Mark schemes

1 (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]

2 (a) Third Law

1

(b) elastic potential

1

(c) weight = mass × gravitational field strength

accept gravity for gravitational field strength

1

accept W = mg

*accept correct rearrangement ie mass = weight / gravitational field strength **or** m = W / g*

(d) 343 = m × 9.8

1

m = 343

9.8

1

m = 35

1

*allow 35 with no working shown for **3** marks*

(e) force = spring constant × compression

>*accept force = spring constant × extension*
>*accept F = k e*
>*accept correct rearrangement ie constant = force / extension **or** k = F / e*

1

(f) compression = 0.07m

1

343 = k × 0.07

1

k = 343 ÷ 0.07

1

k = 4900

1

>*allow 4900 with no working shown for **4** marks*
>*allow 49 with no working shown for **3** marks*

[11]

3 (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) $- u^2 = 2 \times -7.2 \times 22$

award this mark even with 0^2 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]

4 (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
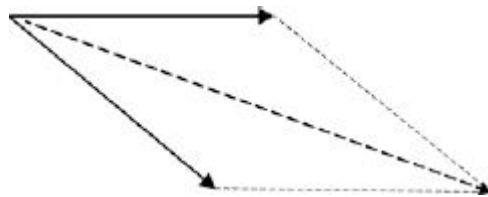
(iii)   resultant force is zero
accept forces are equal / balanced

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]

5 (a)   terminal

1

(b)   5.4 (kg)

        *correct substitution of 54 = m × 10 gains **1** mark*

2

(c)   (i)   0< a <10

1

        some upward force

            accept some drag / air resistance

1

        reduced resultant force

1

    (ii)   0

1

        upward force = weight (gravity)

1

        resultant force zero

1

[9]

6   (a)   (i)   **X** placed at 50 cm mark

1

    (ii)   <u>point</u> at which mass of object may be (thought to be) concentrated

1

(b)   (i)   **Y** placed between the centre of the rule and the upper part of mass

1

    (ii)   16.5

           *allow for **1** mark*
           (16.5 + 16.6 +16.5) / 3

2

      1.65

           value consistent with mean value given
           only penalise significant figures once

1

(iii) Marks awarded for this answer will be determined by the quality of communication as well as the standard of the scientific response. Examiners should apply a 'best-fit' approach to the marking.

0 marks
No relevant content

Level 1 (1 – 2 marks)
A description of a method which would provide results which may not be valid

Level 2 (3 – 4 marks)
A clear description of a method enabling some valid results to be obtained. A safety factor is mentioned

Level 3 (5 – 6 marks)
A clear and detailed description of experiment. A safety factor is mentioned. Uncertainty is mentioned

examples of the physics points made in the response:

additional apparatus

- stopwatch

use of apparatus

- measure from hole to centre of the mass
- pull rule to one side, release
- time for 10 swings and repeat
- divide mean by 10
- change position of mass and repeat

fair test

- keep other factors constant
- time to same point on swing

risk assessment

- injury from sharp nail
- stand topple over
- rule hit someone

accuracy

- take more than 4 values of d
- estimate position of centre of slotted mass
- small amplitudes
- discard anomalous results
- use of fiducial marker

6

(c) (i) initial reduction in T (reaching minimum value) as d increases

1

after 30 cm *T* increases for higher value of *d*

1

(ii) (no)

any **two** from:

- fourth reading is close to mean
- range of data 0.2 s / very small
- variation in data is expected

2

[16]

7 (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* $\frac{16-4}{8}$ *or* $\frac{12}{8}$

provided no subsequent step shown

ignore sign

2

m/s^2

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]

8   (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]

9   (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]

10   (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* $\frac{5}{3}$

***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

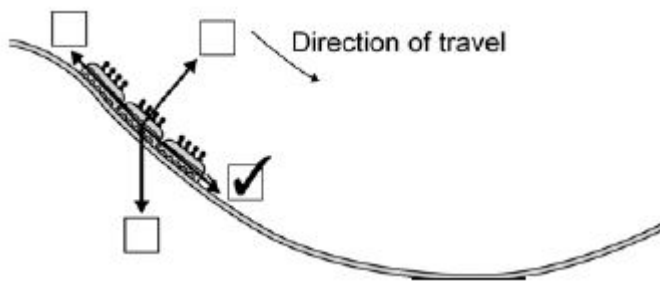*allow **1** mark for correct use of graph, eg* $\frac{1}{2} \times 5 \times 3$

