**Mark schemes**

Q1.

(a) D

1

(b) C

1

(c) W = 300 × 45

1

W = 13 500

1

allow 13 500 with no working shown for 2 marks

(d) straight line drawn from 13 m / s to 0 m / s

1

finishing on x-axis at 65 s

1

[6]

Q2.

(a) the distance travelled under the braking force

1

(b) the reaction time will increase

1

increasing the thinking distance (and so increasing stopping distance)

(increases stopping distance is insufficient)

1

(c) No, because although when the speed increases the thinking distance increases by the same factor the braking distance does not.

1

eg

increasing from 10 m / s to 20 m / s increases thinking distance from 6 m to 12 m but the braking distance increases from 6 m to 24 m

1

(d) If the sled accelerates the value for the constant of friction will be wrong.

1

(e) only a (the horizontal) component of the force would be pulling the sled forward

1

the vertical component of the force (effectively) lifts the sled reducing the force of the surface on the sled

1

(f) − u2 = 2 × −7.2 × 22

award this mark even with 02 and / or the negative sign missing

1

u = 17.7(99)

1

18

1

allow 18 with no working shown for 3 marks

allow 17.7(99) then incorrectly rounded to 17 for 2 marks

[11]

Q3.

(a) resultant force = zero

or

upward force = downward force

accept forces are balanced

accept weight for downward force

1

(b) (i) 84

allow 1 mark for correct substitution ie 840 = m × 10

2

(ii) 12

accept 12.02 for both marks

or

1010 ÷ their (b)(i) correctly calculated

a resultant force of 1010 (N) gains 1 mark

an answer 22(.02) gains 1 mark

2

m/s2

accept m/s/s

1

[6]

Q4.

(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]

Q5.

(a) (i) D

1

(ii) friction

1

(iii) any two from:

• the speed / velocity

• the radius of the bend

the radius is insufficient

accept curvature of the road

size of the bend is insufficient

accept distance of car from centre (of bend)

• the mass (of the car).

accept weight for mass

2

(b) the car has a wide base

accept any description of a wide base e.g. the wheels are far apart

accept wide wheel base

do not accept long wheel base

a large surface area is insufficient

wide tyre(s) is insufficient

1

the car has a low centre of mass / gravity

accept any description of low centre of mass e.g. mass is close to the ground

a down force is insufficient

1

[6]

Q6.

(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]

Q7.

(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]

Q8.

(a) 4 N to the right

1

(b) (i) bigger than

1

equal to

1

(ii) reduces it

1

increases air resistance / drag / force C

accept parachute has large(r) (surface) area

1

[5]

Q9.

(a) (i) electrons

1

a positive

1

(ii) (forces are) equal

accept (forces are)the same

forces are balanced is insufficient

1

(forces act in) opposite directions

accept (forces) repel

both sides have the same charge is insufficient

1

(b) aluminium

1

[5]

Q10.

(a) more streamlined

accept decrease surface area

1

air resistance is smaller (for same speed)

accept drag for air resistance

friction is insufficient

1

so reaches a higher speed (before resultant force is 0)

ignore reference to mass

1

(b) (i) 1.7

allow 1 mark for correct method, ie

or allow 1 mark for an answer with more than 2 sig figs that rounds to 1.7

or allow 1 mark for an answer of 17

2

(ii) 7.5

allow 1 mark for correct use of graph, eg × 5 × 3

2

(iii) air (resistance)

accept wind (resistance)

drag is insufficient

friction is insufficient

1

[8]

Q11.

(a) correct box ticked

1

(b) (i) 30

ignore added units

1

(ii) 2250 or their (b)(i) × 75 correctly calculated

allow 1 mark for correct substitution ie 75 × 30 or their (b)(i) × 75 provided no subsequent step shown

an answer of 750 gains 1 mark only if answer to (b)(i) is 10

2

[4]

Q12.

(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]

Q13.

(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]

Q14.

(a) (i) 120

1

(ii) 20

accept 140–their (a)(i) provided answer is not negative

1

(iii) as speed increases

1

drag force / water resistance / friction / D increases

1

(until) D = 140 N or (until) D = T

forces balance is insufficient

1

(b) (i) (average) speed (of swimmer)

1

(ii) any two from:

• more data

accept results for data

do not accept more accurate data

• force may vary (a lot) / change

• give more reliable average

ignore references to anomalies

ignore accurate / precise

2

(iii) examples of acceptable responses:

• most / some females produce smaller forces

do not accept all females produce smaller forces

• most / some males produce larger forces

do not accept all males produce larger forces

• some females swim as fast as males but use a smaller force

• most of the faster swimmers are male

do not accept all males swim faster

• most of the slower swimmers are female

do not accept all females swim slower

• range of the (average) speed of males is smaller than the

 range of the (average) speed of females

• range of the (average) force of the males is greater than the

 range of the (average) force of the females

1

(iv) exert maximum (hand) force (throughout the swim / stroke)

accept (any method to) increase (hand) force

practise more is insufficient

1

[10]

Q15.

