Topic 5 Forces and Motion

Name: ____________________

Class: ____________________

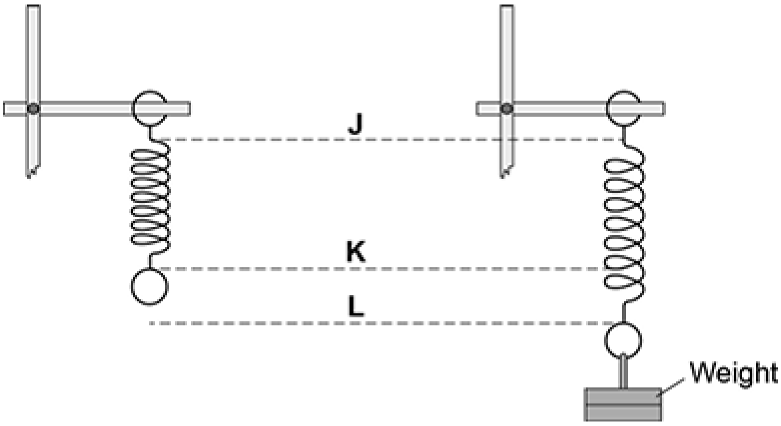
Date: ____________________

Time:	**39 minutes**
Marks:	**39 marks**
Comments:	

Q1. 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) Which distance gives the extension of the spring?

Tick **one** box.

from **J** to **K** ☐

from **K** to **L** ☐

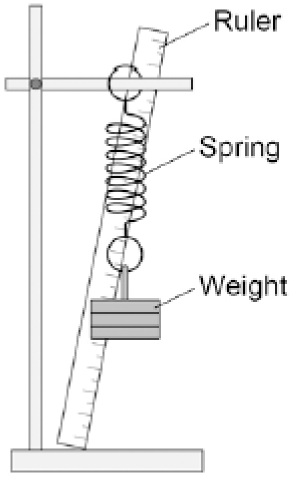
from **J** to **L** ☐

(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.

Figure 2 shows that the ruler is in a tilted position and not upright as it should be.

Figure 2



How would leaving the ruler tilted affect the weight and extension data to be recorded by the student?

Use answers from the box to complete each sentence.

Each answer may be used once, more than once or not at all.

greater than	**the same as**	**smaller than**

The weight recorded by the student would be .... the actual weight.

The extension recorded by the student would be .... the actual extension of the spring.

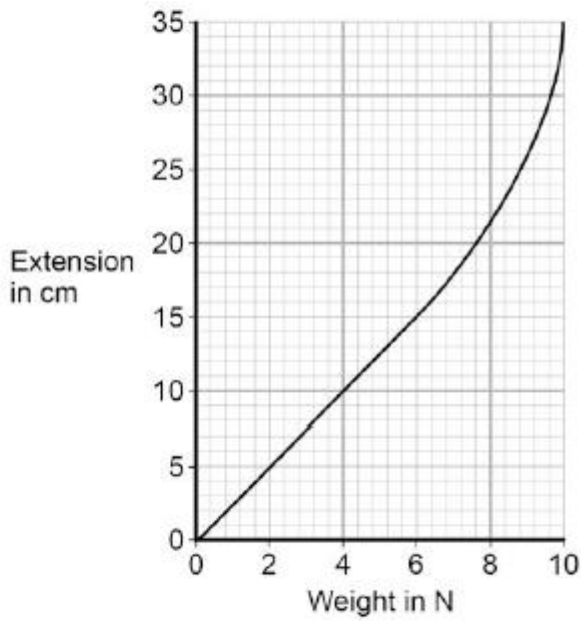
(2)

(c) The student moves the ruler so that it is upright and not tilted.

The student then completed the investigation and plotted the data taken in a graph.

The student's graph is shown in **Figure 3**.

Figure 3



Use **Figure 3** to determine the additional force needed to increase the extension of the spring from 5cm to 15cm.