2

(iii) air (resistance)

accept wind (resistance)
drag is insufficient
friction is insufficient

1

[8]

11 (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]

12 (a) any **two** from:

• (acceleration occurs when) the direction (of each capsule) changes

• velocity has direction

• acceleration is (rate of) change of velocity

2

(b) to(wards) the centre (of the wheel)

1

(c)   the greater the radius / diameter / circumference (of the wheel) the smaller the (resultant) force (required)

> *accept 'the size' for radius*
> *both parts required for the mark*

1

[4]

13   (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
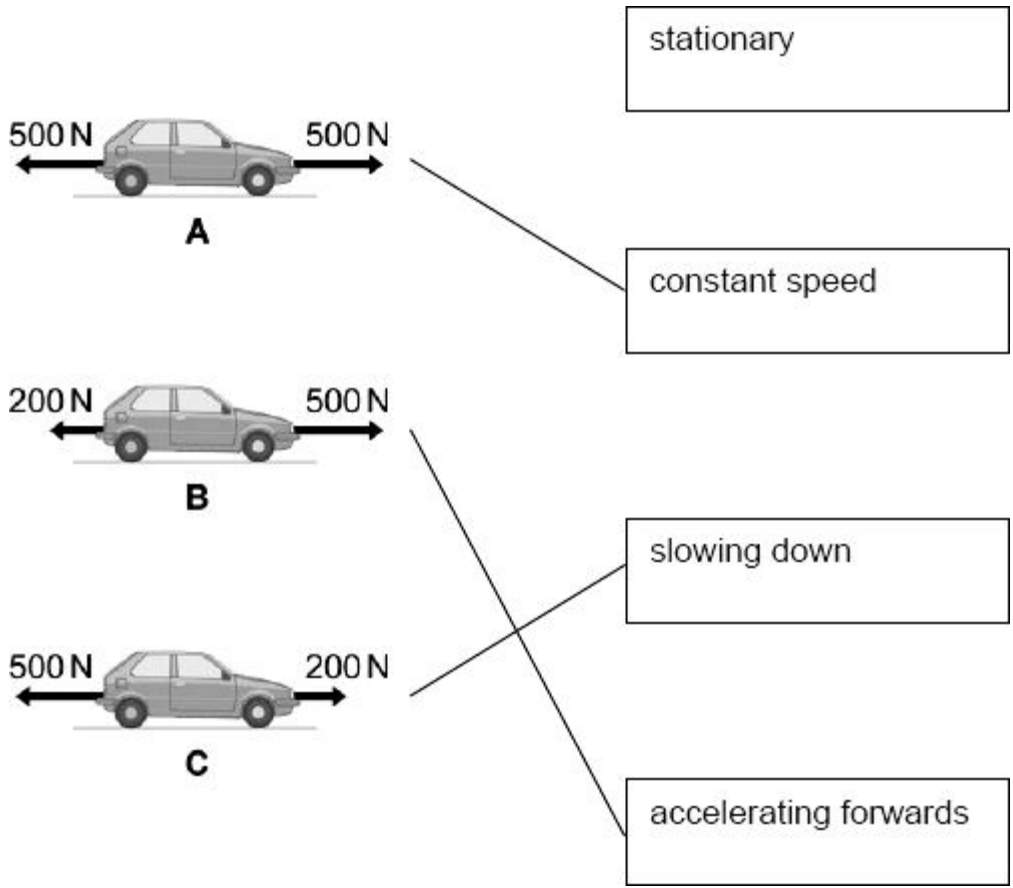
3

(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]

14   (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 <u>distance</u>

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/s^2

> *do **not** accept mps^2*

1

[10]

15 (a) (i) horizontal arrow pointing to the left
> *judge by eye*
> *drawn anywhere on the diagram*

1

(ii) 60 (N)

1

(at steady speed) resultant force must be zero
> *accept forces must balance/are equal*
> *accept no acceleration*
> *do **not** accept constant speed*

1

(b) 1680
> *allow **1** mark for correct substitution, ie 60 x 28 provided no subsequent step shown*

2

joule
> *accept J*
> *do not accept j*

1

[6]

16 (a) 750
> *allow **1** mark for correct substitution, ie 75 × 10 provided no subsequent step shown*

2

newton(s) / N
> *do **not** accept n*

1

(b)   Marks awarded for this answer will be determined by the Quality of Written Communication
       (QWC) as well as the standard of the scientific response.
       Examiners should also refer to the Marking Guidance, and apply a 'best-fit'
       approach to the marking.

