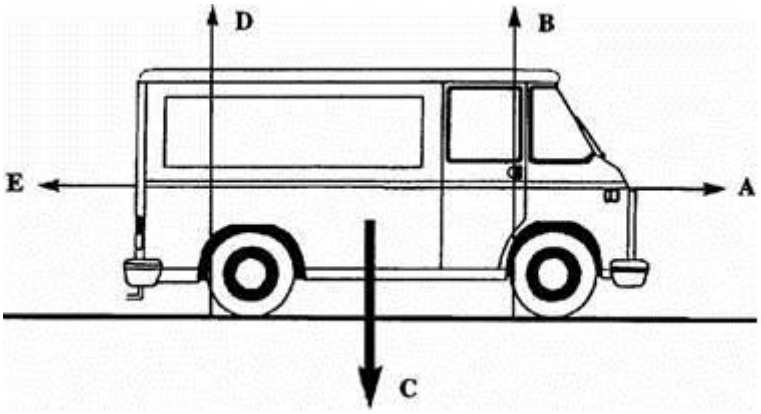
100 minutes on Physics ready for P2 Thursday 29th February -14 days time

Q1.



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)

Q2.

(a) Some scientists think that there is a link between using a mobile phone and some types of illness. Other scientists disagree. They say that the evidence is limited and unreliable.

(i) Suggest what scientists could do to show a link between using a mobile phone and illness.

_____

_____

(1)

(ii) How could scientists improve the reliability of the evidence?

_____

_____

(1)

(iii) Complete the following passage by drawing a ring around the word in the box that is correct.

There has been little or no experimental research into the health of children who use mobile phones.

This is partly because of the

economic
environmental
ethical

issues involved in using children in scientific research.

(1)

(b) Before being sold, new mobile phones must be tested and given a SAR value.
The SAR value is a measure of the energy absorbed by the head while a mobile phone is being used.

The table gives the SAR value for three mobile phones made by different companies.
To be sold in the UK, a mobile phone must have a SAR value lower than 2.0 W/kg.

Mobile phone	SAR value in W/kg
J	0.18
K	0.86
L	1.40

(i) All companies use the same test to measure a SAR value.

Why is using the same test important?

_____

_____

(1)

(ii) Would the companies that make the mobile phones, **J**, **K** and **L**, be correct to claim that these three phones are totally safe to use?

Answer yes or no. _____

Give a reason for your answer.

_____

_____

(1)

(c) Devices designed to protect a mobile phone user from microwave radiation are now available.

Why is it important that these devices are tested by scientists who are **not** working for the company that makes the devices?

_____

_____

(1)

(Total 6 marks)

Q3.

After a person is injured a doctor will sometimes ask for a photograph to be taken of the patient's bone structure, e.g. in the case of a suspected broken arm.

(i) Which type of electromagnetic radiation would be used to take the photograph?

_____

(1)

(ii) Describe the properties of this radiation which enable it to be used to photograph bone structure.

_____

_____

_____

_____

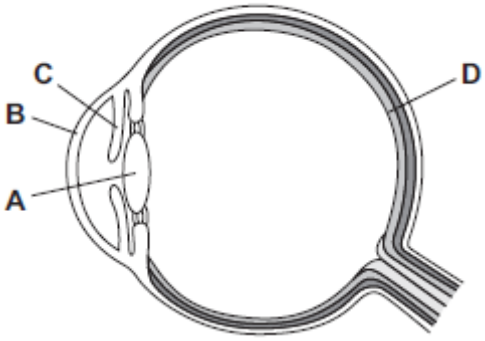
(2)

(Total 3 marks)

Q4.

(a) **Figure 1** shows a section through a human eye.

Figure 1



Write the correct letter, **A**, **B**, **C** or **D**, in each empty box to identify the parts of the eye labelled in **Figure 1**.

Part of the eye	A, B, C or D
Cornea	
Lens	
Retina	

(3)

(b) The table shows how the mass of 1 cm^3 of different materials varies with refractive index.

Material	Refractive index	Mass in g
Water	1.33	1.00
Glass **X**	1.52	2.54
Glass **Y**	1.70	2.93
Glass **Z**	1.81	3.37

(i) Describe the pattern shown in above table.

_____

_____

(1)

(ii) Lenses used for correcting visual defects often have a low refractive index.

State **one** advantage and **one** disadvantage of using lenses with a high refractive index for correcting visual defects.

Advantage _____

Disadvantage _____

(2)

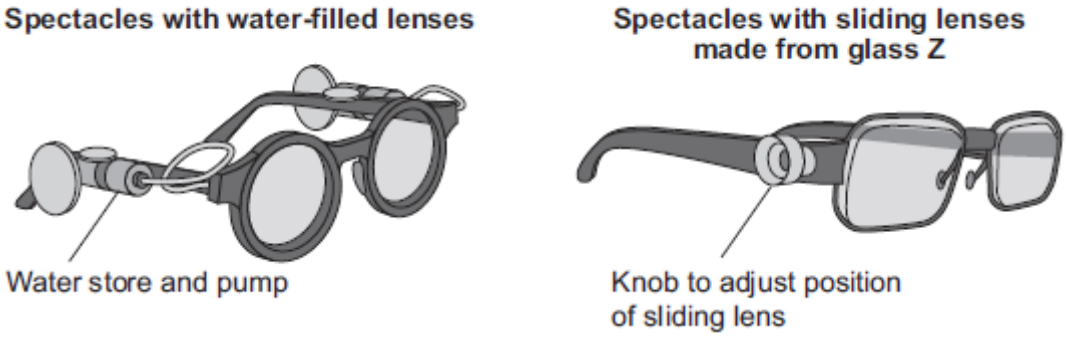
(iii) The eyesight of a person can change throughout their lifetime. Scientists have designed cheap spectacles that allow the wearer to change the focal length of the lenses as their eyesight changes.

