

AQA GCSE PHYSICS (HIGHER) • 8463

PHYSICS



EXAM QUESTION PACK

4.5.1.3 GRAVITY (PACK 1)

SCORE

/78

PERCENTAGE

%

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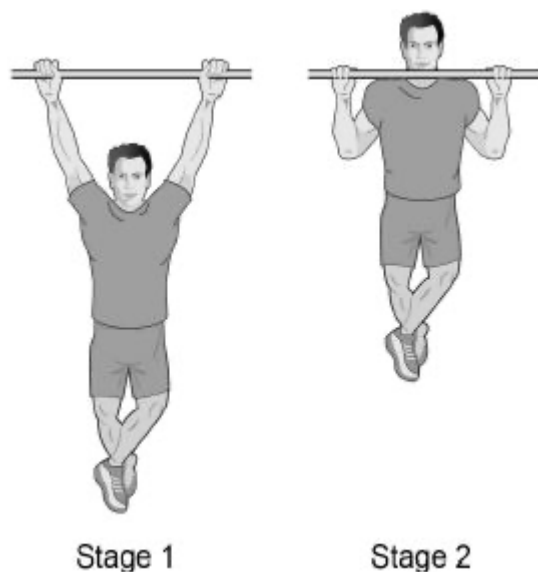
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Q1.

The diagram below shows a man doing two stages of a pull up. In both diagrams the man is stationary.



- (a) Complete the sentence.

Choose the answers from the box.

equal to	less than	more than
----------	-----------	-----------

In stage 1 the downwards force of the man on the bar is _____
the upwards force of the bar on the man.

(1)

- (b) The man has a mass of 85 kg

Gravitational field strength = 9.8 N/kg

Calculate the weight of the man.

Use the equation:

$$\text{weight} = \text{mass} \times \text{gravitational field strength}$$

Weight = _____ N

(2)

- (c) The man raises his body a vertical distance of 0.63 m to go from stage 1 to stage 2

Calculate the work done by the man.

Use your answer to part (b)

Use the equation:

$$\text{work done} = \text{force} \times \text{distance}$$

$$\text{Work done} = \underline{\hspace{2cm}} \text{ J}$$

(2)

- (d) The man was **not** moving at stage 2

How much work is done by the man at stage 2?

$$\text{Work done} = \underline{\hspace{2cm}} \text{ J}$$

(1)

- (e) A woman uses the bar to do a pull up.

The woman has a mass of 62 kg

She accelerates at 11 m/s^2

Calculate the resultant force on the woman.

Use the equation:

$$\text{force} = \text{mass} \times \text{acceleration}$$

$$\text{Force} = \underline{\hspace{2cm}} \text{ N}$$

(2)

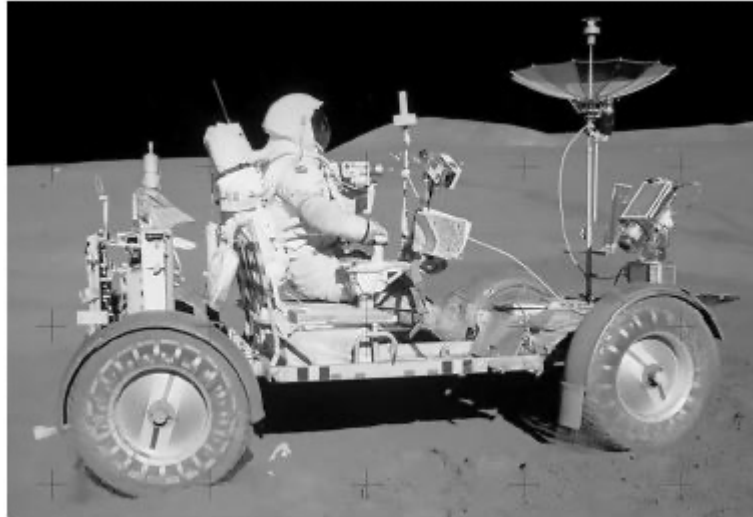
(Total 8 marks)

Q2.