0 marks
No relevant content.

Level 1 (1-2 marks)
There is a brief attempt to explain why the velocity /
speed of the parachutist changes.
or
the effect of opening the parachute on velocity/speed is given.

Level 2 (3-4 marks)
The change in velocity / speed is clearly explained in terms of force(s)
or
a reasoned argument for the open parachute producing a lower speed.

Level 3 (5-6 marks)
There is a clear and detailed explanation as to why the parachutist
reaches terminal velocity
and
a reasoned argument for the open parachute producing a lower speed

**examples of the physics points made in the response to explain
first terminal velocity**

- on leaving the plane the only force acting is weight (downwards)
  accept gravity for weight throughout

- as parachutist falls air resistance acts (upwards)
  accept drag / friction for air resistance

- weight greater than air resistance
  or
  resultant force downwards

- (resultant force downwards) so parachutist accelerates

- as velocity / speed increases so does air resistance

- terminal velocity reached when air resistance = weight
  accept terminal velocity reached when forces are balanced

to explain second lower terminal velocity

- opening parachute increases surface area

- opening parachute increases air resistance

- air resistance is greater than weight

- resultant force acts upwards / opposite direction to motion

- parachutist decelerates / slows down

- the lower velocity means a reduced air resistance

  air resistance and weight become equal but at a lower (terminal) velocity

  6

(c) (i) any **one** from:

- mass of the (modelling) clay
  accept size/shape of clay size/amount/volume/shape of clay
  accept plasticine for (modelling)clay

- material parachute made from
  accept same (plastic) bag

- number / length of strings

  1

(ii) **C**

  reason only scores if C is chosen

  1

  smallest (area) so falls fastest (so taking least time)
  accept quickest/quicker for fastest
  if A is chosen with the reason given as 'the largest area so falls slowest' this gains 1 mark

  1

  [12]

17 (a) **B**

  reason only scores if B is chosen

  1

  gradient / slope is the steepest / steeper
  answers must be comparative
  accept steepest line
  ignore greatest speed

  1

(b) (velocity includes) direction
  'it' refers to velocity

  1

  [3]

18 *Resource currently unavailable*

19 (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 <u>all</u> females produce smaller forces*

- most / some males produce larger forces
  *do **not** accept <u>all</u> 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 <u>all</u> males swim faster*

- most of the slower swimmers are female
  *do **not** accept <u>all</u> 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
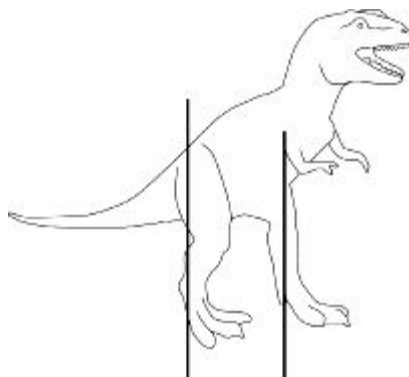 *practise more is insufficient*

1

[10]

20   (a)   (i)   centre of **X** above the feet and in the body
  *a vertical line from their **X** falls between two lines in diagram - judged by eye*

1

(ii)   where the mass seems to be concentrated

accept it's above the <u>base</u> (area)

accept because otherwise it would topple

accept line of action (of weight) passes through the <u>base</u>

*do **not** accept where the mass is concentrated*

1

(b)   any **two** from:

•   make (the area of) feet / base bigger

•   make feet wider apart

•   makes legs shorter / heavier

•   make head smaller / lighter

•   make tail touch the ground / make the tail longer

accept 'make centre of mass / gravity lower'

2

[4]

21 (a)   1.2

*allow **1** mark for conversion of 2.4 kN to 2400 N*

or for correct transformation without conversion

ie d = 2880 ÷ 2.4

2

metre(s)/m

1

(b)   any **two** from:

•   as the load increases the (total) clockwise moment increases

•   danger is that the fork lift truck / the load will topple / tip forward

•   (this will happen) when the total clockwise moment is
     equal to (or greater than) the anticlockwise moment

accept moments will not be balanced

•   (load above 10.0 kN) moves line of action (from C of M)
     outside base (area)

2

[5]

22 (a) (i) will not fall over (1)

        accept will not easily fall over (2)

        or
        centre of mass will remain above the base (1)

