Topic 5 Forces and Motion

Name: _____

Class: _____

Date: _____

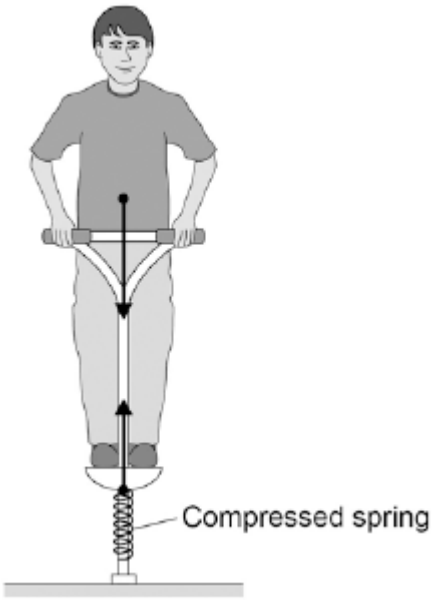
Time: **44 minutes**

Marks: **42 marks**

Comments:

Q1. The figure below shows the forces acting on a child who is balancing on a pogo stick.

The child and pogo stick are not moving.



(a) The downward force of the child on the spring is equal to the upward force of the spring on the child.

This is an example of which one of Newton's Laws of motion?

Tick **one** box.

First Law ☐

Second Law ☐

Third Law ☐

(1)

(b) Complete the sentence.

Use an answer from the box.

elastic potential	**gravitational potential**
kinetic	

The compressed spring stores ..... energy.

(1)

(c) The child has a weight of 343 N.

Gravitational field strength = 9.8 N / kg

Write down the equation which links gravitational field strength, mass and weight.

.....

(1)

(d) Calculate the mass of the child.

.....

.....

.....

Mass = ... kg

(3)

(e) The weight of the child causes the spring to compress elastically from a length of 30cm to a new length of 23cm.

Write down the equation which links compression, force and spring constant.

.....

(1)

(f) Calculate the spring constant of the spring.

Give your answer in newtons per metre.

.....

.....

.....

Spring constant = ... N / m

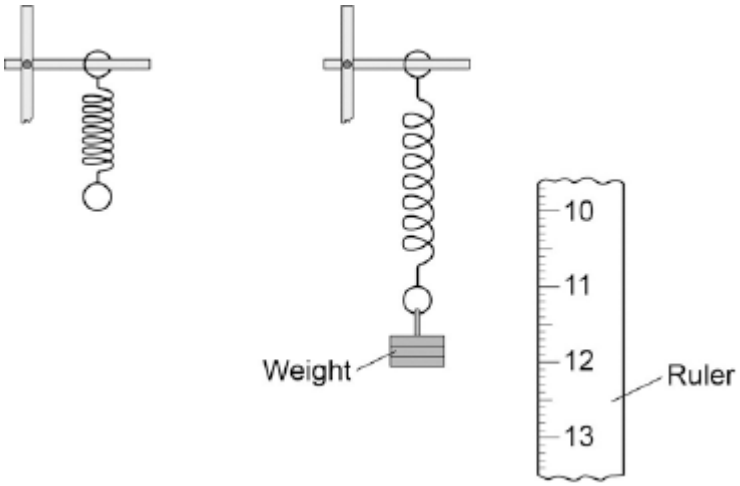
(4)

(Total 11 marks)

Q2. A student suspended a spring from a laboratory stand and then hung a weight from the spring.

Figure 1 shows the spring before and after the weight is added.

Figure 1



(a) Measure the extension of the spring shown in **Figure 1**.

Extension = ... mm

(1)

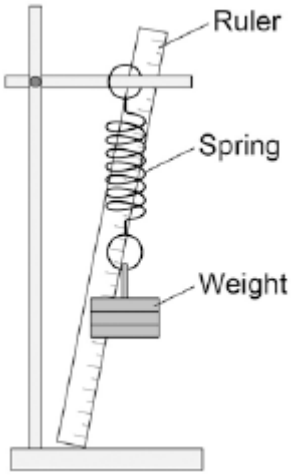
(b) The student used the spring, a set of weights and a ruler to investigate how the extension of the spring depended on the weight hanging from the spring.

Before starting the investigation the student wrote the following prediction:

The extension of the spring will be directly proportional to the weight hanging from the spring.

Figure 2 shows how the student arranged the apparatus.

Figure 2



Before taking any measurements, the student adjusted the ruler to make it vertical.

Explain why adjusting the ruler was important.

