**Mark schemes**

Q1.

(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

[8]

Q2.

(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.

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]

Q3.

(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

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 × 122 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]

Q4.

(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

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

temperature

accept thermal energy

accept heat

1

[13]

Q5.

(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]

Q6.

(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]

Q7.

(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]

Q8.

(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]

Q9.

(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

1

[8]

Q10.

(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 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]

Q11.

(a) 53 (m)

1

(b) (i) Similar shape curve drawn above existing line going through (0, 0)

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]

Q12.

(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 speed / velocity increases

accept faster and 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]

Q13.

(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]

Q14.

(a) (i) gravity/weight

1

(ii) 2193750000000 or 2.19 × 1012

not 2.1912

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 =

accept word speed instead of velocity

accept a =

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/s2 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]

Q15.

(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]

Q16.

(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

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

1

(b) (i) acceleration =

accept correct transformation

accept

accept m/s2 =

do not accept acceleration =

1

(ii) 56

accept –56

1

(iii) deceleration is reduced

accept deceleration is slower

accept acceleration

1

force on car and or passengers is reduced

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

1

[11]

Q17.

(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

do not accept loaded most

ignore references to time as neutral

1

[5]

Q18.

(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 mv2

gets 1 mark

ke = 1/2.1500.302

ke = 675 000 J

3

[17]

Q19.

(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/s2

for 1 mark each

4

(ii) ke = 1/2 mv2

ke = 1/2 1250.482

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]

Q20.

(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

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]

Q21.

(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]

Q22.

(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

(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]

Q23.

newton or N

metre or m

joules or J

all three correct 2 marks

two or one correct 1 mark

[2]

Q24.

(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) X1 at 0.64 s, 0 m

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

X2 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]

Q25.

(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. v2 or k.e. = ½ mv2

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]

Q26.

(a) evidence of or

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

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 at any given speed (credit a bigger drag (factor))

for 1 mark

1

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

for 1 mark

1

[8]

Q27.

(a) evidence of or

gains 1 mark

but 0.25 or ¼

gains 2 marks

2

(b) evidence of or

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

gains 1 marks

but

friction with/resistance of air 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]

Q28.

• gravity

• accelerates

• friction

• falls at a steady speed

each for 1 mark

[4]

Q29.

(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]