Forces part 7 AQA Triple Physics

Name: _____

Class: _____

Date: _____

Time: **72 minutes**

Marks: **69 marks**

Comments:

1. A car manufacturer makes two cars, **X** and **Y**.

The cars are identical, apart from their mass.

Car **X** has a greater mass than car **Y**.

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

_____

_____

(1)

(b) Cars have air bags that inflate to protect the driver if the car stops very suddenly.

Explain how air bags reduce the chance of injury to the driver.

_____

_____

_____

_____

_____

_____

(3)

(c) Car **X** has a mass of 1400 kg and is travelling at 18 m/s.

The driver applies the brakes.

The car has a constant deceleration and comes to a stop in a distance of 24 m.

Calculate the resultant force on the car.

Use the Physics Equations Sheet.

Resultant force = _____ N

(5)

(d) Explain why braking causes an increase in the temperature of the brakes.

(2)

(e) The driver of a car applies the brakes so the car has a large deceleration.

Give **two** possible risks of a large deceleration.

1 _____

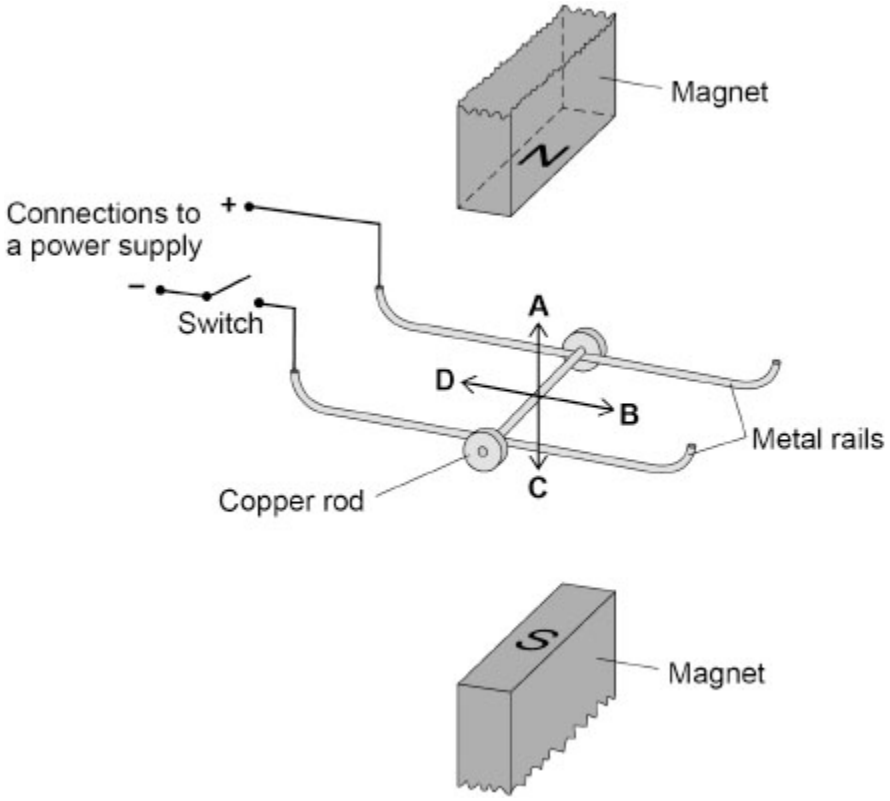
2 _____

(2)

(Total 13 marks)

2. **Figure 1** shows some apparatus used to demonstrate the motor effect.

Figure 1



When the switch is closed the copper rod accelerates.

(a) What direction is the acceleration of the copper rod?

Tick (✓) **one** box.

A ☐

B ☐

C ☐

D ☐

(1)

(b) The copper rod has a mass of 5.0 g.

The length of the copper rod in the magnetic field is 0.070 m.

The magnetic flux density is 0.30 T.

Calculate the initial acceleration of the rod when the current in the rod is 2.0 A.

Use the Physics Equations Sheet.

