**Mark schemes**

Q1.

(a) Level 2 (3–4 marks):

A detailed and coherent description of a plan covering all the major steps is provided.

The steps are set out in a logical manner that could be followed by another person to obtain valid results.

Level 1 (1–2 marks):

Simple statements relating to relevant apparatus or steps are made but they may not be in a logical order. The plan would not allow another person to obtain valid results.

0 marks:

No relevant content.

Indicative content

• measure the distance the ruler falls before being stopped

• the greater this distance the greater the reaction time

• repeat measurements and calculate a mean

• repeat several times with the student listening to music (through earphones). Calculate a mean.

• a (significant) difference between the two means would show that music affects reaction time.

4

(b) reaction time decreases with practice

allow Y has a shorter reaction time

1

allow Y has faster reaction times (than X)

(c) the stop clock was started before the computer test started

1

the student was distracted

1

[7]

Q2.

(a) It will have a constant speed.

1

(b) distance travelled = speed × time

1

(c) a = 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) 182 − 92 = 2 × 1.5 × s

1

s = 182 − 92 / 2 × 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]

Q3.

(a) 3 (.0)

allow 1 mark for correct substitution i.e. 25 × 0.12 provided no subsequent step

2

(b) (i) elastic potential

correct order only

1

kinetic

1

(ii) increases

1

to 80 (mm) (or more)

accept any number greater than 75

an answer ‘it (more than) doubles’ gains both marks

1

(c) (i) weight

1

(ii) downward speed increases

1

[8]

Q4.

(a) the forces are equal in size and act in opposite directions

1

(b) (i) forwards / to the right / in the direction of the 300 N force

answers in either order

1

accelerating

1

(ii) constant velocity to the right

1

(iii) resultant force is zero

accept forces are equal / balanced

1

so boat continues in the same direction at the same speed

1

(iv) parallelogram or triangle is correctly drawn with resultant

3

value of resultant in the range 545 N – 595 N

parallelogram drawn without resultant gains 1 mark

If no triangle or parallelogram drawn:

drawn resultant line is between the two 300 N forces gains 1 mark

drawn resultant line is between and longer than the two 300 N forces gains 2 marks

1

[10]

Q5.

(a) (i) not moving

1

(ii) straight line from origin to (200,500)

ignore a horizontal line after (200,500)

1

(b) 35 000

allow 1 mark for correct substitution, ie 14 000 × 2.5 provided no subsequent step

an answer of 87 500 indicates acceleration (2.5) has been squared and so scores zero

2

[4]

Q6.

(a) (produces) a force from water on the boat

1

in the forward direction

accept in the opposite direction

this must refer to the direction of the force not simply the boat moves forwards

an answer produces an (equal and) opposite force gains 1 mark

1

(b) (i) 1.5

allow 1 mark for correct substitution, ie or

provided no subsequent step shown

ignore sign

2

m/s2

1

(ii) 102

or

their (b)(i) × 68 correctly calculated

allow 1 mark for correct substitution, ie 1.5 × 68

or their (b)(i) × 68

provided no subsequent step shown

2

(iii) greater than

reason only scores if greater than chosen

1

need to overcome resistance forces

accept named resistance force

accept resistance forces act (on the water skier)

do not accept gravity

1

[9]

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) 3 lines drawn

all correct

allow 1 mark for each correct line

if two or more lines are drawn from any diagram then all these lines are incorrect

3

(b) (i) horizontal arrow to the right

judge by eye

accept an arrow drawn outside the box if it is labelled correctly

1

(ii) horizontal arrow to the left

judge by eye

accept an arrow drawn outside the box if it is labelled correctly

1

(iii) equal to

1

(iv) to measure the forces exerted on the dummy during the impact

1

[7]

Q9.

(a) A constant speed / velocity

accept steady pace

do not accept terminal velocity

do not accept stationary

1

B acceleration

accept speeding up

1

C deceleration

accept slowing down

accept accelerating backwards

accept accelerating in reverse

do not accept decelerating backwards

1

(b) (i) the distance the car travels under the braking force

accept braking distance

1

(ii) speed/velocity/momentum

1

(c) (i) 5000 (N) to the left

both required

accept 5000(N) with the direction indicated by an arrow drawn pointing to the left

accept 5000(N) in the opposite direction to the force of the car (on the barrier)

accept 5000(N) towards the car

1

(ii) to measure/detect forces exerted (on dummy / driver during the collision)

1

(iii) 4

allow 1 mark for showing a triangle drawn on the straight part of the graph

or correct use of two pairs of coordinates

2

m/s2

do not accept mps2

1

[10]

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) 2.75

allow 1 mark for correct substitution, ie

or

provided no subsequent step shown

2

m/s2

1

(b) driving force increases

1

frictional force increases

accept air resistance / drag for frictional force

1

driving force > frictional force

1

[6]

Q12.

