Mark schemes

1.

(a) Move the wooden block to the left.

1

(b) use a pulley (on the edge of the bench)

allow any feasible method to stop the string from rubbing

1

(c) suitable scale

1

points plotted correctly

*allow 5 correctly plotted for **2** marks **OR** 3–4 correctly plotted for **1** mark*

2

line of best fit

1

(d) (directly) proportional

allow a correct description of direct proportionality

ignore positive correlation

allow weight (added to mass holder) for force

*allow f = ma for **1** mark*

1

(e) repeat the measurements/investigation

1

ignore anomalies **and** calculate the mean / average

1

(f) resultant force = mass × acceleration

or

F = m a

1

(g) 0.375 = 0.60 × a

1

$a = \frac{0.375}{0.60}$

1

a = 0.625 (m/s2)

1

a = 0.63 (m/s2)

1

[14]

2. (a) will return to its original shape/length

1

when the force is removed

allow (when) the child gets off

the second mark is dependent on scoring the first mark

1

(b) **Level 3:** The method would lead to the production of a valid outcome. The 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 rule alongside the spring

- record the ruler reading that is level with the bottom of the spring
- hang a 1 N / a known 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 1 N at a time up to 5 N

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

Risk Assessment

Hazard: Clamp (stand, boss and masses) might fall off desk
Risk: injury to feet
Precaution: Use clamp to fix apparatus to the bench **or**
Ensure that the slotted masses hang over the base/foot of the stand **or**
Ensure that the boss is screwed tightly into the stand and clamp **or**
Put (heavy) masses on the base/foot of the stand **or** Stand up so that you can move out of the way

Hazard: Spring could break / come loose
Risk: damage eye
Precaution: Wear safety goggles

If a risk assessment / hazard is not given, the answer can still reach level 3, but not full marks.
Full marks may be awarded for alternative feasible methods.

(c) force = spring constant × extension

1

(d) 5.00 0.125

allow any correct pair of values from the graph

1

$k = \frac{5.00}{0.125}$

allow a misread value(s) from the graph

1

k = 40 (N/m)

allow a correct calculation using their incorrect value(s)

1

(e) the line is straight

allow the line does not curve

allow a constant gradient

1

and passes through the origin

1

(f) e = 0.20 m

1

Ee = 0.5 ×13 × 0.202

allow an incorrectly / not converted value of e

1

Ee = 0.26 (J)

use of two incorrectly/not converted values scores a maximum of 1 mark

1

[17]

3. (a) **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

Factors

- poor condition of tyres
- poor road surface
- wet or icy road
- poor/worn brakes

Explanation

- because of decreased friction

Factors

- increased mass of car/passengers

Explanation

- increases kinetic energy of car
- more work needs to be done to stop car
- increases momentum of the car

Factor

- road slopes downhill

Explanation

- (a component of) gravity opposes the braking force
  resultant (braking) force is reduced
-

allow answers in terms of reducing braking distance throughout

A single factor with no related explanation is insufficient to score a mark

(b) resultant force = mass × acceleration

1

(c) $7200 = 1600 \times a$

ignore negatives throughout

1

$a = \frac{7200}{1600}$

1

$a = 4.5$ (m/s2)

1

(d) 15 (m) 38 (m)

two correct values identified

1

= 53 (m)

allow the correct addition of a misread braking distance and /or a misread thinking distance taken from the graph

1

(e) $p = \frac{F}{A}$

1

(f) $120\,000 = \frac{60}{A}$ **1**

$A = \frac{60}{120\,000}$ **1**

$A = 0.0005$ **1**

$A = 5\ (.0) \times 10{-}4$

allow an answer given to 2 sig figs from an incorrect calculation using the given data **1**

m^2 **1**

[16]

4. (a) friction **1**

(b) air resistance **1**

(c) **A = B** **1**

(d) $M = 150 \times 0.24$ **1**

$M = 36$ (Nm) **1**

(e) chain **1**

(f) 5.8 m/s **1**

(g) $a = \frac{5.8}{20}$

allow their v from part (f) **1**

$a = 0.29$ (m/s2)

allow a correctly calculated value using their v from part (f) **1**

(h) Deceleration **1**

(i) straight arrow drawn between home and school pointing towards school. **1**

[11]

