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PHYSICS 4420, MARK SCHEME

Abbreviations used in mark schemes:
OWTTE - or words to that effect
ecf - error carried forward
ora - or reverse argument
UP - unit penalty

Paper 1F

1.	(a)	Iron		Accept any method, clearly	1
		Steel		indicating the answer, eg one ring round both or underlining	1
	(b)	(i)	Bar/rectangular	Rectangle	1
		(ii)	Pole(s)	N and S wherever seen, eg on diagram either way round	1
		(iii)	(magnetic) field/flux (line(s))	Magnetic lines of force lines of field	1
	(c)	**Any two, 1 mark each**			
		• North and south ends facing		**Or** opposite/unlike poles facing or both poles different	
		• North on the left		**Or** south on the right	
		• Held in position		**Or** held so that they do not come together (**do not credit** 'held in position so they do not attract')	
		• Lines run from N to S			2

Total 7 marks

2.	(a)	Charges (on each strip)			1
		the same so repelled		**Or** both had been negatively charged so repelled (2 marks) (**do not credit** 'both had been positively charged so repelled')	1
	(b)	Positive			1
		Electrons			1
		Cloth ... polythene/strip(s)		Both correct in correct order	1
	(c)	(i)	Conductors	Allow metals	1
		(ii)	Insulators	Allow 'non/poor conductors' Allow 'plastics' (**do not credit** 'non-metals')	1

Total 7 marks

3.	(a)	Information/data/signals Matter	Not 'sound' etc Allow 'substance', 'material', 'mass', 'medium'	1 1
	(b)	Amplitude B	Allow 'energy' 'intensity'	1 1
	(c)	(number of) waves per second	**Or** waves per unit of time **Or** rate at which waves are transmitted **Or** number of waves ÷ time (taken) **Or** frequency = 1 ÷ (time) period Accept 'vibrations' for 'waves'	1
	(d)	Frequency range we can hear	**Or** frequency range for human hearing Accept qualifications such as 'healthy', 'young', 'normal' but not if contradiction, eg 'elderly'. Accept 'sounds we can hear'	1
	(e)	(i) Longitudinal (ii) Sound(s)/vibration(s)	**Or** (seismic/earthquake) P wave(s) (**do not credit** just 'seismic/earthquake waves')	1 1
				Total 8 marks
4.	(a)	Vibrate Random Close to Close to	**Words from the box only**	1 1 1 1
	(b)	Evaporating/evaporation	Accept 'vaporising' Accept 'turning to a vapour'	1
	(c)	Freezing	**Or** solidifying/solidification	1
				Total 6 marks
5.	(a)	(i) Walking at a constant speed (ii) Standing still	Accept minor variations if meaning is clear	1 1
	(b)	More/greater/faster The slope/gradient (of A to B) is greater (than the slope of C to D)	 Or the converse NB this 2nd marking point is dependent on the 1st marking point	1 1
	(c)	Distance = (average) speed x time	Or any correctly transposed version	1
				Total 5 marks

6.	(a)	Moving/ in motion		**1**
	(b)	**Chemical**	**Or** 'chemical potential'	**1**
	(c)	Heat/thermal/potential sound/vibration	Either order Accept 'chemical (energy)' Accept 'gravitational (energy)' (**do not credit** 'nuclear', 'light', 'kinetic', 'electrical')	**1** **1**
	(d)	Increase (pulling) force Move hand towards the end (of the spanner)	Either order	**1** **1**
	(e)	**Area** (under the tyres/wheels) greater (than with narrow tyres) (but) **force** (due to the weight of tractor) is (nearly) the same (as before) (so) **pressure** is less	In each case the key word must be used correctly for credit **Or** force is spread out more	**1** **1** **1**
				Total 9 marks
7.	(a)	Beta/ß ... gamma/γ	**Both in this order**	**1**
	(b)	(i) Increases/ more clicks/ more frequent/ higher frequency	Treat 'louder' as neutral	**1**
		(ii) gamma/γ Can penetrate pipe/soil and rock(s) Most penetrating High penetration	Others/alpha and beta cannot penetrate pipe/soil and rock(s) **NB** this 2nd marking point is dependent on 1st marking point	**1** **1**
	(c)	Nucleus/nuclei		**1**
	(d)	**Any one of:** • (causes) cancer(s) • Radiation sickness • Genetic damage • Birth defect(s)	**Or** named cancer, eg leukaemia **Or** mutations Not damage health or make us sick or ill	**1**
	(e)	**Any one of:** • Limit time exposed • Increases distance (from source) • Shielding • Protective clothing		**1**
				Total 7 marks

8.	(a)	Constant		**1**
	(b)	Friction	**Or** air resistance or drag (**do not credit** 'wind (resistance)')	**1**
	(c)	Reaction/thinking (time)	Not distance	**1**
	(d)	(i) Great(er) / long(er) / more / high(er)		**1**
		(ii) **Any two, 1 mark each:** • Type of road surface/ material • Condition of road surface • Power/force/ efficiency/condition of the brakes • Speed/velocity (of the lorry) • Friction between brakes and wheel	Accept just 'road' Accept just 'brakes'	**2**
				Total 6 marks
9.	(a)	5(N) W = m x g (1 mark)	4.9 using 9.8 **Or** W = 0.5 x 10 (1 mark)	**2**
	(b)	(i) Indicates initial linear region		**1**
		(ii) The region indicated is linear / extension is proportional to weight OWTTE		**1**
	(c)	(straight) line through origin of shallower slope than existing straight line (1 mark) Straight line continues beyond weight associated with elastic limit for thinner wire (1 mark)		**2**
				Total 6 marks

