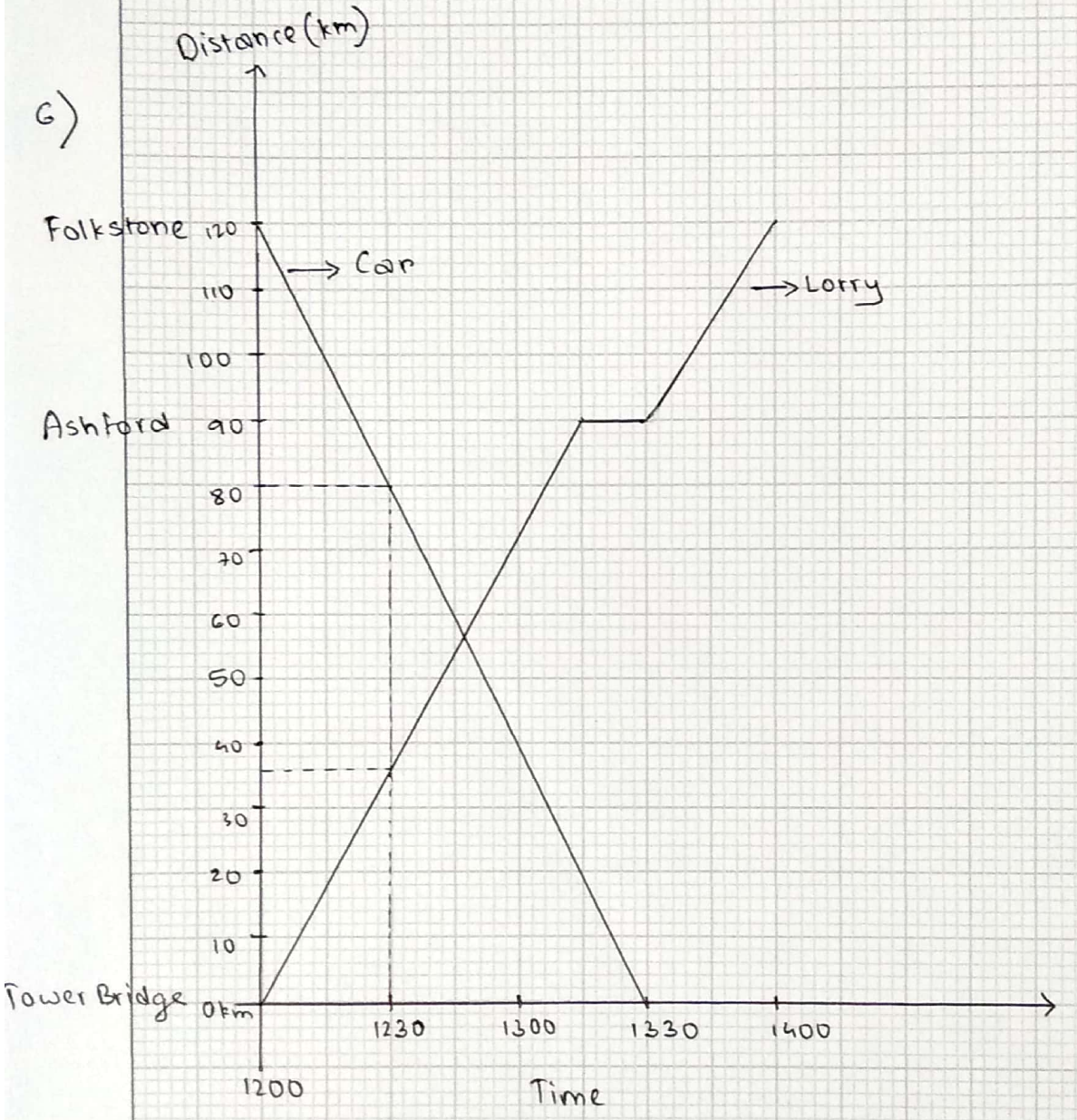
c) speed = $\frac{90\ km}{1.25\ hr}$

= 72 km/h

d) distance = 80 - 36

= 44 km

G)