5. (a) 30 (°)

1

(b) zero error

1

(c) subtract 0.5 N from each measurement

1

(d) points plotted correctly

*allow 5 correctly plotted for **2** marks, 2–4 correctly plotted for **1** mark*

allow ± half a square

ignore any attempt at a line of best fit

2

(e) the long ramp has a smaller angle

allow description (eg shallower gradient / less steep)

1

(so) less force is needed (to hold the wheelchair stationary on the ramp)

allow (so) less force is needed to move the wheelchair up the ramp

1

(f) $W = 160 \times 2.5$

1

$W = 400$ (J)

1

[9]

6. (a) B to D

1

(b) metre rule

allow tape measure

allow ruler

1

(c) so that each piece falls the same distance

allow to stop them from building up at the bottom

1

(d)

$$\frac{34 + 37 + 34}{3}$$

allow $\frac{105}{3}$

1

35 (s)

1

(e) cone

1

the (mean) time is the lowest

reason only scores if correct shape is selected
allow it fell the fastest
allow it had the most streamlined shape
ignore reference to surface area

1

(f) Time through air would be less.

1

(g) w = 0.050 × 9.8

1

w = 0.49 (N)

1

(h) Electrostatic force

1

Magnetic force

1

[12]

7. (a) velocity includes direction

allow velocity is a vector (quantity) ***and*** *speed is a scalar (quantity)*

1

(b) (an equal) force from the air pushes on the engine/aircraft

1

in the opposite direction

only scores if first marking point scored
accept to the left ***or*** *forwards*
if no other marks scored, allow ***1*** *mark for pushes the engine forwards*

1

(c) correct value for distance and corresponding time
(e.g. 12 000 m and 50 s)

1

$$v = \frac{\text{their change in distance}}{\text{their change in time}}$$

this mark may be awarded if distance and/or time are incorrectly read ***from the graph***

1

speed = 240 (m/s)

allow a correctly calculated answer using their values of distance and time ***from the graph***

1

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

or

$a = \frac{\Delta v}{t}$

1

(e) 250 – 68 = 182

1

$0.14 = \frac{182}{t}$

this mark may be awarded if the change in velocity is incorrectly/not calculated

1

$t = \frac{182}{0.14}$

this mark may be awarded if the change in velocity is incorrectly/not calculated

1

t = 1300 (seconds)

allow a correctly calculated answer using a change in velocity incorrectly/not calculated

1

(f) work done = force × distance

or

W = F s

1

(g) 140 000 000 = force × 2000

1

force = $\frac{140\,000\,000}{2000}$

1

force = 70 000 (newtons)

1

[15]

8. (a) equal to

allow the symbol =

allow a correct answer indicated in the box provided the answer space is blank

1

(b) J -------- increasing speed

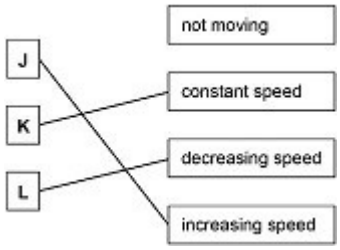
K--------- constant speed

L --------- decreasing speed

all three lines correct

*allow **1** mark for **1** line correct*

*more than three lines are drawn scores **0***



2

(c) 25 (m)

1

(d)

$$\text{av speed} = \frac{100}{12.5}$$

an answer of 8(.0) (m/s) scores 2 marks

1

av speed = 8(.0) (m/s)

1

OR

$$\text{av speed} = \frac{100}{12.6}$$

av speed = 7.93... (m/s)

allow 7.9 or 7.94

(e) 3.0

1

[7]

9. (a) B

1

(b) horizontal line drawn from (40, 20) to (300, 20)

1

straight line drawn from the point where line B finishes to 0 m/s

1

finishing on the x-axis at 360 s

allow a straight line showing time to decelerate as 60s

1

(c)

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

allow $a = \frac{(\Delta)v}{t}$

1

(d)

$$1.15 = \frac{\Delta v}{22}$$

*an answer 25.3 scores **3** marks*

1

$\Delta v = 1.15 \times 22$

1

$\Delta v = 25.3$ (m/s)

