Exampro GCSE Physics

P2 Foundation - Calculating Energy and Momentum Self Study Questions

Name:

Class:

Author:

Date:

Time: 95

Marks: 95

Comments:

Q1. A paintball gun is used to fire a small ball of paint, called a paintball, at a target.

The figure below shows someone just about to fire a paintball gun.

The paintball is inside the gun.

(a) What is the momentum of the paintball before the gun is fired?

....

Give a reason for your answer.

....

....

(2)

(b) The gun fires the paintball forwards at a velocity of 90 m / s.

The paintball has a mass of 0.0030 kg.

Calculate the momentum of the paintball just after the gun is fired.

Use the correct equation from the Physics Equations Sheet.

....

....

....

Momentum = ... kg m / s

(2)

(c) The momentum of the gun and paintball is conserved.

Use the correct answer from the box to complete the sentence.

equal to	**greater than**	**less than**

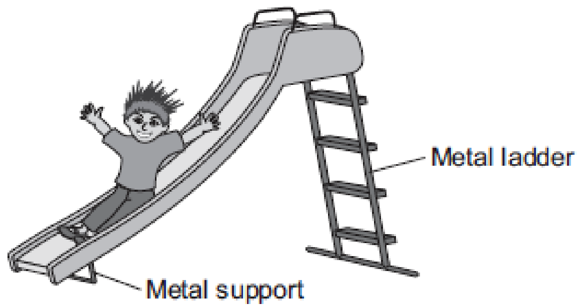
The total momentum of the gun and paintball just after the gun is fired

will be .... the total momentum of the gun and paintball

before the gun is fired.

(1)
(Total 5 marks)

Q2. The figure below shows a slide in a children's playground.



(a) A child of mass 18 kilograms goes down the slide.

The vertical distance from the top to the bottom of the slide is 2.5 metres.

Calculate the decrease in gravitational potential energy of the child sliding from the top to the bottom of the slide.

Gravitational field strength = 10 N / kg

Use the correct equation from the Physics Equations Sheet.

....

....

....

Decrease in gravitational potential energy = ... J

(2)

(b) The slide is made of plastic.

(i) The child becomes electrically charged when he goes down the slide.

Explain why.

....

....

....

....

(2)

(ii) Going down the slide causes the child's hair to stand on end.

What conclusion about the electrical charge on the child's hair can be made from this observation?

....

....

Give a reason for your answer.

....

....

(2)

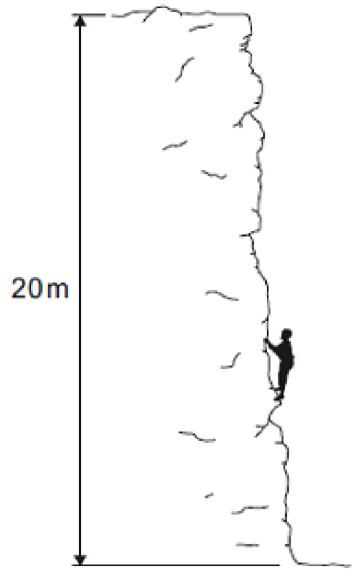
(iii) Why would the child **not** become electrically charged if the slide was made from metal?

....

....

(1)
(Total 7 marks)

Q3. The diagram shows a climber part way up a cliff.



(a) Complete the sentence.

When the climber moves up the cliff, the climber

gains gravitational .... energy.

(1)

(b) The climber weighs 660 N.

(i) Calculate the work the climber must do against gravity, to climb to the top of the cliff.

Use the correct equation from the Physics Equations Sheet.

....

....

Work done = ... J

(2)

(ii) It takes the climber 800 seconds to climb to the top of the cliff.
During this time the energy transferred to the climber equals the work done by the climber.

Calculate the power of the climber during the climb.

Use the correct equation from the Physics Equations Sheet.

....

....

Power = ... W

(2)
(Total 5 marks)

Q4. A car has an oil leak. Every 5 seconds an oil drop falls from the bottom of the car onto the road.

(a) What force causes the oil drop to fall towards the road?

....

(1)

(b) The diagram shows the spacing of the oil drops left on the road during part of a journey

Describe the motion of the car as it moves from **A** to **B**.

....

Explain the reason for your answer.

....

....

....

....

(3)

(c) When the brakes are applied, a braking force slows down and stops the car.

(i) The size of the braking force affects the braking distance of the car.

State **one** other factor that affects the braking distance of the car.

....

(1)

(ii) A braking force of 3 kN is used to slow down and stop the car in a distance of 25 m.

Calculate the work done by the brakes to stop the car and give the unit.

Use the correct equation from the Physics Equations Sheet.

....