Astronauts have been to the Moon.

- (a) Astronauts moved around the surface of the Moon in a lunar rover.

The photograph below shows a lunar rover.



The batteries on the lunar rover provided a potential difference of 36 V

The total charge stored in the batteries was 870 000 C

Calculate the maximum energy that could have been transferred from the batteries.

Use the equation:

$$\text{energy transferred} = \text{charge flow} \times \text{potential difference}$$

Maximum energy transferred = _____ J

(2)

- (b) Not all of the energy from the batteries was usefully transferred to the kinetic energy of the lunar rover.

Explain why.

(2)

The astronauts collected rock samples from the Moon.

Scientists analysed the percentages of elements in Moon rock and Earth rock.

The table below shows the results.

Element	Percentage in Moon rock	Percentage in Earth rock
Aluminium	8	8
Iron	13	5
Oxygen	42	47
Silicon	X	28
Other elements	10	12

- (c) Calculate value **X** in the table above.

X = _____ %

(1)

- (d) Give **one** similarity and **one** difference between Moon rock and Earth rock.

Use the table above.

Similarity _____

Difference _____

(2)

- (e) Scientists used to think the Earth and Moon formed separately.

Scientists now believe that the Moon formed after a collision between the Earth and a small planet.

This new idea came from the study of Moon rocks.

Why do scientific theories sometimes change?

Tick **one** box.

Scientists agree that the existing theory is old-fashioned

☐

Scientists change their theories to make the theories more popular

☐

Scientists decide that the new theory is more exciting

☐

Scientists discover new evidence which the existing theory cannot explain

☐

(1)

- (f) Write down the equation which links gravitational field strength, gravitational

potential energy, height and mass.

(1)

- (g) When the astronauts left the Moon, they used a spacecraft with a mass of 2150 kg

Calculate the height reached by the spacecraft at the point where it had a gravitational potential energy of 86 000 000 J

The gravitational field strength of the Moon is 1.6 N/kg

Height = _____ m

(3)

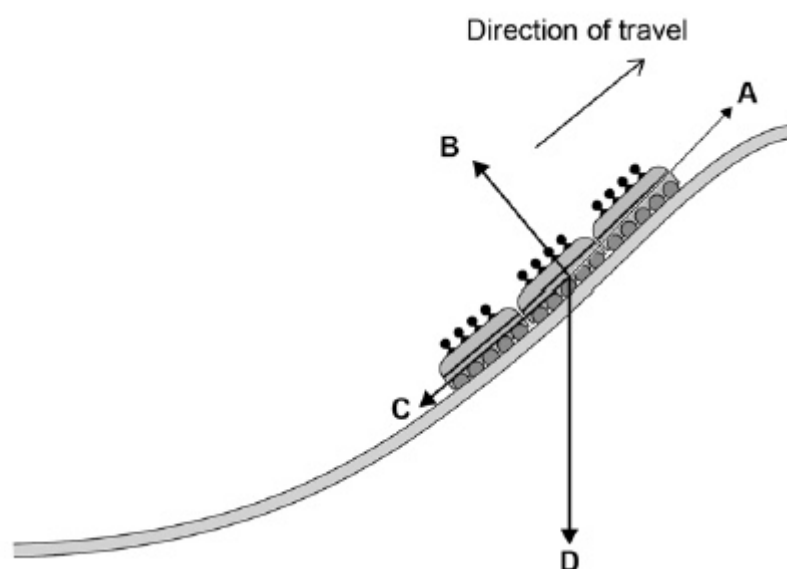
(Total 12 marks)

Q3.

Figure 1 shows a rollercoaster train as it is pulled up a slope on the track.

The arrows, **A**, **B**, **C** and **D**, represent the forces acting on the rollercoaster train.

Figure 1



- (a) Give **two** ways that the force arrows show that forces are vector quantities.

1. _____

2. _____

(2)

(b) Which arrow shows the weight of the rollercoaster train?

Tick **one** box.