18 cm x 26 cm

FAISAL MIZAN

7) a) graph

b) distance = 160 - 48

= 112 km

time : 10:09 to 11:45

=> 10:09 to 11:00 + 11:00 to 11:45

↓ 51/60 = 0.85 hr + ↓ 45/60 = 0.75 hr

= 1.6 hr

$$\text{speed} = \frac{112}{1.6}$$

= 70 km/h

c) graph

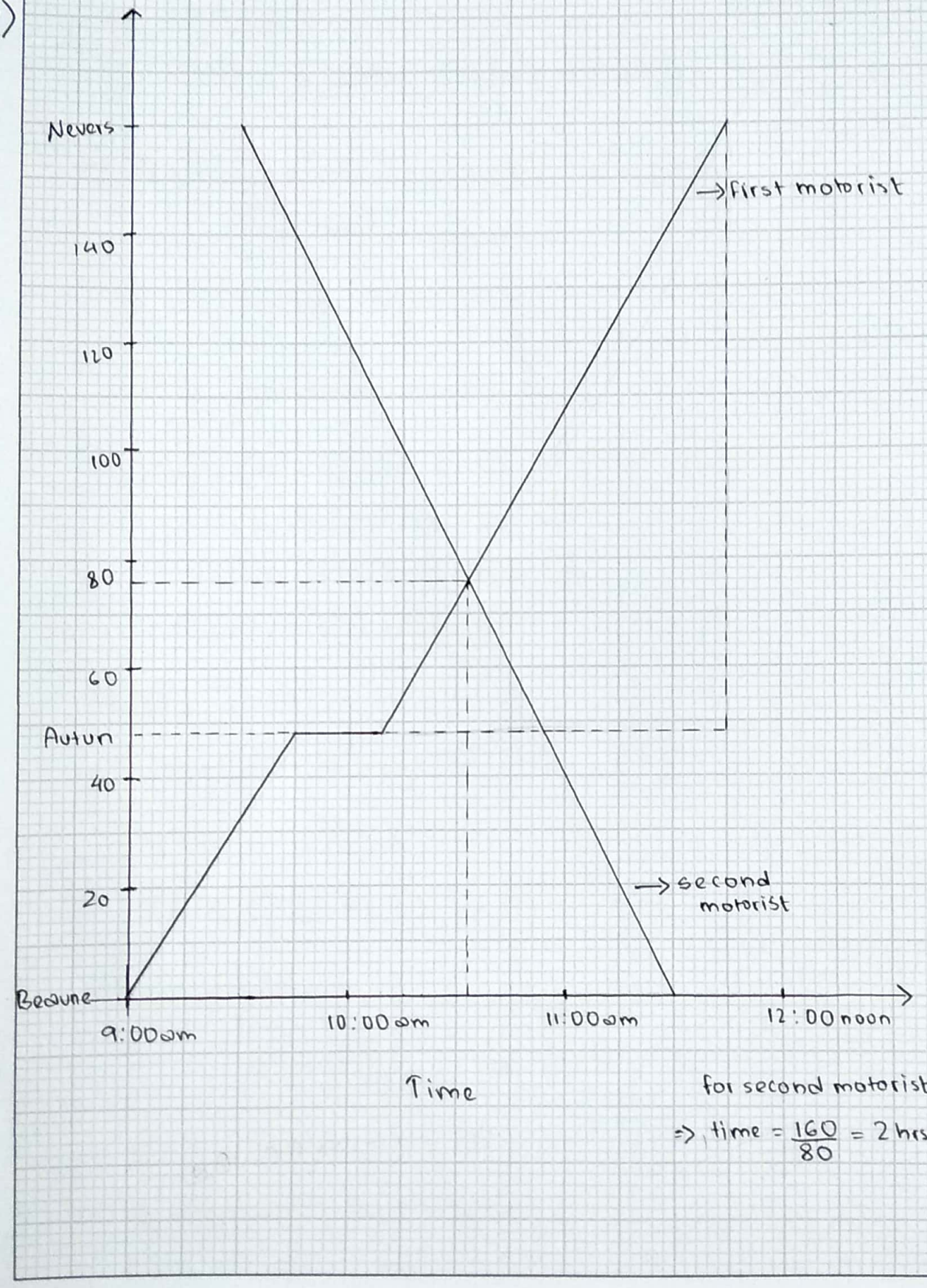
d) from graph,

i) 10:33

ii) distance = 76 - 48

= 28 km

7)



for second motorist:

$\Rightarrow$ time $= \frac{160}{80} = 2$ hrs

18 cm x 26 cm

FAISAL MIZAN

8) $f(x) = 4x^3 - 13x - 6$

a) $f(-1/2) = 4(-1/2)^3 - 13(-1/2) - 6$

$= 0$

$\therefore (2x+1)$ is a factor of $f(x)$. (shown)

b) $2x+1 \;|\; 4x^3 + 0x^2 - 13x - 6 \;|\; 2x^2 - x - 6$

$\ominus \; 4x^3 \pm 2x^2$

$-2x^2 - 13x$

$\pm 2x^2 \mp x$

$-12x - 6$

$-12x - 6$

$(+) \quad (+)$

0

$\therefore f(x) = (2x+1)(2x^2 - x - 6)$

$= (2x+1)(2x^2 - 4x + 3x - 6)$

$= (2x+1)(2x(x-2) + 3(x-2))$

$= (2x+1)(2x+3)(x-2)$

c) $f(x) = y = 0$;

$\Rightarrow (2x+1)(2x+3)(x-2) = 0$

$\therefore x = -1/2, -3/2, 2$

$\Rightarrow (-1/2, 0), (-3/2, 0), (2, 0)$

d) $\frac{dy}{dx} = 12x^2 - 13 = 0$ at turning point.

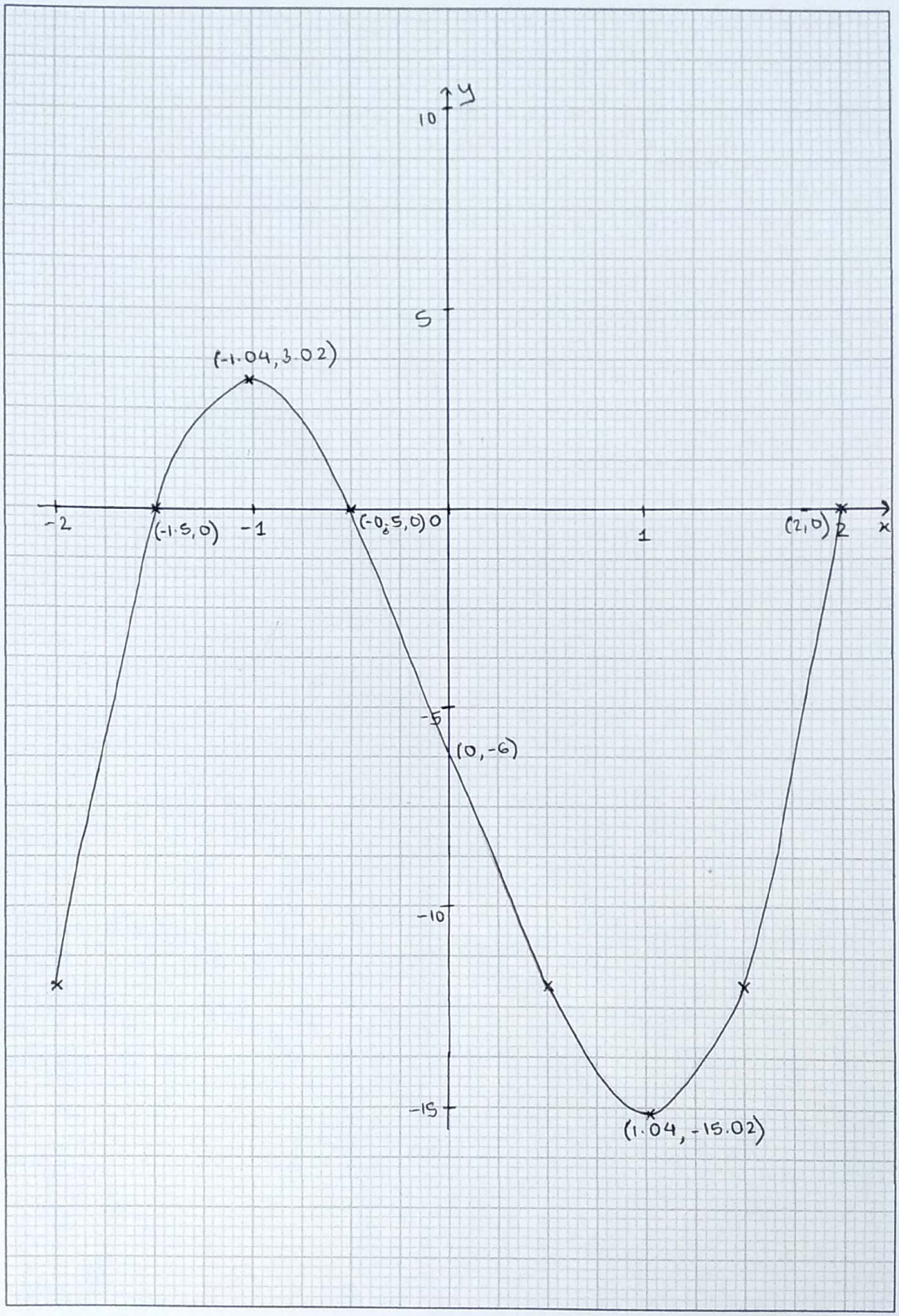
$\Rightarrow x = \pm\sqrt{13/12} = \pm 1.04$

$y_1 = 4(1.04)^3 - 13(1.04) - 6 =$

$y_2 = 4(-1.04)^3 - 13(-1.04) - 6 = 3.02$

$\therefore (1.04, -15.02), (-1.04, 3.02)$

8)



