Forces part 4 AQA Triple Physics

Name: _____

Class: _____

Date: _____

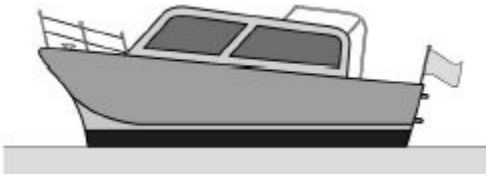
Time: **88 minutes**

Marks: **82 marks**

Comments:

1. **Figure 1** shows a boat floating on the sea. The boat is stationary.

Figure 1



(a) **Figure 2** shows part of the free body diagram for the boat.

Complete the free body diagram for the boat.

Figure 2

(2)

(b) Calculate the mass of the boat.

Use the information given in **Figure 2**.

gravitational field strength = 9.8 N/kg

Give your answer to **two** significant figures.

_____

_____

_____

_____

Mass = _____ kg

(4)

(c) When the boat propeller pushes water backwards, the boat moves forwards.
The force on the water causes an equal and opposite force to act on the boat.

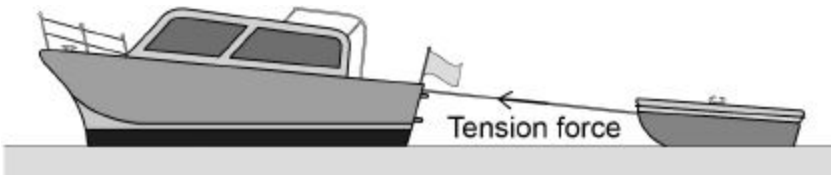
Which law is this an example of?

_____

(1)

(d) **Figure 3** shows the boat towing a small dinghy.

Figure 3



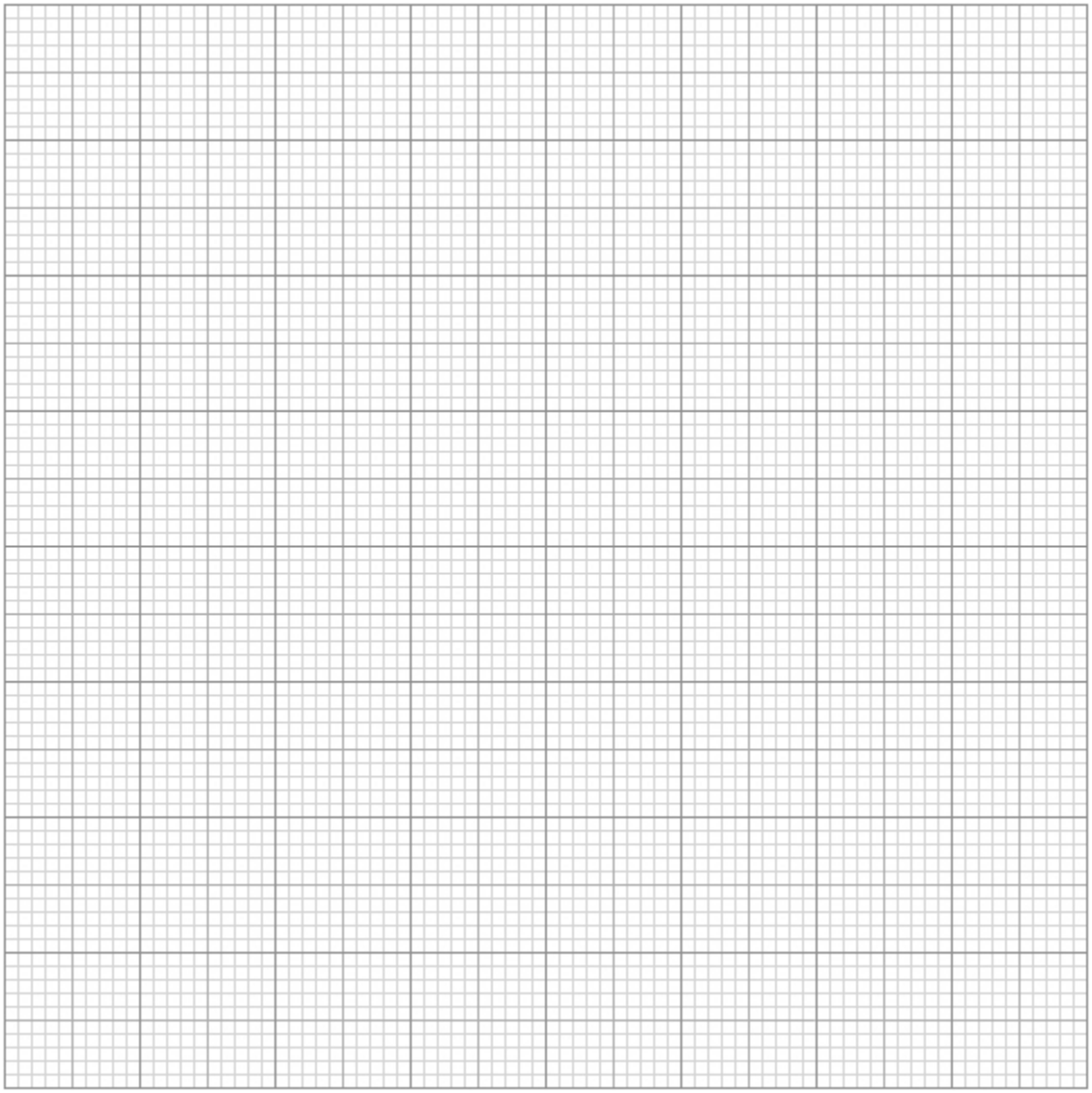
The tension force in the tow rope causes a horizontal force forwards and a vertical force upwards on the dinghy.

horizontal force forwards = 150 N
vertical force upwards = 50 N

Figure 4 shows a grid.