10. (a) 0.0015 (A)

$I = \frac{V}{R}$ (1 mark)

$(I =) \frac{1.5}{1000}$ (1 mark) 1.5 / 100 scores (1 mark) **3**

(b) Decreases **1**

(c) Increases **must** ecf in (c) from (b) Accept 'increases' if nothing in (b) **1**

Total 5 marks

11. (a) Radio waves **1**

(b) X-rays no ecf **1**

(c) Observing internal structure of objects/ medical applications Looking at bones/body scans **1**

(d)
- Same speed
- Travel in a vacuum
- Both transverse
- Can be polarised

Any one **1**

(e) Angle of incidence = angle of reflection
Or
Incident and reflected rays and normal all in same plane **1**

- Visible **ora**
- X-rays are dangerous **ora**
- Equipment not readily available **ora**

Any two **2**

Total 7 marks

12. (a) Electrical **1**
Heat / thermal **1**
Light **1**

(b) 3000(J) (2 marks)
E = P x t (1 mark) **Or** E = 100 x 30 (1 mark) **2**

(c) 5% (of output) (1 mark) **Or** 150 J (1 mark)
(is) light (1 mark) Either '5% light' or '95% heat' scores 2 marks **2**

Total 7 marks

13. (a) A **1**

(b) 1.2 (kg / m^3) (3 marks)

density = $\frac{\text{mass}}{\text{volume}}$ (1 mark) Or V = A x h

(density) = $\frac{72}{60}$ (1 mark) **3**

(c) A No ecf **1**

(d) Conduction **1**

Total 6 marks

14. (a) 10 minutes (2 marks) **2**
20 minutes is two half lives
(1 mark)

(b) Half-life is too short / decays too quickly **1**

(c) **Any two sources**
- Rocks OR soil
- Trees OR plants
- Air
- Cosmic rays
- Buildings
- People OR animals
- Sun

2

Total 5 marks

15. (a) Continuously **1**

(b) ON **1**
Zero **1**
OFF **1**

Total 4 marks

16. (a) Conductor (1 mark)
Moves through magnetic field / flux (1 mark)
Voltage induced (1 mark) **3**

Move wire faster (1 mark)
Stronger magnetic field (1 mark) **Or** move magnets closer together **2**

Total 5 marks

TOTAL FOR PAPER 1F: 100 MARKS

Paper 2H

1. (a) 5(N)
$W = m \times g$ (1 mark)
4.9 using 9.8
Or $W = 0.5 \times 10$ (1 mark)
2

(b) (i) Indicates initial linear region
1

(ii) The region indicated is linear / extension is proportional to weight OWTTE
1

(c) (straight) line through origin of shallower slope than existing straight line (1 mark)

Straight line continues beyond weight associated with elastic limit for thinner wire (1 mark)
2

Total 6 marks

2. (a) 0.0015 (A)
3
$I = \frac{V}{R}$ (1 mark)
$(I =) \frac{1.5}{1000}$ (1 mark)
1.5 / 100 scores 1 mark

(b) Decreases
1

(c) Increases **must** ecf in (c) from (b)
Accept 'increases' if nothing in (b)
1

Total 5 marks

3. (a) Radio waves
1

(b) X-rays no ecf
1

(c) Observing internal structure of objects/ medical applications
Looking at bones/body scans
1

(d)
- Same speed
- Travel in a vacuum
- Both transverse
- Can be polarised

Any one
1

(e) Angle of incidence = angle of reflection
or incident and reflected rays and normal all in same plane
1

(f)
- Visible **ora**
- X-rays are dangerous **ora**
- Equipment not readily available **ora**

Any two
2

Total 7 marks

4. (a) Electrical **1**
Heat / thermal **1**
Light **1**

(b) 3000(J) (2 marks) **2**
E = P x t (1 mark) **Or** E = 100 x 30 (1 mark)

(c) 5% (of output) (1 mark) **Or** 150 J (1 mark)
(is) light (1 mark) Either '5% light' or '95% heat' scores 2 marks **2**

Total 7 marks

5. (a) A **1**

(b) 1.2 (kg / m^3) (3 marks) **3**
density = $\frac{\text{mass}}{\text{volume}}$ (1 mark) or V = A x h
(density) = $\frac{72}{60}$ (1 mark)

(c) A No ecf **1**

(d) Conduction **1**

Total 6 marks

6. (a) 10 minutes (2 marks) **2**
20 minutes is two half lives
(1 mark)

(b) Half-life is too short / decays too quickly **1**

(c) **Any two**
- Rocks OR soil
- Trees OR plants
- Air
- Cosmic rays
- Buildings
- People OR animals
- Sun

