Check your understanding

Physics 1

Infra red radiation

1 The hot pie is at a higher temperature than the refrigerator; the hot pie emits infra red radiation at a faster rate than it absorbs infra red radiation (or it emits infra red radiation to the surroundings) (*2 marks*)

2 **a)** A matt white; B shiny black; C matt black; D shiny silver (*4 marks*)
b) So the small differences in emitted infra red radiation can be measured (*1 mark*)

3 **a)** Y; the room is at a constant temperature (*2 marks*)
b) 22 °C (*2 marks*)

Kinetic theory

4 Particles in a gas are much further apart than particles in a liquid (*1 mark*)

5 Forces between particles in a solid are much stronger than the forces between particles in a liquid (*1 mark*)

6 Forces between particles do not hold them in a fixed pattern (*1 mark*)

7 High speed; direction cannot be predicted (*2 marks*)

Evaporation and condensation

8 Removes 'escaped' particles away from the surface; increasing the rate of evaporation (*2 marks*)

9 Water evaporates; removing energy from the skin (*2 marks*)

10 Boiling adds water vapour/molecules to the air; some vapour changes back to water when it hits the (cold) windows (*2 marks*)

Conduction and convection

11 At the top of the box; cold air is denser than warm air, so will fall through the box; keeping the contents cool (*3 marks*)

12 C; E (*2 marks*)

13 Copper contains mobile electrons; plastic does not (*1 mark*)

Changing the rate of energy transfer

14 The wool traps pockets of air; air is a good insulator (*2 marks*)

15 Traps (small pockets) of air in the fur; air is a good insulator (*2 marks*)

16 Vacuum; plastic stopper (*1 mark*)

17 Fins increase the surface area; so increasing energy loss by radiation and convection; painting black increases rate at which (infra red) radiation is emitted (*3 marks*)

Heating and insulating buildings

18 A black surface is a good absorber of infra red radiation; copper is a good conductor of thermal radiation; aluminium foil reflects infra red radiation back towards the water pipes; expanded foam contains small pockets of air, which is a good insulator so reducing the thermal energy loss (*6 marks*)

19 **a)** No; the reduction in energy loss and small savings in energy bills does not justify the additional cost (has a long payback time) (*1 mark*)
or Yes; any reduction in energy loss is worthwhile (despite the additional cost) (*1 mark*)
b) The figures would increase; rate of transfer of energy increases with temperature difference (*2 marks*)
c) 1 and 3; or 2 and 4 (*1 mark*)

20 640 000 J or 640 kJ (*2 marks*)

Energy transfers and efficiency

21 15 years (*2 marks*)

22 Transferred to the air; where it spreads out (*2 marks*)

23 **a)** 800 J (*2 marks*)
b) Switching off, the energy input is zero; energy is still wasted on standby (*1 mark*)

24 192 J (*2 marks*)

Electrical power and energy costs

25 48p (*3 marks*)

26 475 200 J or 0.132 kWh (*2 marks*)

27 35 286 (*3 marks*)

Generating electricity and the National Grid

28 Does not heat water (*1 mark*)

29 Nuclear, oil, natural gas, coal (*2 marks*)

30 Nuclear fuel is not burned (*1 mark*)

31 6 years 3 months (accept 7 years) (*2 marks*)

Renewable energy resources

32 Generates electricity at predictable times (*1 mark*)

33 Hydroelectric (*1 mark*)

34 Replant at the same rate as it is harvested (cut down) (*1 mark*)

35 4000 m^2 (*3 marks*)

Comparing energy resources

36 It is a concentrated energy source; it produces no pollutant gases (*2 marks*)

37 The location has no other electricity supply; solar energy is plentiful (*1 mark*)

38 Coal is a concentrated energy resource; wind is a dilute energy resource (*1 mark*)

39 To conserve fossil fuels; to reduce air pollution; to cope with increasing demand (*2 marks*)

Properties of waves

40 100 000 m (100 km) or 1×10^5 m (*2 marks*)

