Name of the Student:_____
Max. Marks : 20 Marks **Time : 20 Minutes**

Mark Schemes

Q1.

(a) Tangent drawn at t = 2.0±1 s ✔

Use of suvat loses first 2 marks

Guidance- take tangent point to be half-way between where the line clearly leaves the curve

1

Mean deceleration from use of tangent using correct coordinates (correct Δv and Δt) and answer in range (-)2.5 to (-)2.9 (m s^{-2}) ✔

Ignore minus sign

=15/5.5 = 2.7(3) m s^{-2}

Allow if answer rounds to these values

1

Use of F = ma using their a with answer

i.e. Force =1.8 × 10^4 × their a from an attempt at a tangent or trying to use *suvat* equation✔

Answers from best attempts at tangent in range 4.7 to 4.9 × 10^4 N

1

(b) Attempt to estimate area under the graph ✔

Use of suvat equation = 0

1

Correct square count 21 to 23 10 mm squares

(525-575 small squares)

OR

distance per square = 2.5 m or 0.1 m✔

For attempt to find area using trapezium rule expect use of 1 s intervals for this mark

1

Value in range 50 m to 60 m **and conclusion**

that escape lane would be long enough✔

1

(c) KE of lorry :

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to KE of gravel (as it is pushed aside/moved)✔

OR

PE of gravel (as it may be ejected upwards)✔

Ignore losses due to friction
Not KE of the ground

1

transfer to thermal energy /internal energy/heating of gravel /ground/lorry

OR

work done on the gravel/vehicle increasing internal energy/raising temperature✔

Must refer to what is heated

1
Max 2

(d) Appreciates that KE converted into PE

OR

May be stated or by attempt to use of $mgh = ½ mv^2$

OR

Calculates initial KE of lorry ½$1.8 \times 10^4 \times 17.5^2 = 2.76 \times 10^6$ (J) ✔

1

Height needed in escape lane = $2.76 \times 10^6/(1.8 \times 10^4 \times 9.81) = 15.6$ m

OR

Length of lane required = 15.6/sin25 = 37 m (compare with 85 m)

OR

vertical height of ramp = 35.9 m (compare with height needed 15.6 m)

OR

maximum change in PE possible = 85 sin 25 × 9.81 × $1.8 \times 10^4 = 6.3 \times 10^6$ (J)

(compare with initial KE) ✔

Allow max 2 if height = 85 tan 25
or length of lane = 15.6/tan 25
i.e. allow these incorrect values when drawing conclusion

1

Comparison and conclusion that escape lane would be long enough. This must follow from correct working✔

.....

Deceleration produced by slope = 9.8(1) sin 25 or

4.15 (4.1 or 4.2) m s^{-2} seen✔

Distance to stop from $v^2 = 2as$ give s = 37 m (compare with 85 m)✔

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Arriving at 37 m gets first two marks

OR

Minimum deceleration needed = $17.5^2/2 \times 85 = 1.8$ m s^{-2} (compare with 4.15 m s^{-2})

Comparison and conclusion that escape lane would be long enough This must follow from correct working✔

1

(e) The straight road of uniform gradient because:

The deceleration (condone acceleration) is uniform ✔

with the gravel the initial deceleration is larger/may vary ✔

Travelling through gravel could make the vehicle unstable/bounce erratically(owtte) ✔

Gravel because:

On the ramp the lorry would roll backwards after stopping (as it has no brakes)

Do not allow deceleration less when on gravel(It is greater initially)

Do not allow answers that (average) force using gravel lane is less than decelerating force on the ramp (due to increased stopping distance or stopping time)

Or because stopping time is longer

MAX 1

[12]

Q2.

(a) (Total) kinetic energy ✔

1

(b) Attempt to apply conservation of momentum ✔

NB This is a 'show that' so all stages must be seen

1

16 000 × 2.8 – 12 000 × 3.1 = 28 000 *v* ✔

Must see substitution

1

v = 0.27(1) (m s^{-1}) ✔

Correct equation (watch signs) gets first and second marks

1

(c) Impulse = 16 000(2.8 – 0.271) or 12 000(3.1 + 0.271) = 4.0(5) × 10^4 ✔

If 0.3 m s–1 used then impulse will be 4.0 × 10^4 or 4.08(4.1) × 10^4

1

N s or kg m s^{-1} ✔

1

(d) Trucks move in opposite directions/rebound ✔

1

Velocity of **B** is greater than that of **A** because total momentum is to the right OR **B** has lower mass ✔

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OR

Momentum of **B** after collision is same as that of **A** before the collision (and vice versa) **1**

[8]

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