Forces part 3 AQA Triple Physics

Name: _____

Class: _____

Date: _____

Time: **80 minutes**

Marks: **77 marks**

Comments:

1. (a) The driver of a vehicle sees a hazard on the road.

The driver uses the brakes to stop the vehicle.

Explain the factors that affect the distance needed to stop a vehicle in an emergency.

(6)

(b) Write down the equation which links distance, force and work done.

(1)

(c) The work done by the braking force to stop a vehicle was 900 000 J

The braking force was 60 000 N

Calculate the braking distance of the vehicle.

_____

_____

_____

_____

Braking distance = _____ m

(3)

(d) The greater the braking force, the greater the deceleration of a vehicle.

Explain the possible dangers caused by a vehicle having a large deceleration when it is braking.

_____

_____

_____

_____

_____

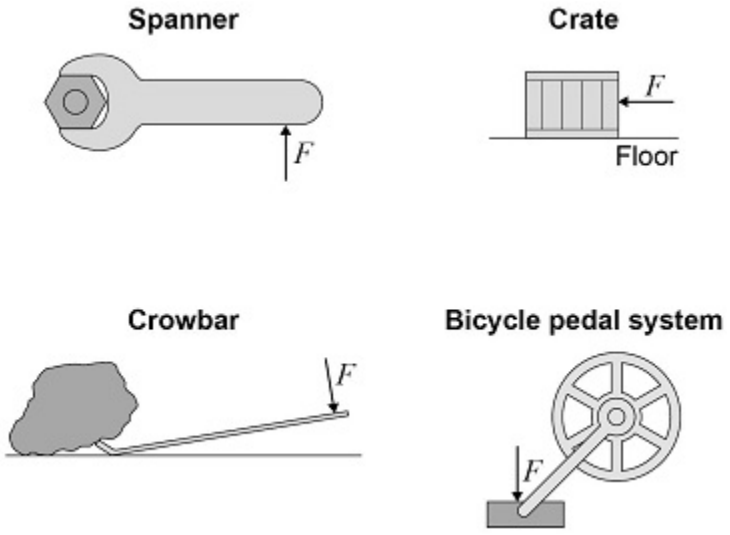
_____

(2)

(Total 12 marks)

2. (a) **Figure 1** shows four examples of a force causing an object to move.

Figure 1



Which object is **not** likely to rotate?

Tick (✓) **one** box.

Bicycle pedal system ☐

Crate ☐

Crowbar ☐

Spanner ☐

(1)

Figure 2 shows a simple device that can be used as a weighing scale.

Figure 3 shows the device being used to measure a quantity of rice.

The weight of the device is balanced by the weight of the rice and basket.

Figure 2

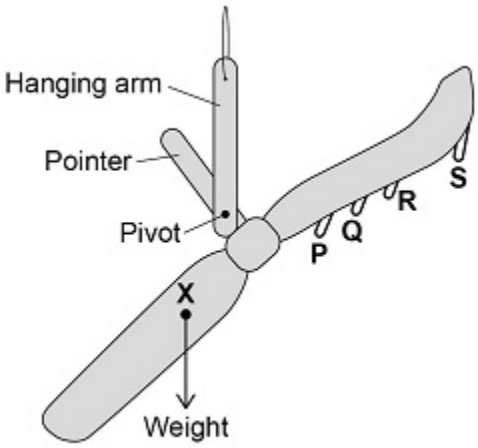
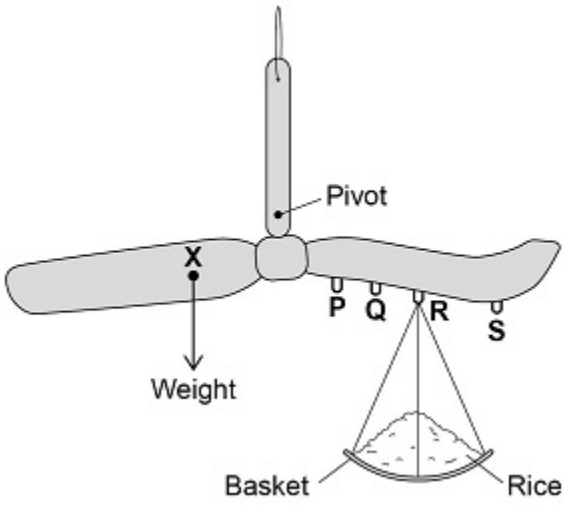


Figure 3



(b) The weight of the device acts through the point labelled **X**.

