Mark schemes

1 (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]

2 (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]

3 (a) (i) as one goes up so does the other

or (directly) proportional

accept change by the same ratio

1

(ii) steeper straight line through the origin

judge by eye

1

(iii) Yes with reason

eg data would have been checked / repeated
accept produced by a reliable/ official/ government source
*do **not** accept it needs to be reliable*

or No with reason

eg does not apply to all conditions / cars / drivers

or are only average values

or Maybe with a suitable reason

eg cannot tell due to insufficient information

1

(b) (i) stopping distance = thinking distance + braking distance

1

(ii) any **two** from:
factors must be to do with increasing braking distance

- smooth road / loose surface
- rain / snow / ice
  accept wet road/ petrol spills
  *do **not** accept condition of road unless suitably qualified*
- badly maintained brakes
  accept worn brakes
  accept bad/ worn/ rusty brakes
  *do **not** accept old brakes*
- worn tyres
  accept bald tyres
  accept lack of grip on tyres
  *do **not** accept old tyres*
- downhill slope/gradient
- heavily loaded car

2

[6]

4 (a) 4

*allow **1** mark for extracting correct information 12*

2

m/s^2

ignore negative sign

1

(b) 9 (s)

1

[4]

5 (a) MN

accept 5.8, 8 seconds must include unit

1

(b) LM

accept 0.8, 5.8 seconds must include unit

1

(c) (i) 0.8

1

(ii) drinking alcohol

1

(d) straight (by eye) line starting at 0.8 seconds

1

line drawn steeper than LM starting before L

ignore lines going beyond 2 seconds but line must exceed 2.5 metres per second before terminating

1

[6]

6 (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]

7 (a) concentration / tiredness / drugs / alcohol

accept any reasonable factor that could affect a driver's reactions

*do **not** accept speed or any physical condition unrelated to the driver*

1

(b) 31.25

*credit for **1** mark correct attempt to calculate the area under the slope **or** for using the equation*
distance = <u>average</u> velocity (speed) × time

*credit for **1** mark use of correct velocity change (12.5) <u>and</u> correct time (5) **or** answer of 62.5*

3

(c) 2.5

*credit for **1** mark triangle drawn on slope **or** correct equation **or** two correct pairs of coordinates*

credit for 1 mark use of correct velocity change (12.5) and correct time (5)
accept time = between 4.8 and 5.2 if used in (b)

do not accept an attempt using one pair of coordinates taken from the slope

3

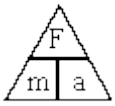
metres / second / second **or** metres / second / squared **or** m/s^2 **or** ms^{-2}

1

(d) (i) force = mass × acceleration

accept correct transformation

accept F = m × a

accept 

provided subsequent use of Δ is correct

*do **not** accept an equation in units*

1

(ii) 2250

credit their (c) × 900 for 2 marks

*credit **1** mark for correct substitution*

2

[11]

8 (a) 60

1

(b) $5\frac{1}{2}$ hours

must include unit

1

(c) 30

1

(d) 30 minutes or

$\frac{1}{2}$ hour

must include unit

1

(e) D **and** E

accept finish for E
accept correct numbers from axes with units

1

least steep part of the graph

accept covers smallest distance in a set time
accept only moves 5 km in 1 ½ hours (accept anything between 5 and 6)
ignore horse is tired

1

[6]

9 (a) (i) accelerating

accept getting faster
accept speed / velocity increasing

1

(ii) acceleration <u>increases</u>

accept velocity / speed increases <u>more</u> rapidly
*do **not** accept velocity / speed increases*

1

(b) (i) acceleration = $\frac{\text{change in velocity}}{\text{time (taken)}}$

accept $a = \frac{v-u}{t}$ ***or*** $a = \frac{v_1 - v_2}{t}$

*do **not** accept velocity for change in velocity*

*do **not** accept change in speed*

*do **not** accept* $a = \frac{v}{t}$

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]

10 (a) **Quality of written communication**

for correct use of term speed in all correct examples
Q ✓ Q ✗

1

*describes all 3 sections correctly for **2** marks*
*describes 2 or 1 section correctly for **1** mark*

max 2

A – **B** constant speed

*do **not** accept pace for speed*

B – **C** (has accelerated) to a higher (constant) speed

C – **D** goes back to original / lower (constant) speed

*allow for **1** mark, initial and final (constant) speeds are the same*
accept velocity for speed
ignore reference to direction

(b) 62.5

allow answer to 2 s.f.