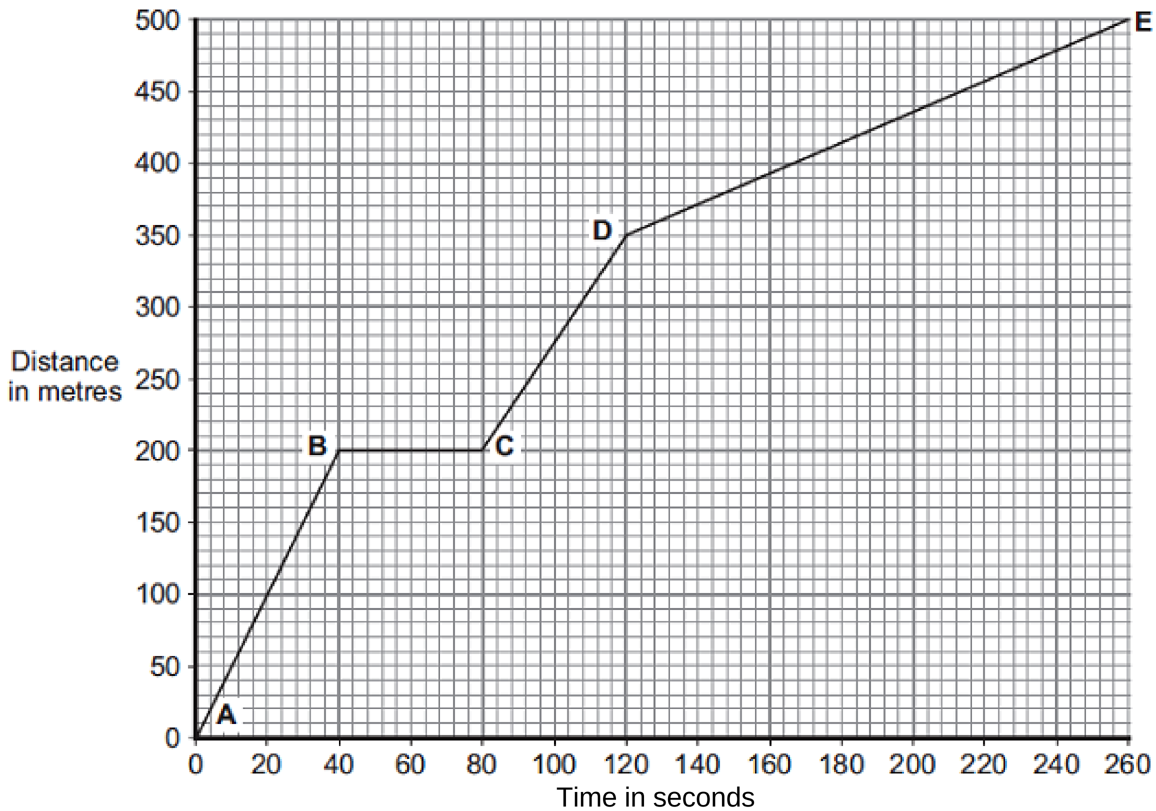
....

....

Work done = ...

(3)
(Total 8 marks)

Q5. Part of a bus route is along a high street.
The distance-time graph shows how far the bus travelled along the high street and how long it took.



(a) Between which two points was the bus travelling the slowest?

Put a tick (✓) in the box next to your answer.

Points	Tick (✓)
A – B	
C – D	
D – E	

Give a reason for your answer.

....

....

(2)

(b) The bus travels at 5 m/s between points **A** and **B**.
The bus and passengers have a total mass of 16 000 kg.

Use the equation in the box to calculate the momentum of the bus and passengers between points **A** and **B**.

momentum = mass x velocity

Show clearly how you work out your answer.

....

....

Momentum = ... kg m/s

(2)

(c) A cyclist made the same journey along the high street.
The cyclist started at the same time as the bus and completed the journey in 220 seconds. The cyclist travelled the whole distance at a constant speed.

(i) Draw a line on the graph to show the cyclist’s journey.

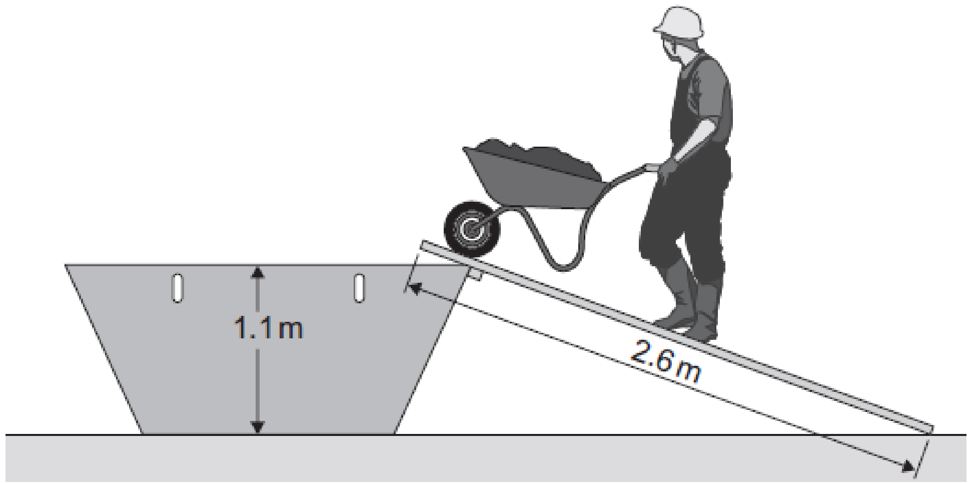
(2)

(ii) After how many seconds did the cyclist overtake the bus?