What is point **X** called?

Tick (✓) **one** box.

Centre of balance ☐

Centre of mass ☐

Centre of weight ☐

(1)

(c) How does **Figure 3** show that the weight of the device is balanced by the weight of the rice and basket?

_____

_____

_____

(1)

(d) The basket can hang from different points on the device.

Where should the basket hang to measure the largest quantity of rice?

Tick (✓) **one** box.

P ☐ **Q** ☐ **R** ☐ **S** ☐

(1)

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

_____

(1)

(f) In **Figure 3**, the weight of the device causes an anticlockwise moment of 0.15 Nm about the pivot.

The weight of the rice and basket acts 0.06 m from the pivot.

Calculate the weight of the rice and basket.

_____

_____

_____

_____

Weight of rice and basket = _____ N

(3)

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

_____

(1)

(h) The basket has a mass of 0.04 kg

gravitational field strength = 9.8 N/kg

Calculate the mass of rice in the basket.

_____

_____

_____

_____

Mass = _____ kg

(3)

(Total 12 marks)

3. (a) An adult of mass 80 kg has more inertia than a child of mass 40 kg

What is inertia?

_____

_____

(1)

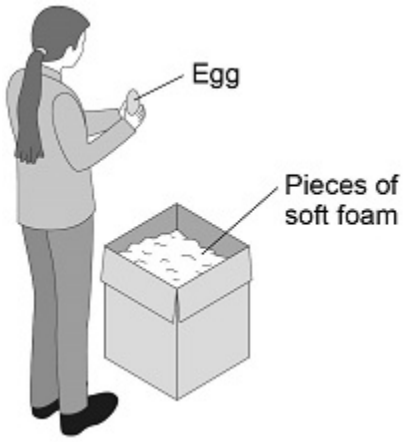
(b) A teacher demonstrated the idea of a safety surface.

She dropped a raw egg into a box filled with pieces of soft foam.

The egg did not break.

Figure 1 shows the demonstration.

Figure 1



Explain why the egg is less likely to break when dropped onto soft foam rather than onto a concrete floor.

_____

_____

_____

_____

_____

_____

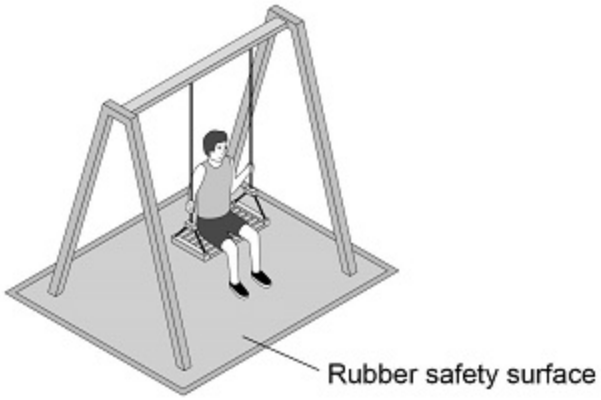
_____

_____

(3)

(c) **Figure 2** shows a child on a playground swing. The playground has a rubber safety surface.

Figure 2



A child of mass 32 kg jumped from the swing.

When the child reached the ground she took 180 milliseconds to slow down and stop.

During this time an average force of 800 N was exerted on her by the ground.

Calculate the velocity of the child when she first touched the ground.

Use the Physics Equations Sheet.

Velocity = _____ m/s

(4)

(Total 8 marks)

4. (a) The Sun is a star.

Which galaxy is the Sun in?

Tick **one** box.

- Cartwheel ☐
- Milky Way ☐
- Starburst ☐
- Tadpole ☐

(1)

(b) Light takes 500 seconds to travel from the Sun to the Earth.

Light travels at 300 000 kilometres per second.

Calculate the distance between the Sun and the Earth.

Use the equation:

distance = speed × time

_____

_____

_____

_____

Distance = _____ kilometres

(2)

The table below gives information about some of the planets in our solar system.

The planets are in order of increasing distance from the Sun.

Planet	Time to orbit the Sun in years
Mercury	0.2
Venus	0.6
Earth	1.0
Mars	
Jupiter	12.0

(c) There are some planets in our solar system missing from the table above.

How many planets are missing?

_____

(1)

(d) Estimate how many years it takes Mars to orbit the Sun.