A ☐ B ☐ C ☐ D ☐

(1)

(c) Which arrow shows the normal contact force?

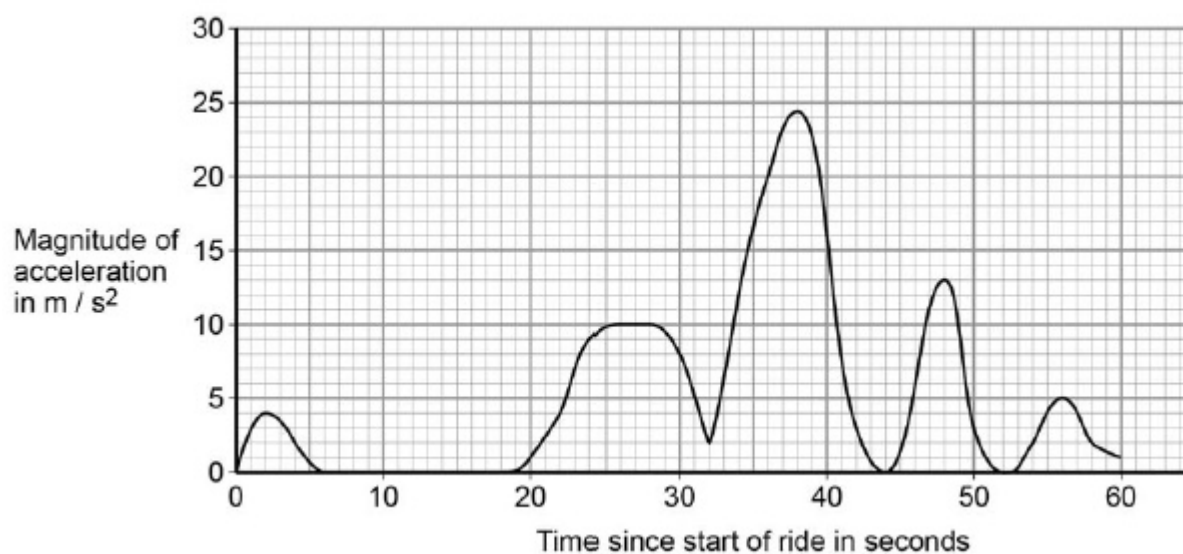
Tick **one** box.

A ☐ B ☐ C ☐ D ☐

(1)

Figure 2 shows the magnitude of the acceleration of the rollercoaster train during the ride.

Figure 2



(d) Why has a line graph been drawn instead of a bar chart?

Tick **one** box.

Acceleration is a control variable.

☐

Both variables are continuous.

☐

Line graphs are easier to read.

☐

Time is a categoric variable.

☐

(1)

- (e) What conclusion can be made from **Figure 2** about the motion of the rollercoaster train between 10 and 15 seconds?

Tick **one** box.

It is moving at a constant velocity.

☐

Its velocity is decreasing.

☐

Its velocity is increasing.

☐

(1)

- (f) What is the maximum acceleration of the rollercoaster train?

Use **Figure 2**.

Acceleration = _____ m/s²

(1)

- (g) The maximum safe acceleration for most people is 5 times the acceleration due to gravity.

Acceleration due to gravity = 9.8 m/s²

Explain whether the acceleration of this rollercoaster train is safe for most people

(3)

- (h) One of the passengers on the rollercoaster train has a mass of 58 kg

Calculate the maximum force experienced by the passenger during the ride.

Use the equation:

$$\text{force} = \text{mass} \times \text{acceleration}$$

Give the unit.

Maximum force = _____ Unit _____

(3)

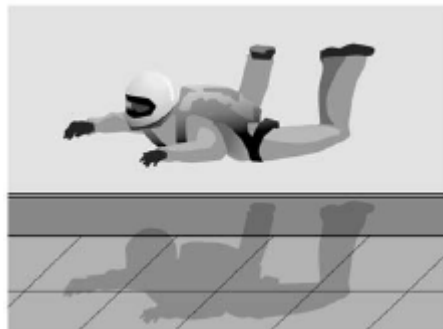
(Total 13 marks)

Q4.

