AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



MARK SCHEME

4.5.6.1.5 ACCELERATION (PACK 1)

SCORE	PERCENTAGE
/285	%

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Q1.

(a) uniform acceleration

allow constant / steady acceleration
allow velocity / speed increasing at a constant rate
ignore reference to direction
*acceleration scores **1** mark*
or
*velocity / speed is increasing scores **1** mark*
*do **not** accept acceleration increases*

2

(b) up(wards)

1

(c) a group of objects that interact

1

(d) velocity just after bounce is less than just before bounce

allow velocity is less / decreases
velocity decreases to zero − on its own scores zero

or

the height at the top of the bounce is less than the height from which it was dropped

1

so the ball has lost energy

1

correct reference to (loss of) ke or (reduced) gpe

1

total energy of ball and Earth / ground is constant

allow 'a system' for ball and Earth
allow energy is conserved

1

[8]

Q2.

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

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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]

Q3.

(a) induced

1

(b) bar 2

1

(the same end) of bar 1 attracts both ends of bar 2

or

only two magnets can repel so cannot be bar 1 or bar 3

1

(c) so the results for each magnet can be compared

or

so there is only one independent variable

fair test is insufficient

allow different thickness of paper would affect number of sheets each magnet could hold

accept it is a control variable

1

(d) because the magnet with the biggest area was not the strongest

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accept any correct reason that confirms the hypothesis is wrong eg smallest magnet holds more sheets than the largest

1

[5]

Q4.

(a) D

1

(b) C

1

(c) W = 300 × 45

1

W = 13 500

1

*allow 13 500 with no working shown for **2** marks*

(d) straight line drawn from 13 m / s to 0 m / s

1

finishing on x-axis at 65 s

1

[6]

Q5.

(a) It will have a constant speed.

1

(b) distance travelled = speed × time

1

(c) $a = \frac{18 - 9}{6}$

1

a = 1.5

*allow 1.5 with no working shown for **2** marks*

1

(d) resultant force = mass × acceleration

1

(e) F = (1120+80) × 1.5

1

F = 1800 (N)

*allow 1800 with no working shown for **2** marks*

1

*accept their 10.3 × 1200 correctly calculated for **2** marks*

(f) $18^2 - 9^2 = 2 \times 1.5 \times s$

1

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$s = 18^2 - 9^2 / 2 \times 1.5$

1

$s = 81$ (m)

1

*allow 81 (m) with no working shown for **3** marks*

*accept answer using their 10.3 (if not 1.5) correctly calculated for **3** marks*

(g) **Level 2 (3–4 marks):**
A detailed and coherent explanation is provided. The response makes logical links between clearly identified, relevant points that include references to the numerical factor.

Level 1 (1–2 marks):
Simple statements are made. The response may fail to make logical links between the points raised.

0 marks:
No relevant content.

Indicative content

- doubling speed increase the kinetic energy
- kinetic energy increases by a factor of 4
- work done (by brakes) to stop the car increases
- work done increases by a factor of 4
- work done is force × distance and braking force is constant
- so if work done increases by 4 then the braking distance must increase by 4

4

[14]

Q6.

(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

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(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]

Q7.

(a) starting / stopping the stopwatch

human error is insufficient

reaction time is insufficient

or

timing over the smaller distances

accept not timing accurately

do not accept references to measuring distance incorrectly

1

(b) (i) before

1

(ii) increasing

accept accelerating

it is not constant is insufficient

it is less than after four seconds is insufficient

it reaches a constant speed negates

1

(iii) calculate the gradient of the straight/steepest/constant section

accept gradient of any section after 5.5 seconds/30 cm

1

(iv) drag (force) increases (as the ball bearing gets faster)

accept frictional/upward force for drag

1

(until) drag (force) = weight

or

(until) resultant force is zero

accept upward force = downward force

accept till forces are balanced

1

(c) less than

1

ball bearing increases speed at a greater rate

accept it travels the same distance in less time

or

ball bearing has a greater acceleration

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accept the ball bearing is going faster

or
terminal velocity has not been reached

1

so resultant force must be greater
or
as weight is the same (the drag must be less)

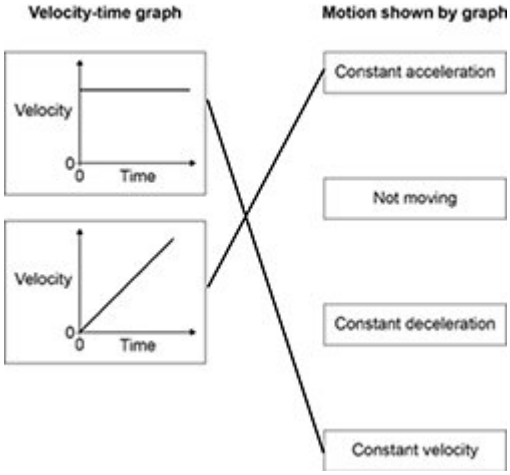
accept warmer oil has a lower density/viscosity for 1 mark if neither of the two reason marks score

1

[9]

Q8.