_____ years

(1)

(e) Calculate how many times Venus will orbit the Sun in 9 years.

_____

_____

_____

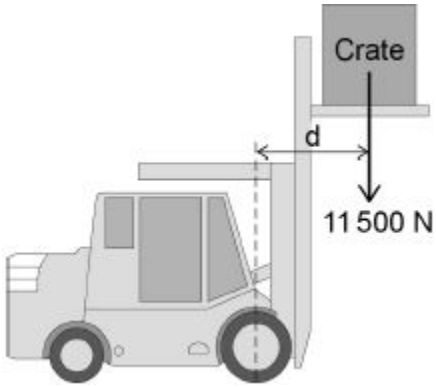
_____

In 9 years, Venus will orbit the Sun _____ times.

(2)

(Total 7 marks)

5. The diagram below shows a fork-lift truck lifting a heavy crate.



(a) The crate weighs 11 500 N and is lifted vertically 2.60 m.

Calculate the work done to lift the crate.

Use the equation:

work done = force × distance

_____

_____

_____

Work done = _____ J

(2)

The weight of the crate causes a clockwise moment of 13 800 Nm about the centre of the front wheel of the fork-lift truck.

(b) The weight of the fork-lift truck and driver cause an anticlockwise moment.

What is the minimum size of the anticlockwise moment needed so that the fork-lift truck does **not** topple over?

_____

(1)

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

_____

(1)

(d) Calculate the distance '**d**' marked on the diagram above.

_____

_____

_____

_____

Distance '**d**' = _____ m

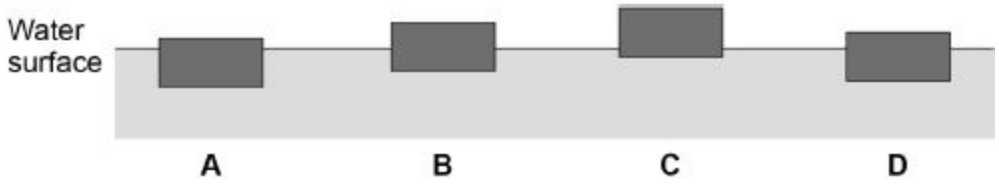
(3)

(Total 7 marks)

6. **Figure 1** shows four blocks of different materials floating on water.

The four blocks are the same volume.

Figure 1



(a) Which of the blocks has the smallest weight?

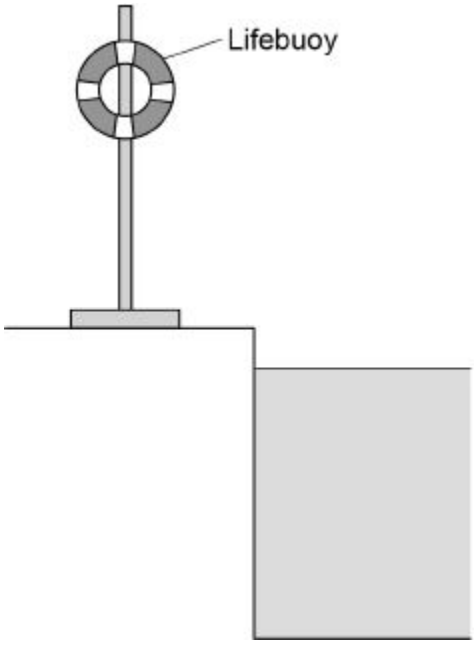
Tick **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

Figure 2 shows a lifebuoy next to a deep swimming pool.

Figure 2



(b) The lifebuoy has a mass of 2.5 kg.

gravitational field strength = 9.8 N/kg

Calculate the weight of the lifebuoy.

Use the equation:

weight = mass × gravitational field strength

_____

_____

_____

_____

Weight = _____ N

(2)

(c) When thrown into the water the lifebuoy floats. The two forces acting on the lifebuoy are the weight of the lifebuoy downwards and upthrust upwards.

How big is the upthrust on the lifebuoy compared to the weight of the lifebuoy?

Tick **one** box.

The upthrust is greater than the weight. ☐

The upthrust is less than the weight. ☐

The upthrust is the same as the weight. ☐

(1)

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

_____

(1)

(e) A rope is used to pull the lifebuoy to the side of the swimming pool.

A resultant force of 4.0 N acts on the lifebuoy.

The mass of the lifebuoy is 2.5 kg.

Calculate the acceleration of the lifebuoy.