Draw a vector diagram to determine the magnitude of the tension force in the tow rope and the direction of the force this causes on the dinghy.

Figure 4



Magnitude of the tension force in the tow rope = _____ N

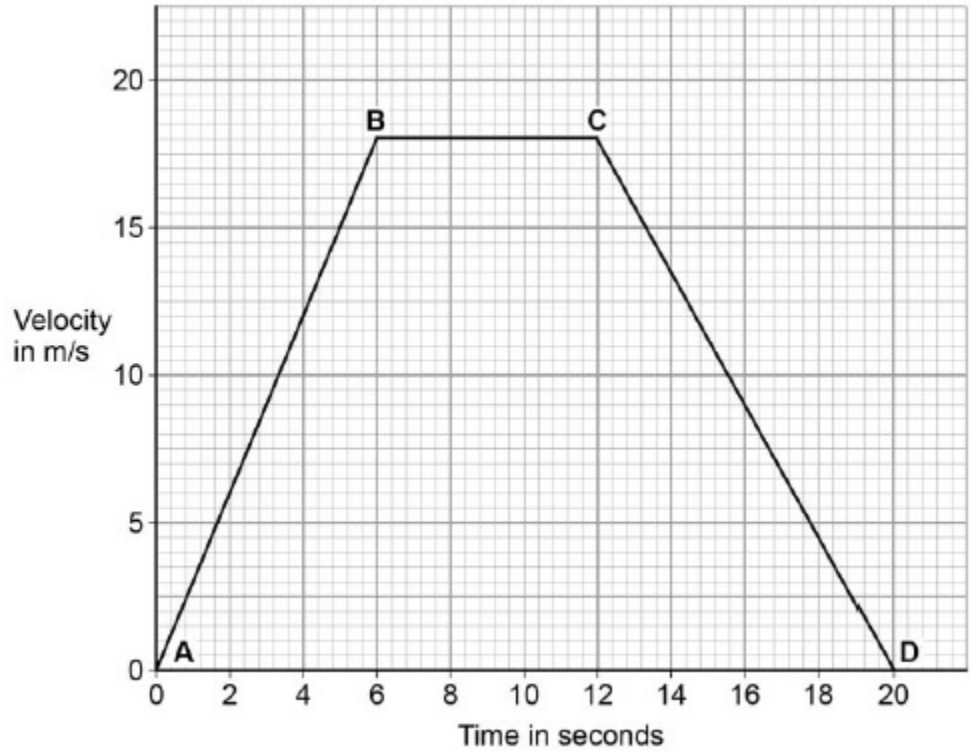
Direction of the force on the dinghy caused by the tension force in the tow rope = _____

(4)

(Total 11 marks)

2. **Figure 1** shows the velocity-time graph for a car driven along a straight road.

Figure 1



(a) From **B** to **C** the car is moving at a constant velocity.

Complete the sentence.

Choose the answer from the box.

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

From **B** to **C** the forward driving force is _____ the backward resistive force.

(1)

(b) From **C** to **D** the car is slowing down.

What word is used to describe the motion of an object that is slowing down?

_____

(1)

(c) Between **A** and **B** the car is accelerating.

Calculate the acceleration of the car between **A** and **B**.

Use the equation:

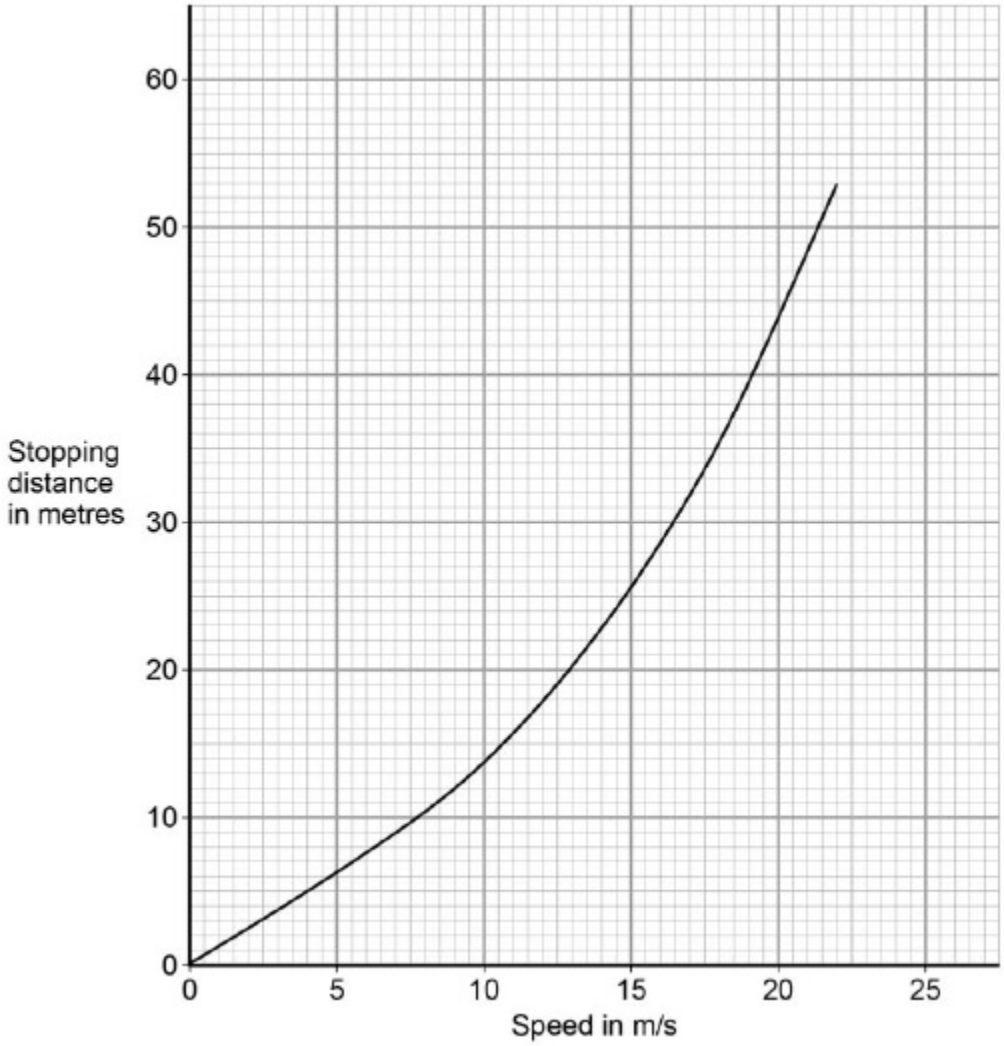
$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