Figure 1 shows a skydiver training in an indoor wind tunnel.

Large fans below the skydiver blow air upwards.

Figure 1



(a) The skydiver is in a stationary position.

Complete the free body diagram for the skydiver.

Force from the air



(2)

(b) The skydiver now straightens his legs to increase his surface area.

This causes the skydiver to accelerate upwards.

Explain why straightening his legs cause the skydiver to accelerate upwards.

(2)

- (c) A small aeroplane used for skydiving moves along a runway.

The aeroplane accelerates at 2 m / s^2 from a velocity of 8 m / s .

After a distance of 209 m it reaches its take-off velocity.

Calculate the take-off velocity of the aeroplane.

Take-off velocity = _____ m / s

(3)

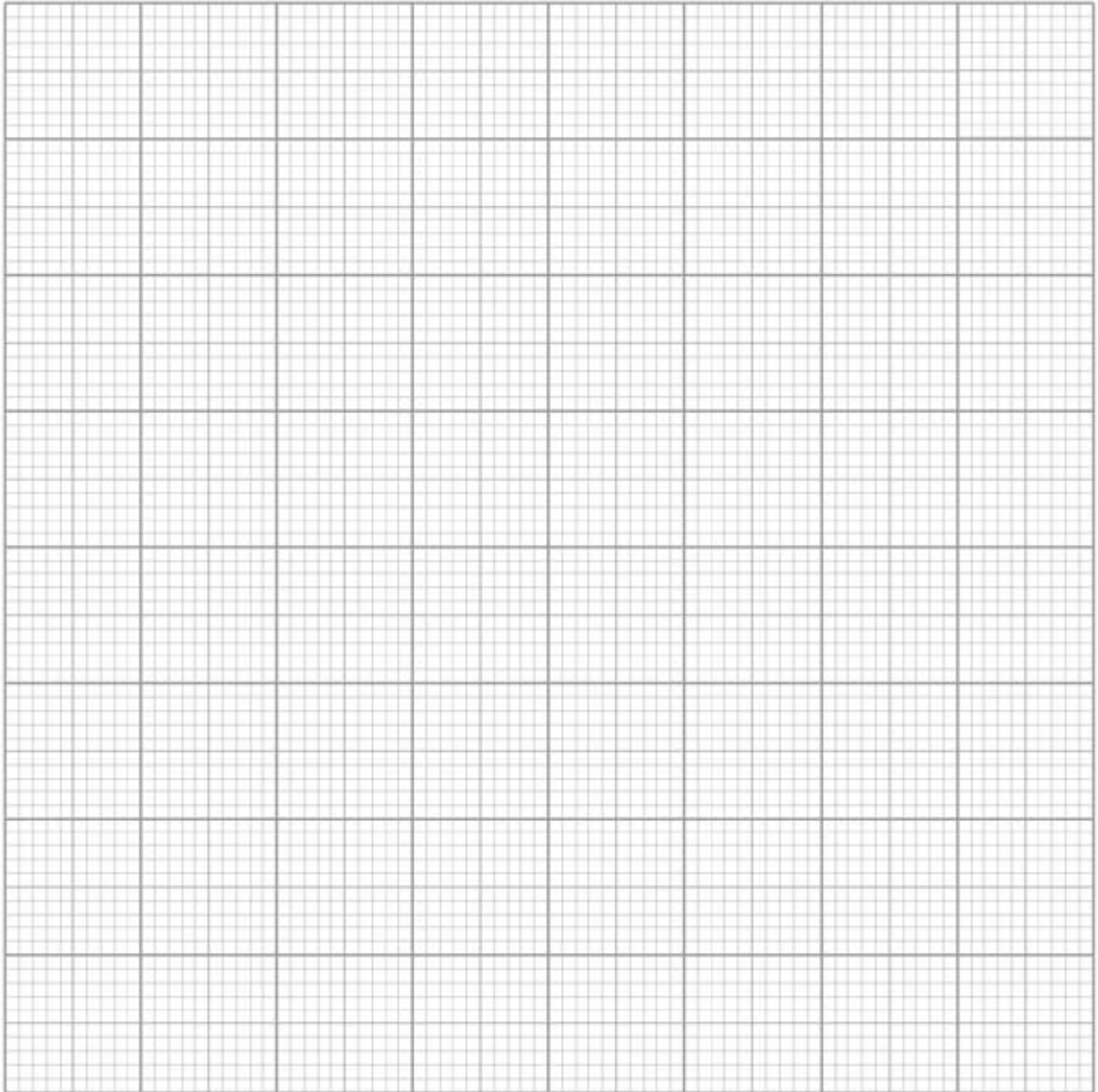
- (d) A skydiver jumps from an aeroplane.