(i) the thicker the tile, the greater the(fall) height

accept the higher (the fall) the thicker the tile

accept there is a positive correlation

do not accept they are proportional

1

(ii) 60 (mm)

accept any number or range between 60 and 85 inclusive

if units are given must match range

1

 (minimum thickness) needed to reduce risk of injury

reason must match thickness choice

do not accept to keep child safe

accept an answer in terms of – the thicker the tile, the less chance there is of a serious injury if the answer given is greater than 60

accept answers in terms of use of graph e.g. the graph shows that for a 2m fall a thickness of 60 mm is needed

minimum level answer’ the graph shows that’s what’s needed’ accept only if 60 is the answer

1

[3]

Q13.

(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/s2

1

(c) as speed increases air resistance increases

accept drag / friction for air resistance

1

 reducing the resultant force

1

[7]

Q14.

(a) (i) 0.6

allow 1 mark for correct substitution

2

 newtons

accept N

do not accept n

accept Newtons

1

(ii) the same as

1

(b) (i) changed velocity

accept increased/ decreased for change

accept speed for velocity

accept change direction

accept getting faster/ slower

accept start/ stop moving

accept correct equation in terms of change in speed or change in velocity

1

(ii) down(wards)

accept towards the ground

accept ↓

do not accept south

1

[6]

Q15.

(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]

Q16.

(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 =

accept a = or a =

do not accept velocity for change in velocity

do not accept change in speed

do not accept a =

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]

Q17.

(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]

Q18.

(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]

Q19.

(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]

Q20.

(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]

Q21.

(i) force = mass acceleration

accept F = m a

accept upper or lower case letters

accept equation using correct units

accept

if subsequent method correct

1

(ii) 0.007

allow 1 mark for correct transformation or substitution

2

[3]

Q22.

(a) 3

gains 1 mark

 m/s2

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]

Q23.

(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 = or a =

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]

Q24.

(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]

Q25.

(a) A then E

for one mark

1

(b) A > E

A = E

A < E

in this order for 1 mark each

3

(c) when van stops / is stationary / is parked

for one mark

1

(d) WX – slowing down (owtte)

XY – constant speed (owtte)

YZ – speeding up (owtte)

for 1 mark each

3

(e) ….. force …. forwards …. backwards

for 1 mark each

3

[11]

Q26.

(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]

Q27.

12 100

correct answer with no working = 3

if answer incorrect, allow 1 mark for force = mass × acceleration

1210 × 10 = 2 force / weight = mass × gravity is neutral

N.B. no marks for correct answers with incorrectly recalled relationship

[3]

Q28.

(a) WD = force × distance or 6 × 2

gains 1 mark

 but 12 gains 2 marks

units J/joules [credit Nn]

for 1 mark

3

(b) 0.6 (i.e. using the recalled 10N/kg)

gains 1 mark

 but evidence of force = mass × acceleration

or of correct substitution e.g. 6/9.8

gains 2 marks

 but 0.61 (2...)

gains 3 marks

3

(c) any reference to

initial acceleration due to gravity

(force due to) friction/air resistance

each for 1 mark

 ideas that

this increases as speed increases

forces eventually balance

each for 1 further mark

9

[9]

Q29.

(a) \*evidence of acceleration = or

gains 1 mark

 but 0.2

gains 2 marks

 units m/s2

for 1 mark

3

(b) (i) 2000 or 1960

for 1 mark

1

(ii) evidence of power = or weight × speed (credit figures)/

(iii)

gains 1 mark

 but 1200/1176 or figure consistent with (b)(i)

gains 2 marks

2

(c) evidence of force = mass × acceleration or 200 × 0.3

gains 1 mark

 but 60

gains 2 marks

 but 60 + weight of girder (2060/2020\*) (or figure consistent with (b)(i))

gains 3 marks

3

[9]

Q30.

(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]