Acceleration = _____ m/s^2

(2)

(d) **Figure 2** shows how the stopping distance of a car depends on the speed of the car.

Figure 2



Describe what happens to the stopping distance of the car when the speed of the car doubles.

_____

_____

_____

_____

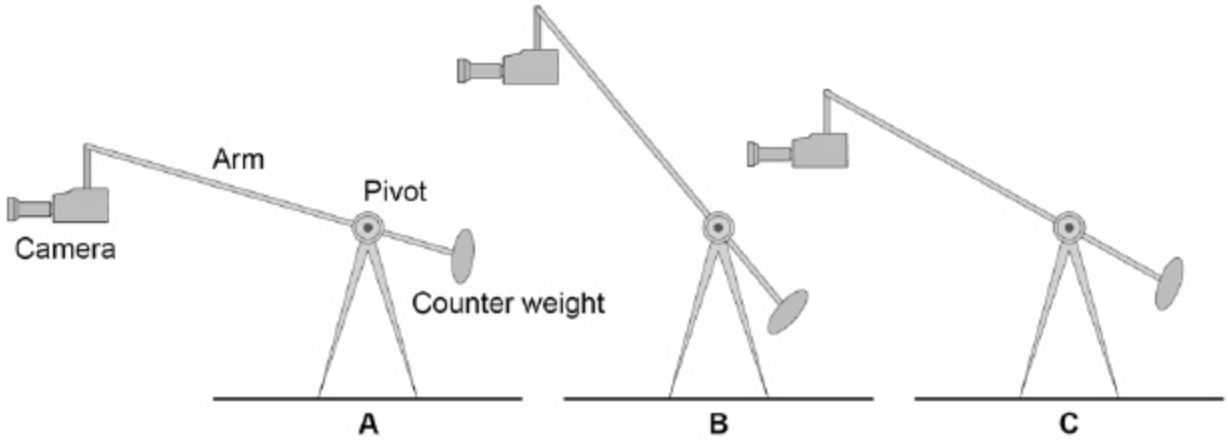
(2)

(Total 6 marks)

3. A camera boom is used at a television studio to allow filming from different positions.

Figure 1 shows the arm of the boom in three different positions.

Figure 1



(a) In which position will the weight of the camera cause the largest moment about the pivot?

Tick **one** box.

A ☐ **B** ☐ **C** ☐

Give the reason for your answer.

_____

_____

(2)

(b) Complete the sentence.

Choose the answer from the box.

decreases	**does not change**	**increase**

When the moment caused by the weight of the camera increases, the moment caused by the counterweight _____ .

(1)

(c) The camera has a mass of 5.0 kg

gravitational field strength = 9.8 N/kg

Calculate the weight of the camera.

Use the equation:

weight = mass × gravitational field strength

Give the unit.

Choose the answer from the box.

joule	kilogram	newton

_____

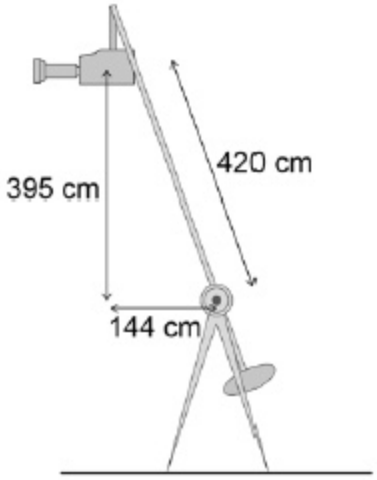
_____

Weight = _____ Unit _____

(3)

Figure 2 shows the camera boom in a new position, **D**.

Figure 2



(d) Write the equation which links distance, force and moment of a force.

_____

(1)

(e) Calculate the moment about the pivot caused by the weight of the camera when the arm of the boom is in position **D**.