Initial acceleration = _____ m/s^2

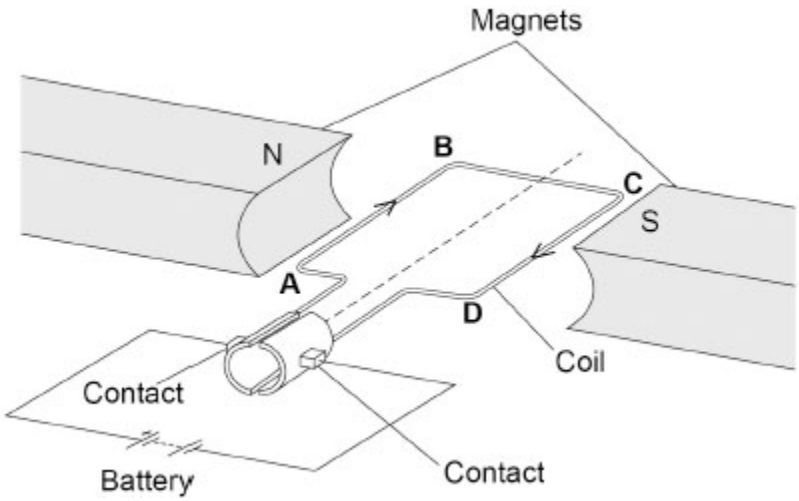
(5)

Figure 2 shows a simple motor.

There is a magnetic field between the two permanent magnets.

When there is a current in the coil, a magnetic field is produced around the coil.

Figure 2



(c) Explain how these magnetic fields cause the coil to continuously rotate.

(4)

(d) In **Figure 2** the coil of the motor is in a horizontal position.

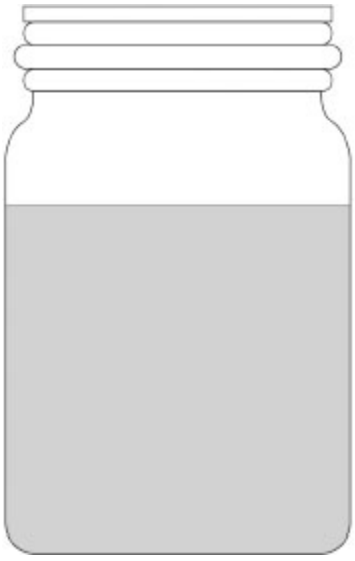
Explain why the resultant moment on the coil is zero when the coil is in a vertical position.

(2)

(Total 12 marks)

3. **Figure 1** shows a jar containing some liquid.

Figure 1



(a) The pressure in the liquid causes a force on the inside walls of the jar.

What direction is the force acting on the inside walls of the jar?

_____

_____

(1)

(b) The liquid in the jar has a weight of 1.50 N.

The liquid exerts a pressure of 774 N/m^2 on the base of the jar.

Calculate the area of the base of the jar.

Use the Physics Equations Sheet.

Give your answer to 3 significant figures.

_____

_____

_____

_____

_____

_____

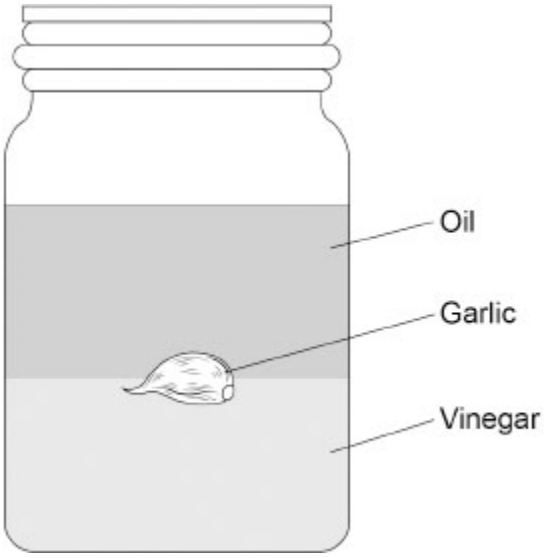
_____

Area (3 significant figures) = _____ m^2

(4)

(c) **Figure 2** shows a jar containing oil, vinegar and a piece of garlic.