        (line of action of the) weight will remain above within the base

        accept centre of gravity / c of g / c of m / c m

        if the monitor is given a small push (1)

        depends on mark above

    2

    (ii) (total) clockwise moment = (total) anticlockwise moment

        or *they are equal / balanced*

    1

  (b) the position of the <u>centre of mass</u> has changed (1)
     the line of action of the <u>weight</u> is outside the base (1)
     producing a (resultant) <u>moment</u> (1)

        points may be expressed in any order

    3

                                               [6]

23 (a) (i) moment

    1

    (ii) rotation

    1

    (iii) the girl moves nearer to point **P**

    1

  (b) (i) **X** drawn in the centre of the space enclosed by the tyre

        judge by eye

    1

    (ii) below

    1

                                               [5]

24 (a) the point at which the (total) mass seems to act / appears to be concentrated

        accept 'weight' for 'mass'

        accept the point at which gravity seems to act

        *do **not** accept a definitive statement eg where (all) the mass is*

    1

(b)   wid**er** / larg**er** base

marks are for a correct comparison

1

low**er** centre of mass

accept lower centre of gravity / c of g

1

(c)   line of action (of the weight) lies / falls inside the base

in each case the underlined term must be used correctly to gain the mark

1

the resultant moment returns mixer to its original position

accept there is no resultant moment / resultant moment is zero

accept resulting moment for resultant moment

*do **not** accept converse argument*

1

[5]

25   (a)   correct box ticked
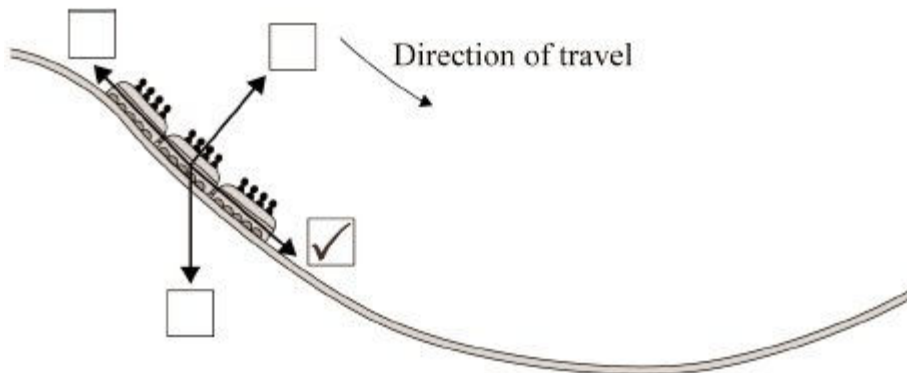
1

(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]

26　(a)　any **two** from:

- inversely proportional

- as the load gets biggerthe (maximum safe) distance gets less
  allow 'as the mass increases the distance decreases'
  accept an unspecified response e.g. 'big load at a short distance'
  for (1)

- load × distance = 60 (kNm)

2

(b)　yes, because 30 × 2 = 60 (2)

accept for (1) a correct but insufficiently explained response
e.g. 'yes because it's safe'

accept for (2) a correct response which is sufficiently explained

e.g. 'yes, because 60 (kNm) at 1 metre is safe and 30 (kNm) is half the load at twice the distance

*do **not** accept 'no' and do not accept just 'yes'*

*do **not** accept 'yes, because 30 is between 24 and 40 and 2 is between 2.5 and 1.5'*

*do **not** accept 'the crane/ cable may break' or other dangers*

2

(c)　the crane may/will topple over/fall <u>over/forward</u>

1

(d)　results of experiments on this mobile crane

accept any unambiguous indication

1

[6]

27   (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]**

28   (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]

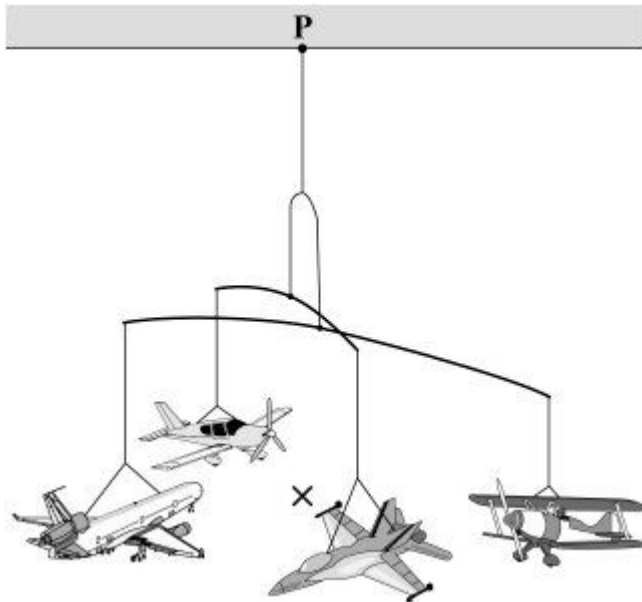**29**   (a)   (i)   centre of **X** directly below **P** and between the model aeroplanes

as judged by eye but between centre of propeller of top aeroplane
and canopy of bottom aeroplane
example

