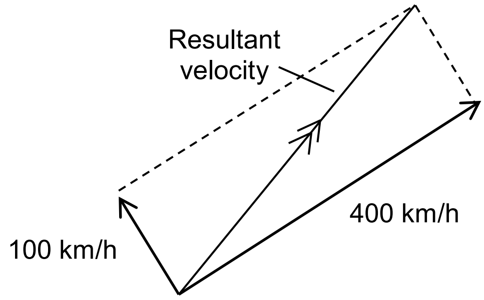
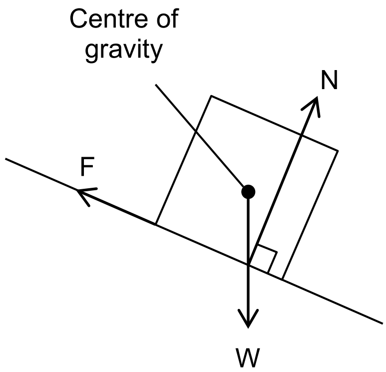
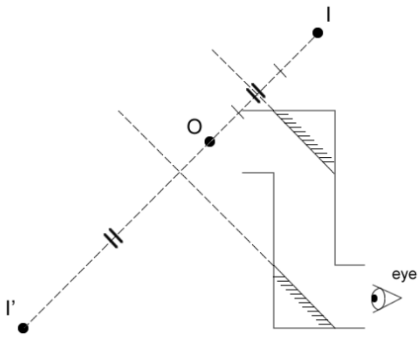
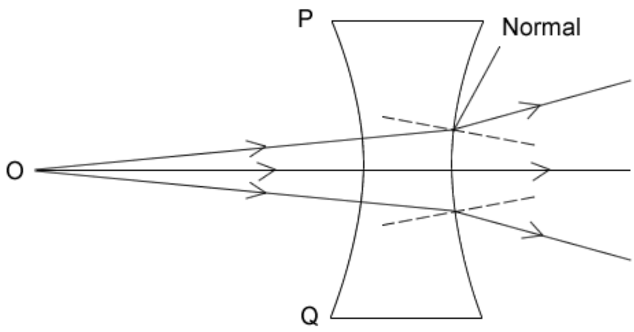
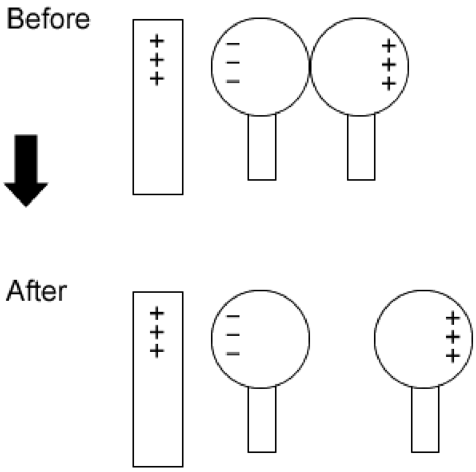
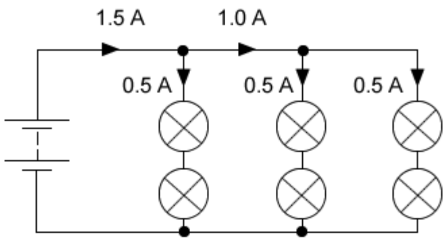
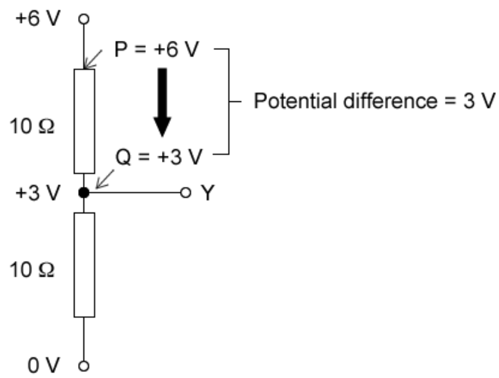
#	Ans	Workings / Remarks
1	A	The positive zero error is +0.03 mm. The reading is 1.84 mm. Thus, final reading = 1.84 – (+0.03) = 1.81 mm
2	A	We can use parallelogram of forces to determine the final resultant velocity. 
3	A	Average speed = $\frac{\text{total distance}}{\text{total time}}$ Total distance can be calculated by finding out the area under the graph, while the total time can be read from the graph.
4	B	Since there is no air resistance in vacuum, thus, the only force that is acting on the object is gravitational force. Thus, using F = ma, the acceleration is constant. When the acceleration is constant, the velocity is increasing at the constant rate.
5	C	The weight of the block acts downwards from the centre of gravity of the block, with the normal reaction force acting perpendicular to the surface. Frictional force will be acting in such a way to prevent the block from sliding down the slope. 
6	B	Weight = mass × gravitational acceleration $W = 3.2 \times 10^6 \times 10 = 3.2 \times 10^7$ N. Resultant force = upward force – weight $\Rightarrow 3.4 \times 10^7 - 3.2 \times 10^6 = 0.2 \times 10^7$ N. Using force = mass × acceleration, $a = (0.2 \times 10^7) / (3.2 \times 10^6) = 0.625$ m/s^2