1

[8]

10. (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*

$0.15 = W \times 0.06$

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]

11. (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]

12. (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*

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

1

(c) the upthrust is the same as the weight

1

(d) (resultant) force = mass × acceleration

allow F = m a

1

(e) $4.0 = 2.5 \times a$ **1**

$$a = \frac{4.0}{2.5}$$ **1**

a = 1.6 (m/s2) **1**

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

[8]

13. (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 **1**
allow M = F d

(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]

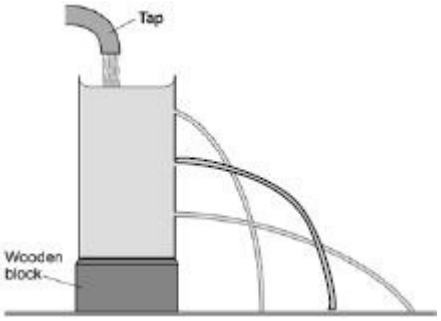
14. (a) $p = \frac{27}{0.009}$ **1**

p = 3000 **1**

Pa **1**

*an answer of 3000 scores **2** marks*

(b)



the water path hits the surface somewhere between the other two paths

1

(c) pressure increases with depth

allow when the pressure is higher, the water travels further

1

(d) pressure acts in all directions

or

pressure causes a force on (all) the surfaces

ignore liquids cannot be compressed

1

[6]

15. (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]

16. (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]

17. (a) D

1

(b) C

1

(c) W = 300 × 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]

18. (a) moment = 280 × 0.9

1

moment = 252

1

*allow 252 with no working shown for **2** marks*
*allow 25200 with no working shown for **1** mark*

(b) the clockwise moment (of child B) decreases

1

making it is less than the anticlockwise moment (of child A)

accept so moments are no longer balanced

1

so child A moves downwards

or

so child B moves upwards

1

[5]

19. (a) Third Law

1

(b) elastic potential

1

(c) weight = mass × gravitational field strength

accept gravity for gravitational field strength

1

accept W = mg

accept correct rearrangement ie mass = weight / gravitational field strength ***or*** *m = W / g*

(d) 343 = m × 9.8

1

$m = \frac{343}{9.8}$

1

m = 35

1

allow 35 with no working shown for ***3*** *marks*

(e) force = spring constant × compression

accept force = spring constant × extension

accept F = k e

accept correct rearrangement ie constant = force / extension ***or*** *k = F / e*

1

(f) compression = 0.07m

1

343 = k × 0.07

1

k = 343 ÷ 0.07

1

k = 4900

1

allow 4900 with no working shown for ***4*** *marks*

allow 49 with no working shown for ***3*** *marks*

[11]

20. (a) It will have a constant speed.

1

(b) distance travelled = speed × time

1

(c) $a = \frac{18 - 9}{6}$

1

$a = 1.5$

*allow 1.5 with no working shown for **2** marks*

1

(d) resultant force = mass × acceleration

1

(e) $F = (1120+80) \times 1.5$

1

$F = 1800$ (N)

*allow 1800 with no working shown for **2** marks*

*accept their 10.3 × 1200 correctly calculated for **2** marks*

1

(f) $182 - 92 = 2 \times 1.5 \times s$

1

$s = 182 - 9^2 / 2 \times 1.5$

1

$s = 81$ (m)

1

*allow 81 (m) with no working shown for **3** marks*

*accept answer using their 10.3 (if not 1.5) correctly calculated for **3** marks*

(g) **Level 2 (3–4 marks):**
A detailed and coherent explanation is provided. The response makes logical links between clearly identified, relevant points that include references to the numerical factor.

Level 1 (1–2 marks):
Simple statements are made. The response may fail to make logical links between the points raised.

0 marks:
No relevant content.

Indicative content

- doubling speed increase the kinetic energy
- kinetic energy increases by a factor of 4
- work done (by brakes) to stop the car increases
- work done increases by a factor of 4
- work done is force × distance and braking force is constant
- so if work done increases by 4 then the braking distance must increase by 4

4

[14]