Paper 1

1.1 a Kinetic energy = 0.5 × mass × speed^2. Or $\frac{1}{2}mv^2$

b Kinetic energy = 0.5 × mass × speed^2

Kinetic energy = 0.5 × 3 × 10^2

= 150 J or joules

c Kinetic energy = 0.5 × mass × speed^2

Kinetic energy = 0.5 × 8 × 10^2

= 400 J or joules

d $E_k = 0.5 \times m \times v^2$ rearrange to $v = \sqrt{\frac{2 \times E_k}{m}}$

[Accept alternative direct substitution method into original equation then rearrange]

$v = \sqrt{\frac{2 \times 576}{8}} = 12$ m/s

e Speed of dog relative to cat = 12 – 10 = 2 m/s

speed = $\frac{\text{distance}}{\text{time}}$ rearrange to

time = $\frac{\text{distance}}{\text{time}}$

time = $\frac{10}{2} = 5$ seconds

1.2 a Light as a pathway transferring energy by radiation

b Elastic potential

c Vibrational/mechanical

d Chemical

e Kinetic

f Gravitational potential

1.3 Bradley increases his chemical store by eating his breakfast; When he is cycling up the hill he is depleting his chemical store; meanwhile he is increasing his gravitational store; and increasing his kinetic store; At the top of the hill his gravitational store is at a maximum; As he descends his gravitational store decreases and his kinetic store increases (If he is free-wheeling his chemical store remains fairly constant); On hitting his brakes at the bottom, a redistribution takes place from his (and the bike's) kinetic energy store to the thermal store of the brake disk, wheels and other parts where friction takes place.

2.1 a Atoms must be approximately the same size; In liquid diagram spaces cannot be any bigger than actual atoms; In gas diagram at least approximately 75% of box should be empty space;

Solid: ordered, regular close together, vibration around a fixed point.

Liquid: close together, disordered, multidirectional weaker bonds.

Gas: far apart, high speed, random motion.

b Particles/atoms/molecules

c Keep the marbles together in a uniform/ordered/regular pattern, then vibrate them slightly.

d Shake the marbles hard/so some of the marbles fall out of the tray; High speed molecules that evaporate are like the marbles that leave the tray; Only the fastest marbles with the highest energy in the kinetic store will leave the tray.

3.1 $E = m \times c \times \Delta\theta$

$E = 0.25 \times 4200 \times 10$

$E = 10\,500$ J or joules

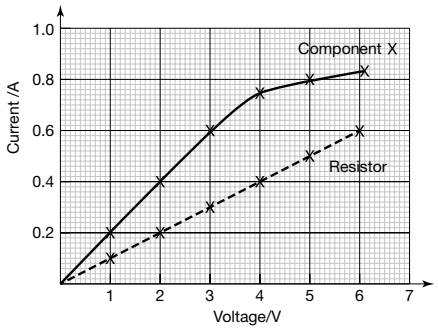
3.2 $E_p = mgh$ rearrange to:

$m = \frac{E_p}{g \times h}$; 6 kJ = 6000 J

m = $\frac{6000}{10 \times 12}$; = 50 kg

4.1 a Correctly labelled axis and units; correctly plotted points

b Resistor straight line with ruler; and filament lamp straight line then curve



c Filament lamp; Device only ohmic within a limited range; Then resistance increases as potential difference (or temperature) increases.

d 10 Ω; evidence of using line of best fit, not single value, to calculate the resistance.

5.1 a $E_p = mgh$

$E_p = 2000 \times 10 \times 90$

$E_p = 1\,800\,000$ J

$E_p = 1800$ kJ

b $E_p = mgh$ and $E_k = \frac{1}{2}mv^2$

All potential energy store converted to kinetic energy of carriage and passengers; [Expressed in words or as equation]

$mgh = 0.5 \times m \times v^2$

$v = \frac{g \times h}{0.5}$

$v = \frac{10 \times 90}{0.5} = 42.4$ m/s

6.1 a An alpha emitter ionises the air and allows a current to flow; It is not very penetrative so smoke prevents the alpha emitter from continuing to ionise the air.