Additional force = ... N

(1)

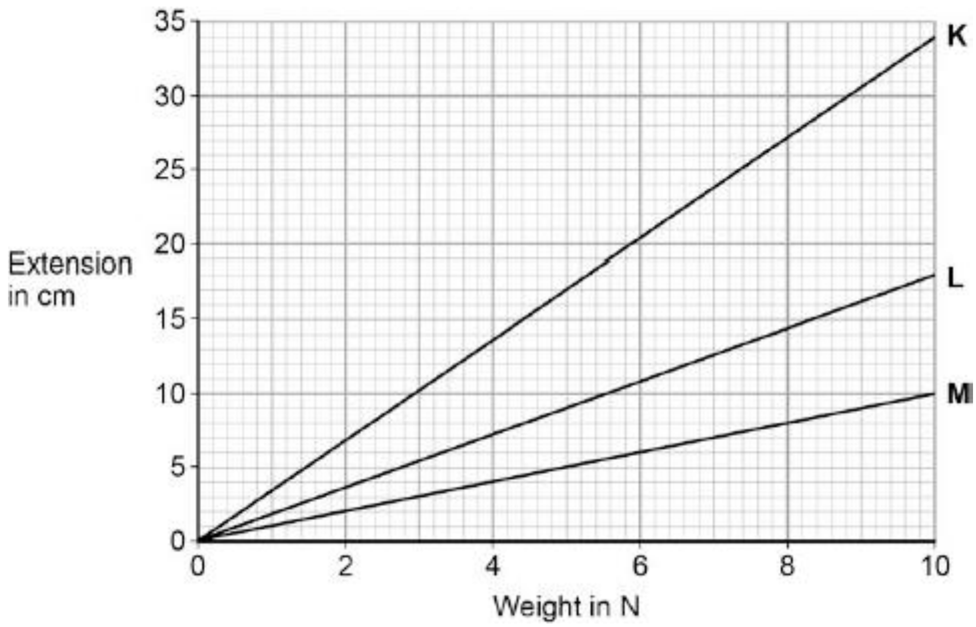
(d) What can you conclude from **Figure 3** about the limit of proportionality of the spring?

(1)

(e) The student repeated the investigation with three more springs, **K**, **L** and **M**.

The results for these springs are given in **Figure 4**.

Figure 4



All three springs show the same relationship between the weight and extension.

What is that relationship?

Tick **one** box.

The extension increases non-linearly with the increasing weight. ☐

The extension is inversely proportional to the weight. ☐

The extension is directly proportional to the weight. ☐

(1)

(f) Which statement, **A**, **B** or **C**, should be used to complete the sentence?

Write the correct letter, **A**, **B** or **C**, in the box below.

A a lower spring constant than

B the same spring constant as

C a greater spring constant than

From **Figure 4** it can be concluded that spring **M** has ☐ the other two springs.

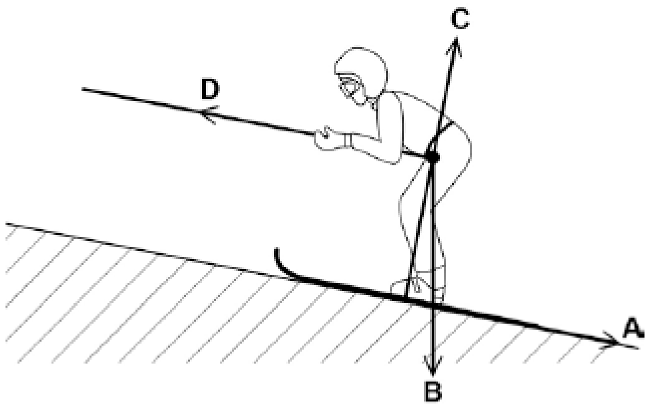
(1)
(Total 7 marks)

Q2. Figure 1 shows a skier using a drag lift.

The drag lift pulls the skier from the bottom to the top of a ski slope.

The arrows, **A**, **B**, **C** and **D** represent the forces acting on the skier and her skis.

Figure 1



(a) Which arrow represents the force pulling the skier up the slope?

Tick **one** box.

