

- M1.(a) Velocity and speed correct ✓
 Distance and displacement correct ✓

	velocity	speed	distance	displacement
vector	✓			✓
scalar		✓	✓	

2

(b) (i) $v^2 = u^2 + 2as$
 $v = \sqrt{u^2 + 2as}$ ✓ $v = \sqrt{1.5^2 + 2 \times 9.81 \times 0.65}$ ✓

= (-)3.9 (m s⁻¹) ✓ two or more sig fig needed (- 3.87337 m s⁻¹)

1st mark for equation rearranged to make v the subject (note sq' root may be implied by a later calculation) penalise the use of g = 10 m s² only on this question

2nd mark for substituting numbers into any valid equation

3rd mark for answer

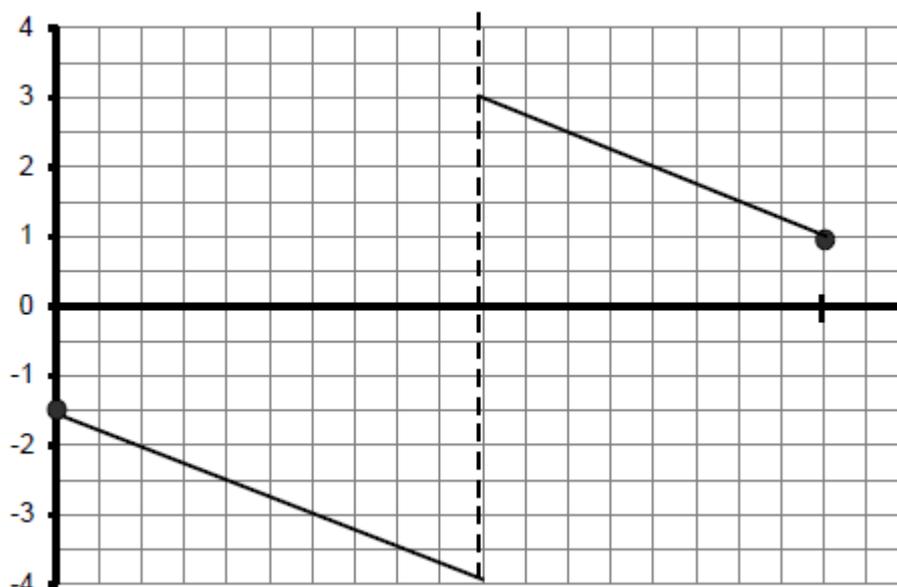
Alt' approach is gainKE = lossPE

missing out u gives zero marks

answer only gains one mark [Note it is possible to achieve the correct answer by a wrong calculation]

3

(ii) velocity / ms⁻¹



first line descends from X to the dotted line at t_A or up to one division sooner ✓
 (allow line to curve)

first line is straight and descends from X to $v = -4 \text{ (m s}^{-1}\text{)}$ ✓ (allow tolerance one division)

second line has same gradient as the first, straight and descends to $v = 1 \text{ (m s}^{-1}\text{)}$ ✓ (tolerance $\frac{1}{2}$ division)

a steep line may join the two straight lines but its width must be less than 2 divisions

3

(c) $s = ut + \frac{1}{2}at^2$

$t = \sqrt{\frac{2s}{a}}$ OR correct substitution seen into either equation $t = \sqrt{\frac{2 \times 1.2}{9.81}}$ ✓

$= 0.49 \text{ (s)}$ ✓ (0.4946 s)

working must be shown for the first mark but not the subsequent marks

$v = s / t$

$= 5.0 / 0.49 = 10 \text{ (m s}^{-1}\text{)}$ ✓ (10.2 m s⁻¹) (allow CE from their time)

[note it is possible to achieve the correct answer by a wrong calculation]

3

[11]

M2.(a) (i) 0.416 or 0.417 and 0.495 or 0.496

1

(ii) Both plotted points to nearest mm ✓

Straight line of best fit ✓

The line should be a straight line with approximately an equal number of points on either side of the line.