Figure 2



The garlic in **Figure 2** is floating at the boundary between the two liquids.

Explain why there is an upthrust on the garlic.

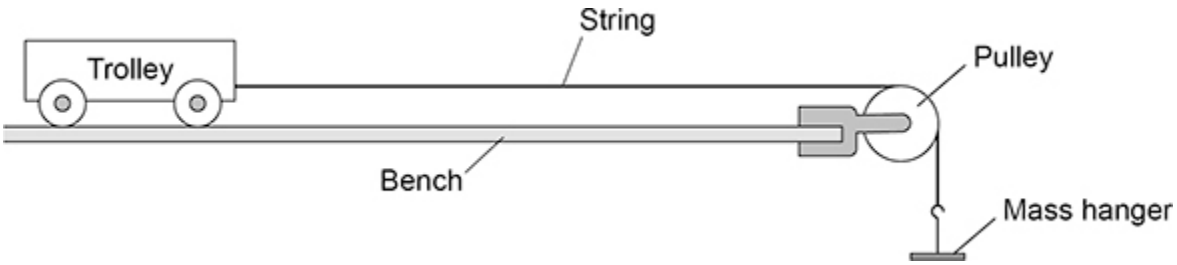
(4)

(Total 9 marks)

4. A student investigated how changing the mass of a trolley affects the acceleration of the trolley.

Figure 1 shows some of the equipment used.

Figure 1



(a) The trolley in **Figure 1** is not moving.

Which force prevents the trolley from moving?

Tick (✓) **one** box.

Friction ☐

Tension ☐

Weight ☐

(1)

The force pulling on the trolley was increased so that the trolley accelerated.

The force was then kept constant and different masses were put on the trolley.

For each different mass the acceleration of the trolley was measured.

(b) Draw **one** line from each variable to the correct quantity.

Variable	**Quantity**
	Acceleration of the trolley
Independent variable	
	Length of the bench
	Total mass of the trolley
Dependent variable	
	Force pulling on the trolley

(2)

(c) For one of the masses put on the trolley, the student recorded three values of acceleration.

1.58 m/s^2 1.53 m/s^2 1.54 m/s^2

Calculate the mean acceleration of the trolley.