(a)



*if more than one line is drawn from a graph then all those lines are wrong allow **1** mark for 1 correct line*

2

(b) speed

1

(c) (i) 2.25

*allow **1** mark for correct substitution i.e.*

$a = \frac{9 - 0}{4}$ or $a = \frac{9}{4}$

provided no subsequent step

2

(ii) the air resistance increases

1

(d) 2000 J

1

mass is half
or
kinetic energy depends on mass

*do **not** accept weight for mass*

1

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[8]

Q9.

(a) terminal

1

(b) 5.4 (kg)

*correct substitution of 54 = m × 10 gains **1** mark*

2

(c) (i) 0< a <10

1

some upward force

accept some drag / air resistance

1

reduced resultant force

1

(ii) 0

1

upward force = weight (gravity)

1

resultant force zero

1

[9]

Q10.

(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* $\frac{17}{10}$

***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

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(iii) air (resistance)

accept wind (resistance)

drag is insufficient

friction is insufficient

1

[8]

Q11.

(a) (i) longer reaction time

accept slower reactions

*do **not** accept slower reaction time unless qualified*

or

greater thinking distance

accept greater thinking time

or

greater stopping distance

accept greater stopping time

greater braking distance negates answer

1

(ii) lines / slopes have the same gradient

accept slopes are the same

or

velocity decreases to zero in same time / in 2.6 seconds

accept any time between 2.4 and 2.8

accept braking distances are the same

1

(iii) 12

*accept extracting both reaction times correctly for **1** mark (0.6 and 1.4)*

or

*time = 0.8 (s) for **1** mark*

*accept 0.8 × 15 for **2** marks*

*accept calculating the distance travelled by car **A** as 28.5 m*

or

*the distance travelled by car **B** as 40.5 m for **2** marks*

3

(b) **Z**

1

different force values give a unique / different resistance

*only scores if **Z** chosen*

*do **not** accept force and resistance are (directly) proportional*

*accept answers in terms of why either **X** or **Y** would not be best eg*

***X** – same resistance value is obtained for 2 different force values*

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Y *– all force values give the same resistance*

1

[7]

Q12.

(a) any **two** from:

- (acceleration occurs when) the direction (of each capsule) changes
- velocity has direction
- acceleration is (rate of) change of velocity

2

(b) to(wards) the centre (of the wheel)

1

(c) the greater the radius / diameter / circumference (of the wheel) the smaller the (resultant) force (required)

accept 'the size' for radius
both parts required for the mark

1

[4]

Q13.

(a) 750

*allow **1** mark for correct substitution, ie 75 × 10 provided no subsequent step shown*

2

newton(s) / N

*do **not** accept n*

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the Marking Guidance, and apply a 'best-fit' approach to the marking.

0 marks
No relevant content.

Level 1 (1-2 marks)
There is a brief attempt to explain why the velocity / speed of the parachutist changes.
or
the effect of opening the parachute on velocity/speed is given.

Level 2 (3-4 marks)
The change in velocity / speed is clearly explained in terms of force(s)
or
a reasoned argument for the open parachute producing a lower speed.

Level 3 (5-6 marks)
There is a clear and detailed explanation as to why the parachutist

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reaches terminal velocity
and
a reasoned argument for the open parachute producing a lower speed

examples of the physics points made in the response to explain first terminal velocity

- on leaving the plane the only force acting is weight (downwards)
  accept gravity for weight throughout
- as parachutist falls air resistance acts (upwards)
  accept drag / friction for air resistance
- weight greater than air resistance
  or
  resultant force downwards
- (resultant force downwards) so parachutist accelerates
- as velocity / speed increases so does air resistance
- terminal velocity reached when air resistance = weight
  accept terminal velocity reached when forces are balanced

to explain second lower terminal velocity

- opening parachute increases surface area
- opening parachute increases air resistance
- air resistance is greater than weight
- resultant force acts upwards / opposite direction to motion
- parachutist decelerates / slows down
- the lower velocity means a reduced air resistance

air resistance and weight become equal but at a lower (terminal) velocity

6

(c) (i) any **one** from:

- mass of the (modelling) clay
  accept size/shape of clay size/amount/volume/shape of clay
  accept plasticine for (modelling)clay
- material parachute made from
  accept same (plastic) bag
- number / length of strings

1

(ii) **C**

*reason only scores if **C** is chosen*

1

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smallest (area) so falls fastest (so taking least time)

accept quickest/quicker for fastest

*if **A** is chosen with the reason given as 'the largest area so falls slowest' this gains **1** mark*

1

[12]

Q14.