*allow **1** mark for drawing a correct triangle **or** for using two correct pairs of coordinates*

*allow **1** mark for correct use of y/x*

ignore units

3

[6]

11 (a) (i) constant speed

*do **not** accept normal speed*
*do **not** accept it is stopped / stationary*

1

in a straight line

accept any appropriate reference to a direction

*constant velocity gains **2** marks*
*'not accelerating' gains **2** marks*

*terminal velocity alone gets **1** mark*

1

(ii) goes down owtte

accept motorbike (it) slows down

1

(b) (i) 20 (m/s)

ignore incorrect units

1

(ii) acceleration = $\frac{\text{change in velocity}}{\text{time (taken)}}$

*do **not** accept velocity for change in velocity*
accept change in speed

accept $a = \frac{v - u}{t}$ ***or*** $a = \frac{v_1 - v_2}{t}$

or $a = \frac{\Delta v}{t}$

*do **not** accept* $a = \frac{v}{t}$

1

(iii) 4

or their (b)(i) ÷ 5

*allow **1** mark for correct substitution*

2

m/s^2

*m/s/s **or** ms^{-2} **or** metres per second squared **or** metres per second per second*

1

(c) vehicle may skid / slide

loss of control / brakes lock / wheels lock
*accept greater stopping distance **or** difficult to stop*

1

due to reduced friction (between tyre(s) and road)

accept due to less grip
*do **not** accept <u>no</u> friction*

1

(d) any **three** from:

*do **not** accept night time / poor vision*

- <u>increased</u> speed
- <u>reduced</u> braking force
- <u>slower</u> (driver) reactions

  *NB specific answers may **each** gain credit eg tiredness (1), drinking alcohol (1), using drugs (1), driver distracted (1) etc*

- <u>poor</u> vehicle maintenance

  *specific examples may **each** gain credit eg worn brakes or worn tyres etc*

- <u>increased</u> mass / weight of vehicle

  accept large mass / weight of vehicle

- <u>poor</u> road surface
- <u>more</u> streamlined

  *if candidates give three answers that affect stopping distance but not specific to <u>increase</u> award **1** mark only*

3

[13]

12 (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]

13 (a) (i) gravity/weight

1

(ii) 2193750000000 or 2.19×10^{12}

***not** 2.19^{12}*

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

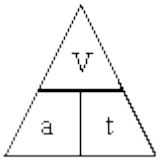
(b) (i) acceleration = $\frac{\text{change in velocity}}{\text{time (taken)}}$

accept word speed instead of velocity

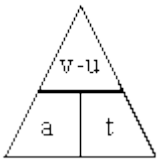
accept $a = \frac{v-u}{t}$

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/s^2 1

accept m/s/s or ms^{-2}

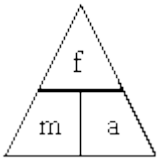
2

(c) (i) force = mass × acceleration

accept correct rearrangement

accept $F = m \times a$

do not accept



unless subsequent calculation correct

1

(ii) 156 000

accept 78 000 × their (b)(ii)(only if (b)(i) correct)

1

[9]

14 (i) first statement must be accelerated

if it just accelerated then decelerates award 2 marks

1

final statement must be stationary

1

interim statement decelerates

1

(ii) direction is changing

1

[4]

15 (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]

16 (i) C and D **or** D and C

accept CD
accept DC
accept answers in terms of time

1

(ii) any **one** from:

streamline position streamline clothes

accept crouched position
accept tight clothes
accept design of cycle
accept cycle slower

1

(iii) 0.5 hours **or** 30 minutes **or** 1800 seconds

***must** have unit*

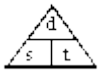
1

(iv) speed = $\frac{\text{distance}}{\text{time (taken)}}$

accept any correct rearrangement

accept s = d/t ***or*** *v s/t*

accept velocity for speed

accept 

if subsequent use of  *correct*

1

(v) 16

allow for mark for each of time = 3.5 hours
distance = 56km
allow e.c.f. from *part (a)(iii) if correctly used*

an answer of 14 gains ***2*** *marks*

allow ***1*** *mark for correct attempt to average the three sections*

3

[7]

17 (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 = $\frac{\text{change in velocity}}{\text{time taken}}$

accept correct transformation

accept $\frac{v-u}{t}=a$

accept $m/s^2 = \frac{m/s}{s}$

*do **not** accept acceleration* $= \frac{velocity}{time}$

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]

18 (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]

19 (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]

