**Mark schemes**

Q1.

(a) (i) 0.15 × 0.08 = 0.012

1

(ii) kg m/s

1

(iii) equal to

1

(b) momentum of the air increases

or

force backwards increases

accept air moves faster

accept momentum backwards increases

accept pushes more air back(wards)

1

so momentum of the toy must increase

or

the force forwards (on the toy) increases

accept momentum forwards must increase

it = toy

1

[5]

Q2.

(a) speed

must be in correct order

1

direction

1

(b)

Quantity Scalar Vector

Momentum

Acceleration

Distance

Force

Time

any three correct scores 2 marks

any two correct scores 1 mark

only one correct scores zero

3

(c) (i) 16 and 2

16 or 2 scores 2 marks

allow 1 mark for correct substitution, ie

8 × 2

or

4 × 0.5

3

kg m / s or N s

1

(ii) 1.5 (m / s)

or

their pA + pB = 12 × v correctly calculated

allow 2 marks for correct substitution, ie

18 = 12 × v

or

their pA + pB = 12 × v

18 or their pA + pB scores 1 mark if no other mark awarded

3

(iii) 14 (kg m / s)

or

their pA - pB

1

16.5 (J)

1

[14]

Q3.

(a) (i) distance travelled under the braking force

accept distance travelled between applying the brakes and stopping

1

(ii) any one from:

• icy / wet roads

accept weather (conditions)

• (worn) tyres

• road surface

accept gradient of road

• mass (of car and passengers)

accept number of passengers

• (efficiency / condition of the) brakes.

friction / traction is insufficient

1

(iii) greater the speed the greater the braking force (required)

must mention both speed and force

1

(b) 22.5

allow 1 mark for showing correct use of the graph with misread figures

or

for showing e.g. 90÷4

an answer 17 gains 1 mark

any answer such as 17.4 or 17.5 scores 0

2

(c) (i) momentum before = momentum after

or

(total) momentum stays the same

accept no momentum is lost

accept no momentum is gained

ignore statements referring to energy

1

(ii) 5

allow 2 marks for correctly obtaining momentum before as

12 000

or

allow 2 marks for

1500 × 8 = 2400 × v

or

allow 1 mark for a relevant statement re conservation of momentum

or

allow 1 mark for momentum before = 1500 × 8

3

(d) the seat belt stretches

1

driver takes a longer (impact) time to slow down and stop (than a driver hitting a hard surface / windscreen / steering wheel)

1

for the (same) change of momentum

accept so smaller deceleration / negative acceleration

1

a smaller force is exerted (so driver less likely to have serious injury than driver without seat belt)

or

the seat belt stretches (1)

do not accept impact for force

driver travels a greater distance while slowing down and stopping (than a driver hitting a hard surface / windscreen / steering wheel) (1)

for (same) amount of work done (1)

accept for (same) change of KE

a smaller force is exerted (so driver less likely to have serious injury than driver without seat belt) (1)

do not accept impact for force

1

[13]

Q4.

(a) increases

1

increases

1

(b) 23 (m)

accept 43 circled for 1 mark

accept 9 + 14 for 1 mark

2

(c) (i) all points correctly plotted

all to ± ½ small square

one error = 1 mark

two or more errors = 0 marks

2

line of best fit

1

(ii) correct value from their graph (± ½ small square)

1

(d) (i) 70

½ × 35 × 4 gains 2 marks

attempt to estimate area under the graph for 1 mark

3

(ii) line from (0.6,35)

1

sloping downwards with a less steep line than the first line

1

cutting time axis at time > 4.6 s

accept cutting x-axis at 6

1

(e) (i) 42 000

1200 × 35 gains 1 mark

2

kgm / s

Ns

1

(ii) 10 500 (N)

42 000 / 4 gains 1 mark

alternatively:

a = 35 / 4 = 8.75 m / s2

F = 1200 × 8.75

2

[19]

Q5.

