AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



MARK SCHEME

4.5.6.2.2 NEWTON'S SECOND LAW (PACK 2)

SCORE	PERCENTAGE
/247	%

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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) the magnets are not touching

1

but (each) experiences a force

allow but there is a force of attraction between them

1

(b) place a (plotting) compass near the (north / south) pole of the magnet and mark the direction that the compass points

1

move the (plotting) compass around the bar magnet (to the other pole) marking at (regular) intervals the direction the compass points

1

join the points up and add an arrow pointing from the north pole to the south pole

1

(c) (closing switch S) causes a current in the coil

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allow switches on the electromagnet

1

a magnetic field is created

1

a force of attraction acts on the ball bearing

1

so the ball bearing accelerates (towards the iron rod)

1

[9]

Q3.

(a) (resultant) force = mass × acceleration

allow F = ma

symbols must be correct

1

(b) (2.7 – 1.5) = 0.75 × a

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

1

$$a = \frac{1.2}{0.75}$$

allow compensation marks for correct use of incorrect resultant force

1

a = 1.6

1

m/s^2

1

(c) transverse

1

the oscillation / vibration is perpendicular to the direction of energy transfer

allow wave travel for energy transfer

1

(d) use springs with a smaller spring constant

allow use weaker springs

or

use a trolley with greater mass

allow use a heavier trolley

do not accept use a larger trolley

allow add a mass / weight to the trolley

1

(Total 8 marks)

Q4.

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(a) double

1

(b) the hypothesis does not say how increasing / decreasing the force increases / decreases the acceleration

1

(c) appropriate equipment to apply and measure force

*eg newtonmeter **or** slotted masses + string + pulley*

1

appropriate equipment to measure change in velocity and time

*eg ticker timer + tape **or** light gates + datalogger*

1

(d) to reduce the effect of friction on the trolley

1

(e)

Level 3: The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5-6
Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	3-4
Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1-2
No relevant content	0
Indicative content • method by which the trolley is to be accelerated • how the accelerating force is varied to give a suitable range of results • how the accelerating force is measured • the use of suitable apparatus to measure the change in velocity of the trolley over a given distance or time • what data is to be collected in order to calculate acceleration • how the data required is to be measured	

6

(f) so that the mass is constant

fair test is insufficient

1

as changing mass would change the acceleration (produced by a given force)
or
so there is only one independent variable

1

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(f) hypothesis A because

***A** must be identified to gain either mark*

1

the results give a straight line that passes through the origin

showing direct proportionality

1

[15]

Q5.

(a) **Level 2 (3–4 marks):**
A detailed and coherent description of a plan covering all the major steps is provided.
The steps are set out in a logical manner that could be followed by another person to obtain valid results.

Level 1 (1–2 marks):
Simple statements relating to relevant apparatus or steps are made but they may not be in a logical order. The plan would not allow another person to obtain valid results.

0 marks:
No relevant content.

Indicative content

- measure the distance the ruler falls before being stopped
- the greater this distance the greater the reaction time
- repeat measurements and calculate a mean
- repeat several times with the student listening to music (through earphones). Calculate a mean.
- a (significant) difference between the two means would show that music affects reaction time.

4

(b) reaction time decreases with practice

allow Y has a shorter reaction time

1

allow Y has faster reaction times (than X)

(c) the stop clock was started before the computer test started

1

the student was distracted

1

[7]

Q6.

(a) It will have a constant speed.

1

(b) distance travelled = speed × time

1

(c) a = $\frac{18 - 9}{}$

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6

1

a = 1.5

*allow 1.5 with no working shown for **2** marks*

1

(d) resultant force = mass × acceleration

1

(e) F = (1120+80) × 1.5

1

F = 1800 (N)

*allow 1800 with no working shown for **2** marks*

1

*accept their 10.3 × 1200 correctly calculated for **2** marks*

(f) $18^2 - 9^2 = 2 \times 1.5 \times s$

1

$s = 18^2 - 9^2 / 2 \times 1.5$

1

s = 81 (m)

1

*allow 81 (m) with no working shown for **3** marks*
*accept answer using their 10.3 (if not 1.5) correctly calculated for **3** marks*

(g) **Level 2 (3–4 marks):**
A detailed and coherent explanation is provided. The response makes logical links between clearly identified, relevant points that include references to the numerical factor.

Level 1 (1–2 marks):
Simple statements are made. The response may fail to make logical links between the points raised.

0 marks:
No relevant content.