(a) 2.75

*allow **1** mark for correct substitution, ie* $\frac{11}{4}$

or $\frac{23-12}{4}$

provided no subsequent step shown

2

m/s^2

1

(b) driving force increases

1

frictional force increases

accept air resistance / drag for frictional force

1

driving force > frictional force

1

[6]

Q15.

(a) (i) 12

1

(ii) 0.2

*allow **1** mark for their (a)(i) ÷ 60 and correctly calculated*

1

m/s^2

accept correct unit circled in list

accept ms^{-2}

*do **not** accept* mps^2

1

(b) **B**

1

[4]

Q16.

(a) 48

*allow for **1** mark correct method shown, ie 6 × 8*

***or** correct area indicated on the graph*

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2

(b) diagonal line from (0,0) to (6,48) / (6, their (a))

if answer to (a) is greater than 50, scale must be changed to gain this mark

1

horizontal line at 48m between 6 and 10 seconds

accept horizontal line drawn at their (a) between 6 and 10 seconds

1

[4]

Q17.

(a) 96

*allow **1** mark for correct substitution*

ie 80 × 1.2

2

newton or N

allow Newton

*do **not** allow n*

1

(b) (i) direction

1

(ii) velocity and time are continuous (variables)

answers must refer to both variables

accept the variables are continuous / not categoric

accept the data / 'it' is continuous

accept the data / 'it' is not categoric

1

(iii) **C**

1

velocity is not changing

*the **2** marks for reason may be scored even if **A** or **B** are chosen*

accept speed for velocity

accept speed is constant (9 m/s)

*accept **not** decelerating*

*accept **not** accelerating*

accept reached terminal velocity

1

forces must be balanced

accept forces are equal

accept arrows are the same length / size

or

resultant force is zero

*do **not** accept the arrows are equal*

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1

[8]

Q18.

(a) distance travelled under the braking force

accept braking (distance)

1

(b) (directly) proportional

accept a correct description using figures

or

increase in the same ratio

eg if speed doubles then

thinking <u>distance</u> doubles

*accept for **1** mark positive correlation*

*accept for **1** mark as speed*

increases so does thinking <u>distance</u>

accept as one increases the other increases

accept as thinking <u>distance</u> increases speed increases

2

(c) (i) control variable

1

(ii) experiment done, student listens to music / ipod (etc)

1

experiment (repeated), student not listening to music

for both marks to be awarded there must be a comparison

1

(d) increase it

accept an answer which implies reactions are slower

*do **not** accept answers in terms of thinking distance only*

1

(e) **Y**

1

[8]

Q19.

(a) (i) longer reaction time

accept slower reactions

*do **not** accept slower reaction time unless qualified*

or

greater thinking distance

accept greater thinking time

or

greater stopping distance

accept greater stopping time

greater braking distance negates answer

1

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(ii) lines / slopes have the same gradient

accept slopes are the same

or

velocity decreases to zero in same time / in 2.6 seconds

accept any time between 2.3 and 2.8

accept braking distances are the same

1

(iii) 12

*accept extracting both reaction times correctly for **1** mark (0.6 and 1.4) **or** time = 0.8(s) for **1** mark*

*accept 0.8 × 15 for **2** marks*

*accept calculating the distance travelled by car **A** as 28.5 m **or** the distance travelled by car **B** as 40.5 m for **2** marks*

3

(b) **Z**

1

different force values give a unique / different resistance

*only scores if **Z** chosen*

*do **not** accept force andresistance are (directly) proportional*

accept answers in terms of why

*either **X or Y** would not be the best eg*

***X** – same resistance value is obtained for 2 different force values*

***Y** – all force values give the same resistance*

1

[7]

Q20.