(a) Zero / 0

Accept none

Nothing is insufficent

1

velocity / speed = 0

accept it is not moving

paintball has not been fired is insufficient

1

(b) 0.27

allow 1 mark for correct substitution, ie p = 0.003(0) × 90 provided no subsequent step

2

(c) equal to

1

[5]

Q6.

(a) momentum before (jumping) = momentum after (jumping)

accept momentum (of the skateboard and skateboarder) is conserved

1

before (jumping) momentum of skateboard and skateboarder is zero

accept before (jumping) momentum of skateboard is zero

accept before (jumping) total momentum is zero

1

after (jumping) skateboarder has momentum (forwards) so skateboard must have (equal) momentum (backwards)

answers only in terms of equal and opposite forces are insufficient

1

(b) 7

accept –7 for 3 marks

allow 2 marks for momentum of skateboarder equals 12.6

or

0 = 42 × 0.3 + (1.8 × –v)

or

allow 1 mark for stating use of conservation of momentum

3

[6]

Q7.

(a) any two from:

• (make shape / body) more streamlined

accept a correct description

accept lower the seating position of the driver

• increase power of engine

faster engine is insufficient

• reduce mass / weight (of go-kart)

change wheel size is insufficient

2

(b) (i) A–B

reason only scores if A–B is chosen

1

steepest / steeper gradient / slope

1

(iii) 1820

allow 1 mark for correct substitution, ie 140 × 13 provided no subsequent step shown

2

[6]

Q8.

(a) D – E

reason only scores if D – E chosen

1

shallowest slope / gradient

accept smallest distance in biggest time

accept longest time to travel the same distance

accept the line is not as steep

accept it is a less steep line

do not accept the line is not steep

1

(b) 80 000

allow 1 mark for correct substitution, ie 16 000 × 5 provided no subsequent step shown

2

(c) (i) straight line starting at origin

accept within one small square of the origin

1

passing through t = 220 and d = 500

1

(i) 186

accept any value between 180 and 188

accept where their line intersects given graph line correctly read ±4 s

1

[7]

Q9.

(a) (i) momentum before = momentum after

accept no momentum is lost

accept no momentum is gained

or

(total) momentum stays the same

1

(ii) an external force acts (on the colliding objects)

accept colliding objects are not isolated

1

(b) (i) 9600

allow 1 mark for correct calculation of momentum before or after ie 12000 or 2400

or

correct substitution using change in velocity = 8 m/s

ie 1200 × 8

2

kg m/s

or

Ns

this may be given in words rather

than symbols

do not accept nS

1

(ii) 3 or their (b)(i) 3200 correctly calculated

allow 1 mark for stating momentum before = momentum after

or

clear attempt to use conservation of momentum

2

[7]

Q10.

(a) 98

allow 1 mark for correct substitution

ie ½ × 0.16 × 35 × 35 provided no subsequent step shown

an answer of 98 000 scores 0

2

(b) (i) 9.6

allow 1 mark for (change in velocity =) 60

ignore negative sign

2

(ii) 9600

ignore negative sign

or

their (b)(i) ÷ 0.001 correctly calculated, unless (b) (i) equals 0

1

(c) increases the time

1

to reduce/change momentum (to zero)

only scores if 1st mark scored

decreases rate of change of momentum scores both marks provided there are no contradictions

accept decreased acceleration/deceleration

equations on their own are insufficient

1

[7]

Q11.

(a) (moving in) different / opposite directions

accept one has positive momentum the other negative momentum

accept they have different velocities

1

(b) (i) momentum before = momentum after

or

(total) momentum stays the same

accept no momentum is lost

accept no momentum is gained

1

(ii) 2.2

allow 1 mark for calculation of teenagers’ momentum as

22 (kgm/s) and

allow 1 mark for correct statement, eg momentum

before = momentum after

or

allow 2 marks for a numerical expression of above, eg

55 × 0.4 = m × 10

or 0 = (55 × 0.4) + (m × (-10))

3

(c) any two from:

• work is done

• (against) friction

any reference to increasing friction negates this marking point

• (transforming) (kinetic) energy into heat

2

[7]

Q12.