b Radiation is ionising; Tampering with an alpha emitter could lead to irradiation or contamination; If ingested, alpha radiation could be extremely dangerous.

c The time it takes; for the number of nuclei of the isotope to halve. [Accept other correct definition linked to mass/count-rate/activity]

d $1 \rightarrow \frac{1}{2} \rightarrow \frac{1}{4} = 2$ half-lives

e 2 × 433 = 866 years

6.2 a a – 2; b – 1; c – 4; d – 3

b Beta decay

c A helium nucleus

7.1 When an object becomes **charged** it creates an **electric** field; The field **exerts** a **force** on other charged objects placed inside the field; It exerts an **attractive** force on objects with **opposite** charge and; a **repulsive** force on objects with the **same** charge.

8.1 a Beta (radiation)

b Neutron splits; and emits a proton; and an electron.

c It will prevent contamination.

d It will not prevent irradiation; as beta radiation will penetrate gloves (and skin).

e Keep source at arm's length with tongs, then place inside a lead-lined box.

9.1 a Volume = length × breadth × height = 4 × 2 × 3
= 24 cm^3

b density = $\frac{\text{mass}}{\text{volume}} = \frac{192}{24}$; = 8 g/cm^3

c g/cm^3 → kg/m^3 = 8 × 1000; = 8000 kg/m^3

d Side B because it has a smaller area; and area is inversely proportional to pressure.

e Conversion of mass to weight = × 10 N/kg because $W = mg$

Conversion of cm^2 to m^2 ÷ 10 000

Area of face A = 4 × 3 = 12 cm^2

Pressure = $\frac{\text{force}}{\text{area}}$ = $\frac{0.192 \times 10}{\frac{12}{10000}}$ = 1600 Pa

= 1.6 kPa

Paper 2

1 Non-contact forces: gravity; and electrostatic.

Contact forces: friction; and air resistance.

2 a N/kg

b m/s^2

c force

d Nm

3 a Pressure due to a column of liquid (p) = height of column (h) × density of liquid (ρ) × gravitational field strength (g)

or $p = h \times \rho \times g$ (accept words or correct symbols and penalise incorrect use of uppercase letters in symbols)

b Pressure increases with depth or height of column of water; because of $p = h\rho g$; Deeper hole has higher pressure so water is pushed out further.

c i $p = h\rho g$ = 25 × 1027 × 10 = 256 800 or 257 000; Pa (or 257 or 256.8 kPa for 3 marks) (accept N/m^2 for Pa)

ii $p = h\rho g$ rearrange to: $h = \frac{p}{\rho g}$; $\frac{22000}{1027 \times 10}$ = 2.14; m

4 a Triangle area = 0.5 × b × h rectangle area = b × h

triangles:
0.5 × 15 × 40 = 300 m and 0.5 × 20 × 10 = 100 m; (both triangle areas required)

rectangle: 20 × 40 = 800

Total distance = 300 + 100 + 800 = 1200 m

b Acceleration = $\frac{\text{change in velocity}}{\text{time taken}}$

= $\frac{50 - 40}{35 - 15} = \frac{10}{20}$; = 0.5; m/s^2

c Constant speed

d Deceleration/negative acceleration/slowing down

5 a Momentum of bullet: $p = mv$ = 0.020 × 500 = 10; kg m/s (moment undirection → not required)

b Velocity of block and bullet = $\frac{\text{momentum of bullet}}{\text{combined mass}}$;

= $\frac{10}{10 + 0.020}$;

= 0.99 or 1 m/s

c $E_k = \frac{1}{2}$ 0.5 × 10.02 × 1^2;

= 5.01 J or joules

d All E_k is conserved and transferred to gravitational store of block so: $E_k = E_p$

mgh = 5.01 J; necessary to rearrange to $h = \frac{5.01}{m \times g}$

$h = \frac{5.01}{m \times g} = \frac{5.01}{10.02 \times 10}$ = 0.05 m (accept 5 cm or 50 mm)

