Paper 1

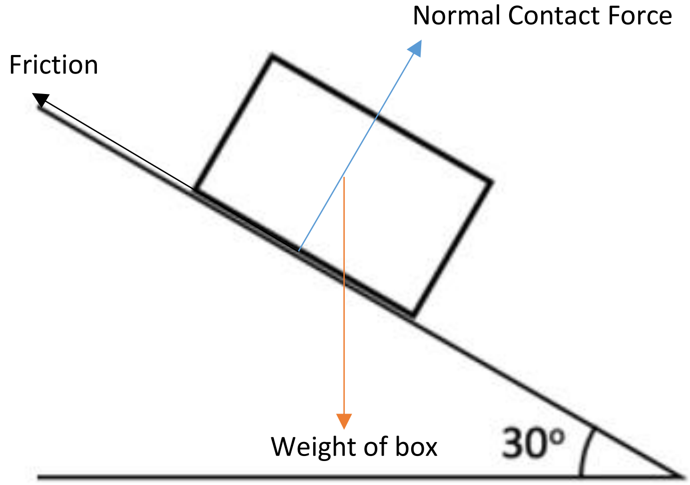
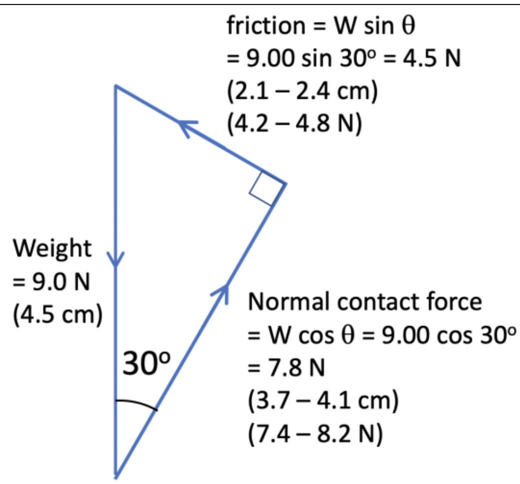
1	2	3	4	5	6	7	8	9	10
C	A	C	B	C	D	A	B	D	D

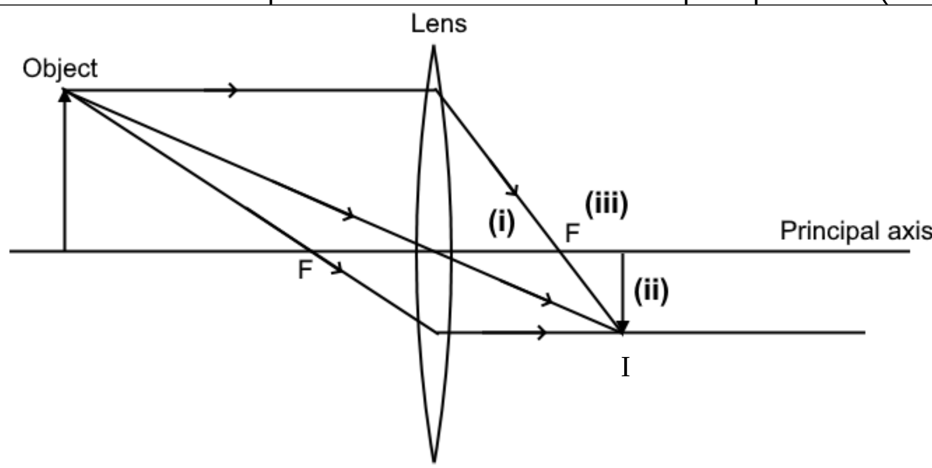
11	12	13	14	15	16	17	18	19	20
A	C	B	D	D	B	C	A	A	C

21	22	23	24	25	26	27	28	29	30
D	D	A	D	A	A	D	B	A	A

31	32	33	34	35	36	37	38	39	40
D	B	D	B	C	C	B	C	D	B

Section A

1	(a)	 	[1]
	(a)	W = mg = (0.900 kg)(10 N/kg) = 9.00 N (3sf) or 9.0 N (2sf)	[1]
	(b)	 1m – appropriate scale (1.0 cm to 2.0 N) 1m – correct vector diagram (right angle triangle, direction of arrows) 1m – correct magnitude of friction force Allow for e.c.f. from (a)	[1] [1] [1]
	(c)	Newton's first law. Forces are balanced. Resultant force of friction, weight and normal contact force = 0 N. (Any one)	[1]
2	(a)	moment by brake pad = moment by master piston (220)(32) = (F)(8) F = 880 N	[1] [1]

