

Forces part 6 AQA Triple Physics

Name: _____

Class: _____

Date: _____

Time: **72 minutes**

Marks: **68 marks**

Comments:

1.

Very long trains can be pulled by more than one engine.

A train is made up of four engines pulling trucks filled with coal.

(a) The coal in one truck has a mass of 75 000 kg.

gravitational field strength = 9.8 N/kg

Calculate the weight of the coal in **one** truck.

Use the equation:

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

Weight = _____ N

(2)

(b) **One** engine exerts a forward force of 850 000 N.

Calculate the work done by **one** engine when the train moves a distance of 80 m.

Use the equation:

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

Work done = _____ J

(2)

(c) Each of the four engines exerts a forward force of 850 000 N on the trucks.

Calculate the total forward force on the trucks.

Total forward force = _____ N

(2)

(d) The force exerted by the engines on the trucks is a contact force.

Which of the following is also a contact force?

Tick (✓) **one** box.

Electrostatic force

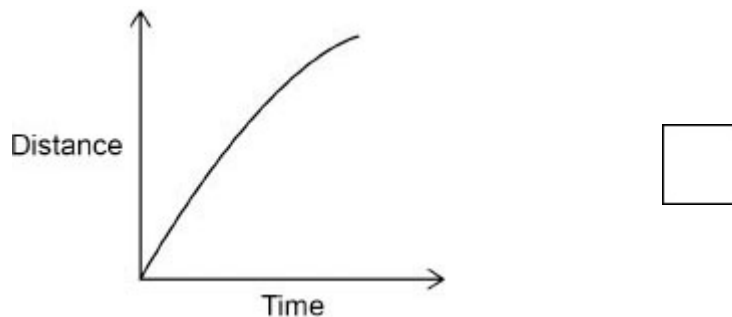
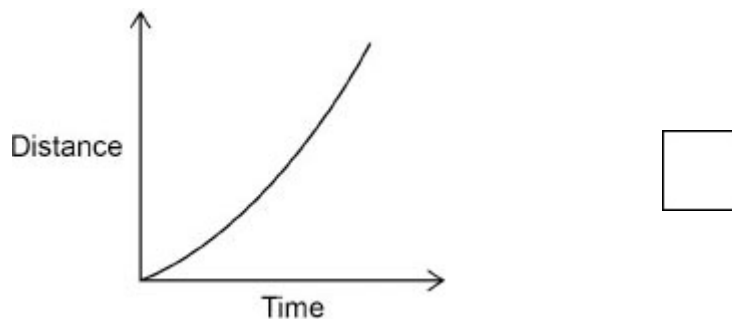
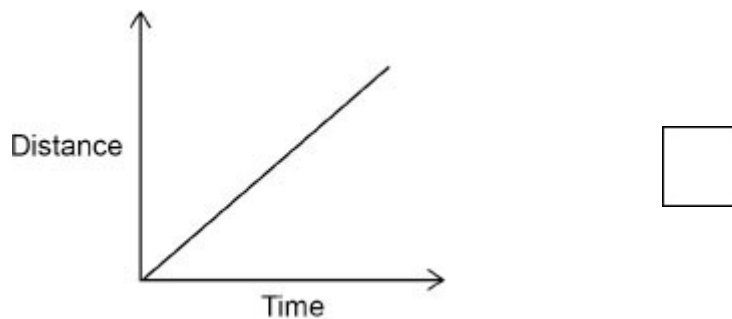
Frictional force

Gravitational force

(1)

(e) Which sketch graph represents the train moving at a constant speed?

Tick (✓) **one** box.



(1)

(f) The train accelerates for 150 s.

The velocity of the train changes from 16 m/s to 25 m/s.

Calculate the acceleration of the train.

Use the equation:

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

Acceleration = _____ m/s²

(3)

(Total 11 marks)

2.

Car **X** and car **Y** have engines that produce the same maximum forward force.

The cars are the same shape, but car **X** has a greater mass than car **Y**.

(a) How does the maximum acceleration of car **X** and car **Y** compare?

Tick (✓) **one** box.

Car **X** has a greater maximum acceleration.