(a) (i) 4.5

*allow **1** mark for correct substitution i.e. 9 ÷ 2*

2

(ii) m/s^2

accept answer given in (a)(i) if not contradicted here

1

(iii) speed

1

(iv) straight line from the origin passing through (2s, 9m/s)

*allow **1** mark for straight line from the origin passing through to t = 2 seconds*

*allow **1** mark for an attempt to draw a straight line from the origin passing through (2,9)*

*allow **1** mark for a minimum of 3 points plotted with no line provided if joined up would give correct answer. Points must include(0,0) and (2,9)*

2

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(b) (i) **B**

*if **A** or **C** given scores **0** marks in total*

1

smallest (impact) force

1

on all/ every/ any surfaces

these marks are awarded for comparative answers

1

(ii) (conditions) can be repeated

or

difficult to measure forces with human athletes

accept answers in terms of variations in human athletes e.g.
athletes may have different weights area / size of feet may be different difficult to measure forces athletes run at different speeds

accept any answer that states or implies that with humans the conditions needed to repeat tests may not be constant

e.g.
athletes unable to maintain constant speed during tests (or during repeat tests)

*do **not** accept the robots are more accurate*

removes human error is insufficient

fair test is insufficient

1

[10]

Q21.

(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

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(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]

Q22.

(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]

Q23.

(a) (i) velocity includes direction

accept velocity is a vector

1

(ii) 64

*allow **1** mark for obtaining values of 16 and 4 from the graph*
***or** marking correct area or correct attempt to calculate an area*

2

(iii) any **two** from:

- velocity zero from 0 to 4 seconds

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- increasing in 0.2 s (or very rapidly) to 8 m/s
- decreasing to zero over the next 8 seconds

2

(iv) momentum before does not equal momentum after
ignore reference to energy

or total momentum changes

or an external force was applied

1

(b) to reduce the momentum of the driver

1

a smaller (constant) force would be needed
*do **not** accept reduces the impact / impulse on the driver*

1

[8]

Q24.

(a) 4
*allow **1** mark for extracting correct information 12*

2

m/s^2
ignore negative sign

1

(b) 9 (s)

1

[4]

Q25.

(a) MN
accept 5.8, 8 seconds must include unit

1

(b) LM
accept 0.8, 5.8 seconds must include unit

1

(c) (i) 0.8

1

(ii) drinking alcohol

1

(d) straight (by eye) line starting at 0.8 seconds

1

line drawn steeper than LM starting before L
ignore lines going beyond 2 seconds but line must exceed 2.5 metres per second before terminating

1

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[6]

Q26.

(a) (i) accelerating

accept getting faster

accept speed / velocity increasing

1

(ii) acceleration increases

accept velocity / speed increases more rapidly
*do **not** accept velocity / speed increases*

1

(b) (i) acceleration = $\frac{\text{change in velocity}}{\text{time (taken)}}$

accept $a = \frac{v - u}{t}$ ***or*** $a = \frac{v_1 - v_2}{t}$

*do **not** accept velocity for change in velocity*

*do **not** accept change in speed*

*do **not** accept* $a = \frac{v}{t}$

1

(ii) 15

*allow **1** mark for an answer of 900 **or** for correct use of 540 seconds*

2

(iii) velocity includes direction

accept velocity is a vector (quantity)
accept converse answer

1

[6]

Q27.

(a) (i) constant speed

*do **not** accept normal speed*
*do **not** accept it is stopped / stationary*

1

in a straight line

accept any appropriate reference to a direction

*constant velocity gains **2** marks*
*'not accelerating' gains **2** marks*

*terminal velocity alone gets **1** mark*

1

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(ii) goes down owtte

accept motorbike (it) slows down

1

(b) (i) 20 (m/s)

ignore incorrect units

1

(ii) acceleration = $\frac{\text{change in velocity}}{\text{time (taken)}}$

*do **not** accept velocity for change in velocity*
accept change in speed

accept $a = \frac{v - u}{t}$ ***or*** $a = \frac{v_1 - v_2}{t}$

or $a = \frac{\Delta v}{t}$

*do **not** accept* $a = \frac{v}{t}$

1

(iii) 4

or their (b)(i) ÷ 5

*allow **1** mark for correct substitution*

2

m/s^2

*m/s/s **or** ms^{-2} **or** metres per second squared **or** metres per second per second*

1

(c) vehicle may skid / slide

loss of control / brakes lock / wheels lock
*accept greater stopping distance **or** difficult to stop*

1

due to reduced friction (between tyre(s) and road)

accept due to less grip
*do **not** accept <u>no</u> friction*

1

(d) any **three** from:

*do **not** accept night time / poor vision*

- <u>increased</u> speed
- <u>reduced</u> braking force
- <u>slower</u> (driver) reactions

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*NB specific answers may **each** gain credit eg tiredness (1), drinking alcohol (1), using drugs (1), driver distracted (1) etc*

- poor vehicle maintenance

  *specific examples may **each** gain credit eg worn brakes or worn tyres etc*

- increased mass / weight of vehicle

  accept large mass / weight of vehicle

- poor road surface

- more streamlined

  *if candidates give three answers that affect stopping distance but not specific to increase award **1** mark only*

3

[13]

Q28.