_____

_____

_____

_____

Acceleration = _____ m/s^2

(3)

(Total 8 marks)

7. A student carried out an investigation to determine the spring constant of a spring.

The table below gives the data obtained by the student.

Force in N	Extension in cm
0	0.0
2	3.5
4	8.0
6	12.5
8	16.0
10	20.0

(a) Describe a method the student could have used to obtain the data given in the table above.

Your answer should include any cause of inaccuracy in the data.

Your answer may include a labelled diagram.

(6)

(b) The student measured the extension for five different forces rather than just measuring the extension for one force.

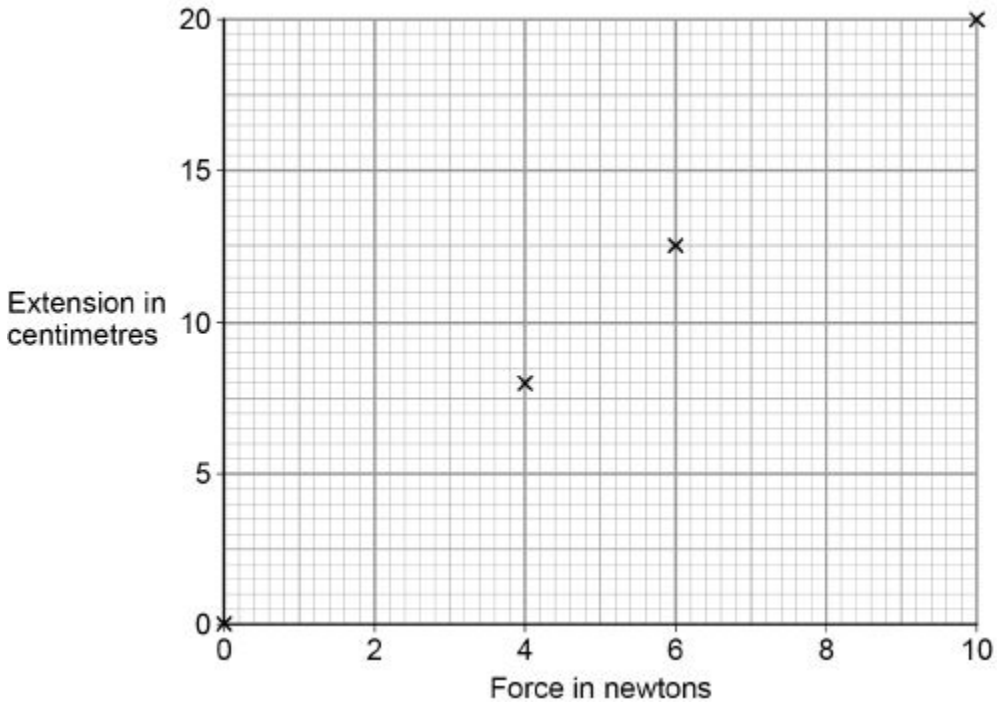
Suggest why.

_____

_____

(1)

The diagram below shows some of the data obtained by the student.



(c) Complete the diagram above by plotting the missing data from the table above.

Draw the line of best fit.

The table above is repeated here to help you answer this question.

Force in N	Extension in cm
0	0.0
2	3.5
4	8.0
6	12.5
8	16.0
10	20.0

(2)

(d) Write down the equation that links extension, force and spring constant.

_____

(1)

(e) Calculate the spring constant of the spring that the student used.

Give your answer in newtons per metre.

_____

_____

_____

_____

Spring constant = _____ N/m

(4)

(f) Hooke's Law states that:
'The extension of an elastic object is directly proportional to the force applied, provided the limit of proportionality is not exceeded.'

The student concluded that over the range of force used, the spring obeyed Hooke's Law.

Explain how the data supports the student's conclusion.

_____

_____

_____

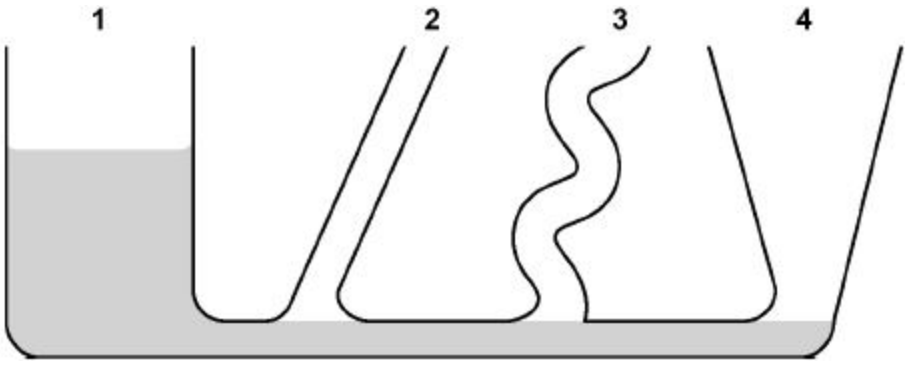
_____

(2)