.....

.....

.....

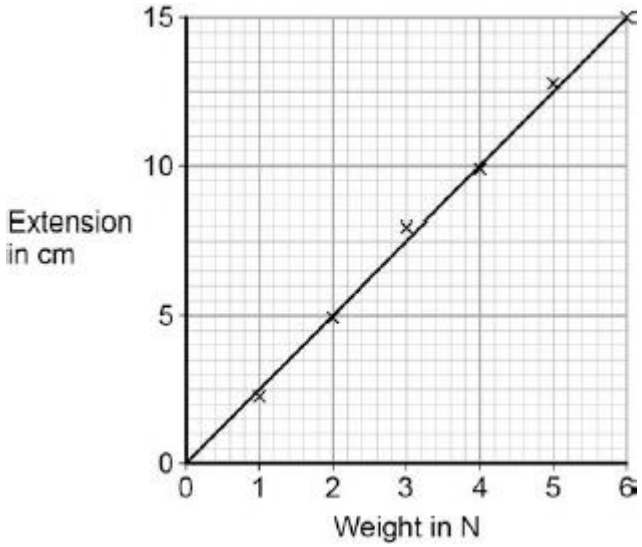
.....

(2)

(c) The student measured the extension of the spring using a range of weights.

The student's data is shown plotted as a graph in **Figure 3**.

Figure 3



What range of weight did the student use?

.....

(1)

(d) Why does the data plotted in **Figure 3** support the student's prediction?

.....

.....

(1)

(e) Describe **one** technique that you could have used to improve the accuracy of the measurements taken by the student.

.....

.....

.....

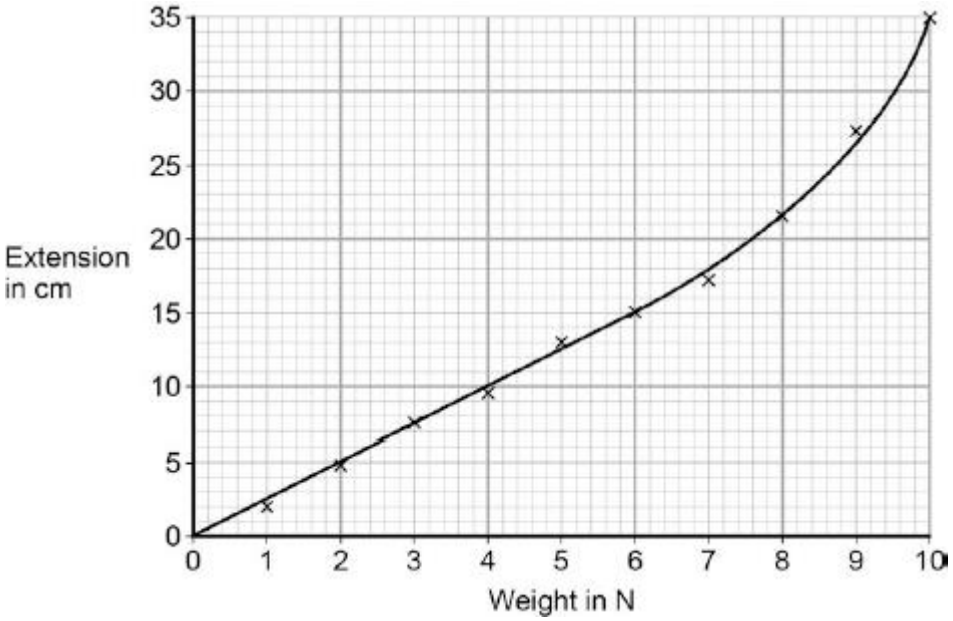
.....

(2)

(f) The student continued the investigation by increasing the range of weights added to the spring.

All of the data is shown plotted as a graph in **Figure 4**.

Figure 4



At the end of the investigation, all of the weights were removed from the spring.

What can you conclude from **Figure 4** about the deformation of the spring?

.....

.....

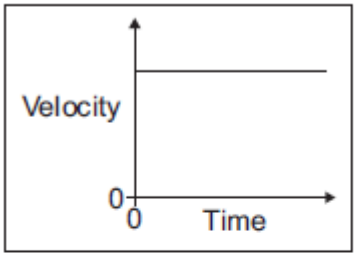
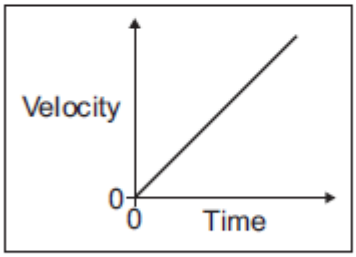
Give the reason for your conclusion.