A ☐

B ☐

C ☐

D ☐

(1)

(b) Which arrow represents the normal contact force?

Tick **one** box.

A ☐

B ☐

C ☐

D ☐

(1)

(c) The drag lift pulls the skier with a constant resultant force of 300N for a distance of 45 m.

Use the following equation to calculate the work done to pull the skier up the slope.

work done = force × distance

....

....

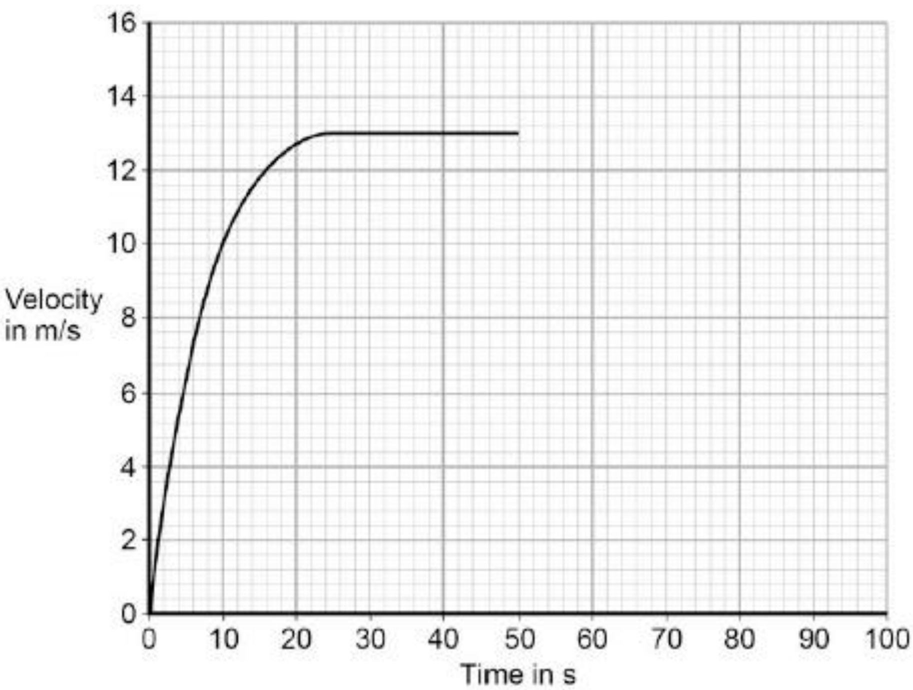
Work done = ... J

(2)

(d) At the top of the slope the skier leaves the drag lift and skis back to the bottom of the slope.

Figure 2 shows how the velocity of the skier changes with time as the skier moves down the slope.

Figure 2



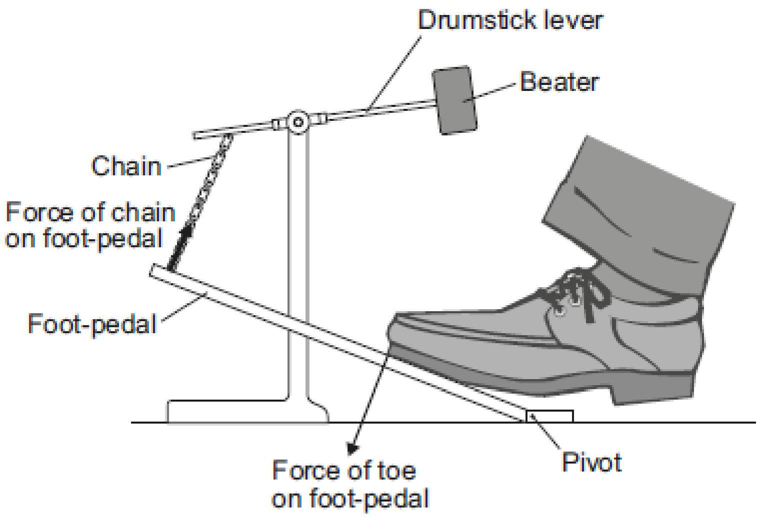
After 50 seconds the skier starts to slow down.