1

(ii)   the centre of mass is (vertically) below the point of suspension / P

1

the centre of mass is in the middle of the aeroplanes
accept the centre of mass is level with the aeroplanes

1

(b)   centre of mass of the worker and the ladder (and device)

1

line of action of the weight is inside the base

accept the centre of mass is above / within / inside the base (of the ladder and device)

1

so there will not be a (resultant) moment

accept so he / it / the ladder will not topple even if he leans over

or it will (only) topple over if the line of action of the weight / the centre of mass is outside the base

*accept each point, either on the diagram or in the written explanation, but do **not** accept the point if there is any contradiction between them*

1

[6]

30   (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/s^2

1

(c)   as speed increases air resistance increases

accept drag / friction for air resistance

1

reducing the resultant force

1

[7]

31

(a)　centre of X at the point where the axes cross

　　　　　to within 1 mm in any direction

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

(b)　(i)　(at / in the) centre (of the tyre)

　　　　　or unambiguously shown on the diagram

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

　　(ii)　(this is) where axes of symmetry (of the tyre) cross / intersect / meet

　　　　　or point at which the mass of the tyre seems to be (concentrated)

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　[3]

32

(a)　(line of action of) its weight

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

falls inside its wheel base

　　　　accept 'falls between the wheels'

　　　　*the first **two** points may be credited by adding a vertical line from the centre of the X on the diagram (1)*
　　　　and labelling it weight / force / with a downwards arrow (1)
　　　　provided there is no contradiction between what is added to the diagram and anything which may be written

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

(so there is) no (resultant / clockwise) moment / turning effect

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

(b)　centre of mass should be lower

　　　　accept '… centre of gravity'
　　　　accept 'weight / mass low down'
　　　　not *just 'lower the roof'*

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

wheel base should be wider

　　　　accept 'long axle(s)' for 'wide wheel base'
　　　　allow bigger / larger wheel base
　　　　*do **not** credit 'long wheel base'*
　　　　responses in either order

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　[5]

33 (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 <u>change</u> 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]

34 (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*

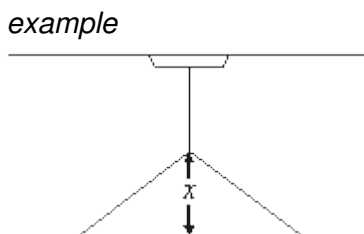   **1**

                                                                                                           [8]

35   (a)   centre of **X** should appear to be on the continued line of the flex and in the body of the lamp as judged by eye

example

                                                                                      1

(b)   below

                                                                                      1

(c)   (D)→B→F→A→C→(E)

*all four correct for **3** marks*

***or** any two correct for **2** marks*

***or** just one correct for **1** mark*

3

[5]

36   (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** <u>speed</u> / velocity increases

accept faster <u>and</u> 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]

37   (a)   point at which its mass (seems to) act **or** point at which gravity (seems to) act

accept ... its weight acts

accept correct statements if the intent is clear e.g.. .. if suspended, the centre of gravity will be directly under the point of suspension

*e.g.... (if the object is symmetrical), the centre of gravity is on the **or** an axis (of symmetry)*

*do **not** credit just 'it is a point'*

1

(b)   *The answer to this question requires 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*

   *maximum of **4** marks if ideas not well expressed*

any **five** from:

clamp (steel) rod (horizontally)
   ***no** marks if method quite unworkable*

hang plastic / sheet by rod through (one) hole

hang plumb line from rod

mark ends of plumb line on the sheet and
use the ruler to draw a straight line

repeat with other hole

centre of mass is where the lines cross

check by balancing at this point
   *maximum of **3** marks if no 'repeat with other hole'*

   5

(c)   (i)   (turning) effect **or** moment
         force
         distance
            all three correct
            accept weight
            accept length