The cyclist overtook the bus after .... seconds.

(1)
(Total 7 marks)

Q6. (a) The diagram shows a builder using a plank to help load rubble into a skip.



The builder uses a force of 220 N to push the wheelbarrow up the plank.

Use information from the diagram and the equation in the box to calculate the work done to push the wheelbarrow up the plank to the skip.

work done = force applied × distance moved in the direction of force

Show clearly how you work out your answer.

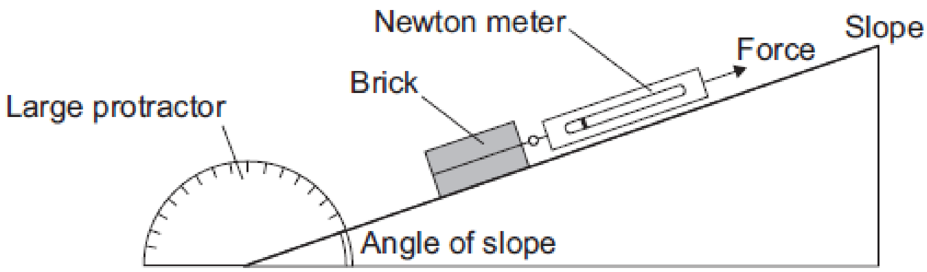
....

....

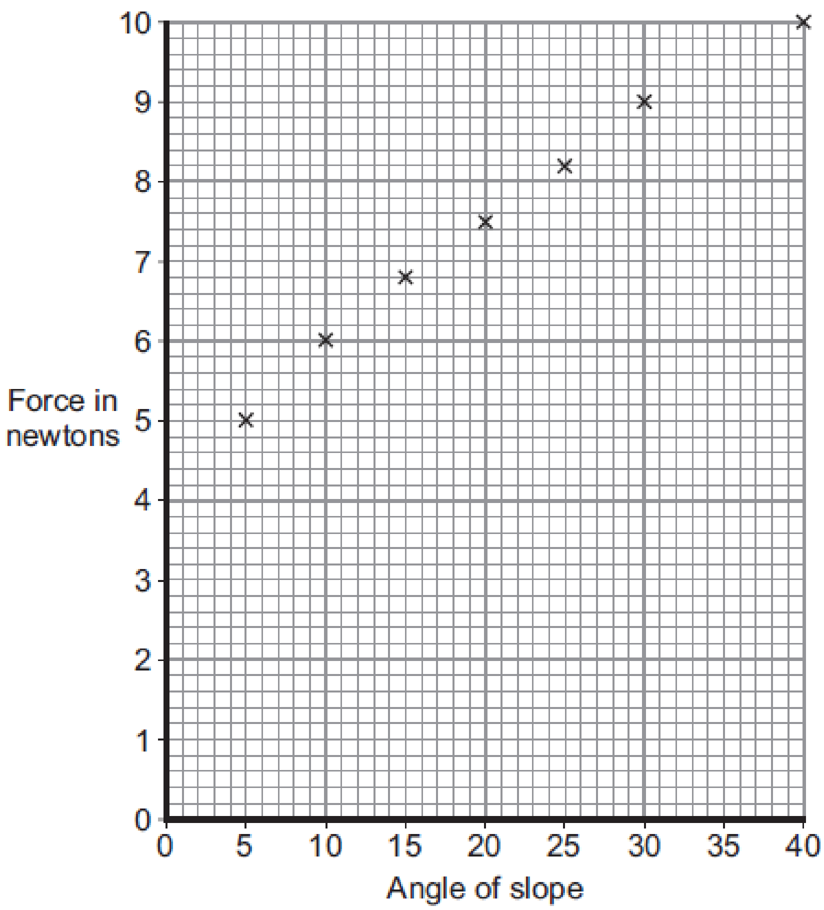
Work done = ... J

(2)

(b) A student investigated how the force needed to pull a brick up a slope, at a steady speed, depends on the angle of the slope.
The apparatus used by the student is shown in the diagram.



The student used the results from the investigation to plot the points for a graph of force used against the angle of the slope.



(i) Draw a line of best fit for these points.

(1)

(ii) How does the force used to pull the brick up the slope change as the angle of the slope increases?

....

....

(1)

(iii) Consider the results from this experiment.
Should the student recommend that the builder use a long plank or a short plank to help load the skip?

Draw a ring around your answer.

long plank **short plank**

Explain the reason for your answer.

....

