

Mark schemes

1	(a) D	1
	(b) C	1
	(c) $W = 300 \times 45$	1
	$W = 13\,500$	1
	<i>allow 13 500 with no working shown for 2 marks</i>	
	(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 \times gravitational field strength <i>accept gravity for gravitational field strength</i>	1
	<i>accept $W = mg$</i> <i>accept correct rearrangement ie mass = weight / gravitational field strength or $m = W / g$</i>	
	(d) $343 = m \times 9.8$	1
	$m = \frac{343}{9.8}$	
		1
	$m = 35$	1

allow 35 with no working shown for 3 marks

(e) force = spring constant \times compression

accept force = spring constant \times extension

accept $F = k e$

accept correct rearrangement ie constant = force / extension **or** $k = F / e$

1

(f) compression = 0.07m

1

$$343 = k \times 0.07$$

1

$$k = 343 \div 0.07$$

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) 2 protons and 2 neutrons

accept 2p and 2n

accept (the same as a) helium nucleus

symbol is insufficient

do not accept 2 protons and neutrons

1

(b) (i) gamma rays

1

(ii) loses/gains (one or more) electron(s)

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

- (d) 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 apply a 'best-fit' approach to the marking.

Level 3 (5 – 6 marks):

There is a description of all three types of radiation in terms of at least two of their properties

or

a full description of two types of radiation in terms of all three properties.

Level 2 (3 – 4 marks):

There is a description of at least two types of radiation in terms of some properties

or

a full description of one type of radiation in terms of all three properties

or

the same property is described for all three radiations

Level 1 (1 – 2 marks):

There is a description of at least one type of radiation in terms of one or more properties.

Level 0 (0 marks):

No relevant information

examples of physics points made in the response

alpha particles

- are least penetrating
- are stopped by paper / card

- have the shortest range
- can travel (about) 5cm in air

- are (slightly) deflected by a magnetic field
- alpha particles are deflected in the opposite direction to beta particles by a magnetic field

beta particles

- (some are) stopped by (about) 2mm (or more) of aluminium/metal
- can travel (about) 1 metre in air
- are deflected by a magnetic field
- beta particles are deflected in the opposite direction to alpha particles by a magnetic field

accept (some are) stopped by aluminium foil

gamma rays

- are the most penetrating
- are stopped by (about) 10cm of lead
- have the longest range
- can travel at least 1 km in air
- are not deflected by a magnetic field

5	(a) elastic potential	1
	(b) (i) line is straight <i>accept line does not curve</i>	1
	(ii) 400 <i>allow 1 mark for correct substitution of any pair of numbers correctly taken from the graph e.g. $160 = k \times 0.40$</i>	2
	newtons per metre or N/m <i>if symbols are used they must be correct</i>	1
	(iii) 300 <i>allow 1 mark for correctly obtaining force on 1 spring = 100N</i>	2
	(c) 52 <i>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 $gpe = 65 \times 10 \times 0.4 (\times 12)$ or correct use of power equation with an incorrect value for energy transferred</i>	3
		[10]

6	(a) resultant force = zero or upward force = downward force <i>accept forces are balanced accept weight for downward force</i>	1
	(b) (i) 84 <i>allow 1 mark for correct substitution ie $840 = m \times 10$</i>	2

(ii) 12

accept 12.02 for both marks

or

1010 ÷ their (b)(i) correctly calculated

a resultant force of 1010 (N) gains 1 mark

an answer 22(.02) gains 1 mark

2

m/s²

accept m/s/s

1

[6]

7

(a) X marked in the centre of the sign



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]

8

(a) speed

must be in correct order

1

direction

1

(b)

Quantity	Scalar	Vector
Momentum		✓
Acceleration		✓
Distance	✓	
Force		✓
Time	✓	

any three correct scores 2 marks

any two correct scores 1 mark

only one correct scores zero

3

(c) (i) 16 and 2

16 or 2 scores 2 marks

allow 1 mark for correct substitution, ie

$$8 \times 2$$

or

$$4 \times 0.5$$

3

kg m / s **or** N s

1

(ii) 1.5 (m / s)

or

their $p_A + p_B = 12 \times v$ correctly calculated

allow 2 marks for correct substitution, ie

$$18 = 12 \times v$$

or

their $p_A + p_B = 12 \times v$

18 or their $p_A + p_B$ scores 1 mark if no other mark awarded

3

(iii) 14 (kg m / s)

or

their $p_A - p_B$

1

16.5 (J)

1

[14]