_____

_____

_____

_____

_____

Moment = _____ Nm

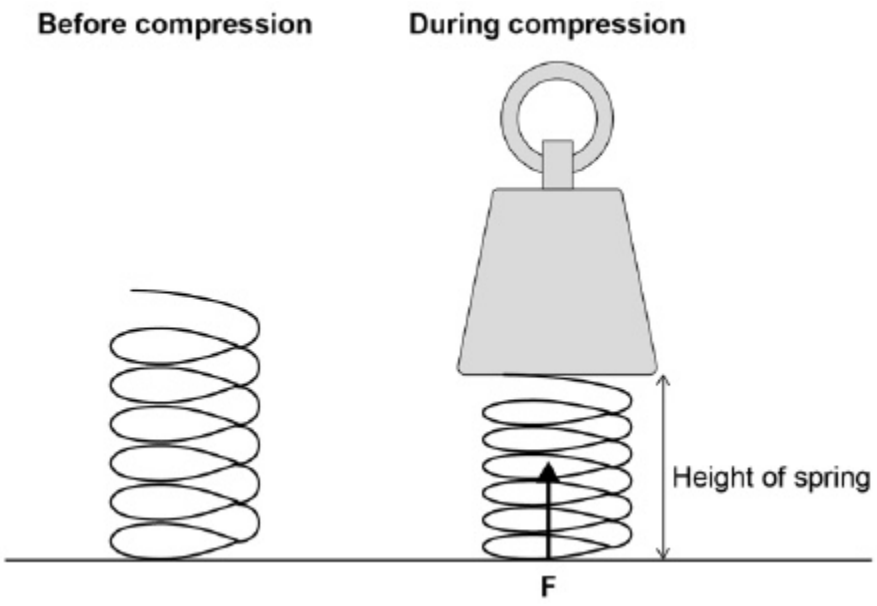
(3)

(Total 10 marks)

4. **Figure 1** shows a spring before and during compression.

The arrow F represents one of the two forces involved in compressing the spring.

Figure 1



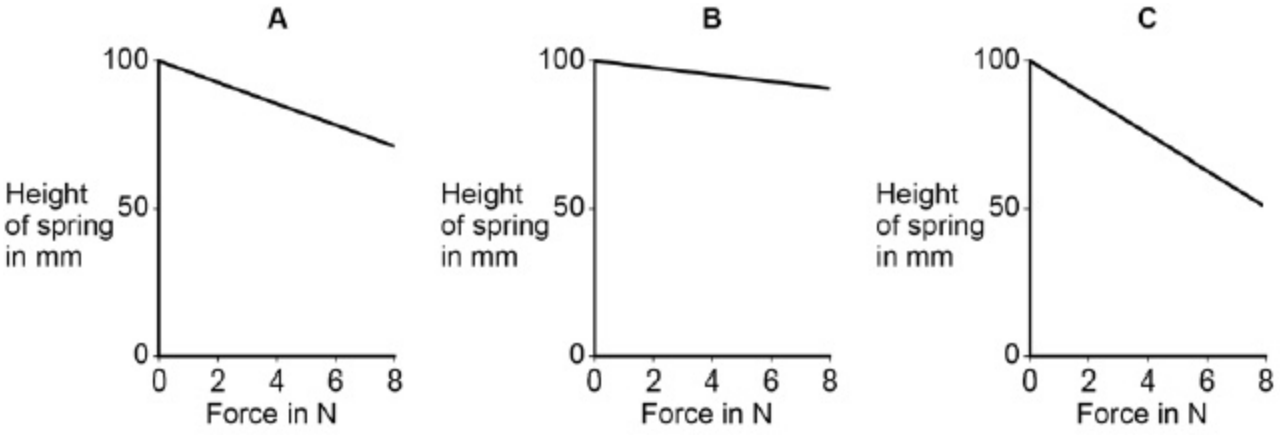
(a) Draw another arrow on **Figure 1** to represent the second force involved in compressing the spring.

(2)

A student investigated three different springs to compare the spring constants.

The results of the investigation are shown in **Figure 2**.

Figure 2



(b) Which **one** of the springs has the smallest spring constant?

Tick **one** box.

A ☐ **B** ☐ **C** ☐

Give the reason for your answer.

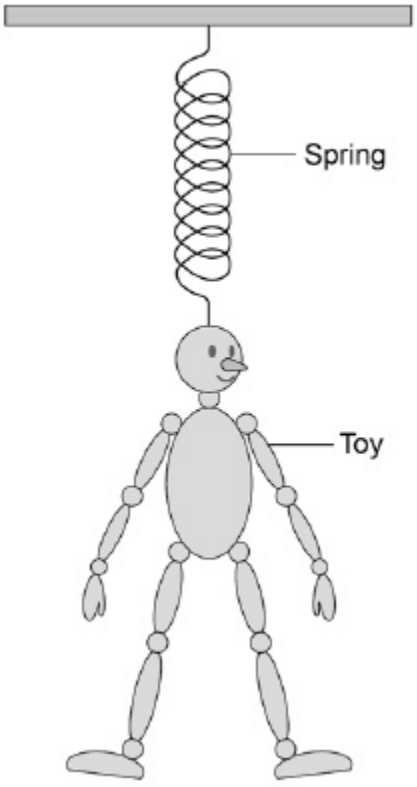
_____

_____

(2)

Figure 3 shows a child's toy. The toy hangs from a hook in the ceiling.

Figure 3



A child pulls the toy downwards and then releases it.

The toy oscillates up and down with a frequency of 1.25 Hz

(c) How many times each second will the toy oscillate up and down?

_____

(1)

(d) Calculate the period of the oscillating toy.