_____

_____

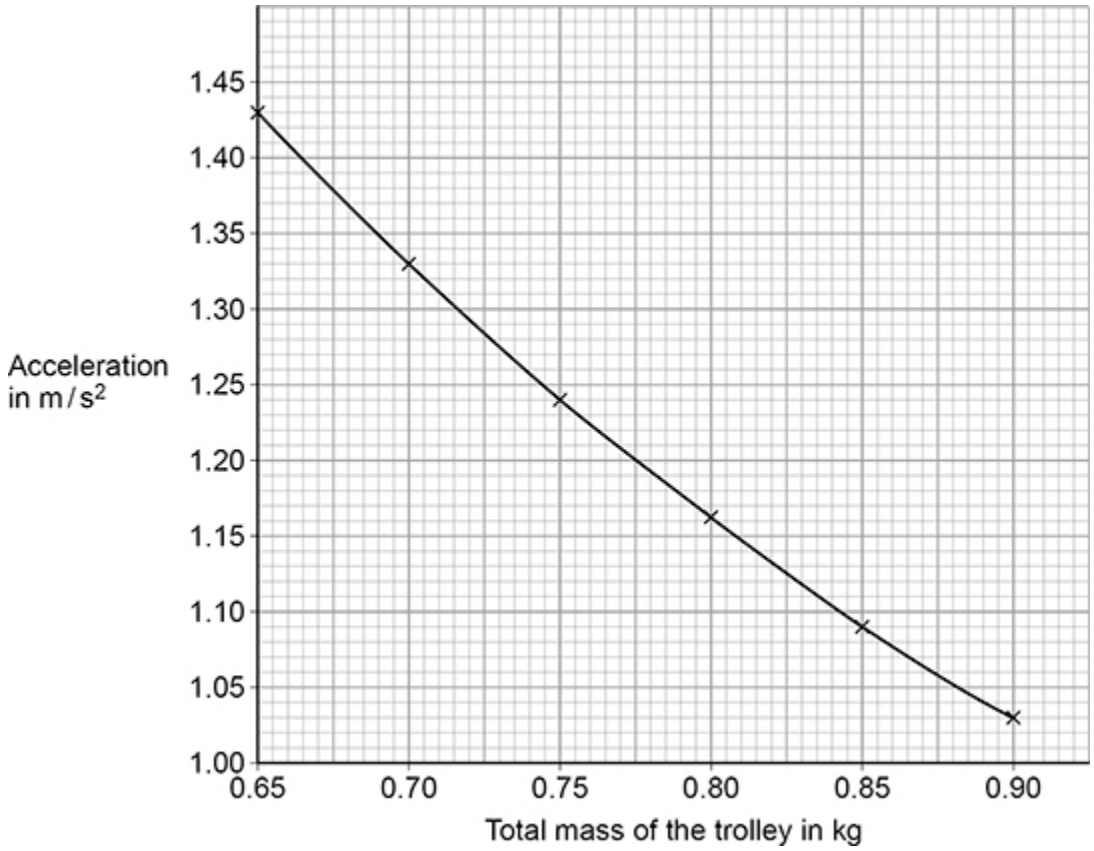
_____

Mean acceleration = _____ m/s^2

(2)

Figure 2 shows some of the results.

Figure 2



(d) Describe the relationship shown in **Figure 2**.

_____

_____

(1)

(e) When the total mass of the trolley was 1.5 kg, the acceleration of the trolley was 0.62 m/s^2.

Calculate the resultant force acting on the trolley.

Use the equation:

resultant force = mass × acceleration

_____

_____

_____

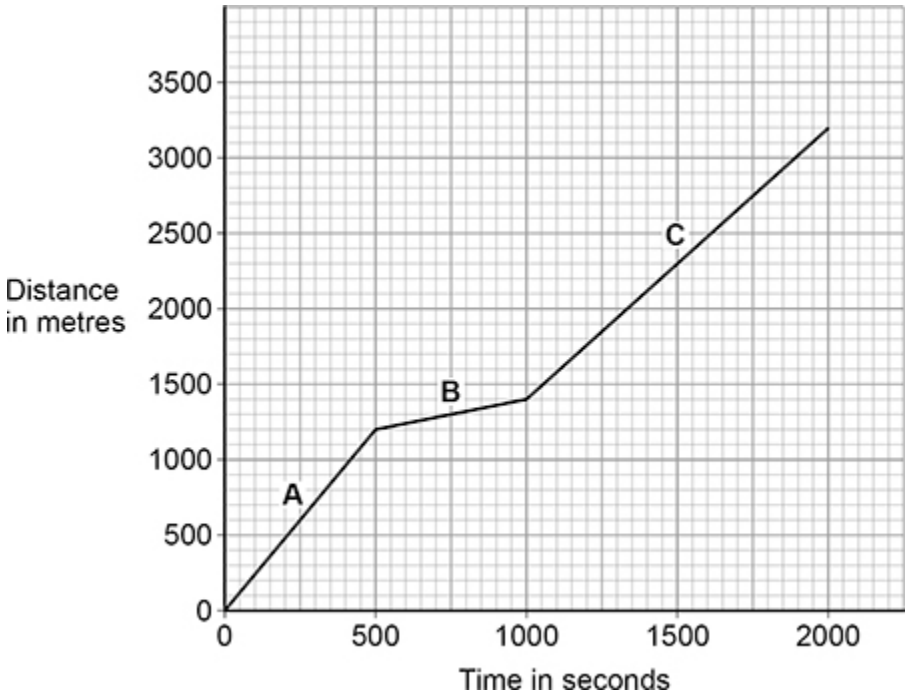
Resultant force = _____ N

(2)

(Total 8 marks)

5. A person has been for a walk.

The figure below shows the distance–time graph for the walk.