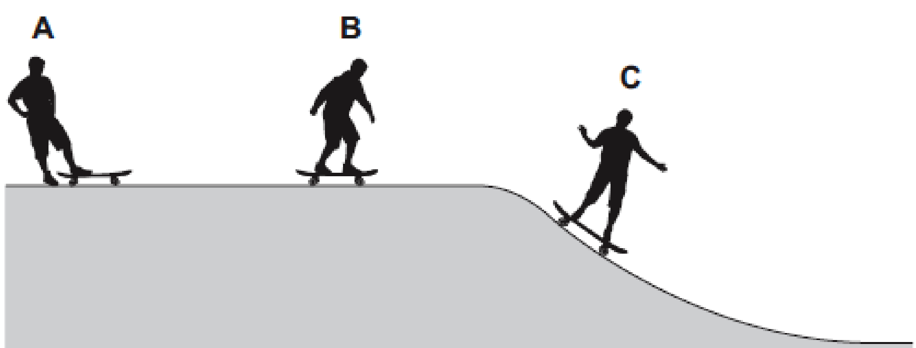
....

....

....

(2)
(Total 6 marks)

Q7. The picture shows three skateboarders, **A**, **B** and **C**.



Skateboarder **A** is not moving.
Skateboarder **B** is moving towards the ramp at a constant speed.
Skateboarder **C** is moving on the ramp at a constant speed.

(a) The skateboarders have different amounts of kinetic energy.

Which **two** factors affect the kinetic energy of the skateboarders?

Put a tick (✓) in the box next to your answer.

direction and mass	☐
mass and speed	☐
speed and direction	☐

(1)

(b) The skateboarders also have different amounts of momentum.

(i) Which **one** of the skateboarders has the smallest amount of momentum?

Draw a ring around your answer.

A **B** **C**

Give a reason for your answer.

....

....

(2)

(ii) Skateboarder **B** has a mass of 55 kg.

Use the equation in the box to calculate the momentum of skateboarder **B** when moving at 4 m/s.

momentum = mass × velocity

Show clearly how you work out your answer.

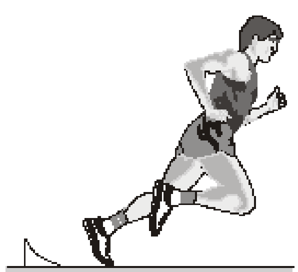
....

....

Momentum = ... kg m/s

(2)
(Total 5 marks)

Q8. (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) Use the equation in the box to calculate the acceleration of the athlete.

$$\text{accelleration} = \frac{\text{change in velocity}}{\text{time taken for change}}$$

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/s^2** **Nm**

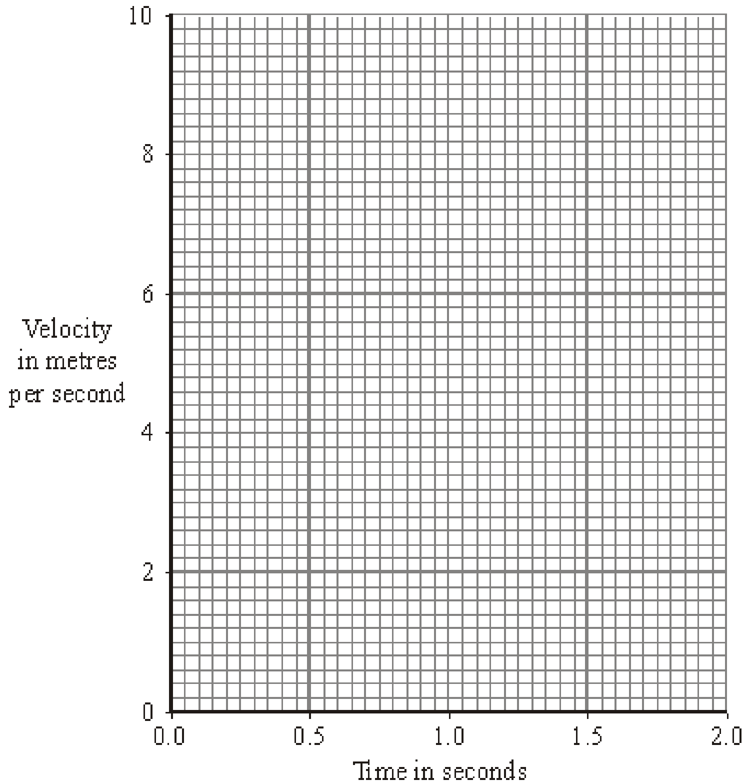
(1)

(iii) Complete the following sentence.

The velocity of the athlete is the .... of the athlete in a given direction.