Use the Physics Equations Sheet.

_____

_____

_____

Period = _____ s

(2)

(e) When the toy is stationary, its weight causes the length of the spring to increase from 0.05 m to 0.25 m

The spring constant = 7.0 N/m

Calculate the elastic potential energy stored in the spring.

_____

_____

_____

_____

_____

Elastic potential energy stored = _____ J

(3)

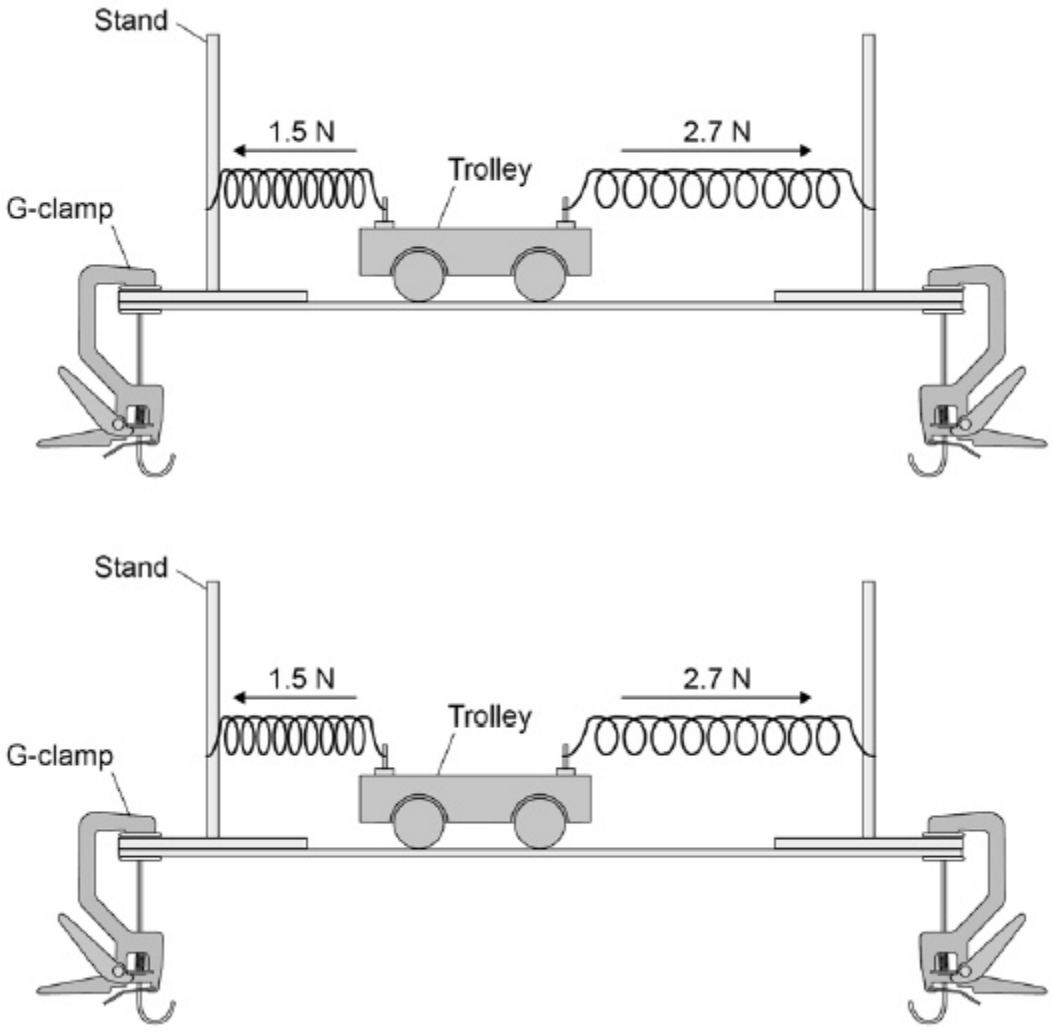
(Total 10 marks)

5. A trolley is attached to two identical springs.

The trolley is pushed to the left and then released.

Figure 1 shows the horizontal forces acting on the trolley just after it is released.

Figure 1



(a) Write the equation which links acceleration, mass and resultant force.

_____

(1)

(b) The trolley has a mass of 0.75 kg

Calculate the acceleration of the trolley just after it is released.

Give the unit.

_____

_____

_____

_____

_____

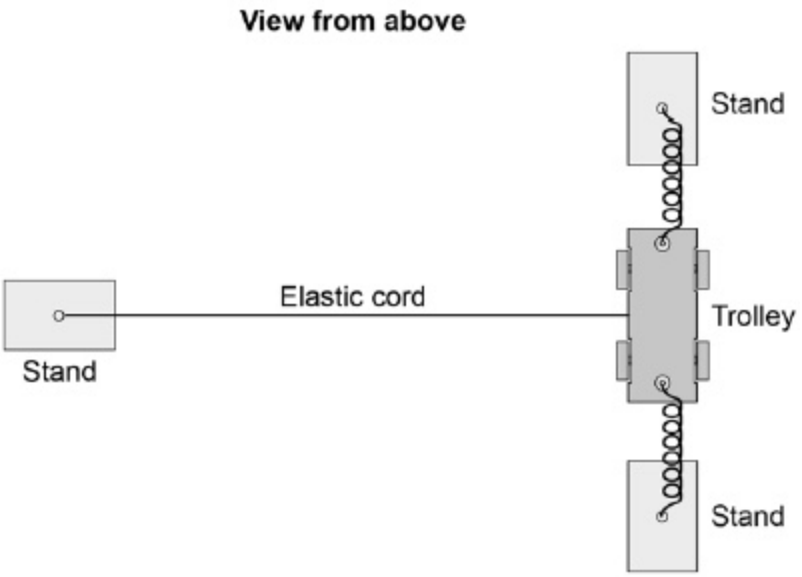
Acceleration = _____ Unit _____

(4)

An elastic cord is fixed to the trolley.