18 cm x 26 cm

FAISAL MIZAN

9) a) $y = 2(0.5)^3 - (0.5)^2 - 6(0.5)$

$= -3$

$y = 2(1.5)^3 - (1.5)^2 - 6(1.5)$

$= -4.5$

$y = 2(3)^3 - (3)^2 - 6(3)$

$= 27$

b) graph

c) from graph, $y = -5.1$

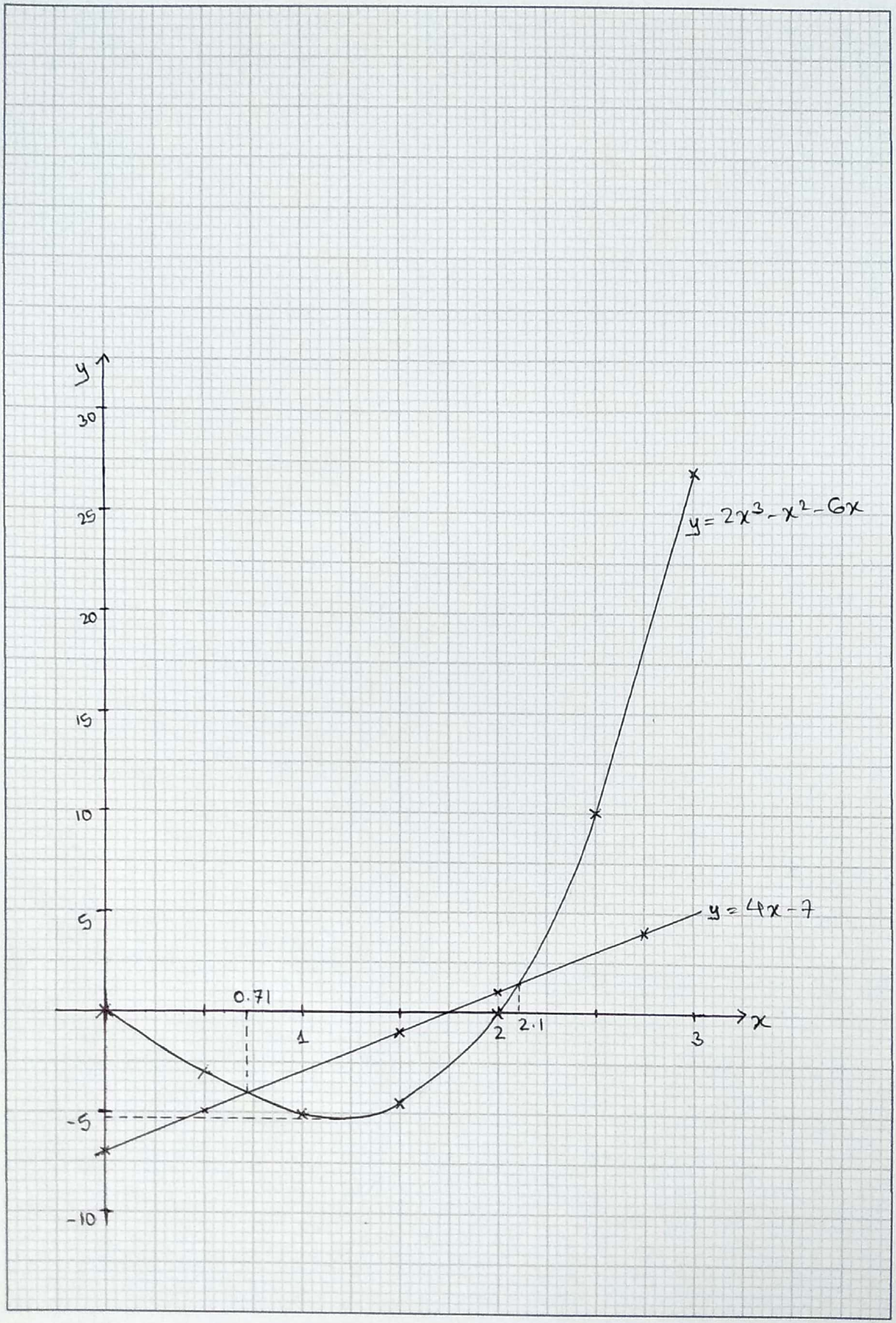
d)

x	0	0.5	1.5	2	2.5
y	0	-5	-1	1	3

e) from graph,

$0.7 < x < 2.1$

9)



18 cm x 26 cm

FAISAL MIZAN

10) a) $y = \frac{9}{(1.25)^2} + 2(1.25) - \frac{8}{(1.25)}$

$= 1.86$

$y = \frac{9}{(1.75)^2} + 2(1.75) - \frac{8}{1.75}$

$= 1.87$

$y = \frac{9}{(2.5)^2} + 2(2.5) - \frac{8}{2.5}$

$= 3.24$

b) graph

c) from graph, $x = 1.46$ at min. pt.

d) $4x^3 - 6x^2 - 8x + 9 = 0$

$\Rightarrow 4x - 6 - \frac{8}{x} + \frac{9}{x^2} = 0$ [dividing with x^2]

$\Rightarrow \frac{9}{x^2} - \frac{8}{x} = -4x + 6$

$\Rightarrow \frac{9}{x^2} + 2x - \frac{8}{x} = -4x + 2x + 6$ [adding 2x to both sides]