2

Total 5 marks

7. (a) Continuously **1**

(b) ON **1**
Zero **1**
OFF **1**

Total 4 marks

8.	(a)	Conductor (1 mark) Moves through magnetic field / flux (1 mark) Voltage induced (1 mark)		**3**
	(b)	Move wire faster (1 mark) Stronger magnetic field (1 mark)	**Or** move magnets closer together	**2**
				Total 5 marks
9.	(a)	(force of) gravity down(wards) Air resistance up(wards)	**Or** weight down(wards) **Or** friction up(wards)	**1** **1**
		Both forces (1 mark)	Do not credit any reference to wind	
		Both directions (1 mark)	Both force and direction for each	
	(b)	Air resistance increases as speed increases	**Or** friction increases **Or** as velocity increases (depending on previous response)	**1** **1**
	(c)	either 0.133 (2 marks) m/s^2 (1 mark) **Or** force = mass x acceleration (1 mark) **Or** (acceleration =) 60 ÷ 450 (1 mark)	Accept N /kg Accept F = ma or any correctly transposed version	**3**
	(d)	(i) Steady/constant speed/ motion	**Or** constant velocity **Or** no acceleration	**1**
		(ii) Zero	**Or** 0 N	**1**
				Total 9 marks
10.	(a)	(i) (flow of) (free) electrons which are negatively charged (and move from negative (to) positive)	**Or** the negative end/cathode has a surplus of electrons **Or** the positive end/anode has a shortage of electrons	**1** **1**
		(ii) joule ... coulomb	Only in this order	**1**
	(b)	Either 0.02 (2 marks) amps/A (1 mark) **Or** (current =) 216 ÷ (1.5 x 2 x 60 x 60) (1 mark)	**Or** 20 mA (3 marks) 1.2 A or 72 A scores 2 treat as UP	**3**
				Total 6 marks

11. (a) Either 7 (2 marks)

Or kinetic energy = ½ m v^2 (1 mark)

7 with any unit other than m/s (1 mark)

Or in words
Or a correctly transposed version

Or $v^2 = 784 \div 16$
Or $v = \sqrt{49}$

2

(b) (i) 784 J — Correct unit essential for the mark **1**

(ii) **Any two** (1 mark each)

- Air resistance was zero
- Wind had no effect **Or** there was no wind
- Ann did not push off (at X)
- She was not given a push (or slowed down) (by a friend)
- Ann did not slow herself; by dragging her feet, for example
- Ann started 'from rest'
- There is no friction between the rope and the branch/tree
- The 'system'/energy transfer was 100 % efficient or no energy lost
- No energy was transferred as heat
- No energy was transferred as sound
- No work done against friction
- No energy lost as friction

2

Total 5 marks

12. (a) (i) **Any four** (1 mark each)

- Glass block (placed) on a suitable background
- Either use of ray box or use of pins and eye
- Position of block and rays marked or shown on diagram
- Correct angles shown by diagram or description even if i and r inconsistent
- Angles measured with a protractor
- Plot graph of sin i against sin r
- Slope = refractive index

Maximum of (3 marks) if muddled or otherwise vexatious.
Any point may be shown on a suitable drawing/diagram but do not credit if there is a contradiction with what may have been written about it. **4**

(ii) Either 1.5 (3 marks) — 1.5 with any unit (2 marks) **3**

or refractive index = sin i ÷ sin r (1 mark)
= 0.93 ÷ 0.62 (1 mark)

	(b)	(i)	Angle of incidence at which	Do not credit 'maximum angle of incidence'	1
			refraction just occurs	angle r = 90° sin r = 1 or minimum at which total internal reflection will (just) occur **NB** look out for refraction/ reflection errors	1
		(ii)	Sine of critical angle = 1÷ refractive index	**Or** the converse **Or** in symbols	1

Total 10 marks

13.	(a)	The particles have stopped vibrating/moving	**Or** the particles cannot vibrate/move **Or** the particles have no (kinetic) energy	1
	(b)	295	Do not credit if any unit given other than kelvin or K	1
	(c)	Either temp (at explosion) = 907 °C (so conclusion correct) (2 marks) **Or** at 900 °C the pressure would have been (only) 1988 kPa (so temperature must have been higher) (2 marks)	**Or** temperature = 1180 (K) (1 mark) **Or** P = 1173 x 500 ÷ 295 (1 mark) Expect to see ratios 1.695 or.705	2
	(d)	doubled		1

Total 5 marks

14.	(a)	(i)	Alternating current	Accept alternate	1
		(ii)	The current keeps (regularly) changing direction/magnitude Flow in both (or two) directions	**Or** the voltage/p.d. keeps (regularly) changing polarity/ magnitude **Or** shown on a suitable sketch graph	1
	(b)	(i)	Either 30 (2 marks) **Or** input power = output power (1 mark)	30 with any unit other than amps/A (1 mark) **Or** $V_P I_P = V_S V_S$ (1 mark) or in words (1 mark)	2
		(ii)	**Any one** • It/the transformer is 100 % efficient (**Or** efficiency = 1) • No eddy currents • No heat loss • No sound/vibration • Wires have zero resistance • That all the (magnetic) field from the primary passes through the secondary		1

Total 5 marks

15. (a) The pressure (of the water) is the greatest (at the bottom) so that is where it needs to be strongest **1**

Or so this is where the force is greatest **1**

(b) Gravitational/potential ... kinetic

Correct order essential for the mark **1**

(c) Appropriate statement (1 mark) with appropriate explanation/example/amplification (1 mark)

