Momentum

Mark Scheme

Name: _____

Class: _____

Date: _____

Time: **111 minutes**

Marks: **111 marks**

Comments:

Mark schemes

1

(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]

2

(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]

3

(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]

4

(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]

5 (a) *ideas that* greater speed means more kinetic energy

gains 1 mark

but *any evidence of the formula* ½ mv^2
but making the case that kinetic energy depends on the speed squared

gains 3 marks

or that $2^2 = 4$

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 <u>not</u> required)

gains 3 marks

6

(ii) <u>kinetic</u> 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]

6 (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 $F = \frac{\Delta mv}{\Delta t}$

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]

7 (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]

8 (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 <u>total</u> momentum after (the collision) equals the <u>total</u> 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]

9

(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 = $\frac{\text{change in momentum}}{\text{time}}$

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]

10 (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]