2

(iii) Large triangle drawn (at least 8cmx8cm) ✓

Correct values read from graph ✓

Gradient value in range 0.805 to 0.837 to 2 or 3 sf ✓

3

(iv) (1) For showing correct vertical component of at least one of the forces / tensions as $mg\cos\theta$ or both vertical components as $2mg\cos\theta$

Question specifically referred to resolving forces so component

must include g. ✓

1

$$(2) \quad \cos\theta = \frac{d}{\text{hypotenuse}} = \frac{d}{\sqrt{(d^2 + (x^2/4))}} \quad \checkmark$$

$$\frac{d}{\sqrt{(d^2 + (x^2/4))}} = \frac{M}{2m} \quad \text{compared to } y = mx \quad \checkmark$$

(Hence gradient is $\frac{1}{2m}$)

2

- (3) Magnitude of m correct from
E.g middle gradient value gives $m = 0.609 \text{ kg}$

$$\frac{1}{2 \times \text{their gradient from (c)}} \quad \checkmark \quad \text{kg and 2 or 3 sf} \quad \checkmark$$

Allow ecf from gradient value.

Sf and unit mark depends on correct calculation of m from the gradient value.

2

- (v) (1) Friction at the pulleys ✓

1

- (2) Take a mean value of readings from loading and unloading ✓

1

- (b) (i) Description of technique:
Use small plane mirror beneath string / use of set square / bright light source to project shadow of the strings onto the paper, and marking points on shadow to aid drawing lines ✓

Explanation:

Line of sight not perpendicular from string to paper / mark on paper depends on the angle the eye is positioned at / reference to parallax error. ✓

2

Markers should measure the angle to check that no scaling error has been introduced in the photocopying of the paper.

If the angle is different, mark accordingly.

Answers should be consistent with protractor precision stated by the candidate.

- (ii) (1) Value of θ quoted as 30° or 31° (for a protractor with precision $\pm 1^\circ$)
OR
 $\theta = 30.0, 30.5, 31.0$
(for a protractor with precision $\pm 0.5^\circ$) ✓

Correct computation of % uncertainty, answer quoted to 2 or 1sf ✓

Allow ecf for incorrect angle (penalised in 1st marking point). (e.g. if using a protractor with 1° precision % uncertainty will be $1/31 \times 100\% = 3.2\%$ or 3% OR for candidates who measured the angle 2θ % uncertainty = $1/62 \times 100 = 1.6\%$ or 2% . With a protractor with precision $\pm 0.5^\circ$ the % uncertainties will be half these values)

This is because the question specifically stated "as accurately as possible". It should be clear from the candidate's percentage uncertainty calculation whether 2θ or θ has been measured.

Extra mark for a candidate who measures the angle 2θ (rather than just the single angle θ) ✓

(This 3rd mark can also be awarded for a candidate who has measured θ on both sides of the 'vertical line', and taken the mean value)

3

- (2) Evidence of right angled triangle drawn on to the diagram with dimensions of two sides also shown on the diagram. The minimum dimension shown must be 70mm. ✓

Correct use of cosine rule without right angled triangle is acceptable.

Angle correctly computed using sine cosine or tangent, with value quoted in the range 30.0° to 31.4° ✓

*Angle quoted to 3 sf/to 0.1°
 2^{nd} mark is still available to a candidate who didn't achieve the 1^{st} mark.*

2

- (iii) Plot a graph of $\cos \theta$ against $1/m$
AND

Statement that it should give a straight line through origin. ✓

*Allow graphs of $1/m$ **against** $\cos \theta$, against $1/\cos \theta$ against m , which would all be straight lines through the origin.*

1

[21]

M3.Right-angled triangle, nose-to-tail with arrows

M1

Appropriate scale (fills half the space minimum)

A1

52 ± 1 (degrees)

1 mark for 52.3° by calculation

B1

[3]

M4.B

[1]

M5.D

[1]