Two designs are:

- using water-filled lenses where water is pumped in or out of the lens to change its shape
- using a pair of specially shaped lenses for each eye that are able to slide across each other.

Figure 2 shows these two designs.

Figure 2



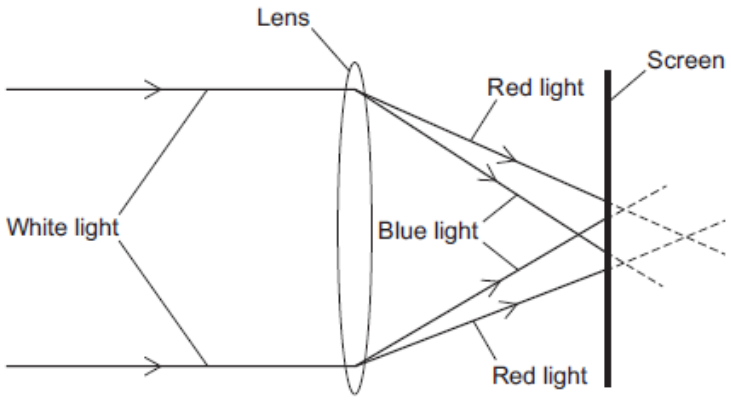
Suggest **one** advantage and **one** disadvantage of each design.

(4)

(c) **Figure 3** shows parallel rays of white light from a distant point being refracted towards a screen by a lens.

The lens is made from a glass with a much greater refractive index than glass normally used for correcting visual defects.

Figure 3



What would you notice about the image on the screen?

State **two** observations.

1. _____

_____

2. _____

_____

(2)

(Total 12 marks)

Q5.

Figure 1 shows an electric wheelchair.

Figure 1

(a) The wheelchair moves at a constant speed of 2.4 m/s for 4.5 seconds.

Calculate the distance moved by the wheelchair.

Use the equation:

distance = speed × time

_____

_____

_____

_____

Distance = _____ m

(2)

(b) What could be a reason for the speed of the wheelchair decreasing?

Tick **one** box.

It started going downhill. ☐

It started going uphill. ☐

Its store of kinetic energy increased. ☐

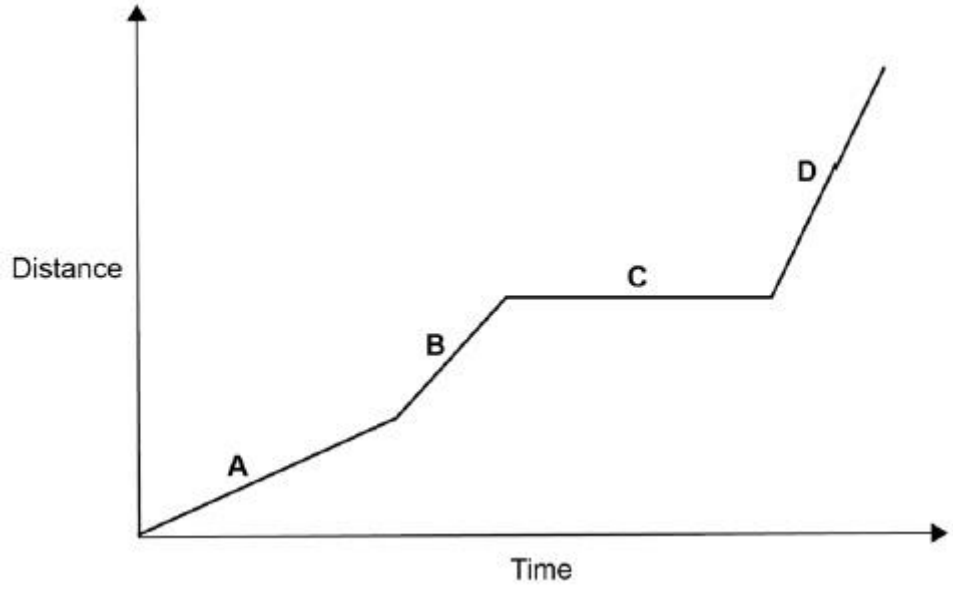
It used more power from its battery. ☐

(1)

A student measured how the distance travelled by the wheelchair changed over time.

Figure 2 shows a sketch-graph of the results.

Figure 2



(c) In which section of the graph, **A**, **B**, **C**, or **D**, did the wheelchair travel fastest?

Give the reason for your answer.

Section _____

Reason _____

_____

(2)

(d) The student used a data logger with a distance sensor to record the data.

Give **two** advantages of using a data logger rather than using a stopclock and tape measure.