.....

.....

(2)
(Total 9 marks)

Q3.(a) Draw **one** line from each velocity−time graph to the statement describing the motion shown by the graph.

Velocity–time graph	Motion shown by graph
	Constant acceleration
	Not moving
	Constant deceleration
	Constant velocity

(2)

(b) Use the correct answer from the box to complete the sentence.

energy	**momentum**	**speed**

The velocity of an object includes both the ..... of the object
and the direction the object is moving.

(1)

(c) At the start of a race, a horse accelerates from a velocity of 0 m / s to a velocity of 9 m / s in 4 seconds.

(i) Calculate the acceleration of the horse.

.....

.....

Acceleration = ... m / s^2

(2)

(ii) When the horse accelerates, what, if anything, happens to the air resistance acting against the horse?

Tick (✓) **one** box.

The air resistance decreases	☐
The air resistance is constant	☐
The air resistance increases	☐

(1)

(d) A horse and a pony walk across a field at the same constant speed.

The horse has 4000 joules of kinetic energy.

The pony is **half** the mass of the horse.

What is the kinetic energy of the pony?

Draw a ring around the correct answer

2000 J **4000 J** **8000 J**

Give a reason for your answer.

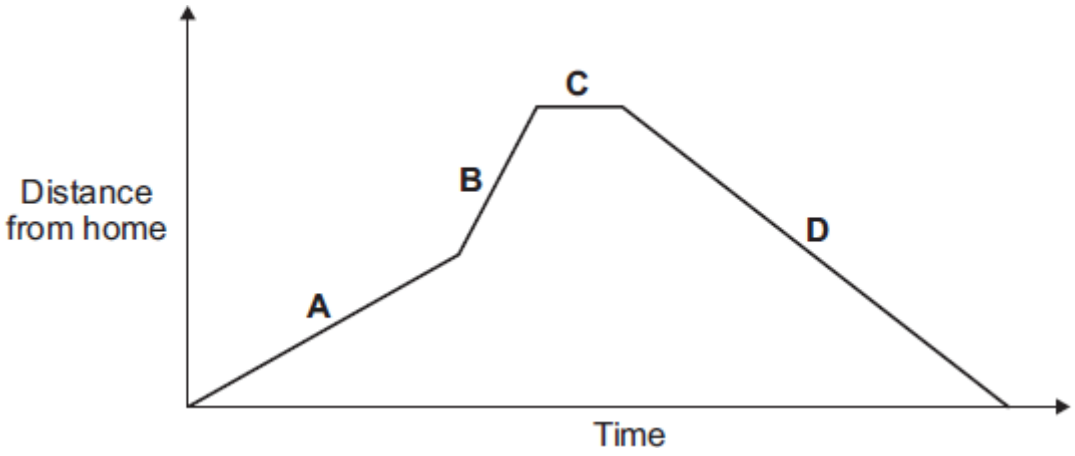
.....

.....

(2)
(Total 8 marks)

Q4. (a) A person takes their dog for a walk.

The graph shows how the distance from their home changes with time.



Which part of the graph, **A**, **B**, **C** or **D**, shows them walking the fastest?

Write your answer in the box. ☐

Give the reason for your answer.

.....

.....

(2)

(b) During the walk, both the speed and the velocity of the person and the dog change.

How is *velocity* different from *speed*?

.....

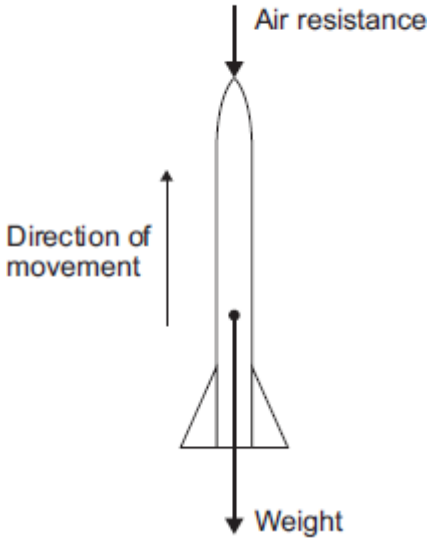
.....

(1)

(Total 3 marks)

Q5.(a) **Figure 1** shows the forces acting on a model air-powered rocket just after it has been launched vertically upwards.