Advantage examples **2**

- Renewable (1 mark) so no waste of non-renewable resources (1 mark)
- No release of CO_2 (1 mark) which is a greenhouse gas/damages environment (1 mark)
- No release of SO_2 (1 mark) which causes acid rain/damages environment (1 mark)
- (relatively) low maintenance costs (1 mark) and no fuel has to be paid for (1 mark)
- Tourist amenity if a new/enlarged lake is created (1 mark) for boating/fishing etc (1 mark)

Disadvantage examples **2**

- Only suitable for hilly/mountainous region (1 mark) with high rainfall (1 mark)
- Only suitable for particular sites (1 mark) which may (often) be inconveniently located for users of electricity (1 mark)
- Occupies a large area (1 mark) so possible loss of scenic amenity (1 mark)
- Land has to be flooded (1 mark) so loss of habitat(s) (1 mark)
- Unsuitable/unusable during drought (1 mark) as no water/insufficient water behind/in the dam (1 mark)

(d) Appropriate statement (1 mark) with appropriate explanation/example/amplification (1 mark)

Advantage examples **2**

- Electricity is cheaper (1 mark) because (system) more efficient (1 mark)
- Current lower (1 mark) so power/heat/energy loss is less (1 mark)

Disadvantage examples **2**

- Difficulty of insulation/prevention of earthing (1 mark) [allow 'danger of electrocution'], contact may be lethal (1 mark)
- Overhead cables must be high (above ground) (1 mark), tall pylons are expensive/unsightly (1 mark)
- Underground cables are very expensive/ difficult to maintain/to cool/to insulate (possible (2 marks))
- Cost of transformers (1 mark), both step-up and step-down transformers are needed (1 mark) ('expense' must be part of a good answer)

Total 11 marks

16.	(a)	(i)	(Fleming's) left hand (rule)	Not motor rule	**1**
		(ii)	Correct description of rule(1 mark) ie Thumb ...motion First finger ...field Second finger ...current	May be shown on a suitable drawing/diagram but do not credit if contradiction with what may have been written about it	
			Correct application to coil (2 marks) ie Field from N to S Current from + to - (so) motion up on left/ down on right (depending on previous response)	As above	**2**
		(iii)	**Any one of:** • Stronger magnetic field • More turns on coil • Less clearance/ pole pieces nearer to the coil • Bigger current • Use metal of a lower resistance for the coil • Have (an iron) core	Accept 'stronger magnets' Accept 'more coils' but **not** 'bigger coil' Accept 'bigger voltage' Do not credit just 'lower resistance'	**1**
		(iv)	Reverse the current	**Or** reverse the power supply **Or** reverse the poles Accept 'reverse/swap the magnets'	**1**
	(b)	(i)	Either 2.4 (2 marks) joules/J (1 mark) or work = force x distance (1 mark)	Accept Nm **Or** work = 3 x 0.8 (1 mark)	**3**
		(ii)	2.4 joules/J	**Or** same answer as (b)(i) provided the unit is correct	**1**
		(iii)	**Any two** (1 mark each) • (system) not 100 % efficient (accept '3.6 J (of energy) wasted') • Energy transferred as heat/motor gets hot • (energy transferred to overcome) friction (do not credit reference to air resistance) • Energy transferred as sound • Slippage at the pulley wheel • Tightening of the string • Working against friction • Windings/motor have electrical resistance		**2**

Total 11 marks

17.	(a)	Thermal/heat	**Or** kinetic energy of particles/fission products	**1**
			Do not credit just 'kinetic energy'	
	(b)	Fission	**Or** chain	**1**
	(c)	Any point (1 mark) then linked point (1 mark) • (to act as a) moderator • (which) slows neutrons • (that are) produced by fission • (then) slow moving neutrons more likely to split (other) nuclei	Accept 'produced by splitting atoms' or '(so that) the reactor works more efficiently'	**2**
	(d)	(i) Moved (slightly) in and out/ up and down (1 mark) to control the rate of (the nuclear) reaction/fission (1 mark) Independent marks	Accept '...speed ...' Do not credit this mark if the erroneous suggestion is made that the rate will increase if the rods are lowered	**2**
		(ii) Plunged in/ forced down/ at speed (1 mark) to stop the reaction(s) (1 mark) Independent marks	Accept 'dropped in' or to absorb the neutrons	**2**
				Total 8 marks
18.	(a)	**Any two** (1 mark each) • they are electrons • they are negative(ly charged) • they have (almost) zero mass		**2**
	(b)	Isotopes		**1**
	(c)	$^{4}_{2}He$	All correct with no other additions	**1**
		$^{222}_{86}Rn$	Any change to the radium -226 cancels this mark	**1**
				Total 5 marks
				TOTAL FOR PAPER 2H: 120 MARKS

Paper 3

1. (a) Any eight points which must include the two marked *.