1. _____

_____

2. _____

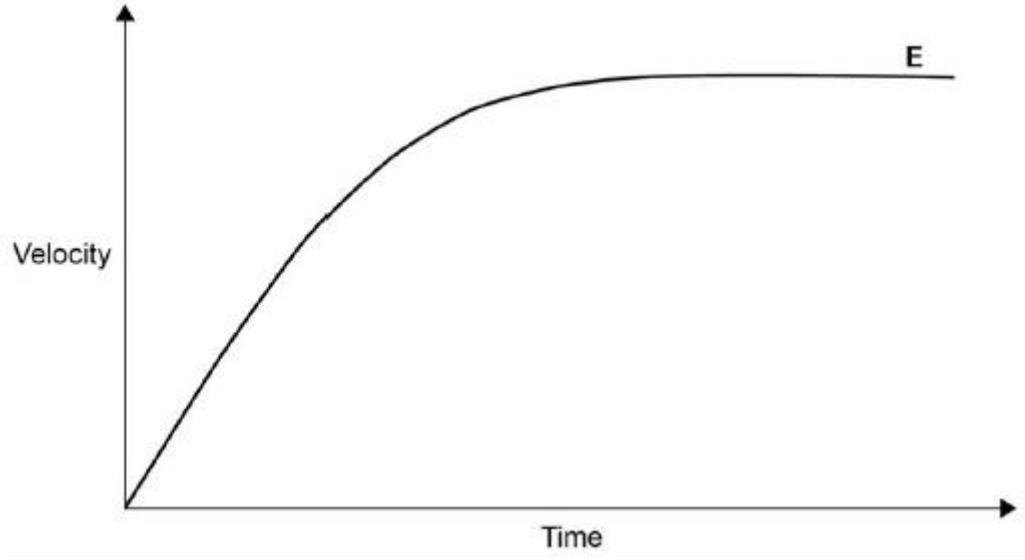
_____

(2)

The velocity of the wheelchair changes as it accelerates to its top speed.

Figure 3 shows a sketch-graph of the changes.

Figure 3



(e) The forward force on the wheelchair is constant as it accelerates on flat ground.

Which force reduces the acceleration?

Tick **one** box.

Air resistance	☐
Magnetism	☐
Tension	☐
Weight	☐

(1)

(f) Explain the acceleration of the wheelchair at point **E** on **Figure 3**.

_____

_____

_____

_____

(2)

(g) The wheelchair starts from rest.

It accelerates at a constant rate until it has a speed of 1.5 m/s

The wheelchair travels a distance of 2.0 m while it is accelerating.

Calculate the acceleration of the wheelchair.

Using the Physics Equations Sheet.

_____

_____

_____

_____

_____

_____

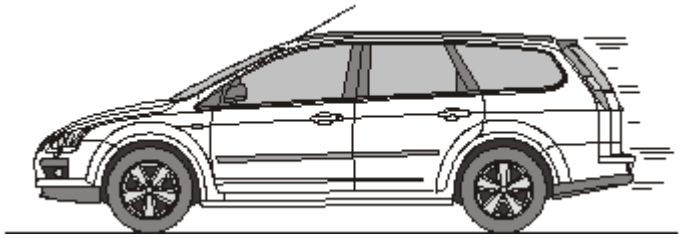
Acceleration = _____ m/s^2

(3)

(Total 13 marks)

Q6.

(a) The diagram shows a car travelling at a speed of 12 m/s along a straight road.



(i) Calculate the momentum of the car.

Mass of the car = 900 kg

Show clearly how you work out your answer.

_____

Momentum = _____ kg m/s

(2)

(ii) Momentum has direction.

Draw an arrow on the diagram to show the direction of the car's momentum.

(1)

(b) The car stops at a set of traffic lights.

How much momentum does the car have when it is stopped at the traffic lights?

_____

Give a reason for your answer.

_____

_____

_____

_____

(2)

(Total 5 marks)

Q7.

(a) Electromagnets are often used at recycling centres to separate some types of metals from other materials.

Give **one** reason why an electromagnet would be used rather than a permanent magnet.

_____

_____

(1)

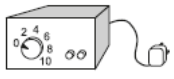
(b) **In this question you will gain marks for using good English, organising information clearly and using scientific words correctly.**

Some students want to build an electromagnet.

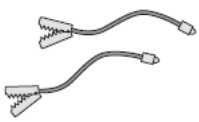
The students have the equipment shown below.

Insulated wire

Iron nail

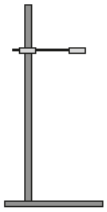


Power supply



Connecting leads

Steel paperclips



Wooden clamp and stand

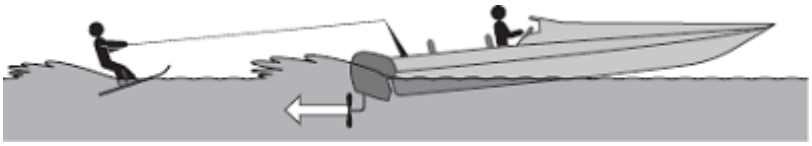
Describe how the students could build an electromagnet. Include in your answer how the students should vary and test the strength of their electromagnet.

(6)

(Total 7 marks)

Q8.

The diagram shows a boat pulling a water skier.



(a) The arrow represents the force on the water produced by the engine propeller. This force causes the boat to move.

Explain why.

_____

_____

_____

_____

(2)

(b) The boat accelerates at a constant rate in a straight line. This causes the velocity of the water skier to increase from 4.0 m/s to 16.0 m/s in 8.0 seconds.

(i) Calculate the acceleration of the water skier and give the unit.

_____

_____

_____

Acceleration = _____

(3)

(ii) The water skier has a mass of 68 kg.

Calculate the resultant force acting on the water skier while accelerating.

_____

_____

_____

Resultant force = _____ N

(2)

(iii) Draw a ring around the correct answer to complete the sentence.

The force from the boat pulling the water skier forwards

will be | less than / the same as / greater than | the answer to part **(b)(ii)**.

Give the reason for your answer.

_____

_____

(2)

(Total 9 marks)

Q9.

(a) The diagram shows the forces acting on a parachutist in free fall.

The parachutist has a mass of 75 kg.