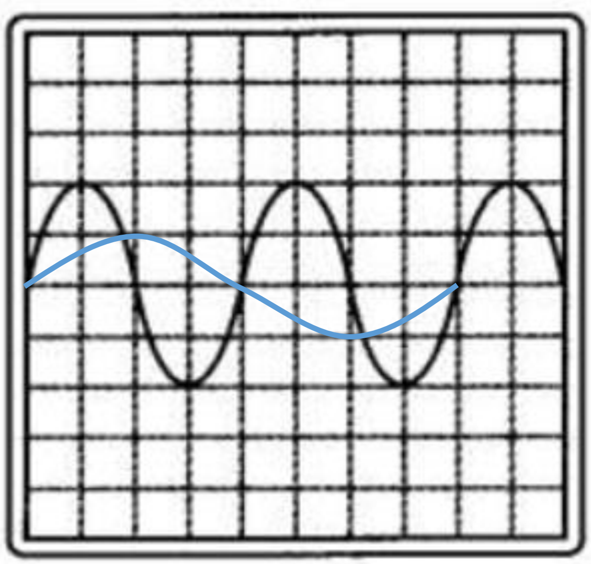
	(b)	$P_{master\ piston} = P_{slave\ piston}$ $F_1/A_1 = F_2/A_2$ $880 / 1.5 = F_2/5.0$ $F_2 = 2930$ N or 2900 N (allow for e.c.f.)	 [1] [1]
3	(a)	The product of force applied and distance moved in the direction of the force	[1]
	(b)	KE = ½ x m x v^2 = 0.5 x 0.20 x 20^2 = 40 J	[1] [1]
	(c)	G.P.E at max height = m x g x h = 0.200 x 10 x 12 = 24 J (2sf)	[1] [1]
	(d)	At max height, KE remaining = 40 J – 24 J = 16 J (allow for e.c.f.) 0.5 x 0.200 x v^2 = 16 v = 12.6 m / s or 13 m / s	[1] [1]
4	(a)	The focal length is the **distance along the principal axis**, between the **principal focus and the optical centre** of the lens. OR Distance between the optical centre of the lens and the principal focus (focal point).	 [1]
	(b)	 Accept either position of principal focus of **(iii)** Rays and arrowheads should be in solid lines	[1] [1] [1]
	(c)(i)	60.0 cm	[1]
	(ii)	2f = 60.0 cm f = 30.0 cm	 [1]
	(iii)	1. Virtual 2. Upright 3. Magnified	 [1]
5	(a)	Negatively charged	[1]
	(b)	The negative charges will be transferred from rod Y to sphere B.	[1]

		The negative charges are attracted by positively charged rod X as unlike charges attract.	[1]
		Hence, there is more negative charges than positive charges in sphere B upon removal of the rods. (Sphere B has a net negative charge)	[1]
	(c)	Sphere A will become positively charged (and B is negatively charged).	[1]
		They will attract each other.	[1]
		Since unlike charges attract.	[1]
6	(a)(i)	I = V/R = 4.8 / 32 = 0.15 A	[1] [1]
	(ii)	Q = I(t) = (0.15)(25) = 3.75 C or 3.8 C (allow for e.c.f.)	[1] [1]
	(iii)	Pd across parallel branch = 6.0 – 4.8 V = 1.2 V R = V/I = 1.2 / 0.15 = 8.0 Ω Alternative method: Potential Divider method [32 / (32 + R)] x 6.0 = 4.8 (32 + R) / 32 = 6.0 / 4.8 R = 8.0 Ω	[1] [1]
	(iv)	Method 1 ($1/R_1 + 1/R_2 = 1/R_{total}$) 1/R + 1/24 = 1/8 R = 12 Ω allow for e.c.f. Method 2 Current flowing through Y = 1.2 / 24 = 0.050 A Current flowing through X = 0.15 – 0.050 = 0.10 A R = V/I = 1.2 / 0.10 = 12 Ω	 [1] [1] [1] [1]
	b	Overall resistance of circuit decreases, so overall current (I) increases. Voltmeter reading will increase since <u>pd across Z increases</u> (or V = RI). Alternative Answer Overall resistance of parallel branch decreases. Pd across Z will increase since Z will receive a larger proportion of the e.m.f and voltmeter reading increases. (Potential Divider)	[1] [1] [1] [1]
7	(a)	Either AB – Downward arrow Or CB – Upward arrow	[1]
	(b)	Current flows from A to B. By **Fleming's Left Hand rule**, the induced force which is perpendicular to the magnetic field and current will be **downwards**. For side, CD, current flows from C to D and the force will be **upwards**. The coil rotates in an **anticlockwise** direction.	[1] [1] [1]
	(c)	The **coil is horizontal**.	[1]

		That is when the **perpendicular distance from the centre of rotation to the line of action of the force** is **maximum**.	[1]
8	(a)	Iron is easily **magnetised and demagnetised** (or **soft magnetic material**) whereas steel **does not magnetise or demagnetise easily (**or **hard magnetic material)**. This ensures **better magnetic flux linkage** between the 2 coils if iron is used instead of steel. Any other plausible answer.	[1] [1]
	(b)	**Reduce energy loss** during transmission Since **heat loss is $P = I^2R$**, the **lower the current, the lower the energy loss** during transmission.	[1] [1]