(a) (i) 16 000

allow 1 mark for correct substitution ie 3200 × 5

2

(ii) 16 000 or their (a)(i)

1

(iii) less than

1

(b) increases

1

decreases

correct order only

1

[6]

Q13.

(a) direction

1

(b) 54 000

allow 1 mark for calculating and identifying momentum as 10 800

or

allow 1 mark for correct substitution into second equation

ie

2

(c) increases the time taken (for head) to stop

accept increases impact time

do not accept reference to slowing down time unless qualified

1

decreases rate of change in momentum

accept reduces acceleration / deceleration

accept increases the time taken to reduce momentum to zero is worth 2 marks

reduces momentum is insufficient

1

reduces the force (on the head)

1

[6]

Q14.

(a) (i) lorry

reason only scores if lorry chosen

1

greatest mass

accept weight for mass

accept heaviest

accept correct calculations for all 3 vehicles

the biggest is insufficient

1

(ii) 2450

allow 1 mark for correct substitution

ie 175 × 14

2

(b) (i) increases

accept any clear indication of the correct answer

1

(ii) speed increases

accept velocity for speed

accept gets faster

do not accept it accelerates on its own

moves more is insufficient

1

(iii) straight line going to 6, 20

allow 1 mark for a curve going to 6,20

or a straight line diagonally upwards but missing 6,20

2

horizontal line from 6,20 to 8,20

allow a horizontal line from where their diagonal meets 20m/s to 8,20

1

[9]

Q15.

(a) 4.2

2 marks for correct substitution and transformation, ie 1155/275

allow 1 mark for correct resultant force with a subsequent incorrect method, ie 1155

allow 1 mark for an incorrect resultant force with a subsequent correct method,

eg answers of 7.27 or 10.34 gain 1 mark

3

(b) (i) YES

marks are for the explanation

any two from:

• data (from police files) can be trusted

• data answers the question asked

allow a conclusion can be made from the data

• large sample used

NO

any two from:

• the sample is not representative

• the sample size is too small

• accident files do not indicate age / experience of riders

an answer YES and NO can score 1 mark from each set of mark points

2

(ii) more accidents with motorbikes up to 125 cc

accept for 2 marks an answer in terms of number of under 125 cc to accidents ratio compared correctly with number of over 500 cc to accidents ratio

1

even though there are fewer of these bikes than bikes over 500 cc

1

(c) (i) increases the time taken to stop

accept increases collision time

1

decreases rate of change in momentum

accept reduces acceleration / deceleration

accept

reduces momentum is insufficient

1

reduces the force (on the rider)

1

(ii) YES

any sensible reason, eg:

the mark is for the reason

• cannot put a price on life / injury

accept may save lives

• fewer (serious) injuries

accept reduces risk of injury

• reduces cost of health care / compensation

NO

any sensible suggestion, eg:

• money better spent on …

needs to be specific

• total number of riders involved is small

1

[11]

Q16.

(a) (i) momentum before = momentum after

or

(total) momentum stays the same

accept no momentum is lost

accept no momentum is gained

1

(ii) an external force acts (on the colliding objects)

accept colliding objects are not isolated

1

(b) (i) 9600

allow 1 mark for correct calculation of momentum before or after

ie 12000 or 2400

or

correct substitution using change in velocity = 8 m/s

ie 1200 × 8

2

kg m/s

this may be given in words rather than symbols

or

Ns

1

(ii) 3 or their (b)(i) ÷ 3200 correctly calculated

allow 1 mark for stating momentum before = momentum after

or

clear attempt to use conservation of momentum

2

[7]

Q17.

(a) (i) 10800

allow 1 mark for correct substitution i.e. 900 × 12

2

(ii) arrow pointing towards the left

allow anywhere on the diagram or at bottom of the page

1

(b) zero

accept 0 / none / nothing

1

 velocity is zero

accept speed for velocity

accept stopped / not moving

accept a calculation i.e. 900 × 0 = 0

1

[5]

Q18.