41 Any electromagnetic waves; e.g. light and radio (*2 marks*)

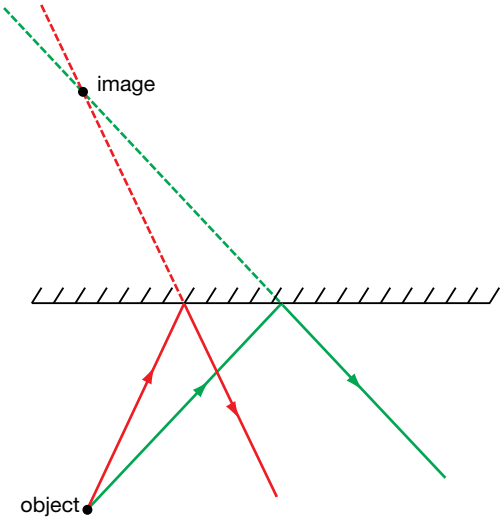
42 Transverse: the oscillation is perpendicular to the direction of energy transfer
Longitudinal: the oscillation is parallel to the direction of energy transfer (*2 marks*)

43 20 Hz (*2 marks*)

44 Sound needs a surface to reflect from (*1 mark*)

Reflection, refraction and diffraction

45



(*3 marks*)

46 Towards (*1 mark*)

47 Between 4×10^{-7} and 7×10^{-7} metres; gap width similar size to the wavelength of the light (*2 marks*)

48 Both light (transverse) and sound (longitudinal) can be diffracted (*1 mark*)

Electromagnetic waves and communications

49 **a)** Microwaves; **b)** microwaves; **c)** infra red (*3 marks*)

50 Infra red; microwaves; radio waves (*1 mark*)

51 Infra red have a lower frequency and a longer wavelength (*2 marks*)

52 Evidence relating mobile phone use to health is limited to the first 10 years of use; the long-term effect on health in unknown (*2 marks*)

53 **a)** So you know the maximum exposure; or, if tested under the same conditions, different phones can be compared (*2 marks*)

b) No; there is no proof that absorbing even small amounts of radiation energy is totally harmless (*1 mark*)

c) Z; the amount of radiation absorbed is the lowest so you can expect it to present the least hazard (*2 marks*)

Expanding universe and 'big bang'

54 Light from distant galaxies shows a red-shift; so these galaxies are moving away from the Earth; and the universe is expanding; as predicted by the 'big bang' theory (*3 marks*)

55 B (*1 mark*)

56 Cosmic microwave background radiation (accept CMBR) (*1 mark*)

Check your understanding

Physics 2

Forces and resultant forces

1 **a)** Constant height (*1 mark*)
b) Constant speed (or constant velocity) (*1 mark*)

2 Zero (*1 mark*)

3 24 000 N/m (*2 marks*)

4 Will go back to original length when force removed (*1 mark*)

Speed, velocity and acceleration

5 $\frac{(32 - 12)}{4}$ (*1 mark*); 5 m/s^2 (*1 mark*)

6 Correct axes (*1 mark*); positive, constant gradient line (*1 mark*)

7 **a)** $\frac{(12 - 0)}{6}$ (*1 mark*); 2 m/s^2 (*1 mark*)
b) $\frac{(12 - 0)}{4}$ (*1 mark*); 3 m/s^2 (accept −3 m/s^2) (*1 mark*)
c) Correct axes (*1 mark*); initial positive slope line from t = 0 s to t = 6 s (*1 mark*); horizontal line for t = 6 s to t = 21 s (*1 mark*); negative gradient reaching 0 at 25 s (*1 mark*)

8 **a)** $\frac{(15 - 5)}{20}$ (*1 mark*), 0.5 m/s^2 (*1 mark*);
b) force = 800 × 0.5 (*1 mark*), 400 N (*1 mark*)

More on speed, velocity and acceleration

9 **a)** Marking part of line with the greatest gradient (*1 mark*); $\frac{(900 - 600)}{(550 - 450)}$ (*1 mark*); 3 m/s (*1 mark*)
b) Marking part of line with the least gradient (*1 mark*); $\frac{(600 - 0)}{(300 - 0)}$ (*1 mark*); 2 m/s (*1 mark*)

10 **a)** $\frac{(35 - 0)}{(20 - 0)}$ (*1 mark*); 1.75 m/s^2 (*1 mark*)
b) Marking area of graph correctly (*1 mark*); $\frac{1}{2} \times 20 \times 35$ (*1 mark*); 350 m (*1 mark*)

11 **a)** $\frac{(5 - 0)}{(10 - 6)}$ (*1 mark*); 1.25 m/s^2 (*1 mark*)
b) Marking area of graph correctly (*1 mark*); 5 + 20 + 10 (*1 mark*); 35 m (*1 mark*)

Forces and braking

12 Thinking distance is affected only by the condition of the driver (*1 mark*)

13 Drinking alcohol; taking drugs; being tired; condition of brakes/tyres; road surface; weather conditions, e.g. rain/ice (*3 marks*)