- Put water in kettle
- ***Heat water (priority mark)**
- Boil water
- Use measuring cylinder
- Water into cup
- Check no water left in measuring cylinder
- Put thermometer in cup of water
- Note(initial) temperature of water
- Start stopwatch
- Note temperature at a later time (or note temperature after a certain time)
- Stir (before taking readings)
- ***Repeat for other cups (priority mark)**
- A valid conclusion comment **8**

(b) **Any two** (1 mark each)

- amount/volume of water (in cup) {accept mass/weight of water (in cup))
- initial/start temperature
- external/room temperature
- surface on which the cup stands (as it cools)
- position of cup **2**

(c) 68 (°C) (1 mark) Units not essential for these marks
130 (ml) (1 mark) **2**

(d) **Any four** (1 mark each)

- Which plastic - thick or thin
- Thermometer cannot measure/ be read to this accuracy
- Time is too vague/ not specified well enough
- Starting temperature too low
- No tabulation of data
- Does it refer to a temperature or a temperature fall **4**

Total 16 marks

2. (a) (i) Eight **1**

(ii) Either 0.160 (s) (2 marks)
Or (time =) 0.020 x 8
(1 mark) ecf from (i) **2**

(b) Dots evenly spaced **Or** words to that effect **1**

(c) In the range 103 - 105 (mm) **1**

(d) (i) Substitution of values from (a)(ii) and (c) **For example** 104 mm / 0.16 s

Correct calculation = 650
Significant figures 2 significant figures
Appropriate unit mm/s **4**

	(ii)	Time to two significant figures	Any sensible comment will be credited	
		Distance to three significant figures		
		Speed to **two** significant figures		1
(e)	(i)	3 (mm)		1
	(ii)	24 (mm)		1
	(iii)	Accelerating/ getting faster/ speeding up		1
(f)	(i)	Both axes labelled correctly with correct units (1 mark)		
		All five points correct (2 marks)	Correct to within 1 mm in any direction Any 3 or 4 points correct (1 mark)	
		Good straight line (not freehand) of best fit through points as plotted (1 mark)		4
	(ii)	Both graphs and tape show acceleration (1 mark)		1

Total 18 marks

3.	(a)	Answer in range 36 - 38 (°)		1
	(b)	(i) Ends of given rays connected through the prism by a straight line		1
		(ii) Incident ray extended through the prism (1 mark) Blue light ray extrapolated back to meet the extended incident ray (1 mark) Angle between unambiguously shown and labelled Q (1 mark)		3
		(iii) Answer in range 50 - 52 (°)		1
	(c)	Angle in the range 46 - 49 ° (2 marks)	Any other angle > 37 ° and < 51 ° (1 mark) **Or** any other angle between answers for (a) and (b)(iii)	2

Total 8 marks

4.	(a)	Five turns drawn on left side		**1**
	(b)	Voltmeter connected across the output from the ten-turns coil (1 mark) a.c. supply connected across the input to the five-turn coil (1 mark)	Both a.c. supply and voltmeter on left hand side (1 mark) Both a.c. supply and voltmeter on right hand side (0 mark)	**2**
	(c)	Value would be 12.4(V) Would be off scale (of voltmeter) (1 mark)	Value would be greater than 10(V)	**2**
	(d)	**High** voltage unsafe/ could result in severe/lethal/fatal (electric) shock/heart attack (1 mark)	Accept 'could lead to electrocution'	
		Wires or voltmeter would be **damaged/destroyed/ overheated** or insulation melts(1 mark)	Do **not** credit • An answer which implies that a.c. is the problem • 'Voltmeter would explode/blow up' • Transformer overheats	**2**

Total 7 marks

TOTAL FOR PAPER 3: 49 MARKS

PHYSICS 4420, CHIEF EXAMINER'S REPORT

Paper 1F

General Comments

Questions 1 to 8 were targeted at candidates likely to achieve grade F. Candidates scored more marks here than on questions 9 to 16 which were targeted at grade C candidates. A small number of candidates entered for the Foundation Tier could with advantage have been entered for the Higher Tier and so might possibly have obtained a higher grade.

Question 1

In part (a), where two magnetic materials had to be circled in a list of materials which included iron and steel, a common wrong answer was 'aluminium'.
Three marks were available in part (b) for describing the shape of a bar magnet, locating its poles and describing the lines coming from and towards the poles. This was well answered.
Candidates were less sure in part (c) where they had to describe what to do with two magnets to get a particular pattern of magnetic field lines. They often knew that a North pole and a South pole were involved but did not indicate which way round. An acceptable answer was 'so that the lines go from N to S'. Few thought to say that the magnets should be held in position.

Question 2

In part (a), most candidates knew that the bottom ends of two polythene strips rubbed with a cloth moved apart because they had the same charge and like charges repel.
Part (b) was more of a challenge where four answers needed to fit a logical progression. Pleasingly many candidates wrote that, given the strips had a negative charge, the cloth was left with a positive charge because electrons had transferred from the cloth to the polythene strips.
In part (c) most candidates recognised that aluminium and polythene were a conductor and non-conductor of electricity respectively.

Question 3

This question was poorly answered and showed a weakness in recall and understanding of wave properties. Very few candidates knew that waves allow the transfer of information or data or signals without transferring matter.
In parts (b) and (c) there was a lot of uncertainty about the identification of the amplitude and wavelength of a transverse wave and the meaning of frequency, although many recognised the frequency limits of the human audible range.
In part (e) about half of the candidates recognised a wave on a spring as a longitudinal wave and knew that sound is an example of such a wave. Apart from the common wrong answer of 'transverse', other answers showed a good deal of confusion on this topic.

Question 4

This question was well answered with one exception. Hardly any candidates knew that particles in a liquid are close to each other. Given a choice of expressions from a box, nearly all candidates thought that the particles were far from each other.
In parts (b) and (c) most candidates knew that a substance can change from liquid to gas by evaporation as well as boiling and that 'freezing' or 'solidifying' is the opposite of melting.

