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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Section A

1 (a) (i) \( (a = \frac{\Delta v}{t} \text{ or } 95/0.011) \)
\[ 8.6(3636) \times 10^3 \text{ m/s}^2 \] A1

(ii) \( (F = ma \text{ or } 0.018 \times 8.63 \times 10^3) \)
\[ 150 / 155(0.4545) / 160 \text{ N} \] C1 A1

(b) Line from (0, 0) to (0.011, 95) with decreasing gradient (becomes) horizontal at (0.011, 95) B1 [6]

2 (a) poor absorber/good reflector of (infra-red) radiation (not with poor emitter) less thermal energy absorbed B1

(b) (i) (pressure/it) decreases molecules slow down less frequent/less violent (molecular) collisions with wall B1

(ii) (pressure difference causes) a downward force on lid or pressure outside > pressure inside B1 [6]

3 (a) \( (k.e. = \frac{1}{2}mv^2) \)
\[ \frac{1}{2} \times 4.4 \times 10^4 \times 20^2 \]
\[ 8.8 \times 10^6 \text{ J} \] C1 C1 A1

(b) (i) \( WD = F \times x(\text{or}) \text{ or force } \times \text{ distance (parallel to/in direction of force)} \) B1

(ii) \[ 8.8 \times 10^6 / 40 \text{ or } a = (–)5.0 \text{ (m/s}^2) \text{ or } t = 4.0 \text{ (s) seen} \]
\[ 2.2 \times 10^5 \text{ N} \] C1 A1 [6]

4 (a) (point) C immediately above tip of pivot (and in middle(vertically) of screwdriver (±1 mm)) B1

(b) (i) 0.64 N B1

(ii) arrow W vertically downwards through candidate’s C or pivot B1

(c) no resultant force or upward force = downward force or force left = force right no resultant moment (of force) or clockwise moment = anticlockwise moment B1 [5]

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5 (a) **temperature** at which a liquid becomes a gas B1

(b) (i) molecules close together / touching **or** closer than in gas randomly arranged **or** irregular structure B1

(ii) to separate / increase the distance between molecules work done against (intermolecular) forces **or** supply p.e. **or** break bonds B1 [5]

6 (a) **distance** from (optical) centre to focal point (principal focus) B1

(b) (i) both Fs correctly positioned at ±1 mm B1

(ii) two of: paraxial ray to lens through focal point to image ray through optical centre ray through focal point and then paraxial to image (ign. arrows) X at crossing point of rays M2

A1

(iii) 3.4–3.8 cm B1 [6]

7 (a) at compression: molecules closer together **or** pressure higher **or** vice versa for rarefaction B1

(b) (i) \( v = f \lambda \) **or** in words B1

(ii) larger and because the frequency is lower B1

(c) states one use (e.g. prenatal scanning) B1

basic idea (e.g. ultrasound reflects off foetus) B1 [5]

8 (a) (i) \( I = \frac{V}{R} \) **or** \( 12/(6000 + 2000) \) **or** \( 12/8000 \) **or** \( 12/2000 \) **or** \( 12/6000 \)

\( V = 0.0015 \times 6000 \) 1.5 mA C1

(ii) 9.0 V A1

(b) (reading / it) increases resistance of LDR falls B1

(c) light meter / sensor **or** automatic light switch **or** something sensible B1 [6]
Section B

9 (a) (i) (vector) has direction or scalar does not have direction or (vectors) may cancel or scalars cannot cancel B1

(ii) one vector quantity e.g.: displacement; velocity, acceleration B1 one scalar quantity e.g.: distance, length, speed, time, current, resistance B1 [3]

(b) downward weight arrow of length 3.9–4.1 cm B1 correct triangle/parallelogram drawn and correct diagonal clear B1 270–285 kN B1 horizontal (±3°) B1

(c) (i) from chemical/fuel energy to kinetic (and thermal energy) (not with any intermediate) B1

(ii) air resistance/friction/drag B1
air resistance/friction/drag increases or resultant force decreases B1
acceleration decreases B1
resultant force is zero or (air) resistance/friction equals thrust B1
direction of motion is changing B1
velocity is vector or has a direction B1
(resultant force depends on) changing velocity or resultant force towards centre (of circle) or centripetal force B1 [12]

10 (a) (i) at least two straight parallel lines inside the coil B1
at least two (complete) lines one above the coil and one below the coil B1
third line in middle and evenly spaced and two closed loops B1
(any crossings max. 2/3)

(ii) current (in X) increases B1
magnetic field becomes stronger/changes B1
current/e.m.f./voltage induced in Y/electromagnetic induction B1
opposite deflection B1
larger deflection B1
magnetic field decreasing or quicker (rate of) change B1 [9]

(b) (i) to increase the strength of the magnetic field B1
to direct/concentrate the magnetic field (into the secondary coil) B1

(ii) \( P = IV \) or \( 33000 \times 85 \)
\( 2.8 \times 10^6 \) W or 2800 kW or 2.8 MW C1 A1

(iii) \( E = IVt \) or \( 33000 \times 85 \times 3600 \) or \( 2.8 \times 10^6 \times 3600 \)
\( 1.0/1.01/1.008 \times 10^{10} \) J C1 A1 [6]
11 (a)  
(i) (atoms) 3 and 4  
(ii) (atoms) 3 and 5  
(iii) (atoms) 3 and 4  

(b)  
(i) 17  
(ii) 35  

(c)  
(i) two separate sources: rocks (e.g. radon), outer space (e.g. cosmic rays), man-made sources (e.g. nuclear waste/fallout)  
(ii) 22 counts/minute  
(iii) 27 counts/minute  
(iv) use of $\frac{27}{2}$ or $\frac{27}{4}$ or $\frac{27}{8}$  
from 85 to 90 days (inclusive)  

(d)  
(i) (background count-rate is) reduced not to zero or not stopped or (some) gamma-rays in background count  
(ii) not sensible  
all the beta-radiation would be absorbed or no beta-radiation reaches the detector