20 (a) points correct; line correct

for 1 mark each

2

(b) increases

for 1 mark

1

(c) (i) 9

for 1 mark

1

(ii) 6 ecf

for 1 mark

1

(iii) increased ecf

for 1 mark

1

[6]

21 (a) 3

gains 1 mark

m/s^2

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]

22 (a) (i) decreases

for 1 mark

1

(ii) decreases

for 1 mark

1

(iii) lower speed everywhere

for 1 mark

1

(b) (i) $3\ a = \frac{s}{t}$ **or** $a = \frac{33}{11}$

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]

23 (a) 20 m/s

gets 2 marks

Else working

gets 1 mark

2

(b) 10 m/s

1

(c) 20 m

gets 2 marks

Else working

gets 1 mark

2

(d) 12 000 N

gets 2 marks

Else working

gets 1 mark

2

(e) 2 400 000 J

gets 2 marks

Else working

gets 1 mark

2

(f) (i) Ans to (e)

1

(ii) Ans to (e)/60
Else working

2

(iii) Ans to (ii)/5

1

[13]

24 (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]

25 (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/s^2

for 1 mark each

4

(ii) $ke = 1/2\ mv^2$
$ke = 1/2\ 1250.48^2$
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]

26 (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]

27 (a) (i) 3km [allow 2.9 to 3.1]

for 1 mark

1

(ii) 6.6 min [allow 6.5 to 6.8]

for 1 mark

1

(b) can be in any units, 1.5 km/min, 1500 m/min, 25 m/s, 90 km/h
Sp = d/t
=12/8
=1.5
km/min

for 1 mark each (see marking of calculations)

4

[6]

28 (a) AB

for 1 mark

1

(b) (i) 0.7

for 1 mark each

1

(ii) 16.8

gains 2 marks

2

but correct working
(d = v.t, d = 24 × 0.7, or in terms of area under graph)

gains 1 mark

1

(c) a = (v-u)/t
= 24/4
= 6
m/s^2

(see marking of calculations)

(can work in terms of graph gradient)

4

(d) d = v.t
= 24/2 × 4
= 48

(see marking of calculations)

(can work in terms of area under graph)

3

(e) F = ma
= 800 × 6
= 4800

(see marking of calculations)

3

[15]

29 (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

(ii) 500
(iii) 50
} (but apply e.c.f. from (i))

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]

30 (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]

31 (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]

32 (a) (i) tiredness / boredom
drugs
alcohol
distraction

any two for 1 mark each

2

(ii) A greater / longer
B no effect
C greater / longer

each for 1 mark

3

(b) on a wet road: there is less friction / grip

for 1 mark

braking distance is greater / takes longer to stop
or car skids / slides forward

for 1 mark

2

(c) (i) deceleration = gradient or 30 / 4.8

each for 1 mark

2

(ii) force = mass × acceleration or 900 × 6.25

each for 1 mark

2

(iii) distance = area under graph or 0.5 × 4.8 × 30 **or** average speed × time **or** 15 × 4.8
Accept answer in terms of change in k.e. = work done
if incorrect unit given (eg 72km) then no mark
each for 1 mark

2

[13]

33

(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 …. backward
for 1 mark each

3

[11]

34

(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]

35 (a) time

1

force

1

(b) any **three** from

- driver's reactions are slow(er)

  *accept driver could have taken drugs **or** alcohol **or** due to tiredness **or** distractions*

- poor weather conditions

  *accept raining **or** snowing **or** fog / mist (poor visibility)*

- greater mass **or** weight
- poor road conditions

  oil / gravel / mud / leaves / wet / icy going downhill

- poorly maintained brakes

  *do **not** accept driver's weak foot force*

- worn tyres

3

[5]

36 (a) mass

1

(b) work (done) = force (applied) × distance (moved in the direction of the force)

*do **not** accept correctly substituted figures for this equation mark*
*accept W = Fs **or** W = Fd **or** W = Fh (well done) = force × height)*
mark formula independently

1

1 000 000 × 15

allow 1 000 000 × $\frac{15}{1000}$

1

= 15 000 000

= 15 000

1

J / joules

KJ / kilojoules

1

allow 1 000 000 × 1500

= 15 00 000 000 for 1 mark only – no unit mark

allow 3 marks for correct answer if no working / correct working is shown

(c) **Quality of written communication**

The answer to this question requires ideas in good English, in a sensible order with correct use of scientific terms. Quality of written communication should be considered in crediting points in the mark scheme

