

Name of the Student: _____

Max. Marks : 25 Marks

Time : 25 Minutes

Mark Schemes

Q1.

- (a) rate = 1.40 to 1.75 ($V s^{-1}$) _{1✓}
for _{1✓} accept 2 sf 1.5, 1.6 and 1.7 ($V s^{-1}$)

rate = 1.50 to 1.65 ($V s^{-1}$) _{2✓}
for _{2✓} accept >3 sf rounding to value in range;
accept 2 sf 1.6;
expected answer is 1.57(2) ($V s^{-1}$)

2

- (b) maximum 1 mark per marking point (see _{1✓} to _{4✓} below)

reduces impact of statistical error (involved in reading and recording data manually) _{1✓}

data can be collected at a high(er) rate or wtte _{2✓}

idea that data (in digital form) may be easily processed _{3✓}

two (or more) sets of data (I and V) can be made simultaneously or wtte _{4✓}

treat suggestions that data logging improves 'precision' / 'resolution' / reduces 'uncertainty' / eliminates 'systematic' / 'parallax errors' / 'anomalous readings' as neutral

for > 2 ideas mark as a list

for _{1✓} allow reducing 'human error' / 'random error' / 'improving accuracy' as same idea;

idea that random error / uncertainty can be eliminated is talk out;

condone 'no human error / reaction';

for _{2✓} condone 'quickly' / 'works faster'

'collect data at a steady rate' / 'saves time' / comments about 'reaction time' are neutral

for _{3✓} eg can be transferred to / graphed with / analysed using a digital device or application eg computer / spreadsheet

allow 'can be processed automatically'

treat the following as neutral since they are not specifically applicable to this experiment:

can carry out experiment 'remotely' / 'in inaccessible or dangerous environments' / 'automatically' / 'without any human (being present)' or wtte;

can 'start / stop data collection at some suitable (future) time' / 'collect large amount of data' or wtte;

'a wide variety of sensors are available' / 'data logging is (increasingly) cheap'

Max 2

- (c) identifies that **circuit 2** can produce the data because the pd can be varied between 0 V and 12 V ₁✓

for ₁✓ allow 'can achieve 12 V range' or write; reject 'can produce 0 V and 12 V'

identifies that **circuit 1** cannot produce (all of) the data shown on **Figure 2** ₂✓

for ₂✓ allow '**circuit 1** is not suitable' / 'not **circuit 1**';

award ₁*₂✓ for 'neither can produce the data'

2

for **circuit 1** with **X** set to maximum resistance

calculates (minimum) *I*

OR

calculates (minimum) *V* ₃✓

for ₃✓ (at least one) result should be evaluated to min 2 sf but condone '≈ 0.7' if decimal intermediate result is ok;

do not accept rounding to 0.69;

allow use of 17.2 without justification;

$$\text{minimum } I \left(= \frac{12}{17.2} \right) = 0.70 \text{ A OR}$$

$$\text{minimum } V \left(= 12 \times \frac{2.3}{17.2} \right) = 1.6 \text{ V}$$

their minimum *I* or minimum *V* for **circuit 1** compared with value of first (or second) point in **Figure 2** ₄✓

for ₄✓ could say their minimum *I* > 0.36 / *I* for first data point < 0.7(0) / 0.70 > 0.36 etc

allow 'cannot produce *I* < 0.7(0) in Fig 2';

'cannot produce all the values' is not enough

2

- (d) *P* = 6.82 in row 2 ₁✓

I = 1.77 in row 4 ₂✓

P = 17.0 in row 4 ₃✓

	V/V	I/A	P/W
	3.30	1.07	3.53
$1\checkmark$	5.17	1.32	6.82
	7.69	1.59	12.2
$2\checkmark 3\checkmark$	9.58	1.77	17.0
	11.47	1.94	22.3

for $1\checkmark$ CAO

for $2\checkmark$ allow 1.77 ± 0.01

for $3\checkmark$ ECF for their (incorrect) $I \times 9.58$;