Figure 2 shows the arrangement viewed from above.

Figure 2



When the trolley is pushed and released a wave travels along the cord.

(c) What type of wave travels along the cord?

_____

Give the reason for your answer.

_____

_____

(2)

(d) Suggest one change that could be made to the apparatus shown in **Figure 2** to produce a wave with a lower frequency.

_____

_____

(1)

(Total 8 marks)

6. Momentum is a vector quantity.

(a) How is a vector quantity different to a scalar quantity?

_____

_____

(1)

(b) Name another vector quantity.

_____

(1)

(c) Give the definition of momentum.

_____

_____

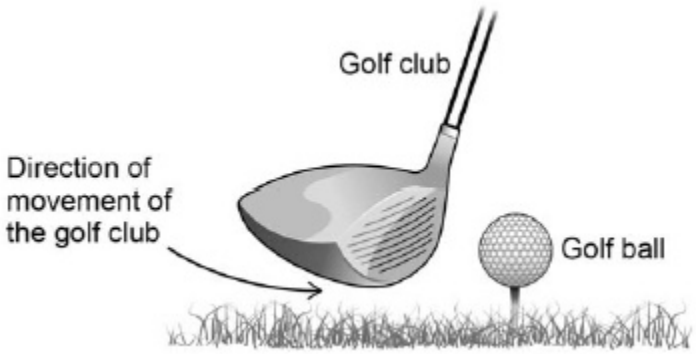
(1)

(d) What is the unit of momentum?

_____

(1)

(e) The image shows a golf club about to hit a stationary golf ball.



The golf club is in contact with the golf ball for 1.8 ms and exerts a force of 1500 N on the golf ball.

The mass of the golf ball is 0.045kg

Calculate the velocity of the golf ball as it leaves the golf club.

_____

_____

_____

_____

_____

_____

_____

Velocity = _____ m/s

(4)

(f) When hitting the golf ball the golfer swings the golf club to keep it in contact with the golf ball for as long as possible.

The force acting on the golf ball is constant during this time.

Explain the effect that the time of contact between the golf club and the golf ball has on the distance the golf ball travels.

(4)

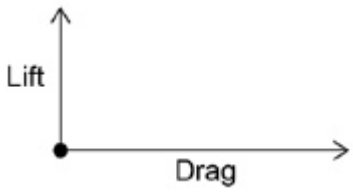
(Total 12 marks)

7. (a) **Figure 1** shows an aircraft flying at a constant velocity and at a constant height above the ground.

Figure 1

Complete the free body diagram in **Figure 2** to show the other two forces acting on the aircraft.

Figure 2



(2)

(b) A small aircraft accelerated down a runway at 4.0 m/s^2

The aircraft started from rest and reached a speed of 34 m/s just before take-off.

Calculate the distance the aircraft travelled while accelerating.

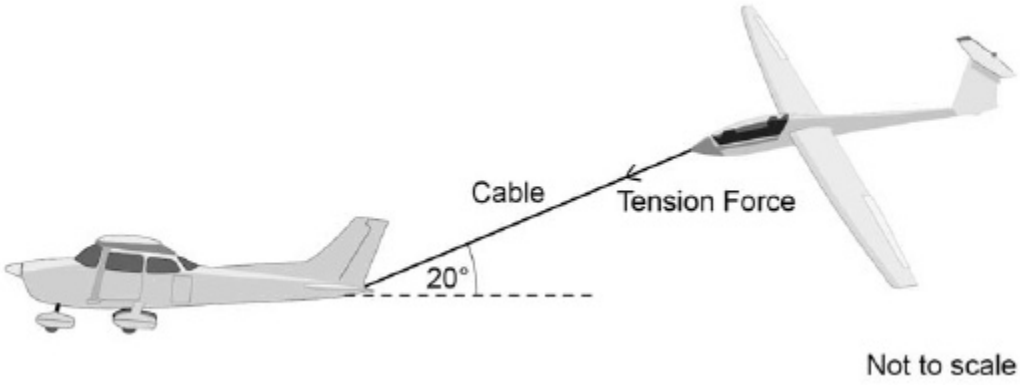
Give your answer to 2 significant figures.

Distance = _____ m

(4)

(c) **Figure 3** shows the small aircraft being used to tow a glider.

Figure 3



The tension force in the cable can be resolved into a horizontal component and a vertical component.

The tension in the cable is 2000 N

The cable makes an angle of 20° with the horizontal.

Draw a vector diagram to determine the magnitude of the two components of the tension force in the cable.

Magnitude of the horizontal component = _____ N

Magnitude of the vertical component = _____ N

(1)

(Total 10 marks)

8. Two students investigated how the acceleration of a trolley depends on the force applied to the trolley.

Before starting the investigation, each student wrote a hypothesis.

Hypothesis of student **A**:

'The acceleration of the trolley is directly proportional to the force applied to the trolley.'

Hypothesis of student **B**:

'Changing the force applied to the trolley will change the acceleration of the trolley.'