(a) (i) 4.5

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

2

(ii) m/s2

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

(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]

Q19.

(a) (i) 210

allow 1 mark for correct substitution i.e. 35 × 6

2

 kg m/s or Ns

do not accept n for N

accept 210 000g m/s for 3 marks

1

(ii) 840

if answer given is not 840 accept their (a)(i) in kg m/s ÷ 0.25 correctly calculated for both marks

allow 1 mark for correct substitution i.e. 210 ÷ 0.25 or their (a)(i) ÷ 0.25

2

(b) increases the time to stop

accept increases impact time

do not accept any references to slowing down time

1

 decreases rate of change in momentum

accept reduces acceleration/deceleration

reduces momentum is insufficient

1

 reduces the force (on the child)

1

(c) any two from:

• insufficient range of tests/thicknesses for required cfh

accept need data for thicknesses above 80 mm/ cfh 2.7 m

not enough tests is insufficient

• (seems to be) some anomalous data

• (repeats) needed to improve reliability (of data)

accept data/ results are unreliable

do not accept maybe systematic/random error

do not accept reference to precision

• need to test greater range/variety of dummies

accept children for dummies

accept specific factor such as weight/height/size

2

(d) Tyres do not need to be dumped/burned/ less land-fill/ saves on raw

materials

accept less waste

do not accept recycling on its own

1

[11]

Q20.

(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

• 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]

Q21.

(a) 4 (m/s)

1 mark for correct transformation of either equation

1 mark for correct substitution with or without transformation

1 mark for correct use of 0.6N

max score of 2 if answer is incorrect

3

(b) greater change in momentum

 or greater mass of air (each second)

 or increase in velocity of air

accept speed for velocity

 force upwards increased

lift force is increased

do not accept upthrust

1

 or force up greater than force down

accept weight for force down

1

(c) • increase the time to stop

1

• decrease rate of change in momentum or same momentum change

accept reduced deceleration/ acceleration

1

• reducing the force on the toy

do not accept answers in terms of the impact/ force being absorbed

do not accept answers in terms of energy transfer

do not credit impact is reduced

1

[8]

Q22.

(i) momentum (change in) = mass × velocity (change in)

accept ... speed

1

(ii) 9000

1500 × 6 for 1 mark but not from incorrect equation

2

 kilogram metre(s) per second or kg m/s

1

(iii) either 7.5 (m/s)

 or change in momentum of car B change in momentum of car A (1)

9000 = 1200 × v (1)

or v = 9000 ÷ 1200 (1)

 or error carried forward from part (ii)

examples

5 (m/s) if 6000 offered in (ii) (3)

12.5(m/s) if 15000 offered in (ii)

(3)

3

[7]

Q23.

(a) (i) momentum = mass × velocity

accept … × speed or any transposed version

1

(ii) 11.2 to 11.3

0.75 × 15 for 1 mark

2

kg m/s down(wards) or Ns down(ward)

n.b. both unit and direction required for this mark

1

(iii) 11.2 to 11.3

accept same numerical answer as part (a)(ii)

accept answer without any unit or with the same unit as in part (a)(ii), even if incorrect, but any other unit cancels the mark

1

(iv) force =

accept transposed version

1

(v) 112 to 113 or numerical value from (a)(ii) × 10

11.25 ÷ 0.1 or (a)(ii) ÷ 0.1 for 1 mark

2

newton(s)

or N

accept Newton(s)

do not credit ‘Ns’ or n

1

(b) (the user will experience a) large change in momentum

do not credit just ‘… momentum changes’

1

 (but) seat belt increases the time for this to occur or

seat belt stops you hitting something which would stop you quickly

do not credit just ‘… stops you hitting the windscreen etc.’

1

(so) the force on the user is less(\*)

1

(so) less chance of (serious / fatal) injury(\*)

(\*) depends on previous response re momentum or continued movement

1

[13]

Q24.