Section B

9	(a)	Water is used as a coolant because of its very **high specific heat capacity**. It can **take in a large amount of thermal energy** with only a **small rise in its temperature**.	[1] [1]
	(b)(i)	Thermal energy required to be removed as claimed $= (0.8 \times 5.0 \text{ X } 10^7) \times 80\%$ $= 3.2 \times 10^7$ J	[1]
	(ii)	Actual amount of thermal energy removed $Q = mc\Delta\theta$ $= (0.22 \times 4 \times 60)(4200)(80-30)$ $= 1.1088 \times 10^7$ J $= 1.1 \times 10^7$ J	[1]
	(iii)	Some thermal energy is **lost to the surroundings**, apart from it being absorbed by the cooling water.	[1]
	(c)	**Metal** pipes are used as they are **good conductors** of heat and allows heat to be **conducted faster away** from the <u>hot water to the external wall</u> of the pipe. The metal pipes being coloured in **black** are **good emitters of radiation** and therefore **radiates heat to the surrounding air at a higher rate**. Using **narrow** pipes **increase the surface area** to facilitate a **higher rate of emission of heat** to the surrounding air.	[1] [1] [1]
	(d)	Energy absorbed by air = 1.1088×10^7 J (allow for e.c.f.) $(1.25 \times 4 \times 60)(760)(\theta - 20) = 1.1088 \times 10^7$ J $\theta = 68.6\ ^oC$ $= 69\ ^oC$ ($68.6\ ^oC$ also accepted)	[1] [1]
10	(a)(i)	As the coil moves away, there is a **changing magnetic field experienced by it**. Or	[1]

		There is a **changing magnetic flux linkage** between the magnet and the solenoid. According to **Faraday's Law**, there is an **induced emf** in a closed circuit, hence there is a flow of an induced current.	[1]
	(ii)	North-pole	[1]
	(iii)	Deflect right; According to Lenz's Law**, the direction of the induced e.m.f. opposes the change producing it.** Hence, the induced current flows in opposite direction as compared with the original motion.	[1] [1]
	(b)(i)	4.0 V ; T = 0.04 s f = 1 / 0.04 = 25 Hz	[1] [1] [1]
	(ii)	**Vertical line** across **4 divisions**	[1]
	(iii)	1 division above and 1 division below the x-axis 8 divisions along the x-axis 	[1]
11E	(a)	(i) microwaves (satellite communication) (ii) radio waves (television broadcast) (iii) visible light (optic fibre communication)	[1]
	(b)	n = $\frac{c}{v}$ 1.5 = $\frac{3.0 \times 10^8\ m/s}{v}$ v = 2.0 x 10^8 m/s	[1] [1]

	(c)	Signal with least time = (ii) radio communication time = $\frac{distance}{speed}$ Time taken for (i) satellite communication = $\frac{2 \times 35\ 000\ 000\ m}{3.0 \times 10^8\ m/s}$ = 0.23 s (2sf) Time taken for (ii) radio communication = $\frac{3\ 000\ 000\ m}{3.0 \times 10^8\ m/s}$ = 0.010 s (2sf) Time taken for (iii) optic fibre = $\frac{3\ 000\ 000\ m}{2.0 \times 10^8\ m/s}$ = 0.015 s (2sf)	[1] [1]
	(d)	Signal / wave / light experiences **total internal reflection**. Angle of incidence is **greater than critical angle**. Light is traveling **from optically denser medium** (glass) to optically less dense medium (air).	[1] [1] [1]
	(e)	(i) Sound waves **cannot be transmitted in vacuum**. Sound waves require a medium for propagation. (ii) speed of sound in air = 330 m/s. This **much slower speed** of sound would mean a **very long time** between transmitting the signal and receiving the signal. (time = $\frac{3\ 000\ 000\ m}{330\ \ m/s}$ = 9090 s = 2.5 hours)	[1] [1]
11 O	(a)(i)	The imaginary line drawn by joining all adjacent points of a wave that are on the same phase.	[1]
	(a)(i)	T = 2 x 0.80 s = 1.60 s f = 1/T = 1/1.60 = 0.625 Hz	[1] [1]
	(a)(iii)	wavelength = 2.0 m speed = 2.0 x 0.625 = 1.25 m / s or 1.3 m / s (allow for e.c.f.)	[1] [1]
	(a)(iv)	Arrows correctly drawn A – up, B - down	[1]
	(b)(i)	Echo smaller in amplitude – some energy absorbed by the surrounding Echo may be diffused – the seabed may be uneven.	[1] [1]
	(ii)	2 x d = 1450 x 0.150 d = 109 m (2 or 3 sf)	[1] [1]