There is a resultant vertical force of 300 N on the skydiver.

There is a horizontal force from the wind of 60 N .

Draw a vector diagram on **Figure 2** to determine the magnitude and direction of the resultant force on the skydiver.

Figure 2



Magnitude of resultant force = _____ N

(5)

(Total 12 marks)

Q5.

This question is about forces.

- (a) Force is a vector quantity.

Which is a correct statement about a vector quantity?

Tick **one** box.

Has direction only

☐

Has direction and magnitude

☐

Has magnitude only

☐

Has neither magnitude nor direction

☐

(1)

- (b) A newtonmeter measures the weight of an object.

Look at the figure below.



What is the weight of the object in the figure above?

Weight = _____ N

(1)

- (c) An object has a weight of 6.4 N.

Calculate the mass of the object.

Use the equation

$$\text{mass} = \text{weight} \div \text{gravitational field strength (g)}$$

$$\text{gravitational field strength} = 9.8 \text{ N / kg}$$

Mass = _____ kg

(1)

- (d) The mass of a bag of sugar is 1 kg.

- On Earth the weight of this bag of sugar is 10 N.
- On Mars the weight of this bag of sugar is 4 N.

Suggest why the weight of the bag of sugar is different on Earth and on Mars.

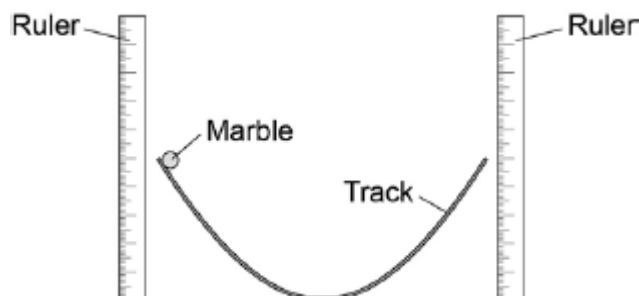
(1)

(Total 4 marks)

Q6.

A student investigates rolling a marble down a track.

The figure below shows how he sets up the investigation.



The student lets go of the marble from different heights.

He records:

- the height from which he drops the marble (the drop height)
- the height the marble rolls up the other side (the roll height).

(a) What force causes the marble to fall down the track?

Tick **one** box.

Air resistance

☐

Friction

☐

Gravity

☐

Magnetism

☐

(1)

(b) What is one variable the student should control in the investigation?

Tick **one** box.

Length of ruler

☐

Length of track

Mass of marble

Roll height

(1)

- (c) The table below shows the student's results.

Drop height in cm	Roll height in cm			
	Test 1	Test 2	Test 3	Mean
20	15	14	14	14
40	29	33	32	
60	47	19	46	46
80	65	61	63	63

What is the **independent** variable in the investigation?

Tick **one** box.

Drop height ☐

Length of track ☐

Mass of marble ☐

Roll height ☐

(1)

- (d) Calculate the mean roll height of the marble when it is dropped from 40 cm.

Mean roll height = _____ cm

(1)

- (e) The student calculated the mean roll height for a drop height of 60 cm.

He did not include the result for Test 2 in his calculation.

Why did the student leave out the result for Test 2?