(Total 16 marks)

8. The diagram below shows an unusually shaped container.

The container has four vertical tubes of different shape and size.



Water is poured into the container up to the level shown in tube **1**.

(a) Complete the diagram above to show the height of the water in tubes **2**, **3** and **4**.

(1)

(b) The further a swimmer dives below the surface of the sea, the greater the pressure on the swimmer.

Explain why.

_____

_____

_____

_____

(2)

(c) A person swims from a depth of 0.50 m to a depth of 1.70 m below the surface of the sea.

density of the sea water = 1030 kg/m^3

gravitational field strength = 9.8 N/kg

Calculate the increase in pressure on the swimmer.

Give the unit.

Use an equation from the Physics Equation Sheet.

_____

_____

_____

_____

Increase in pressure = _____ Unit _____

(4)

(Total 7 marks)

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

5–6

Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.

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

- reaction time

explained in terms of longer reaction times increase thinking distance (from a given speed)

- taking drugs
- drinking alcohol
- tiredness
- age
- distractions

explained in terms of effect on driver's reaction time

- speed

explained in terms of the faster the vehicle the greater the distance travelled in the driver's reaction time (or converse)
OR
explained in terms of increased speed increases KE so increases work done to stop the vehicle

- condition of the tyres
- condition of road surface
- wet/icy roads

explained in terms of condition of tyres and road surface (including weather considerations) affecting friction (between tyres and road)

- condition of brakes

explained in terms of effect on braking force (applied to the wheels) or reduced friction

- mass / weight of vehicle

explained in terms of deceleration force or kinetic energy or change in momentum

answers do not need to reference thinking / braking distance
a Level 1 answer would list factors only **or** one factor with one linked explanation
a Level 2 answer lists at least three factors with one linked explanation **or** two factors with two linked but different explanations
a Level 3 answer lists at least three factors with at least two linked but different explanations

(b) work (done) = force × distance

allow W = F s

1

(c)

*an answer 15 (m) scores **3** marks*

900 000 = 60 000 × distance

1

$$\text{distance} = \frac{900\,000}{60\,000}$$

1

distance = 15 (m)

1

(d) brakes overheating

allow brake fade

or

brakes locking

allow wheels locking

1

(causing) loss of control

or

(causing) a skid

*allow increasing the stopping / braking distance **ONLY** if the first marking point scored*
ignore any effects on passengers or possible accidents

1

[12]

2. (a) crate

1

(b) centre of mass

1

(c) the pointer is vertical

allow unable to see the pointer

allow the bar is horizontal

1

(d) P

1

(e) moment (of a force) = force x distance

allow M = F d

1

(f)

*an answer 2.5 (N) scores **3** marks*

0.15 = W × 0.06

1

$$W = \frac{0.15}{0.06}$$

1

W = 2.5 (N)

1

(g) weight = mass × gravitational field strength

allow W = m g

1

(h)

*an answer 0.215 or 0.22 (kg) scores **3** marks*

2.5 = m × 9.8

allow ecf from part (f)

1

m = 2.5 / 9.8

1

mass rice = 0.215 (kg)

*an answer of 0.255 or 0.26 (kg) scores **2** marks*

1

[12]

3. (a) the tendency of an object to continue in its state of rest or motion

allow how difficult it is to change the velocity of an object

1

(b) (soft foam) increases the time taken to stop

allow increases impact/contact time

or

increases the time taken to decrease momentum

allow increases the time of the collision

*do **not** accept slows down time*

1

decreases the rate of change in momentum

allow reduces acceleration/deceleration

reduces momentum is insufficient

*allow increases the time to reduce the momentum to zero for **2** marks*

1

reducing the force (on the egg)

allow impact for force

1

(c)

*an answer 4.5 (m/s) scores **4** marks*

*an answer 4500 scores **3** marks*

180 ms = 0.18 s

if incorrectly or not converted, subsequent marks may still be awarded for correct method and calculations