$= -2x + 6$

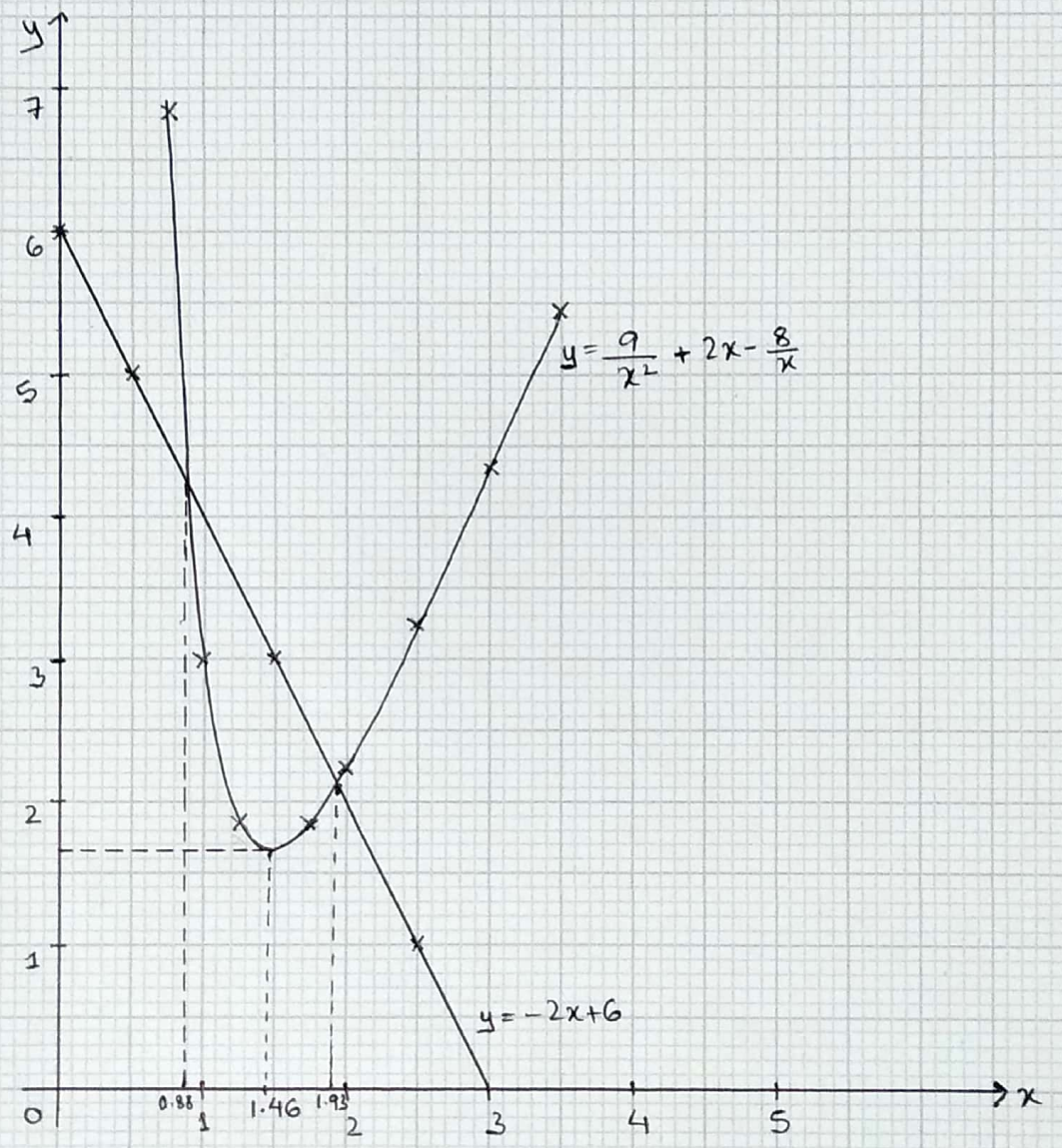
$a \quad b$

e)

x	0	0.5	1.5	2.5	3
y	6	5	3	1	0

$x = 0.88, 1.93$ (from graph)

10)



18 cm x 26 cm

FAISAL MIZAN

11) a) i) $AB^2 + BC^2 = AC^2$

$\therefore \angle ABC = 90°$

ii) Area $= \frac{1}{2} \times 3x \times 4x = 6x^2 \text{ cm}^2$ (shown)

iii) $S = ABDE + BCEF + \Delta ABC \times 2 + ACDF$

$= 3xy + 4xy + 6x^2 \times 2 + 5xy$

$= 12x^2 + 12xy$

b) $S = 144$,

$\Rightarrow 144 = 12x^2 + 12xy$

$\Rightarrow 12xy = 144 - 12x^2$

$\therefore y = \frac{144 - 12x^2}{12x} = \frac{12 - x^2}{x}$ (shown)

c) Volm = C.S.A x length

$= 6x^2 y$

$= 6x^2 \left(\frac{12 - x^2}{x}\right)$

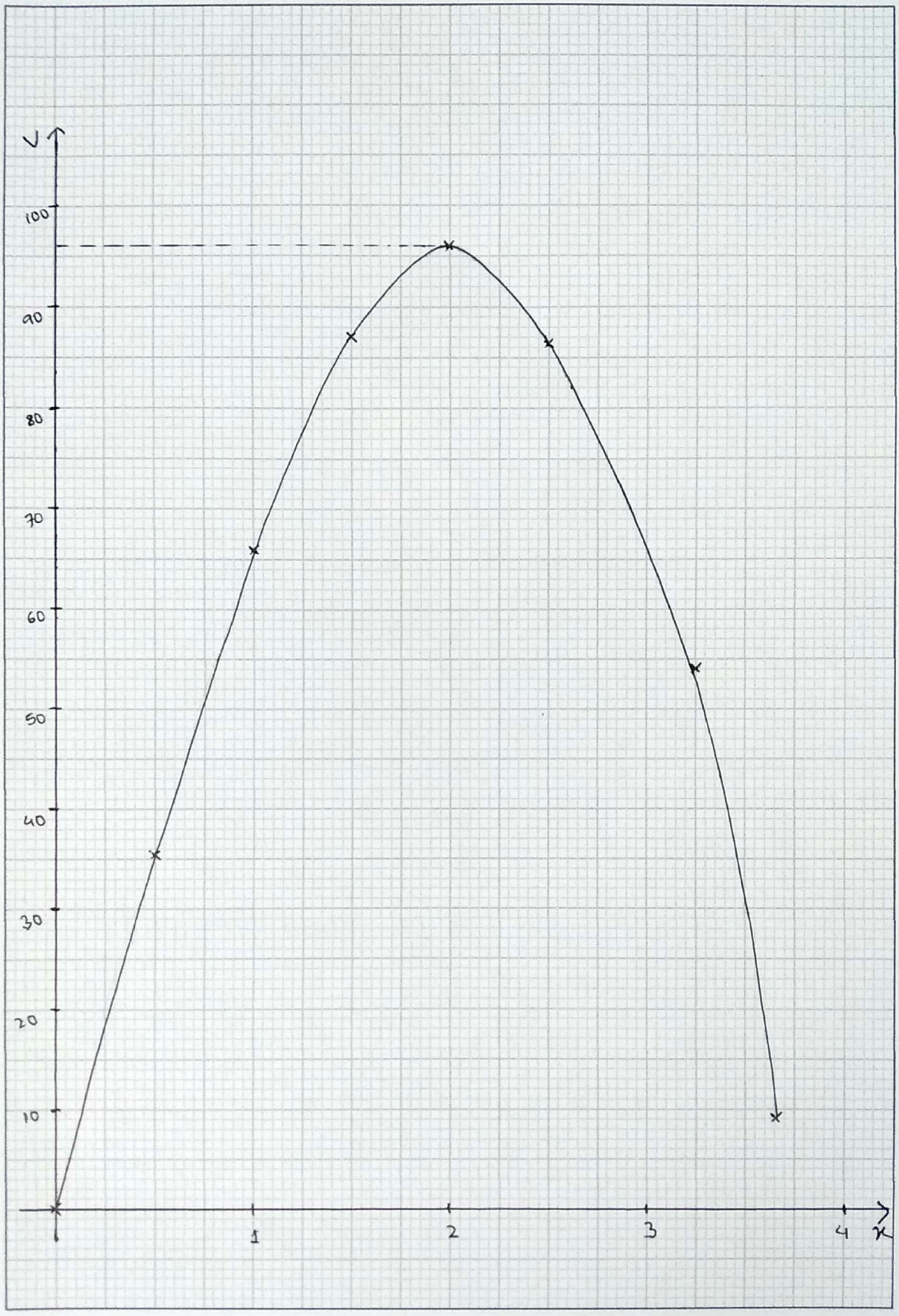
$= 6x(12 - x^2)$ (shown)

d) 35.3, 87.8, 96, 86.3

e) graph

f) from graph, $V_{max} = 96 \text{ cm}^3$

11)



18 cm x 26 cm

FAISAL MIZAN

12) a) $h + 6r = 15$

$\Rightarrow h = 15 - 6r$

$\Rightarrow h > 0$

$\Rightarrow 15 - 6r > 0$

$r < 2.5$

$\therefore$ upper bound value of $r = 2.5$

b) V = volume of hemisphere + volume of cone

$= \frac{2}{3}\pi r^3 + \frac{1}{3}\pi r^2 h$

$= \frac{2}{3}\pi r^3 + \frac{1}{3}\pi r^2 (15 - 6r)$

$= \frac{2}{3}\pi r^3 + 5\pi r^2 - 2\pi r^3$

$= -\frac{4}{3}\pi r^3 + 5\pi r^2$

$= \frac{1}{3}\pi r^2 (15 - 4r)$ (shown)

c) 2.2, 15.4, 23.1

d) graph

e) from graph, $r = 1.76$ cm

$\simeq 1.8$ cm (1 d.p.)