7	B	Let a single division of the rule to be 1 unit. Taking moments about the pivot, the 3 weights 3 units away from the pivot will generate an **anticlockwise** moment = 3 weights × 3 units = 9 weight-unit The 2 weights 4 units away from the pivot will generate a **clockwise** moment = 2 weights × 4 units = 8 weight-unit To balance the see-saw, we need an additional 1 weight-unit of **clockwise** moment to make total anticlockwise moment = total clockwise moment Thus, the weight must be placed one unit to the right of the pivot to generate this additional clockwise moment so that the resultant moment is zero.
8	A	The only force acting on the lamina is its own weight. The moment the weight of the lamina generates will be a clockwise moment about the pivot P i.e. moment about P = 2.0 × QC = 2.0 × 0.3 = 0.6 Nm
9	B	Fact: As long as the question did not mention any loss of mass, the mass will always be constant.
10	C	Density = $\frac{\text{mass}}{\text{volume}}$ Mass = density × volume = 10 × [(5 × 4 × 10) – (2 × 3 × 10)] = 1400 g
11	A	Pressure = $\frac{\text{Force}}{\text{Contact surface area}}$ Force exerted on block by table = reaction force of the table on the block = weight of small block (Q) by Newton's 3rd law Contact surface area = X Hence pressure exerted on block by the table = $\frac{Q}{X}$
12	D	Total pressure = **atmospheric pressur**e + pressure due to the water = 100000 + hρg = 100000 + (8 × 1000 × 10) = 180000 Pa
13	D	Using the conversation of energy, Kinetic energy at bottom of hill = gravitational potential energy at height of 2.0 m + kinetic energy at height of 2.0 m Thus, kinetic energy = 0.5 × 0.4 × 3 × 3 + 0.4 × 2 × 10 = 9.8 J
14	B	Using formula Power = $\frac{\text{Work Done}}{\text{Time}}$ Assuming the vertical height of the stairs to be x, Power developed by Student A = $\frac{300x}{10} = 30x$ Power developed by Student B = $\frac{390x}{12} = 32.5x$ Power developed by Student C = $\frac{420x}{15} = 28x$ Power developed by Student D = $\frac{490x}{16} = 30.625x$ Thus, student B generates the most power.