(a) Some quantities are scalar quantities and others are vector quantities.

Which of the following are scalar quantities?

Tick (✓) **two** boxes.

Displacement	☐
Distance	☐
Force	☐
Speed	☐
Velocity	☐

(2)

(b) What was the total distance walked by the person in 2000 seconds?

Total distance = _____ m

(1)

(c) Calculate the average speed of the person during the 2000 seconds.

Use your answer to part (b)

Use the equation:

$$\text{average speed} = \frac{\text{total distance}}{\text{total time}}$$

_____

_____

_____

Average speed = _____ m/s

(2)

(d) Which section of the figure above shows the person walking the slowest?

Give a reason for your answer.

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐

Reason _____

_____

(2)

(e) The person walked slowest when going up some steps.

Complete the sentence.

Choose the answer from the box.

air resistance	**friction**	**gravity**

When walking up the steps, the person did more work against the

force of _____ .

(1)

(f) On another day, the person ran the same route.

What is a typical speed for a person running?

Tick (✓) **one** box.

0.3 m/s ☐

3.0 m/s ☐

30 m/s ☐

(1)

(Total 9 marks)

6. A swimming pool is being filled with water.

(a) Calculate the weight of the water in the swimming pool when the mass of the water is 25 000 kg.

gravitational field strength = 9.8 N/kg

Use the equation:

weight = mass × gravitational field strength

_____

_____

_____

Weight = _____N

(2)

(b) When the swimming pool is full, the weight of the water is 1 960 000 N.

The bottom of the swimming pool has an area of 49 m^2.

Calculate the pressure at the bottom of the swimming pool when it is full.

Use the equation:

$$\text{pressure} = \frac{\text{weight}}{\text{area}}$$

Choose the unit from the box.

m^2	**m^3**	**N**	**Pa**

_____

_____

_____

_____

_____

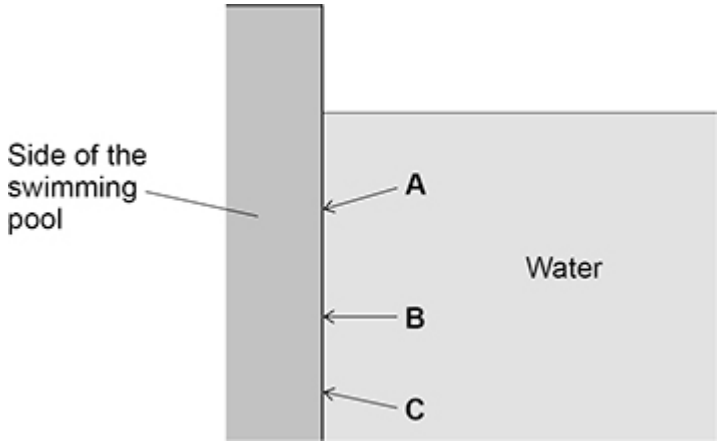
Pressure = _____ Unit _____

(3)

(c) There is a force acting on the side of the swimming pool because of the water pressure.

Figure 1 shows the side of the swimming pool.

Figure 1



Which arrow shows the direction of the force acting on the side of the swimming pool?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐

(1)

(d) A child is swimming in the pool. The velocity of the child is 0.70 m/s.

The child then accelerates for 5.0 s, reaching a final velocity of 1.3 m/s.

Calculate the acceleration of the child.