Max.4 if ideas not well expressed

A – **B** not moving

*accept stationary **or** at rest*

1

B - C acceleration **or C** – **D** acceleration

accept increases speed / velocity accept gets faster

1

comparison made that the acceleration **B – C** is less than **C** – **D**

*accept comparison made that the acceleration **C-D** is greater than **B-C***

1

D – E constant velocity

*accept steady speed **or** at 0.4 m/s*

1

E – **F** deceleration

accept decreases speed / velocity
accept gets slower

1

[10]

37 newton **or** N

metre **or** m

joules **or** J

all three correct 2 marks
two or one correct 1 mark

[2]

38 (a) (i) **E-F** (ticked)

1

(ii) **B-C or D-E**

accept both answers

1

(b) fast(er)

accept downhill

1

slow(er)

1

force

*do **not** accept distance*

1

[5]

39 (a) 7.5

correct answer with no working = 3 if incorrect allow 1 mark for (change in velocity from graph =) 15

1 mark for $\frac{change\ in\ velocity}{time\ taken}$

2 marks for $\frac{15}{2}$

N.B. correct answer from the incorrectly recalled relationship $\frac{distance}{time}$ *= 2 marks*

3

(b) (4 – 5 seconds) the bungee jumper slows down (decelerates)

1

(the rubber cord) stops the fall

1

(5 – 6 seconds) the bungee jumper starts moving (accelerating) upwards (in the opposite direction)

max 2 marks if no correct indication of time

1

[6]

40 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]

41 (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]

42 (a) (i) acceleration / speeding up

do not accept acceleration increases

1

(ii) constant / steady velocity

accept constant / steady speed

1

(b) 10

3

m/s^2 or ms^{-2}

reject ms^2

if answer not correct then allow 1 mark for

$$\textit{acceleration} = \frac{\textit{change in velocity}}{\textit{time taken for change}}$$

and allow 1 mark for $\frac{40\ (m/s)}{4(s)}$

1

[6]

43 (a) Any **three** factors from any of the

groups of factors below (1) each a clear and correct statement of the effect of the particular factor on the stopping distance (1) each

do not credit mobile phones do not credit other distractions

2

examples: (factors relating to the driver)

* (driver's) reaction time or time for the driver to apply the brakes

the longer the reaction time the longer the s.d.

which may be related to age, experience, sobriety, effect of drugs, mental capacity, physical capacity, driver fatigue, confusion and panic

does not depend on the driver's eyesight as this affects the occurrence of the 'need-to-stop' realisation rather than the stopping distance

examples: (factors relating to the car)

4

* force applied by the brakes the greater the force the shorter the s.d.
* speed (of the car) the greater the speed the longer the s.d.
* mass **or** weight (of the car) the greater the mass **or** weight the longer the s.d.
* ABS answers

examples: (factors relating to the road or tyres)

* tread on the tyres **or** friction the more tread **or** friction the shorter the s.d.
* slipperiness of the road the greater the slipperiness the longer the s.d.
* it is raining

does not depend on the visibility as this affects the occurance of the 'need-to-stop' realisation rather than the stopping distance

(b) velocity

accept speed

1

mass

*accept weight **or** shape **or** aerodynamics*

do not credit size

1

(c) any **two** ((1) + (1)) each of

do not credit a description

* friction (between the tyres and the road) backwards or opposite to the direction of motion

do not credit the direction if the force not specified

* air resistance **or** drag **or** wind resistance backwards **or** opposite to the direction of motion

do not credit wind

* weight **or** gravity down (wards) **or** towards the centre of the Earth

*do not credit mass **or** inertia*

* reaction (of **or** from the road) upwards

4

(d) direction

allow bearing(s)

do not credit orientation

1

[13]

44 (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) **X_1** 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

X_2 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]

45

(a) (i) walking at constant speed

1

(ii) standing still

1

(b) is higher **or** faster

accept less time to walk more distance (both time and distance must be mentioned)

1

the slope of graph is steeper

accept slope is more

1

(c) speed = $\frac{\text{distance}}{\text{time}}$

accept suitable symbols used in correct formula
do not accept a triangle

1

[5]

46 (a) (i) work = force × distance

or *any correctly transposed version e.g.*

force = $\frac{work}{distance}$

or *in correct units throughout e.g.*
J = N × m
or *in acceptable abbreviations e.g.*
W = f × d
do not credit W = Nm ***or*** *any other ambiguous* ***or*** *unclear response*
do not credit

unless subsequent calculation shows understanding

1

(ii) **EITHER**

3.7 (m)