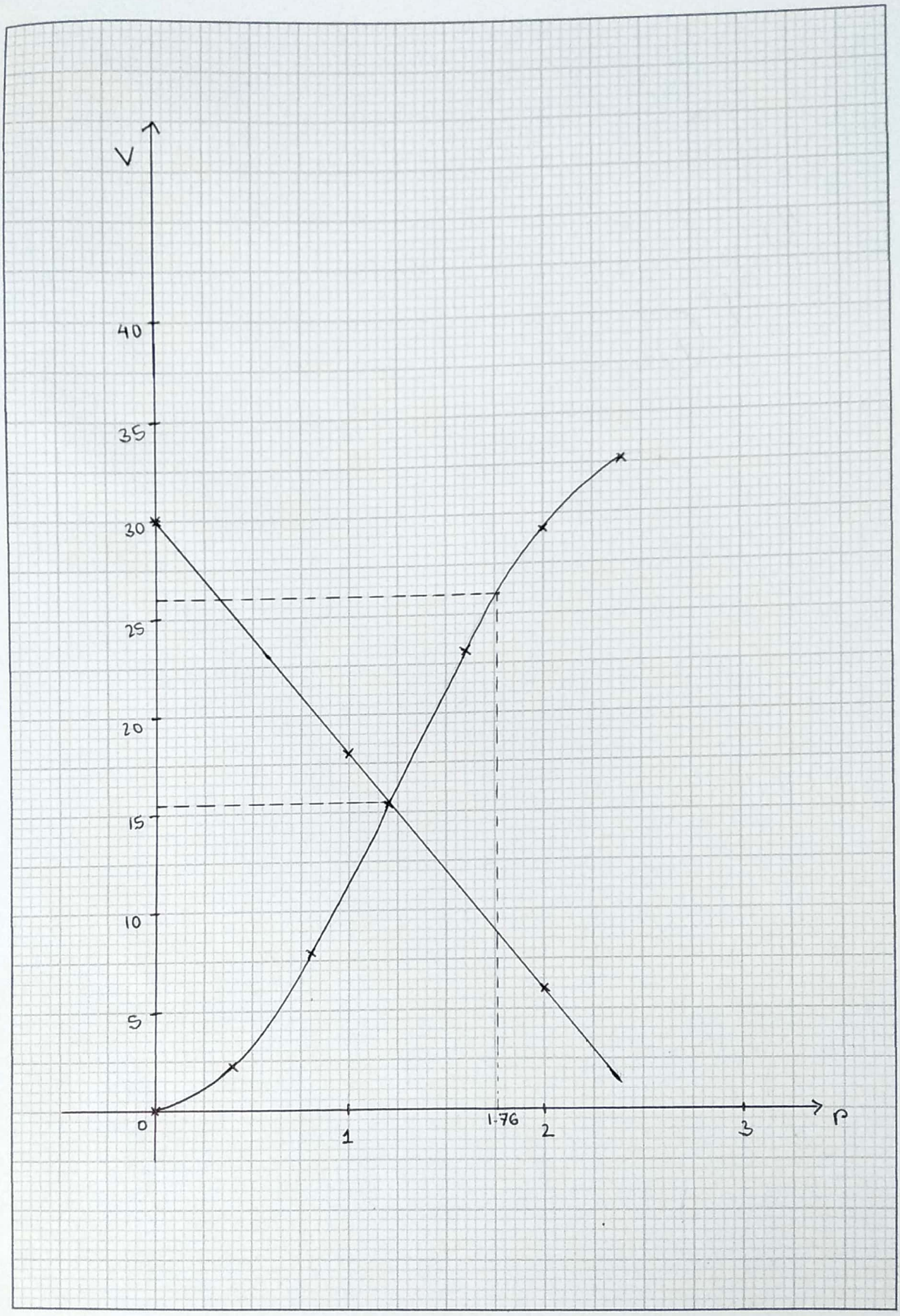
f) $V = 30 - 12r$

r	0	1	2	3
V	30	18	6	-6

$V = 15.5$

$\simeq 16$ (from graph)

12)



18 cm x 26 cm

FAISAL MIZAN

1. State Charles´ Law.

2. Write the formula for Gay-Lussac´s Law and name the 2 variables that must be constant.

3. Draw the graph of Boyle´s Law.

4. If the volume of a balloon is doubled then what will happen to its pressure? (at constant T and n)

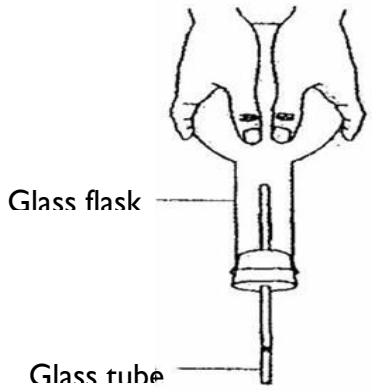
5. Eugenio had a metal box with an initial temperature of 10 °C and a pressure of 5 atm. He then heated it to 60 °C. What was the final pressure? (*Hint: what units should T be in?)*

6. María put 64 g of oxygen gas (O_2) into an empty 20 L container at 37 ° C. What is the pressure in her container? (*Help: The molecular mass of O_2 is 32 g/mol)*

7. A 127 ° C and 3000 torr, David´s gas occupies 2 m^3. What volume will the same gas occupy if the temperature changes to 227 ° C and a pressure at 500 torr?

8. After his birthday party, Manolo put his balloon in the fridge. 5 minutes later, he noticed the balloon had shrunk. Explain why? Which gas law does it relate to?

9. Mr Canning took the following apparatus and placed the end of the glass tube into a beaker of water. He then started to warm up the end of the flask with his hands. What might you have observed when he did this? Explain why? What would happen if he then cooled the glass flask?



10. We make 3 assumptions when dealing with Ideal Gases. State the 3 assumptions and explain why they are most valid at high temperatures and low pressure.?

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Worksheet on unit-1 – Through Space and time

Answer the following question

Question 1a

Model trains move along a track passing through two model stations. Students analyse the motion of a train. They start a digital timer as the train starts to move. They record the time that it enters Station A and the time it enters Station B.