Use the equation:

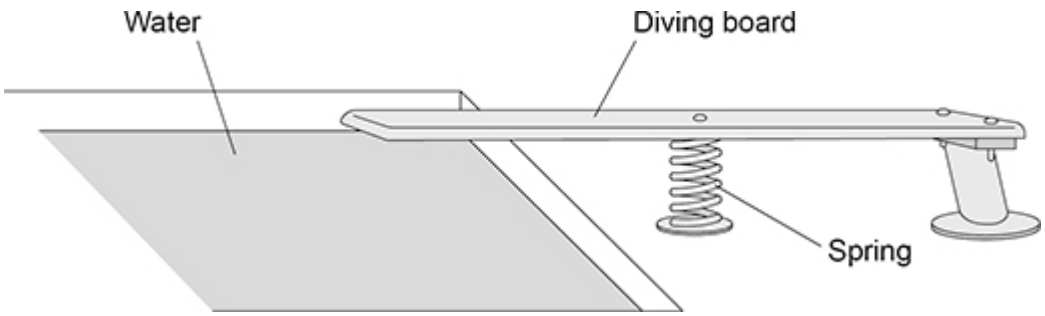
$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

Acceleration = _____ m/s^2

(2)

Figure 2 shows a diving board at the side of the swimming pool.

Figure 2



(e) The original length of the spring is 0.84 m.

When the child stands on the diving board, the length of the spring decreases by 0.21 m.

Calculate the percentage change in the length of the spring.

_____

_____

_____

Percentage change in length = _____ %

(2)

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

(f) Write down the equation which links extension (*e*), force applied to a spring (*F*) and spring constant (*k*).

_____

(1)

(g) The force applied to the spring by the weight of the child is 336 N.

The change in length of the spring is 0.21 m.

Calculate the spring constant of the spring.

_____

_____

_____

_____

_____

Spring constant = _____ N/m

(3)

(h) The child steps off the diving board and falls into the swimming pool.

The initial velocity of the child is 0 m/s.

acceleration due to gravity = 9.8 m/s^2

Calculate the final velocity when the child has fallen a distance of 0.95 m through the air.

Give your answer to 2 significant figures.

Use the Physics Equations Sheet.

Final velocity of child (2 significant figures) = _____ m/s

(4)

(Total 18 marks)

1.

(a) car **X** has a smaller maximum acceleration (than car **Y)**

1

(b) increases the time taken (for the driver to come to a stop)

allow for MP1 ***and*** *MP2*

the change of momentum is the same but over a greater time

1

(so) the rate of change of momentum decreases
or
the deceleration / acceleration of the driver is less

1

(so) the force (on the driver) is reduced

1

(c) $0 - 18^2 = 2 \times a \times 24$

1

$$a = -\frac{324}{48}$$

1

$a = -6.75$

the equation $v^2 - u^2 = 2as$ must have been used to score subsequent marks

1

$F = 1400 \times (\&-) 6.75$

1

9450 (N)

OR

$$E_k = \frac{1}{2} \times 1400 \times 18^2$$

=226 800 (1)

$226\,800 = F \times 24$ (1)

the equation $E_k = \frac{1}{2} m v^2$ must have been used to score subsequent marks

$$F = \frac{226\,800}{24}$$

9450 (N) (1)

OR

average velocity = (18 + 0) / 2 (1)

$24 = 9 \times t$ (1)

$$t = \frac{24}{9}$$

$$F = \frac{1400 \times 18}{\frac{24}{9}}$$

subsequent marks may be awarded if t has been calculated using initial velocity rather than average velocity

9450 (N) (1)

1

(d) work is done by friction (in the brakes)

ignore friction alone

1

(some of the kinetic) energy (of the vehicle) is transferred as thermal energy (in the brakes)

1

(e) the brakes will overheat

1

the driver will lose control of the car

1

[13]

2. (a) B

1

(b) $F = 0.30 \times 2.0 \times 0.070$

1

$F = 0.042$ (N)

the equation $F = BIl$ must have been used to score subsequent marks

1

$0.042 = 0.005 \times a$

subsequent marks may be awarded if an incorrectly / not converted mass is used

1

$$a = \frac{0.042}{0.005}$$

1

$a = 8.4$ (m/s^2)

1

(c) (the interaction of) the magnetic fields produce forces on the sides of the coil (AB and CD)

*do **not** accept answers describing a generator*

1

AB and CD move in opposite directions

1

(each half-revolution) the ends of the coil swap from one contact to the other

allow 'split ring commutator' for ends of the coil'

1

(so) current in each side of the coil is reversed, so the forces on each side of the coil are reversed

1

(d) there is no current in the wire

1

(so) there is no (magnetic) force acting (therefore there is no moment)

MP2 is dependent on MP1

1

[12]

3.