(a) (i) either

the momentum in a particular direction after (the collision) is the same as the

momentum in that direction before (the collision)

accept ‘momentum before equals momentum after’ for 1 mark

 or total momentum after (the collision) equals the total momentum before

(the collision) (2)

accept ‘momentum before equals momentum after’ for 1 mark

2

(ii) explosion(s)

or (action of a) rocket (motor(s))

or (action of a) jet (engine)

or firing a gun

accept any other activity in which things move apart as a result of the release of internal energy eg throwing a ball

1

(iii) momentum = mass velocity or any correctly transposed version

accept momentum = mass speed

accept p = mv

do not accept momentum = ms

or M = mv

1

(iv) 0.8

if answer 0.8 not given, any two for (1) each:

momentum of X = 0.2 1.2

= momentum of X and Y after impact

= 0.3 v or = (0.1 + 0.2) v

3

m/s

1

to the right

1

(v) any one from:

conservation of momentum (applies)

no external forces

do not accept just ‘no (other) forces act’

friction is negligible / insignificant

no friction

no air resistance

1

(b) force = (change in) momentum ÷ time

or any correctly transposed version

1

4000 or 4 kilonewtons

dependent on correct or no equation

force = 5 ÷ 0.00125 gains 1 mark

2

[13]

Q25.

(a) Total momentum (of a system of bodies) remains constant

accept momentum before (a collision) = momentum after (a collision)

1

Provided no external force acts

1

(b) (i) rotate the compressor

1

(ii) • fuel is mixed with the air and ignited

• causing an increase in the pressure

or temperature or speed of the gases

accept air out faster than air in

accept gases have momentum or

• force backwards

• exhaust gases have momentum

(backwards) or force (backwards)

if the answer is in terms of force then this third point must be scored before the fourth can be credited

• engine or aircraft has (equal) momentum forwards or force forwards

4

(c) m = 350

answer 0.35 one mark only

allow one mark if 105 000 or 475-175 or 300 have been used

2

[9]

Q26.

(a) (i) zero

accept nothing

1

speed is zero

accept not moving

1

(ii) A

1

 largest mass or weight

accept heaviest luggage

do not accept largest luggage

1

(iii) momentum does change

accept yes

1

 direction is changing

accept velocity is changing

do not accept answers in terms of

speed changing

1

(b) kg m/s

1

[7]

Q27.

(a) (i) direction indicated

accept to right or + or – or arrow drawn on diagram

1

 300

1

 kg m/s or Ns

1

(ii) 300 (kg m/s)

1

(b) momentum of person towards jetty = momentum of boat away from jetty

or total momentum is constant so as person goes one way boat goes the other

1 mark is for the idea of momentum conservation

1 is for direction

2

(c) time of collision increases

do not accept momentum is conserved

1

so a smaller force is exerted

do not accept designed to absorb energy or momentum

1

 to produce the same change of momentum or impulse force

do not accept cushions fall

1

[9]

Q28.

(a) the snow

1

smallest mass

do not accept it is not moving

accept weight for mass

accept it’s the lightest

1

(b) (i) decrease

1

velocity reducing

accept speed for velocity

accept it is stopping

do not accept the brakes are on

accept car is decelerating

1

(ii) forwards

1

 direction of momentum does not change

or the car stops and snow does not

dependent on forwards given

accept answers given in terms of Newton’s second or first law of motion

accept momentum of snow

do not accept the snow still has momentum

1

(c) Ns

1

[7]

Q29.

(a) (i) 6

for 1 mark

1

(ii) 6

for 1 mark

1

(iii) 1.5

for 1 mark

1

(iv) 4.5

for 1 mark

1

(v) 3

for 1 mark

1

(b) initial ke = 12J;

final ke = 0.75J + 6.75J;

energy loss = 4.5J

for 1 mark each

 (If wrong; any correct ke value gains 1 mark; maximum of 2

path through calculation clear and correct gains 1 mark)

(ignore either ball – max 1 mark)

3

[8]

Q30.