9	(a) 3 (.0)	<i>allow 1 mark for correct substitution i.e. 25×0.12 provided no subsequent step</i>	2
	(b) (i) elastic potential	<i>correct order only</i>	1
		kinetic	1
	(ii) increases		1
		to 80 (mm) (or more)	
		<i>accept any number greater than 75</i>	
		<i>an answer 'it (more than) doubles' gains both marks</i>	1
	(c) (i) weight		1
		(ii) downward speed increases	1
			[8]
10	(a) (i) decreases (to zero)		1
		resultant force acts in opposite direction to motion	
		<i>accept air resistance and weight for resultant force</i>	
		<i>accept resultant force acts downwards</i>	
		<i>do not accept air resistance increases</i>	1
	(ii) velocity includes direction		
		or	
		velocity is a vector (quantity)	1

- (b) (i) 3.6
allow 1 mark for correct substitution i.e.
 $\frac{1}{2} \times 0.05 \times 12^2$ provided no subsequent step 2
- (ii) 3.6 **or** their (i) 1
- (iii) 7.2
or
 their (ii) $\div 0.5$ correctly calculated
allow 1 mark for correct substitution i.e.
 3.6 or *their (ii) = $0.05 \times 10 \times h$* 2
- (iv) **B** 1
- (c) range increases up to 45° 1

range decreases from 45°

*the range is a maximum at 45° gains both marks
 for any two angles that add up
 to 90° the range is the same gains both marks
 the range increases then decreases gains 1 mark*

1
[11]

11

- (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]

12

(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

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]

13

- (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

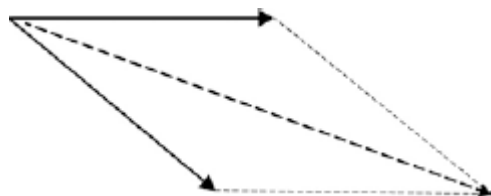
- (iii) resultant force is zero
accept forces are equal / balanced

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]

14 (a) terminal

1

(b) 5.4 (kg)

correct substitution of $54 = m \times 10$ 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]

15 (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

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]

16

(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/s²

1

(ii) 102

or

their (b)(i) \times 68 correctly calculated

allow 1 mark for correct substitution, ie 1.5×68

or *their (b)(i) \times 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]

17	(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	
	<i>accept parachute has large(r) (surface) area</i>	1
		[5]
18	(a) (i) electrons	1
	a positive	1
	(ii) (forces are) equal	
	<i>accept (forces are)the same</i>	
	<i>forces are balanced is insufficient</i>	1
	(forces act in) opposite directions	
	<i>accept (forces) repel</i>	
	<i>both sides have the same charge is insufficient</i>	1
	(b) aluminium	1
		[5]
19	(a) more streamlined	
	<i>accept decrease surface area</i>	1
	air resistance is smaller (for same speed)	
	<i>accept drag for air resistance</i>	
	<i>friction is insufficient</i>	1
	so reaches a higher speed (before resultant force is 0)	
	<i>ignore reference to mass</i>	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

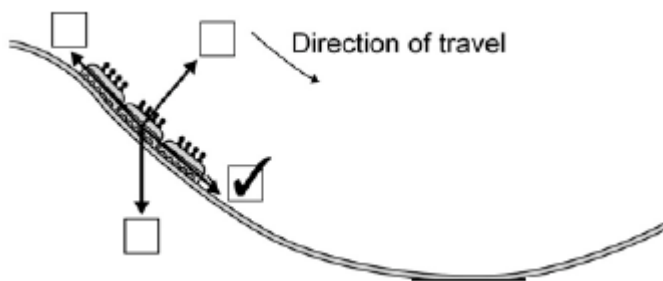
friction is insufficient

1

[8]

20

(a) correct box ticked



1

(b) (i) 30

ignore added units

1

(ii) 2250 or their (b)(i) \times 75 correctly calculated

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

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

2

[4]

21

(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)