Car **X** and car **Y** have the same maximum acceleration.

Car **X** has a smaller maximum acceleration.

(1)

(b) Car Y has a mass of 900 kg.

Car Y accelerates at 2.5 m/s^2 .

Calculate the resultant force on car Y.

Use the equation:

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

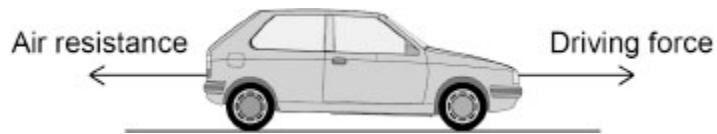
Resultant force = _____ N

(2)

(c) A car moves at a constant speed on a level road.

Figure 1 shows the horizontal forces on the car.

Figure 1



The driver makes the car accelerate until the car reaches its maximum speed.

Explain how the horizontal forces on the car change as the car accelerates to its maximum speed.

(4)

To pass a driving test, drivers need to understand the difference between thinking distance and braking distance.

(d) Complete the sentence.

Choose the answer from the box.

force	length	time
-------	--------	------

The thinking distance is affected by the driver's reaction _____.

(1)

(e) Complete the sentence.

Choose the answer from the box.

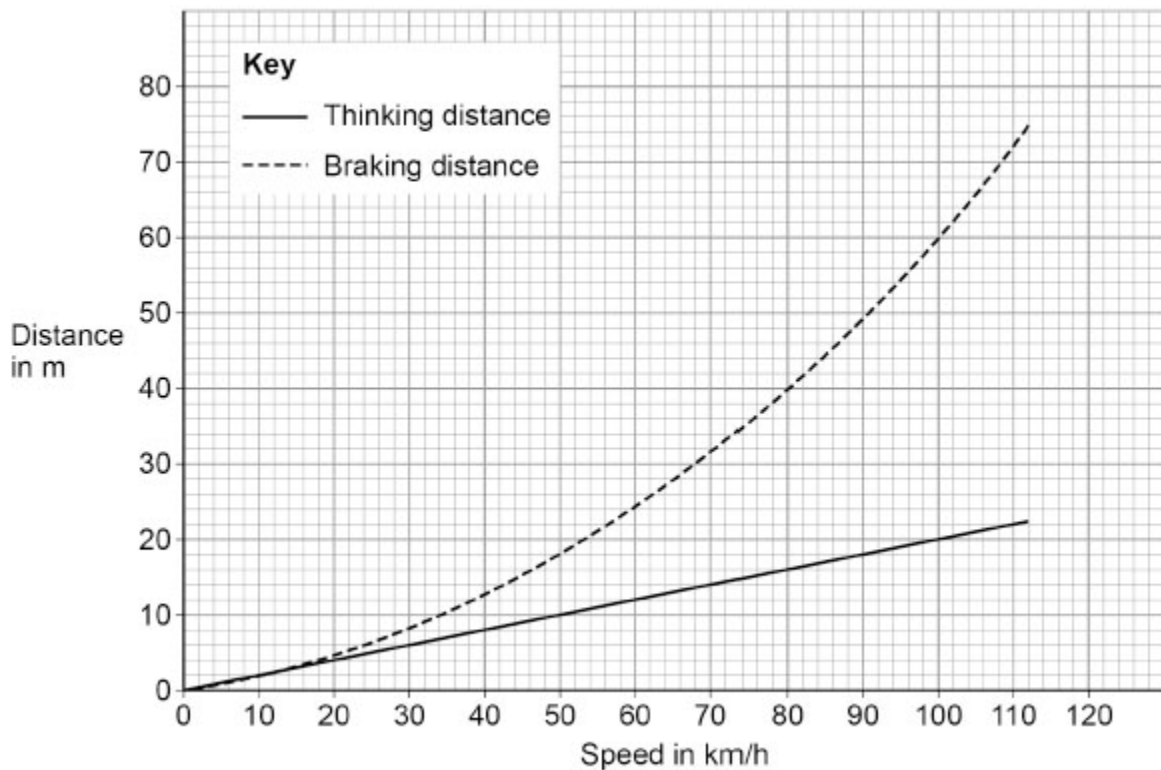
force	length	time
-------	--------	------

The braking distance is the distance travelled by the car under the braking _____.

