AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



MARK SCHEME

4.5.1.3 GRAVITY (PACK 2)

SCORE	PERCENTAGE
/235	%

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Q1.

(a) C

1

(b) weight = 2.5 × 9.8

1

weight = 24.5 (N)

*an answer of 24.5 rounded to 25 scores **2** marks*

1

*an answer of 24.5 scores **2** marks*

(c) the upthrust is the same as the weight

1

(d) (resultant) force = mass × acceleration

allow F = m a

1

(e) 4.0 = 2.5 × a

1

$$a = \frac{4.0}{2.5}$$

1

a = 1.6 (m/s^2)

1

*an answer of 1.6 scores **3** marks*

[8]

Q2.

(a) arrow of equal size pointing vertically upwards

judged by eye
ignore horizontal arrows if equal and opposite
horizontal arrows of unequal length negates this mark

1

labelled 'upthrust'

ignore buoyancy
ignore 25 kN

1

(b) weight = 25 kN

allow 24 to 25 kN inclusive

1

25 000 = mass × 9.8
or

$$m = \frac{25000}{9.8}$$

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allow their W correctly converted and substituted

1

m = 2551 kg

allow correctly calculated value using their converted W
allow a value correctly calculated with W in kN

1

m = 2600 kg

allow a calculated answer correctly rounded to 2 significant figures

1

*an answer of 2600 scores **4** marks*

(c) Newton's 3rd law (of motion)

1

(d) vertical force (50 N) drawn
and
horizontal force (150 N) drawn to the same scale

1

resultant tension force in the correct direction

shown by an arrowhead

1

value of the tension force in the range 156 N−160 N

allow a calculated value of 158

1

value of direction in the range 18°−20° (from the horizontal)

allow 70° to 72° (from the vertical)
allow a bearing in the range 288 to 290

1

[11]

Q3.

(a) **A**

1

(perpendicular) distance between the camera and pivot is greatest

1

(b) increases

1

(c) 5.0 × 9.8

*an answer of 49 scores **2** marks*

1

49

1

newton

allow N

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1

(d) moment (of a force) = force × distance

allow M = Fd

1

(e) 144 cm = 1.44 m

*an answer of 70.56 scores **3** marks*

*an answer of 71 scores **3** marks*

1

moment = 49 × 1.44

allow ecf from part (c)

1

moment = 70.56

*answers of 7056 or 7100 score **2** marks*

1

[10]

Q4.

(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

$m = \frac{343}{9.8}$

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

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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]

Q5.

(a) 2 protons and 2 neutrons

accept 2p and 2n
accept (the same as a) helium <u>nucleus</u>
symbol is insufficient
do not accept 2 protons and neutrons

1

(b) (i) gamma rays

1

(ii) loses/gains (one or more) <u>electron(s)</u>

1

(c) any **one** from:

- wear protective clothing
- work behind lead/concrete/glass shielding
- limit time of exposure
- use remote handling

accept wear mask/gloves
wear goggles is insufficient
wear protective equipment/gear is insufficient
accept wear a film badge
accept handle with (long) tongs
accept maintain a safe distance
accept avoid direct contact

1

[4]

Q6.

(a) elastic potential

1

(b) (i) line is straight

accept line does not curve

1

(ii) 400

*allow **1** mark for correct substitution of any pair of numbers correctly taken from the graph e.g.160 = k × 0.40*

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2

newtons per metre **or** N/m

if symbols are used they must be correct

1

(iii) 300

*allow **1** mark for correctly obtaining force on 1 spring = 100N*

2

(c) 52

*allow **2** marks for calculating change in gpe for 1 chin-up as 260 (J) or for 12 chin-ups as 3120 (J)*

*an answer 4.3 gains **2** marks*

*allow **1** mark for correct substitution into gpe equation ie gpe = 65 × 10 × 0.4 (× 12)*

or

correct use of power equation with an incorrect value for energy transferred

3

[10]

Q7.

