



Mark schemes

1.

(a) friction

1

(b) (area of rectangle =) 108 (m)

1

(area of triangle =) 54 (m)

1

(total area / distance =) 162 (m)

*allow a correctly calculated total area / distance from an
incorrectly calculated area of rectangle and / or triangle*

1

(c) (the force on the pedal) causes a moment about the pedal axle

1

which causes a force on the chain (which causes a moment about the rear axle)

allow gear B for chain

1

(d) $2.4^2 (- 0^2) = 2 \times a \times 18$

1

$$a = \frac{2.4 \times 2.4}{36}$$

1

$$a = 0.16 \text{ (m/s}^2\text{)}$$

1

alternative method

$$t = 18 / 1.2$$

$$t = 15 \text{ (s) (1)}$$

$$a = 2.4 / 15 \text{ (1)}$$

*this mark may be awarded if the time is incorrectly
calculated*

$$a = 0.16 \text{ (m/s}^2\text{) (1)}$$

*allow a correctly calculated acceleration from an
incorrectly calculated time 1*



(e) horizontal (200N) **and** vertical (75N) forces drawn to the same scale

1

resultant force drawn in the correct direction

shown by an arrow head from bottom right to top left

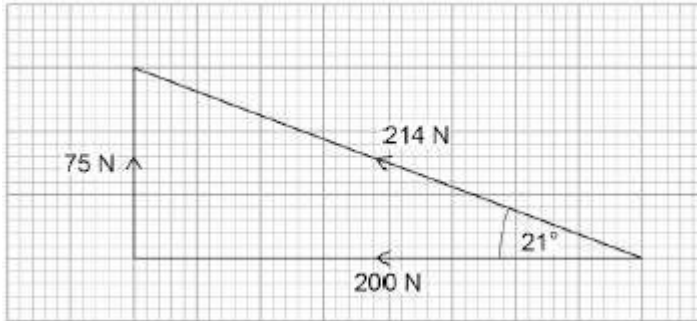
1

resultant force with a value in the range 212 to 218 (N)

*allow a calculated value of 213.6 **or** 214 (N)*

1

direction in the range 20–22 (degrees from the horizontal)



allow 68–70 (degrees from the vertical)

allow a bearing in the range 290–292

to gain full marks a vector diagram must have been drawn

1

[13]

2.

(a) (total) momentum before = (total) momentum after

allow (total) momentum stays the same

1

(b) momentum of player A = 585 (kg m/s)

1

momentum of player B = -500.5 (kg m/s)

1

$$\frac{(-500.5 + 585)}{(78 + 91)}$$

OR

$$\frac{84.5}{169}$$

allow $\frac{1085.5}{169}$

1

= 0.5 (m/s)



- (c) (protective pads) increase the time taken to stop (during the collision)

allow increases impact / contact / collision time
*do **not** allow slows down time*

1

so the rate of change of momentum decreases

allow reduces acceleration/deceleration

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

1

reducing the force (on the ice hockey player)

allow impact for force

*do **not** allow if linked to an incorrect explanation*

1

[8]

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

$$180 \text{ ms} = 0.18 \text{ s}$$

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

$$v = 4.5 \text{ (m/s)}$$

1

Alternative method

$$180 \text{ ms} = 0.18 \text{ s} \quad (1)$$

$$\Delta mv = 144 \text{ (kgm/s)} \quad (1)$$

$$\Delta v = 144 \div 32 \quad (1)$$

$$v = 4.5 \text{ (m/s)} \quad (1)$$

Alternative method

$$180 \text{ ms} = 0.18 \text{ s} \quad (1)$$

$$a = 25 \text{ (m/s}^2\text{)} \quad (1)$$

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

$$v = 4.5 \text{ (m/s)} \quad (1)$$

[8]**4.**

(a) longer arrow pointing vertically downwards

one arrow only

1

labelled weight

allow (force of) gravity

1



- (b) initially air resistance is less than weight / gravity so the skydiver accelerates

allow drag for air resistance

allow increased velocity / speed for accelerates

1

acceleration causes the air resistance to increase

*acceleration **or** increased velocity / speed is not required here if given in the first mark point*

1

resultant force decreases to zero

allow air resistance becomes equal to weight / gravity

1

so the skydiver falls at terminal velocity

*allow constant velocity/speed for terminal velocity
ignore any mention of subsequent motion and use of parachute*

1

- (c)

*an answer of 50 (m/s) scores **3** marks*

distance at 7s = 200 (m)

distance at 12s = 450 (m)

***both** distances required*

1

$$\text{speed} = \frac{450 - 200}{12 - 7} \text{ or } \frac{250}{5}$$

allow correct use of their two distances divided by 5

1

50 (m/s)

allow an answer consistent with their two distances

1



(d) The higher the altitude the less dense the air

1

so the air resistance on the skydiver (falling from 39000 m) was less
(at the same speed)

1

so the skydiver was able to accelerate for longer before reaching (a higher) terminal
velocity

allow constant velocity/speed for terminal velocity

1

or

so the skydiver was able to accelerate for longer before air resistance = weight /
gravity

[12]

5.

