AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



MARK SCHEME

4.5.6.1.3 VELOCITY

SCORE	PERCENTAGE
/254	%

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Q1.

(a) equal to

1

(b) deceleration / decelerate

braking is insufficient

1

(c) $\frac{18}{6}$

1

3 (m/s^2)

*an answer of 3 (m/s^2) scores **2** marks*

*allow other correct pairs of numbers taken from **A** to **B***

1

(d) the stopping distance increases

1

by more than double

1

[6]

Q2.

(a) a vector has direction (a scalar does not)

1

(b) accept any vector quantities eg

- velocity
- force
- weight
- acceleration
- displacement

1

(c) mass × velocity

*do **not** accept speed for velocity*

*do **not** accept symbols*

1

(d) kilogram(s) metre per second

allow kg m/s

1

(e) 1.8 ms = 0.0018 s

*an answer of 60 (m/s) scores **4** marks*

1

$$1500 = \frac{0.045 \times v\,(-0.045 \times 0)}{0.0018}$$

1

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$$v = \frac{1500 \times 0.0018}{0.045}$$

1

v = 60 (m/s)

*an answer of 60 000 scores **3** marks*

1

(g) longer the time of contact the greater the change of momentum

allow the converse

1

since the mass of the golf ball is constant

1

the velocity of the golf ball must increase

1

increasing the distance the golf ball travels

1

[12]

Q3.

(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

(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

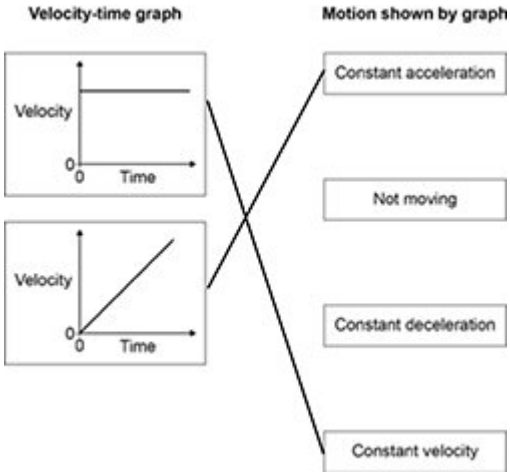
1

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[8]

Q4.

(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

[8]

Q5.

(a) (i) decreases (to zero)

1

resultant force acts in opposite direction to motion

accept air resistance and weight for resultant force
accept resultant force acts downwards
*do **not** accept air resistance increases*

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1

(ii) velocity includes direction
or
velocity is a vector (quantity)

1

(b) (i) 3.6

allow 1 mark for correct substitution i.e.
½ × 0.05 × 12^2 provided no subsequent step

2

(ii) 3.6 **or** their (i)

1

(iii) 7.2
or
their (ii) ÷ 0.5 correctly calculated

*allow **1** mark for correct substitution i.e.*
3.6 or their (ii) = 0.05 × 10 × h

2

(iv) **B**

1

(c) range increases up to 45°

1

range decreases from 45°

the range is a maximum at 45° gains both marks
for any two angles that add up
to 90° the range is the same gains both marks
*the range increases then decreases gains **1** mark*

1

[11]

Q6.

(a) (i) friction

1

(ii) air resistance

accept drag
friction is insufficient

1

(iii) 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 information on page 5, and apply a 'best-fit' approach to the marking.

0 marks
No relevant content.

Level 1 (1–2 marks)
There is an attempt to explain in terms of forces A and B why the velocity of the cyclist changes between any two points

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or
a description of how the velocity changes between any two points.

Level 2 (3–4 marks)
There is an explanation in terms of forces A and B of how the velocity changes between X and Y and between Y and Z
or
a complete description of how the velocity changes from X to Z.
or
an explanation and description of velocity change for either X to Y or Y to Z

Level 3 (5–6 marks)
There is a clear explanation in terms of forces A and B of how the velocity changes between X and Z
and
a description of the change in velocity between X and Z.

examples of the points made in the response

extra information

X to Y

- at X force A is greater than force B
- cyclist accelerates
- and velocity increases
- as cyclist moves toward Y, force B (air resistance) increases (with increasing velocity)
- resultant force decreases
- cyclist continues to accelerate but at a smaller value
- so velocity continues to increase but at a lower rate