- (f) Describe how the drop height of the marble affects the roll height.

(1)

- (g) Why does the marble never roll up to the same height the student drops it from?

(1)

(1)
(Total 7 marks)

Q7.

This question is about forces, quantities and vectors.

- (a) Write down the equation that links gravitational field strength, mass and weight.

(1)

- (b) A small ball weighs 1.4 N.

gravitational field strength, $g = 9.8 \text{ N / kg}$

Calculate the mass of the ball.

Mass = _____ kg

(3)

- (c) A white ball with mass 143 g is moving at a velocity of 7.9 m / s.

It collides with a red ball with mass of 150 g.

The red ball is stationary before the collision. The white ball stops after the collision.

Calculate the velocity of the red ball after the collision.

Give your answer to two significant figures.

Velocity of red ball = _____ m / s

(4)

- (d) The white ball is thrown high into the air.

After it is released the ball moves up and then back down in a vertical line.

The free body force diagram in the figure below shows the forces on the ball at one point in its flight.

The force arrows are drawn to scale.



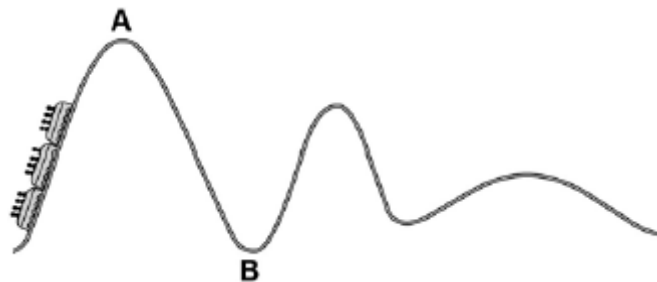
Explain what is happening to the ball at this point in its flight.

(4)

(Total 12 marks)

Q8.

The figure below shows a rollercoaster.



The rollercoaster car is raised a vertical distance of 35 m to point **A** by a motor in 45 seconds.

The mass of the rollercoaster is 600 kg.

The motor has a power rating of 8 000 W.

- (a) Calculate the percentage efficiency of the motor.

Gravitational field strength = 9.8 N / kg.

Efficiency = _____ %

(5)

- (b) The rollercoaster rolls from point **A** to point **B**, a drop of 35 m.

Calculate the speed of the roller coaster at point **B**.

Assume that the decrease in potential energy store is equal to the increase in kinetic energy store.

Speed at point **B** = _____ m / s
(6)
(Total 11 marks)

Mark schemes

Q1.

- (a) equal to 1
- (b) $\text{weight} = 85 \times 9.8$ 1
- $\text{weight} = 833 \text{ (N)}$
- allow weight = 830 (N)* 1
- an answer of 833 (N) **or** 830 (N) scores 2 marks*
- (c) $\text{work done} = 833 \times 0.63$
- allow their calculated value from part (b) $\times 0.63$* 1
- $\text{work done} = 525 \text{ (J)}$
- allow an answer that is consistent with their calculated value from part (b)* 1
- an answer that rounds to 525 (J) scores 2 marks*
- (d) $\text{work done} = 0 \text{ (J)}$ 1
- (e) $\text{force} = 62 \times 11$ 1
- $\text{force} = 682 \text{ (N)}$
- allow force = 680 (N)* 1
- an answer of 682 (N) **or** 680 (N) scores 2 marks*

[8]

Q2.

- (a) $870\,000 \times 36$ 1
- $31\,320\,000 \text{ (J)}$
- or**
- $3.1 \times 10^7 \text{ (J)}$
- allow 31 000 000 (J)*
- or** 31 300 000(J)* 1
- an answer 31 320 000 (J) scores 2 marks*
- (b) some energy was wasted / dissipated
- allow efficiency is always less than 100%* 1
- (and) transferred to thermal energy 1

(c) 27 (%) 1

(d) **similarity**

any **one** from:

- contain same amount of aluminium
- contain (very) similar amounts of silicon
ignore same amount of silicon unless their answer to part (c) was 28%
- oxygen makes up the highest percentage
allow both contain aluminium, iron, oxygen and silicon

1

difference

any **one** from:

- Moon rock contains more iron (than Earth rock)
 - Moon rock contains less oxygen (than Earth rock)
 - Moon rock contains less silicon (than Earth rock)
allow ecf from part (c)
- do **not** allow 2 marks for silicon as both similarity and difference*

1

(e) scientists discover new evidence which the existing theory cannot explain

1

(f) gravitational potential energy = mass × gravitational field strength × height

allow $E_p = mgh$

1

(g) $86\,000\,000 = 2150 \times 1.6 \times h$

1

$$(h =) \frac{86\,000\,000}{2150 \times 1.6}$$

1

(h =) 25 000 (m)

1

an answer 25 000 (m) scores 3 marks

[12]

Q3.

(a) the arrows have different lengths

allow forces can have different sizes

1

the arrows point in different directions

allow forces can have different directions

1

(b) **D**

1

(c)	B	1
(d)	both variables are continuous	1
(e)	it is moving at a constant velocity	1
(f)	24.5 (m/s ²)	1
(g)	5 g = 49 (m/s ²)	1
	49 m/s ² > 24.5 m/s ²	1
	so the ride is safe	
	<i>allow ecf from (f) (ie if their answer to (f) was greater than 49, then the ride is unsafe)</i>	1
(h)	force = 58 × 24.5	
	<i>allow ecf from (f)</i>	1
	force = 1421	1
	Newtons	
	<i>allow N</i>	1
		[13]

Q4.

(a)	arrow of equal size pointing vertically downwards	
	<i>judged by eye</i>	1
	labelled 'weight'	1
(b)	the upwards force is greater than the downwards force	1
	because air resistance increases	1
(c)	$v^2 = (2 \times 2 \times 209) + 8^2$	1
	$v = \sqrt{900}$	1
	$v = 30 \text{ (m / s)}$	1
	<i>allow 30 (m / s) without working shown for 3 calculation</i>	

marks

(d)	vertical force (300 N) drawn with a suitable scale	1
	horizontal force (60 N) drawn to the same scale	1
	resultant force drawn in correct direction	1
	value of resultant in the range 304 N – 308 N	1
		[11]

Q5.

(a)	Has direction and magnitude	1
(b)	5.5	1
(c)	$6.4 \div 9.8 = 0.65$ (kg)	1
(d)	the Earth's gravitational field strength is 2.5 times greater <i>allow the gravitational field strength on Earth is greater than on Mars</i>	1
		[4]

Q6.

(a)	Gravity	1
(b)	Mass of marble	1
(c)	Drop height	1
(d)	31 (cm)	1
(e)	the result was anomalous <i>allow the result was too different from the other values</i>	1
(f)	increasing the drop height increases the roll height	1
(g)	energy losses (due to friction) <i>allow air resistance, friction, drag</i>	1
		[7]

Q7.

(a) weight = mass × gravitational field strength

1

(b) mass = weight ÷ g

1

$$= 1.4 \div 9.8$$

1

$$= 0.143 \text{ (kg)}$$

allow 0.143 with no working shown for 3 marks

1

(c) momentum = mass × velocity

$$\text{momentum before} = \text{momentum after}$$

1

$$143 \times 7.9 = 150 \times v$$

1

$$v = \frac{143 \times 7.9}{150}$$

1

$$= 7.5 \text{ (m / s)}$$

allow 7.5 (m / s) with no working shown for 4 marks

1

incorrect number of sig. figs max. 3 marks

(d) ball is falling / moving down

1

$$\text{at terminal velocity}$$

1

$$\text{air resistance and weight have the same magnitude / size}$$

1

$$\text{so no acceleration / constant speed}$$

1

[12]

Q8.

