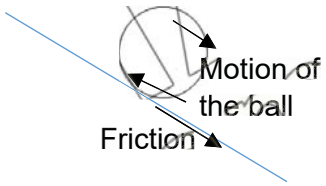
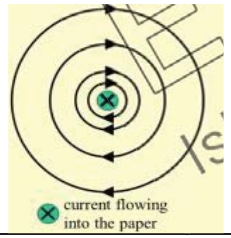
No	Answer	Remark
1	A	Diameter of the Earth : 1.2×10^{7} m Diameter of atom : 1×10^{-10} m Length of bus: 1×10^{1} m Thickness of hair: 1×10^{-4} m
2	B	Average speed = total distance / total time = 36 / 18 = 2 m/s Average velocity = total displacement / total time = 12 / 18 = 0.67 m/s
3	D	Without the effect of air resistance, objects that are dropped from a height will experience free-fall, meaning that the only force acting on it is its weight. Hence, both objects will experience the same acceleration due to gravity.
4	C	Sum of moments about axle are equal: 50 N x 0.20 = Force on master cylinder x 0.04 Force on master cylinder = 250 N Pressure on master cylinder, P_m = F/A = 250 / 5 = 50 N cm^{-2} $P_w = P_m$ = 50 N cm^{-2}
5	D	Since the ball rolls down the slope, the motion of the ball at the point of contact between the ball and slope is upwards. Hence, friction is downwards. 
6	B	As all the glasses are filled with water, the CG of glass B will be higher. The CG of glasses A, C, D will be lower than that of B.
7	D	Both X and Y are turning points in the motion of the mass M. Hence, the speed of the mass at these points is minimum, leading it to have maximum gravitational potential energy at X and maximum elastic potential energy at Y.
8	A	As a gas in a sealed container is heated, the average kinetic energy of the molecules increases as the temperature increases too. Thus, the number of collisions of the gas on the walls of the container increases and the average force exerted by the molecules on the walls increases as well. However, the gas does not expand as it is in the a sealed container and thus, the average distance does not increase.
9	A	Radiation is minimised through changes in surface area, colour and texture. Hence, using a double walled glass container does not minimize radiation but instead conduction (since glass is a thermal insulator).
10	B	Ice melts at 0 ^{o}C.

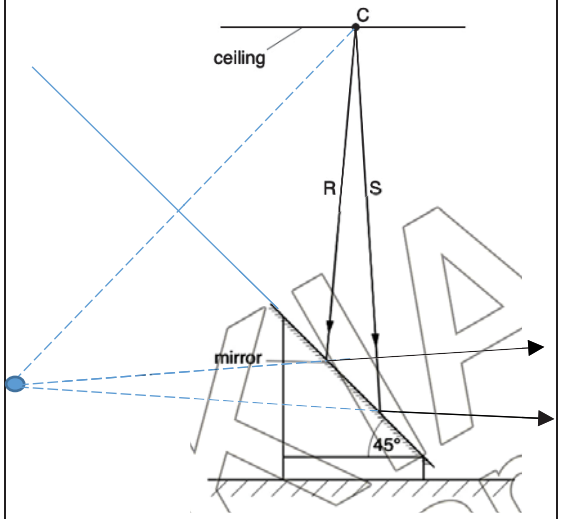
11	A	As the wave moves away, the distance between the wavefronts is increasing. This indicates an increase in wavelength. Since v = fλ, the speed is increasing.
12	A	Given that the light ray enters a glass block, the incident angle, i, is always larger than refracted angle, r (light ray will bend towards the normal). Hence, we know that the value of sin i should be larger than the value of sin r. Additionally, we know that the gradient of sin i – sin r graph should be positive due to our knowledge of refractive index: n = sin i / sin r .
13	C	The image is formed at the intersection of the two rays. To ensure the image on the screen is focused, the intersection of the rays should occur at the screen. Using a shorter focal length would make the rays bend more and the image will be formed closer to the lens. Moving screen away will make the image more blurry. Moving object closer to the lens will cause the intersection of the rays to occur further away from the lens. Changing the brightness of the object will not improve the focus of the image.
14	D	R – ultraviolet rays. S – Xrays.
15	C	Wavelength (distance between successive compressions/rarefactions) = 12/2 = 6 m v = fλ 300 = f (6) f = 50.0 Hz
16	B	The question states that the drum is positive. If the toner is attracted to the drum, it is negatively charged as unlike charges attract. Similarly, for the toner to be attracted to paper, it must be positively charges as unlike charges attract.
17	C	Current in A is the largest as it is the only resistor in series. In the parallel branch of B and C, more current flows through B as it has a lower resistance than C. As for the parallel branch of D, both resistors will have the same current (half of current in A) as they have the same resistance. Hence, C has the least current.
18	D	Resistance wire with length 2L has twice the resistance of X. However, since in parallel with X, total resistance in the circuit will drop. Hence, the current in the circuit will increase. Since X is parallel with the new resistor, the p.d. across both wires are still the same.
19	B	Water heater: 3 kW x 0.5 h = 1.5 kWh Hot plate: 1.5 kW x 2.0 h = 3.0 kWh Iron: 0.75 kW x 3.0 h = 2.25 kWh Lamp: 0.1 kW x 15.0 h = 1.5 kWh
20	C	The direction of the current is into the paper. To find the magnetic field, use the right hand grip to find that the direction of the magnetic field: 

