2024 BSS 6091 S4E Physics Preliminary Examination Mark Scheme

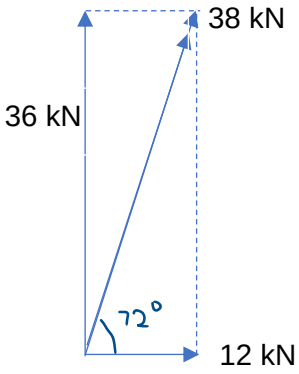
Paper 1

'BCCCA' 'ADABC' 'DACDB' 'DBCBB' 'ABCAB' "BCCCB' 'DBDCC' 'DCAAC'

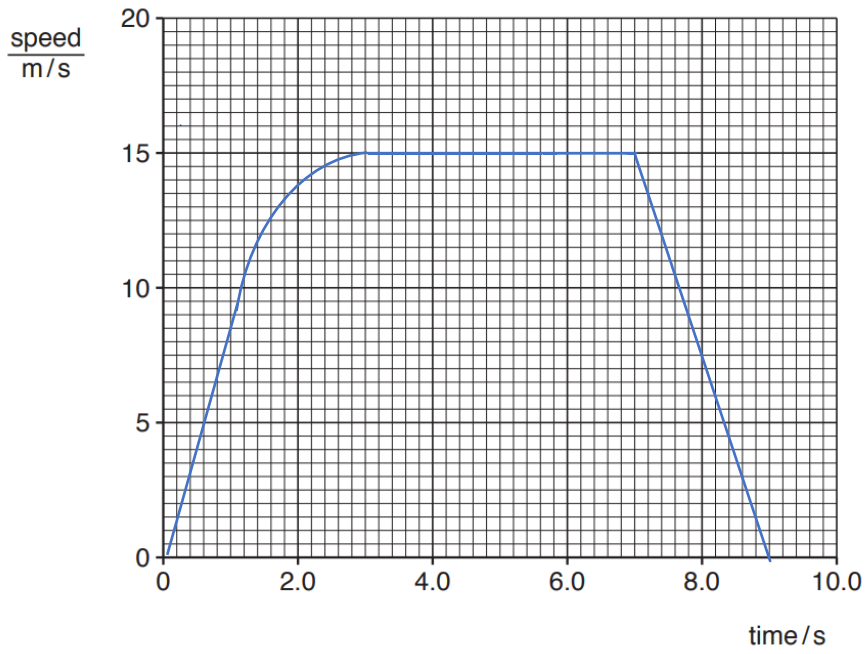
Qsn	Answer	Explanation
1	B	Displacement has direction and is a vector quantity.
2	C	128 TB = 128 x 10^{12} B = 1.28 x 10^{14} B
3	C	Point A - lowest point on ground, velocity zero as object is changing direction. Point B – just before going back up (velocity already changed to going upwards) Point C – object is at the highest point after first bounce Point D – object moves back down, velocity increases
4	C	Object falling through air decelerate and reach a terminal velocity that is lesser than velocity of object in vacuum.
5	A	Using Newton's 2nd law, Fnet = ma 2000 – resistive force = 750 x 2.0 Resistive force = 500 N
6	A	Action reaction force of weight (force by earth on box) is the force by box on earth.
7	D	Object moving in a constant speed in a straight line has no change in speed and direction, hence no acceleration and no resultant force.
8	A	Taking moments about F_3, $F_1 \times d_1 = F_2 \times d_2$ Since d_1 is smaller than d_2 , F_1 is larger than F_2
9	B	Pressure at surface of mercury = pressure at same level at column 76 cm Hg = 1200gX + 74 cm Hg 1200gX = 2 cm Hg 1200gX = 13600 g (0.02) X = 0.227 m
10	C	½ mv^2 = mgh 32000 = 40 g (20) g = 40 N/kg W = mg = (40)(40) = 1600 N = 1.6 kN
11	D	Power = work done / time
12	A	When temperature increases, KE increases Frequency of collisions of air molecules with smoke particles increases, causing the smoke particles to change direction more frequently.
13	C	Less space to move, particles collide with each other and the wall more frequently causing pressure to increase.
14	D	It takes one year to pay back the cost of installation.
15	B	The cooling fins increases the exposed surface area for heat to be dissipated quickly to the environment. Metal is a material used to increase rate of conduction, normally painted black to increase rate of radiation.
16	D	Energy supplied = Energy used to melt salt Pt = m l_f 175 × (700 – 300) = 0.50 × l_f l_f = 175 × (700 – 300) ÷ 0.50 = 140 000 J/kg = 1.4 × 10^5 J/kg
17	B	decreasing the humidity (reduce moisture in air) surrounding the liquid and increasing the temperature of the liquid increases the rate of evaporation
18	C	Wavelength between 2 successive compressions = 15 x (2/3) = 10 cm Speed = wavelength/period = 10 / 2 = 5 cm/s
19	B	At time = 0, the particle is at the equilibrium position and moves downwards as the wave moves to the right.
20	B	Frequency halved, time taken for one complete oscillation is longer. Loudness remains constant, amplitude does not change.