   1

   (ii)   17.6
            *allow 44 x 0.4 **or** 0.4 x 44 for **1** mark*

   2

         Nm **or** newton metre(s)
            *do **not** accept N/m **or** N/cm*
            *1760 Ncm gains all **3** marks*

   1

   [10]

38 (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 = $\dfrac{\text{change in velocity}}{\text{time (taken)}}$

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

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

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

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

1

(ii) 15

*allow **1** mark for an answer of 900 **or** for <u>correct</u> use of 540 seconds*

2

(iii) velocity includes direction

accept velocity is a vector (quantity)

accept converse answer

1

[6]

39 (a) (i) **X** at the centre of the lifebelt

*measuring from the centre of **X**, allow 2 mm tolerance in any direction*

1

(ii)   any **two** from:

> *if X is on vertical line below the hanger (but not at*
> *centre) can gain the first point only*

below the point of suspension
> *accept '(vertically) below Y*

at the centre (of the lifebelt)
> *accept 'in the middle'*

(because) the lifebelt / it is symmetrical
> *or (because) the mass / weight is evenly distributed*

2

(b)   Nm **or** newton metre(s)
> *accept Newton metre(s)*
> *do **not** accept any ambiguity in the symbol ie NM, nM or nm*

1

750
> *(moment) = force × (perpendicular) distance (between line of*
> *action and pivot)*
> *or (moment) = 500 × 1.5 gains **1** mark*

2

(c)   Quality of written communication:
> *for **2** of the underlined terms used in the correct context*

1

any **three** connected points from:

low(er) centre of mass / gravity
> *or centre of mass / gravity will be close(r) to the wheels*
> */ axle / ground*

(more) stable
> *or less unstable*

less likely to fall over
> *accept 'less likely to overturn'*
> *do **not** accept 'will not fall over'*

the turning effect / moment (of the weight of case) is less
> *or so less effort is needed to hold the case*
> *ignore references to pulling the case*

so the pull on her arm is less

3

[10]

40   (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]

41   (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]

42 (a)   **Z**

1

weight **or** mass acts through pivot

*accept rod **or** base for pivot*

accept centre of gravity in line with pivot

1

no (resultant) (turning) <u>moment</u>

accept clockwise moment equals anticlockwise moment

*do **not** accept same weight on each side of rod*

1

(b) (i)   30

*allow **1** mark for 2 × 15*

or 2 × 0.15

2

N cm

or

for full credit the unit must be consistent with the numerical answer

0.3

Nm

*do **not** accept joules*

1

(ii)   1.5 (N)

*allow **1** mark for correct transformation*

*allow **2** marks ecf their part (b)(i)/20 (ecf only if correct physics)*

2

(c)   5 (cm)

*allow **1** mark for 6.0 (cm)*

*allow **1** mark for a subtraction of 1 from a value clearly obtained from the graph*

*allow **2** marks for correct ecf using an incorrect value for (b)(i) ± 0.2cm*

*allow **1** mark for clearly showing correct use of graph using an incorrect value for (b)(ii)*

2

[10]

43 (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]

44   (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]

45   (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]

46 (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]

47 (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]

48   (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 …. backwar(
              for 1 mark each

3

[11]

49   **B** and **D** (either order)

1

B and **D** (either order)
              *accept **A** and **C***

1

A or **C**

1

[3]

50   (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]

51　*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]

52　*any evidence of idea that* weight acts through/near centre of mass/gravity/brick
gains 1 mark

but *clear indication that brick topples if*
vertical line through centre of mass is outside base line of brick
or line of action of weight is outside base line of brick
gains 2 marks

[2]

53　gravity
newtons
balanced

each for 1 mark

[3]

54

(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/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]

55   (a)   D
         for 1 mark

   1

(b)   wear it away **or** make it warmer
         for 1 mark do not accept 'stops it'

   1

   [2]

56 (a) *idea*

- <u>line of action</u> of weight/force/gravity
  (if drawn: a vertical line through the centre of mass)

- falls outside the (wheel) base (mark NOT from diagram)
    for 1 mark each

2

(b) ideas that

- less stable/topples more easily

- centre of mass at a higher level

- so need small angle to make line of action of weight fall outside
  (wheel) base
    for 1 mark each

3

(c) idea that

 this is the <u>most</u> unstable condition (when bus used)
 or
 this makes c. of m. as high <u>as it is likely to be</u>
    for 1 mark

1

[6]

57 (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]