Figure 1



(i) How does the velocity of the rocket change as the rocket moves **upwards**?

.....

Give a reason for your answer.

.....

.....

(2)

(ii) The velocity of the rocket is not the same as the speed of the rocket.

What is the difference between the velocity of an object and the speed of an object?

.....

.....

.....

(1)

(b) The speed of the rocket just after being launched is 12 m / s.
The mass of the rocket is 0.05 kg.

(i) Calculate the kinetic energy of the rocket just after being launched.

.....

.....

.....

Kinetic energy = ... J

(2)

(ii) As the rocket moves upwards, it gains gravitational potential energy.

State the maximum gravitational potential energy gained by the rocket.

Ignore the effect of air resistance.

Maximum gravitational potential energy = ... J

(1)

(iii) Calculate the maximum height the rocket will reach.

Ignore the effect of air resistance.

Gravitational field strength = 10 N / kg.

.....

.....

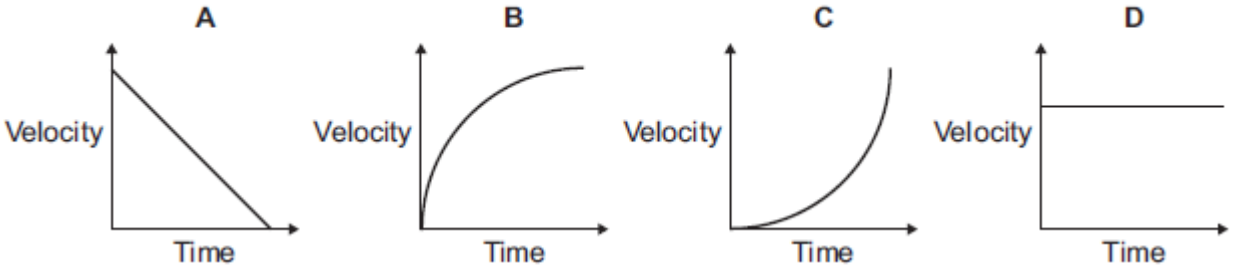
.....

Maximum height = ... m

(2)

(iv) **Figure 2** shows four velocity−time graphs.

Figure 2



Taking air resistance into account, which graph, **A**, **B**, **C** or **D**, shows how the velocity of the rocket changes as it **falls** from the maximum height it reached until it just hits the ground?

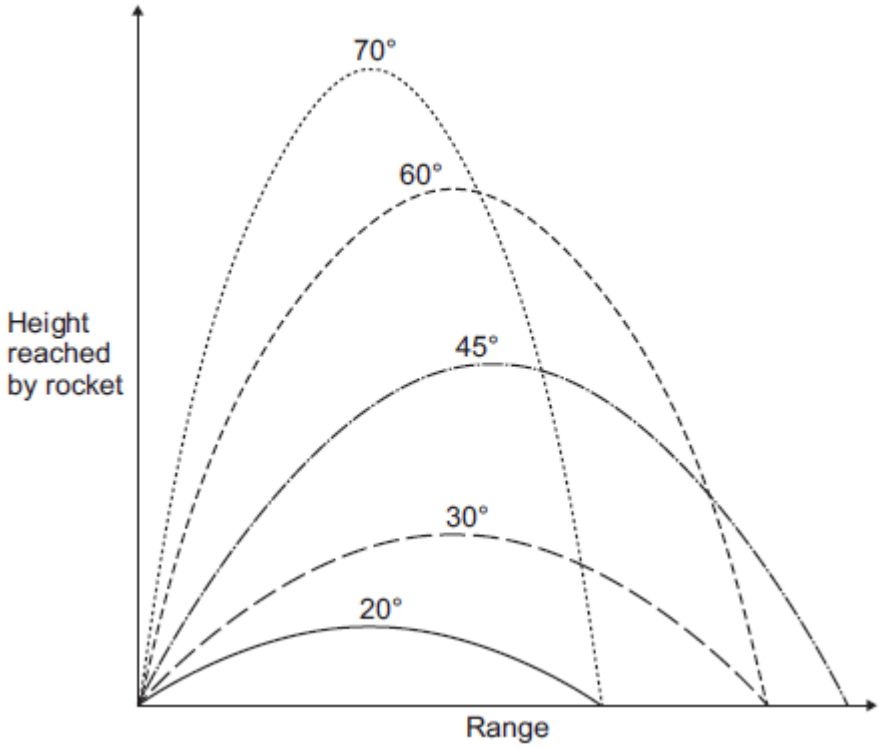
Write the correct answer in the box. ☐

(1)

(c) The rocket can be launched at different angles to the horizontal.
The horizontal distance the rocket travels is called the range.