Question 5
This question was poorly answered. Most candidates interpreted the distance-time graph as if it were a speed-time graph, describing a straight line with a positive slope as increasing speed rather than constant speed and a horizontal line as steady speed rather than standing still.
In part (b) candidates were usually unable to interpret the slope of the distance-time graph as an indication of speed.

Question 6
Parts (a) and (b) were answered well; candidates were able to identify 'kinetic' as the form of energy possessed by a moving tractor and name the type of energy that diesel fuel has. In part (c), terms such as 'friction' and 'efficiency' were seen where other types of energy output from the tractor were asked for. Candidates need reminding what constitutes a type of energy.
In part (d) candidates were shown a spanner being used to tighten a nut and asked for two ways of increasing the turning effect. Several answers suggested reducing friction or greasing the nut. Some answered that 'more turns needed to be used' and even 'use a soft iron core'. This together with 'electrical' appearing frequently as a form of energy in part (c) suggests that some candidates saw the word 'turning' and thought that the question was partly about electricity.
In part (e), wide tyres are used for the tractor and candidates had to use the words 'area', 'force' and 'pressure' to explain their use. Almost all candidates thought that there was an increase in area but the few who also noted a reduction in pressure mentioned a reduction in force as well. Some candidates who scored poorly in this section did quote the correct formula linking the three variables. Although few calculations will appear in the questions aimed at F grade candidates, these candidates are still expected to know and understand the formulae in the specification.

Question 7
This question on radioactivity was either answered very well or quite poorly.
In part (a), most candidates could identify beta particles and gamma radiation but were not always able to identify which of the three ionising radiations was suitable for detecting an underground gas pipeline, or why it was suitable.
In part (c) a surprising list of wrong answers and blank spaces appeared in response to the question on which part of the atom emits radiation.
Parts (d) and (e), which asked for a danger of and a means of protection from radioactive emissions, produced many correct answers from a generous mark scheme.
In part (d) an unacceptable answer to 'state a danger to health' is 'it makes you ill'. Examiners are not looking for answers which just re-word the question.

Question 8
Candidates showed they were familiar with the topic of motion. Most knew the factors that affect braking distance but did not know the term 'reaction time' for the time between wanting to brake and applying the brakes of a vehicle.

Question 9
Many candidates scored only two marks on this question, for calculating the weight of a 0.5 kg mass in part (a). The remaining marks were for indicating the Hooke's law region on a force-extension graph for a metal wire and drawing a further graph to represent the results for a thicker wire of the same material. This was beyond all but the strongest candidates.

Question 10
Grade C candidates are expected to be able to calculate a value of I using V = I x R and this was well answered, with some giving the answer in standard form. Some candidates did not know that the resistance of a thermistor decreases with increased temperature but most knew that the current followed the opposite trend to the resistance.

Question 11
This question was well answered with most candidates knowing that radio waves have a longer wavelength than X-rays. In part (c), where candidates had to state a use of X-rays, many vague answers such as 'in hospitals' and 'detection' were seen with a few giving uses of gamma rays.
In part (d) some could not state a property that all electromagnetic waves have in common, and in part (e) a statement of the law of reflection often lacked the word 'angle'.
In part (f) candidates could often suggest two reasons for using visible light rather than X-rays for demonstrating the law of reflection, showing a good application of knowledge.

Question 12
Most candidates were able to fill in boxes to show that the energy transfer when a metal filament lamp is switched on is from electrical to light and heat. The calculation in part (b) to find the energy transferred to the lamp when left on for 30 seconds was well answered, but 300 J and 3.33 J were common wrong answers. Candidates had a poor understanding of what is meant by the lamp only being 5% efficient. Although some knew a formula for efficiency they were unable to state that, in this case, 5% of the energy input became light energy or 95% became heat energy.

Question 13
Most candidates knew that the region marked A above a convector heater was the position of highest temperature within a room. The calculation in part (b) was poorly done, with many candidates unable to calculate the volume of a room given its height and floor area. The region of lowest density was also A, but the common occurrence of the wrong answer C suggests that C being at floor level in the diagram was associated with the word 'lowest' in the question.
Candidates who scored full marks at this point often could not score the final mark for an energy transfer process, often answering with an energy type.

Question 14
The calculation in part (a) proved too difficult for most candidates who showed little understanding of half life. An occasional wrong answer was 300/20 to show the average change of activity. This is an area that needs attention.
A generous mark scheme allowed candidates to score well in part (c) by naming two sources of background radiation.

Question 15
No candidates gave a good answer to this question on analogue and digital signals although some answered part (a) correctly. The frequent answer of 'time' for the third gap in part (b) suggests an association with the x-axis. Mostly candidates filled the gaps with any physics words that came to mind.

Question 16

Responses showed a lack of understanding of the topic of electromagnetic induction. A conductor was moved through a magnetic field and a voltage was induced. Two ways of increasing the voltage using the same apparatus are to move the conductor quicker and to increase the strength of the magnetic field by moving the two magnetic poles closer together. Candidates rarely scored any of the five marks allotted.