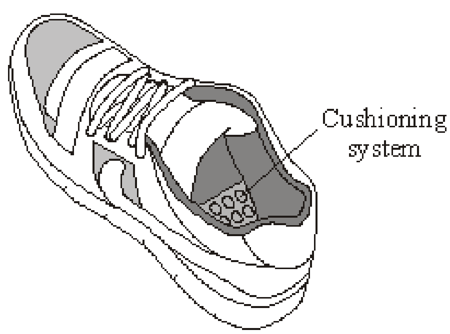
(1)

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

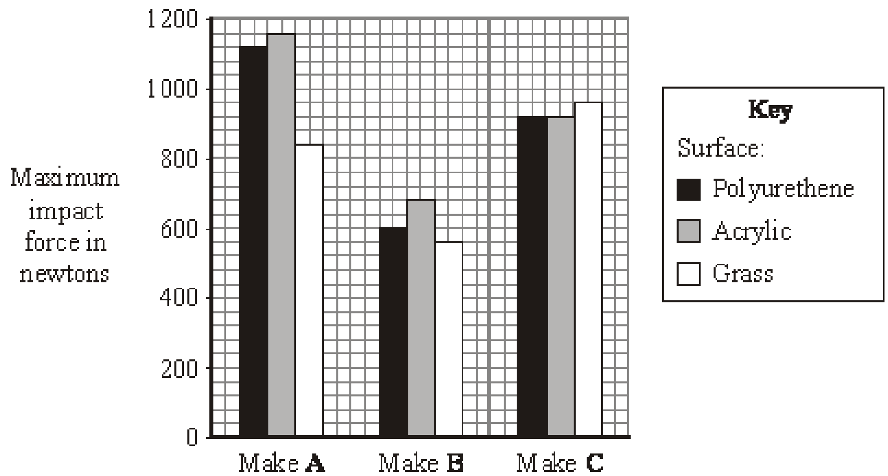


(2)

(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.

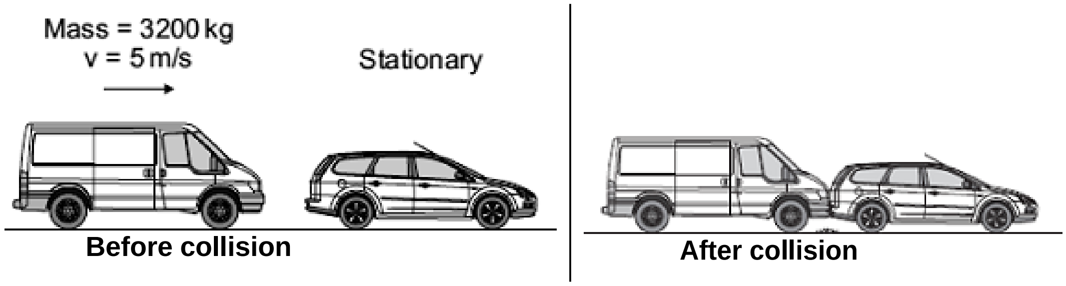
Why is this data likely to be more reliable than data obtained using human athletes?

....

....

(1)
(Total 10 marks)

Q9. (a) A van has a mass of 3200 kg. The diagram shows the van just before and just after it collides with the back of a car.



Just before the collision, the van was moving at 5 m/s and the car was stationary.

(i) Use the equation in the box to calculate the momentum of the van just before the collision.

momentum = mass × velocity

Show clearly how you work out your answer.

....

....

Momentum = ... kg m/s

(2)

(ii) The collision makes the van and car join together.

What is the total momentum of the van and the car just after the collision?

Momentum = ... kg m/s

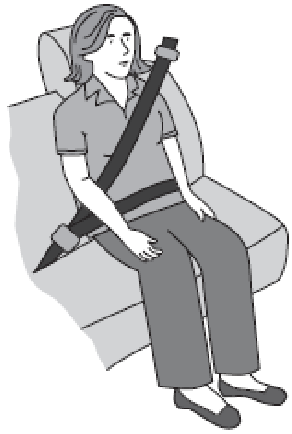
(1)

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

The momentum of the car before the collision is [more than / the same as / less than] the momentum of the car after the collision.

(1)

(b) A seat belt is one of the safety features of a car.



In a collision, wearing a seat belt reduces the risk of injury.

Use words or phrases from the box to complete the following sentences.

decreases	stays the same	increases

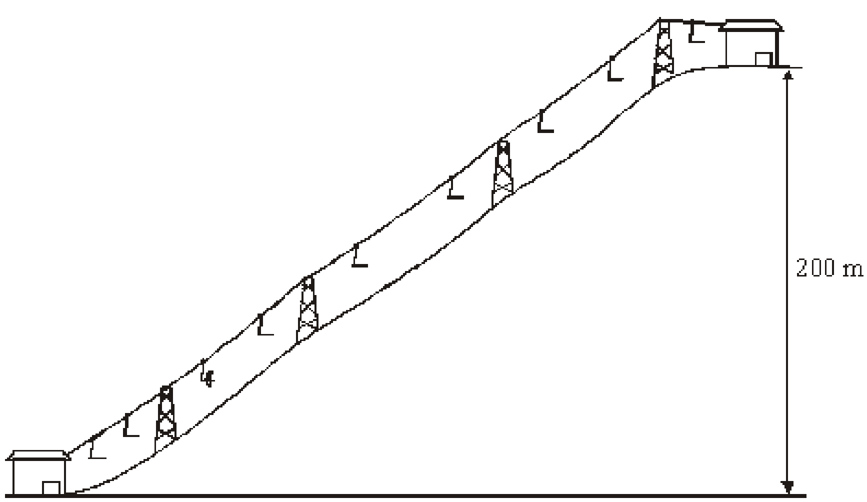
In a collision, the seat belt stretches. The time it takes for the person held by the seat belt to lose momentum compared to a person not wearing a seat belt,

....