2

OR

(distance =) $\frac{2000}{540}$

1

(iii) 2000 J

unit required

1

(b) **EITHER**

20

3

OR

speed^2 = 600 ÷ 1.5

or *speed*^{2} *= 600 ×* $\frac{2}{3}$

or *speed*^{2} *= 400*

or speed^2 *= KE ÷* $\frac{1}{2}$ *mass*

1

metres per second

or *m/s*

1

(c) any **three** from

deceleration (would be) (very) great

or rate of change of speed / velocity would be (very) great

(because) F = ma

or (because) force is proportional to deceleration / (negative) acceleration

(so the) force (on Susan / the rope) would be (very) great

do not credit she would be hurt

do not credit just the rope could snap

the rope may exceed its elastic limit

3

[10]

47 (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]

48

(a) *evidence of* distance = speed × time **or** 4 × 20

gains 1 mark

but
80

gains 2 marks

units m

for 1 mark

3

(b) *idea that* (both) become warm/hot

for 1 mark

idea of wearing (away/down)/becoming scratched

gains 1 mark

but
(brake) pads wear more (than wheel discs)

gains 2 marks

3

[6]

49 (a) **evidence of* acceleration = $\frac{\text{change in speed}}{\text{time}}$ or $\frac{0.6}{3}$

gains 1 mark

but 0.2

gains 2 marks

units m/s^2

for 1 mark

3

(b) (i) 2000 **or** 1960

for 1 mark

1

(ii) *evidence of* power = $\frac{\text{work done}}{\text{time taken}}$ **or** weight × speed (*credit figures*)/ $\frac{25}{0.6}$

(iii) $\frac{25}{0.6}$

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]

50 (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. $\propto v^2$ **or** k.e. = ½ mv^2
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]

51 (a) *evidence of* $\frac{\text{change in speed}}{\text{time taken}}$ *or* $\frac{40}{5}$
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/s^2)
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]

52 (a) *evidence of* $\frac{\text{change in speed}}{\text{time taken}}$ *or* $\frac{3}{12}$

gains 1 mark

but 0.25 **or ¼**

gains 2 marks

2

(b) *evidence of* $\frac{\text{work done}}{\text{time taken}}$ *or* $\frac{2400}{12}$

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 <u>air</u> 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]

53

- gravity
- accelerates
- friction
- falls at a steady speed

each for 1 mark

[4]

54

(a) A = speeding up

[Accept 'accelerating / acceleration / going faster]

B =moving at a steady speed

[Accept 'constant speed']

C = slowing down

[Accept 'going slower' / decelerating]

each for 1 mark

3

(b) acceleration = $\frac{\text{change in speed/velocity}}{\text{time taken}}$

NB if formula given must be correct

or $\frac{10}{4}$

gains 1 mark

but 2.5

gains 2 marks

unit m/s^2 **or** metres per second squared

or metres per second per second

for 1 mark

or m/s^{-2}

[Credit even if no / an incorrect numerical answer is given]

3

[6]

55 (a) acceleration = $\frac{\text{change in speed/velocity}}{\text{time taken}}$

or $\frac{10}{4}$

gains 1 mark
do not penalise if <u>both</u> of these present
but 'change in' omitted from formula

but
2.5

gains 2 marks

unit m/s^2 **or** metres per second squared

or metres per second per second

or ms^{-}*

for 1 mark

3

(b) *evidence* of using area under graph or distance <u>average</u> speed × time
or
$10 \times 4 \times \frac{1}{2}$

gains 1 mark

but
20

gains 2 marks

units metres / m^{-2}*

for 1 mark

3

(c) force = mass × acceleration **or** 75 × 25

gains 1 mark

but
1875

gains 2 marks

**NB Correct unit to be credited even if numerical answer wrong or absent.*

2

[8]

56 (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]

57 (a) evidence of

speed = $\frac{\text{distance}}{\text{time}}$ (travelled) or $\frac{100}{20}$ or $\frac{40}{20}$

gains 1 mark

but or any correct calculation of gradient

(except when zero) gains 2 marks

$\frac{140}{70}$ or 2

gains 1 mark

units metres per second **or** m/s **or** ms^{-1}

(not mps)

for 1 mark

3

(b) *evidence of* calculating the two speeds

($\frac{100}{20}$ and $\frac{40}{20}$ **or** 5 and 2) (evidence of this may be in (a))

or

noting distances travelled in same time (20 secs) i.e. 100m and 40m **but** 2.5

gains 2 marks

2

[5]