(a) resultant force = zero

or

upward force = downward force

accept forces are balanced

accept weight for downward force

1

(b) (i) 84

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

2

(ii) 12

accept 12.02 for both marks

or

1010 ÷ their (b)(i) correctly calculated

*a resultant force of 1010 (N) gains **1** mark*

an answer 22(.02) gains 1 mark

2

m/s^2

accept m/s/s

1

[6]

Q8.

(a) X marked in the centre of the sign

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Check position by eye

1

(b) concentrated

1

(c) 0.5 (s)

*allow **1** mark for correct substitution, ie*

$\frac{1}{2}$

provided no subsequent step

2

(d) make the cables longer

accept pendulum / sign for cables

1

[5]

Q9.

(a) (i) the line of action of the weight (of the bus) lies / acts outside of the base (of the bus)

allow line of action through the centre of mass lies / acts outside the base

1

there is a resultant moment (acting on the bus)

1

(ii) in normal use the centre of mass may be in a different position

1

or

passengers on the bus may affect the position of the centre of mass

for safety, buses should always be tested beyond the normal operating conditions / parameters

for safety is insufficient

accept in case something unexpected happens

1

(b) (i) a liquid is (virtually) incompressible

accept a liquid cannot be squashed

a liquid is difficult to compress is insufficient

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1

(ii) 84000

*award **2** marks for*

$$\frac{F}{0.28} = \frac{360}{0.0012}$$

or

$$\frac{F}{0.28} = 300\ 000$$

***or** award **1** mark for*

$$P = \frac{360}{0.0012}$$

or

300 000 (Pa)

seen anywhere

3

[8]

Q10.

(a) (i) D

1

(ii) friction

1

(iii) any **two** from:

- the speed / velocity
- the radius of the bend

the radius is insufficient

accept curvature of the road

size of the bend is insufficient

accept distance of car from centre (of bend)

- the mass (of the car).

accept weight for mass

2

(b) the car has a wide base

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

accept wide wheel base

*do **not** accept long wheel base*

a large surface area is insufficient

wide tyre(s) is insufficient

1

the car has a low centre of mass / gravity

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

a down force is insufficient

1

[6]

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Q11.

(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]

Q12.

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

1

(ii) point 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

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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

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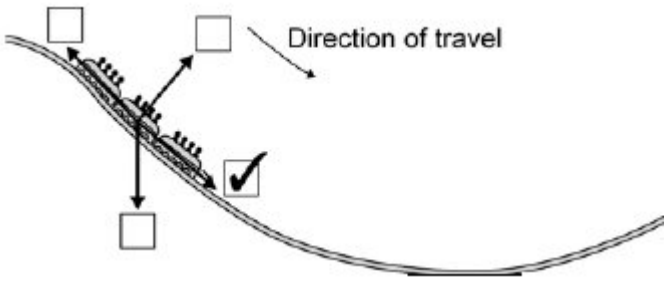
- variation in data is expected

2

[16]

Q13.

(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]

Q14.

(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)

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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

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(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]

Q15.

(a) method of suspending card through one hole

e.g. supported pin / nail through hole

1

use of plumb line suspended from same point as card

term plumb line is not essential

1

repeating for a second hole

1

mark points can be scored from labelled diagram(s)

*unlabelled diagram(s) alone score(s) a maximum of **1** mark*

(b) suspended card and plumb line from third hole and mark (new) line

accept repeat experiment using the third hole

1

if accurate 3 lines cross at same point

1

or

place card on finger (tip) (1)

accept alternatives eg pin

balances where lines cross (1)

accept suspend card from point where lines cross

accept 'centre of mass' for where lines cross

'card balances' is insufficient

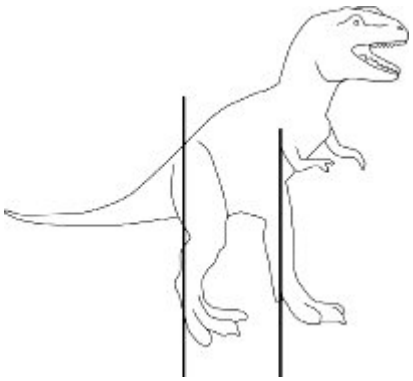
[5]

Q16.