The force on the person's body .... and so reduces the risk of injury.

(2)
(Total 6 marks)

Q10. (a) A chair lift carries two skiers, Greg and Jill, to the top of a ski slope. Greg weighs 700 N and Jill weighs 500 N.



(i) Write down the equation that links distance moved, force applied and work done.

....

(1)

(ii) Calculate the work done to lift Greg and Jill through a vertical height of 200 m. Show clearly how you work out your answer and give the unit.

....

....

....

work done = ...

(3)

(b) The chair takes 5 minutes to move from the bottom to the top of the ski slope.

Use the following equation to calculate the power required to lift Greg and Jill to the top of the ski slope. Show clearly how you work out your answer.

$$\text{power} = \frac{\text{work done}}{\text{time taken}}$$

....

....

power = ... watts

(2)

(c) The chair lift is driven by an electric motor.

(i) Why would the power output of the electric motor need to be larger than your answer to part (b)?

....

....

(1)

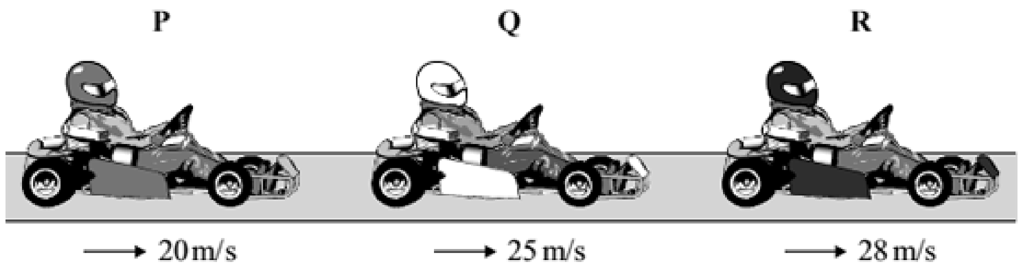
(ii) Complete the following sentence.

When the ski lift is working .... energy supplied to the motor

is usefully transferred as gravitational .... energy.

(1)
(Total 8 marks)

Q11. (a) The diagram shows three identical go-karts, **P**, **Q** and **R**, travelling at different speeds along the straight part of an outdoor racetrack.



Which **go-kart**, **P**, **Q** or **R**, has the greatest momentum?

....

Give the reason for your answer.

....

....

(2)

(b) The total mass of go-kart **Q** and the driver is 130 kg.

(i) Use the equation in the box to calculate the total momentum of go-kart **Q** and the driver.

momentum = mass × velocity

Show clearly how you work out your answer.

....

....

Momentum = ...

(2)

(ii) Which of the following is the unit of momentum?

Draw a ring around your answer.

J/s	**kg m/s**	**Nm**

(1)

(c) To race safely at high speed, a go-kart driver must have fast reaction times and the outdoor racetrack should be dry.

(i) How would being tired affect a driver's reaction time?

....

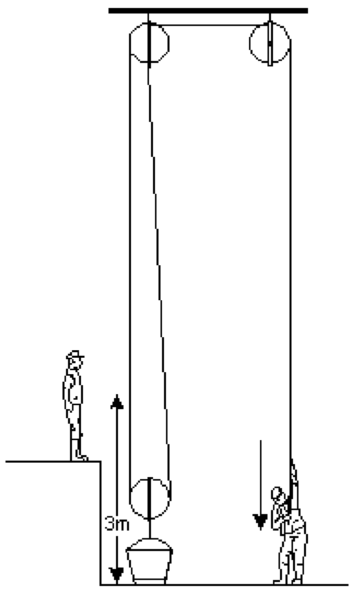
(1)

(ii) How would a wet track affect the braking distance of a go-kart?

....

(1)
(Total 7 marks)

Q12. The diagram below shows one way of lifting a bucket of bricks.



(a) When the free end of the rope is pulled down, the load is lifted.

Complete the following sentence.

The work done in pulling the rope down is used to increase the ....

energy of the .... and bricks.

(2)

(b) The weight of the bricks is 100 N and they are lifted 3 m.

Calculate the work done on the bricks.

....

....

Answer .... J

(2)
(Total 4 marks)

Q13. The diagram shows a supermarket worker stacking jars of coffee onto a shelf.

(a) The mass of each jar of coffee is 0.4 kg.

Calculate the weight of each jar of coffee.

gravitational field strength = 10 N/kg

Write down the equation you use, and then show clearly how you work out your answer.

....

....

....

....

Weight = ... N

(2)

(b) The distance between the floor and the middle shelf is 1.2 m.

Calculate the work done to lift one jar of coffee from the floor onto the shelf.