(a) at right angles (to surfaces)
or
normal (to surfaces)

1

(b)

$$774 = \frac{1.50}{A}$$

1

$$A = \frac{1.50}{774}$$

1

A = 0.0019379…

1

0.00194 (m^2)

allow an answer calculated using all the data in the question given to three significant figures

1

(c) pressure increases with depth

allow the vinegar has a greater density than the oil

1

(so) the pressure on the bottom of the garlic (from the vinegar) is greater than the pressure on the top of the garlic (from the oil)

1

(therefore) the upwards force on the bottom is greater than the downwards force on the top

1

the resultant of these two forces is the upthrust

this mark is dependent on MP2 ***or*** *MP3*

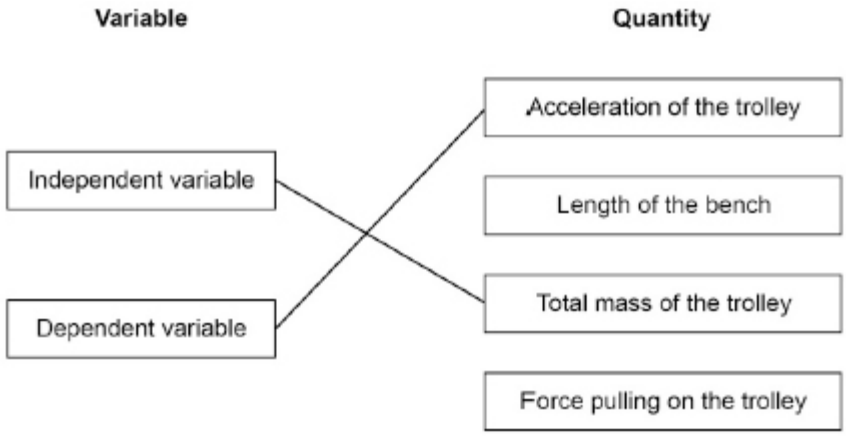
1

[9]

4. (a) friction

1

(b)



2

(c)

$$\frac{1.58 + 1.53 + 1.54}{3}$$

1

1.55 (m/s^2)

1

(d) the acceleration is inversely proportional to the mass

allow as the mass increases the acceleration decreases

allow negative correlation

1

(e) $F = 1.5 \times 0.62$

1

$= 0.93$ (N)

1

[8]

5. (a) distance

1

speed

1

(b) 3200 (m)

1

(c)

average speed = $\frac{3200}{2000}$

allow ecf from question ***b***

1

= 1.6 (m/s)

1

(d) B

1

It has the smallest gradient

MP2 is dependent on MP1

1

(e) gravity

1

(f) 3.0 m/s

1

[9]

6. (a) $W = 25\,000 \times 9.8$

1

= 245 000 (N)

1

(b)

$p = \frac{1\,960\,000}{49}$

1

= 40 000

1

Pa

1

(c) B

1

(d)

$$a = \frac{1.3 - 0.7}{5.0}$$

1

$= 0.12\ (m/s^2)$

1

(e)

$$\frac{0.21}{0.84} \times 100$$

1

25%

1

(f) force (applied to the spring) = spring constant × extension

or

$F = k \times e$

1

(g) $336 = k \times 0.21$

1

$$\frac{336}{0.21} = k$$

1

$k = 1600$ (N/m)

1

(h) $v^2 - 0 = 2 \times 9.8 \times 0.95$

1

$v^2 = 18.62$

allow $v = \sqrt{(18.62)}$

1

$v = 4.3150\ldots$

1

$= 4.3$ (m/s)

allow an answer correctly rounded to 2 significant figures from an incorrect calculation which uses the values in the question

1

[18]