(a) Consider the hypothesis of student **A**.

Predict what would happen to the acceleration of the trolley if the force applied to the trolley is doubled.

_____

_____

(1)

(b) Why is it difficult to make a valid prediction using the hypothesis of student **B**?

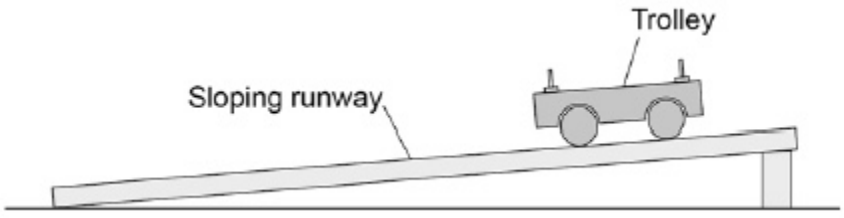
_____

_____

(1)

Figure 1 shows some of the equipment used by the students.

Figure 1



(c) Write a list of any other equipment the students will need to complete the investigation.

_____

_____

_____

_____

_____

(2)

(d) Why should the students use a sloping runway?

Tick **one** box.

To reduce the effect of friction on the trolley. ☐

To decrease the acceleration of the trolley. ☐

To stop the trolley rolling back up the runway. ☐

(1)

(e) Describe a method the students could have used for their investigation.

(6)

(f) The students used the same trolley throughout the investigation.

Suggest why.

_____

_____

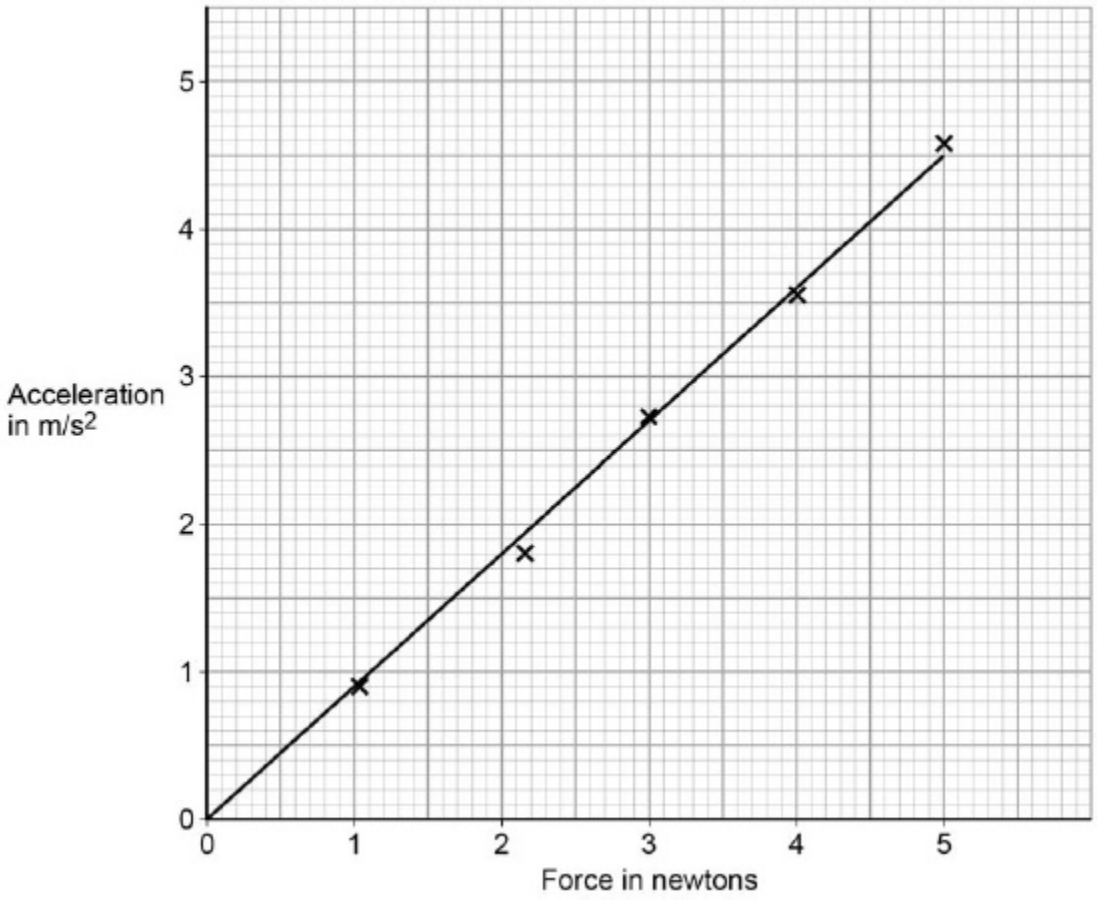
_____

_____

(2)

The students' results are shown as a graph in **Figure 2**.

Figure 2



(g) Explain why hypothesis **A** gives a better explanation of the results.

_____

_____

_____

_____

(2)

(Total 8 marks)

1.