(1)

(f) **Figure 2** shows how speed affects the thinking distance and braking distance of a car.

Figure 2



The car is moving at a speed of 100 km/h.

Calculate the stopping distance of the car.

Use **Figure 2**.

Stopping distance = _____ m

(3)

(g) Which **two** of the following would **increase** the stopping distance of a car?

Tick (✓) **two** boxes.

Fitting new brakes to the car

Fitting new tyres to the car

The driver becoming tired

Driving uphill

Driving on a wet road

(2)

(Total 14 marks)

3.

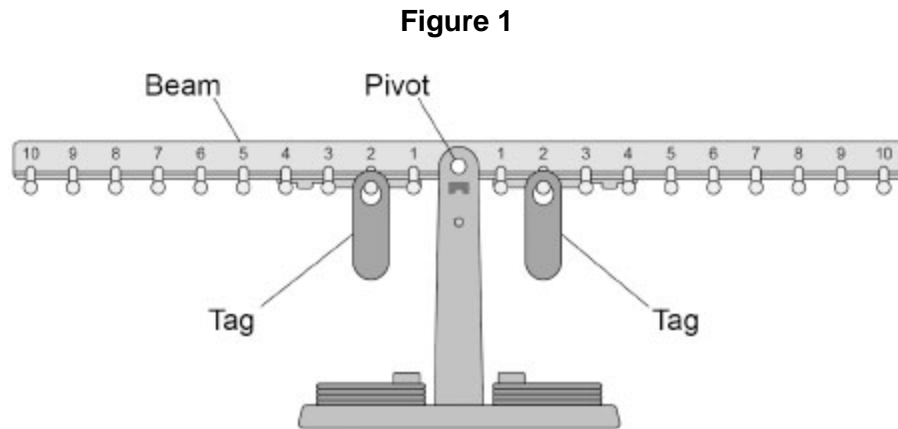
A 'number balance' is used to help children understand addition.

A number balance has a beam that can rotate around a pivot.

Small tags can be hung from the pegs on the beam.

Each tag has the same weight.

Figure 1 shows a number balance. The balance is in equilibrium.



(a) The weight of each tag on the beam in **Figure 1** causes a moment about the pivot.

What is meant by the 'moment' of a force?

Tick (✓) **one** box.

The direction of the force

The magnitude of the force

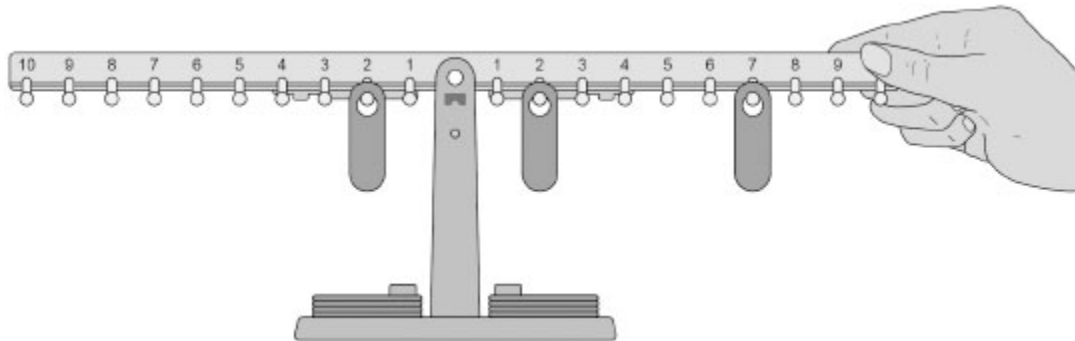
The turning effect of the force

(1)

A student holds the beam in a horizontal position and adds a tag to position 7 to the right of the pivot.

Figure 2 shows the new arrangement.

Figure 2



(b) The student lets go of the beam.

Which of the following describes the resultant moment on the beam?

Tick (✓) **one** box.