Write down the equation you use, and then show clearly how you work out your answer and give the unit.

....

....

....

....

....

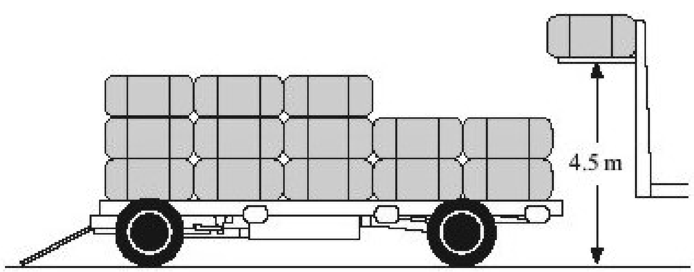
....

Work done = ...

(3)
(Total 5 marks)

Q14. 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)

Q15. (a) The weightlifter in the picture has lifted a weight of 2250 newtons above his head. The weight is held still.

(i) In the box are the names of three forms of energy.

gravitational potential	kinetic	sound

Which **one** of these forms of energy does the weight have?

....

(1)

(ii) What force is used by the weightlifter to hold the weight still?

Size of force = ... N

Give a reason for your answer ....

....

....

(2)

(b) To lift the weight, the weightlifter does 4500 joules of work in 3.0 seconds.

Use the following equation to calculate the power developed by the weightlifter. Show clearly how you work out your answer.

$$\text{power} = \frac{\text{work done}}{\text{time taken}}$$

....

....

Power = ... watts

(2)
(Total 5 marks)

Q16. A cyclist accelerates from a set of traffic lights.

The driving force of the back tyre on the ground is 250 N.

(a) How much work is done by this force when the cyclist travels 5 metres?
(Show your working.)

....

....

....

Answer .... joules (J)

(2)

(b) What happens to the energy transferred by this force?

....

....

....

(2)
(Total 4 marks)

M1. (a) Zero / 0

Accept none

Nothing is insufficent

1

velocity / speed = 0

accept it is not moving

paintball has not been fired is insufficient

1

(b) 0.27

*allow **1** mark for correct substitution, ie p = 0.003(0) × 90 provided no subsequent step*

2

(c) equal to

1

[5]

M2. (a) 450

*allow **1** mark for correct substitution,*

ie 18 × 10 × 2.5 provided no subsequent step shown

2

(b) (i) friction between child (‘s clothing) and slide

accept friction between two insulators

accept child rubs against the slide

accept when two insulators rub (together)

1

causes electron / charge transfer (between child and slide)

accept specific reference, eg electrons move onto / off the child / slide

reference to positive electrons / protons / positive charge / atoms transfer negates this mark

answers in terms of the slide being initially charged score zero

1

(ii) all the charges (on the hair) are the same (polarity)

accept (all) the charge/hair is negative / positive

accept it is positive/negative

1

charges / hairs are repelling

both parts should be marked together

1

(iii) charge would pass through the metal (to earth)

accept metal is a conductor

accept metal is not an insulator

accept there is no charge / electron transfer

accept the slide is earthed

accept metals contain free electrons

1

[7]

M3. (a) potential

1

(b) (i) 13 200

*allow **1** mark for correct substitution, ie 660 × 20 provided no subsequent step shown*

2

(ii) 16.5

allow 1 mark for correct

or

$\frac{\text{their (b)(i)}}{800}$ correctly calculated

substitution, ie $\frac{13\,200}{800}$ ***or*** $\frac{\text{their (b)(i)}}{800}$

provided no subsequent step shown

2

[5]

M4. (a) gravitational / gravity / weight

*do **not** accept gravitational potential*

1

(b) accelerating

accept speed / velocity increases

1

the distance between the drops increases

1

but the time between the drops is the same

accept the time between drops is (always) 5 seconds
accept the drops fall at the same rate

1

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

- speed / velocity
- (condition of) brakes / road surface / tyres
- weather (conditions)

accept specific examples, eg wet / icy roads

accept mass / weight of car friction is insufficient

reference to any factor affecting thinking distance negates this answer

1

(ii) 75 000

*allow **1** mark for correct substitution, ie 3000 × 25 provided no subsequent step shown*

***or** allow **1** mark for an answer 75*
***or** allow **2** marks for*
75 k(+ incorrect unit), eg 75 kN

2

joules / J

*do **not** accept j*

*an answer 75 kJ gains **3** marks*

for full marks the unit and numerical answer must be consistent

1

[8]

M5. (a) **D** – **E**

reason only scores if D – E chosen

1

shallowest slope / gradient

accept smallest distance in biggest time
accept longest time to travel the same distance
accept the line is not <u>as</u> steep
accept it is a less steep line
*do **not** accept the line is not steep*

1

(b) 80 000

*allow **1** mark for correct substitution, ie 16 000 × 5 provided no subsequent step shown*

2

(c) (i) <u>straight</u> line starting at origin

accept within one small square of the origin

1

passing through t = 220 and d = 500

1

(i) 186

accept any value between 180 and 188
accept where their line intersects given graph line correctly read ±4 s