Paper 2H

General Comments

The majority of candidates had been correctly entered for this Higher Tier paper and their responses were generally good, with some exceptionally good work seen. In particular, the ability of candidates in the mathematical parts of questions was commendable. Questions 1 to 8 were common to this paper and the Foundation Tier. Questions 9 to 18 were generally more difficult and some of their content was from the 'Higher Tier only' part of the specification.

Question 1

Part (a) was well answered. Some candidates chose to use the given value of g = 10 m/s^2 and others g = 9.8 m/s^2. Both values were accepted. In part (b)(i) some did not indicate clearly the region associated with Hooke's Law. The easiest way to do this was to mark a straight line on top of the first part of the student's results. To obtain both marks in part (c), candidates were expected to show that the line would be less steep and that the elastic limit would not be reached until the force was greater than in the case of the first wire.

Question 2

Part (a) was well answered. Most knew, in part (b), that the resistance would decrease and as a result the current would be increased in part (c), and so they got both marks. However, some obtained the second mark only. This was because they thought the resistance would increase but then correctly deduced that the current would decrease.

Question 3

In parts (a) and (b) candidates had to choose either X-rays or radio waves. A small minority ensured incorrect answers by choosing other parts of the electromagnetic spectrum. Parts (c), (d), (e) and (f) were generally well done.

Question 4

Parts (a) and (b) were generally well attempted but in (c) some found it difficult to give a two-mark answer by stating, for example, that 5% of the output is light.

Question 5

Most chose the correct place for the highest temperature. In part (b) the most common mistakes were either to confuse volume and area or to have the equation for density as volume over mass, even though the given unit should have signalled that this is incorrect. In part (c) some candidates thought that the lowest density would be at the lowest point. In part (d) a minority did not realise that conduction is the only way in which heat can be transferred through a solid floor without gaps.

Question 6

Many calculated that twenty minutes is two half-lives in this case and so arrived at an answer of ten minutes in part (a). However, those who did not still got an answer in minutes and so were able to reason correctly in part (b) that the half-life is far too short for the purpose. A generous mark scheme gave nearly all candidates two marks in part (c).

Question 7

Few candidates appeared to be familiar with the basic ideas of analogue and digital signals.

Question 8
Many who got two marks for 'moving in a magnetic field' and 'induction' failed to mention that the metal rod is a conductor.
Most got two marks in part (b) but some did not read the question carefully. They suggested changes to the apparatus (stronger magnets were popular) and lost one or both of the marks.

Question 9
Many candidates who were confident of the physics got full marks for this question but others muddled themselves in various ways. For example, a significant minority could not give the unit for acceleration either as m/s^2 or as N/kg. Others did not seem to understand the words 'unbalanced force', and instead of stating that at terminal velocity it is 'zero' or '0 newtons' wrote that 'upwards force = downwards force'.

Question 10
This was quite well answered but only a small majority knew that a volt is a joule per coulomb. A common mistake in part (b) was to fail to change hours to seconds.

Question 11
Most did well with the kinetic energy equation, but some then became muddled because they did not realise that the kinetic energy resulted from the difference in gravitational potential energy at position X and at position Y.

Question 12
Many candidates knew something of the theory but did not give any practical details. For example they did not mention using a ray box, or using pins so that they were apparently in line, or drawing the position of the block.
In part (a)(ii) some correctly stated that refractive index = sin i ÷ sin r but then chose incorrect values from the table and/or took 38° rather than 68° as the angle of incidence. The minority who used a calculator and gave their answers as, for example, 1.51 obtained full credit.
In part (b)(i), the minority who were confident enough to state that 'the critical angle is the angle of incidence at which.... ' generally obtained full credit. A common error in part (b)(ii) was to omit any reference to the sine of the critical angle.

Question 13
Most were able to explain in terms of particles why absolute zero is the lowest possible temperature. Many calculated the kelvin temperature equivalent to 22 °C but then failed to use it in part (c), stating that the investigators' conclusion was wrong because the temperature only reached 88 °C. In part (d) most obtained one mark by stating that the kelvin temperature would increase but few stated that it would double.

Question 14
Most candidates obtained a mark in part (a)(i) but not all of them could correctly describe a.c. The examiners would have been pleased to see some descriptions which included suitable sketch graphs. Parts (b)(i) and (b)(ii) were generally well answered.

Question 15
Most obtained one mark because they knew that pressure increases with depth but many failed to make the point that, for this reason, the dam needs to be strongest at its base. In part (b), only a minority appeared to have read the question and given a thoughtful response. Some were under the impression that a transfer to electrical energy takes place in the pipes near the top of the dam. In parts (c) and (d) the examiners were looking for, in each case, an appropriate statement for one mark followed by an appropriate explanation or example or suitable amplification. This second part was often absent with many candidates writing, for example, as an advantage in part (a) that 'it is renewable energy'. However, many candidates did correctly give the connection between high voltage and low current and hence low energy losses as an advantage for transmitting at high voltage.

Question 16
Many knew it was a left-hand rule and were able to state the different parts, for example, that the first finger gives the direction of the magnetic field. However only a minority were able to use the rule and apply it correctly to the coil. Most were able to suggest changes that would result in part (a)(iii) the coil turning faster and part (a)(iv) in the opposite direction.
In part (b) many candidates were able to use the correct equation, choose the correct values for force and distance from the diagram and arrive at the correct numerical answer and unit. Some were not clear that the answer to part (b)(ii) must be the same as part (b)(i). However in part (b)(iii) most were able to suggest at least one reason for the difference between 6 J and the answer to part (ii).