Y to Z

- from Y to Z force B (air resistance) increases
- acceleration decreases
- force B becomes equal to force A
- resultant force is now zero
- acceleration becomes zero
- velocity increases until…
- cyclist travels at constant / terminal velocity

accept speed for velocity throughout

6

(b) (i) 3360

*allow **1** mark for correct substitution,*
ie 140 × 24 provided no subsequent step
*accept 3400 for **2** marks if correct substitution is shown*

2

joule / J

*do **not** accept j*
*do **not** accept Nm*

1

(ii) decreases

accept an alternative word / description for decrease
do not accept slows down

1

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temperature

accept thermal energy

accept heat

1

[13]

Q7.

(a) (i) gravitational potential (energy)

1

(ii) kinetic (energy)

1

(b) (i) slope or gradient

1

(ii) area (under graph)

*do **not** accept region*

1

(iii) starts at same y−intercept

1

steeper slope than original and cuts time axis before original

the entire line must be below the given line

allow curve

1

(c) (i) 31
and
31

*correct answers to 2 significant figures gains **3** marks even if no working shown*

*both values to more than 2 significant figures gains **2** marks:*
30.952…...
30.769….

65 / 2.1 and / or
*80 / 2.6 gains **1** mark*

*if incorrect answers given but if both are to 2 significant figures allow **1** mark*

3

(ii) student 1 incorrect because 80 ≠ 65

1

student 2 correct because average velocities similar

*ecf from **(c)(i)***

1

student 3 incorrect because times are different

1

[12]

Q8.

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(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*

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

1

[7]

Q9.

(a) any **two** from:

- (acceleration occurs when) the direction (of each capsule) changes

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- 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]

Q10.

(a) **B**

reason only scores if B is chosen

1

gradient / slope is the steepest / steeper

answers must be comparative
accept steepest line
ignore greatest speed

1

(b) (velocity includes) direction

'it' refers to velocity

1

[3]

Q11.

(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

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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*

1

[8]

Q12.

(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 <u>velocity</u>

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]

Q13.

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(a) 53 (m)

1

(b) (i) Similar shape curve drawn <u>above</u> existing line going <u>through (0, 0)</u>

*allow **1** mark for any upward smooth curve or straight upward line above existing line going through (0, 0)*

2

(ii) rain on road

1

car brakes in bad condition

1

(c) (i) all three lines correctly labelled

*allow **1** mark for one correctly labelled*

top line – C

accept 1.2

middle line – B

accept 0.9

bottom line – A

accept 0.7

2

(ii) any **two** from:

- (table has) both variables are together
  accept tired and music as named variables
- both (variables) could/ would affect the reaction time
- cannot tell original contribution
  accept cannot tell which variable is affecting the drive (the most)
- need to measure one (variable) on its own
  accept need to test each separately
- need to control one of the variables

2

[9]

Q14.

(a) (i) friction

accept any way of indicating the correct answer

1

(ii) gravity

accept any way of indicating the correct answer

1

(b) (i) accelerates **or** <u>speed</u> / velocity increases

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accept faster <u>and</u> faster (1 mark)

*do **not** accept faster pace / falls faster*
or suggestions of a greater but constant speed

1

downwards / falls

accept towards the Earth / ground

this may score in part (b)(ii) if it does not score here and there is no contradiction between the two parts

1

(ii) constant speed / velocity **or** terminal velocity / speed or zero acceleration

stays in the same place negates credit

1

[5]

Q15.

(a) B

more aerodynamic **or** most streamlined shape **or**
smaller (surface) area

*accept less air/wind resistance **or** less drag **or** less friction*
*clothing traps less air **or** rolled up into ball **or** arms, legs drawn in*

accept converse

2

(b) (i) gravity

1

(ii) air resistance

1

(iii) go up

1

(iv) stays the same

1

(c) bigger the area, the bigger force Y

accept the converse

or bigger the area more drag

accept when the parachute opens then force Y bigger

or bigger the area more air resistance

need the relation of area to force

1

[7]

Q16.