1

[7]

M6. (a) 572

*allow **1** mark for correct substitution,*

ie 220 × 2.6

*allow **1** mark for*

220 × 260 = 57 200

or

220 × 2600 = 572 000

but to score this mark the entire calculation must be shown

2

(b) (i) smooth curve drawn

accept a line that is extrapolated back to 0 degrees, but not through the origin

accept a straight line of best fit (point at 40 degrees can be treated as anomalous and line may stop at 30 degrees)

*do **not** accept straight lines drawn 'dot to dot' or directly from first to last point or a line going through the origin*

1

(ii) increases

accept a positive correlation

*do **not** accept proportional*

1

(iii) long plank

no mark for this, the marks are for the explanation

makes the angle small(er) (than a short plank)

accept increases the distance

accept small(er) slope

1

a small(er) force is needed
or
short plank

no mark for this, the marks are for the explanation

a large(r) force is used over a short(er) distance (1)

less work done (1)

accept less energy transfer

1

[6]

M7. (a) mass and speed

1

(b) (i) **A**

reason cannot score if B or C chosen

1

velocity = 0 (m/s)

accept speed for velocity

accept not moving

accept lowest velocity / speed

1

(ii) 220

*allow **1** mark for correct substitution,*
ie 55 × 4 provided no subsequent step shown

2

[5]

M8. (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) <u>straight</u> line from the <u>origin</u> passing through (2s, 9m/s)

*allow **1** mark for <u>straight</u> 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

small<u>est</u> (impact) force

1

on <u>all/ every/ any</u> 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]

M9. (a) (i) 16 000

*allow **1** mark for correct substitution ie 3200 × 5*

2

(ii) 16 000 or their (a)(i)

1

(iii) less than

1

(b) increases

1

decreases

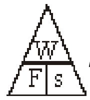
correct order only

1

[6]

M10. (a) (i) work (done) = force (applied) × distance (moved)

accept W = F × s or W = F × d

accept 

provided subsequent method is correct

1

(ii) 240 000

*allow **1** mark for correct substitution **or** correct use of 1200 (N)*

2

joules

accept J

*do **not** accept j / Nm*

1

(b) 800 (watts)

accept 0.8 kW

*accept their (a)(ii) ÷ 300 correctly evaluated for **2** marks*

*allow **1** mark for correct substitution*

*(a)(ii) ÷ 5 correctly evaluated for **1** mark*

2

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

- needs to raise the chair / lift
- lifting more than one chair

  allow lifting more than 2 people

  implication of a heavier weight
- energy transfer to the surroundings correctly qualified

  accept loss for transfer

  *do **not** accept motor inefficient*

  *do **not** accept motor gets hot*

  *do **not** accept friction unless the location is specified as external to the motor*

1

(ii) electrical

accept electric

potential

***both** answers required for the mark*

1

[8]

M11. (a) **R**

*reason cannot score if **R** is not chosen*

1

has the great<u>est</u> speed / velocity

accept it is going at 28 m/s

answer should be comparative

1

(b) (i) 3250

*allow **1** mark for correct substitution of 130 and 25*

ie 130 × 25

*accept 2600 or 3640 for **1** mark*

2

(ii) kg m/s

accept answer given in (b)(i) if no answer given here

1

(c) (i) increase it

accept make it slower

accept slow it down

accept make it longer

accept (reactions) would be slower

*do **not** accept if the answer clearly refers to distance*

comparative answers expected

1

(ii) increase it

accept make it longer

*do **not** accept if the answer clearly refers to time*

comparative answers expected

1

[7]

M12. (a) potential; bucket/pulley

for 1 mark each

2

(b) 300

gains 2 marks

else working

gains 1 mark

2

[4]

M13. (a) 4 (N)

*allow **1** mark for correct substitution into correct equation*
ie 0.4 × 10

2

(b) 4.8

*their (a) × 1.2 correctly calculated gains **2** marks*

*allow **1** mark for substitution into correct equation*
ie 4 × 1.2 or their (a)(i) × 1.2

2

joule or J

1

[5]

M14. 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]

M15. (a) (i) gravitational potential

accept gravitational

accept potential

1

(ii) 2250 (N)

1

forces must be balanced
or
forces are equal and opposite

*do **not** accept because it is not moving*
*do **not** accept 'equilibrium' by itself*
*do **not** accept 'it is not balanced'*
*do **not** accept 'forces are equal'*
*do **not** accept 'forces are the same'*

1

(b) 1500

***1** mark for correct substitution*

2

[5]

M16. (a) [NB e.c.f not allowed from incorrect formula]

work done = force × distance or 250 × 5

gains 1 mark

but

1250

gains 2 marks

2

(b)

- (mainly) transferred as kinetic / movement energy
  [not makes bike move]

- (some) lost / wasted / transferred as heat / sound
  or
  used to overcome friction / air resistance

each • for 1 mark

2

[4]