1

$$800 = \frac{32 \times v}{0.18}$$

1

$$v = \frac{800 \times 0.18}{32}$$

1

v = 4.5 (m/s)

1

Alternative method

180 ms = 0.18 s (1)

Δmv = 144 (kgm/s) (1)

Δv = 144 ÷ 32 (1)

v = 4.5 (m/s) (1)

Alternative method

180 ms = 0.18 s (1)

$a = 25\ (m/s^2)$ (1)

$25 = \Delta v \div 0.18$ (1)

v = 4.5 (m/s) (1)

[8]

4. (a) Milky Way

1

(b) distance = 300 000 × 500

1

d = 150 000 000 (km)

1

*an answer of 150 000 000 scores **2** marks*

(c) 3

1

(d) accept any number greater than 1.0 and less than 12.0

1

(e) $\frac{9}{0.6}$

1

15

1

*an answer of 15 scores **2** marks*

[7]

5. (a) work done = 11 500 × 2.60

1

work done = 29 900 (J)

1

*an answer of 29 900 scores **2** marks*

(b) 13 800

1

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

allow M = F d

1

(d) 13 800 = 11 500 × distance

1

$$\text{distance} = \frac{13\,800}{11500}$$

1

distance = 1.2(0 m)

1

*of an answer 1.2(0) scores **3** marks*

[7]

6. (a) C

1

(b) weight = 2.5 × 9.8

1

weight = 24.5 (N)

*an answer of 24.5 rounded to 25 scores **2** marks*

1

*an answer of 24.5 scores **2** marks*

(c) the upthrust is the same as the weight

1

(d) (resultant) force = mass × acceleration

allow F = m a

1

(e) 4.0 = 2.5 × a

1

$$a = \frac{4.0}{2.5}$$

1

a = 1.6 (m/s^2)

1

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

[8]

7. (a) **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 method 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

set up a clamp stand with a clamp

hang the spring from the clamp

use a second clamp and boss to fix a (half) metre ruler alongside the spring

record the metre ruler reading that is level with the bottom of the spring

hang a 2 N weight from the bottom of the spring

record the new position of the bottom of the spring

calculate the extension of the spring

measure the extension of the spring

add further weights to the spring so the force increases 2 N at a time up to 10 N

for each new force record the position of the bottom of the spring and calculate / measure the extension

possible source of inaccuracy

not fixing the ruler in position but simply holding the ruler next to the spring

not clamping the ruler vertical

misjudging the position of the bottom of the spring

parallax error

allow any other sensible suggestion that could reasonably lead to inaccuracy in the data

allow a description that would increase accuracy

repeating the measurements is insufficient

(b) to identify any anomalous results

allow calculate an average for the spring constant

or

to reduce the effect of random error

allow (more) accurate

to obtain an average is insufficient
to be able to draw a graph is insufficient

1

(c) both points plotted correctly

1

correct line of best fit drawn

to pass through (0,0) and (10,20)

1

(d) force = spring constant × extension

allow F = ke

1

(e) extension = 0.2

allow 0.035 / 0.08 / 0.125 / 0.16

1

10 = k × 0.2

force value must match extension
this mark may be awarded if e is in cm

1

$$k = \frac{10}{0.2}$$

allow correct transformation of their chosen values
this mark may be awarded if e is in cm

1

k = 50

*an answer 0.5 scores **3** marks*

1

*an answer of 50 scores **4** marks*

(f) the line is straight

allow the line does not curve

1

and passes through the origin

this mark is dependent on scoring the first mark

*allow a correct description of direct proportionality for **2** marks*

ignore the line shows they are directly proportional

1

[16]

8. (a) all heights drawn the same as tube 1

judge by eye

1

(b) increasing depth increases the height / mass / volume (of the water column) above the swimmer

allow more water above (the swimmer)
more water is insufficient

1

increasing the weight / force (of water) acting on the swimmer

1

(c) increase in depth = 1.2 (m)

1

(Δ) p = 1.2 × 1030 × 9.8

allow either 0.50 ***or*** *1.70 for 1.2*

1

(Δ) p = 12112.8

allow a correctly rounded answer
allow a correct calculation using either 0.50 ***or*** *1.70*

1

pascals **or** Pa

do ***not*** *accept pa*
allow N/m^2

1

an answer of 12 112.8 scores ***3*** *marks*

[7]