15	B	Pressure has inverse relationship with the volume i.e. $p \propto \frac{1}{V}$. Hence when the volume increases, the pressure of the gas will decrease (frequency of collisions of gas molecules with the piston wall reduced due to larger volume of space). Internal energy is a function of temperature. **Given in the question** that internal energy is unchanged, the temperature does not change. In this case, gas molecules move with the same speed and kinetic energy even as volume is increased slowly, with the metal piston (being a good conductor of heat) conducting any excess heat away to the surroundings.
16	B	What we can see is the reflection of light due to the smoke particles. Smoke particles will move randomly due to the collision with the continual random motion of the fast-moving "invisible" air molecules (Brownian motion).
17	D	As the heat is conducted along the metal, the electrons will flow and molecular vibration will occur. The molecules vibrate more vigorously at the hot end compared to the end with the wax attached so the temperature will be lower at the end with the wax attached compared to the end that is placed in boiling water. The temperature at *d* will be higher than the room temperature since the question mentioned that the wax has started to melt.
18	B	A thermocouple thermometer is made up of 2 different metals (Options A and C out). Voltmeter will record a reading when there is a difference in temperature between the cold and the hot junction. (Option D out).
19	C	Using the formula, heat = $mc\Delta T$, we can find the change in the temperature. $\Delta T = \frac{2000}{1.1 \times 75}$ °C
20	A	Student needs to be careful when observing the axes. The horizontal axis in the question represents **time** and not distance. Thus, the P will be amplitude which is the maximum displacement of the vibration from the rest point. Q is the period which is the time taken to produce one complete wave form.
21	A	The frequency of the wave (f) does not change even after refraction has occurred. By using that fact, we can use the formula, $v = f\lambda$ $f = \frac{v_1}{\lambda_1} = \frac{0.2}{3}$ $v_2 = f\lambda_2 = \frac{0.2}{3} \times 1.5 = 0.1$ m/s
22	D	The object O undergoes double reflection due the presence of the two mirrors. An image I will be formed behind the plane of the top mirror which in turn will form the final image I' behind the plane of the bottom mirror. Hence the final image will appear to be "farther" into the bottom mirror due to this double reflection. 

23	B	Since the angle of incidence is smaller than the critical angle, there will not be total internal reflection (Option C is out). Since the angle of incidence is not equal to the critical angle, there will not be refraction along the boundary (Option A is out). However, as refraction will always be accompanied by reflection, there will not be 100% refraction out of the glass and there will always be a small amount of light reflected back into the glass block.
24	C	As the rays originate from the centre of the circle which the curved surface PQ is part of, the incident rays should NOT refract at PQ since they are travelling along the normal of PQ (Options A and D are out).  As light ray B is travelling along the normal of both surfaces, it should not refract when it exits the lens (Option B is out). Light ray C correctly refract away from the normal as it exits from the lens (optically denser medium) to air (optically less dense medium).
25	B	Uses of electromagnetic waves.
26	C	Wavelength of the sound wave is measured from the centre of one compression to the next centre of another compression or from the centre of one rarefaction to the next centre of another rarefaction. C is the only option that gives the distance from centre of one compression to the next centre of compression.
27	B	The strength of the magnetic field is determined by the closeness of the magnetic field lines. Thus, M will have the strongest magnetic field since the lines are the closest to each other here.
28	D	Due to the electrostatic forces of repulsion and attraction, X will have the net negative charges and Y will have the net positive charges.  The size of the charges are the same since initially, X and Y are neutral (total number of the positive and negative charges are the same)

29	D	To measure current through the diode, ammeter must be connected in series with the diode. To measure potential difference across the diode, voltmeter must be connected in parallel directly across both ends of the diode. Thus the only correct diagram is D.
30	A	Since a diode only allows current to flow in one direction, it is used to convert an AC into DC.
31	A	Since there are two identical lamps in each branch, the current will be split equally into three similar parallel paths in the circuit, with 0.5 A flowing in each path.  So ammeter B, C and D will each read 0.5 A. Ammeter A will read 1.0 A since the combined current of two paths flows through it.
32	D	When another resistor is connected in **parallel** to the 2Ω resistor, the overall resistance of the circuit will be slightly smaller i.e. $\frac{1}{R}=\frac{1}{2000}+\frac{1}{2}=\frac{1001}{2000}\Rightarrow R\approx 1.998\ \Omega$ Thus, the current will be slightly larger than the value of 3 A since current has an inverse relation with the resistance by Ohm's Law.
33	B	Potential at P = 6 V Potential at Q = Potential at Y = $\frac{10}{10+10}\times 6$ V = 3 V When S is at P, potential **difference** between X and Y = potential at P - potential at Y = 6 V - 3 V = 3 V When S is at Q, potential **difference** between X and Y = potential at Q - potential at Y = 3 V - 3 V = 0 V So as S moves from P to Q, the potential *difference* between X and Y decreases from a maximum of 3 V to a minimum of 0 V. 