(a) (i) gravity/weight

1

(ii) 2193750000000 or 2.19×10^{12}

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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

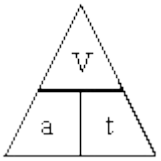
(b) (i) acceleration = $\frac{\text{change in velocity}}{\text{time (taken)}}$

accept word speed instead of velocity

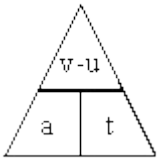
accept $a = \frac{v-u}{t}$

or *correct rearrangement*

do not accept



even if subsequent calculation correct



can gain credit if subsequent calculation correct

1

(ii) 2

ignore + or – signs

m/s^2 1

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

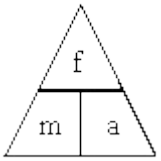
2

(c) (i) force = mass × acceleration

accept correct rearrangement

accept F = m × a

do not accept



unless subsequent calculation correct

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1

(ii) 156 000

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

1

[9]

Q17.

(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]

Q18.

(a) (i) linear scales used

do not credit if less than half paper used

1

points plotted correctly

all of paper used

1

(straight) line of best fit drawn

allow a tolerance of ± half square

1

(ii) correct **and** straight line through origin

***all** needed*
e.c.f. if their (a)(i) is straight but not through the origin - incorrect because line does not go through origin
credit a calculation that shows proportionality

1

(iii) 62 ± 0.5 (m)

*credit **1** mark for KE = 490000 **or** 490kJ*
*credit **1** mark for correct use of graph clearly shown*

2

(iv) any **one** from: wet **or** icy **or** worn **or** smooth road

accept slippery slope

brakes worn

accept faulty brakes

car heavily loaded
worn tyres
downhill slope

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do not accept anything to do with thinking distance e.g. driver tired or drunk

1

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

accept correct transformation

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

accept m/s² = $\frac{m/s}{s}$

*do **not** accept acceleration* = $\frac{velocity}{time}$

1

(ii) 56

accept –56

1

(iii) deceleration is reduced

accept deceleration is slower

accept acceleration

1

<u>force</u> on car and or passengers is reduced

accept an answer in terms of change in momentum for full credit

1

[11]

Q19.

(a) (i) same size

1

(ii) **K**

1

(b) velocity

1

(c) **C**

1

greatest mass **or** because it's heavier

accept biggest load

*accept heaviest **or** more weight*

*do **not** accept fuller*

*do **not** accept more items*

*do **not** accept it's loaded*

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*do **not** accept loaded most*

ignore references to time as neutral

1

[5]

Q20.

(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

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]

Q21.

(a) there is a (maximum) forward force
drag/friction/resistance (**opposes** motion) (**not** pressure)
increases with speed

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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]

Q22.

(a) (i) air resistance/drag/friction (or upthrust)
weight/gravitational pull/gravity

for 1 mark each

1

(ii) air resistance/friction acts in opposite direction to motion

1

(iii) Y

1

(iv) the sky-diver accelerates/his speed increases
in downward direction/towards the Earth/falls

for 1 mark each

2

(b) force X has increased force Y has stayed the same the speed of the sky-diver will stay the same

for 1 mark each

3

(c) (i) CD

1

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(ii) 500
(iii) 50 } (but apply e.c.f. from (i))

3

(iv) 10 (but apply e.c.f. from (ii) and (iii))
gets 2 marks

or 500/50 or d/t
gets 1 mark

2

[14]

Q23.

(a) (i) 9400(m)
for 1 mark

1

(ii) 26.5(hours)
for 1 mark

1

(b) (i) F
for 1 mark

1

(ii) D
for 1 mark

1

(iii) B
for 1 mark

1

[5]

Q24.

(a) weight or gravity or gravitational
for 1 mark

1

(b) (i) only force A acts / force A > air resistance / gravity / weight
for 1 mark

1

(ii) force A > force B
for 1 mark

1

(iii) force C > force A
for 1 mark
(Forces A, B and C need not be used, description of forces are OK)

1

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(c) (i) graph points all correct ± little square

gains 2 marks

one point wrong

gains 1 mark

2+ points wrong

gains 0 mark

appropriate line – good freehand OK

gains 1 mark

Bar chart gets 0, but if points clear can get 2

3

(ii) *16 or candidates own intercept should be* 16 m in range 1-19 if no kinks on graph line

for 1 mark

1

[8]

Q25.

newton **or** N

metre **or** m

joules **or** J

all three correct 2 marks
two or one correct 1 mark

[2]

Q26.