(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]

Q31.

(a) mass and velocity/speed multiplied

for 1 mark each

2

(b) total momentum before and after collision are the same

for 1 mark each

2

(c) (i) MAUA + MBUB = (MA + MB)v

2 × 6 = (2 + 1)v

v = 4

m/s

for 1 mark each

4

(ii) 1/2 mv2 (before) – 1/2 mv2 (after) 1/2 2.36 – 1/2 3.16 = 12

J

for 1 mark each

4

[12]

Q32.

(a) Throughout the question the equation M = mv is credited once only.

This is the first time it appears. The mark scheme below assumes

it will appear in (i).

(i) M = mv m × v sufficient not m × s, mass × speed

= 1500 × 8

= 12 000

(see marking of calculations)

3

(ii) M = mv

M = 2000 × 1 = 2000

(see marking of calculations)

2

(iii) must be sum of (i) and (ii) 14 000

for 1 mark

1

(b) total mass = 3500

momentum = 14 000 (conserved)

M = mv or v = 14 000/3500

v = 4

m/s

5

(c) (i) it reduces

for 1 mark

1

(ii) ke to sound/heat

for 1 mark

1

[12]

Q33.

(a) product of mass and velocity

1

(b) (i) 4kg or 4000g

1

(ii) M = 8kgm/s or Ns

for 3 marks

 else M = 8

for 2 marks

 else M – mv or 4 × 2

for 1 mark

3

(iii) 8 kgm/s (watch e.c.f.)

1

(iv) v = 400

for 3 marks

 else v = 8/0.02

for 2 marks

 else M – mv, v – M/m or 8 = 0.02v

for 1 mark

3

(v) ke = 8

for 3 marks

 else ke = 1/2 (4 × 22)

for 2 marks

 else ke = 1/2 (mv2)

for 1 mark

3

(vi) transferred to heat and sound

or does work against wood/pushing wood aside/deforming bullet

1

[13]

Q34.

(a) WX deceleration / speed decreasing / slowing down / negative acceleration

 XY constant speed / steady speed not constant motion / slow speed

 YZ acceleration / speed increasing / speeding up

for 1 mark each

3

(b) distance = v × t or distance = 30 × 20

gains 1 mark

 but

distance = 600(m)

gains 2 marks

2

(c) acceleration = v / t or acceleration = 30 / 12

gains 1 mark

(if –30 / 12, allow negative sign here if not in the answer)

3

 but

acceleration = 2.5 (m/s²)

gains 2 marks

 but

acceleration = -2.5 (m/s²)

gains 3 marks

(d) in a crash / during hard braking car body stops / slows rapidly driver / passengers continue to move forward not thrown forward seatbelts provide backward force / keep them in their seats / restrain them to stop them hitting the windscreen / dashboard

(an alternative argument involving momentum is acceptable)

for 1 mark each

4

[12]

Q35.

(a) ideas that greater speed means more kinetic energy

gains 1 mark

 but any evidence of the formula ½ mv2

but making the case that kinetic energy depends on the speed squared

gains 3 marks

 or that 22 = 4

3

(b) (i) any evidence of concept of momentum or mass × speed

(or velocity) in words or figures e.g. 9.5 × 20 or 0.5 × 40

gains 1 mark

 but correct values for momentum of lorry and car

i.e. 190 and 20 [ignore units]

gains 2 marks

 but initial momentum correctly calculated

170 or 190 – 20

gains 3 marks

 THEN

evidence when calculating final speed of

idea that momentum is conserved

use of combined mass

each gain 1 mark

 but

17 [or 0.1 × figure for initial momentum]

(NB direction not required)

gains 3 marks

6

(ii) kinetic energy is lost

for 1 mark

 [credit (some kinetic) energy transferred as heat/sound]

[NB Accept only answers in terms of energy as required by the question]

1

[10]