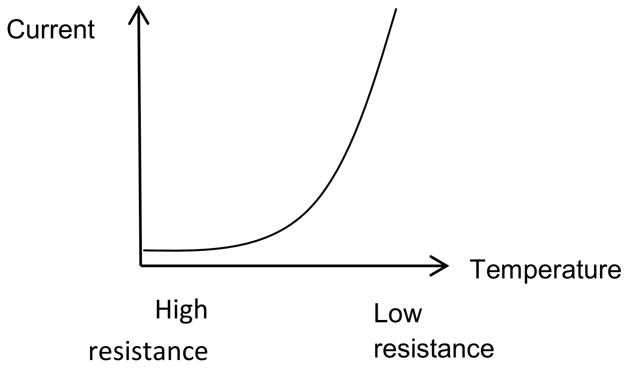
34 **A**

A thermistor is a transducer that is dependent on temperature.

By Ohms Law, the current (I) flowing through the thermistor will increase as its resistance (R) gets smaller.

At low temperatures (T) when its resistance is relatively high, a small decrease in R will result in a moderate increase in I (moderate gradient of I-T graph). At high temperatures when R approaches very low values, a small decrease in R will result in a very large change in I (large gradient of I-T graph).

Hence the shape of the current-temperature (I-T) graph is similar to the I-V graph of a thermistor, which is consistent with Ohm's Law since $I \propto V$.



Note: A thermistor operating with a very low resistance at high temperatures beyond its recommended range could be damaged by the large current flowing through it. This is often prevented by connecting another resistor in series with it to limit the maximum current that flows through.

35 **C**

Using formula P = VI,

Current flowing through the 6 W lamp = $\frac{6}{24}$ A

Current flowing through the 12 W lamp = $\frac{12}{24}$ A

The total current will be the sum of the current flows in both paths.

$$\text{Total current} = \frac{6}{24} + \frac{12}{24} = 0.75 \text{ A}$$

36 **D**

Rate of electrical energy transformed corresponds to the power, $P = I^2 R$.

So from the formula, the circuit with the smallest effective resistance will draw the largest current which leads to the greatest power dissipated.

37 **B**

Using Maxwell's right hand grip rule, when the current flows into the page, the circular magnetic field around each wire is clockwise.

38 **C**

By Lenz's Law, the induced current in the coil is always such that its magnetic effect opposes the motion producing it.

When the N pole of the magnet moves towards the top of the coil, a N pole is created at the top of the coil to oppose this. So,

N pole at **top** of coil ⇔ ammeter needle moves quickly to the right

When the S pole of the magnet falls away from the bottom of the coil (after falling through the coil), a N pole is created at the bottom of the coil to "try to pull back" (oppose) the leaving S pole. So,

N pole at **bottom** of coil ⇔ ammeter needle moves quickly to the left

When the magnet has fallen farther away till its magnetic lines of force are out of reach of the coil ⇒ no induced emf generated ⇒ Needle will return to zero

39	D	Component X of the **a.c. generator** is a slip ring. Note that it is a full circular ring compared to the split-ring commutator of the d.c. motor.
40	A	$\frac{N\ secondary}{N\ primary} = \frac{V\ secondary}{V\ primary}$ $V_{secondary} = \frac{50}{200} \times 240 = 60\ V$ Using formula $I = \frac{V}{R}$ $I_{secondary} = \frac{60}{20} = 3\ A$ Using formula $I_sV_s = I_pV_p$, $I_{primary} = \frac{3 \times 60}{240} = 0.75\ A$