Indicative content

- doubling speed increase the kinetic energy
- kinetic energy increases by a factor of 4
- work done (by brakes) to stop the car increases
- work done increases by a factor of 4
- work done is force × distance and braking force is constant
- so if work done increases by 4 then the braking distance must increase by 4

4

[14]

Q7.

(a) 3 (.0)

*allow **1** mark for correct substitution i.e. 25 × 0.12 provided no subsequent step*

2

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(b) (i) elastic potential
correct order only
1

kinetic
1

(ii) increases
1

to 80 (mm) (or more)
accept any number greater than 75
an answer 'it (more than) doubles' gains both marks
1

(c) (i) weight
1

(ii) downward speed increases
1

[8]

Q8.

(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

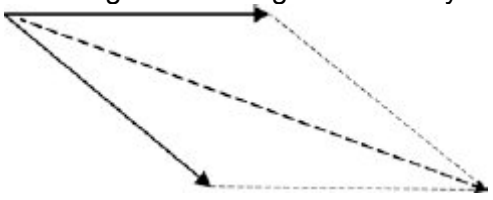
accelerating
1

(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*

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*drawn resultant line is between and longer than the two 300 N forces gains **2** marks*

1

[10]

Q9.

(a) (i) not moving

1

(ii) straight line from origin to (200,500)

ignore a horizontal line after (200,500)

1

(b) 35 000

*allow **1** mark for correct substitution, ie 14 000 × 2.5 provided no subsequent step*

an answer of 87 500 indicates acceleration (2.5) has been squared and so scores zero

2

[4]

Q10.

(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

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need to overcome resistance forces

accept named resistance force

accept resistance forces act (on the water skier)

*do **not** accept gravity*

1

[9]

Q11.

(a) any **two** from:

- (make shape / body) more streamlined

  accept a correct description
  accept lower the seating position of the driver

- increase power of engine

  faster engine is insufficient

- reduce mass / weight (of go-kart)

  change wheel size is insufficient

2

(b) (i) A–B

reason only scores if A–B is chosen

1

steepest / steeper gradient / slope

1

(iii) 1820

*allow **1** mark for correct substitution, ie 140 × 13 provided no subsequent step shown*