14 Passengers may distract the driver; increasing the time it takes to react; effectively increasing the thinking distance (*2 marks*)

Forces and terminal velocity

15 Weight = 0.430 × 10 (*1 mark*); 4.3 N (*1 mark*)

16 a) Mass = $\frac{800}{10}$ (*1 mark*); 80 kg (*1 mark*)

b) Weight = 80 × 1.6 (*1 mark*); 128 N (*1 mark*)

17 a) Terminal velocity (*1 mark*)

b) 50 N (*1 mark*)

c) 0 N (*1 mark*)

18 a) Smaller frictional / drag / air resistance force on the golf ball (*1 mark*)

b) Accelerate faster / at 10 m/s^2; accelerate in the same way / together (*1 mark*)

Forces and energy

19 a) Force = $\frac{1000}{20}$ (*1 mark*); 50 N (*1 mark*)

b) Transferred mainly into heat (*1 mark*)

20 Mass = $\frac{(2 \times E_k)}{\text{speed}^2}$ (*1 mark*); 1500 kg (*1 mark*)

21 a) KE = $\frac{1}{2} \times 500 \times 85^2$ (*1 mark*); 1 806 250 J (*1 mark*)

b) KE = $\frac{1}{2} \times 0.04 \times 30^2$ (*1 mark*); 18 J (*1 mark*)

c) KE = $\frac{1}{2} \times 25 \times 6^2$ (*1 mark*); 450 J (*1 mark*)

22 6 J (*2 marks*)

Momentum

23 4800 kg m/s (*1 mark*); 75 kg (*1 mark*); 2.5 m/s (*1 mark*)

24 a) Momentum = 0.3 × 2 (*1 mark*), 0.6 kg m/s (*1 mark*)

b) Momentum is conserved (*1 mark*); total mass × combined speed = 0.6 kg m/s (*1 mark*); 1.5 m/s (in the direction of the moving trolley) (*1 mark*)

25 Increases the time of collision (*1 mark*); momentum changes more slowly (*1 mark*); smaller force exerted on driver (*1 mark*)

26 Deceleration = $\frac{30}{4}$ (*1 mark*); 7.5 m/s^2 (*1 mark*)

Force = 600 × 7.5 = 4500 N (*1 mark*)

Static electricity

27 Repel (1 mark); both have the same type of charge (*1 mark*)

28 **a)** Electrons move (*1 mark*); from the jumper to the balloon (*1 mark*)
b) Gains an equal (*1 mark*); positive charge (*1 mark*)

29 A flow of charge (*1 mark*)

30 $t = \frac{10\,500}{35}$ (*1 mark*); 300 s (5 min) (*1 mark*)

Electrical circuits

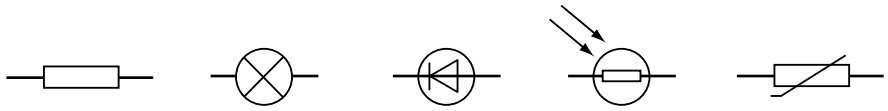
31 **a)** 6 Ω (*1 mark*)
b) 15 Ω (*1 mark*)
c) 13 Ω (*1 mark*)

32 3 A (*1 mark*); 230 V (*1 mark*); 460 Ω (*1 mark*)

33 Ammeter in series (*1 mark*); voltmeter in parallel with lamp (*1 mark*); correct circuit symbols throughout (*1 mark*)

Resistance, current and potential difference

34 **a)** **b)** **c)** **d)** **e)**



(5 *marks*)

35 Resistance changes with temperature (*1 mark*)

36 Increases (*1 mark*)

37 **a)** 0.002 × 600 (*1 mark*); 1.2 V(*1 mark*)
b) Decreases (*1 mark*)

Oscilloscope traces

38 a.c. regularly changes direction (*1 mark*); d.c. always flows in the same direction (*1 mark*)

39 Cell; battery (*1 mark*)

40 **a)** **(i)** B (*1 mark*); **(ii)** 4.5 V (*2 marks*)
b) Reading off time period as 4 squares (*1 mark*); frequency = $\frac{1}{(0.002 \times 4)}$ (*1 mark*); 125 Hz (*1 mark*)

