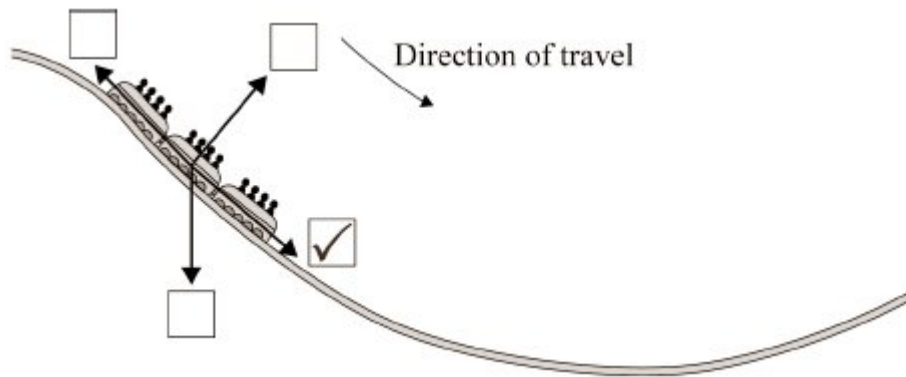


Mark schemes

- 1**
- (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]
- 2**
- (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) wider / larger base
marks are for a correct comparison 1
- lower 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]

3

(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]

4

(a) any **two** from:

- inversely proportional
- as the load gets bigger the (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 $30 \times 2 = 60$ (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 over/forward 1
- (d) results of experiments on this mobile crane
accept any unambiguous indication 1

[6]

5

- (a) (i) 50 (N)
ignore any units 1
- (ii) resultant force 1
- (iii) 4000
accept their (a)(i) $\times 80$ correctly calculated for 2 marks
allow 1 mark for correct substitution i.e. 50×80 or their (a)(i) $\times 80$
ignore any units 2
- (b) (i) joule 1
- (ii) heat 1

[6]

6

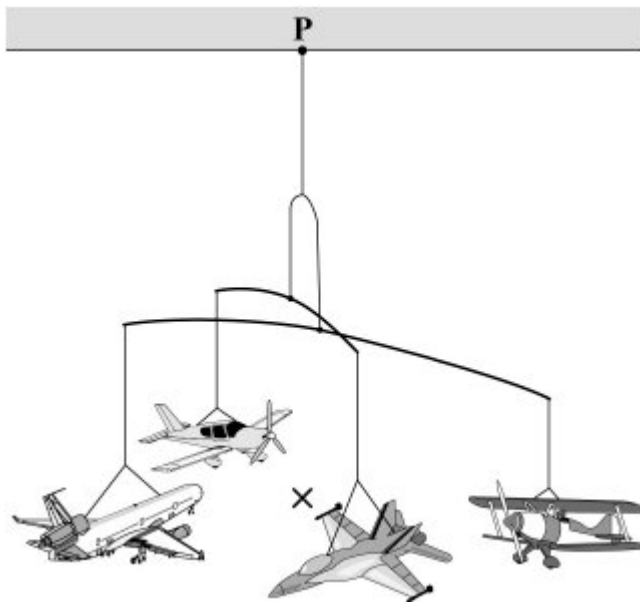
- (a) gravity
accept weight
*do **not** accept mass*
accept gravitational pull 1

- (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]

7

- (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]

8

(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]

- 9** (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]**

- 10** (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]**

- 11** (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]

12

(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**
 - decrease rate of change in momentum or same momentum change
accept reduced deceleration/ acceleration
 - 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

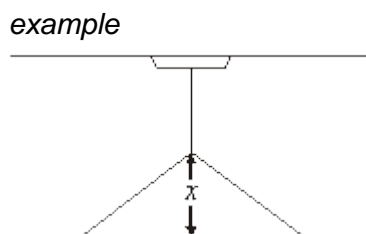
1

1

[8]

13

- (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



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]

14

(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]

15

(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]

16

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

$$\text{accept } a = \frac{V - U}{t} \text{ or } a = \frac{V_1 - V_2}{t}$$

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

do **not** accept change in speed

$$\text{do } \mathbf{not} \text{ accept } a = \frac{V}{t}$$

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]

17

(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]

18

- (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

[7]

- 19** (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]

- 20** (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) moment
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) $\pm 0.2\text{cm}$
allow 1 mark for clearly showing correct use of graph using an incorrect value for (b)(ii) 2

[10]

21

(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]

22

(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]

23

(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]

24

(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]

25

(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]

- 26** (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]**

- 27** **B and D** (either order) 1
- B and D** (either order)
accept A and C 1
- A or C** 1
- [3]**

- 28** (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]

29

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]

30

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]

31

gravity
newtons
balanced

each for 1 mark

[3]

32

(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 $\times 10 / \times 9.8 / \times 9.81$ or 750/735(75)

for 1 mark

1

[8]

33

(a) D

for 1 mark

1

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

1

[2]

34

(a) *idea*

- line of action 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 most unstable condition (when bus used)
or
 this makes c. of m. as high as it is likely to be
for 1 mark

1

[6]

35

(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]