Question 17
Well prepared candidates gave confident answers and obtained all, or nearly all, the available marks. However throughout the question some candidates appeared to be making wild guesses, suggesting, for example, that the best response to an emergency would be to pull out the control rods.

Question 18
Many candidates obtained full marks for this question. Part (c) was particularly well done.

Paper 3

Question 1

In part (a), thirteen marking points were available for candidates to score a maximum of eight marks, of which two particular points were required for full marks. These were:

- heat the water
- repeat for other cups

This section was very well answered with many candidates scoring full marks. Few candidates made reference to the stirrer and possibly did not recognise it from the diagram.
Some candidates unnecessarily described timing the water to heat up in the kettle or the measurement of the volume of water in the kettle.

In part (b), loose statements such as 'volume of water', 'time' or 'temperature of water' could sometimes be traced back to clear statements in part (a) and so the marking points for part (b) could be credited where seen in part (a). Candidates should be encouraged to give full and clear responses at every stage.

The observations in part (c) were almost always accurately recorded.

In part (d) some candidates did not understand the idea of critical evaluation of data. Answers often merely listed four elements of the student's notes shown in the question. Occasionally a point was made twice such as:

- the temperature was shown to four significant figures
- the temperature cannot be measured that accurately.

Some candidates falsely criticised the data because they assumed that this represented the only reading taken throughout the experiment. Very few commented that the temperature of the water after about half a minute was unacceptably low.

Question 2

In parts (a), (b) and (c) most candidates were able to count eight spaces between the dots on a ticker-timer tape and multiply by 0.020 to get a total time of 0.16 seconds, recognising why it represented constant speed over a distance of 104 mm.

Determination of average speed in part (d)(i) was allowed a maximum of four marks in the mark scheme (not three as indicated in the paper), awarded as follows:

- substitution of candidate's values
- correct calculation
- answer to two significant figures
- appropriate units

Part (d)(ii) showed that most candidates have little understanding of significant figures (sf).

(a)(ii) 8 x 0.020 (pure number x 2 sf) gives time 0.16 to 2 sf

(d)(i) 104 / 0.16 (3 sf divided by 2 sf) gives a final value to 2 sf, eg 650 mm/s or 0.65 m /s

It was clear from responses in part (d)(ii) that many candidates did not know the difference between significant figures and decimal places and several answers used the term 'significant' in a different sense, claiming that the value for distance was more significant than that for time or vice versa.

In part (e) good marks were obtained for the measurements from the tape and the conclusion that it was accelerating or gaining speed. Occasionally candidates falsely described the motion as initially decelerating and then accelerating.

The graph work in part (f) was usually of a high standard although units were sometimes missed off the axes. Disappointingly, a few candidates did not recognise the graph as representing acceleration. This last section was reduced from 2 to 1 mark and the whole paper was marked out of 49.

Question 3

This question was answered extremely well. There were some inexplicable values showing the wrong use of a protractor; a minority of candidates need classroom help here.

The drawing of lines was competently carried out and angles recorded within accepted limits. A further mark in part (c) was available for narrowing down the value for the angle of deviation for green light. This was often scored.

Question 4

Some careful drawing in parts (a) and (b) scored three marks for many candidates. The most common error was to get the a.c. supply and voltmeter round the wrong way or to attach both to one side or the other.

Where candidates wrote a value of 12.4 V in part (c) it showed they were thinking along the right lines, this value being greater than 10 V and so off the scale of the voltmeter.

Answers to part (d) often lacked substance. Using 240 V a.c. on the input would provide an **unsafe** situation with a **high** voltage on the output, but this was rarely stated. The voltmeter would be damaged. Instead candidates said that the transformer would overheat and the voltmeter go off scale, as already stated in (c).

PHYSICS 4420 COURSEWORK, PRINCIPAL MODERATOR'S REPORT

The number of students entered for this component of the IGCSE examination was as follows:

Spec Code	Subject	Number entered
4420	Physics	1

All centres that entered students for this component of the examination had their science coursework moderated by Edexcel's Co-ordinating Principal Moderator. The moderating instrument used was the Sc1 criteria as used by Home centres, using exemplars provided by the JCQ (Joint Council for Qualifications) as a guide. Centres entering students for the coursework component of the IGCSE examinations in 2005 therefore had their coursework moderated to the same standards as for all Home centres.

Physics 4420

The only task seen this year was "Bounce of a squash ball". This is an appropriate task for the assessment of GCSE coursework. Please note, however, that observations of the bounce height made by eye cannot be **accurate**, and this is a key feature of the P8a and O8a mark descriptions.

PHYSICS 4420, GRADE BOUNDARIES

Grade	A*	A	B	C	D	E	F	G
Option 1				60	49	38	28	18
Option 2	NO ENTRIES							
Option 3	81	71	59	47	35	29		
Option 4	81	71	59	47	36	30		

Option 1: Papers 03 / 1F
Option 2: Papers 04 / 1F
Option 3: Papers 03 / 2H
Option 4: Papers 04 / 2H

Note: Grade boundaries may vary from year to year and from subject to subject, depending on the demands of the question paper.

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