Figure 3 shows the paths taken by the rocket when launched at different angles.
Air resistance has been ignored.

Figure 3



What pattern links the angle at which the rocket is launched and the range of the rocket?

.....

.....

.....

.....

(2)
(Total 11 marks)

M1.(a) Third Law

1

(b) elastic potential

1

(c) weight = mass × gravitational field strength

accept gravity for gravitational field strength

1

accept W = mg

*accept correct rearrangement ie mass = weight / gravitational field strength **or** m = W / g*

(d) 343 = m × 9.8

1

$m = \frac{343}{9.8}$

1

m = 35

1

*allow 35 with no working shown for **3** marks*

(e) force = spring constant × compression

accept force = spring constant × extension

accept F = k e

*accept correct rearrangement ie constant = force / extension **or** k = F / e*

1

(f) compression = 0.07m

1

343 = k × 0.07

1

k = 343 ÷ 0.07

1

k = 4900

1

*allow 4900 with no working shown for **4** marks*
*allow 49 with no working shown for **3** marks*

[11]

M2.(a) accept any value between 12 (mm) and 13 (mm) inclusive

1

(b) to reduce the error in measuring the extension of the spring
accept length for extension throughout

1

as the ruler at an angle would make the measured extensions shorter

1

(c) 1 (N) to 6 (N)
accept from 0 (N) to 6 (N)

1

(d) gives a straight line through the origin

1

(e) any practical technique that would improve the accuracy of length measurement eg

use a set square

1

to line up the bottom of the spring with the ruler scale

or

attach a horizontal pointer to the bottom of the spring (1)

so that the pointer goes across the ruler scale (1)

1

(f) the spring has been inelastically deformed

1

because it went past its limit of proportionality

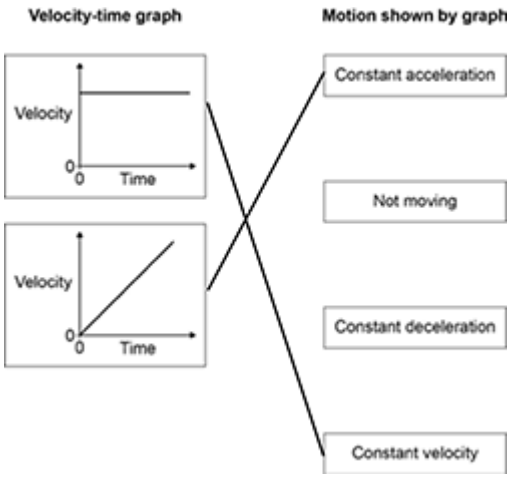
accept elastic limit for limit of proportionality

1

accept it does not go back to its original length when the weights are removed

[9]

M3.(a)



*if more than one line is drawn from a graph then all those lines are wrong allow **1** mark for 1 correct line*

2

(b) speed

1

(c) (i) 2.25

*allow **1** mark for correct substitution i.e.*

$a = \frac{9 - 0}{4}$ or $a = \frac{9}{4}$

provided no subsequent step

2

(ii) the air resistance increases

1

(d) 2000 J

1

mass is half
or
kinetic energy depends on mass

*do **not** accept weight for mass*

1

[8]

M4. (a) **B**

reason only scores if B is chosen

1

gradient / slope is the steepest / steeper

answers must be comparative
accept steepest line
ignore greatest speed

1

(b) (velocity includes) direction

'it' refers to velocity

1

[3]

M5.(a) (i) decreases (to zero)

1

resultant force acts in opposite direction to motion

accept air resistance and weight for resultant force

accept resultant force acts downwards

*do **not** accept air resistance increases*

1

(ii) velocity includes direction

or

velocity is a vector (quantity)

1

(b) (i) 3.6

allow 1 mark for correct substitution i.e.

½ × 0.05 × 12^2 provided no subsequent step

2

(ii) 3.6 **or** their (i)

1

(iii) 7.2

or

their (ii) ÷ 0.5 correctly calculated

*allow **1** mark for correct substitution i.e.*

3.6 or their (ii) = 0.05 × 10 × h

2

(iv) **B**

1

(c) range increases up to 45°

1

range decreases from 45°

the range is a maximum at 45° gains both marks

for any two angles that add up

to 90° the range is the same gains both marks

*the range increases then decreases gains **1** mark*

1

[11]