6 $p = m \times v$ = 1000 × 20
= 20 000 kg m/s

Change in momentum = force × time, rearrange to:

force = $\frac{\text{change in momentum}}{\text{time}}$

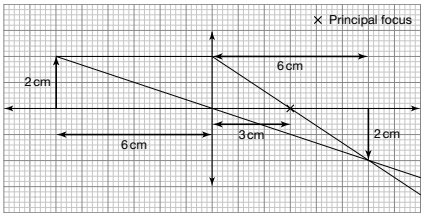
= $\frac{20000}{0.05}$ = 400 000 N

7 a The transducer sends a pulse; and is able to detect the reflected pulse; The pulse is partially reflected from the different tissue boundaries in its path; The different pulses reflected arrive back (to the transducer) at different times; The transducer is moved across the body; and the pulses detected by the transducer can be used to form images of the internal tissue of the foetus.

b X-rays are ionising and; therefore may be harmful to a developing foetus; Ultrasound has no harmful effects; Ultrasound is reflected from different boundaries allowing images of organs and other soft tissues to be formed.

8 The speed of the light wave is reduced in the block; The light wave is refracted; The wavelength is also decreased inside the block; The light ray bends towards the normal.

9 a Horizontal line from object to lens; line from top of object through centre of lens to intersection point; line from top of lens passing through focal point; intersection of at least two lines; image drawn with arrow (allow the construction lines through focal point on object side and parallel line to principal axis as alternative to mark points 1 and 2)



b Convex

c Real

d × 1

magnification = $\frac{\text{image height}}{\text{object height}}$

= $\frac{2.0}{2.0}$ = × 1 ±10%

(accept stated as words: image is neither enlarged or diminished but same size as object)

10 Place magnet on a large piece of paper (A3); Draw around magnet with a pencil (so it doesn't move during the experiment); Place the compass near the magnet and draw a dot in front of arrow point; Move compass so tail of compass is over the dot and draw a new dot; Continue to move the compass so that in each position it aligns itself with the magnetic field of the magnet; At the end, join the lines and remember to include the arrows showing direction north to south.

11 a Clockwise

b Clockwise

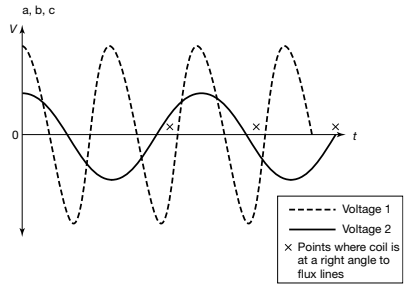
c No the motors will not all rotate at the same speed; B will rotate faster than A and C; B has more cells, so there will be a greater current in the coil (than A and D) so a greater force.

d Stronger magnet; or increase number of turns.

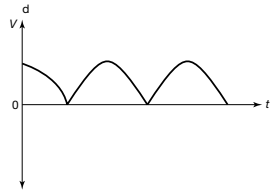
12 a A cosine wave form (accept starting at positive or negative max value); graph marked when voltage is zero; at least 2 points labelled.

b Trace is twice the amplitude as potential difference 1; Trace is twice the frequency of potential difference 1.

c dc wave form with negative part of sinusoidal trace inverted.



d Split-ring commutator = dc; slip rings = ac.



e The output of the split-ring commutator is dc, whereas the output of the slip rings is ac.

13 a Gravity; and outward force of fusion energy.

b Red giant stage; hydrogen fuel is used up; Outer layers expand and start to cool and become red.

c Larger (mass) stars burn hotter to balance greater gravitational force; so run out of fuel faster than the Sun; When fuel runs out it expands and instead of becoming a red giant it becomes a red super giant; For both large (mass) and very large (mass) stars the next stage is a supernova. This is where the outer layers are blown off in an 'explosion'; For a large star the supernova core collapses to a neutron star; A neutron star is very, very dense and although small has a huge gravitational field; For a very, very large star the supernova core continues to collapse until a black hole is formed; A black hole is a tiny point with a huge gravitational field and the pull is so great not even light can escape.