Calculate the weight of the parachutist.

gravitational field strength = 10 N/kg

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

_____

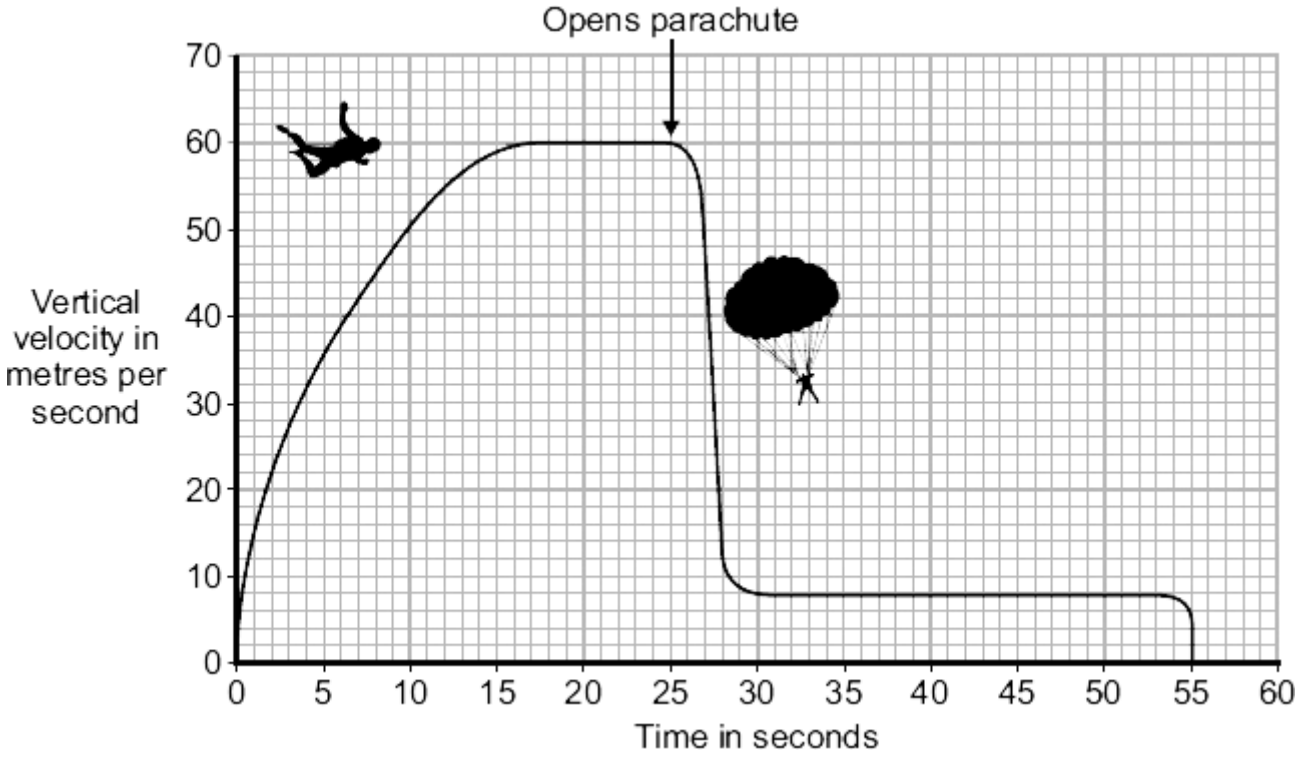
_____

Weight = _____

(3)

(b) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

The graph shows how the vertical velocity of a parachutist changes from the moment the parachutist jumps from the aircraft until landing on the ground.



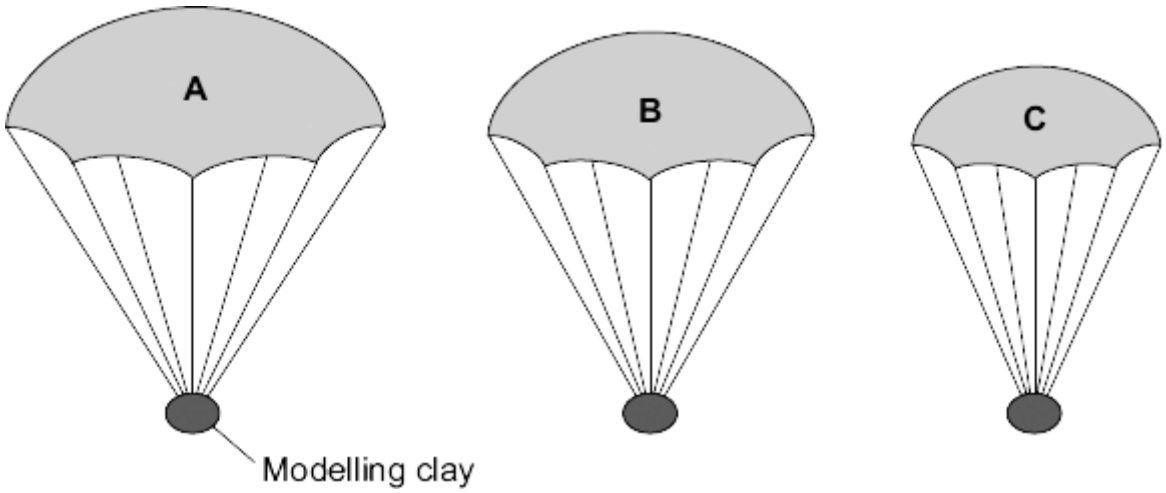
Using the idea of forces, explain why the parachutist reaches a terminal velocity and why opening the parachute reduces the terminal velocity.

(6)

(c) A student wrote the following hypothesis.

'*The larger the area of a parachute, the slower a parachutist falls.*'

To test this hypothesis the student made three model parachutes, **A**, **B** and **C**, from one large plastic bag. The student dropped each parachute from the same height and timed how long each parachute took to fall to the ground.



(i) The height that the student dropped the parachute from was a control variable.

Name **one** other control variable in this experiment.

_____

(1)

(ii) Use the student's hypothesis to predict which parachute, **A**, **B** or **C**, will hit the ground first.