Household electricity

41 Blue (*1 mark*)

42 Good (electrical) conductor (*1 mark*); hard material (*1 mark*)

43 Large current flows (*1 mark*); from live to earth (*1 mark*); the fuse melts. (*1 mark*)

44 Switches the circuit off faster; can be reset (*1 mark*)

Current, charge, energy and power

45 a) $\frac{1150}{230}$ (*1 mark*); 5 A (*1 mark*)
b) 13 A (*1 mark*)

46 a) $\frac{7200}{(5 \times 60)}$ (*1 mark*); 24 W (*1 mark*)
b) $\frac{24}{6}$ (*1 mark*); 4 A (*1 mark*)
c) $4 \times (5 \times 60)$ (*1 mark*); 1200 C (*1 mark*)

47 a) 90×2 (*1 mark*); 180 C (*1 mark*)
b) $(12 \times 90) \times 2$ (*1 mark*); 2160 J (*1 mark*)

48 a) $\frac{2300}{230}$ (*1 mark*); 10 A (*1 mark*)
b) $10 \times (2 \times 60 \times 60)$ (*1 mark*); 72 000 C (*1 mark*)

Atomic structure

49 a) X; Y (*1 mark*)
b) X; Z (*1 mark*)
c) Y (*1 mark*)

50 Loses or gains electrons (*1 mark*)

51 Neutron (*1 mark*)

52 New experimental evidence could not be explained using the plum pudding model (*1 mark*)

Atoms and radiation

53 Same number of protons (and electrons); have different numbers of neutrons (*2 marks*)

54 Less absorption of cosmic rays by atmosphere (*1 mark*); so dose from cosmic rays increases (*1 mark*)

55 Alpha (*1 mark*); mass number goes down by 4, atomic number goes down by 2 (*1 mark*)

56 a) 40 (*1 mark*)
b) 20 (*1 mark*)
c) ${}^{40}_{19}\text{K} \rightarrow {}^{40}_{20}\text{Ca} + {}^{0}_{-1}\text{e}$ (*1 mark*)

Uses of radioactivity

57 a) Strontium-90; level of beta radiation detected changes with thickness of polythene; gamma radiation would be unchanged, alpha would be stopped; long half-life so source does not need changing often/ radiation level will not fluctuate much (*2 marks*)
b) Cobalt-60; gamma rays pass through the body to the tumour; radiation can kill cells; long half-life so radiation level does not fluctuate much (*2 marks*)
c) Manganese-52; gamma rays pass through the ground to be detected; long enough half-life to take measurements; but not so long that oil becomes contaminated (*2 marks*)

58 4 half-lives (*1 mark*); 4 days (*1 mark*)

59 Count rate (*1 mark*)

60 Can ionise the atoms of living cells; causing damage to the cells or cancer (*2 marks*)

Fission and fusion

61 Absorb/capture a neutron (*1 mark*)

62 Slows it down (*1 mark*)

63 Output increases (*1 mark*)

64 Nuclei/atoms are closer together (*1 mark*)

Life cycle of a star

65 Compressed mass that will form a star (*1 mark*); when its temperature is high enough for fusion reactions to start. (*1 mark*)

66 In a supernova (*1 mark*)

67 Expands to a red giant; shrinks to a white dwarf; finally shrinking to a black dwarf. (*3 marks*)

68 The initial mass of the Sun was too small (*1 mark*)

Check your understanding

Physics 3

X-rays and CT scans

1 Shows up on an X-ray; absorbs X-rays (*1 mark*)

2 If exposed to light the film goes dark (*1 mark*)

3 X-rays are ionising radiations (*1 mark*); and can kill/damage cells (*1 mark*)

4 Exposure to X-rays kept to a minimum (*1 mark*)

5 Work behind shielding / wear protective clothing (*1 mark*)

Ultrasound

6 So that most of the ultrasound enters the body (*1 mark*)

7 $t = \frac{0.02}{4000}$ (*1 mark*); = 0.000 005 s (*1 mark*)

