

Forces in action

Mark Scheme 1

Level	A Level
Subject	Physics
Exam Board	OCR
Topic	Forces and Motion
Sub-Topic	Forces in action
Booklet	Mark Scheme 1

Time Allowed: 56 minutes

Score: / 46

Percentage: /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	77.5%	70%	62.5%	57.5%	45%	<45%

Question		Answer	Marks	Guidance	
1	a	pressure and stress or pressure and Young modulus or stress and Young modulus or moment (of a force) and torque (of a couple)	B1	<p>Allow other correct combinations Allow the following:</p> <ul style="list-style-type: none"> e.m.f. and p.d. Any two from frequency, activity, decay constant and Hubble constant because of the s^{-1} <p>Ignore any units given (even if incorrect)</p> <p>Special case: Allow quantities with no units, e.g. strain and efficiency. Not any combination of length, distance and extension</p>	
	b	i	x-component = 6.0 (N) and y-component = 2.0 (N)	B1	<p>Allow 1 sf answers Allow tolerance ± 0.1 N Not x-component = 2.0 (N) and y-component = 6.0 (N)</p>
		ii	resultant components are 8.0 (N) and 5.0 (N) $F^2 = 8.0^2 + 5.0^2$ force = 9.4 (N)	C1 C1 A1	<p>Allow: 1 sf values for this C1 mark Possible ecf from (b)(i) with x-components = 2 + b(i) and y-component = 3 + b(i).</p> <p>Note: Answer is 9.43 to 3sf Not an answer left in square root form, e.g. $\sqrt{89}$</p> <p>Allow full credit for a scale drawing; marks awarded as below:</p> <ul style="list-style-type: none"> A dot / cross / mark at 8.0,5.0 (± 0.1) C1 Line drawn from 0,0 to 8.0,5.0 C1 force = 9.4 ± 0.1 (N) A1
	c	i	Down	B1	Allow a downward arrow on Fig. 2.2

Question			Answer	Marks	Guidance
		ii	Horizontal component of the velocity is constant There is no <u>horizontal force</u>	B1 B1	Allow: There is no horizontal <u>acceleration</u> Allow: Weight / g has no horizontal component or Weight / g is 90° to the horizontal or Weight / g is vertical or 'there is <u>only</u> a vertical force' (Not 'gravity' for 'weight'; allow 'force of gravity')
		iii	Any <u>two</u> from: <ul style="list-style-type: none"> • It decreases from X to Y • It is zero at Y / It has the same magnitude at X and Z • It increases from Y to Z • It is positive from X to Y and negative from Y to Z (or vice versa) 	B1 × 2	Ignore description in terms of acceleration or deceleration Allow it changes sign / direction from X to Z
			Total	10	

Question			Answer	Marks	Guidance
2	a	i	Length from A to B = 8.0 (cm) displacement = 400 (km) or time = 1500 (s) average velocity = $400 \times 10^3 / 1500$ average velocity = 270 (m s ⁻¹)	C1 C1 A1	Allow ± 0.1 cm Possible ecf within the calculation for an incorrect value for length AB . Note no credit if distance is used.
		ii	(The average speed is different because) the <u>distance</u> (travelled) is different / not the same / greater than the <u>displacement</u>	B1	
	b	i	distance = $2 \times \pi \times 4.2 \times 10^8$ speed = $\frac{2 \times \pi \times 4.2 \times 10^8}{1.5 \times 10^5}$ speed = 1.8×10^4 (m s ⁻¹)	C1 A1	Note: Answer to 3 sf is 1.76×10^4 (m s ⁻¹) Not 5600π (m s ⁻¹)
		ii	$(0 = v^2 - 2as)$ $(1.3 \times 10^3)^2 = 2 \times a \times 470 \times 10^3$ (Any subject) $a = \frac{(1.3 \times 10^3)^2}{2 \times 470 \times 10^3}$ (a must be the subject) acceleration = 1.8 (m s ⁻²)	C1 C1 A1	Allow full credit for ' $mgh = \frac{1}{2} mu^2$ ' approach Ignore signs Allow: 2 marks for 1.8×10^n ; $n \neq 0$
Total				9	