21	A	Signals transmitted to satellite via microwaves has the longest wavelength.
22	B	n = sin p/sin r = 2.5 n = 1/sin*c* Critical angle *c* = $\sin^{-1}$ (1/ n) = $\sin^{-1}$(1/2.5) = 23.6 ^{o}
23	C	Object is placed between 0 and *f*, image formed is on the same side, magnified, upright and virtual.
24	A	Angle of reflection off PQ is 50°. Angle sum of triangle = 180°, 180-40-60 = 80° Hence angle of incidence = 10°
25	B	Y is a positive charge as field lines point away from Y. Since X is negatively charged, it will be attracted to Y (to the left)
26	B	The direction of an electric field at any point is the direction of the force on a small positive charge placed at the point.
27	C	Since resistance of a wire is proportional to length and inversely proportional to cross sectional area. To get the highest resistance, the length should be long and diameter should be small.
28	C	V_2 = I R 2.0 = I (1/4+1/4)-1 I = 1A V_1 = IR 6= (1)(R) R = 6.0 Ω
29	C	I = P/V = 24/12 = 2.0 A Q = It = 2.0 (25 x 3600) = 180 000 C **OR** Q = W/V = (Pt)/V = 24 x 25 x 60 x 60 / 12 = 180 000 C
30	B	Excessive current will cause fuse to melt and the current to the electric iron will be cut off.
31	D	Live wire connected to switch, passes through bulb, and return to main via neutral. Earth wire connected to casing (safety feature).
32	B	Energy consumption x rate = total cost (0.500 x 0.5 + 1.8 x 210/60) x rate = 1.57 Rate = $0.24
33	D	The iron rings will become induced magnets with the end nearer to the strong magnet being a south pole. Hence, the end nearest to magnet X will be an induced north pole, which will cause it to be attracted to magnet X.
34	C	Demagnetising: use a.c. supply and gradually decrease the current in the circuit
35	C	Using right-hand grip rule, the magnetic field is clockwise for current into page and anti-clockwise for current out of page. Resultant magnetic field in the centre is in the same direction, vector addition of magnetic fields to obtain resultant field downwards.
36	D	When speed of rotation doubles, frequency doubles and max voltage doubles.
37	C	In Fig. 37.1, by Lenz's law, a S pole is produced at the top of the solenoid to repel the approaching S pole (oppose motion), using Right-Hand Grip Rule, current flows from Y to X. In Fig.37.2, a S pole is produced at the bottom of the solenoid to attract the leaving N pole (oppose motion), using Right-Hand Grip Rule, current flows from X to Y.
38	A	Alpha particles are all stopped by paper (least penetrating) and there will be no significant difference in count rate if gamma were to be used (highly penetrating)
39	A	Nature of alpha decay – helium nucleus. $^{241}_{95}Am \rightarrow {}^{237}_{93}X + {}^{4}_{2}\alpha$
40	C	The count rate decreases when aluminium and lead is used, showing the presence of beta and gamma rays.