(a) arrow of equal size pointing vertically upwards

judged by eye
ignore horizontal arrows if equal and opposite
horizontal arrows of unequal length negates this mark

1

labelled 'upthrust'

ignore buoyancy
ignore 25 kN

1

(b) weight = 25 kN

allow 24 to 25 kN inclusive

1

25 000 = mass × 9.8
or
$m = \frac{25000}{9.8}$

allow their W correctly converted and substituted

1

m = 2551 kg

allow correctly calculated value using their converted W
allow a value correctly calculated with W in kN

1

m = 2600 kg

allow a calculated answer correctly rounded to 2 significant figures

1

*an answer of 2600 scores **4** marks*

(c) Newton's 3rd law (of motion)

1

(d) vertical force (50 N) drawn
and
horizontal force (150 N) drawn to the same scale

1

resultant tension force in the correct direction
shown by an arrowhead

1

value of the tension force in the range 156 N−160 N
allow a calculated value of 158

1

value of direction in the range 18°−20° (from the horizontal)
allow 70° to 72° (from the vertical)
allow a bearing in the range 288 to 290

1

[11]

2. (a) equal to

1

(b) deceleration / decelerate
braking is insufficient

1

(c) $\frac{18}{6}$

1

3 (m/s^2)
*an answer of 3 (m/s^2) scores **2** marks*
*allow other correct pairs of numbers taken from **A** to **B***

1

(d) the stopping distance increases

1

by more than double

1

[6]

3. (a) **A**

1

(perpendicular) distance between the camera and pivot is greatest

1

(b) increases

1

(c) 5.0 × 9.8

*an answer of 49 scores **2** marks*

1

49

1

newton

allow N

1

(d) moment (of a force) = force × distance

allow M = Fd

1

(e) 144 cm = 1.44 m

*an answer of 70.56 scores **3** marks*

*an answer of 71 scores **3** marks*

1

moment = 49 × 1.44

allow ecf from part (c)

1

moment = 70.56

*answers of 7056 or 7100 score **2** marks*

1

[10]

4. (a) arrow drawn vertically downwards from the weight

1

same length as given arrow

1

(b) **C**

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

1

smallest force required for the same compression

steepest gradient is insufficient

1

(c) 1.25

1

(d) $\text{period} = \frac{1}{25}$

*an answer of 0.8 (s) scores **2** marks*

1

period = 0.8 (s)

1

(e) extension = 0.20 m

1

$E_e = 0.5 \times 7.0 \times (0.20)^2$

1

$E_e = 0.14$ (J)

*an answer of 0.14 scores **3** marks*

1

[10]

5. (a) (resultant) force = mass × acceleration

allow F = ma

symbols must be correct

1

(b) (2.7 – 1.5) = 0.75 × a

*an answer of 1.6 scores **3** marks*

1

$a = \frac{1.2}{0.75}$

allow compensation marks for correct use of incorrect resultant force

1

a = 1.6

1

m/s^2

1

(c) transverse

1

the oscillation / vibration is perpendicular to the direction of energy transfer

allow wave travel for energy transfer

1

(d) use springs with a smaller spring constant

allow use weaker springs

or

use a trolley with greater mass

allow use a heavier trolley

do not accept use a larger trolley

allow add a mass / weight to the trolley

1

(Total 8 marks)

6. (a) a vector has direction (a scalar does not)

1

(b) accept any vector quantities eg

- velocity
- force
- weight
- acceleration
- displacement

1

(c) mass × velocity

*do **not** accept speed for velocity*

*do **not** accept symbols*

1

(d) kilogram(s) metre per second

allow kg m/s

1

(e) 1.8 ms = 0.0018 s

*an answer of 60 (m/s) scores **4** marks*

1

$$1500 = \frac{0.045 \times v\,(-0.045 \times 0)}{0.0018}$$

1

$$v = \frac{1500 \times 0.0018}{0.045}$$

1

v = 60 (m/s)

*an answer of 60 000 scores **3** marks*

1

(g) longer the time of contact the greater the change of momentum

allow the converse

1

since the mass of the golf ball is constant

1

the velocity of the golf ball must increase

1

increasing the distance the golf ball travels

1

[12]

7. (a) arrow vertically down – same size as lift – labelled weight

judge by eye

1

arrow to the left – same size as drag - labelled thrust

judge by eye

*two correct arrows without labels gains **1** mark*

1

(b) $34^2 - (0^2) = 2 \times 4.0 \times s$

1

$$\frac{34 \times 34}{8} = s$$

1

s = 144.5

1

s = 140 (2 sig figs)

*an answer of 140 scores **4** marks*

*an answer of 144.5 scores **3** marks*

1

(c) tension force drawn to a suitable scale and in correct direction

1

triangle completed showing correct components

1

scale used to determine both component forces

1

horizontal component = 1900 N
vertical component = 680 N

allow 1850 to 1925 inclusive

allow 660 to 700 inclusive

1

[10]

8. (a) double

1

(b) the hypothesis does not say how increasing / decreasing the force increases / decreases the acceleration

1

(c) appropriate equipment to apply and measure force

*eg newtonmeter **or** slotted masses + string + pulley*

1

appropriate equipment to measure change in velocity and time

*eg ticker timer + tape **or** light gates + datalogger*

1

(d) to reduce the effect of friction on the trolley

1

(e)

Level 3: The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5-6
Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	3-4
Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1-2
No relevant content	0
Indicative content • method by which the trolley is to be accelerated • how the accelerating force is varied to give a suitable range of results • how the accelerating force is measured • the use of suitable apparatus to measure the change in velocity of the trolley over a given distance or time • what data is to be collected in order to calculate acceleration • how the data required is to be measured	

6

(f) so that the mass is constant

fair test is insufficient

1

as changing mass would change the acceleration (produced by a given force)

or

so there is only one independent variable

1

(f) hypothesis A because

***A** must be identified to gain either mark*

1

the results give a straight line that passes through the origin

showing direct proportionality

1

[15]