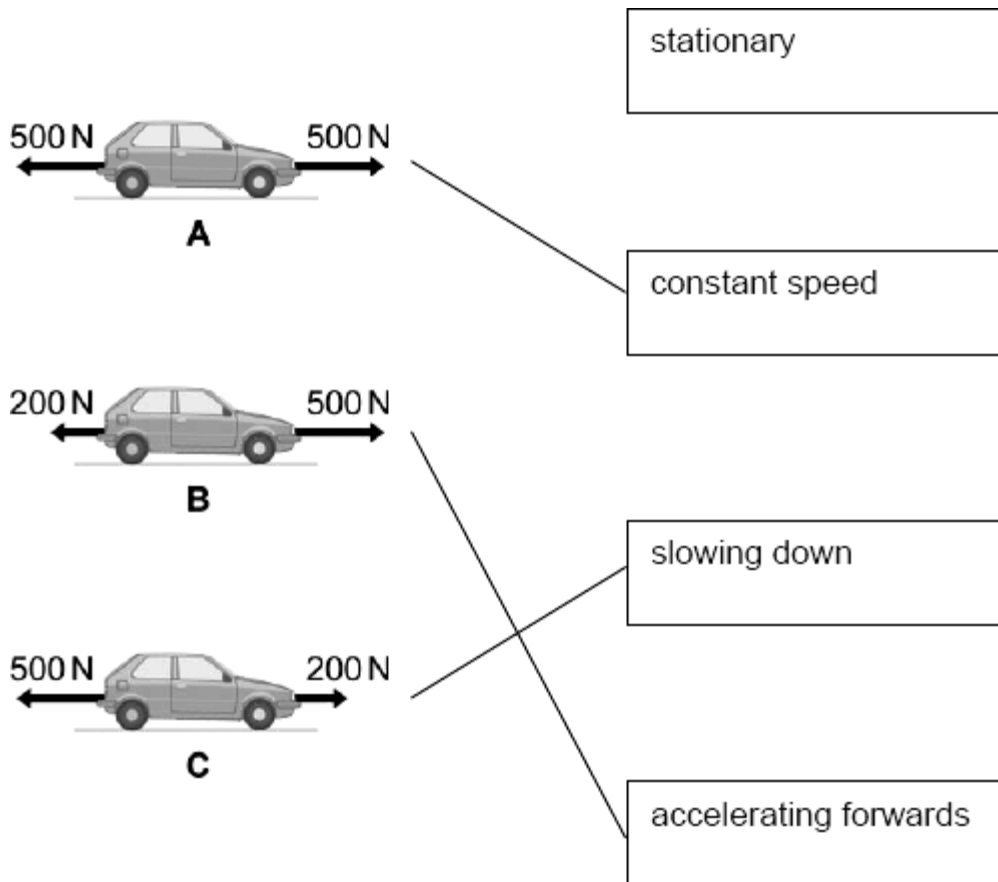
*accept 'the size' for radius
both parts required for the mark*

1

[4]

22

- (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]

23

(a) **A** constant speed / velocity

accept steady pace

*do **not** accept terminal velocity*

*do **not** accept stationary*

1

B acceleration

accept speeding up

1

C deceleration

accept slowing down

accept accelerating backwards

accept accelerating in reverse

*do **not** accept decelerating backwards*

1

(b) (i) the distance the car travels under the braking force

accept braking distance

1

(ii) speed/velocity/momentum

1

(c) (i) 5000 (N) to the left

***both** required*

accept 5000(N) with the direction indicated by an arrow drawn pointing to the left

accept 5000(N) in the opposite direction to the force of the car (on the barrier)

accept 5000(N) towards the car

1

(ii) to measure/detect forces exerted (on dummy / driver during the collision)

1

(iii) 4

allow 1 mark for showing a triangle drawn on the straight part of the graph

***or** correct use of two pairs of coordinates*

2

m/s²

*do **not** accept mps²*

1

[10]

24

- (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]

25

- (a) 750

allow 1 mark for correct substitution, ie 75 x 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]

26

(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]

27

Resource currently unavailable

28

- (a) (i) 120 1
- (ii) 20
accept 140—their (a)(i) provided answer is not negative 1
- (iii) as speed increases 1
- drag force / water resistance / friction / **D** increases 1
- (until) **D** = 140 N or (until) **D** = **T**
forces balance is insufficient 1
- (b) (i) (average) speed (of swimmer) 1
- (ii) any **two** from:
- more data
accept results for data
*do **not** accept more accurate data*
 - force may vary (a lot) / change
 - give more reliable average
ignore references to anomalies
ignore accurate / precise 2

(iii) examples of acceptable responses:

- most / some females produce smaller forces
*do **not** accept all females produce smaller forces*
- most / some males produce larger forces
*do **not** accept all males produce larger forces*
- some females swim as fast as males but use a smaller force
- most of the faster swimmers are male
*do **not** accept all males swim faster*
- most of the slower swimmers are female
*do **not** accept all females swim slower*
- range of the (average) speed of males is smaller than the range of the (average) speed of females
- range of the (average) force of the males is greater than the range of the (average) force of the females

1

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

*accept (any method to) increase (hand) force
practise more is insufficient*

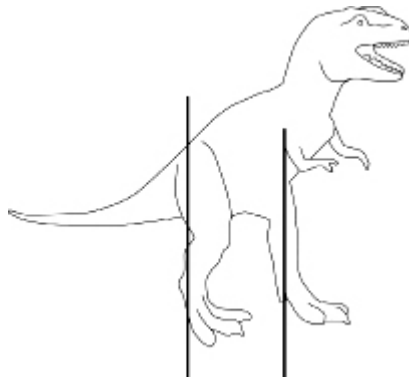
1

[10]

29

(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 base (area)
accept because otherwise it would topple
accept line of action (of weight) passes through the base
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]

30

(a) 1.2

*allow 1 mark for conversion of 2.4 kN to 2400 N
or for correct transformation without conversion
ie $d = 2880 \div 2.4$*

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]

31

(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]