Fig 1.1 below shows the time on entering Station A and the time on entering Station B.

time entering Station A time entering Station B

Fig. 1.1

Calculate the time taken from the train entering Station A to the train entering Station B.
State your answer in seconds.

time taken = ... s

[1 mark]

Question 1b

A faster train takes 54 s to travel from Station A to Station B. The distance between the stations is 120 m.

Calculate the average speed of this train.

average speed = ... m/s

[3 marks]

Question 1c

Fig. 1.2 shows the speed-time graph for a train travelling on a different part of the track.

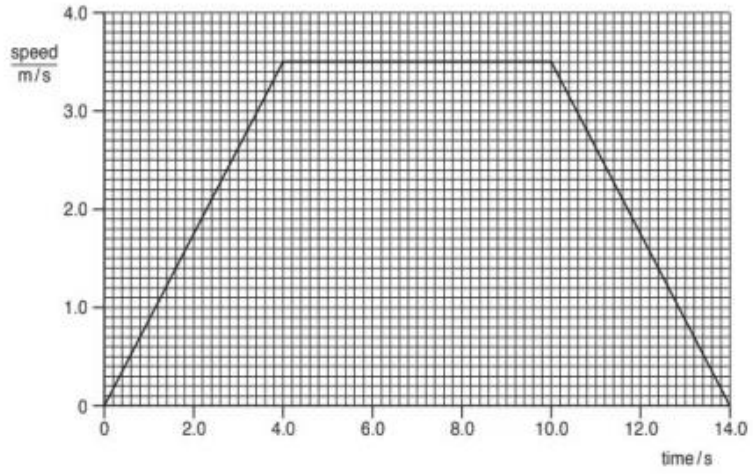

Fig. 1.2

Determine the total distance travelled by the train on this part of the track.

distance = ... m

[4 marks]

Question 3b

The length of the track is 250m.

Another cyclist goes around the track four times (four laps). This takes 80.0 seconds.

(i)
Calculate the average speed of this cyclist.

average speed = ... m/s [4]

(ii)
A friend of the cyclist starts a stopwatch at the beginning of the race.

Fig.2.2 shows the reading on the stopwatch when the cyclist has gone around the track **once**.

Fig.2.3 shows the reading on the stopwatch when the cyclist has gone around the track **twice**.

Fig. 2.2

Fig. 2.3

Calculate the time taken for the cyclist to go around the track during the second lap.

time = ... s [1]

[5 marks]

Fig. 3.1 shows the vertical forces on a rocket.

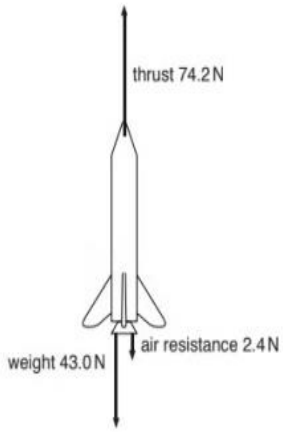

Fig. 3.1

Calculate the resultant force on the rocket.

resultant force = ... N

direction = ...

Fig. 3.1 shows the horizontal forces acting on a swimmer.

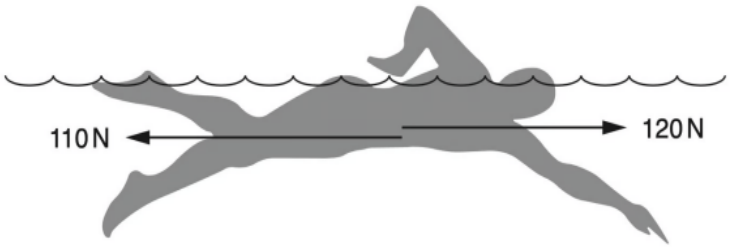

Fig. 3.1

(i) Calculate the size and direction of the resultant horizontal force on the swimmer.

size of resultant horizontal force = ... N

direction of resultant horizontal force = ...

[1]

(ii) State the name of the 110 N force on the swimmer.

[1]

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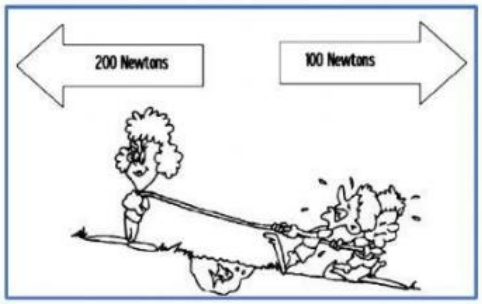
Worksheet on resultant force

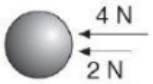
A. Look at the diagram below and circle the best answer.



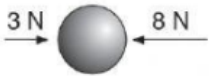
1. The forces shown are (pushing / pulling) forces. ☐
2. The forces shown are in the (same direction / opposite direction). ☐
3. The Resultant Force is (300N / 100N). ☐
4. The forces shown are (balanced / unbalanced) forces. ☐
5. The direction of the Resultant Force is to the (right / left). ☐

B. The stationary balls are being pushed by different forces. Calculate the resultant force and write the direction of its movement.

B. The stationary balls are being pushed by different forces. Calculate the resultant force and write the direction of its movement.

1. 

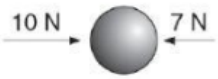
Resultant Force: ☐ Direction: ☐

2. 

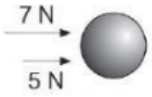
Resultant Force: ☐ Direction: ☐

3. 

Resultant Force: ☐ Direction: ☐

4. 

Resultant Force: ☐ Direction: ☐

5. 

Resultant Force: ☐ Direction: ☐

6. 

Resultant Force: ☐ Direction: ☐

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Revision Worksheet
MYP 4

Mechanics [Force and motion, Energy, Work done]

1. The speed limit of most sections of the highway is 65 miles/hour. If a car travels 450 miles in in six hours, was the car exceeding the speed limit? How far above or below the speed limit was the car?

2. In 1990, Glenn Spear set a world speed record by swimming the 50 meter freestyle in 21.81 seconds. What was Glenn's speed?

3. A college scout is looking for a swimmer to break Glenn Spear's speed record. He watches a swimmer doing a 100 meter freestyle event. When the swimmer reaches the halfway point in distance, he is timed at 23.71 seconds. Did he beat Glenn Spear's speed record? Why or why not?

4. If the swimmer's final time at the end of the 100m free-style was 41.32 s, would the scout recruit the swimmer for his swim team to swim the 50 meter race? What about the 100 meter race? Why or why not?

5. A snowmobile travels south at 45 km/hr for 30 minutes, turns west, and continues traveling at 35 km/hr for an hour. What distance did the snow mobile cover? What was the displacement of the snowmobile? What was its speed? What was its velocity?

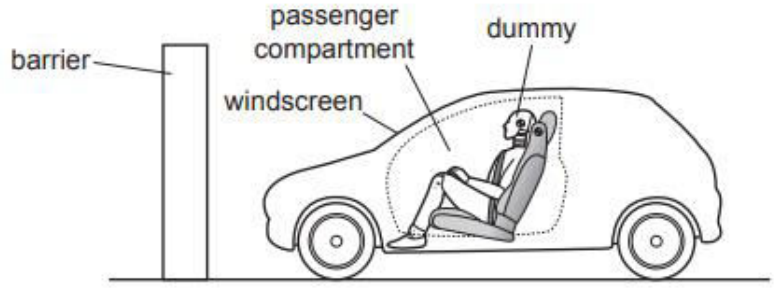
6. A student wishes to work out how much power she uses to lift her body when climbing a
flight of stairs. Her body mass is 60 kg and the vertical height of the stairs is 3.0 m. She takes 12 s to walk up the stairs.