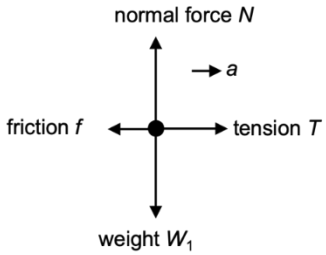
Paper 2

Question	Answer	Marks
1	Scale: 1 cm: 4 N  scale stated **and** correct vector diagram	B1
	magnitude: 38 ± 1 kN	B1
	direction: 18 ± 3° from the 36 kN force **or** 72 ± 3° from the 12 kN force	B1
	Total	**3**

Question	Answer	Marks
2 (a)	$90^o - 61^o = 29^o$ $n = \frac{\sin 45^0}{\sin 29^0}$ $= 1.46$	M1 A1
(b)	Light ray travelling from optically denser medium to optically less dense medium.	B1
	with angle of incidence at B is greater than the critical angle of the glass **and** total internal reflection occurs	B1
	Total	**4**

Question	Answer	Marks
3 (a)	 First 3 s, **decreasing gradient** from **t = 0 to t = 3.0 s** From 3.0 s to 7.0 s, PMA is moving at constant speed (distance travelled= area under graph = 15 x 4 = 60), **horizontal line drawn for 4 seconds**. Last 2 seconds, constant negative gradient, **straight line from 15 /s to 0 m/s**.	B1 B1 B1
(b) (i)	Chemical potential store/ energy	B1
(ii)	Energy transferred electrically **or** electrical work done (from chemical potential store) to	B1
	work done by the motor/ wheel **or** to increase in kinetic store of energy of the PMA	B1
(c)	KE = ½ $m v^2$ = ½ (80)$(5.0)^2$	C1
	1000 J	A1
(d)	$t = E / P$ = 350 / 70	C1
	= 5.0 x 60 x 60 = 18 000 s	 A1
	Total	**10**

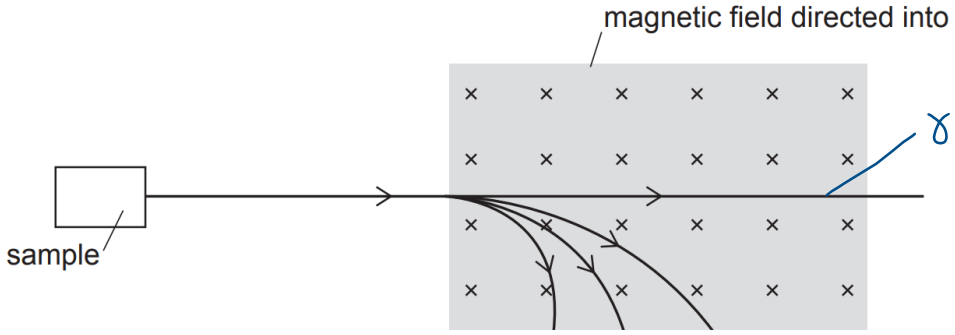
Question	Answer	Marks
4(a)	when a body is in **equilibrium**, **the total clockwise moment about a pivot equals the total anticlockwise moment about the same pivot**.	B1
(b)	As the arm is in equilibrium, the clockwise moment produced by the mass is equal to the anticlockwise moment produced by the force of the rubber band.	B1
	The mass has a larger perpendicular distance from the pivot, hence the rubber band needs to exert a greater force.	B1
(c)	Taking moments about X, 5.0 x 18 = *F* x 2.0	M1
	F = 45 N	A1
(d)	The force exerted by rubber band will be greater as weight contributes to clockwise moment.	B1
	Total	**6**