Write your answer in the box. ☐

Give a reason for your answer.

_____

_____

_____

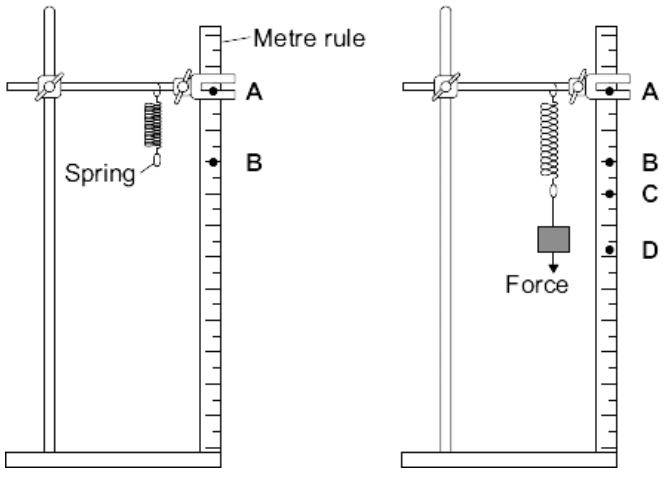
(2)

(Total 12 marks)

Q10.

A student investigated how the extension of a spring depends on the force applied to the spring.

The diagram shows the spring before and after a force had been applied.



(a) (i) Complete the following sentence using letters, **A**, **B**, **C** or **D**, from the diagram.

The extension of the spring is the distance between the positions labelled

_____and _____ on the metre rule.

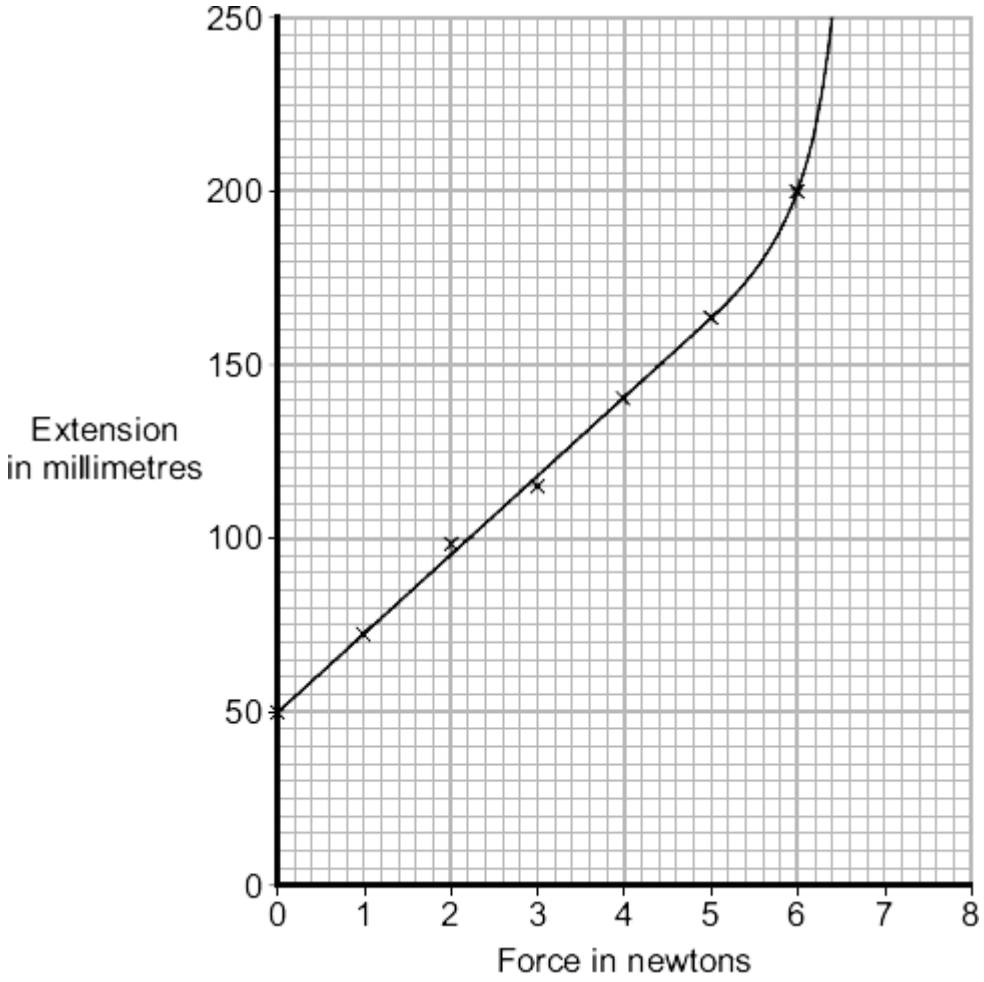
(1)

(ii) What form of energy is stored in the stretched spring?

_____

(1)

(b) The results from the investigation are plotted on the following graph.



(i) The graph shows that the student has made an error throughout the investigation.

What error has the student made?

_____

_____

Give the reason for your answer.

_____

_____

(2)

(ii) The student has loaded the spring beyond its *limit of proportionality*.

Mark on the graph line the *limit of proportionality* of the spring. Label the point **P**.

Give the reason for choosing your point **P**.

_____

_____

_____

(2)

(c) The student uses a different spring as a spring balance. When the student hangs a stone from this spring, its extension is 72 mm.

The spring does not go past the limit of proportionality.

Calculate the force exerted by the stone on the spring.

spring constant = 25 N/m

Show clearly how you work out your answer.

_____

_____

Force = _____ N

(2)

(Total 8 marks)

Q11.

(a) The diagram shows an athlete at the start of a race. The race is along a straight track.