The resultant moment is anti-clockwise.

The resultant moment is clockwise.

The resultant moment is zero.

(1)

(c) Explain where the student should add another tag to make the beam in **Figure 2** balance.

(2)

Use the Physics Equations Sheet to answer parts (d) and (e).

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

(1)

(e) One tag causes a moment about the pivot of 1.8 N cm.

The weight of the tag is 0.15 N.

Calculate the distance between the pivot and the tag.

Give your answer in cm.

Distance = _____ cm

(3)

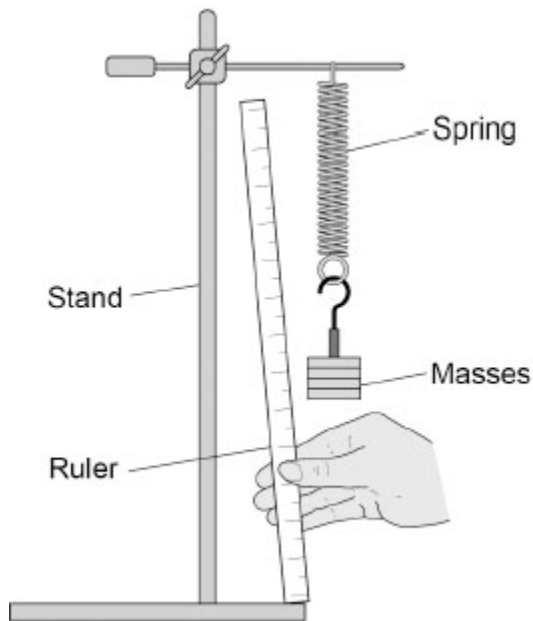
(Total 8 marks)

4.

A student investigated how the force applied to a spring affects the length of the spring.

Figure 1 shows the apparatus used.

Figure 1



(a) What is the independent variable in this investigation?

(1)

(b) Describe **one** risk of harm in this investigation and a safety precaution to reduce the risk.

Risk of harm _____

Safety precaution _____

(2)

(c) The student measured the length of the spring using the arrangement shown in **Figure 1**.

Give **two** ways the student could have changed the arrangement to improve the accuracy of the measurement.

1 _____

2 _____

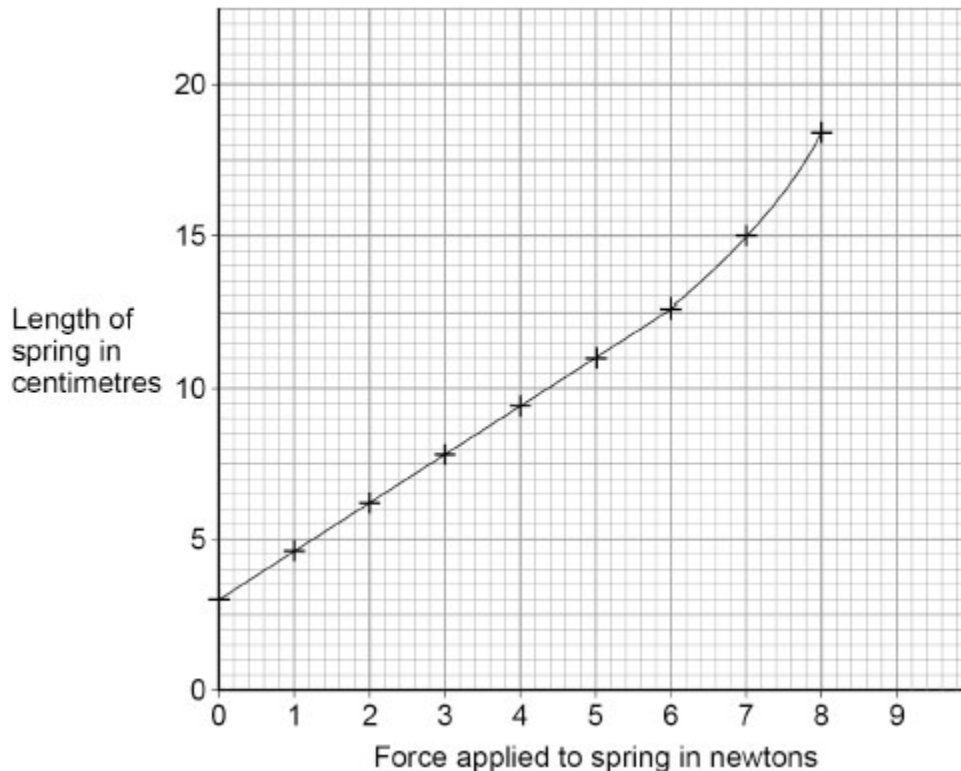
(2)