(a) correct box ticked

1

(b) each passenger has a different mass

accept weight for mass

ignore other irrelevant factors about the person e.g. mass and height

do not accept a list with incorrect factors e.g. mass and position

accept passengers started with different (gravitational) potential energy

1

(c) (i) 29.4

ignore added units

1

(ii) 2400

accept their (c)(i) × 80 correctly calculated for both marks

allow 1 mark for correct substitution of their (c)(i) and 80

an answer of 800 gains 1 mark only if answer to (c)(i) is not 10

2

[5]

Q16.

(a) (i) 50 (N)

ignore any units

1

(ii) resultant force

1

(iii) 4000

accept their (a)(i) × 80 correctly calculated for 2 marks

allow 1 mark for correct substitution i.e. 50 × 80 or their (a)(i) × 80

ignore any units

2

(b) (i) joule

1

(ii) heat

1

[6]

Q17.

(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]

Q18.

(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]

Q19.

(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]

Q20.

(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]

Q21.

(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]

Q22.

(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]

Q23.

(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]

Q24.

(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]

Q25.

(a) up

for 1 mark

1

(b) (i) increased

for 1 mark

1

(ii) more water displaced; ship heavier

either for 1 mark

1

[3]

Q26.

(a) (i) plasticine stretches/snaps

stays stretched/snapped

for 1 mark each

2

(ii) spring compresses OWTTE

returns to original length/shape or gets longer

for 1 mark each

2

(iii) ruler bends/breaks

returns to original shape or stays broken

for 1 mark each

2

(b) (i) 1.5N

for 1 mark

1

(ii) 4 cm

for 1 mark

1

(iii) 19 cm

for 1 mark

1

[9]

Q27.

(a) plasticine stretches/snaps

stays stretched/snapped/same

for 1 mark each

2

(b) spring compresses OWTTE

returns to original length/gets longer

for 1 mark each

2

[4]

Q28.

(a) (i) Constant speed

2

(ii) Accelerates to higher constant speed

1

(b) (i) Points correct (allow one major or two minor mistakes)

Line correct (for their points)

2

(ii) 5 m/s

or 5

gets 2 marks

or correct unit

gets 1 mark mark

3

(c) (i) 50 s or 50

gets 2 marks

or t = d/v

gets 1 mark

3

(ii) Line correct (of gradient 4 and spans 30 consecutive seconds)

1

(d) (i) 0.04 or 6/15

gets 2 marks

or a = v/t

gets 1 mark

3

[15]

Q29.

(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]

Q30.

(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]

Q31.

B and D (either order)

1

B and D (either order)

accept A and C

1

 A or C

1

[3]

Q32.

(a) (i) the pushing force balanced by the friction

accept the pushing force equals friction or pushing force is too small or frictional force is too great

1

(ii) any two from

an unbalanced force acts on the model bus

the model bus moves

in same direction as pushing force

accept forwards

and will speed up

2

(iii) force (applied)

any order

1

distance ( moved)

1

(b) (i) car is travelling fast

1

driver has been drinking alcohol

1

ice on the road

1

(ii) tyres and road / ground

1

[9]

Q33.

ideas that

gravity/weight (downwards)

upwards/opposite force of water or upthrust

forces are balanced

any three for 1 mark each

 (N.B. All these ideas may be included in a short response)

 (If no marks gained but candidate makes reference to forces, award 1 mark)

[3]

Q34.

gravity

newtons

balanced

each for 1 mark

[3]

Q35.

(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]

Q36.

(a) D

for 1 mark

1

(b) wear it away or make it warmer

for 1 mark do not accept ‘stops it’

1

[2]

Q37.

(a) idea that balanced by friction force\* / pushing force equals

friction force (\*note “balanced” by unspecified force)

or

specification of relevant force but no reference to balancing

in both 1(a) and 1(b) gains 1 mark overall

for 1 mark

1

(b) balanced by upwards force of table\*

for 1 mark

1

(c) makes it (slightly) warm / hot

or

wears it away (slightly) / damages surface

for 1 mark

1

[3]