The skier decelerates at a constant rate coming to a stop in 15 seconds.

Draw a line on **Figure 2** to show the change in velocity of the skier as she slows down and comes to a stop.

(2)
(Total 6 marks)

Q3. A drum is hit by a beater attached to a drumstick lever. The drumstick lever is attached to a foot-pedal by a chain, as shown below.



(a) State how the size of the force of the chain on the foot-pedal compares with the size of the force of the toe on the foot-pedal.

....

....

(1)

(b) The foot-pedal is pushed halfway down and held stationary.

The force of the toe and the force of the chain each create a moment which acts on the foot-pedal.

Compare the size and direction of the moments of the toe and the chain.

Tick (✔) **one** box.

Size	Direction	Tick (✔)
The moments are equal	same	
The moments are equal	opposite	
The moment of the force of the toe is greater	same	

(1)

(c) How can the drummer create a greater moment about the pivot without increasing the force he applies?

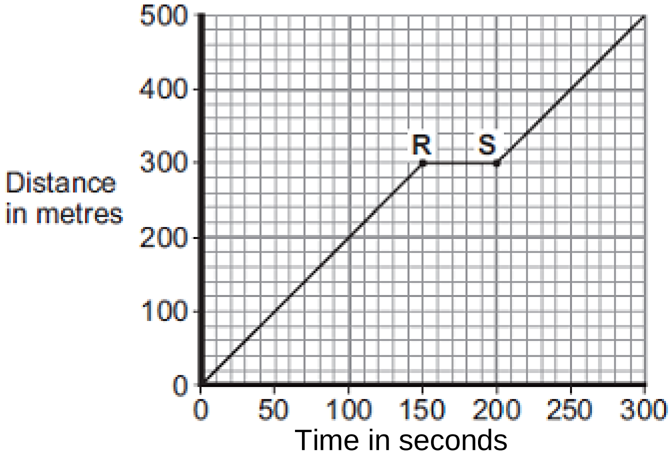
....

....

(1)
(Total 3 marks)

Q4.(a) **Figure 1** shows the distance–time graph for a person walking to a bus stop.

Figure 1



(i) Which **one** of the following statements describes the motion of the person between points **R** and **S** on the graph?

Tick (✓) **one** box.

Not moving ☐

Moving at constant speed ☐

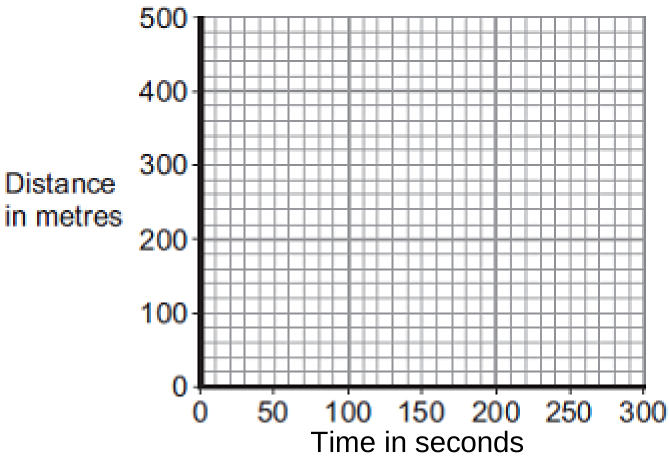
Moving with increasing speed ☐

(1)

(ii) Another person, walking at constant speed, travels the same distance to the bus stop in 200 seconds.

Complete **Figure 2** to show a distance–time graph for this person.

Figure 2



(1)

(b) A bus accelerates away from the bus stop at 2.5 m/s^2.

The total mass of the bus and passengers is 14 000 kg.

Calculate the resultant force needed to accelerate the bus and passengers.

....