The student recorded accurate values for the length of the spring as the mass on the spring increased.

The student calculated the force applied to the spring by each mass.

Figure 2 shows the results.

Figure 2



(d) Why does the line on the graph **not** pass through the origin?

(1)

(e) Above 6.0 N the line on **Figure 2** curves upwards.

Explain why.

(2)

Use the Physics Equations Sheet to answer parts (f) and (g).

(f) Which equation links extension (e), force (F) and spring constant (k)?

Tick (✓) **one** box.

force = spring constant \times extension

force = $\frac{\text{spring constant}}{\text{extension}}$

force = $\frac{\text{extension}}{\text{spring constant}}$

(1)

(g) When the force on the spring is 4.0 N, the extension of the spring is 0.064 m.

Calculate the spring constant of the spring.

Spring constant = _____ N/m

(3)

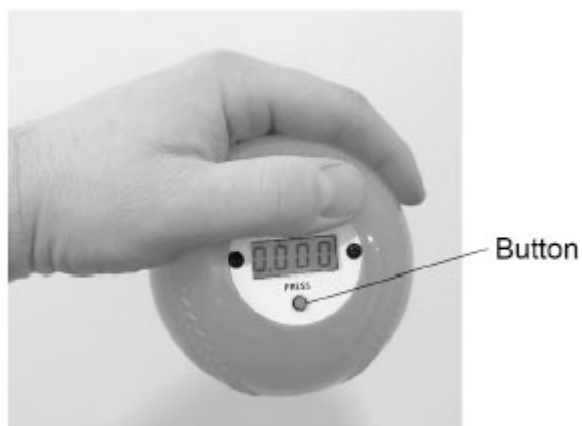
(Total 12 marks)

5.

A student investigated the acceleration of a ball dropped from different heights.

Figure 1 shows a 'gravity ball' that the student used.

Figure 1



The button on the gravity ball starts the stopwatch.

When the gravity ball hits the floor, the stopwatch stops.

This is the method used.

1. Measure a vertical height above the floor.
2. Hold the gravity ball at the measured height.
3. Start the stopwatch on the gravity ball and drop the gravity ball.
4. Record the time shown on the stopwatch.
5. Repeat steps 1 to 4 using the same height.
6. Repeat steps 1 to 5 using different heights.

- (a) The student dropped the ball from the same height five times and recorded the following results.

0.49 s 0.51 s 0.58 s 0.56 s 0.61 s

Calculate the uncertainty in these measurements of time.

Uncertainty = \pm _____ s

(2)

- (b) What type of error caused the variation in the measurements of time?

Tick (✓) **one** box.

