This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners’ meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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1 (a) (i) either rate of change of displacement or (change in) displacement/time (taken) B1 [1]

(ii) speed has magnitude only B1
velocity has magnitude and direction B1 [2]

(b) (i) idea of area under graph/use of $s = \frac{(u + v)}{2} \times t$ C1

$s = \frac{(18 + 32)}{2} \times 2.5$ C1
$= 62.5 \text{ m}$ A1 [3]

(ii) $a = \frac{(18 - 32)}{2.5} = -5.6$ C1
$F = ma$ C1
$F = 1500 \times (-5.6) = (-8400) \text{ N}$ A1 [3]

(c) arrow labelled A and arrow labelled F both to the left B1 [1]

2 (a) (i) work (done)/time (taken) B1 [1]

(ii) work = force $\times$ displacement (in direction of force) B1
power = force $\times$ displacement/time (taken) $= \text{force} \times \text{velocity}$ B1 [2]

(b) (i) weight $= mg$ C1

$P = Fv = 2500 \times 9.81 \times \sin 9^\circ \times 8.5 \text{ (or use } \cos 81^\circ) \text{ C1}$
$= 33 (32.6) \text{ kW}$ A1 [3]

(ii) no gain or loss of KE B1
no work (done) against air resistance B1 [2]

3 (a) (i) resultant force is zero B1

weight of plank + weight of man = $F_A + F_B$
$\text{or} \ 200(\text{N}) + 880(\text{N}) \text{ or } 1080 = F_A + F_B$ B1 [2]

(ii) principle of moments used C1
(anticlockwise moments) $F_B \times 5.0$ C1
(clockwise moments) $880 \times 0.5 + 200 \times 2.5$ C1
$F_B = \frac{(440 + 500)}{5.0} = 188 \text{ N}$ A1 [4]

(b) straight line with positive gradient (allow freehand) M1
start point (0, 100) A1
finish point (5, 980) A1 [3]
### 4 (a) kinetic energy = \( \frac{1}{2} mv^2 \)
\[
= \frac{1}{2} \times 0.040 \times (2.8)^2 = 0.157 \text{ J or } 0.16 \text{ J}
\]

(b) (i) \( k = F/x \text{ or } F = kx \)
\[
X_B = 14/800 = 0.0175 \text{ m}
\]

(ii) area under graph = elastic potential energy stored
\( \text{or } \frac{1}{2} kx^2 \text{ or } \frac{1}{2} Fx \)
\[
\text{(energy stored =)} 0.1225 \text{ J less than KE (of 0.16 J)}
\]

### 5 (a) (i) displacement is the distance from the equilibrium position/undisturbed position/midpoint/rest position

amplitude is the maximum displacement

(ii) frequency is the number of wavefronts/crests passing a point per unit time/number of oscillations per unit time

time period is the time between adjacent wavefronts or time for one oscillation

(b) (i) 1. amplitude = 1.5 mm
2. wavelength = 25/6
\[
= 4.2 \text{ cm or } 4.2 \times 10^{-2} \text{ m}
\]

(ii) \( v = \lambda / T \text{ or } v = f \lambda \text{ and } T = 1/f \)
\[
T = 4.2/7.5 = 0.56 \text{ s}
\]

(c) (i) progressive wavefront/crests moving/energy is transferred by the waves

(ii) transverse the vibration is perpendicular to the direction of energy transfer/wave velocity or travel of the wave/wavefronts

### 6 (a) e.m.f.: energy converted from chemical/other forms to electrical per unit charge
p.d.: energy converted from electrical to other forms per unit charge

(b) (i) the p.d. across the lamp is less than 12 V
\( \text{or there are lost volts/power/energy in the battery/internal resistance} \)

(ii) \( R = V^2 / P \text{ (or } V = RI \text{ and } P = VI) \)
\[
= 144/48 = 3.0 \Omega
\]

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(iii) \[ I = \frac{E}{(R_T + r)} \]
\[ = \frac{12}{2.0} \]
\[ = 6.0 \text{A} \] C1

\[ \text{A1 [2]} \]

(iv) power of each lamp = \[ I^2R \]
\[ = (3.0)^2 \times 3.0 \]
\[ = 27 \text{W} \] C1

\[ \text{A1 [2]} \]

(c) less resistance (in circuit)/more current M1
more lost volts/less p.d. across battery A1 [2]

7 (a) \( \alpha \): helium nucleus
\( \beta \): electron
\( \gamma \): electromagnetic radiation/wave/ray or photon

three correct 2/2, two correct 1/2 B2 [2]

(b) (i) atomic number/proton number/\( Z - 2 \), nucleon/mass number/\( A - 4 \) B1 [1]

(ii) atomic number/proton number/\( Z + 1 \)
nucleon/mass number/\( A \) no change B1 [1]

(iii) no change in proton or mass number
or “no change” B1 [1]