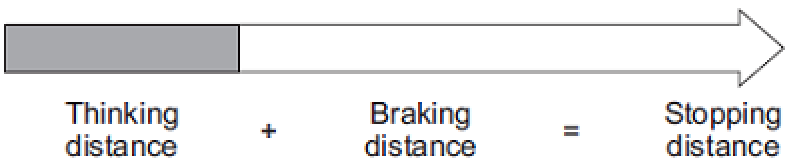
....

....

Resultant force = ... N

(2)
(Total 4 marks)

Q5. The diagram shows how the thinking distance and braking distance of a car add together to give the stopping distance of the car.



(a) Use words from the box to complete the sentence.

distance	**energy**	**force**	**time**

The stopping distance is found by adding the distance the car travels during the driver's reaction .... and the distance the car travels under the braking ....

(2)

(b) Which **one** of the following would **not** increase the thinking distance?

Tick (✓) **one** box.

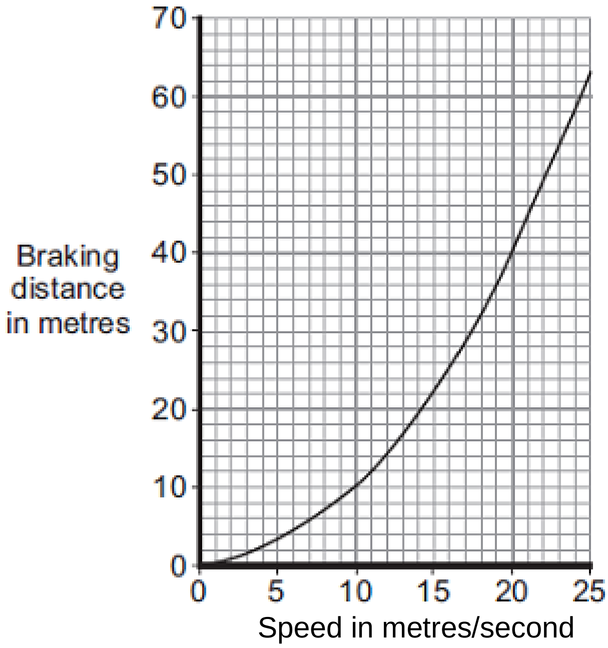
The car driver being tired. ☐

The car tyres being badly worn. ☐

The car being driven faster. ☐

(1)

(c) The graph shows how the braking distance of a car changes with the speed of the car.
The force applied to the car brakes does not change.



(i) What conclusion about braking distance can be made from the graph?

....

....

....

....

(2)

(ii) The graph is for a car driven on a dry road.

Draw a line on the graph to show what is likely to happen to the braking distance at different speeds if the same car was driven on an icy road.

(1)

(d) A local council has reduced the speed limit from 30 miles per hour to 20 miles per hour on a few roads. The reason for reducing the speed limit was to reduce the number of accidents.

(i) A local newspaper reported that a councillor said:

"It will be much safer because drivers can react much faster when driving at 20 miles per hour than when driving at 30 miles per hour."

This statement is wrong. Why?

....

....

(1)

(ii) The local council must decide whether to introduce the lower speed limit on a lot more roads.

What evidence should the local council collect to help make this decision?

....

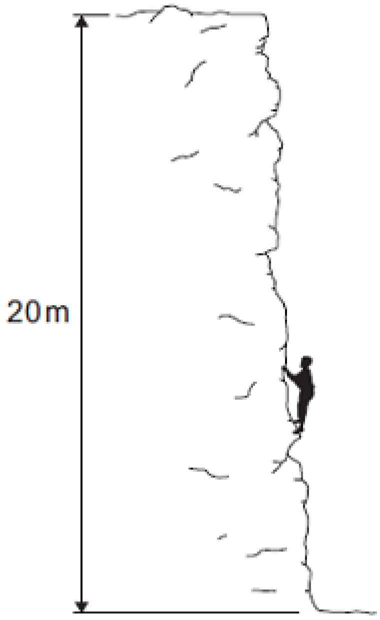
....

....

....

(2)
(Total 9 marks)

Q6. 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.

....

....

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.