Question		Answer	Marks	Guidance	
3	a	$F \rightarrow \text{kg m s}^{-2}$ or $A \rightarrow \text{m}^2$ <u>and</u> $v \rightarrow \text{m s}^{-1}$	M1	Alternative: (units on rhs:) $\text{kg m}^{-3} \times \text{m}^2 \times \text{m}^2 \text{s}^{-2}$ or (unit for lhs:) = kg m s^{-2} M1 Manipulation leading to same units on both sides M1 Allow other correct methods	
		Manipulation leading to $k \rightarrow \text{kg m}^{-3}$	M1		
		$k \rightarrow \text{kg m}^{-3}$	A0		
	b	i	Arrow directly opposite to D on Fig. 6.1	B1	Ignore position and length of arrow
		ii	The ball is not at terminal velocity, since D and W are not (directly) opposite / The ball is not at terminal velocity because there is a net force	B1	Not D and W are at 90°
		iii	It is travelling (vertically) upwards It will slow down / It decelerates / It accelerates (vertically) downwards / There is a net downward force / drag opposes motion	M1 A1	
	c	At the start, acceleration = g (because there is no drag) Drag increases (as its speed increases / accelerates) net force decreases or net force < weight (As it falls) acceleration decreases / (As it falls) acceleration < g	B1 B1 B1 B1	Allow $9.8(1) \text{ m s}^{-2}$ / acceleration of free fall / acceleration due to gravity (Not 'gravity' on its own) Not rate of acceleration is g Not ' <u>rate</u> of acceleration decreases' unless it is qualified or 'acceleration slows down'	
Total			10		

Question			Answer	Marks	Guidance
4	a	i	$\text{mass} = 2400 \times (0.80 \times 1.2 \times 15)$ / $\text{mass} = 3.46 \times 10^4$ (kg) $\text{weight} = 3.46 \times 10^4 \times 9.81$ $\text{weight} = 3.4 \times 10^5$ (N)	C1 A1	
		ii	$\text{pressure} = 3.4 \times 10^5 / (15 \times 0.80)$ $\text{pressure} = 2.8 \times 10^4$ (Pa)	C1 A1	Possible ecf from (a)(i)
	b	i	Net moment is zero (about any point / axis).	B1	Allow 'clockwise moment(s) = anticlockwise moment(s)' Allow net torque is zero
		ii	The force exerted (at X) decreases. Correct explanation, e.g: The moment must be the same (about the other wall / pivot) and the distance (from it) has increased.	M1 A1	Allow 'force \times (perpendicular) distance' for moment
			Total	7	

Question			Answer	Mark	Guidance
5	(a)	(i)	<p>N & W act on the same body / Newton's 3rd Law forces should act on different bodies</p> <p>N & W are different types (of force) / are not same type</p>	<p>B1</p> <p>B1</p>	<p>Allow: 3rd law pair to W acts on (centre of)Moon 3rd law pair to N acts on <u>surface</u> of Moon</p> <p>Allow: N is electromagnetic/electrostatic/electrical/contact W is gravitational. Allow: Paired forces should be of the same type Ignore a general statement of Newton's 2nd or 3rd law</p>
		(ii)	Equal to / same as W acting on (the centre of) the Moon	B1	Do not allow 'acts on surface of Moon Diagram is not sufficient for this mark
	(b)		<p>Clear use of vertical motion with downward acceleration and horizontal motion at constant velocity</p> <p>vertically $0 = (u \sin \theta)t - \frac{1}{2} g_M t^2$</p> $t = \frac{2u \sin \theta}{g_M}$ <p>horizontally $x = u \cos \theta \times \frac{(2u \sin \theta)}{g_M}$</p> $x \propto \frac{u^2}{g_M}$ <p>—</p>	<p>B1</p> <p>M1</p> <p>A1</p> <p>A0</p>	<p>If $\sin \theta$ and $\cos \theta$ are confused allow max 1/3.</p> <p>Allow: use of a for g_m Allow: determination of time to max height using $v=u + at$</p> <p>Then total time = 2 x time to max height (M1)</p> <p>Allow use of 9.81 instead of g_m</p>
Total				6	

Question		Answers	Marks	Guidance
6	(a)	$5.1 \times \cos 40 \times 0.75$ or $d \times 1.2 \times g$ $5.1 \times \cos 40 \times 0.75 = d \times 1.2 \times 9.81$ $d = \frac{5.1 \times \cos 40 \times 0.75}{1.2 \times 9.81}$ $d = 0.25 \text{ (m)}$	C1 C1 A1	Allow 2 marks if sine of the angle is used instead of cosine; this gives an answer of 0.21 (m). Allow use of 9.8 (m s ⁻²) Note: '5.1 × 0.75 = d × 1.2 × 9.81; d = 0.32.. (m)' scores 1 mark because of the first C1
	(b)	The string provides a horizontal force (to the left), hence there must be a horizontal force at the support (to the right, therefore the force at the support cannot be vertical). (AW) Or If the force was just vertical at the support then the object would move to the left (and so will not be in equilibrium). (AW) Or Force at support is at an angle and passes through the point of intersection (of the lines of action) of the weight and the tension. (AW)	B1	Allow $T \sin 40$ for the horizontal force
Total			4	