Questions on Forces – Mark Scheme

1. (i) Expected answer:
'For equilibrium of an object the sum of clockwise moments about a point = sum of anticlockwise moments about the same point.'

clockwise moment(s) = anticlockwise moment(s)

***Note**: The term 'clockwise' to be included and spelled correctly to gain the M1 mark*
***Note**: 'net moment = 0' is equivalent to the M1 mark*

M1

Reference to one of the moments taken about a point/'equilibrium'/sum (or total or net or ∑) mentioned once

***Note**: If M1 is lost for incorrect spelling of 'clockwise', then allow this A1 mark*

A1

(ii) $200 \times 12 = F \times 75$

C1

$F = 32$ (N)

***Note**: Bald answer of 32 (N) scores 2/2 marks*

A1

(iii) $p = \dfrac{32}{6.0 \times 10^{-5}}$

Possible ecf

C1

pressure = 5.3×10^5 (Pa)

***Note**: Bald answer of 5.3×10^5 (Pa) scores 2/2 marks*

A1

(iv) (Pressure is) greater

B1

because the force/F is larger (to provide the same moment)

B1

[8]

2. (i) **1** The (distribution of the) mass of the lawn mower is not uniform B1

2. One correct moment about A stated

$B \times 110$ or 350×20 B1

$B = (350 \times 20) / 110$ (moments equated) B1

$B = 63.6$ (N) A0

3. $A = 350 - 63.6 = 286(.4)$ (N) A1

(ii) A goes down and B goes up B1

Turning effect of B is less / B needs greater force to produce the same moment / if distance goes down force needs to go up (to maintain the same turning effect) B1

[6]

3. (i) 1 $3600 \times 1.0 = X \times 2.5$ C2

one mark for one correct moment, one mark for the second correct moment and equated to first moment A0

2 $X = 1440$ (N) C1

$Y = 3600 - 1440$ or $3600 \times 1.5 = Y \times 2.5$ A1

$= 2160$ (N) B1

(ii) Not a couple as forces are not equal B1

and not in opposite directions / the forces are in the same direction C1

(iii) $P = F / A$ B1

$= 1440 / 2.3 \times 10^{-2}$ B1

$= 62609$ (6.3×10^4)

unit Pa or N m^{-2}

[9]

4. (Force is 1 N) when a **1 kg** mass has an acceleration of **1 m s^{-}**

***Not**: '1 kg and 1 m **s^{-1}**'*

Allow**: (1 N =) **1 kg** × **1 m s^{-2}

B1

[1]

5. (i) Kinetic energy = ½ m v^2 C1

= ½ 1380 × $(31.1)^2$ C1

= 667375 (J) (667 kJ) A1

6.7×10^5 (J)

(ii) $v^2 = u^2 + 2as$ C1

$0 = (31.1)^2 + 2 \times a \times 48.2$ A1

a = 10 .0(3) (m s^{-2}) C1

(iii) F = ma or work = force × distance

= 1380 × 10.03 F = 667375 / 48.2 A1

= 13800 (13846) (N) = 13800 (13846) (N)

[7]

6. **Four** from:
Prevents the driver from hitting the steering wheel / windscreen
Deflates quickly to prevent whiplash
Increases the time/distance to stop
Decreases the (impact) force on the driver
Much wider area of the bag reduces the pressure B1 × 4

[4]

7. Any <u>two</u> factors from:
speed, mass, condition of tyres, condition of brakes,
condition of road, gradient of road

***Allow**: KE if neither mass nor speed is mentioned.*

B1×2

For each factor, correct description of how braking distance is affected
E.g:

- Greater speed means greater distance
  Or distance $\propto$ speed^2 (ora)
- Greater mass means greater distance
  Or distance $\propto$ mass (ora)
- Worn tyres / brakes implies less friction
  therefore greater distance (ora)
- Wet / slippery / icy road means less friction
  therefore greater distance (ora)
- Uphill means shorter distance (ora)

For description marks, reference to 'distance' instead of 'braking distance' is fine

For 1st bullet point allow reference to kinetic energy

***Allow**: 'more' or 'longer' instead of 'greater' when referring to distance*

Do not allow 'grip' for friction for 3rd and 4th bullet points

B1×2

[4]

