Forces and their interactions

Mark Scheme

Name: _____

Class: _____

Date: _____

Time: **93 minutes**

Marks: **91 marks**

Comments:

Mark schemes

1

(a) *idea that* balanced by friction force* / pushing force equals friction force (*note "balanced" by unspecified force)
or
specification of relevant force but no reference to balancing
in both 1(a) and 1(b) gains 1 mark overall
for 1 mark

1

(b) balanced by upwards force of table*
for 1 mark

1

(c) makes it (slightly) warm / hot
or
wears it away (slightly) / damages surface
for 1 mark

1

[3]

2

(a) resultant force = zero
or
upward force = downward force
accept forces are balanced
accept weight for downward force

1

(b) (i) 84
*allow **1** mark for correct substitution ie 840 = m × 10*

2

(ii) 12
accept 12.02 for both marks
or
1010 ÷ their (b)(i) correctly calculated
*a resultant force of 1010 (N) gains **1** mark*
an answer 22(.02) gains 1 mark

2

m/s^2
accept m/s/s

1

[6]

3 (a) (i) a single force that has the same effect as all the forces combined

accept all the forces added / the sum of the forces / overall force

1

(ii) constant speed (in a straight line)

*do **not** accept stationary*

or constant velocity

1

(b) 3

*allow **1** mark for correct substitution into transformed equation*
*accept answer 0.003 gains **1** mark*
*answer = 0.75 gains **1** mark*

2

m/s^2

1

(c) as speed increases air resistance increases

accept drag / friction for air resistance

1

reducing the resultant force

1

[7]

4 (a) gravity

accept weight
*do **not** accept mass*
accept gravitational pull

1

(b) (i) Initially force L greater than force M

accept there is a resultant force downwards

1

(as speed increases) force M increases

accept the resultant force decreases

1

when M = L, (speed is constant)

accept resultant force is 0
accept gravity/weighty for L
accept drag/ upthrust/resistance/friction for M
*do **not** accept air resistance for M but penalise only once*

1

(ii) terminal velocity

1

(iii) 0.15

accept an answer between 0.14 – 0.16
an answer of 0.1 gains no credit
*allow **1** mark for showing correct use of the graph*

2

[7]

5

(a) more streamlined

accept decrease surface area

1

air resistance is smaller (for same speed)

accept drag for air resistance
friction is insufficient

1

so reaches a higher speed (before resultant force is 0)

ignore reference to mass

1

(b) (i) 1.7

*allow **1** mark for correct method, ie* $\frac{5}{3}$

***or** allow **1** mark for an answer with more than 2 sig figs that rounds to 1.7*
***or** allow **1** mark for an answer of 17*

2

(ii) 7.5

*allow **1** mark for correct use of graph, eg* $\frac{1}{2} \times 5 \times 3$

2

(iii) air (resistance)

accept wind (resistance)
drag is insufficient
friction is insufficient

1

[8]

6

(a) the forces are equal in size and act in opposite directions

1

(b) (i) forwards / to the right / in the direction of the 300 N force

answers in either order

1

accelerating

1

(ii) constant velocity to the right

1

(iii) resultant force is zero

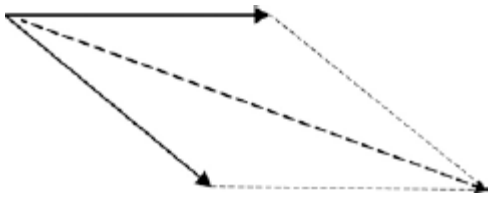
accept forces are equal / balanced

1

so boat continues in the same direction at the same speed

1

(iv) parallelogram or triangle is correctly drawn with resultant



3

value of resultant in the range 545 N – 595 N

*parallelogram drawn without resultant gains **1** mark*

If no triangle or parallelogram drawn:

*drawn resultant line is **between** the two 300 N forces gains **1** mark*

*drawn resultant line is between and longer than the two 300 N forces gains **2** marks*

1

[10]

7

(a) arrow vertically down – same size as lift – labelled weight

judge by eye

1

arrow to the left – same size as drag - labelled thrust

judge by eye

*two correct arrows without labels gains **1** mark*

1

(b) $34^2 - (0^2) = 2 \times 4.0 \times s$

1

$$\frac{34 \times 34}{8} = s$$

1

s = 144.5

1

s = 140 (2 sig figs)

*an answer of 140 scores **4** marks*

*an answer of 144.5 scores **3** marks*

1

(c) tension force drawn to a suitable scale and in correct direction

1

triangle completed showing correct components

1

scale used to determine both component forces

1

horizontal component = 1900 N
vertical component = 680 N

allow 1850 to 1925 inclusive

allow 660 to 700 inclusive

1

[10]

8

(a) speed

must be in correct order

1

direction

1

(b)

Quantity	Scalar	Vector
Momentum		✓
Acceleration		✓
Distance	✓	
Force		✓
Time	✓	

*any three correct scores **2** marks*

*any two correct scores **1** mark*

only one correct scores zero

3

(c) (i) 16 and 2

*16 **or** 2 scores **2** marks*

allow 1 mark for correct substitution, ie

8 × 2

or

4 × 0.5

3

kg m / s **or** N s

1

(ii) 1.5 (m / s)
or
their $p_A + p_B = 12 \times v$ correctly calculated
allow 2 marks for correct substitution, ie
18 = 12 × v
or
their $p_A + p_B = 12 \times v$
18 or their $p_A + p_B$ scores 1 mark if no other mark awarded

3

(iii) 14 (kg m / s)
or
their $p_A - p_B$

1

16.5 (J)

1

[14]

9 (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.

1

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)

18

1

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

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

[11]

10 (a) (i) Constant speed

2

(ii) Accelerates to higher constant speed

1

(b) (i) Points correct (allow one major or two minor mistakes)
Line correct (for their points)

2

(ii) 5 m/s
or 5

gets 2 marks

or correct unit

gets 1 mark mark

3

(c) (i) 50 s or 50

gets 2 marks

or t = d/v

gets 1 mark

3

(ii) Line correct (of gradient 4 and spans 30 consecutive seconds)

1

(d) (i) 0.04 or 6/15

gets 2 marks

or a = v/t

gets 1 mark

3

[15]