(a) air molecules colliding with a surface create pressure

1

at increasing altitude distance between molecules increases

or

at increasing altitude fewer molecules (above a surface)

1

so number of collisions with a surface decreases

or

or so always less weight of air than below (the surface)

1

(b) atmospheric pressure = 20 kPa from graph **and** conversion of 810 cm² to 0.081 m²
allow ecf for an incorrect value clearly obtained from the graph

1

$$5 \times 10^4 = \frac{F}{0.081}$$

$$0.081$$

1

$$F = 5 \times 10^4 \times 0.081$$

1

$$4050$$

1

$$4100 \text{ (N)}$$

1



allow 4100 (N) with no working shown for 5 marks

allow 4050 with no working shown for 4 marks

- (c) force from air pressure acting from inside to outside bigger than force acting inwards

1

so keeps the window in position

1

[10]

6.

- (a) the (perpendicular) distance from the pivot / hinge to (the line of action of) the force is greater

allow distance from the rope to the pivot / hinge is greater (than distance between handle and pivot / hinge)

1

so a smaller force is required

this mark is dependent on scoring the 1st mark

an answer a smaller force is required at the rope to produce the same moment scores 2 marks

1



(b)

an answer of 770 scores **6** marks

$$924 = F \times 0.15$$

1

$$F = 6160 \text{ (N)}$$

allow use of $E = \frac{1}{2} F e$ instead of $k = F \div e$ and

$$E = \frac{1}{2} \times k \times e^2$$

1

$$6160 = k \times 0.25$$

allow their calculated $F = k \times 0.25$

1

$$k = \frac{6160}{0.25}$$

or

$$k = 24640 \text{ (N/m)}$$

allow a value for k calculated using their calculated F

1

$$E = \frac{\frac{1}{2} \times 6160 \times 0.25 \times 0.25}{0.25}$$

allow $E = \frac{1}{2} \times$ their calc. $k \times 0.25^2$

1

$$E = 770 \text{ (J)}$$

allow an answer consistent with their calculated k

1

[8]**7.**

(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)

$$(\Delta) p = 1.2 \times 1030 \times 9.8$$

allow either 0.50 or 1.70 for 1.2

$$(\Delta) p = 12112.8$$

allow a correctly rounded answer

allow a correct calculation using either 0.50 or 1.70

pascals **or** Pa

*do **not** accept pa*

allow N/m²

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

8.

- (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

labelled 'upthrust'

1

ignore buoyancy

ignore 25 kN

1

- (b) weight = 25 kN

allow 24 to 25 kN inclusive

$$25\,000 = \text{mass} \times 9.8$$

1

or

$$m = \frac{25000}{9.8}$$

allow their W correctly converted and substituted

1

$$m = 2551 \text{ kg}$$

[7]

allow correctly calculated value using their converted W

allow a value correctly calculated with W in kN

$$m = 2600 \text{ kg}$$

allow a calculated answer correctly rounded to 2

significant figures



- (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]

9.

- (a) accept any value between 12 (mm) and 13 (mm) inclusive 1

- (b) to reduce the error in measuring the extension of the spring
accept length for extension throughout 1

- as the ruler at an angle would make the measured extensions shorter 1

- (c) 1 (N) to 6 (N)
accept from 0 (N) to 6 (N) 1

- (d) gives a straight line through the origin 1

- (e) any practical technique that would improve the accuracy of length measurement eg
 use a set square 1

- to line up the bottom of the spring with the ruler scale
or
 attach a horizontal pointer to the bottom of the spring (1)
 so that the pointer goes across the ruler scale (1) 1

- (f) the spring has been inelastically deformed 1



because it went past its limit of proportionality

accept elastic limit for limit of proportionality

accept it does not go back to its original length when the weights are removed

1

[9]

10.

(a) distance is a scalar and displacement is a vector

or

distance has magnitude only, displacement has magnitude and direction

1

(b) 37.5 km

accept any value between 37.0 and 38.0 inclusive

1

062° or N62°E

accept 62° to the right of the vertical

1

accept an angle in the range 60° – 64°

accept the angle correctly measured and marked on the diagram

(c) train changes direction so velocity changes

1

acceleration is the rate of change of velocity

1

(d) number of squares below line = 17

accept any number between 16 and 18 inclusive

1

each square represents 500 m

1

distance = number of squares × value of each square correctly calculated – 8500 m

1

[8]

11.

(a) the distance travelled under the braking force

1

(b) the reaction time will increase

1

increasing the thinking distance (and so increasing stopping distance)

(increases stopping distance is insufficient)

1

(c) No, because although when the speed increases the thinking distance increases by the same factor the braking distance does not.



eg

increasing from 10 m / s to 20 m / s increases thinking distance from 6 m to 12 m but the braking distance increases from 6 m to 24 m

1

(d) If the sled accelerates the value for the constant of friction will be wrong.

1

(e) only a (the horizontal) component of the force would be pulling the sled forward

1

the vertical component of the force (effectively) lifts the sled reducing the force of the surface on the sled

1

(f) $-u^2 = 2 \times -7.2 \times 22$

award this mark even with 0^2 and / or the negative sign missing

1

$u = 17.7(99)$

1

18

1

*allow 18 with no working shown for **3** marks*

*allow 17.7(99) then incorrectly rounded to 17 for **2** marks*

[11]