8. 1. (Several) satellites used

B1

2. Distance from (each) satellite is determined

B1

3. Position / distance is determined using c / speed of e.m waves / radio waves / microwaves and delay time (wtte)

B1

4. Trilateration is used to locate the position of the car
   Or position of car is where circles / spheres cross (wtte)

***Note**: The term 'satellite(s)' to be included and spelled correctly,on all occasions, to gain this first (or second) B1 mark (Deduct this mark only once.)*

Do not allow this 4th mark for just a diagram of intersecting spheres / circles

B1

[4]

9. (a) $W = mg$

Allow: *Use of 9.8 (m s^{-2})*

weight =1.50 × 9.81 = 14.72 (N) or 14.7 (N) or 15 (N)

Allow: *Bald 15 (N); but* ***not*** *'1.50 × 10 = 15(N)'*

B1

(b) (i) Net / resultant force (on **B**) is less / (net) force (on **B**) is less than its weight / there is tension (in the string) / there is a vertical / upward / opposing force (on **B**)

Note: *Must have reference to force*

B1

(ii) $s = ut + \frac{1}{2}at^2$ and $u = 0$

C1

$1.40 = \frac{1}{2} \times 1.09 \times t^2$

Allow: *2 marks for 1.75/1.09' if answer from (iii) is used*

C1

$t = 1.60$ (s)

Allow: *2 sf answer*

Allow: *2 marks if* ***2.80 m*** *is used; time = 2.27 (s)*

A1

(iii) $v^2 = 2 \times 1.09 \times 1.40$ / $v = 0 + 1.09 \times 1.60$

Possible ecf

C1

$v = 1.75$ (m s^{-1}) / $v = 1.74$ (m s^{-1})

Allow: *1.7 or 1.8 (m s^{-1})*

A1

(iv) change in velocity = 2.47 + 1.50 (= 3.97 m s^{-1})

Ignore sign for change in velocity

C1

acceleration = $\frac{3.97}{0.030}$

acceleration = 132 (m s^{-2})

Allow: *130 (m s^{-2})*

Special case:

acceleration = $\frac{2.47-1.50}{0.030}$ *or 32 (m s^{-2}) scores 1 mark*

A1

[9]

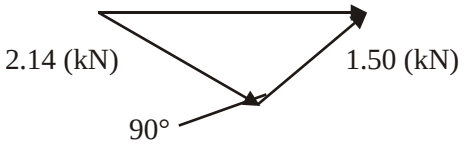
10. The <u>mass</u> of particles increases (at its speed gets closer to the speed of light)

Not*: 'weight of particle increases'*
Not*: 'mass changes / different'*

B1

[1]

11. (i) Correct vector triangle drawn



B1

Note:
Expect at least one 'label' on the sketch, eg: 2.14, 1.5, 90°.
The 'orientation' of the triangle is not important.
The directions of all three arrows are required

(resultant force)^2 = $2.14^2 + 1.50^2$

C1

(resultant force) = 261 (kn)

Allow: *2 sf answer of 2.6 (kN)*
Allow *a scale drawing; 2 marks if answer is within ±0.1 kN and 1 mark if ± 0.2 kN*
Alternative *for the C1 A1 marks:*
1.50cos(55) or 2.14cos(35) *C1*
resultant force = 1.50cos(55) + 2.14cos(35)
resultant force = 2.61 (kN) *A1*

A1

(ii) 2.6(1) (kN)

Possible ecf

B1

(Constant velocity implies) zero net force / zero acceleration

Not: *'resultant force = drag' since the first B1 assumes this*

B1

[5]

12. Any three from:

1. (Suspend plate from a point and then) mark a vertical line on the plate (wtte)
2. Plumb line / 'pendulum' (used to find the vertical line)
3. Hang from another point / place (and draw another vertical line) (wtte)
4. Where the lines intersect gives position of centre of gravity (wtte)

Note*: For 1st point accept 'mark line of string'*

Allow*: 1 mark for 'By trial and error find a position where the plate balances'*

B1 × 3

[3]

13. (i) net force = 120 (N)

C1

$a = \frac{120}{900}$

$a = 0.13$ (m s^{-2})

Note*: Bald answer scores 2 marks; answer must be 2 sf or more*

A1

(ii) The drag force changes with speed / acceleration is not constant

B1

[3]