Random error

Systematic error

Zero error

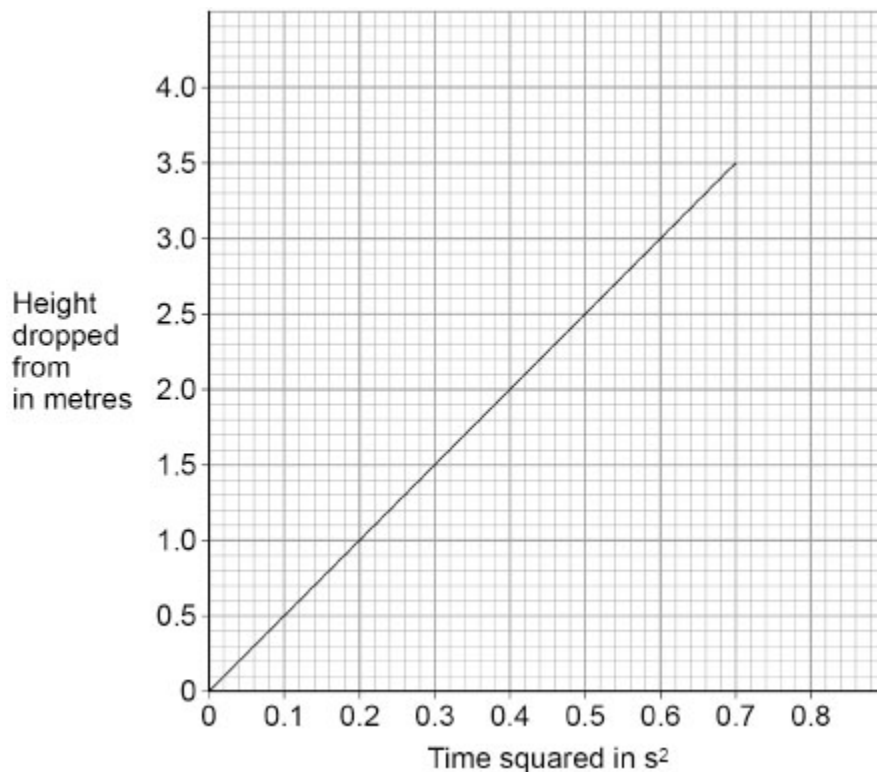
(1)

(c) Suggest **one** reason for the error that caused the variation in the measurements of time.

(1)

(d) **Figure 2** shows a graph of the height the ball was dropped from against the time squared.

Figure 2



The acceleration of the ball can be calculated using the equation:

$$\text{acceleration} = 2 \times (\text{gradient of the graph})$$

Determine the acceleration of the ball.

Acceleration of ball = _____ m/s²

(3)

(Total 7 marks)

6.

In a world record attempt, a skydiver jumped from a height of 40 km above the Earth.

- (a) The figure below shows an incomplete free-body diagram for the skydiver a few seconds after the start of the jump.



The skydiver has not reached terminal velocity.

Complete the free-body diagram in the figure above.

(2)

- (b) During the first 2.5 minutes the mean acceleration of the skydiver was 0.64 m/s^2 .

The initial velocity of the skydiver was 0 m/s .

Calculate the velocity of the skydiver 2.5 minutes after the start of the jump.

Use the Physics Equations Sheet.

Velocity = _____ m/s

(4)

(c) The skydiver accelerated until reaching terminal velocity.

Explain why the skydiver reached terminal velocity.

(4)

(d) Explain why the atmospheric pressure acting on the skydiver increased as the skydiver fell.