(a) 3.125

accept 3.1 or 3.12

1

(b) plotted at 1. 15 – 1.17, 1.24 – 1.28

across on the second from 1.2, up between first and second line

1

sketch curve steeper near 0.64 s fairly smooth curve bending

1

to become pretty well horizontal at 1.16, 1.25

1

(c) (i) 1.68 **or** 1.7

working is 2(l.16 – 0.64) + 0.64 =

(ii) 2.5 m unit required

consequential marking applies here

1

(d) $\mathbf{X_1}$ at 0.64 s, 0 m

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it is in contact with the floor **or** the ball changes direction **or** the downward force is balanced by the reaction of the floor

accept the ball is hitting the floor

do not credit it has hit the floor

1

X_2 at 1.16 s, 1.25m it is at the top of its bounce

accept the ball changes direction or has run out of KE

2

[8]

Q27.

(a) *any evidence of:* momentum = mass × velocity (words, symbols or numbers)
appropriate re-arrangement mass as 0.05kg

each gains 1 mark

but 800

gains 4 marks

4

(b) (i) *any reference to* friction with air/air resistance

gains 1 mark

but *idea that* friction with air/air resistance is high (at high speed)

gains 2 marks

2

(ii) *any evidence of:* k.e. $\propto v^2$ **or** k.e. = ½ mv^2
final k.e.
initial k.e.
either initial or final k.e. correctly calculated (i.e. 16000; 10240)

each gains 1 mark

but $(0.8)^2$

gains 3 marks

but 64%(credit 0.64)

gains 4 marks (also credit e.c.f)

4

[10]

Q28.

(a) *evidence of* $\frac{\text{change in speed}}{\text{time taken}}$ *or* $\frac{40}{5}$

gains 1 mark

(*credit* 50/10 **or** 5 with *1 mark*) NOT 40/10 or 50/5

but 8 [N.B. negative not required]

gains 2 marks

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units metres per second per second **or** (metres per second squared or m/s²)

for 1 mark

3

(b) (i) *idea that*
accelerates at first due to gravity
air/wind resistance
friction/resistance/drag with air increases with speed
eventually gravity and friction cancel balance
or (no net/accelerating force) [NOT terminal velocity]

each for 1 mark

3

(ii) *idea*
a bigger resistance/friction/drag <u>at any given speed</u> (*credit* a bigger drag (<u>factor</u>))

for 1 mark

1

(c) *evidence of* × 10 / × 9.8 / × 9.81 **or** 750/735(75)

for 1 mark

1

[8]

Q29.

(a) *evidence of* $\frac{\text{change in speed}}{\text{time taken}}$ *or* $\frac{3}{12}$

gains 1 mark

but 0.25 **or** ¼

gains 2 marks

2

(b) *evidence of* $\frac{\text{work done}}{\text{time taken}}$ *or* $\frac{2400}{12}$

gains 1 mark

but 200

gains 2 marks

2

(c) *idea that*

second car has a bigger mass
(allow bigger weight/heavier)

gains 1 mark

but
second car has 1.5 times bigger mass
or
second car has mass of 1200 kg

gains 2 marks

2

(d) friction/resistance increases with speed

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gains 1 marks

but
friction with/resistance of <u>air</u> increases with speed
gains 2 marks

- increase in speed because driving force greater than friction
- steady speed when friction = driving force

or
increases in speed until friction = driving force
each for 1 further mark to maximum of 3

3

[9]

Q30.

- gravity
- accelerates
- friction
- falls at a steady speed
each for 1 mark

[4]

Q31.

(a) reference to

- weight / force of gravity / acting downwards
- unbalanced (by any upwards force)
for 1 mark each

2

(b) *ideas that* forces balance(d)
gains 1 mark

but
weight / force of gravity / downwards force balanced by friction / air resistance / drag / upwards force
gains 2 marks

latter increases with speed

(*accept* arrows or relevant length and direction if clearly labelled, as answers to parts (a) and (b))
for 1 further mark

3

[5]

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