(a) 600 kg = 5880 N

1

$$\text{power} = \frac{5880 \times 35}{45}$$

1

$$= 4573.3 \text{ (W)}$$

this step without the previous steps stated gains 3 marks

1

$$\% \text{ Eff.} = \frac{4573.3 \times 100}{8000}$$

$$= 57.17 \text{ (\%)}$$

allow 57.17 with no working shown for 5 marks

(b) $\text{gpe} = 600 \times 9.8 \times 35$

$$= 205\,800$$

$$\text{gpe} = \text{KE} = \frac{1}{2} m v^2$$

$$v = \sqrt{\frac{2 \times \text{KE}}{m}}$$

$$= \sqrt{\frac{411\,600}{600}}$$

$$= 26.2 \text{ (m / s)}$$

allow 26.2 with no working shown for 6 marks

[11]

Examiner reports

Q1.

- (a) Only 21% identified the downwards force of the man on the bar as being equal to the upwards force of the bar on the man. Many believed it to be more than.
- (b) Nearly 90% of students were able to substitute the correct numbers into the given equation and calculate the correct value of weight.
- (c) 68% took their answer from part **(b)** and multiplied by 0.63 m to obtain the correct answer for work done. Many incorrect answers were given when students used $9.8 \text{ N/kg} \times 0.63 \text{ m}$ and a significant minority multiplied the part **(b)** by 0.32 m.
- (d) Just over 40% demonstrated they understood that when the man was not moving the work done would be 0 J. Many put in their calculated values from other parts of the question.
- (e) 85% gained two marks with most students able to substitute the correct numbers into the equation given.

Q2.

- (a) Around three quarters of students gained the two marks for this calculation.

10% did not attempt it, and a small number of students divided the two given numbers.

Some students worked out the correct answer, then divided by 1000, possibly because the answer of 31 320 000 J looked very large.

- (b) Around one quarter of students did not attempt this question. Few realised that this was a question about useful and wasted energy and only 6% gained both marks. Those who scored one mark tended to get it for the mention of thermal / heat energy.

A common incorrect response was to refer to the energy being 'lost' rather than 'wasted'. Many seemed to think that the Moon's gravity affected how the energy from the batteries was transferred to kinetic energy.

- (c) Around 6% of students did not attempt this question. Around one third gave the correct value of 27%.

A fairly common incorrect answer was 73%, where the given values had been added, but not subtracted from 100.

There were a large number of answers in the region of 27, indicating that students knew what to do but either added the values together incorrectly or subtracted from 100 incorrectly. In some cases, working was shown which confirmed this.

- (d) 12% of students did not attempt this question. Around one third of students were able to correctly identify both a similarity and a difference from the table, the majority choosing the aluminium and iron percentages respectively.

Despite the instruction to use the table of data, many students stated similarities and differences in texture, hardness, gravity, colour, density, etc. Such answers gained

no marks.

Some students, although using the table, did not score marks because they did not 'add value' to the data. This was relevant for the 'difference' mark, where a qualitative description of the difference was required. For instance, an answer or 'iron' or 'iron is different' did not gain a mark, whereas 'Moon rock contains a higher percentage of iron' did.

- (e) Around 85% of student responses were correct. Responses for the incorrect options were fairly evenly spread, with 'scientists change their theories to make the theories more popular' being chosen more than the other two.
- (f) This was the first occasion in this paper where an equation had to be recalled. Nearly one third of students left this blank.

Of those who wrote something, some wrote an equation which was totally unconnected to the quantities listed. Some wrote expressions which were not equations, i.e. did not have an equals sign. Some wrote equations in the form of chemical equations, e.g. gravitational potential energy + mass → gravitational field strength + height.

Of those who wrote a mathematical equation connecting the given quantities, less than 20% gave a correct form of the equation to gain the mark.

- (g) More than one quarter of students left this blank, which tied in with the fact that many had left the previous question blank because they did not know the gravitational potential energy equation.

Of the students who attempted this calculation, many had difficulty manipulating an equation linking four quantities. Many combinations of the given values were seen, the most popular being to multiply the energy value by one of the other two quantities and then divide by the third. Some students took all three numbers, or just two of them and multiplied them together.