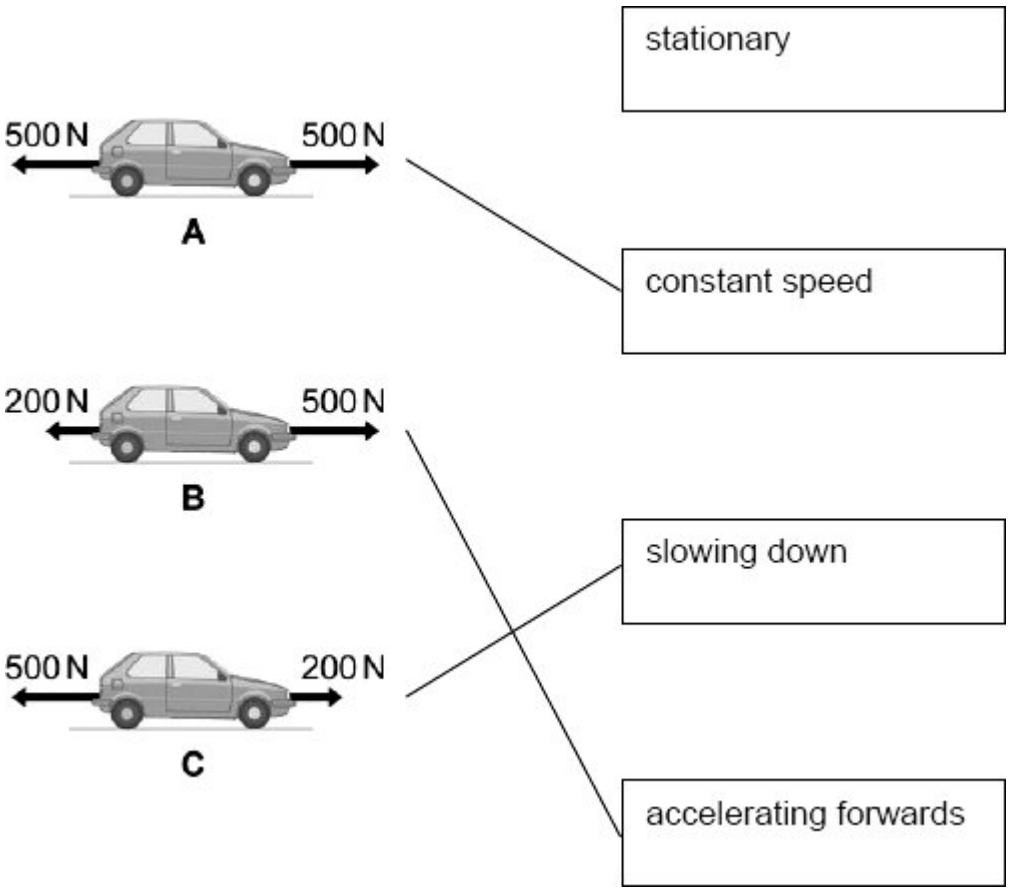
2

[6]

Q12.

(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

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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]

Q13.

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

accept steady pace

*do **not** accept terminal velocity*

*do **not** accept stationary*

1

B acceleration

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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/s^2

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

1

[10]

Q14.

(a) 98

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

ie ½ × 0.16 × 35 × 35 provided no subsequent step shown

an answer of 98 000 scores 0

2

(b) (i) 9.6

*allow **1** mark for (change in velocity =) 60*

ignore negative sign

2

(ii) 9600

ignore negative sign

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or
their (b)(i) ÷ 0.001 correctly calculated, unless (b) (i) equals 0

1

(c) increases the time

1

to reduce/change <u>momentum</u> (to zero)

only scores if 1st mark scored

decreases rate of change of momentum scores both marks provided there are no contradictions

accept decreased acceleration/deceleration

equations on their own are insufficient

1

[7]

Q15.

(i) the thicker the tile, the greater the(fall) height

accept the higher (the fall) the thicker the tile
accept there is a positive correlation
*do **not** accept they are proportional*

1

(ii) 60 (mm)

accept any number or range between 60 and 85 inclusive
if units are given must match range

1

(minimum thickness) needed to <u>reduce risk of injury</u>

reason must match thickness choice
*do **not** accept to keep child safe*

accept an answer in terms of – the thicker the tile, the less chance there is of a serious injury if the answer given is greater than 60

accept answers in terms of use of graph e.g. the graph shows that for a 2m fall a thickness of 60 mm is needed

minimum level answer' the graph shows that's what's needed' accept only if 60 is the answer

1

[3]

Q16.

(a) 2.75

*allow **1** mark for correct substitution, ie* $\frac{11}{4}$

or $\frac{23-12}{4}$

provided no subsequent step shown

2

m/s^2

1

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(b) driving force increases

1

frictional force increases

accept air resistance / drag for frictional force

1

driving force > frictional force

1

[6]

Q17.

(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]

Q18.

(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

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(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]

Q19.

(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]

Q20.

(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

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

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

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

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

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

1

(ii) 15

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

2

(iii) velocity includes direction

accept velocity is a vector (quantity)
accept converse answer

1

[6]

Q21.

(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

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or bigger the area more air resistance

need the relation of area to force

1

[7]

Q22.

(a) (i) gravity/weight

1

(ii) 2193750000000 or 2.19×10^{12}

not *2.19^{12}*

allow 1 mark for the correct conversion to 7500 (m/s)

allow one mark for answer 2193750(J)

2

transferred to heat

ignore extras of sound and light

accept changed to heat

accept lost due to friction

1

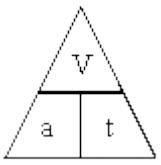
(b) (i) acceleration = $\frac{\text{change in velocity}}{\text{time (taken)}}$

accept word speed instead of velocity

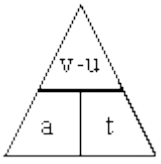
accept $a = \frac{v-u}{t}$

or *correct rearrangement*

do not accept



even if subsequent calculation correct



can gain credit if subsequent calculation correct

1

(ii) 2

ignore + or – signs

m/s^2 1

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

2

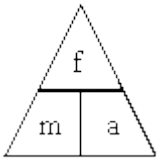
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(c) (i) force = mass × acceleration

accept correct rearrangement

accept F = m × a

do not accept



unless subsequent calculation correct

1

(ii) 156 000

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

1

[9]

Q23.

(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]

Q24.

(a) (i) same size

1

(ii) **K**

1

(b) velocity

1

(c) **C**

1

greatest mass **or** because it's heavier

accept biggest load

*accept heaviest **or** more weight*

*do **not** accept fuller*

*do **not** accept more items*

*do **not** accept it's loaded*

*do **not** accept loaded most*

ignore references to time as neutral

1

[5]

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Q25.