In the first 2 seconds, the athlete accelerates constantly and reaches a speed of 9 m/s.

(i) Calculate the acceleration of the athlete.

Show clearly how you work out your answer.

_____

_____

Acceleration = _____

(2)

(ii) Which **one** of the following is the unit for acceleration?

Draw a ring around your answer.

J/s **m/s** **m/s²** **Nm**

(1)

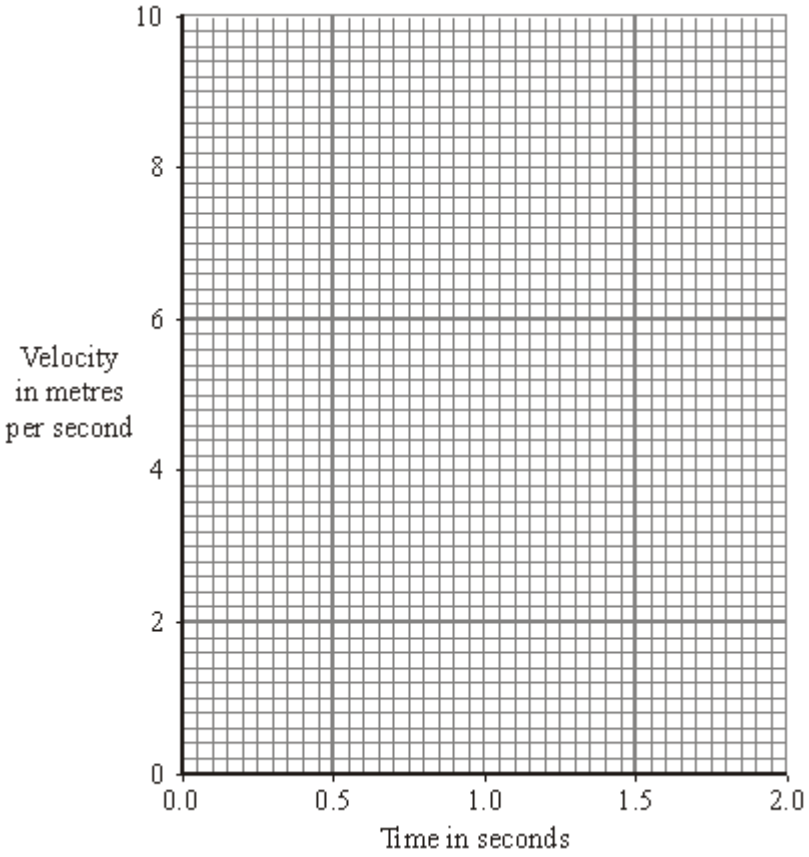
(iii) Complete the following sentence.

The velocity of the athlete is the _____ of

the athlete in a given direction.

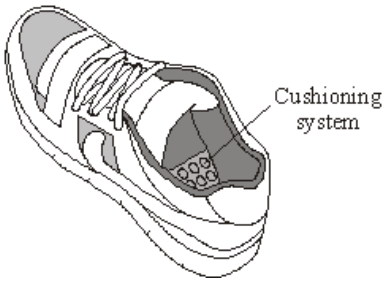
(1)

(iv) Complete the graph to show how the velocity of the athlete changes during the first 2 seconds of the race.

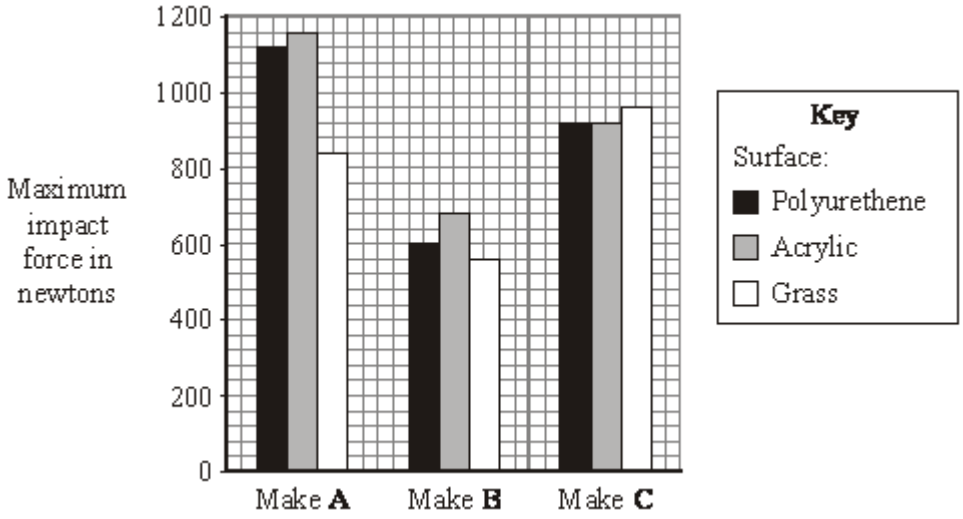


(2)

(b) Many running shoes have a cushioning system. This reduces the impact force on the athlete as the heel of the running shoe hits the ground.



The bar chart shows the maximum impact force for three different makes of running shoe used on three different types of surface.



(i) Which **one** of the three makes of running shoe, **A**, **B** or **C**, has the best cushioning system?

_____

Explain the reason for your answer.

_____

_____

_____

_____

(3)

(ii) The data needed to draw the bar chart was obtained using a robotic athlete fitted with electronic sensors.

Why is this data likely to be more reliable than data obtained using human athletes?