(a) Calculate the work done in raising her body mass as she climbs the stairs
(b). Calculate the output power she develops when raising her body mass. At the top of the stairs she has gravitational potential energy.
(c)Describe the energy transformations taking place as she walks back down the stairs and stops at the bottom.

7. You are traveling in a car that is moving at a velocity of 20 m/s. Suddenly, a car 10 meters in front of you slams on its brakes. At that moment, you also slam on your brakes and slow to 5 m/s. Calculate the acceleration if it took 2 seconds to slow your car down.

8. Falling objects drop with an average acceleration of 9.8 m/s^2. If an object falls from a tall building, how long will it take before it reaches a speed of 49 m/s

9. The below figure shows a dummy of mass 70kg used in a crash test to investigate the safety of a new car.



The car approaches a solid barrier at 20 m / s. It crashes into the barrier and stops suddenly.

(a). Calculate the momentum of the dummy immediately before the crash.
(b) Impulse is the change in momentum. Determine the impulse that must be applied to the dummy to bring it to rest.
(c) The seat belt and air bag bring the dummy to rest so that it does not hit the windscreen. The dummy has an average deceleration of 80 m/s^2.
Calculate the average resultant force applied to the dummy, of mass 70 kg.

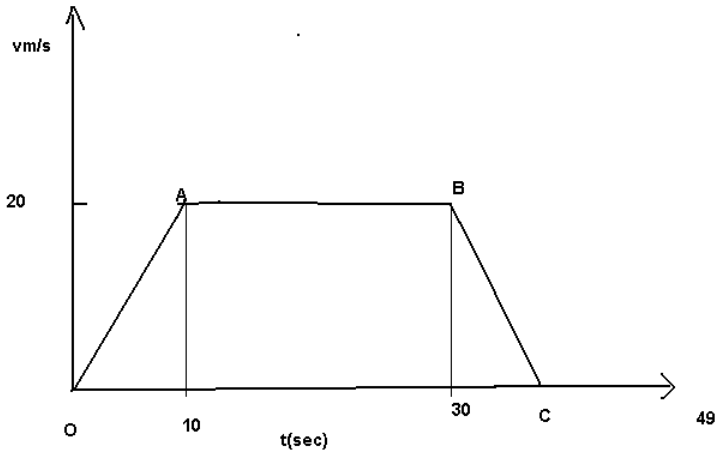
NUMERICALS

1. **A bullet of mass 10g is fired with a rifle. The bullet takes 0.003sec.to move through its barrel and leaves it with a velocity of 300m/s. What is the force exerted on the bullet by the rifle?**
2. **What will be the acceleration of a body of mass 5kg if a force of 200N is applied on it?**
3. **A cricket ball of mass 70g moving with a velocity of 0.5m/s is stopped by a player in 0.5 sec. What is the force applied by the player to stop the ball?**
4. **A 1000kg mass having a speed of 10m/s is brought to rest over a distance of 100m.Find (i) the retardation (ii) the retarding force.**
5. **Suppose that a sledge is accelerating at a rate of 2 m/s^2. If the net force is tripled and the mass is halved, then what is the new acceleration of the sledge?**

6. **Fill in the blank spaces below, using the given data.**

7. **The velocity- time graph of a bike of mass 120 kg is given below. Calculate the force acting on the bike in the first 10 seconds of the journey.**

	Net Force (N)	Mass (kg)	Acceleration (m/s/s)
1.	10	2	
2.	20	2	
3.	20	4	
4.		2	5
5.	10		10



Formulae to be used :

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

$$s = \frac{1}{2}(u + v)t$$

F= m.a
Impulse = final momentum= initial momentum
Impulse = Force x Time
p= m.v
P.E = mhg
KE = ½ mv^2

Work done = change in energy [Work energy theorem]

Power = Energy / time or Power = Work done/time.

Specific Heat Problems

1) **How much heat must be absorbed by 375 grams of water to raise its temperature by 25° C?**

2) **What mass of water can be heated from 25.0° C to 50.0° C by the addition of 2825 J?**

3) **What is the final temperature when 625 grams of water at 75.0° C loses 7.96×10^4 J?**

4) **A copper cylinder has a mass of 76.8 g and a specific heat of 0.092 cal/g·C. It is heated to 86.5° C and then put in 68.7 g of turpentine whose temperature is 19.5° C. The final temperature of the mixture is 31.9° C. What is the specific heat of the turpentine?**

5) **A 65.0 g piece of iron at 525° C is put into 635 grams of water at 15.0° C. What is the final temperature of the water and the iron?**

Solutions

1) $m_w = 375\ g$

$c_w = 4.18\ J/g \cdot K$

$\Delta T = 25°\ C = 25\ K$

$q_g = m_w c_w \Delta T_w$

$q_g = 375\ g \times 4.18\ J/g \cdot \cancel{K} \times 25\ \cancel{K} = 3.9 \times 10^4\ J$

2) $m_w = ?$

$c_w = 4.18\ J/g \cdot K$

$\Delta T = 50.0°\ C - 25.0°\ C = 25.0\ K$

$q_g = m_w c_w \Delta T_w$

$m = q_g / c\Delta T$

$m = 2825\ J/(4.18\ \cancel{J}/g \cdot \cancel{K} \times 25.0\ \cancel{K}) = 27.0\ g\ H_2O$

3) $m_w = 625\ g$

$c_w = 4.18\ J/g{\cdot}K$

$T_i = 75.0°\ C$

$q_l = 7.96 \times 10^4\ J$

$q_l = m_w c_w \Delta T_w$

$\Delta T_w = q_l/(m \times c)$

$\Delta T_w = 7.96 \times 10^4\ \cancel{J}/(625\ \cancel{g} \times 4.18\ \cancel{J}/g{\cdot}K) = 30.5\ K = 30.5°\ C$

$\Delta T = T_i - T_f$

$T_f = T_i - \Delta T = 75.0°\ C - 30.5°\ C =$ **44° C**

4) $m_c = 76.8\ g$ $\qquad$ $m_t = 68.7\ g$

$c_c = 0.092\ cal/g{\cdot}C$ $\qquad$ $c_t = ?$

$\Delta T = T_i - T_f$ $\qquad$ $\Delta T = T_f - T_i$

$\Delta T = 86.5°\ C - 31.9°\ C = 54.6°\ C$ $\qquad$ $\Delta T = 31.9°\ C - 19.5°\ C = 12.4°\ C$

$\Delta q = 0$

$q_l = q_g$

$m_c c_c \Delta T_c = m_t c_t \Delta T_t$

$c_t = m_c c_c \Delta T_c / m_t \Delta T_t$

$c_t = 76.8\ g \times 0.092\ cal/g{\cdot}C \times 54.6\cancel{°\ C}/(68.7\ g \times 12.4\cancel{°\ C}) =$ **0.45 cal/g·C**

5) $m_{iron} = 65.0\ g$ $m_w = 635\ g$

$c_{iron} = 0.451\ J/g \cdot K$ $c_w = 4.18\ J/g \cdot K$

$T_i = 525°\ C$ $T_i = 15°\ C$

$\Delta q = 0$

$q_l = q_g$

$m_i c_i \Delta T_i = m_w c_w \Delta T_w$

$65.0\ g \times 0.451\ \cancel{J/g \cdot K} \times (525°\ C - T_f) = 635\ g \times 4.18\ \cancel{J/g \cdot K} \times (T_f - 15°\ C)$

$T_f = 20.6°\ C$

Criteria A

Q1

96 N

Deduct points for not writing units

Q2
225 m

correct use of area under the curve.