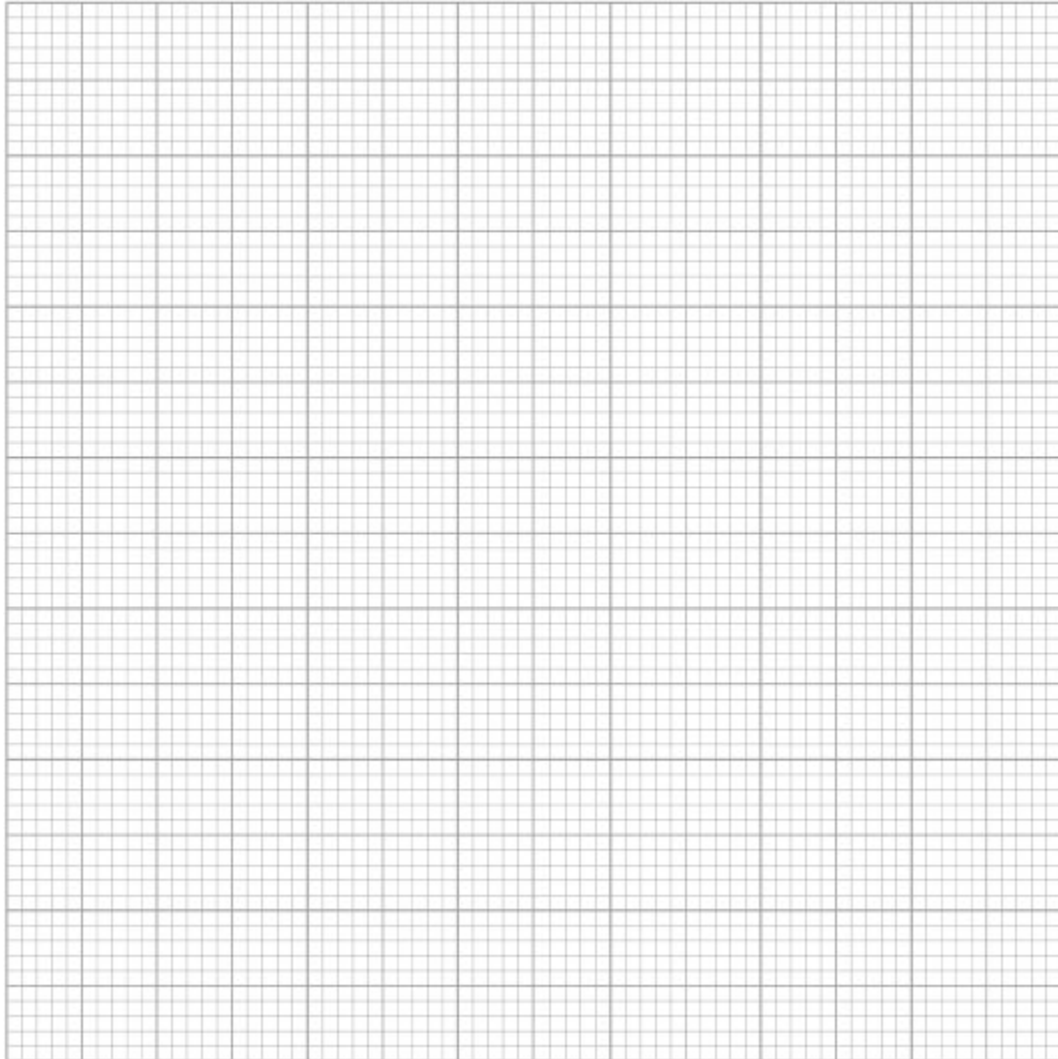
(2)

(e) The skydiver opened his parachute.

A few seconds after opening the parachute, the resultant vertical force on the skydiver was 240 N upwards.

The wind caused a resultant horizontal force of 200 N to the left on the skydiver.

Draw a vector diagram to determine the resultant force on the skydiver.



Magnitude of resultant force = _____ N

Angle to vertical of resultant force = _____ degrees

(4)

(Total 16 marks)

Mark schemes

1.

(a) $W = 75\,000 \times 9.8$

1

735 000 (N)

1

(b) $W = 850\,000 \times 80$

1

68 000 000 (J)

1

(c) $4 \times 850\,000$

1

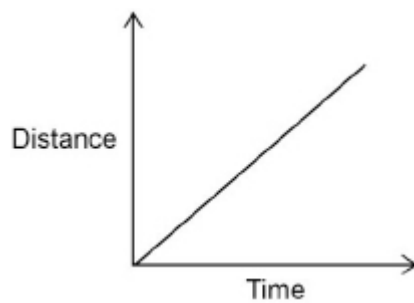
3 400 000 (N)

1

(d) frictional force

1

(e)



1

(f) $25 - 16 = 9$ (m/s)

subsequent marks may be awarded if an incorrectly calculated change in velocity is used

1

$$a = \frac{9}{150}$$

1

0.06 (m/s²)

1

[11]

2.

(a) car X has a smaller maximum acceleration

1

(b) $F = 900 \times 2.5$

1

2250 (N)

allow 2300 (N)

1

(c) **Level 2:** Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account. 3-4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking. 1-2

No relevant content 0

Indicative content

- driving force increases
- driving force has a maximum value
- driving force is greater than air resistance
- there is a resultant forward force
- air resistance increases (as speed increases)
- resultant force decreases
- air resistance becomes equal to the driving force (at maximum speed)
- resultant force is zero

For **Level 2** answers must include how both driving force and air resistance change.