Paper 2

No	Answer	Mark	Remarks
1a	External diameter = 3.47 cm Internal diameter = 3.16 cm Thickness = (3.47 – 3.16) / 2 = 0.155 cm	1 1	
1b	More measurements can be taken from different locations on the pipe to find an average thickness.	1	

2ai	The object slows from 9 m/s to 0 m/s at a uniform rate of 9 m/s^2 as it goes up the ramp.	1	
aii	The object stops momentarily before it increases its velocity from rest to 3 m/s in the opposite direction at a constant rate of 1 m/s^2.	1	
b	Distance travelled = area under the graph = ½ x 9 x 1 = 4.5 m	1 1	
3	The diver falls at constant speed between 4 s to 6 s. This is because the force from the air resistance is the same as the total combined weight of the diver and his load. Since the forces are balanced, the resultant force is zero.	1 1	
4a	Mass = density x volume = 7800 x (0.4x 2 x 1.2) = 7488 kg = 7490 kg	 1 1	
4b	Pressure = F / A = 74880 / (1.2 x 0.4) = 156000 Pa	 1 1	
4c	1 cm : 10 kN (or appropriate scale)	1	

	Labelled forces, arrows Correct Diagram Tension = 10 cm x 10kN = 100 kN (95 kN – 105 kN)	1 1 1	
5a	Adding wood P has lowered and changed the location of the centre of gravity of the door such that it is on the left of the hinge. The line of action of the weight through the new cg causes an anticlockwise moment about the hinge, which prevents the door from opening.	1 1	
5b	Moment = F x d = 35 x 0.08 = 2.8 Nm	 1 1	
6ai	Glass traps the heat from the sunlight much like a greenhouse effect.	1	
6aii	The water pipe is insulated to prevent heat loss.	1	
6aiii	Spiral features are to increase the surface area of the pipe.	1	

	Black is a good emitter of heat Copper is a good conductor of heat.	1 1	
7ai	At t = 0 s, P is at a distance of 1.25 m. It then is displacement in the positive direction until a maximum of 2 m before displacement in the negative displacement until a maximum of – 2 m. It then returns to the original position.	1 1	
7aii	Period = 0.6/2 = 0.3 s Speed = 1.0/0.3 = 3.33 m/s	 1 1	
7b	 Rays R and S (with arrow, correct angle) Position of image perpendicular to mirror extension, labelled.	 1 1 1	

8a	When S1 closed: V = IR 12 = I (8) I = 1.5 A	 1 1	
8b	When both are closed: V = IR 12 = (0.8) R R = 15 Ω	 1 1	
8c	No change to brightness. Since S2 is parallel, the PD across the light bulb does not change regardless whether the switch S2 is open or closed.	1 1	
9ai	The switch should be on the live instead of the neutral wire.	1	
9aii	The fuse will melt and break the circuit to protect the circuitry from damage when excessive current that exceeds the fuse rating flows through it.	1	
9aiii	The switch and fuse should be placed on the live wire so that the appliances will be disconnected from high potential when the switch is off or when the fuse is blown.	1	
9bi	AB will move to the right. There will be a resultant force that acts on AB as it is a current carrying conductor in a magnetic field.	1 1	
9bii	AB moves to the right with greater force/speed	1	
10 ai	Negative charges clustered on the top of the tree, positive charges at the bottom half.	1	
aii	The positive charges at the bottom of the cloud induces a negative charge at the top of the tree as unlike charges attract. The charges build up until there is a discharge from the tree to the cloud.	1 1	

aiii	Current = Charge / Time = 620 / (2.5 x 10^{-4}) = 2.48 x 10^{6} A	1 1	
bi	Field direction from + to – Parallel lines	1 1	
bii	Electric field is a region in which a charge experiences a force.	1	
biii	Negatively charge It moves downward towards the positively charged plate as unlike charges attract.	1 1	
11a	Ultrasound waves are waves that have a high frequency beyond the normal hearing range of 20kHz.	1	
11b	The pulse from the ship causes adjacent water molecules to vibrate. This allows the sound energy to travel through the water in a series of compressions and rarefactions as a longitudinal wave.	1 1	
11c	Q is the deepest The time taken for the echo to return from Q is the longest.	1 1	
11d	Speed = 2d/t 1500 = 2d / (750 x 10^{-3}) D = 562.5 m	1 1	
11e	v = f λ 1500 = 45000 x λ λ = 0.0333 m	1 1	
11f	Amplitude labelled at 5 m Period labelled at 1 s	1	
12ai	When running, kinetic energy to gravitational potential energy and kinetic energy	1	

aii	Kinetic energy to elastic potential energy and gravitational potential energy	1	
bi	Change in GPE = Change in KE $Mgh = ½ mv^2$ $v^2 = 2gh$ $= 2 \times 10 \times 6.1$ $= 122$ $v = 11.0$ m/s	1 1	
bii	Output power = total energy/time = mgh/time = 70 x 10 x 6.1 / 5.4 = 790.7 W = 791	1 1	
biii	KE of athlete = 70 x 10 x (6.1 – 1.5) = 3220 J Work done to stop athlete = 3220 F x d = 3220 F = 6440 N	1 1	
biv	Higher. Work is also done to overcome air resistance.	1 1	