_____

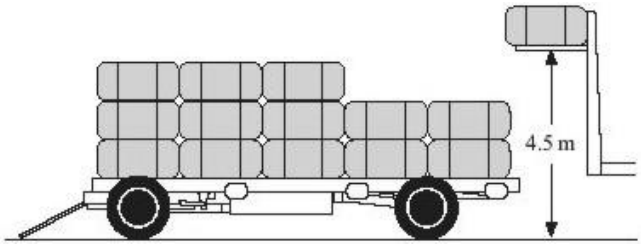
_____

(1)

(Total 10 marks)

Q12.

A forklift truck was used to stack boxes on to a trailer. It lifted a box weighing 1900 N through 4.5 m.



Calculate the work done on the box. Show your working.

_____

_____

_____

_____

Work done = _____ J

(Total 3 marks)

Q1.

(a) A then E

for one mark

1

(b) A > E
A = E
A < E

in this order for 1 mark each

3

(c) when van stops / is stationary / is parked

for one mark

1

(d) WX – slowing down (owtte)
XY – constant speed (owtte)
YZ – speeding up (owtte)

for 1 mark each

3

(e) ….. force …. forwards …. backwards

for 1 mark each

3

[11]

Q2.

(a) (i) compare (the health of) mobile phone users with non-mobile phone users

must be an implied comparison between users and non-users

any idea of doing an experiment negates the mark

1

(ii) increase the sample size

accept use more people
accept have a large sample size
repeat the research / test is neutral

1

(iii) ethical

1

(b) (i) so the phones can be compared (fairly)

a fair test is insufficient
accept different tests (may) give different results

*do **not** accept to make the results reliable, unless qualified eg all variables are controlled*
*do **not** accept bias unless qualified*

1

(ii) yes all are below the legal limit / 2 (W/kg)

or no and any **one** from:

- even absorbing a small amount of energy may be harmful
  accept microwaves for energy
  accept emits energy absorbed by head / other parts of body
- no proof that small amounts of energy are not harmful
  accept because the SAR value is not 0 (W/kg)

1

(c) any **one** from:

- to get an independent opinion
- company scientists may be biased
  accept company scientists may manipulate results

1

[6]

Q3.

(i) X-rays or gamma rays
for 1 mark

1

(ii) passes through flesh;
stopped by bone/absorbed
for 1 mark each

2

[3]

Q4.

(a) B
must be in correct order

1

A

1

D

1

(b) (i) mass increases as refractive index increases
accept weight / density increases as refractive index increases

1

(ii) thinner
accept thin

1

heavier
accept heavy

1

(iii) maximum one advantage and one disadvantage of each design

water-filled
advantages:
- lenses are light
- wide range of focal length
- allows fine adjustment
- allows lenses to be altered independently.

1

disadvantages:
- unattractive
- lens might burst
- lens might leak
- uncomfortable.

1

sliding lenses
advantages:
- hard-wearing
- look like conventional glasses
- easy to adjust
- allows lenses to be altered independently.

1

disadvantages:
- heavy
- might slide out of position
- might get dirt between the lenses.

1

(c) any two from:
the image is
- blurred
- coloured
- inverted
- diminished.

accept not focussed

1
1

[12]

Q5.

(a) distance = 2.4 m/s × 4.5 s

1

distance = 10.8 (m)

*an answer of 10.8 m scores **2** marks*

1

(b) It started going uphill.

1

(c) **D**

1

the line has the largest gradient

allow it is steepest

allow it travels the furthest distance in the shortest amount of time

1

(d) any **two** from:

- the data logger records time more accurately
- the data logger can take readings more frequently
- there is less chance for human error when using a data logger
- the data logger automatically records data

allow the converse of each argument, eg there is a human reaction time error when using a stopclock

2

(e) air resistance

1

(f) acceleration is zero

1

because the resultant force is zero

allow because the forward force equals the air resistance

there is too much air resistance is insufficient

1

(g) $v^2 - u^2 = 2as$

$1.5^2 (- 0^2) = 2 \times a \times 2$

1

$$a = \frac{1.5^2}{2 \times 2}$$

1

$a = 0.56(25)\ m/s^2$

*an answer of 0.56(25) (m/s²) scores **3** marks*

1

[13]

Q6.

(a) (i) 10800

allow 1 mark for correct substitution i.e. 900 × 12

2

(ii) arrow pointing towards the left

allow anywhere on the diagram or at bottom of the page

1

(b) zero

accept 0 / none / nothing

1

velocity is zero

accept speed for velocity

accept stopped / not moving

accept a calculation i.e. 900 × 0 = 0

1

[5]

Q7.

(a) an electromagnet can be switched off

accept a permanent magnet cannot be switched off

or

an electromagnet is stronger

accept control the strength

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should apply a 'best-fit' approach to the marking.

Level 3 (5 – 6 marks):
there is a description of how the electromagnet is made
and
there is a description of how the strength of the electromagnet can be varied
and
there is a description of how the strength of the electromagnet can be tested

Level 2 (3 – 4 marks):
there is a description of how the electromagnet is made
and either
there is a description of how the strength of the electromagnet can be varied
or
there is a description of how the electromagnet can be tested

Level 1 (1 – 2 marks):
there is a basic description of how to make an electromagnet
or
there is a basic description of how the strength of the electromagnet can be varied
or
there is a basic description of how the electromagnet can be tested

Level 0 (0 marks):
No relevant / correct content

examples of the points made in the response

Details of how to make an electromagnet
- wrap the wire around the nail
- connect the wire to the power supply (with connecting leads and croc clips)
- switch on the power supply

accept a current should be sent along the wire

Details of how to vary the strength of the electromagnet
- change the number of turns (on the coil)
- change the current (through the coil)
- change the separation of the turns

allow change the potential difference (across the coil)

accept wrap the coil more tightly

Details of how to test the electromagnet

- suspend paperclips from the electromagnet
- the more paperclips suspended, the stronger the electromagnet is
- clamp the electromagnet at different distances from the paperclip(s)
- the further the distance from which paperclips can be attracted the stronger the electromagnet is
- test before and after making alterations to change the strength
- compare the results from before and after making alterations
- use de-magnetised paper clips

accept count the number of paperclips

*with different current **or** p.d. **or** no. of turns*

***or** core and see if the number changes/increases*

6

[7]

Q8.