Q3
-0.9 m/s^2

Q4
C

velocity is not changing

accept speed for velocity

accept speed is constant (9 m/s) accept not decelerating

accept not accelerating

accept reached terminal velocity

forces must be balanced

accept forces are equal

accept arrows are the same length / size

or

resultant force is zero

do not accept the arrows are equal

Criteria B

Q1
independent variable- Launch angle

dependent variable - Range of flight

any two controlled variables:- air rocket, initial launching speed, air resistance or any relevant variable.

Q2

Launch angle (°)	Flight range (m)

Q3
appropriate method for collecting data and its analysis.

Q4
90 °

Criteria C

Q1
YES

marks are for the explanation

any two from:

- **data (from police files) can be trusted**
- **data answers the question asked allow a conclusion can be made from the data**

large sample used NO

any two from:

- **the sample is not representative**
- **the sample size is too small**
- **accident files do not indicate age / experience of riders**

any answer YES and NO support logical points.

Q2
more accidents with motorbikes up to 125 cc

accept an answer in terms of number of under 125 cc to accidents ratio compared correctly with number of over 500 cc to accidents ratio

even though there are fewer of these bikes than bikes over 500 cc

q3
YES

any sensible reason, eg:

- **cannot put a price on life / injury accept may save lives**
- **fewer (serious) injuries accept reduces risk of injury**
- **reduces cost of health care / compensation**

NO

any sensible suggestion, eg:

- **money better spent on … needs to be specific**
- **total number of riders involved is small**

Criteria D

Inflatable seat belt

Proper use of momentum concept.

More time of contact, less impact/ force.

Wrong if students say impulse change or less.

Physics Worksheet
Topic : Kinematic Equations
MYP 4

Equations of motion (Kinematic Equations):
$v=u+at$
$s= ut + \frac{1}{2} at^2$
$v^2 – u^2 = 2as$

Other equations :
average velocity $(v_{avg}) = (u+v) / 2$
distance travelled during acceleration, $s = v_{avg} \times t$

1. A car starts from rest and accelerates uniformly for 8.0 s. It reaches a final speed of 16 m s^{-1}.
a What is the acceleration of the car?
b What is the average velocity of the car?
c Calculate the distance travelled by the car.

2. A new model Volvo car can start from rest and travels 400 m in 16 s.
a What is its average acceleration during this time?
b Calculate the final speed of the car.
c How fast is this final speed in km h^{-1}?

3. A space-rocket is launched and accelerates uniformly from rest to 160 m s^{-1} in 4.5 s.
a Calculate the acceleration of the rocket.
b How far does the rocket travel in this time?
c What is the final speed of the rocket in km h^{-1}?

4. A cyclist, whilst overtaking another bike, increases his speed uniformly from 4.2 m s^{-1} to 6.3 m s^{-1} over a time interval of 5.3 s.
a Calculate the acceleration of the cyclist during this time.
b How far does the cyclist travel whilst overtaking?
c What is the average speed of the cyclist during this time?

Oakridge international school
Practice worksheet – MYP 4-5

1. An airplane accelerates down a runway at 3.20 m/s^2 for 32.8 s until is finally lifts off the ground. Determine the distance traveled before takeoff.

2. A car starts from rest and accelerates uniformly over a time of 5.21 seconds for a distance of 110 m. Determine the acceleration of the car.

3. Upton Chuck is riding the Giant Drop at Great America. If Upton free falls for 2.60 seconds, what will be his final velocity and how far will he fall?

4. A race car accelerates uniformly from 18.5 m/s to 46.1 m/s in 2.47 seconds. Determine the acceleration of the car and the distance traveled.

5. A feather is dropped on the moon from a height of 1.40 meters. The acceleration of gravity on the moon is 1.67 m/s^2. Determine the time for the feather to fall to the surface of the moon.

6. Rocket-powered sleds are used to test the human response to acceleration. If a rocket-powered sled is accelerated to a speed of 444 m/s in 1.83 seconds, then what is the acceleration and what is the distance that the sled travels?

7. A bike accelerates uniformly from rest to a speed of 7.10 m/s over a distance of 35.4 m. Determine the acceleration of the bike.

8. An engineer is designing the runway for an airport. Of the planes that will use the airport, the lowest acceleration rate is likely to be 3 m/s^2. The takeoff speed for this plane will be 65 m/s. Assuming this minimum acceleration, what is the minimum allowed length for the runway?

9. A car traveling at 22.4 m/s skids to a stop in 2.55 s. Determine the skidding distance of the car (assume uniform acceleration).

10. A kangaroo is capable of jumping to a height of 2.62 m. Determine the takeoff speed of the kangaroo.

11. If Michael Jordan has a vertical leap of 1.29 m, then what is his takeoff speed and his hang time (total time to move upwards to the peak and then return to the ground)?

12. A bullet leaves a rifle with a muzzle velocity of 521 m/s. While accelerating through the barrel of the rifle, the bullet moves a distance of 0.840 m. Determine the acceleration of the bullet (assume a uniform acceleration).

13. A baseball is popped straight up into the air and has a hang-time of 6.25 s. Determine the height to which the ball rises before it reaches its peak. (Hint: the time to rise to the peak is one-half the total hang-time.)

OAKRIDGE INTERNATIONAL SCHOOL

WORKSHEET ON NEWTON'S LAW

Multiple Choice Questions & Answers (MCQs) focuses on "Newton's First Law of Motion".

1. What causes the motion of a body which is initially in the state of rest?
   a) Force
   b) Displacement
   c) Speed
   d) Velocity

2. People sitting in a moving bus experience a jerk when the bus stops. This is due to _____
a) Inertia of motion
b) Inertia of rest
c) Inertia of turning
d) Inertia of acceleration

3. Passengers sitting in a stationary car experience a jerk when the car suddenly starts. This is due to _____
a) Inertia of motion
b) Inertia of rest
c) Inertia of turning
d) Inertia of acceleration

4.Unit of force is _____

a) Newton

b) Pascal

c) Byte

d) Gram

5. How can a moving object be in equilibrium?There is no change in the object's state of motion

a) A moving object cannot be in equilibrium
b) A force gets it moving
c) A force keeps it moving at constant velocity
d) None are correct