(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*

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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]

Q17.

(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

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

2

[5]

Q18.

(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 centre of mass has changed (1)
the line of action of the weight is outside the base (1)
producing a (resultant) moment (1)

points may be expressed in any order

3

[6]

Q19.

(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]

Q20.

(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

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*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

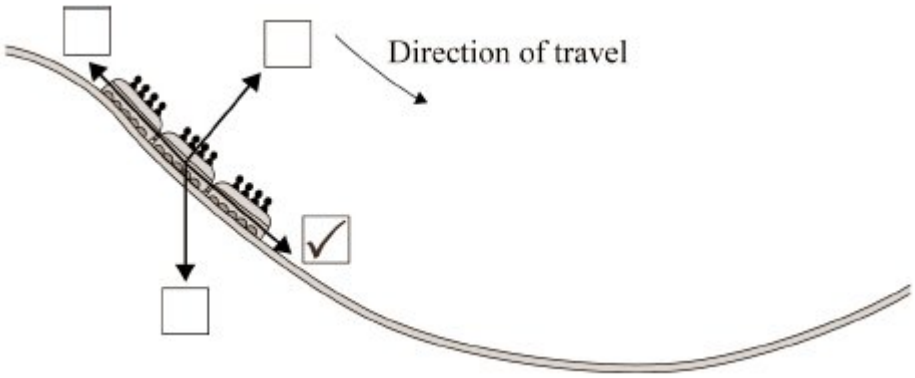
*do **not** accept converse argument*

1

[5]

Q21.

(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

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(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]

Q22.

(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 × 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]

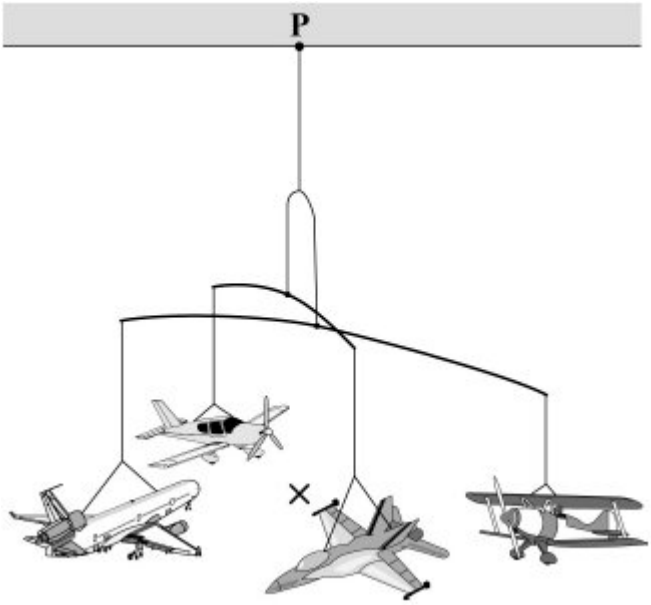
Q23.

(a) (i) centre of **X** directly below **P** <u>and</u> between the model aeroplanes

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

example

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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]

Q24.

(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

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(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]

Q25.

(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 '<u>long</u> wheel base'*

responses in either order

1

[5]

Q26.

(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

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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*

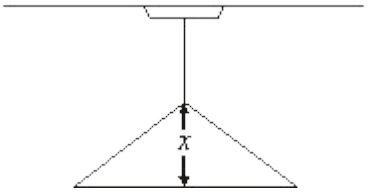
1

[6]

Q27.

(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]

Q28.

(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*

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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]

Q29.

(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

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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 *<u>centre of mass / gravity</u> will be close(r) to the wheels / axle / ground*

(more) <u>stable</u>

or *less <u>unstable</u>*

less likely to fall over

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

the <u>turning effect / moment</u> (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]

Q30.

(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*

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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]

Q31.

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]

Q32.

gravity
newtons
balanced

each for 1 mark

[3]

Q33.

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(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]

Q34.

(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

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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]

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