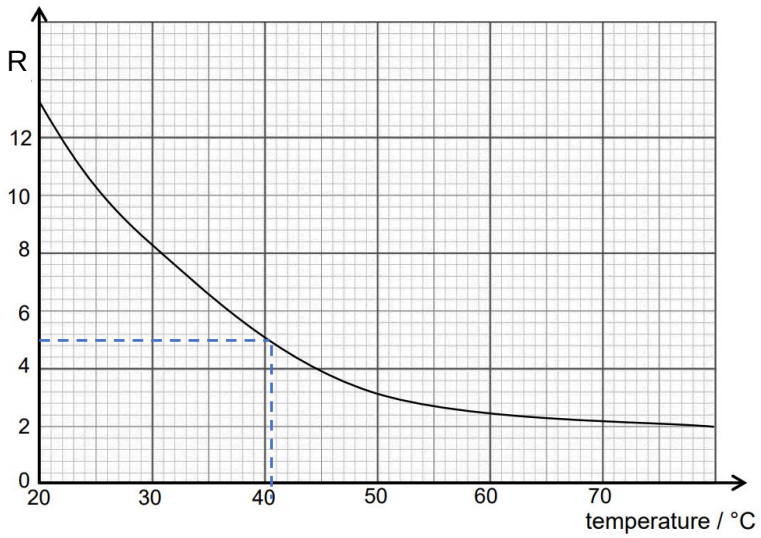
Question	Answer	Marks
5 (a)	Considering both masses as a system, using N2L, F_{net} = ma (20)(10) – 20 = 60 a	M1
	a = 3.0 m/s^2	A1
(b)	 Considering 40 kg mass: $T - f = m_1 a$ (ecf from (a)) T – 20 = 40(3.0)	M1
	T = 140 N	A1
	Total	**4**

Question	Answer	Marks
6(a)	**infrared (radiation) , visible (light) , ultraviolet (radiation)** in order of increasing frequency correctly identified 3 types	 B1 B1
(b)	damaging effect: (skin) cancer / cataracts property: ultraviolet radiation is **ionising**	B1 B1
(c)	Recall speed of light in vacuum c = 3.00 x 10^8 m/s $\lambda = c/f$ = 3.00 x 10^8/ 8.8 × 10^{14} = 3.41 x 10^{-7} m	C1 A1
	Total	**6**

Question	Answer	Marks
7(a)	When **negatively charged electrons are transferred** from the cloth (**to the rod**),	B1
	there are **more positive charges than negative charges on the cloth/ overall positive charge on the cloth** (reject only positive charges left on the cloth)	B1
(b)	**Like charges repel**, hence the **negatively charged (held) rod repels the rod** on the balance,	B1
	rod on the balance experiences a **resultant additional (downwards) force/ greater downwards resultant force** on the balance (increasing the mass reading)/ AVP	B1
	Total	**4**

Question	Answer	Marks
8(a)	Soft iron as it can be easily magnetised and demagnetised	B1
	and concentrates the field lines to ensure better flux linkage	B1
(b)	input voltage or input current is alternating/changing/ varying (magnetic) field (in primary coil)	B1
	by Faraday's law, alternating magnetic field /changing magnetic field/ varying magnetic field/ cutting of magnetic flux in (secondary)/ changing flux/ produces an (induced) emf (in secondary coil)	B1
(c)	$V_p / V_s = N_p / N_s$ $5 / 230 = N_s / 4600$	M1
	N_s = 100 turns	A1
(d)	Any one: reverse the coils/ connect the input to the secondary/ right-side coil/ secondary has more turns than primary / secondary has more than 4600 (with same number on primary)	B1
	Total	**7**

Question	Answer	Marks
9(a)(i)	 Only one horizontal line labelled with γ	C1
(ii)	beta-radiation	B1
	Using Fleming's left-hand rule, first finger into page and thumb downwards/ AVP	B1
	direction of current opposite to motion or particles negative (and so are beta)/ AVP	B1
(b)	180 x ½ x ½ x ½ OR 180 ÷ 8 OR 180, 90, 45, 22.5 (shows idea of 3 half-lives)	M1
	= 22.5 mg	A1
	Total	**6**