(d) time 1

(e) force 1

(f) (thinking distance =) 20 **and** (braking distance =) 60
subsequent marks may be awarded if incorrect reading(s) are taken from the graph 1

stopping distance = 20 + 60 1

80 (m) 1

(g) the driver becoming tired 1

driving on a wet road 1

[14]

3. (a) the turning effect of the force 1

(b) the resultant moment is clockwise 1

- (c) the tag should be positioned left of the pivot 1
- the tag should be on position 7 1
- (d) moment (of a force) = force × distance
or
 $M = F d$ 1
- (e) $1.8 = 0.15 \times d$ 1
- $$d = \frac{1.8}{0.15}$$
- $d = 12 \text{ (cm)}$ 1

[8]

4.

- (a) force (applied to spring)
or
 weight (of the masses)
allow mass (hung from spring) 1
- (b) stand could tip over **and** hurt/hit the student
or
 masses could fall off **and** hurt/hit the student 1
- clamp base of stand to desk
allow rotate base/clamp
allow place some masses on the base of the clamp stand
allow student should stand up
allow limit the mass hung on spring
- OR**
- spring could snap **and** hurt the student (1)
- wear goggles (1)
allow limit the mass hung on spring 1

(c) any **two** from:

- ensure the ruler is vertical
allow move ruler so it is in line with spring
- clamp the ruler (close to the spring)
- attach a pointer to bottom of the spring
- use a ruler with a better resolution

2

(d) the spring length is not proportional to the force

or

the unstretched/initial length of the spring is not zero

allow student has plotted/measured spring length instead of extension

1

(e) the spring is inelastically deformed

1

(so) the extension is no longer proportional to the force

*allow the spring has reached/passed its limit of proportionality
allow no longer obeys Hooke's law*

1

(f) force = spring constant × extension

1

(g) $4.0 = k \times 0.064$

1

$$\frac{4.0}{0.064} = k$$

1

$$k = 62.5 \text{ (N/m)}$$

allow 63 (N/m)

1

[12]

5.

(a) range = $0.61 - 0.49$

or

range = 0.12

allow mean = 0.55

1

uncertainty = ± 0.06 (s)

1

(b) random error

1

- (c) the ball may have been dropped from different heights
or
 the initial speed of the ball may have been different
or
 there may have been a different delay between the student pressing the start button and releasing the ball

allow the stopwatch did not always stop (immediately) when the ball hit the floor

1

- (d) corresponding values of height and time squared read from graph
 eg 3.5 (m) and 0.70 (s²)

1

gradient = 5.0

1

acceleration = 10.0 (m/s²)

MP3 can be awarded for a correct calculation of acceleration using their gradient provided it is change in height ÷ change in time²

1

[7]

6.

- (a) single arrow starting from dot, pointing vertically upwards and shorter than weight arrow

1

labelled air resistance

allow drag

1

- (b) 2.5 minutes = 150 s

all subsequent marks may be awarded if time is incorrectly / not converted

1

$$0.64 = \frac{v-0}{150}$$

1

$$v = 0.64 \times 150$$

1

$$v = 96 \text{ (m/s)}$$

1

- (c) (as the skydiver's velocity / speed increased) the air resistance increased
allow drag for air resistance throughout 1
- until the air resistance was equal to the weight of the sky diver (and in the
 opposite direction) 1
- (so) the resultant force was zero 1
- (so) the acceleration was zero (so the velocity was constant) 1

- (d) greater weight of air above the skydiver as distance fallen increases
*allow the mass / number of air molecules above the skydiver
 increases* 1
- and pressure = F/A (so pressure increases)

OR

the density of the air surrounding the skydiver increases as the skydiver falls (1)
 more frequent collisions of air particles with skydiver (so pressure increases) (1) 1

- (e) triangle / parallelogram drawn with vertical line longer than horizontal line 1
- resultant force arrow in correct direction 1
- magnitude of resultant force in range 300 N to 320 N 1
- angle to vertical of resultant force in range 38 °– 42 ° 1

[16]