Mark schemes

Q1.

(a) tension

1

(b) (combined) mass of trolley and mass hanger

allow mass / weight of trolley / hanger

1

(c) divide distance travelled by time taken to give (average / mean) velocity

allow speed for velocity throughout

1

double mean velocity (to give maximum velocity)

1

divide change in velocity by time taken (to give acceleration)

allow divide maximum velocity by time (to give acceleration) allow use of $v^2 = u^2 + 2as$

allow correct use of

$$s = ut + \frac{1}{2}at^2$$

1

(d) (range =) 0.06 (m/s^2)

or

(mean =) 1.36 (m/s^2)

1

uncertainty = ±0.03 (m/s^2)

1

(e) a component of the weight of the trolley acts parallel to runway

1

(so) resultant force increases so acceleration increases

allow <u>work</u> is done (by raising the trolley) so the trolley gains gravitational potential energy (1)

gravitational potential energy is transferred to kinetic energy increasing the final velocity and the acceleration (1)

1

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Q2.

(a)

$(\frac{1}{2} \times 56 \times 220) = 6160$

1

(56 × 380) = 21280

1

(6160 + 21280) = 27 440 (m)

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

1

(b) the gradient is less after 720 s

allow the gradient is less after (velocity decreases to) 20 m/s

1

so the deceleration is smaller

1

so the braking force is smaller

1

(c) correct section of line identified

judge by values used

1

attempt to calculate a gradient using values from the correct section of the graph
eg

gradient = $\frac{(-)36}{120}$

allow use of correct values obtained from the section of the graph after 720 s

1

correct calculation using their correct values
eg a = (–)0.3 (m/s^2)

allow a correct calculation using correct values obtained from the section of the graph after 720 s

if no other marks scored, an answer that rounds to 0.16 (m/s^2) scores 1 mark

1

(d) (–)270 000 = 240 000 × *a*

1

$a = \frac{(-)270\,000}{240\,000}$

1

a = (–) 1.125 (m/s²)

the equation F = ma must have been used to score subsequent marks

1

0 = 60² + (2 × (–1.125) × *s*)

allow a correct substitution using their value of deceleration

1

$s = \frac{3600}{2.25}$

allow a correct re-arrangement using their value of deceleration

1

s = 1600 (m)

allow a correct calculation using their value of deceleration

OR

$E_k = \frac{1}{2} \times 240\,000 \times 60^2$ (1)

= 432 000 000 (1)

Δ E_k = work done (1)

the equation $E_k = \frac{1}{2}mv^2$ *must have been used to score subsequent marks*

432 000 000 = 270 000 × *s* (1)

allow a correct substitution using their value of E_k

$s = \frac{432\,000\,000}{270\,000}$ (1)

allow a correct re-arrangement using their value of E_k

s = 1600 (m) (1)

allow a correct calculation using their value of E_k

1

OR

p = 240 000 × 60 (= 14 400 000) (1)

$$270\,000 = \frac{14\,400\,000}{t} \quad (1)$$

t = 53.333…(s) (1)

allow t = 53 (s)

the equation $F = \frac{\text{change in momentum}}{\text{time taken}}$ *must have been used to score subsequent marks*

$$\text{mean speed} = \frac{60}{2} = 30 \quad (1)$$

s = 30 × 53.333… (1)

allow a correct substitution using their value of t

s = 1600 (m) (1)

allow a correct calculation using their value of t

(e) stopping distance includes both braking distance and thinking distance

1

alcohol increases driver's reaction time

1

which will increase the thinking distance so stopping distance increases

1

[18]

Q3.

(a) v = 15 (m/s)

1

24 000 = m × 15

allow a value of v = 14.5 (m/s)

1

$$m = \frac{24\,000}{15}$$

1

m = 1600 (kg)

1

(b) distance travelled during first 3 seconds = 22.5 (m)

1

distance travelled during last 2 seconds = 30 (m)

1

total distance = 52.5 (m)

allow 53 (m)

allow 1 mark for the correct addition of their calculated distances

allow a maximum of 2 marks for total distance = 50.75 (m) if velocity used = 14.5 (m/s)

1

(c) stopping distance includes thinking distance

allow stopping distance = braking distance + thinking distance

1

there is an additional time before the driver applies the brakes.

allow the driver's reaction time will increase (due to the distraction)

1

(so) the thinking distance will increase

1

(d) work is done due to friction (in the brakes)

ignore friction alone

1

(causing) an increase in the internal / thermal energy (of the brakes)

1

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Q4.

(a) the force of the car on the barrier is equal to the force of the barrier on the car and in the opposite direction

1

(b) $F = \frac{700}{0.28}$

1

F = 2 500 (N)

1

(c) increases the time taken for the collision to occur

allow increases contact time

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

1

(so) the rate of change of momentum decreases

allow reduces acceleration / deceleration

1

reducing the force (on the people)

reduces impact is insufficient

1

(d) $2.5^2 - u^2 = 2 \times 2.0 \times 1.5$

1

$u^2 = 2.5^2 - (2 \times 2.0 \times 1.5)$

1

u = 0.50 (m/s)

allow 0.5 (m/s)

1

[9]

Q5.

(a) any **two** from:

- wet / icy road conditions

  ignore weather

- poor condition of brakes
- poor condition of tyres
- increased mass of car

  allow weight for mass

- negative gradient of the road

  allow going downhill

2

(b) distance = speed × time

1

(so) longer reaction time = longer distance

1

(c) mean reaction time increases after drinking alcohol

1

the change in reaction time is not the same for all people after drinking alcohol

1

(d) distance = 1500 (m)

1

$1500 = 20 \times t$

allow a correct substitution using an incorrectly / not converted value of distance

1

$t = \frac{1500}{20}$

allow a correct rearrangement using an incorrectly / not converted value of distance

1

75 (s)

allow a correctly calculated value using an incorrectly / not converted value of distance

1

(e) velocity is a vector and speed is a scalar

allow velocity includes direction (speed does not)

1

road is not straight

allow driver may change lanes

1

therefore direction changes so the velocity changes

1

[13]

Q6.

(a) there is a resultant force acting

allow weight/gravity is greater than air resistance

allow (initially) weight/gravity is the only force acting

1

(b) as the velocity of the hailstone increases air resistance increases

allow speed for velocity

1

until air resistance becomes equal to the weight of the hailstone

1

so the resultant force is (equal to) zero

1

(c) as mass increases the weight of a hailstone increases

1

(d) kinetic energy depends on both mass and velocity

allow $E_k = ½ mv^2$

1

as mass increases so does terminal / maximum velocity

a statement is required

1

kinetic energy ∝ m and kinetic energy ∝ v^2 so as mass doubles kinetic energy more than doubles

this mark can be scored by relevant calculations

1

(e) 1 N m

1

(f) mass = 0.0185 (kg)

allow 0.018 to 0.019 inclusive

1

$$F = \frac{0.0185 \times 25}{0.060}$$

allow a correct substitution using an incorrectly / not converted value of m

1

F = 7.708 (N)

allow 7.7 (N)

allow correct calculation using an incorrectly / not converted value of m

1

if no other marks are awarded

a misreading of the scale giving a value between 15.6 and 15.7 inclusive that is then correctly converted giving an answer between 6.50 and 6.54 scores 2 marks

a misreading of the scale giving a value between 15.6 and 15.7 inclusive that is then not converted giving an answer between 6500 and 6542 scores 1 mark

[12]