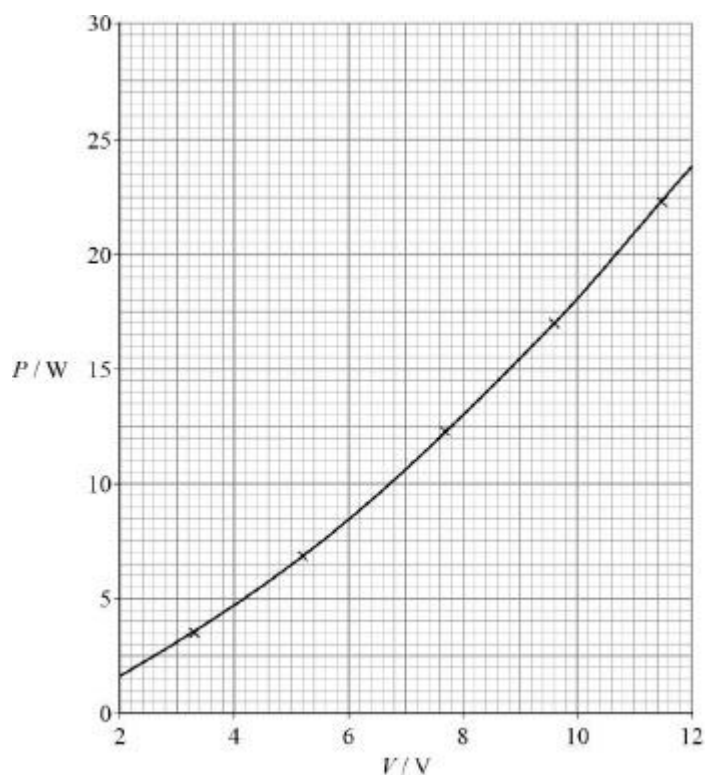
deduct MAX 1 mark if any are **not** to 3 sf

3

(e) vertical axis labelled P/W $1\checkmark$

suitable vertical scale for their data $2\checkmark$

5 points plotted AND smooth curve of increasing gradient $3\checkmark$



for $1\checkmark$ allow $P(W)$, P in W ;

reject comma separator, eg P, W ;

allow words, eg power for P / watt(s) for W

for $2\checkmark$ expect 1 cm interval = 2 W OR 2 cm intervals = 5 W

vertical scale must

- be linear

- be marked in integer values

- be marked with a frequency of not less than 4 cm intervals
 - cover the range of plotted points
- assume $P = 0$ at unmarked origin

2

for \checkmark_3 check the plotting of any obviously suspect point;
 points must **not** be thick / faint / dots / blobs;
 line must

- be a continuous **curve**
 - be neither thick or faint
 - (at least) extend from the first to the fifth point
 - be a reasonable best-fit for their data; withhold mark if line deviates by ≥ 2 minor squares from examiner's best line (by eye)
- if I/A is plotted award \checkmark_2 if the effective range of vertical scale is \geq half height of grid

1

- (f) evidence that P_r read-off to ± 1 minor grid square \checkmark_1
 for \checkmark_1 best-fit line must be extrapolated to $V = 12$ V (at the right-hand margin of the grid);
 P_r correct to \pm half a minor grid square;
 expect $P_r = 23.8$ W for a curve but accept a read-off obtained from a straight best-fit line

reads off P_2 corresponding to 6 V;

evaluates $\frac{2 \times \text{their } P_2}{\text{their } P_r} \times \checkmark_2$

\checkmark_2 is not contingent on \checkmark_1
 for \checkmark_2 expect $P_2 = 8.5$ W for a curve;
 expected % in range 70% to 73%
 if no read-off evidence is seen on **Figure 3** check for the possibility that **Figure 1** was used to obtain P_r and P_2 eg by drawing a curve through points to intersect at $V = 12$ V, then
 using $V (= 12) \times I (= 1.98)$ $P_r = 23.7$
 using $V (= 6) \times I (= 1.42)$ $P_2 = 8.5(2)$
 would lead to 72%

2

[16]

Q2.

- (a) arrow between block and belt pointing upwards along the belt

1

- (b) $(F =) 19g \sin 23^\circ$ to give 72.8 (N) \checkmark
 Allow 2 sf answer.

1

- (c) uses $F = \frac{\Delta(mv)}{\Delta t}$

Allow for MP1 use of appropriate kinematic equation for a **AND** use of $F = ma$

$$F = 12 \text{ (N)} \checkmark$$

their (b) + 12 (N) \checkmark

Expect 82 or 85 (N)

3

(d) uses V and I to get total input power or energy \checkmark

$$P_{\text{input of motor}} = 110 \times 5.0 = 550 \text{ W}$$

$$E_{\text{input}} = 550 \times \frac{8.0}{0.32} = 13\,750 \text{ J}$$

uses efficiency equation \checkmark

$$P_{\text{useful to belt}} = 550 \times 0.28 = 150 \text{ W}$$

$$E_{\text{useful}} = 3850 \text{ J, from } 154 \times \frac{8.0}{0.32}, \text{ or } 13\,750 \times 0.28$$

determines power or energy to move one block \checkmark

$$P_{\text{block}} = 22 \text{ or } 23 \text{ W}$$

$$E_{\text{block}} = 560 \text{ or } 580 \text{ J}$$

divides (total) useful power or energy by individual power or energy to give answer of 6 blocks \checkmark

Allow ecf for MP4 only for their (c)

4

[9]