(a) (produces) a force from water on the boat

1

in the forward direction

accept in the opposite direction

this must refer to the direction of the force not simply the boat moves forwards

*an answer produces an (equal and) opposite force gains **1** mark*

1

(b) (i) 1.5

*allow **1** mark for correct substitution, ie* $\frac{16-4}{8}$ ***or*** $\frac{12}{8}$

provided no subsequent step shown

ignore sign

2

m/s^2

1

(ii) 102

or

their (b)(i) × 68 correctly calculated

*allow **1** mark for correct substitution, ie 1.5 × 68*

***or** their (b)(i) × 68*

provided no subsequent step shown

2

(iii) greater than

reason only scores if greater than chosen

1

need to overcome resistance forces

accept named resistance force

accept resistance forces act (on the water skier)

*do **not** accept gravity*

1

[9]

Q9.

(a) 750

*allow **1** mark for correct substitution, ie 75 × 10 provided no subsequent step shown*

2

newton(s) / N

*do **not** accept n*

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the Marking Guidance, and apply a 'best-fit' approach to the marking.

0 marks
No relevant content.

Level 1 (1-2 marks)
There is a brief attempt to explain why the velocity / speed of the parachutist changes.
or
the effect of opening the parachute on velocity/speed is given.

Level 2 (3-4 marks)
The change in velocity / speed is clearly explained in terms of force(s)
or
a reasoned argument for the open parachute producing a lower speed.

Level 3 (5-6 marks)
There is a clear and detailed explanation as to why the parachutist reaches terminal velocity
and
a reasoned argument for the open parachute producing a lower speed

examples of the physics points made in the response to explain first terminal velocity

- on leaving the plane the only force acting is weight (downwards)
  accept gravity for weight throughout
- as parachutist falls air resistance acts (upwards)
  accept drag / friction for air resistance
- weight greater than air resistance
  or
  resultant force downwards
- (resultant force downwards) so parachutist accelerates
- as velocity / speed increases so does air resistance
- terminal velocity reached when air resistance = weight
  accept terminal velocity reached when forces are balanced

to explain second lower terminal velocity

- opening parachute increases surface area
- opening parachute increases air resistance
- air resistance is greater than weight
- resultant force acts upwards / opposite direction to motion
- parachutist decelerates / slows down
- the lower velocity means a reduced air resistance

air resistance and weight become equal but at a lower (terminal) velocity

6

(c) (i) any **one** from:

- mass of the (modelling) clay
  accept size/shape of clay size/amount/volume/shape of clay
  accept plasticine for (modelling)clay
- material parachute made from
  accept same (plastic) bag
- number / length of strings

1

(ii) **C**

*reason only scores if **C** is chosen*

1

smallest (area) so falls fastest (so taking least time)

accept quickest/quicker for fastest

*if **A** is chosen with the reason given as 'the largest area so falls slowest' this gains **1** mark*

1

[12]

Q10.

(a) (i) **B C**

either order

1

(ii) elastic <u>potential</u> (energy)

accept strain for elastic

1

(b) (i) *mark both parts together*

1

measured / recorded the length of the spring (and not extension)

*accept measured **A–C** (and not **B–C**)*

accept did not work out/measure the extension

extension does not equal zero when force = 0

accept line should pass through the origin

1

(ii) point marked at 5.5 (N)

accept any point between 5.0 and 5.6 inclusive

1

up to that point force and extension are (directly) proportional

accept it's at the end of the straight part (of the graph line)

accept past that point force and extension are no longer (directly) proportional

accept the line starts to curve

1

(c) 1.8

*allow **1** mark for correct substitution, ie 25 x 0.072 provided no subsequent step shown*

*an answer 1800 gains **1** mark*

*an incorrect conversion from mm to m with a subsequent correct calculation gains **1** mark*

2

[8]

Q11.

(a) (i) 4.5

*allow **1** mark for correct substitution i.e. 9 ÷ 2*

2

(ii) m/s^2

accept answer given in (a)(i) if not contradicted here

1

(iii) speed

1

(iv) straight line from the origin passing through (2s, 9m/s)

*allow **1** mark for straight line from the origin passing through to t = 2 seconds*

*allow **1** mark for an attempt to draw a straight line from the origin passing through (2,9)*

*allow **1** mark for a minimum of 3 points plotted with no line provided if joined up would give correct answer. Points must include(0,0) and (2,9)*

2

(b) (i) **B**

*if **A** or **C** given scores **0** marks in total*

1

smallest (impact) force

1

on all/ every/ any surfaces

these marks are awarded for comparative answers

1

(ii) (conditions) can be repeated

or

difficult to measure forces with human athletes

accept answers in terms of variations in human athletes e.g.

athletes may have different weights area / size of feet may be different difficult to measure forces athletes run at different speeds

accept any answer that states or implies that with humans the conditions needed to repeat tests may not be constant

e.g.
athletes unable to maintain constant speed during tests (or during repeat tests)

*do **not** accept the robots are more accurate*

removes human error is insufficient

fair test is insufficient

1

[10]

Q12.

8550

correct answer with no working = 3
if incorrect, allow 1 mark for work = force / weight × distance, 2 marks for = 1900 × 4.5

N.B. correct answer from the incorrectly recalled relationship mass × distance = 2 marks

[3]