8 Advantage: does not damage human cells (*1 mark*); disadvantage: images less detailed (*1 mark*)

9 X-rays may harm the fetus; ultrasound will not (*1 mark*)

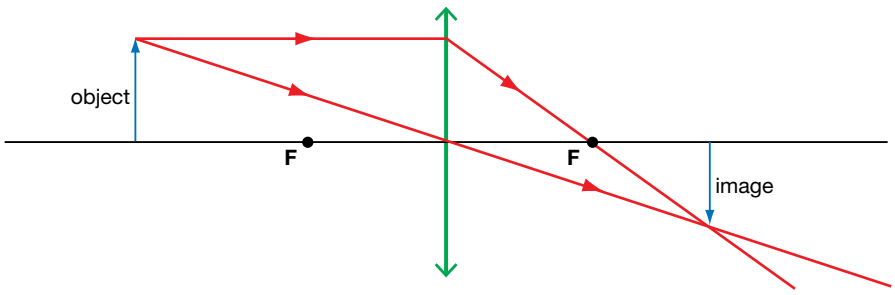
Lenses

10 Refractive index = $\frac{\sin 50°}{\sin 30°}$ (*1 mark*); = 1.53 (*1 mark*)

11 Converging lens thicker in middle than at edges (*1 mark*); diverging lens thinner in middle than at edges (*1 mark*)

12 Virtual; upright; magnified (*2 marks*)

13 Two correct rays drawn (*1 mark*); arrows in correct direction (*1 mark*); image in correct position (*1 mark*); nature of image; real, inverted, same size as object (*1 mark*)



14 Magnification = $\frac{4}{16}$ (*1 mark*) = 0.25 (*1 mark*)

Structure of the eye and camera

15 Cornea; lens (*1 mark*)

16 Pupil allows light to enter the eye (*1 mark*); iris controls size of pupil (*1 mark*)

17 Both converging (*1 mark*)

Correcting vision

18 Distance to the closest object an eye can focus on (*1 mark*)

19 Diverging (*1 mark*)

20 $P = \frac{1}{0.2}$ (*1 mark*); = −5 D (*1 mark*)

21 Converging (*1 mark*); $f = \frac{1}{0.4}$ (*1 mark*); = 2.5 m (*1 mark*)

22 The one with lowest refractive index (*1 mark*)

Other applications using light

23 Refractive index = $\frac{1}{\sin 24.4°}$ (*1 mark*); = 2.4 (*1 mark*)

24 Light must be travelling from dense to less dense medium (*1 mark*); angle of incidence must be greater than critical angle (*1 mark*)

25 Light is taken into the body down one bundle of optical fibres (*1 mark*); returns via a second bundle of optical fibres (*1 mark*)

26 Laser beam heats and seals blood vessels as it cuts, so stops bleeding (*1 mark*)

Centre of mass and stability

27 In the open at the centre of the tyre (*1 mark*)

28 Frequency = 2 Hz (*1 mark*); time period = 0.5 s (*1 mark*)

29 Large base area (*1 mark*); heavy base giving a low centre of mass (*1 mark*)

30 A — smallest base area (*1 mark*); highest centre of mass (*1 mark*)

Moments

31 Moment = 85 × 0.3 (*1 mark*); = 25.5 N m (*1 mark*)

32 Output force is greater than the input force (*1 mark*)

33 360 × 2 = 480 × *d* (*1 mark*); $d = \frac{720}{480}$ (*1 mark*); = 1.5 m (*1 mark*)

34 Make the base area larger (*1 mark*); lower the centre of mass by increasing the mass lower down (*1 mark*)

Hydraulics

35 $P = \frac{768}{(2 \times 0.192)}$ (*1 mark*); = 2000 Pa (*1 mark*)

36 Volume hardly changes no matter how much pressure is applied (*1 mark*)

37 Reduces the pressure on the ground (*1 mark*); tyres sink in less (*1 mark*)

38 Slave piston (*1 mark*)

Circular motion

39 Direction is continually changing (*1 mark*); so velocity is changing (*1 mark*)

40 A resultant force (*1 mark*)

41 **a)** A larger centripetal force acts on Tom (*1 mark*)
b) Centripetal force decreases in size (*1 mark*); no change in direction (*1 mark*)

42 Gravitational pull of the Earth; accept gravity (*1 mark*)

The motor effect

43 Both have an electromagnet that attracts an iron armature (*1 mark*)

44 The wire has been placed so that the current flows in the same direction as the magnetic field lines (*1 mark*); no force acts on the wire (*1 mark*)

45 Reverse polarity of the magnetic field (*1 mark*); reverse direction of the electric current (*1 mark*)

46 Amplitude increases (*1 mark*)

Transformers

47 No (*1 mark*); magnetic field lines not being cut by the wire (*1 mark*)

48 $\frac{230}{9} = \frac{N_p}{36}$ (*1 mark*); N_p = 920 (*1 mark*)

49 $230 \times I_p = 575$ (*1 mark*); I_p = 2.5 A (*1 mark*); efficiency is 100% (*1 mark*)

50 Smaller (*1 mark*)