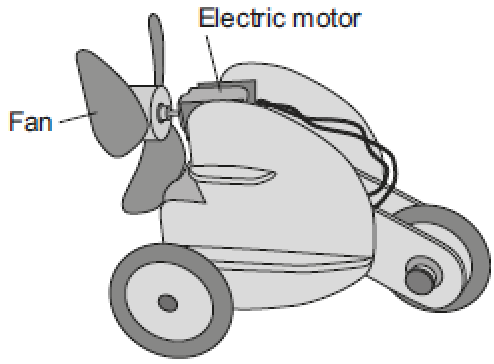
....

....

Power = ... W

(2)
(Total 5 marks)

Q7. The diagram shows an air-driven toy.
When the electric motor is switched on the fan rotates.
The fan pushes air backwards making the toy move forwards.



(a) (i) The toy has a mass of 0.15 kg and moves forward with a velocity of 0.08 m/s.

How is the momentum of the toy calculated?

Tick (✔) **one** box.

0.15 + 0.08 = 0.230 ☐

0.15 ÷ 0.08 = 1.875 ☐

0.15 × 0.08 = 0.012 ☐

(1)

(ii) What is the unit of momentum?

Tick (✔) **one** box.

kg m/s ☐ m/s^2 ☐ kg/m/s ☐

(1)

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

less than	**equal to**	**more than**

The momentum of the air backwards is .... the momentum of the toy forwards.

(1)

(b) The electric motor can rotate the fan at two different speeds.

Explain why the toy moves faster when the fan rotates at the higher of the two speeds.

....

....

....

....

(2)
(Total 5 marks)

M1.(a) from K to L
1

(b) the same as
1

smaller than
1

correct order only

(c) 4 N
1

(d) the limit of proportionality is reached when a weight of 7N is added to the spring

accept any number from 6.8 to 7.2 inclusive
1

(e) the extension is directly proportional to the weight.
1

(f) C
1

[7]

M2.(a) D
1

(b) C
1

(c) $W = 300 \times 45$
1

$W = 13\ 500$
1

*allow 13 500 with no working shown for **2** marks*

(d) straight line drawn from 13 m / s to 0 m / s 1

finishing on x-axis at 65 s 1

[6]

M3.(a) (force on the chain is) smaller (than the force of the toe) 1

(b) Tick in middle box

The moments are equal and opposite 1

(c) move the toe (up the pedal) away from the pivot 1

[3]

M4.(a) (i) not moving 1

(ii) straight line from origin to (200,500)

ignore a horizontal line after (200,500) 1

(b) 35 000

*allow **1** mark for correct substitution, ie 14 000 × 2.5 provided no subsequent step*

an answer of 87 500 indicates acceleration (2.5) has been squared and so scores zero 2

[4]

M5.(a) time

correct order only

1

force

1

(b) The car tyres being badly worn

1

(c) (i) braking distance increases with speed

accept positive correlation

*do **not** accept stopping distance for braking distance*

1

relevant further details, eg

- but not in direct proportion
- and increases more rapidly after 15 m/s

  accept any speed between 10 and 20

  accept numerical example
- double the speed, braking distance increases × 4

1

(ii) line drawn above existing line starting at the origin

as speed increases braking distance must increase

each speed must have a single braking distance

1

(d) (i) reaction time / reaction (of driver) does not depend on speed (of car)

1

(ii) (on the reduced speed limit roads) over the same period of time

accept a specific time, eg 1 year

1

monitor number of accidents before and after (speed limit reduced) *allow **1** mark only for record number of vehicles / cars using the (20 mph) roads **or** collect data on accidents on the (20 mph) roads*

to score both marks the answer must refer to the roads with the reduced speed limit

1

[9]

M6.(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]

M7.(a) (i) 0.15 × 0.08 = 0.012

1

(ii) kg m/s

1

(iii) equal to

1

(b) momentum of the air increases

or

force backwards increases

accept air moves faster

accept momentum backwards increases

accept pushes more air back(wards)

1

so momentum of the toy must increase

or

the force forwards (on the toy) increases

accept momentum forwards must increase

it = toy

1

[5]