(a) (i) gravity/weight

1

(ii) 2193750000000 or 2.19×10^{12}

***not** 2.19^{12}*

allow 1 mark for the correct conversion to 7500 (m/s)

allow one mark for answer 2193750(J)

2

transferred to heat

ignore extras of sound and light

accept changed to heat

accept lost due to friction

1

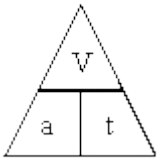
(b) (i) acceleration = $\frac{\text{change in velocity}}{\text{time (taken)}}$

accept word speed instead of velocity

accept a = $\frac{v-u}{t}$

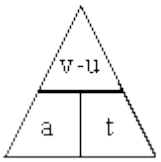
***or** correct rearrangement*

do not accept



even if subsequent calculation correct

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can gain credit if subsequent calculation correct

1

(ii) 2

ignore + or – signs

m/s^2 1

accept m/s/s or ms^{-2}

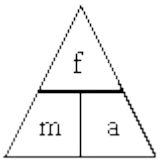
2

(c) (i) force = mass × acceleration

accept correct rearrangement

accept F = m × a

do not accept



unless subsequent calculation correct

1

(ii) 156 000

accept 78 000 × their (b)(ii)(only if (b)(i) correct)

1

[9]

Q29.

(a) air(resistance) has greatest effect on paper

1

(b) paper **or** both fall faster

1

(both) fall together

*accept same speed **or** rate*

1

[3]

Q30.

(i) force = mass × acceleration

accept F = m × a

*accept upper **or** lower case letters*

accept equation using correct units

accept



if subsequent method correct

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1

(ii) 0.007

*allow **1** mark for correct transformation or substitution*

2

[3]

Q31.

(a) 3

gains 1 mark

m/s^2

gains 1 mark

else working *gains 1 mark*

2

(b) 2850 ecf

gains 1 mark

N

gains 1 mark

else working

gains 1 mark

2

(c) friction/air resistance increases with speed;
till frictional = max forward force;
then force/acceleration is zero

for 1 mark each

alternative limitation for safety

gains 1 mark only

3

[7]

Q32.

(a) (i) decreases

for 1 mark

1

(ii) decreases

for 1 mark

1

(iii) lower speed everywhere

for 1 mark

1

(b) (i) $3\ a = \frac{s}{t}$ **or** $a = \frac{33}{11}$

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gains 1 mark

1

ms^{-2}

gains 1 mark

1

(ii) 2850 ecf

gains 2 marks

else working

gains 1 mark

2

(iii) air resistance/frictional forces increase with speed;
till frictional force = max forward engine force;
when acceleration is zero

(incorrect statement – 1 mark)

or (limitation on maximum speed for safety-1 mark)

any two for 1 mark each

2

[9]

Q33.

(a) Each scale optimum
Else both half size
Straight line joining 30,0 to 30,0.67 to 0, 5.67

any 5 for 1 mark each

5

(b) 6
Else a = 30/5

gets 2 marks

Else a = v/t

gets 1 mark

3

(c) 9000
Else F = 6 × 1500

gets 2 marks

Else F = ma

gets 1 mark

3

(d) (i) Driver has forward momentum
Which is conserved
Giving drive relative forward speed to car

for one mark each

3

(ii) Car stops in 75m

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gets 1 mark

W = F.d or 9000 × 75

gets 1 mark

W = 675 000 J
OR ke = 1/2 mv^2

gets 1 mark

ke = 1/2.1500.302
ke = 675 000 J

3

[17]

Q34.

(a) there is a (maximum) forward force
drag/friction/resistance (**opposes** motion) (**not** pressure)
increases with speed
till forward and backward forces equal
so no net force/acceleration

any 4 for 1 mark each

4

(b) (i) F = ma
10 000 = 1250a
a = 8
m/s^2

for 1 mark each

4

(ii) ke = 1/2 mv^2
ke = 1/2 1250.48^2
ke = 1 440 000
J

for 1 mark each

4

(iii) W = Fd
W = 10 000.144
W = 1 440 000
J

for 1 mark each

4

[16]

Q35.

(a) (i) Constant speed

2

(ii) Accelerates to higher constant speed

1

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(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]

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