(i) force = mass × acceleration

accept F = m × a

*accept upper **or** lower case letters*

accept equation using correct units

accept



if subsequent method correct

1

(ii) 0.007

*allow **1** mark for correct transformation or substitution*

2

[3]

Q26.

(a) 3

gains 1 mark

m/s^2

gains 1 mark

else working *gains 1 mark*

2

(b) 2850 ecf

gains 1 mark

N

gains 1 mark

else working

gains 1 mark

2

(c) friction/air resistance increases with speed;
till frictional = max forward force;
then force/acceleration is zero

for 1 mark each

alternative limitation for safety

gains 1 mark only

3

[7]

Q27.

(a) (i) decreases

for 1 mark

1

(ii) decreases

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for 1 mark

1

(iii) lower speed everywhere

for 1 mark

1

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

gains 1 mark

1

ms^{-2}

gains 1 mark

1

(ii) 2850 ecf

gains 2 marks

else working

gains 1 mark

2

(iii) air resistance/frictional forces increase with speed;
till frictional force = max forward engine force;
when acceleration is zero

(incorrect statement – 1 mark)

or (limitation on maximum speed for safety-1 mark)

any two for 1 mark each

2

[9]

Q28.

(a) there is a (maximum) forward force
drag/friction/resistance (**opposes** motion) (**not** pressure)
increases with speed
till forward and backward forces equal
so no net force/acceleration

any 4 for 1 mark each

4

(b) (i) $F = ma$
$10\ 000 = 1250a$
$a = 8$
m/s^2

for 1 mark each

4

(ii) $ke = 1/2\ mv^2$
$ke = 1/2\ 1250.48^2$
$ke = 1\ 440\ 000$
J

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for 1 mark each

4

(iii) W = Fd
W = 10 000.144
W = 1 440 000
J

for 1 mark each

4

[16]

Q29.

(a) WX deceleration / speed decreasing / slowing down / negative acceleration

XY constant speed / steady speed *not* constant motion / slow speed

YZ acceleration / speed increasing / speeding up

for 1 mark each

3

(b) distance = v × t **or** distance = 30 × 20

gains 1 mark

but
distance = 600(m)

gains 2 marks

2

(c) acceleration = v / t **or** acceleration = 30 / 12

gains 1 mark
(if –30 / 12, allow negative sign here if not in the answer)

3

but
acceleration = 2.5 (m/s²)

gains 2 marks

but
acceleration = -2.5 (m/s²)

gains 3 marks

(d) in a crash / during hard braking car body stops / slows rapidly driver / passengers continue to move forward *not* thrown forward seatbelts provide backward force / keep them in their seats / restrain them to stop them hitting the windscreen / dashboard

(an alternative argument involving momentum is acceptable)
for 1 mark each

4

[12]

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Q31.

12 100

correct answer with no working = 3
if answer incorrect, allow 1 mark for force = mass × acceleration
1210 × 10 = 2 force / weight = mass × gravity is neutral
N.B. no marks for correct answers with incorrectly recalled relationship

[3]

Q32.

(a) WD = force × distance **or** 6 × 2
gains 1 mark

but 12 *gains 2 marks*
units J/joules [credit Nn]
for 1 mark

3

(b) 0.6 (i.e. using the **recalled** 10N/kg)
gains 1 mark

but evidence of force = mass × acceleration
or of correct substitution e.g. 6/9.8
gains 2 marks

but 0.61 (2...)
gains 3 marks

3

(c) *any reference to*
initial acceleration due to gravity
(force due to) friction/air resistance
each for 1 mark

ideas that
this increases as speed increases
forces eventually balance
each for 1 further mark

9

[9]

Q33.

(a) **evidence of* acceleration = $\frac{\text{change in speed}}{\text{time}}$ or $\frac{0.6}{3}$
gains 1 mark

but 0.2
gains 2 marks

units m/s^2
for 1 mark

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3

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

for 1 mark

1

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

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

gains 1 mark

but 1200/1176 **or** *figure consistent with (b)(i)*

gains 2 marks

2

(c) *evidence of* force = mass × acceleration **or** 200 × 0.3

gains 1 mark

but 60

gains 2 marks

but 60 + weight of girder (2060/2020*) *(or figure consistent with (b)(i))*

gains 3 marks

3

[9]

Q34.

(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))

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for 1 mark

1

(c) *evidence of* × 10 / × 9.8 / × 9.81 **or** 750/735(75)

for 1 mark

1

[8]

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