Question	Answer	Marks
10(a)	(electromotive force (e.m.f.) of a source is the) energy/work done per unit charge by the source	B1
	in driving charge around a complete circuit	B1
(b)	Using potential divider formula, 8.0 = [10/($R_{thermistor}$ + 10)](12)	M1
	$R_{thermistor}$ = 5.0 Ω	A1
	Using Fig 10.2, when $R_{thermistor}$ = 5.0 Ω , temperature = 40.5 °C (read to half the smallest division)  	B1
(c)	(Adding the LED parallel to 10 Ω resistor causes) resistance across output to decrease.	M1
	To maintain V_{out} at 8.0 V, the resistance across thermistor must decrease.	M1
	From Fig. 10.2 when resistance across thermistor decreases, minimum temperature will increase.	A1
	Total	**8**

Question	Answer	Marks
11(a)(i)	temperature difference between the hot water and the room = 100 – 30 = 70°C	B1
(ii)	T-difference to decrease by half -> decrease by 35°C Hence temp = 100 – 35 = 65°C (ecf from **(a)(i)**)	B1
(iii)	Q = CΔθ = 2940 x (100 – 65) (ecf from **(a)(ii)**)	M1
	=1.03 x 10^5 J	A1
(iv)	Rate of heat loss (ecf from **(a)(iii)**) = 1.03 x 10^5/ (2.8 x 3600) = 10.2 W	B1
(b)(i)	Flask **K**	B1
(ii)	Vacuum – prevents conduction and convection through the walls; Lowest thermal conductivity and is the poorest conductor of heat; Silver paint – poor emitter of (infra-red) radiation compared to black paint	B1 B1 B1
(c)(i)	The higher the thermal conductivity, the higher the rate of heat loss by conduction	B1
(ii)	Any of the following: • The space between the inner and outer walls kept the same • The coating of the inner wall kept the same	B1
(d)	Decrease in temperature causes average kinetic energy of the molecules to decrease and molecules **slides past one another more slowly** (need to mention change in motion **and** motion of liquid molecules)	B1
	Total	**12**

EITHER

Question	Answer	Marks
12(a)	I = V / R = 12 / (20 + 28)	C1
	= 0.25 A	A1
(b) (i)	Downwards within the region between Y and Z	B1
(ii)	current from Z to Y **and** magnetic field left to right/ to the right	B1
	using (Fleming's) left-hand rule force is downwards	B1
c(i)	R_{eff} $= (\frac{1}{30} + \frac{1}{20})^{-1} + 28$	M1
	= 40 Ω	A1
(ii)	Overall resistance decreases or resistance is less (with S_2 closed)	B1
	current increases and force increases	A1
(iii)	V across both resistors are the same. Using $I = V/R$, $I_{20} / I_{30} = R_{30} / R_{20}$ = 30/20 = 1.5	B1
	Total	**10**

OR

Question	Answer	Marks
13 (a)(i)	Total pressure at bottom of tube = atmospheric pressure + pressure due to column of liquid $= 1.0 \times 10^5 + h\rho g$	C1
	$= 1.0 \times 10^5 + (1.0 \times 1.4 \times 10^4 \times 10)$	C1
	$= 2.4 \times 10^5$ Pa	A1
(ii)	F = P x A $= 2.4 \times 10^5$ x 4 x 10^{-4}	C1
	= 96 N	A1
(b)(i)	**the liquid (in the tube) falls** as pressure of liquid at bottom of tube greater than pressure of liquid in basin immediately beneath it	B1
	then stops falling **or** reaches stability	B1
	when pressure (of liquid in tube) becomes equal to atmospheric pressure / pressure in the container **or** leaving a vacuum (at the closed end of the tube)	B1
(ii)	height of liquid in tube (distance between level to water in container to the vacuum measured) measured using a **ruler**	B1
	relative to level of liquid surface in container (can indicate using drawing) **and** formula hρg to calculate the pressure B1	B1
	Total	**10**